ONE TIME SUCCESS

in

OAU PRE-DEGREE PROGRAMME EXAMINATION

CHEMISTRY

Complied by
SAMSON A. AKOMIRE

CONSISTS

- Solution to Mid-Contact Test, 2003 - Till date
- Solution to Contact Exam, 2003 - Till date
- Solution to Tutorial Questions, Set 1-11
- Useful hints to undeniable success

"A Pre-degree program without ONE TIME SUCCESS Book is as good as not coming for the programme."-Rasaq .A (score 311 in UTME, 306 in OAU POST-UTME and 84% overall score in the Pre-Degree programme 2010/11)

Attending DILIGENT TUTORS aided my overall performance in the Pre-Degree programme scoring 89% (Overall Best Student 2011/12). Diligent Tutors is not just a lesson but a training ground for all student whose guest is for higher performance in their academic pursuit. I RECOMMEND DILIGENT TUTORS TO ALL PRE-DEGREE STUDENTS! - ATIM

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(ii) 2005/2006 Pre-degree Session, we coached the overall best student

(iii) 2006/2007 Pre-degree Session, we coached the 2nd best student

(iv) 2009/2010 Pre-degree Session, we recorded 100% success etc

We are masters of one thing: **to bring out the genius in you**; and we are known for one thing: **to make you an excellent student**. We are capable in bringing out the genius in you, please give us a chance to help you realize your dream course in Obafemi Awolowo University, Ile-Ife Osun State. Thanks

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For more information; please call

Emmanuel A. Akomire on 07063474749

PRAISE FOR ONE TIME SUCCESS BOOKS

A pre-degree program without ONE TIME SUCCESS Books is as good as not coming for the programme. This is because it complements the programme and acts as the key to all possible q Chemistry Test Questions and Solutions.

uestions that can be set in the exams. This is the testimony of Rasaq Azeez who scored 311 in UTME, 306 in OAU POST-UTME and 78.6% in the Pre-Degree programme(1st contact,2010/2011) and 84% overall score in the Pre-Degree programme.

I just realized this morning that ONE TIME SUCCESS Books are very good. Thank you sir, we appreciate your help in our lives. - Opeyemi who scored 287 in UTME, 251 in OAU POST-UTME and 82% in the Pre-Degree programme,2009/2010.

Good work! Well done. I salute the authority of the author in writing. Just keep the flag flying. The sky is your starting point. - Ojo Gabriel .T, who scored 271 in UTME and 76.4% in the Pre-Degree programme (1st contact, 2010/2011 session) and 80% overall score in the Pre-Degree programme.

ONE TIME SUCCESS Books really helped me in most of my subjects in the Pre-Degree programme. - Okerek George A., who scored 274 in UTME and 79.5% in the Pre-Degree programme (1st contact, 2010/2011 session) and 83% overall score in the Pre-Degree programme.

ONE TIME SUCCESS Books are very good and fantastic! They have really helped me in the Pre-Degree programme. –Ogundele Oluwafemi Victor, who scored 287 in UTME, 301 in OAU POST-UTME and 79.5% in the Pre-Degree programme (1st contact,2010/2011) and 84% overall score in the Pre-Degree programme.

ONE TIME SUCCESS books are very good and they greatly helped me in the Pre-Degree programme . - Aleji Olusola .D, who scored 307 in UTME and 86% in the Pre-Degree programme (1st contact, 2010/2011 session) and 91% overall score in the Pre-Degree programme.

May the Almighty God bless the author of ONE TIME SUCCESS Books because the contents of the books, with intensive study, are enough to help one to achieve his or her goal. - Afolabi Aduralere .P, who scored 268 in UTME and 76.5% in the Pre-Degree programme (1st contact, 2010/2011 session) and 80% overall score in the Pre-Degree programme.

ONE TIME SUCCESS books are very good books and every student that wishes to acquire knowled should get a copy of each of the books. -Faleye Temitope, who scored 299 in UTME, 265 in OAU POS UTME and 70.6% in the Pre-Degree programme (1st contact,2010/2011).

ONE TIME SUCCESS Books stand out among other books. - Adeleke Victor, who scored 301 in UTM 292 in OAU POST-UTME and 88.3% in the Pre-Degree programme and overall best student (1 contact,2010/2011) and 88.3% overall score in the Pre-Degree programme.

THE PRE-DEGREE PROGRAMME: CHARTING A COURSE OF EXCELLENCE.

I feel incapable of fighting back the urge to motion a million congratulations to you on your admission into the prestigious O.A.U Pre-degree programme. You must count yourself fortunate to be part of the privileged few who successfully navigated into the programme. Without a vestige of doubt, much energy and resources have been invested into securing this admission. This only hints at your undaunted zest for excellence. Once again, a million congratulations.

Beloved Predites, may I alert you that your entry into the programme does not imply an automatic admission into Obafemi Awolowo University. Does that seem to scare you? I do not mean that one bit. My intention is to make you understand that for you to actually go the distance, the game must be played according to the rules. And the game has already begun! Your First Contact performance will have to be strategic, if you hope to land in your desired course. This is the more reason why you have to be properly guided as your academic workload cascades in steady streams. Actually, your First Contact syllabus is aimed at correcting some erroneous views you have imbibed at the O'level. For instance, you know that an aqueous Solution of $NaHCO_3$ is considered acidic due to the presence of the ionizable hydrogen atom and NH_4Cl is assumed to undergo sublimation. But that conclusion is, at its best, good at the O'Level. It doesn't hold in Pre-degree Chemistry. In actual fact, an aqueous Solution of $NaHCO_3$ is alkaline and NH_4Cl does not sublime. To face it, even the most brilliant minds would stumble on that. Hence, your help alarm must be activated.

As an alumnus of the Pre-degree programme (one of the best, 2003/2004 session) and an experienced tutor, I have concisely packaged these hidden details and concepts in a textbook format. This package houses accurate answers (with additional hints) to pass Pre-degree tests, exams and tutorial questions from 2003 to 2008. "One Time Success in O.A.U Pre-degree" is geared towards charting a course of excellence in Pre-degree Chemistry. Sure enough, a perusal will convince you. The writing style is simple, the facts are unambiguously presented, and the answers are double-correct. Do not undermine this "One-Time" privilege. A slap-happy attitude may cost you what you never bargained for.

Furthermore, my wealth of experience as a tutor informs me that for some students, a terrific textbook might be inadequate as their background in Chemistry is nothing to write home about. If you fall into this rank, you may be in need of a private tutelage. And I also have provision for such. I provide private teaching services for students who need special attention with respect to Chemistry, Physics, and Mathematics. Even though this comes at a price, there is provision for a full refund, if you feel dissatisfied after seven days of coaching.

Dearest Predites, you have unlimited potential to be what you were made to be. You were born original, do not die a copy. Remember, talent is not enough; your labour must complement it. Therefore make labour your habit. As you utilize all these opportunities to foster your ascent to the top, I wish you the very best.

Your friend,

Samson.A.Akomire (07063474749)

CONTENTS

PAGE

Diligent Tutors i

Praise for One Time Success books ii

To my dearest 'Predites' iii

FIRST CONTACT PRE-DEGREE SESSION TEST QUESTIONS AND SOLUTIONS

Chemistry Test Questions and Solutions, **2017/2018** 2-10

Chemistry Test Questions and Solutions, **2016/2017** 10-19

Chemistry Test Questions and Solutions, **2015/2016** 19-26

Chemistry Test Questions and Solutions, **2014/2015** 26-35

Chemistry Test Questions and Solutions, **2013/2014** 35-44

Chemistry Test Questions and Solutions, **2012/2013** 44-48

Chemistry Test Questions and Solutions, **2011/2012** 48-53

Chemistry Test Questions and Solutions, **2010/2011** 53-57

Chemistry Test Questions and Solutions, **2009/2010** 58-63

Chemistry Test Questions and Solutions, **2008/2009** 63-68

Chemistry Test Questions and Solutions, **2007/2008** 68-70

Chemistry Test Questions and Solutions, **2006/2007** 70-73

Chemistry Test Questions and Solutions, **2005/2006** 73-78

Chemistry Test Questions and Solutions, **2004/2005** 78-80

Chemistry Test Questions and Solutions, **2003/2004** 80-82

FIRST CONTACT PRE-DEGREE SESSION EXAMINATION QUESTIONS AND SOLUTIONS

Chemistry Examination Questions and Solutions, **2016/2017** 84-96

Chemistry Examination Questions and Solutions, **2015/2016** 96-108

Chemistry Examination Questions and Solutions, **2014/2015** 109-223

Chemistry Examination Questions and Solutions, **2013/2014** 223-136

Chemistry Examination Questions and Solutions, **2012/2013** 136-143

Chemistry Examination Questions and Solutions, **2011/2012** 143-150

Chemistry Examination Questions and Solutions, **2010/2011** 150-158

Chemistry Examination Questions and Solutions, **2009/2010** 158-164

Chemistry Examination Questions and Solutions, **2008/2009** 164-172

Chemistry Examination Questions and Solutions, **2007/2008**.....172-178
Chemistry Examination Questions and Solutions, **2006/2007**.....178-181
Chemistry Examination Questions and Solutions, **2005/2006**.....181-184
Chemistry Examination Questions and Solutions, **2004/2005**.....184-187
Chemistry Examination Questions and Solutions, **2003/2004**.....187-193

O.A.U.P.D.P CHEMISTRY 001 PAST QUESTION CLASSIFICATIONS ACCORDING TO TOPICS

TOPIC	CHEMISTRY 001 PRE-DEGREE PAST QUESTION
SEPARATION TECHNIQUES	♦ PDP/Q2/16-17 TEST ♦ PDP/Q15/16-17 TEST ♦ PDP/Q15/15-16 TEST ♦ PDP/Q9/14-15 TEST ♦ PDP/Q15/14-15 TEST ♦ PDP/Q10/13-14 TEST ♦ PDP/Q3/12-13 TEST ♦ PDP/Q23/12-13 TEST ♦ PDP/Q15/11-12 TEST ♦ PDP/Q20/11-12 TEST ♦ PDP/Q25/10-11 TEST ♦ PDP/Q8/09-10 TEST ♦ PDP/Q29/09-10 TEST ♦ PDP/Q31/09-10 TEST ♦ PDP/Q11/08-09 TEST ♦ PDP/Q12/08-09 TEST ♦ PDP/Q2a/07-08 TEST ♦ PDP/Q2a/06-07 TEST ♦ PDP/Q1a/05-06 TEST ♦ PDP/Q2a/04-05 TEST ♦ PDP/Q3g/04-05 TEST ♦ PDP/Q3a/03-04 TEST ♦ PDP/Q5/16-17 EXAM ♦ PDP/Q36/10-11 EXAM ♦ PDP/Q40/09-10 EXAM ♦ PDP/Q23/08-09 EXAM ♦ PDP/Q32/08-09 EXAM ♦ PDP/Q33/15-16 EXAM ♦ PDP/Q29/SECTION-A/03-04 EXAM ♦PDP/Q26/14-15 EXAM
PURE & IMPURE SUBSTANCES	♦ PDP/Q9/16-17 TEST ♦ PDP/Q18/15-16 TEST ♦ PDP/Q17/13-14 TEST ♦ PDP/Q21/12-13 TEST ♦ PDP/Q3/11-12 TEST ♦ PDP/Q29/08-09 TEST ♦PDP/Q35/14-15 EXAM
BOILING & MELTING POINTS	♦ PDP/Q21/12-13 TEST ♦ PDP/Q10/11-12 TEST ♦ PDP/Q1/10-11 TEST ♦ PDP/Q17/10-11 TEST ♦ PDP/Q12/09-10 EXAM
ELEMENTS, COMPOUNDS & MIXTURES	♦ PDP/Q13/16-17 TEST ♦ PDP/Q16/14-15 TEST ♦ PDP/Q7/12-13 TEST ♦ PDP/Q13/10-11 TEST ♦ PDP/Q6/09-10 TEST ♦ PDP/Q29/09-10 TEST ♦ PDP/Q29/08-09 TEST ♦ PDP/Q2aii/05-06 TEST ♦ PDP/Q2a/04-05 TEST ♦ PDP/Q2b/04-05 TEST ♦ PDP/Q24/11-12 EXAM ♦ PDP/Q10/SECTION-A/03-04 EXAM
CHEMICAL & PHYSICAL CHANGES	♦ PDP/Q7/09-10 TEST ♦ PDP/Q4/08-09 TEST ♦ PDP/Q3aiii/05-06 TEST ♦ PDP/Q20/16-17 EXAM ♦ PDP/Q7/13-14 EXAM ♦ PDP/Q10/10-11 EXAM
LAW OF CONSERVATION OF MATTER	♦ PDP/Q5/14-15 TEST
GAY LUSSAC'S LAW OF COMIBINIG VOLUMES	♦ PDP/Q17/15-16 TEST ♦ PDP/Q32/08-09 TEST
AVOGRADRO'S LAW	♦ PDP/Q2/12-13 TEST ♦ PDP/Q5/11-12 TEST ♦ PDP/Q2/09-10 TEST ♦ PDP/Q2c/07-08 TEST
DALTON'S LAW OF PARTIAL PRESSURE	♦ PDP/Q4/14-15 TEST ♦ PDP/Q25/13-14 TEST ♦ PDP/Q22/12-13 TEST ♦ PDP/Q14/10-11 TEST ♦ PDP/Q25/09-10 TEST ♦ PDP/Q39/09-10 TEST ♦ PDP/Q3bi/06-07 TEST ♦ PDP/Q7/16-17

	EXAM ♦ PDP/Q6/09-10 EXAM ♦ PDP/Q13/09-10 EXAM ♦ PDP/Q14/09-10 EXAM ♦ PDP/Q3/08-09 EXAM ♦ PDP/Q3/SECTION-A/07-08 EXAM
CHARLES' LAW	♦ PDP/Q5/09-10 TEST ♦ PDP/Q18/09-10 TEST ♦ PDP/Q4b/06-07 TEST ♦ PDP/Q3ai/05-06 TEST ♦ PDP/Q3bi/05-06 TEST ♦ PDP/Q3cii/05-06 TEST
GRAHAM'S LAW OF DIFFUSION	♦ PDP/Q14/13-14 TEST ♦ PDP/Q4/12-13 TEST ♦ PDP/Q9/11-12 TEST ♦ PDP/Q37/09-10 TEST ♦ PDP/Q2/08-09 TEST ♦ PDP/Q3di/07-08 TEST ♦ PDP/Q2di/06-07 TEST ♦ PDP/Q1cii/05-06 TEST ♦ PDP/Q1g/04-05 TEST ♦ PDP/Q2/16-17 EXAM ♦ PDP/Q4/15-16 EXAM ♦PDP/Q26/11-12 EXAM ♦ PDP/Q32/SECTION-A/03-04 EXAM ♦PDP/Q10/14-15 EXAM
IDEAL GAS LAW	♦ PDP/Q24/13-14 TEST ♦ PDP/Q17/12-13 TEST ♦ PDP/Q4/11-12 TEST ♦ PDP/Q38/09-10 TEST ♦ PDP/Q7/08-09 TEST ♦ PDP/Q3biii/05-06 TEST ♦ PDP/Q34/16-17 EXAM ♦ PDP/Q22/13-14 EXAM ♦ PDP/Q24/12-13 EXAM ♦ PDP/Q14/11-12 EXAM ♦ PDP/Q9/10-11 EXAM ♦ PDP/Q22/09-10 EXAM ♦ PDP/Q11/SECTION-A/07-08 EXAM
GENERAL GAS LAW	♦ PDP/Q12/14-15 TEST ♦ PDP/Q13/14-15 TEST ♦ PDP/Q3bii/06-07 TEST ♦ PDP/Q15/SECTION-A/07-08 EXAM
KINETIC THEORY OF GASES [POSTULATIONS]	♦ PDP/Q22/16-17 TEST ♦ PDP/Q11/15-16 TEST ♦ PDP/Q2/11-12 TEST ♦ PDP/Q33/09-10 TEST ♦ PDP/Q3/08-09 TEST ♦ PDP/Q24/08-09 TEST ♦ PDP/Q1b/07-08 TEST ♦ PDP/Q2dii/06-07 TEST ♦ PDP/Q4bi/06-07 TEST ♦ PDP/Q1ci/05-06 TEST ♦ PDP/Q3cii/05-06 TEST ♦ PDP/Q3e/04-05 TEST ♦ PDP/Q27/14-15 EXAM ♦ PDP/Q7/14-15 EXAM ♦ PDP/Q32/12-13 EXAM ♦ PDP/Q1/10-11 EXAM ♦ PDP/Q10/SECTION-A/07-08 EXAM ♦ PDP/Q2a/SECTION-B/07-08 EXAM ♦ PDP/Q3a/05-06 EXAM ♦ PDP/Q4a/05-06 EXAM ♦ PDP/Q3c/04-05 EXAM ♦ PDP/Q14/SECTION-A/03-04 EXAM ♦ PDP/Q27/SECTION-A/03-04 EXAM ♦ PDP/Q30/SECTION-A/03-04 EXAM ♦ PDP/Q31/SECTION-A/03-04 EXAM
STOICHIOMETRY	♦ PDP/Q4/16-17 TEST ♦ PDP/Q6/16-17 TEST ♦ PDP/Q7/16-17 TEST ♦ PDP/Q10/16-17 TEST ♦ PDP/Q17/16-17 TEST ♦ PDP/Q25/16-17 TEST ♦ PDP/Q22/15-16 TEST ♦ PDP/Q4/15-16 TEST ♦ PDP/Q5/15-16 TEST ♦ PDP/Q6/15-16 TEST ♦ PDP/Q14/15-16 TEST ♦ PDP/Q17/14-15 TEST ♦ PDP/Q19/14-15 TEST ♦ PDP/Q20/14-15 TEST ♦ PDP/Q22/14-15 TEST ♦ PDP/Q23/14-15 TEST ♦ PDP/Q2/13-14 TEST ♦ PDP/Q8/13-14 TEST ♦ PDP/Q12/13-14 TEST ♦ PDP/Q15/13-14 TEST ♦ PDP/Q2/12-13 TEST ♦ PDP/Q11/12-13 TEST ♦ PDP/Q19/12-13 TEST ♦ PDP/Q25/12-13 TEST ♦ PDP/Q11/11-12 TEST ♦ PDP/Q19/11-12 TEST ♦ PDP/Q21/11-12 TEST ♦ PDP/Q7/10-11 TEST ♦ PDP/Q8/10-11 TEST ♦ PDP/Q24/10-11 TEST ♦ PDP/Q1/09-10 TEST ♦ PDP/Q2/09-10 TEST ♦ PDP/Q3/09-10

	TEST ♦ PDP/Q24/09-10 TEST ♦ PDP/Q32/09-10 TEST ♦ PDP/Q34/09-10 TEST ♦ PDP/Q36/09-10 TEST ♦ PDP/Q40/09-10 TEST ♦ PDP/Q1/08-09 TEST ♦ PDP/Q15/08-09 TEST ♦ PDP/Q25/08-09 TEST ♦ PDP/Q26/08-09 TEST ♦ PDP/Q1a/07-08 TEST ♦ PDP/Q2c/07-08 TEST ♦ PDP/Q3b/07-08 TEST ♦ PDP/Q1ci/06-07 TEST ♦ PDP/Q1d/06-07 TEST ♦ PDP/Q3c/06-07 TEST ♦ PDP/Q4ai/06-07 TEST ♦ PDP/Q4d/06-07 TEST ♦ PDP/Q2c/05-06 TEST ♦ PDP/Q3ci/05-06 TEST ♦ PDP/Q2b/04-05 TEST ♦ PDP/Q2g/04-05 TEST ♦ PDP/Q3c/04-05 TEST ♦ PDP/Q2c/03-04 TEST ♦ PDP/Q3c/03-04 TEST ♦ PDP/Q3d/03-04 TEST ♦ PDP/Q16/16-17 EXAM ♦ PDP/Q19/16-17 EXAM ♦ PDP/Q22/16-17 EXAM ♦ PDP/Q23/16-17 EXAM ♦ PDP/Q32/16-17 EXAM ♦ PDP/Q38/16-17 EXAM ♦ PDP/Q30/14-15 EXAM ♦ PDP/Q31/14-15 EXAM ♦ PDP/Q16/15-16 EXAM ♦ PDP/Q39/15-16 EXAM ♦ PDP/Q3/14-15 EXAM ♦ PDP/Q3/14-15 EXAM ♦ PDP/Q11/13-14 EXAM ♦ PDP/Q20/13-14 EXAM ♦ PDP/Q23/13-14 EXAM ♦ PDP/Q40/13-14 EXAM ♦ PDP/Q2/12-13 EXAM ♦ PDP/Q19/15-16 EXAM ♦ PDP/Q27/12-13 EXAM ♦ PDP/Q29/12-13 EXAM ♦ PDP/Q36/12-13 EXAM ♦ PDP/Q1/11-12 EXAM ♦ PDP/Q2/11-12 EXAM ♦ PDP/Q3/11-12 EXAM ♦ PDP/Q28/11-12 EXAM ♦ PDP/Q29/11-12 EXAM ♦ PDP/Q12/10-11 EXAM ♦ PDP/Q15/10-11 EXAM ♦ PDP/Q23/10-11 EXAM ♦ PDP/Q33/10-11 EXAM ♦ PDP/Q37/10-11 EXAM ♦ PDP/Q39/10-11 EXAM ♦ PDP/Q7/09-10 EXAM ♦ PDP/Q9/09-10 EXAM ♦ PDP/Q29/09-10 EXAM ♦ PDP/Q35/09-10 EXAM ♦ PDP/Q37/09-10 EXAM ♦ PDP/Q1/08-09 EXAM ♦ PDP/Q13/08-09 EXAM ♦ PDP/Q16/08-09 EXAM ♦ PDP/Q21/08-09 EXAM ♦ PDP/Q38/08-09 EXAM ♦ PDP/Q1/SECTION-A/07-08 EXAM ♦ PDP/Q7/SECTION-A/07-08 EXAM ♦ PDP/Q12/SECTION-A/07-08 EXAM ♦ PDP/Q3a/SECTION-B/07-08 EXAM ♦ PDP/Q3b/SECTION-B/07-08 EXAM ♦ PDP/Q3c/SECTION-B/07-08 EXAM ♦ PDP/Q3d/SECTION-B/07-08 EXAM ♦ PDP/Q24/15-16 EXAM ♦ PDP/Q2b/06-07 EXAM ♦ PDP/Q3e/06-07 EXAM ♦ PDP/Q3f/06-07 EXAM ♦ PDP/Q1b/04-05 EXAM ♦ PDP/Q1e/04-05 EXAM ♦ PDP/Q2c/04-05 EXAM ♦ PDP/Q3e/04-05 EXAM ♦ PDP/Q3g/04-05 EXAM ♦ PDP/Q7/SECTION-A/03-04 EXAM ♦ PDP/Q8/SECTION-A/03-04 EXAM ♦ PDP/Q9/SECTION-A/03-04 EXAM ♦ PDP/Q17/SECTION-A/03-04 EXAM ♦ PDP/Q18/SECTION-A/03-04 EXAM ♦ PDP/Q34/SECTION-A/03-04 EXAM ♦ PDP/Q1b/SECTION-B/03-04 EXAM ♦ PDP/Q1c/SECTION-B/03-04 EXAM ♦ PDP/Q3/SECTION-B/03-04 EXAM♦PDP/Q5/14-15 EXAM ♦PDP/Q12/14-15 EXAM ♦PDP/Q16/14-15 EXAM ♦PDP/Q18/14-15 EXAM ♦PDP/Q31/14-15 EXAM
ATOMIC THEORY [SCIENTIFIC	♦ PDP/Q18/16-17 TEST ♦ PDP/Q21/15-16 TEST ♦ PDP/Q12/12-13 TEST ♦ PDP/Q13/12-13 TEST ♦ PDP/Q20/10-11 TEST ♦

CONTRIBUTIONS]	PDP/Q22/08-09 TEST ♦ PDP/Q1b/06-07 TEST ♦ PDP/Q1cii/06-07 TEST ♦ PDP/Q2ai/05-06 TEST, ♦ PDP/Q4a/05-06 TEST ♦ PDP/Q18/12-13 EXAM ♦ PDP/Q8/11-12 EXAM ♦ PDP/Q26/10-11 EXAM ♦ PDP/Q39/08-09 EXAM ♦ PDP/Q13/SECTION-A/07-08 EXAM ♦ PDP/Q1c/04-05 EXAM ♦ PDP/Q14/SECTION-A/03-04 EXAM
ATOMIC STRUCTURE [PROTONS, MASS NUMBER & ATOMIC NUMBER, ISOTOPES, ISOBARS, ISOTONES]	♦ PDP/Q14/16-17 TEST ♦ PDP/Q2/14-15 TEST ♦ PDP/Q14/14-15 TEST ♦ PDP/Q3/14-15 TEST ♦ PDP/Q1/13-14 TEST ♦ PDP/Q8/13-14 TEST ♦ PDP/Q9/12-13 TEST ♦ PDP/Q20/12-13 TEST ♦ PDP/Q21/11-12 TEST ♦ PDP/Q3/10-11 TEST ♦ PDP/Q18/10-11 TEST ♦ PDP/Q21/10-11 TEST ♦ PDP/Q3/09-10 TEST ♦ PDP/Q4/09-10 TEST ♦ PDP/Q30/09-10 TEST ♦ PDP/Q23/08-09 TEST ♦ PDP/Q4ciii/05-06 TEST ♦ PDP/Q4civ/05-06 TEST ♦ PDP/Q2b/03-04 TEST ♦ PDP/Q15/16-17 EXAM ♦ PDP/Q6/16-17 EXAM ♦ PDP/Q27/11-12 EXAM ♦ PDP/Q7/09-10 EXAM ♦ PDP/Q25/15-16 EXAM ♦ PDP/Q30/09-10 EXAM ♦ PDP/Q13/SECTION-A/07-08 EXAM ♦PDP/Q36/14-15 EXAM
ELECTRONIC CONFIGURATION	♦ PDP/Q3/16-17 TEST ♦ PDP/Q8/16-17 TEST ♦ PDP/Q11/16-17 TEST ♦ PDP/Q16/16-17 TEST ♦ PDP/Q23/16-17 TEST ♦ PDP/Q24/16-17 TEST ♦ PDP/Q13/15-16 TEST ♦ PDP/Q12/15-16 TEST ♦ PDP/Q21/14-15 TEST ♦ PDP/Q19/15-16 TEST PDP/Q25/14-15 TEST ♦ PDP/Q11/13-14 TEST ♦ PDP/Q9/12-13 TEST ♦ PDP/Q12/11-12 TEST ♦ PDP/Q17/11-12 TEST ♦ PDP/Q23/11-12 TEST ♦ PDP/Q9/10-11 TEST ♦ PDP/Q15/10-11 TEST ♦ PDP/Q9/09-10 TEST ♦ PDP/Q10/09-10 TEST ♦ PDP/Q11/09-10 TEST ♦ PDP/Q14/09-10 TEST ♦ PDP/Q20/09-10 TEST ♦ PDP/Q18/08-09 TEST ♦ PDP/Q1c/07-08 TEST ♦ PDP/Q3c/07-08 TEST ♦ PDP/Q4c/06-07 TEST ♦ PDP/Q1bi/05-06 TEST ♦ PDP/Q1bii/05-06 TEST ♦ PDP/Q1cii/05-06 TEST ♦ PDP/Q3ciii/05-06 TEST ♦ PDP/Q4bi/05-06 TEST ♦ PDP/Q4bii/05-06 TEST ♦ PDP/Q4civ/05-06 TEST ♦ PDP/Q2c/04-05 TEST ♦ PDP/Q3d/04-05 TEST ♦ PDP/Q2b/03-04 TEST ♦ PDP/Q4/16-17 EXAM ♦ PDP/Q26/16-17 EXAM ♦ PDP/Q2/13-14 EXAM ♦ PDP/Q14/13-14 EXAM ♦ PDP/Q17/13-14 EXAM ♦ PDP/Q26/13-14 EXAM ♦ PDP/Q31/15-16 EXAM ♦ PDP/Q16/12-13 EXAM ♦ PDP/Q39/12-13 EXAM ♦ PDP/Q32/15-16 EXAM ♦ PDP/Q39/11-12 EXAM ♦ PDP/Q8/10-11 EXAM ♦ PDP/Q3/09-10 EXAM ♦ PDP/Q15/09-10 EXAM ♦ PDP/Q21/09-10 EXAM ♦ PDP/Q33/08-09 EXAM ♦ PDP/Q39/08-09 EXAM ♦ PDP/Q5/SECTION-A/07-08 EXAM ♦ PDP/Q6/SECTION-A/07-08 EXAM ♦ PDP/Q1a/SECTION-B/07-08 EXAM ♦ PDP/Q1b/SECTION-B/07-08 EXAM ♦ PDP/Q1d/06-07 EXAM ♦ PDP/Q1a/04-05 EXAM ♦ PDP/Q11/SECTION-A/03-04 EXAM ♦ PDP/Q2a/SECTION-B/03-04 EXAM ♦ PDP/Q2b/SECTION-B/03-04 EXAM
PERIODIC TABLE AND	♦ PDP/Q5/16-17 TEST ♦ PDP/Q8/15-16 TEST ♦ PDP/Q1/15-16

PERIODICITY	TEST ♦ PDP/Q6/14-15 TEST ♦ PDP/Q6/13-14 TEST ♦ PDP/Q22/13-14 TEST ♦ PDP/Q18/12-13 TEST ♦ PDP/Q8/11-12 TEST ♦ PDP/Q12/10-11 TEST ♦ PDP/Q23/10-11 TEST ♦ PDP/Q35/09-10 TEST ♦ PDP/Q13/08-09 TEST ♦ PDP/Q3a/06-07 TEST ♦ PDP/Q1biii/05-06 TEST ♦ PDP/Q2aiv/05-06 TEST ♦ PDP/Q2a/03-04 TEST ♦ PDP/Q30/16-17 EXAM ♦ PDP/Q4/14-15 EXAM ♦ PDP/Q19/11-12 EXAM ♦ PDP/Q39/11-12 EXAM ♦ PDP/Q5/10-11 EXAM ♦ PDP/Q13/10-11 EXAM ♦ PDP/Q4/SECTION-A/07-08 EXAM ♦ PDP/Q3a/04-05 EXAM ♦ PDP/Q1/SECTION-A/03-04 EXAM
POLARITY OF MOLECULES	♦ PDP/Q2/15-16 TEST
SHAPES OF MOLECULES AND HYBRIDIZATION	♦ PDP/Q24/15-16 TEST ♦ PDP/Q7/14-15 TEST ♦ PDP/Q4/13-14 TEST ♦ PDP/Q7/13-14 TEST ♦ PDP/Q18/13-14 TEST ♦ PDP/Q16/11-12 TEST ♦ PDP/Q25/11-12 TEST ♦ PDP/Q4/10-11 TEST ♦ PDP/Q11/10-11 TEST ♦ PDP/Q15/09-10 TEST ♦ PDP/Q21/09-10 TEST ♦ PDP/Q23/09-10 TEST ♦ PDP/Q10/08-09 TEST ♦ PDP/Q14/08-09 TEST ♦ PDP/Q3a/07-08 TEST ♦ PDP/Q2e/06-07 TEST ♦ PDP/Q2bi/05-06 TEST ♦ PDP/Q1a/04-05 TEST ♦ PDP/Q1b/04-05 TEST ♦ PDP/Q1b/03-04 TEST♦ PDP/Q1/14-15 EXAM ♦ PDP/Q32/13-14 EXAM ♦ PDP/Q9/11-12 EXAM ♦ PDP/Q36/11-12 EXAM ♦ PDP/Q24/10-11 EXAM ♦ PDP/Q27/10-11 EXAM ♦ PDP/Q2/09-10 EXAM ♦ PDP/Q19/09-10 EXAM ♦ PDP/Q41/08-09 EXAM ♦ PDP/Q43/08-09 EXAM ♦ PDP/Q18/SECTION-A/07-08 EXAM ♦ PDP/Q3c/06-07 EXAM ♦ PDP/Q2d/04-05 EXAM ♦ PDP/Q4/SECTION-A/03-04 EXAM ♦ PDP/Q13/SECTION-A/03-04 EXAM
COVALENT BONDING	♦ PDP/Q1/16-17 TEST ♦ PDP/Q11/14-15 TEST ♦ PDP/Q8/12-13 TEST ♦ PDP/Q10/12-13 TEST ♦ PDP/Q2/11-12 TEST ♦ PDP/Q17/09-10 TEST ♦ PDP/Q1biv/05-06 TEST ♦ PDP/Q1ciii/05-06 TEST ♦ PDP/Q3aiii/05-06 TEST ♦ PDP/Q3bii/05-06 TEST ♦ PDP/Q1aiv/03-04 TEST ♦ PDP/Q1ci/03-04 TEST ♦ PDP/Q1cii/03-04 TEST ♦ PDP/Q1civ/03-04 TEST ♦ PDP/Q10/11-12 EXAM ♦ PDP/Q23/15-16 EXAM ♦ PDP/Q40/10-11 EXAM ♦ PDP/Q36/09-10 EXAM ♦ PDP/Q1aii/05-06 EXAM
CO-ORDINATE OR DATIVE BONDING	♦ PDP/Q1biv/05-06 TEST ♦ PDP/Q1ai7/03-04 TEST ♦ PDP/Q1cii/03-04 TEST ♦ PDP/Q10/11-12 EXAM ♦ PDP/Q40/10-11 EXAM ♦ PDP/Q5/09-10 EXAM ♦PDP/Q37/14-15 EXAM
IONIC BONDING	♦ PDP/Q20/16-17 TEST ♦ PDP/Q23/15-16 TEST ♦ PDP/Q7/15-16 TEST ♦ PDP/Q1/14-15 TEST ♦ PDP/Q10/14-15 TEST ♦ PDP/Q5/13-14 TEST ♦ PDP/Q10/12-13 TEST ♦ PDP/Q2/11-12 TEST ♦ PDP/Q17/09-10 TEST ♦ PDP/Q22/09-10 TEST ♦ PDP/Q1biv/05-06 TEST ♦ PDP/Q1ciii/05-06 TEST ♦ PDP/Q3aiii/05-06 TEST ♦ PDP/Q3bii/05-06 TEST ♦ PDP/Q3biii/05-06 TEST ♦ PDP/Q1aiii/03-04 TEST ♦ PDP/Q1aiv/03-04 TEST ♦ PDP/Q1ci/03-04 TEST ♦ PDP/Q1cii/03-

	04 TEST ♦ PDP/Q13/15-16 EXAM ♦ PDP/Q40/10-11 EXAM ♦ PDP/Q36/09-10 EXAM ♦ PDP/Q1ai/05-06 EXAM
HYDROGEN BONDING	♦ PDP/Q1/11-12 TEST ♦ PDP/Q5/10-11 TEST ♦ PDP/Q16/10-11 TEST ♦ PDP/Q1ai/06-07 TEST ♦ PDP/Q1aii/06-07 TEST ♦ PDP/Q1/16-17 EXAM ♦ PDP/Q24/13-14 EXAM♦ PDP/Q23/15-16 EXAM ♦ PDP/Q19/12-13 EXAM ♦ PDP/Q26/12-13 EXAM ♦ PDP/Q21/11-12 EXAM ♦ PDP/Q20/08-09 EXAM ♦ PDP/Q5/SECTION-A/03-04 EXAM
VAN DER WAAL'S FORCES	♦ PDP/Q1/11-12 TEST ♦ PDP/Q14/11-12 TEST ♦ PDP/Q1aii/03-04 TEST ♦ PDP/Q29/13-14 EXAM ♦ PDP/Q26/12-13 EXAM ♦ PDP/Q20/08-09 EXAM ♦ PDP/Q1aiv/05-06 EXAM
METALLIC BONDING	♦ PDP/Q1/11-12 TEST ♦ PDP/Q2/11-12 TEST ♦ PDP/Q1ciii/03-04 TEST
RADIOACTIVITY [NUCLEAR CHEMISTRY]	♦ PDP/Q12/16-17 TEST ♦ PDP/Q19/16-17 TEST ♦ PDP/Q18/14-15 TEST ♦ PDP/Q19/14-15 TEST ♦ PDP/Q13/11-12 TEST ♦ PDP/Q10/10-11 TEST ♦ PDP/Q22/10-11 TEST ♦ PDP/Q12/09-10 TEST ♦ PDP/Q26/09-10 TEST ♦ PDP/Q27/09-10 TEST ♦ PDP/Q16/08-09 TEST ♦ PDP/Q17/08-09 TEST ♦ PDP/Q2d/07-08 TEST ♦ PDP/Q3aii/05-06 TEST ♦ PDP/Q1/16-17 EXAM ♦ PDP/Q11/16-17 EXAM ♦ PDP/Q33/09-10 EXAM ♦ PDP/Q12/08-09 EXAM ♦ PDP/Q14/08-09 EXAM ♦ PDP/Q4b/06-07 EXAM ♦ PDP/Q6/SECTION-A/03-04 EXAM ♦ PDP/Q12/SECTION-A/03-04 EXAM ♦PDP/Q38/14-15 EXAM
NUCLEAR REACTION & CALCULATIONS	♦ PDP/Q9/15-16 TEST ♦ PDP/Q3/15-16 TEST ♦ PDP/Q9/13-14 TEST ♦ PDP/Q23/13-14 TEST ♦ PDP/Q1/12-13 TEST ♦ PDP/Q5/12-13 TEST ♦ PDP/Q16/12-13 TEST ♦ PDP/Q10/10-11 TEST ♦ PDP/Q1F3/09-10 TEST ♦ PDP/Q5/08-09 TEST ♦ PDP/Q2b/06-07 TEST ♦ PDP/Q2bii/05-06 TEST ♦ PDP/Q2biii/05-06 TEST ♦ PDP/Q2d/04-05 TEST ♦ PDP/Q2e/04-05 TEST ♦ PDP/Q15/13-14 EXAM ♦ PDP/Q40/12-13 EXAM ♦ PDP/Q37/11-12 EXAM ♦ PDP/Q2/10-11 EXAM ♦ PDP/Q22/10-11 EXAM ♦ PDP/Q26/09-10 EXAM ♦ PDP/Q22/SECTION-A/03-04 EXAM ♦PDP/Q13/14-15 EXAM
AIR	♦ PDP/Q20/10-11 TEST ♦ PDP/Q37/12-13 EXAM
WATER	♦ PDP/Q33/12-13 EXAM ♦ PDP/Q31/11-12 EXAM ♦ PDP/Q20/09-10 EXAM
SOLUBILITY & SOLUBILITY PRODUCT	♦ PDP/Q21/16-17 TEST ♦ PDP/Q14/12-13 TEST ♦ PDP/Q24/12-13 TEST ♦ PDP/Q19/10-11 TEST ♦ PDP/Q19/09-10 TEST ♦ PDP/Q28/09-10 TEST ♦ PDP/Q20/08-09 TEST ♦ PDP/Q4aii/06-07 TEST ♦ PDP/Q14/16-17 EXAM ♦ PDP/Q8/14-15 EXAM ♦ PDP/Q3/13-14 EXAM ♦ PDP/Q9/13-14 EXAM ♦ PDP/Q12/13-14 EXAM ♦ PDP/Q13/13-14 EXAM ♦ PDP/Q16/13-14 EXAM ♦ PDP/Q9/12-13 EXAM ♦ PDP/Q11/12-13 EXAM ♦ PDP/Q17/12-13 EXAM ♦ PDP/Q4/11-12 EXAM ♦ PDP/Q5/11-12 EXAM ♦ PDP/Q25/11-12 EXAM ♦ PDP/Q35/15-16 EXAM ♦ PDP/Q34/11-12

	EXAM ♦ PDP/Q35/11-12 EXAM ♦ PDP/Q25/10-11 EXAM ♦ PDP/Q1/09-10 EXAM ♦ PDP/Q40/15-16 EXAM ♦ PDP/Q10/09-10 EXAM ♦ PDP/Q28/15-16 EXAM ♦ PDP/Q23/09-10 EXAM ♦ PDP/Q25/09-10 EXAM ♦ PDP/Q26/08-09 EXAM ♦ PDP/Q36/08-09 EXAM ♦ PDP/Q2/SECTION-A/07-08 EXAM ♦ PDP/Q1c/06-07 EXAM ♦ PDP/Q3b/06-07 EXAM ♦ PDP/Q2ci/05-06 EXAM ♦ PDP/Q4bi/05-06 EXAM ♦ PDP/Q2a/04-05 EXAM ♦ PDP/Q20/SECTION-A/03-04 EXAM ♦ PDP/Q25/SECTION-A/03-04 EXAM ♦PDP/Q30/14-15 EXAM ♦PDP/Q34/14-15 EXAM
ACIDS, BASES & SALTS [CHARACTERISTICS OF ACIDS, BASES & SALTS]	♦ PDP/Q16/13-14 TEST ♦ PDP/Q24/11-12 TEST ♦ PDP/Q28/08-09 TEST ♦ PDP/Q1biv/05-06 TEST ♦ PDP/Q3b/04-05 TEST ♦ PDP/Q36/16-17 EXAM ♦ PDP/Q8/16-17 EXAM ♦ PDP/Q28/16-17 EXAM ♦ PDP/Q6/15-16 EXAM ♦PDP/Q8/15-16 EXAM ♦ PDP/Q14/15-16 EXAM ♦EXAM PDP/Q2/14-15 EXAM ♦ PDP/Q33/13-14 EXAM ♦ PDP/Q1/12-13 EXAM ♦ PDP/Q38/12-13 EXAM ♦ PDP/Q31/11-12 EXAM ♦ PDP/Q38/11-12 EXAM ♦ PDP/Q28/10-11 EXAM ♦ PDP/Q30/10-11 EXAM ♦ PDP/Q18/08-09 EXAM ♦ PDP/Q34/08-09 EXAM ♦ PDP/Q16/SECTION-A/03-04 EXAM ♦ PDP/Q26/SECTION-A/03-04 EXAM
BASICITY OF ACIDS	♦ PDP/Q28/13-14 EXAM ♦ PDP/Q29/10-11 EXAM
TYPES OF SALT	♦ PDP/Q1c/04-05 TEST ♦ PDP/Q10/15-16 EXAM ♦PDP/Q28/12-13 EXAM ♦ PDP/Q38/10-11 EXAM ♦ PDP/Q28/08-09 EXAM ♦ PDP/Q35/08-09 EXAM ♦ PDP/Q10/SECTION-A/03-04 EXAM
p^H & p^{OH} SCALE	♦ PDP/Q20/15-16 TEST ♦ PDP/Q13/13-14 TEST ♦ PDP/Q20/13-14 TEST ♦ PDP/Q1f/04-05 TEST ♦ PDP/Q27/13-14 EXAM ♦ PDP/Q36/13-14 EXAM ♦ PDP/Q20/12-13 EXAM ♦ PDP/Q23/12-13 EXAM ♦ PDP/Q11/11-12 EXAM ♦ PDP/Q7/10-11 EXAM ♦ PDP/Q16/10-11 EXAM ♦ PDP/Q4/09-10 EXAM ♦ PDP/Q24/09-10 EXAM ♦ PDP/Q28/09-10 EXAM ♦ PDP/Q29/15-16 EXAM ♦ PDP/Q31/09-10 EXAM ♦ PDP/Q36/15-16 EXAM ♦ PDP/Q7/08-09 EXAM ♦ PDP/Q17/SECTION-A/07-08 EXAM ♦ PDP/Q2d/SECTION-B/07-08 EXAM ♦ PDP/Q2e/06-07 EXAM ♦ PDP/Q24/SECTION-A/03-04 EXAM ♦PDP/Q9/14-15 EXAM ♦PDP/Q39/14-15 EXAM ♦PDP/Q20/14-15 EXAM
ACID & BASE TITRATIONS	♦ PDP/Q7/11-12 TEST ♦ PDP/Q2g/04-05 TEST ♦ PDP/Q6/13-14 EXAM ♦ PDP/Q15/15-16 EXAM ♦ PDP/Q20/13-14 EXAM ♦ PDP/Q36/12-13 EXAM ♦ PDP/Q1/11-12 EXAM ♦ PDP/Q17/11-12 EXAM ♦ PDP/Q39/10-11 EXAM ♦ PDP/Q15/08-09 EXAM ♦ PDP/Q21/08-09 EXAM ♦ PDP/Q1/SECTION-A/07-08 EXAM ♦ PDP/Q3f/06-07 EXAM ♦ PDP/Q3g/04-05 EXAM ♦ PDP/Q3b/SECTION-B/03-04 EXAM ♦ PDP/Q3c/SECTION-B/03-04 EXAM
HYDROLYSIS OF SALT	♦ PDP/Q28/13-14 EXAM ♦ PDP/Q42/08-09 EXAM ♦ PDP/Q2cii/05-06 EXAM
OXIDATION & REDUCTION	♦ PDP/Q18/11-12 TEST ♦ PDP/Q16/09-10 TEST ♦ PDP/Q1aii/06-

	07 TEST ♦ PDP/Q8/13-14 EXAM ♦ PDP/Q17/15-16 EXAM ♦ PDP/Q34/12-13 EXAM ♦ PDP/Q6/11-12 EXAM ♦ PDP/Q35/10-11 EXAM ♦ PDP/Q9/SECTION-A/07-08 EXAM ♦ PDP/Q4a/06-07 EXAM ♦ PDP/Q1d/04-05 EXAM ♦ PDP/Q2g/04-05 EXAM ♦ PDP/Q3/SECTION-A/03-04 EXAM
REDOX REACTION	♦ PDP/Q3a/04-05 TEST ♦ PDP/Q31/16-17 EXAM ♦ PDP/Q37/16-17 EXAM ♦ PDP/Q25/12-13 EXAM ♦ PDP/Q15/11-12 EXAM ♦ PDP/Q14/10-11 EXAM ♦ PDP/Q18/15-16 EXAM ♦ PDP/Q17/10-11 EXAM ♦ PDP/Q11/09-10 EXAM ♦ PDP/Q18/09-10 EXAM ♦ PDP/Q17/08-09 EXAM ♦ PDP/Q25/08-09 EXAM ♦ PDP/Q1d/SECTION-B/07-08 EXAM ♦ PDP/Q3d/06-07 EXAM ♦ PDP/Q4c/06-07 EXAM ♦ PDP/Q2bii/05-06 EXAM ♦ PDP/Q2b/04-05 EXAM ♦ PDP/Q3f/04-05 EXAM ♦ PDP/Q23/SECTION-A/03-04 EXAM ♦PDP/Q14/14-15 EXAM ♦PDP/Q33/14-15 EXAM
TEST FOR OXIDISING & REDUCING AGENTS	♦ PDP/Q13/16-17 EXAM ♦ PDP/Q21/16-17 EXAM ♦ PDP/Q13/11-12 EXAM ♦ PDP/Q30/15-16 EXAM ♦ PDP/Q20/15-16 EXAM ♦
IUPAC NOMENCULATURE OF INORGANIC COMPOUNDS	♦ PDP/Q2c/06-07 TEST ♦ PDP/Q1d/04-05 TEST ♦ PDP/Q1e/04-05 TEST ♦ PDP/Q3b/03-04 TEST ♦ PDP/Q3b/04-05 EXAM
ORGANIC COMPOUNDS & ITS IUPAC NOMENCULATURE	♦ PDP/Q4/08-09 TEST ♦ PDP/Q6/08-09 TEST ♦ PDP/Q9/08-09 TEST ♦ PDP/Q19/08-09 TEST ♦ PDP/Q27/08-09 TEST ♦ PDP/Q30/08-09 TEST ♦ PDP/Q31/08-09 TEST ♦ PDP/Q4ci/05-06 TEST ♦ PDP/Q4cii/05-06 TEST ♦ PDP/Q2/08-09 EXAM ♦ PDP/Q5/08-09 EXAM ♦ PDP/Q8/08-09 EXAM ♦ PDP/Q9/08-09 EXAM ♦ PDP/Q11/08-09 EXAM ♦ PDP/Q16/08-09 EXAM ♦ PDP/Q22/08-09 EXAM ♦ PDP/Q27/08-09 EXAM ♦ PDP/Q29/08-09 EXAM ♦ PDP/Q37/08-09 EXAM ♦ PDP/Q45/08-09 EXAM
ELECTROLYSIS	♦ PDP/Q6/10-11 TEST ♦ PDP/Q35/16-17 EXAM ♦ PDP/Q39/16-17 EXAM ♦ PDP/Q40/16-17 EXAM ♦ PDP/Q7/15-16 EXAM ♦ PDP/Q5/15-16 EXAM ♦ PDP/Q21/15-16 EXAM ♦ PDP/Q3/15-16 EXAM ♦ PDP/Q4/13-14 EXAM ♦ PDP/Q22/15-16 EXAM ♦ PDP/Q18/13-14 EXAM ♦ PDP/Q25/13-14 EXAM ♦ PDP/Q37/13-14 EXAM ♦ PDP/Q38/13-14 EXAM ♦ PDP/Q39/13-14 EXAM ♦ PDP/Q3/12-13 EXAM ♦ PDP/Q4/12-13 EXAM ♦ PDP/Q5/12-13 EXAM ♦ PDP/Q15/12-13 EXAM ♦ PDP/Q21/12-13 EXAM ♦ PDP/Q22/12-13 EXAM ♦ PDP/Q30/12-13 EXAM ♦ PDP/Q12/11-12 EXAM ♦ PDP/Q18/11-12 EXAM ♦ PDP/Q32/11-12 EXAM ♦ PDP/Q40/11-12 EXAM ♦ PDP/Q3/10-11 EXAM ♦ PDP/Q38/15-16 EXAM ♦ PDP/Q4/10-11 EXAM ♦ PDP/Q18/10-11 EXAM ♦ PDP/Q32/10-11 EXAM ♦ PDP/Q34/10-11 EXAM ♦ PDP/Q17/09-10 EXAM ♦ PDP/Q32/09-10 EXAM ♦ PDP/Q34/09-10 EXAM ♦ PDP/Q39/09-10 EXAM ♦ PDP/Q6/08-09 EXAM ♦ PDP/Q10/08-09 EXAM ♦ PDP/Q30/08-09 EXAM ♦ PDP/Q31/08-09 EXAM ♦ PDP/Q40/08-09 EXAM ♦ PDP/Q14/SECTION-A/07-08 EXAM ♦ PDP/Q19/SECTION-A/07-08 EXAM ♦ PDP/Q21/SECTION-A/07-08 EXAM ♦ PDP/Q1c/SECTION-B/07-08 EXAM ♦ PDP/Q1a/06-07

	EXAM ♦ PDP/Q2d/06-07 EXAM ♦ PDP/Q3a/06-07 EXAM ♦ PDP/Q4e/06-07 EXAM ♦ PDP/Q1c/05-06 EXAM ♦ PDP/Q2b/05-06 EXAM ♦ PDP/Q1f/04-05 EXAM ♦ PDP/Q1g/04-05 EXAM ♦ PDP/Q21/SECTION-A/03-04 EXAM ♦ PDP/Q2c/SECTION-B/03-04 EXAM ♦ PDP/Q2d/SECTION-B/03-04 EXAM ♦PDP/Q19/14-15 EXAM ♦PDP/Q24/14-15 EXAM ♦PDP/Q25/14-15 EXAM ♦PDP/Q28/14-15 EXAM PDP/Q40/14-15 EXAM ♦PDP/Q32/14-15 EXAM
ENERGY CHANGES [ENTHALPY & ENTROPY]	♦ PDP/Q25/15-16 TEST ♦ PDP/Q16/15-16 TEST ♦ PDP/Q10/15-16 TEST ♦ PDP/Q8/14-15 TEST ♦ PDP/Q24/14-15 TEST ♦ PDP/Q3/13-14 TEST ♦ PDP/Q19/13-14 TEST ♦ PDP/Q21/13-14 TEST ♦ PDP/Q6/12-13 TEST ♦ PDP/Q15/12-13 TEST ♦ PDP/Q6/11-12 TEST ♦ PDP/Q22/11-12 TEST ♦ PDP/Q8/08-09 TEST ♦ PDP/Q21/08-09 TEST ♦ PDP/Q2b/07-08 TEST ♦ PDP/Q3dii/07-08 TEST ♦ PDP/Q2f/04-05 TEST ♦ PDP/Q2f/04-05 TEST ♦ PDP/Q25/16-17 EXAM ♦ PDP/Q29/16-17 EXAM ♦ PDP/Q10/13-14 EXAM ♦ PDP/Q30/13-14 EXAM ♦ PDP/Q34/13-14 EXAM ♦ PDP/Q14/12-13 EXAM ♦ PDP/Q7/11-12 EXAM ♦ PDP/Q16/11-12 EXAM ♦ PDP/Q20/11-12 EXAM ♦ PDP/Q33/11-12 EXAM ♦ PDP/Q6/10-11 EXAM ♦ PDP/Q37/15-16 EXAM ♦ PDP/Q11/10-11 EXAM ♦ PDP/Q19/10-11 EXAM ♦ PDP/Q20/10-11 EXAM ♦ PDP/Q21/10-11 EXAM ♦ PDP/Q8/09-10 EXAM ♦ PDP/Q34/15-16 EXAM ♦ PDP/Q16/09-10 EXAM ♦ PDP/Q38/09-10 EXAM ♦ PDP/Q8/SECTION-A/07-08 EXAM ♦ PDP/Q16/SECTION-A/07-08 EXAM ♦ PDP/Q20/SECTION-A/07-08 EXAM ♦ PDP/Q2c/SECTION-B/07-08 EXAM ♦ PDP/Q2a/06-07 EXAM ♦ PDP/Q2c/06-07 EXAM ♦ PDP/Q2a/05-06 EXAM ♦ PDP/Q2bi/05-06 EXAM ♦ PDP/Q4bii/05-06 EXAM ♦ PDP/Q2e/04-05 EXAM ♦ PDP/Q2f/04-05 EXAM ♦ PDP/Q2d/04-05 EXAM ♦ PDP/Q2/SECTION-A/03-04 EXAM ♦ PDP/Q15/SECTION-A/03-04 EXAM ♦ PDP/Q28/SECTION-A/03-04 EXAM ♦ PDP/Q1a/SECTION-B/03-04 EXAM ♦PDP/Q15/14-15 EXAM ♦PDP/Q17/14-15 EXAM ♦PDP/Q22/14-15 EXAM
RATES OF CHEMICAL REACTION	♦ PDP/Q9/16-17 EXAM ♦ PDP/Q10/16-17 EXAM ♦ PDP/Q12/16-17 EXAM ♦ PDP/Q12/15-16 EXAM ♦ PDP/Q9/15-16 EXAM ♦ PDP/Q2/15-16 EXAM ♦ PDP/Q6/14-15 EXAM ♦ PDP/Q21/14-15 EXAM ♦ PDP/Q21/13-14 EXAM ♦ PDP/Q31/13-14 EXAM ♦ PDP/Q35/13-14 EXAM ♦ PDP/Q8/12-13 EXAM ♦ PDP/Q12/12-13 EXAM ♦ PDP/Q13/12-13 EXAM ♦ PDP/Q35/12-13 EXAM ♦ PDP/Q22/11-12 EXAM ♦ PDP/Q23/11-12 EXAM ♦ PDP/Q26/15-16 EXAM ♦ PDP/Q31/10-11 EXAM ♦ PDP/Q27/09-10 EXAM ♦ PDP/Q46/08-09 EXAM ♦ PDP/Q2b/SECTION-B/07-08 EXAM ♦ PDP/Q1b/06-07 EXAM ♦ PDP/Q4d/06-07 EXAM ♦ PDP/Q3c/05-06 EXAM ♦ PDP/Q19/SECTION-A/03-04 EXAM ♦ PDP/Q33/SECTION-A/03-04 EXAM ♦PDP/Q21/14-15 EXAM

CHEMICAL EQUILIBRA	♦ PDP/Q3/16-17 EXAM ♦ PDP/Q18/16-17 EXAM ♦ PDP/Q24/16-17 EXAM ♦ PDP/Q27/16-17 EXAM ♦ PDP/Q11/15-16 EXAM ♦ PDP/Q1/15-16 EXAM ♦ PDP/Q1/13-14 EXAM ♦ PDP/Q5/13-14 EXAM ♦ PDP/Q19/13-14 EXAM ♦ PDP/Q6/12-13 EXAM ♦ PDP/Q7/12-13 EXAM ♦ PDP/Q10/12-13 EXAM ♦ PDP/Q31/12-13 EXAM ♦ PDP/Q27/15-16 EXAM ♦ PDP/Q30/11-12 EXAM ♦ PDP/Q1b/05-06 EXAM ♦PDP/Q23/14-15 EXAM ♦PDP/Q29/14-15 EXAM

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA

CENTRE FOR DISTANCE LEARNING
PRE-DEGREE PROGRAMME

FIRST CONTACT PERIOD TEST
PRE-DEGREE CHEMISTRY
(CHM 001)

2003/2004 SESSION-TILL DATE

CONSOLIDATED CHM 001 TEST 2017/2018
TIME ALLOWED: 45 MINUTES

1. Why is it necessary to balance chemical equations? (a) the chemicals will not react until you have added the correct mole ratio (b) the correct products will not be formed unless the right amount of reactants have been added (c) a mole to mole ratio must be established for the reaction to occur as written (d) the balanced equation tells you how much reactant is required to predict how much product will be produced
2. The sum of the coefficients of all species (reactants and products) in the balanced equation for the reaction between aqueous mixture of lead(II)nitrate and sodium phosphate is (a) 12 (b) 10 (c) 6 (d) 4
3. The element rhenium (Re) has two naturally occurring isotopes, ^{185}Re and ^{187}Re, with an average atomic mass of 186.207amu. Rhenium is 62.60% ^{187}Re is 186.956amu. Calculate the mass of ^{185}Re (a) 185.000amu (b) 185.458amu (c) 184.965amu (d) 184.953amu
4. The sets of quantum numbers that correctly define the 3p and 5s orbital are: (a) $n = 3, l = 1, m_l = \pm 1, 0$ and $n = 5, l = 0, m_l = 0$ (b) $n = 3, l = 3, m_l = \pm 1, 0$ and $n = 5, l = 2, m_l = 1$ (c) $n = 3, l = 1, m_l = \pm 1, 0$ and $n = 5, l = 1, m_l = 1$ (d) $n = 3, l = 2, m_l = \pm 2, 0$ and $n = 5, l = 4, m_l = 0$
5. The contribution of Rutherford's scattering experiment to atomic model is? (a) the nuclear particles carry all of the mass of the ionizing gas atoms and their charge to mass ratio depending on the nature of the residual gas. (b) atom has small but dense centrally placed nucleus and are negatively charged (c) cathode rays are electrons and are negatively charged (d) atom consist of tiny particles at the center surrounded by orbiting electrons that are negatively charged
6. Which equation represents the second ionization energy of an element X?(a) $X(g) \rightarrow X^{2+}(g) + 2e^-$ (b) $X^+(g) \rightarrow X^{2+}(g) + e^-$ (c)$+X(g) + 2e^- \rightarrow X^{2-}(g)$ (d)$X^-(g) + e^- \rightarrow X^{2-}(g)$
7. Which of the following properties increases down a group in the periodic table? (I) Electron affinity (II) Atomic radius (III) Electronegativity (IV) Ionization Energy (V) Metallic character (a) II & V (b) II & III (c) IV & V (d) II & V
8. Lycopene is a natural product containing carbon and hydrogen found in tomatoes. If it has a molar mass of $536.88 g/mol$ and contains 89.49% carbon. What is Lycopene m olecular formula?(a) C_5H_7 (b) $C_{39}H_{68}$ (c) $C_{40}H_{56}$ (d)$C_{41}H_{44}$
9. Which of the following electronic configuration is correct for specie Ni^{2+}? (a) $[Ar]4S^03d^8$ (b) $[Ar]4S^23d^{10}$ (c)$[Ar]4S^23d^6$ (d) $[Ar]4S^13d^{10}$
10. If $5.0g$ of each reactant was used for the following process, the limiting reactant would be $2KMnO_4 + 5Hg_2Cl_2 + 16\,HCl \rightarrow 10HgCl_2 + 2MnCl_2 + 2KCl + 8H_2O$ (a) $KMnO_4$ (b) HCl (c) Hg_2Cl_2 (d) $HgCl_2$
11. What is the molarity of phosphoric acid in a solution labeled 20.0% phosphoric acid by weight with a density $1.12\ g/mL$?(a) $0.98M$ (b)$2.3M$ (c)$2.7M$ (d) $0.22M$
12. What volume of 15.0M HNO_3 should be added to $1250cm^3$ of 2.00M HNO_3 to prepare 14.0litres of $1.00M$ HNO_3? Water is added to make the final volume exactly 14.0litres (a) $0.993L$ (b) $0.384L$ (c) $1.767L$ (d) $0.767L$ (e) $0.179L$
13. What is the percentage of s character in the hybridization of $SOCl_2$? (a)10% (b)25% (c)75% (d)50%
14. Which of the following does not belong to the class of mixtures? (a) Solution of sodium chloride in water (b) A compound (c) Cement concrete (d) frozen fruit (e) Air
15. How many electrons, protons, and neutrons does the deuterium (an isotope of hydrogen atom with mass number 2) contain in that order? (a) 1,1,0 (b) 0,1,1 (c) 1,0,1 (d) 2,1,0 (e)1,1,1
16. $2.60g$ of a fertilizer on boiling with excess NaOH solution evolved ammonia which neutralized $24.00cm^3$ of 0.80M H_2SO_4 solution. The weight in gram of NH_3 in the fertilizer sample: (a) $1.28g$ (b) $0.84g$ (c)$1.84g$ (d) $0.42g$ (e) $0.65g$
17. What type of force is holding (i) carbon and chlorine atoms in CCl_4 (ii) molecules of Br_2 (a) covalent, London force (b) dipole-dipole interaction, hydrogen bond (c) covalent, ionic bond (d) London force, ionic bond
18. Fluoromethane (CH_3F) and methanol (CH_3OH) have about the same molecular mass but different boiling points. CH_3F boils at $-78°C$ and CH_3OH boils at $65°C$. Account for the high boiling point in CH_3OH (a) hydrogen bonding (b) london forces (c) dipole-dipole interaction (d) none of the above
19. Calculate the heat of formation of methane ($CH_4(g)$) given that the standard heat of combustion of methane is $-891 kJmol^{-1}$, the standard heat of formation of $CO_2(g)$ and $H_2O(l)$ are -394 and $-286 kJmol^{-1}$

respectively. (a) $+75 Jmol^{-1}K^{-1}$ (b) $\pm 150 kJmol^{-1}$ (c) $-75 Jmol^{-1}$ (d) $-75 kJmol^{-1}$

20. What is the standard free energy ΔG° for the following reaction at 25°C? $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ the standard enthalpy of formation of $NH_3(g)$ is $-45.90 kJmol^{-1}$, while the standard entropy of formation of $N_2(g), H_2(g)$ and $NH_3(g)$ are 191.6, 130.6 and $192.7 Jmol^{-1}K^{-1}$ respectively. (a) +32.8kJ (b) −32.8kJ (c) +16.4kJ (d) −16.4kJ

21. Which of the following pairs is correctly represent the electronic configuration of $_{24}Cr$ and $_{26}Cr^{2+}$? (a) $[Ar]4s^2 3d^4$ and $[Ar]4s^2 3d^6$ (b) $[Ar]4s^1 3d^5$ and $[Ar]4s^0 3d^6$ (c) $[Ar]4s^1 3d^5$ and $[Ar]4s^2 3d^6$ (d) $[Ar]4s^2 3d^4$ and $[Ar]3d^8$

22. The enthalpy changes for the complete combustion of ethanol (C_2H_5OH) and ethanal (CH_3CHO) are as shown below:

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O;\ \Delta H = -1264 kJmol^{-1}$$

$$CH_3CHO + 2\,1/2\,O_2 \rightarrow 2CO_2 + 2H_2O;\ \Delta H = -1130 kJmol^{-1}$$

Calculate in kJ/mol, the energy involved when ethanol is oxidized to ethanal (a) −2394 (b) +2394 (c) −134 (d) +134

23. Isotones are nuclides that possess: (a)Same mass number (b) Same number of isotopes (c) Different number of protons (d) Same number of neutrons

24. Which of the following contributions was made by de Broglie to the present theory of atomic structure? (a) Prediction of wave properties for a stream of electrons (b) Postulation of the uncertainty principle (c) Postulation that showed that electrons in the degenerate orbitals would remain unpaired as much as possible (d) Deduction that no two electrons in a given atom can have the same set of four quantum numbers

25. How many unpaired electrons are there in the Zn atom? (a) Two (b) Seven (c) Four (d) Zero

SOLUTION

1. The law of conservation of mass states that atom can neither be created nor destroy but can be change from one form to another during a chemical reaction.

The implication of the law of conservation of mass is that all chemical equation must be balanced. This is because an unbalanced chemical equation shows that an atom can be created or destroyed in a chemical reaction.

A chemical equation is the symbolic representation of a chemical reaction.

Hydrogen gas + oxygen gas → steam (chemical reaction)

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}\ \text{(chemical equation)}$$

A chemical equation is balanced for the following reasons

(i) A balanced equation shows an atom can neither be created nor destroy in a chemical reaction

(ii) A balanced equation shows the amount of reactants required to obtain a given amount of product theoretically

Note that for a chemical reaction, the following are true

(i) The energy of the reacting particles must be greater than the activation energy for the reaction to occur

(ii) The reactant must be present in their mole ratio for the product to be form

(iii)The products depend on the amount of reactants present

$$CaC_2 + H_2O \rightarrow C_2H_2 + CaO$$

$$CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$$

The correct option is D

2. $3Pb(NO_3)_2 + 2Na_3PO_4 \rightarrow Pb_3(PO_4)_2 + 6NaNO_3$

$Sum\ of\ coefficient = 3 + 2 + 1 + 6 = 12$

The correct option is A

3. $R.A.M\ of\ Re = \alpha_1 m_1 + \alpha_2 m_2$

$R.A.M\ of\ Re = 186.207 amu$

$\alpha_1 = 62.60\% = 0.626, m_1 = 186.956 amu$

$\alpha_1 = 100 - 62.60\% = 37.40\% = 0.374$

$m_2 = ?$

$186.207 = 0.626 \times 186.956 + 0.374 m_2$

$186.207 = 117.03456 + 0.374 m_2$

$186.207 - 117.03456 = 0.374 m_2$

$69.172544 = 0.374 m_2$

$$m_2 = \frac{69.172544}{0.374} = 184.9533 amu$$

The correct option is D

4. **Quantum numbers** *are the numbers given to each energy level in an atom.* The four quantum numbers are listed and explained below:

Principal Quantum (n) is the quantum number which indicates the relative size of orbitals and therefore the relative distance of an electron from the nucleus of the peak in the radial probability plot thereby determines or describes the main energy level or shell that an electron occupies in an atom. In summary, the functions of the principal quantum number are stated below:

(i) It determines the energy possessed by an electron due to its distance from the nucleus.

(ii) It determines the size of an electron cloud
(iii)It determines the distance of an electron from the nucleus and
(iv)It determines the maximum number of electrons in a main shell.

The principal quantum number has an integral value of 1, 2, 3, 4, 5 etc.

Subsidiary or Azimuthal Quantum number (ℓ) is the quantum number which determines or defines the shape of orbitals. It is also known as **angular momentum quantum number.** In summary the functions of the subsidiary or azimuthal quantum number are stated below.

(i) It divides subshell into orbital
(ii) It determines the shapes of orbitals, and
(iii)It determines the maximum number of electrons in a subshell

The subsidiary or azimuthal quantum number has an integral value of 0 to $(n-1)$. This implies that the principal quantum number (n) set a limit on the subsidiary quantum number (ℓ). The table below shows the values of ℓ for given values of n.

subsidiary quantum number Principal quantum number (n)	Subsidiary quantum number
1	0
2	0, 1
3	0, 1, 2
4	0, 1, 2, 3

Electrons with subsidiary quantum number of 0, 1, 2 and 3 are known as s, p, d and f electrons respectively.

Subsidiary quantum number (ℓ)	Orbital designated
0	s
1	p
2	d
3	f

The principal quantum number (n) together with the subsidiary quantum number (ℓ) are use to represent or describe an orbital. This is shown in the table below.

n	ℓ	Orbital described
1	0	1s
2	0	2s
3	0	3s
2	1	2p
3	1	3p
4	1	4p
3	2	3d
4	2	4d
5	3	5f

Magnetic Quantum Number (M_ℓ) is the quantum number which indicates or shows the number of orbitals in a given subshell. It prescribes the orientation of the orbital in space around the nucleus. Therefore it is sometimes called **orbital orientation quantum number**. The integral values of M_ℓ ranges from $-\ell$ through 0 to $+\ell$. The number of possible M_ℓ in a given subshell determines the number of orbitals in the subshell.

The value of the subsidiary quantum number (ℓ) determine the value of the magnetic quantum number(M_ℓ). This is given in the table below.

Value of L	Values of $M_\ell = -\ell$ to $+\ell$
0	0
1	$-1, 0, 1$
2	$-2, -1, 0, 1, 2$
3	$-3, -2, -1, 0, 1, 2, 3$
4	$-4, -3, -2, -1, 0, 1, 2, 3, 4$

The value of M_ℓ for a given subshell indicates the number of orbital in the subshell for instance $\ell = 2$ indicate a d-subshell with five orbitals. Since the d-subshell has five orbitals, the M_ℓ values of the d-subshell indicated must take five values i.e. $M_\ell = -2, -1, 0, 1$ *and* 2.

Spin quantum number (M_s): This is the quantum number which is associated with the spin properties of an electron about it axis and the orientation of the magnetic field produced by the spin. Since a charged particles spinning about its axis behaves like a magnet, the spin quantum number has two possible values which are $-\frac{1}{2}$ and $+\frac{1}{2}$. The electron with an upward spin takes the value $+\frac{1}{2}$ but the electron with a downward spin takes the value of $-\frac{1}{2}$.

For the orbital 3p, $n = 3$ and $\ell = 1$ while for the orbital 5s, $n = 5$ and $\ell = 0$

n	ℓ	M_ℓ	M_s
3	1	$-1, 0, +1$	$\pm\frac{1}{2}$
5	0	0	$\pm\frac{1}{2}$

Thus, the orbital 3p and 5s are completely describe by the following sets of quantum numbers.

$n = 3, \ell = 1, M_\ell = -1, 0, +1$ (i.e. $\pm 1, 0$), $m_s = \pm\frac{1}{2}$ and $n = 5, \ell = 0, M_\ell = 0, m_s = \pm\frac{1}{2}$

The correct option is A

5. The alpha scattering experiment is an experiment in which an alpha particle is fired through a gold atom. The alpha particle is expected to travelled through the gold atom undeviated. This is because the atomic theory then, states that the protons, neutrons and electron are evenly distributed within the atom. But it was discovered that, the alpha particle travelling through the central of the atom was strongly deflected but the alpha particle travelling through the other part of the atoms travels undeviated.

The alpha scattering experiment was carried out by Ernest Rutherford students – Hans Geiger and Ernest Marsden in 1909. Based on this experiment, Ernest Rutherford propounded an atomic theory which states that the atom is an empty space with a positively charge nucleus where most of the mass is concentrated and the electrons revolves round the nucleus. This postulates of Rutherford led to the Rutherford model (planetary model) of the atom and eventually to the Bohr model.

The correct option is B

6. **Ionization energy** or **potential** is the energy required to remove one mole of electron from a gaseous atom to form a cation.

$X_{(g)} \rightarrow X^{+}_{(g)} + e^{-}$ ΔH = 1st ionization energy

$X^{+}_{(g)} \rightarrow X^{2+}_{(g)} + e^{-}$ ΔH = 2nd ionization energy

$X^{2+}_{(g)} \rightarrow X^{3+}_{(g)} + e^{-}$ ΔH = 3rd ionization energy

Note that the third ionization energy is greater than the second ionization energy while the second ionization energy is greater than the first ionization energy.

The correct option is B

7.

Atomic properties	Across the period	Down the group
Electropositivity	Decreases	Increases
Metallicity	Decreases	Increases
Metallic character	Decreases	Increases
Atomic volume	Decreases	Increases
Atomic size	Decreases	Increases
Atomic radius	Decreases	Increases
Ionic radius	Decreases	Increases
Electric conductivity	Decreases	Increases
Thermal conductivity	Decreases	Increases
Screening/shielding effect	Decreases	Increases
Electronegativity	Increases	Decreases
Ionization energy	Increases	Decreases
Electron affinity	Increases	Decreases
Nuclear charge effect	Increases	Decreases
Atomic number	Increases	Increases
Mass number	Increases	Increases

Note that Electropositivity, metallic character or metallicity means the same thing

The correct option is D

8. **Step 1:** Lycopene is made up of carbon and Hydrogen only

$\%\ of\ Carbon\ by\ mass = 89.49\%$

$\%\ of\ Hydrogen\ by\ mass = 100 - 89.49\%$

$= 10.51\%.$

Step 2: Convert all percentage to mass

Assuming 100g of the compound

$mass\ of\ C = 89.49\%\ of\ 100g$

$= \frac{89.49}{100} \times 100g = 89.49g$

$mass\ of\ H = 10.51\%\ of\ 100g$

$= \frac{10.51}{100} \times 100g = 10.51g$

Step 3: Convert each mass of the element into moles.

C	:	H
89.49	:	10.51
12.011		1.008
7.4507	:	10.4266

Step 4: Divide through each mole by the smallest mole (i.e. 7.4507)

C	:	H
7.4507	:	10.4266
7.4507	:	10.4266
7.4507		7.4507
1	:	1.3994

Step 5: Approximate each value to 2.d.p

C	:	H	
1	:	1.3994	
1	:	1.4	
1	:	$\frac{7}{5}$	Multiply through by 5
5	:	7	

Therefore, the empirical formula is C_5H_7

Empirical formula × whole number (n) = R.M.M of compound.

R. M. M of compound = $536.88g/mol$

$(C_5H_7) \times n = 536.88g/mol$

$[5(12.011g/mol) + 7(1.008g/mol)] \times n = 536.88g/mol$

$[60.055g/mol + 7.056g/mol] \times n = 536.88g/mol$

$67.111g/mol \times n = 536.88g/mol$

$n = \frac{536.88g/mol}{67.111g/mol} = 7.9999 \approx 8$

$n = 8$

$(C_5H_7) \times n = (C_5H_7) \times 8 = C_{40}H_{56}$

Therefore, the molecular formula is $C_{40}H_{56}$.

The correct option is C

9. Transition elements are elements with their d and f-orbital partially filled e.g. Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu etc.

Properties of the transition elements

(i) Their d-orbital is partially filled
(ii) They show variable oxidation states
(iii)Their ions are coloured
(iv)They act as an excellent catalyst
(v) They form complexes

Note that zinc is a false or not a true transition element for the following reasons

(i) It does not show variable oxidation state
(ii) Its ions are not coloured
(iii)It has a completely filled d-orbital

Note that for the transition element to form ions, they lose all of their 4s-electrons before losing their 3d-electrons.

$_{28}Ni \rightarrow 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^8$

$_{28}Ni \rightarrow [Ar]4s^2\,3d^8$

$_{28}Ni^{+} \rightarrow [Ar]4s^1\,3d^8$

$_{28}Ni^{2+} \rightarrow [Ar]4s^0\,3d^8$

Orbitals are said to be stable if they are fully or half- filled with electrons. As a rule, for the transition elements, whenever the d-orbital required one electron to be fully or half filled the 4s-orbital must take one electron.

$_{29}Cu \rightarrow 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1\,3d^{10}$

The d-orbital required one electron to be fully filled; hence 4s orbital should take one electron.

$_{24}Cr \rightarrow 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1\,3d^5$

In the electronic configuration of chromium, the d-orbital requires one electron to be half filled; as a result the 4s-orbital must take one electron.

Therefore, the correct electronic configuration of chromium and copper are as given below

$_{24}Cr \rightarrow 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1\,3d^5$

$_{29}Cu \rightarrow 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^1\,3d^{10}$

The correct option is A

10. **Step 1:** Write a balance equation of the reaction.

$$2KMnO_4 + 5Hg_2Cl_2 + 16\,HCl \rightarrow 10HgCl_2 + 2MnCl_2 + 2KCl + 8H_2O$$

$R.M.M\ of\ KMnO_4 = 158.032g/mol$

$R.M.M\ of\ Hg_2Cl_2 = 472.086g/mol$

$R.M.M\ of\ HCl = 36.461g/mol$

$mass\ of\ KMnO_4 = 5g$

$mass\ of\ Hg_2Cl_2 = 5g$

$mass\ of\ HCl = 5g$

Step 2: Determine the number of moles of the reactants or products.

$$\cap_{KMnO_4} = \frac{Reacting\ mass}{molar\ mass}$$

$$\cap_{KMnO_4} = \frac{5g}{158.032g/mol} = 0.0316mol$$

$$\cap_{Hg_2Cl_2} = \frac{Reacting\ mass}{molar\ mass}$$

$$\cap_{Hg_2Cl_2} = \frac{5g}{472.086g/mol} = 0.0106mol$$

$$\cap_{HCl} = \frac{Reacting\ mass}{molar\ mass}$$

$$\cap_{HCl} = \frac{5g}{36.461g/mol} = 0.1371mol$$

Step 3: Determine the limiting reagent and its active moles.

$\cap_{KMnO_4}$	:	$\cap_{Hg_2Cl_2}$	:	$\cap_{HCl}$	
$\frac{0.0316}{2}$	:	$\frac{0.0106}{5}$	:	$\frac{0.1371}{16}$	Active mole of each reactant
0.0158	:	0.00212	:	0.0085	The least active mole give the limiting reagent

Note that the division is done by the coefficient each of the reactants in the balanced chemical equation

The limiting reagent is Hg_2Cl_2

The excess reagent are $KMnO_4$ and HCl

The correct option is C

11. $Phosphoric\ acid = H_3PO_4$

$R.M.M\ of\ H_3PO_4 (M) = 97.994g/mol$

$p = 20\%$

$d = 1.12g/cm^3 = 1.12g/ml$

$$Molar\ conc = \frac{10pd}{M} = \frac{10 \times 20 \times 1.12}{97.994} = \frac{224}{97.994}$$

$$= 2.5859moldm^{-3} = 2.2859M$$

Method 2: Analysis Method

$M = 97.994g/mol$

$p = 20\%$

$d = 1.12g/cm^3$

Recall that $d = 1.12g/cm^3$. This means that $1cm^3$ of the solution contain $1.12g$ of solute. But the solution is 20% pure.

$1cm^3$ of the solution contain $= 20\%\ of\ 1.12g\ of\ H_3PO_4$

$$= \frac{20}{100} \times 1.12g = 0.224g$$

$1cm^3\ of\ solution\ contain\ 0.224g\ of\ H_3PO_4$

$1000cm^3\ of\ solution\ contain\ xg\ of\ H_3PO_4$

$$\frac{1}{1000} = \frac{0.224}{x}$$

$x = 0.224 \times 1000 = 224g$

But the amount of solute in gram dissolved in $1000\ cm^3$ or $1dm^3$ of a solution is called mass concentration of the solution.

$\therefore mass\ conc = 224g/dm^3$

$$molar\ conc = \frac{mass\ conc}{molar\ mass} = \frac{224g/dm^3}{97.994g/mol}$$
$$= 2.2859M$$

We advise you to use method 2 if you are seating for theoretical examination.

The correct option is B

12. $HNO_3 + HNO_3 \rightarrow HNO_3$
$Vdm^3, 15M \quad 1.25dm^3, 2M \quad 14dm^3, 1M$

$V_1 = V + 1.25$

$C_1 = \frac{total\ \cap_{HNO_3}}{V_1}$

$C_2 = 1M, V_2 = 14L = 14dm^3$

$\cap_{HNO_3} = V \times 15 = 15Vmol$

$\cap_{HNO_3} = 1.25 \times 2 = 2.5mol$

$total\ \cap_{HNO_3} = 15V + 2.5$

$C_1 = \frac{total\ \cap_{HNO_3}}{V_1}$

$C_1 = \frac{15V + 2.5}{V + 1.25}$

$C_1V_1 = C_2V_2$

$\left(\frac{15V + 2.5}{V + 1.25}\right)(V + 1.25) = 1 \times 14$

$15V + 2.5 = 14$

$15V = 14 - 2.5$

$15V = 11.5$

$V = \frac{11.5}{15} = 0.7667L$

$V \approx 0.767L$

The correct option is D

13. Thionyl chloride, $SOCl_2$ is sp^3hybridized.

$$\%\ of\ S = \frac{number\ of\ S\ orbital}{number\ of\ orbital\ in\ sp^3} \times 100$$

$$\%\ of\ S = \frac{1}{4} \times 100 = 25\%$$

The correct option is B

14. A mixture is a substance that contains two or more substance (i.e. elements or compounds) physically combined together. Mixtures are generally divided into two.

Heterogeneous mixture:- It is a mixture without a uniform composition. In other words, heterogeneous mixture is a mixture in which the components of the mixture are separate into distinct layers e.g. a mixture of water and sand, a mixture of petrol and water, a mixture of ethanol and iron II tetraoxosulphate VI, sea-water, flooded water, concrete etc.

Homogeneous mixture:- Is a mixture with a uniform composition. In other words, homogeneous mixture is a mixture in which the components of the mixture do not separate into distinct layer e.g. air, urine, crude oil or petroleum, blood plasma, coca-cola, palm wine, soil, ripe fruits, stones, clay, gasoline, milk, alloy (e.g. brass, bronze, duralumin etc), honey, rubber latex, vulcanizer's solution, cement,

Note that crude petroleum (i.e. impure petroleum), frozen fruit juice, aqueous solution of potassium permanganate and cement concrete are heterogeneous mixture. This is because each of the mixture contains distinct layers. Aqueous solution of permanganate is heterogeneous because permanganate exists in the solid state. Besides, the solution can be easily identified as aqueous permanganate due to the purple colour of the solution. Frozen fruit juice contains ice block and juice.

The correct option is B

15. Hydrogen occurs in three isotopes, which are protium (^1_1H),
Deuterium or heavy hydrogen (^1_1H *or* ^2_1D) and tritium (^3_1H).

For Protium
Atomic number of tritium (Z) = 1
Mass number of tritium (A) = 1
No of neutron in tritium (NN) =?
$A = Z + NN$
$1 = 1 + NN$
$NN = 1 - 1 = 0$
Therefore, Protium has one proton, no neutron and one electron. Note that Protium is the only element without neutron

For Deuterium
Atomic number of tritium (Z) = 1
Mass number of tritium (A) = 2
No of neutron in tritium (NN) =?
$A = Z + NN$
$2 = 1 + NN$
$NN = 2 - 1 = 1$
Therefore, Deuterium has one proton, one neutron and one electron.

For Tritium
Atomic number of Tritium (Z) = 1
Mass number of tritium (A) = 3
No of neutron in tritium (NN) =?
$A = Z + NN$
$3 = 1 + NN$
$NN = 3 - 1 = 2$
Therefore, tritium has one proton, 2 neutrons and one electron. Note that Tritium is the only radioisotopes of hydrogen.

The correct option is E

16. Mass of fertilizer = $2.6g$
R.M.M of $NH_3 = 17g/mol$
$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$
$24cm^3, 0.8M$

$$\cap_{H_2SO_4} = \frac{Vol.\ in\ cm^3}{1000} \times molar\ conc.$$

$$\cap_{H_2SO_4} = \frac{24}{1000} \times 0.8 = 0.0192mol$$

$$\cap_{NH_3} = 2 \times 0.0192mol = 0.0384mol$$

$$\cap_{NH_3} = \frac{Mass\ of\ NH_3}{Molar\ mass\ of\ NH_3}$$

$$0.0384mol = \frac{Mass\ of\ NH_3}{17g/mol}$$

$$Mass\ of\ NH_3 = 0.0384mol \times 17g/mol$$

$$Mass\ of\ NH_3 = 0.6528g$$

$$Mass\ of\ NH_3 \approx 0.65g$$

The correct option is E

17. **Covalent bonding** is a type of bonding that occurs as a result of sharing electrons. Covalent bonding is of three types.

Pure covalent bonding: This is type of covalent bonding that occurs between atoms of the same non-metals such that electrons are equally shared between the two non-metals. Pure covalent bonding always leads to the formation of molecules. The molecules form in pure covalent bonds are diatomic or homo–nucleic molecules. The following molecules have pure covalent bonding e.g. $H_2, O_2, P_4, S_4, Cl_2, F_2$ etc. All type of covalent bonding produce molecules.

Polar covalent bonding: This is a type of covalent bonding in which the shared electron is attracted strongly by one of the element such that the molecules become polar.

Generally, when two non-metals are bonded together it always result to sharing of electron. If the electronegativity of one of the element is very high compare to the other, that element will attract electron strongly to itself in such a way that it will become partially negative while the other element will be partially positive. The result is that the molecule becomes polar. A **polar molecule** is a molecule with two poles i.e. (positive and negative). Polar covalent bond is usually seen in molecules in which one of the elements is hydrogen and the other element is a highly electronegative element beside oxygen, fluorine, and nitrogen.

Polar covalent molecules exhibit all the properties of ionic substance except that they are not made of aggregate of ions. This implies that polar covalent have the following properties:-

(i) They are molecules
(ii) They are polar i.e. they have positive and negative poles.
(iii) They are good conductor of heat and electricity when in aqueous solution.
(iv) [illegible]
(v) Their reaction in aqueous medium is f[illegible] because they exist completely as ions.
(vi) They are soluble in polar solvent e.g. wa[illegible]
(vii) They are mostly gases at ro[illegible] temperature.

Dative or co-ordinate bonding: This is type of covalent bond in which the shar[illegible] electron is contributed only by one of t[illegible] species. Dative bonding is formed between

(i) Two electron deficient molecules
$AlCl_3 + AlCl_3 \rightarrow Al_2Cl_6$
(ii) Between an electron rich molecules or ion a[illegible] electron deficient molecule. All **cation** a[illegible] **electron deficient** and all **anions are electr[illegible] rich**

$H^+ + H_2O \rightarrow H_3O^+$ [Hydroxonium ion]

$H^+ + NH_3 \rightarrow NH_4^+$ [Ammonium ion]

$Cu^{2+} + 4H_2O \rightarrow [Cu(H_2O)_4]^{2+}$
Hydrated copper II ion

$Fe^{2+} + 6CN^- \rightarrow [Fe(H_2O)_6]^{2+}$
Hexacyanoferate II ion

$Fe^{3+} + 6CN^- \rightarrow [Fe(H_2O)_6]^{3+}$
Hexacyanoferate III

Note that Dative bonding result to the formatio[illegible] of dative compound. Dative compound exhibi[illegible] all the properties of covalent compound excep[illegible] that they are less volatile.

PROPERTIES OF COVALENT COMPOUNDS

(i) They are mainly gases at room temperature
(ii) They have low boiling and melting points
(iii) They are poor conductor of heat and electricity
(iv) They are simply molecules
(v) They are non-polar
(vi) Their solubility in water varies
(vii) Their reaction on aqueous is very slow

London forces (also called **dispersion forces**) are the weak attractive forces between molecules resulting from the small, instantaneous dipoles that occur because of the varying positions of the electrons during their motion about the nuclei.

London or dispersion forces tend to increase with molecular mass. This is because molecules with larger molecular mass usually have more electrons, and London forces increase in strength with the number of electrons. Larger molecular mass often means larger atoms which are easily more *polarizable* (more easily distorted to give instantaneous dipoles because the electrons are farther from the nuclei). For example the London force in

.Neon, Ne is smaller than the London force in Bromine, Br-Br

For molecules with the same molecular mass (i.e. isomers), the more the branch chains, the less polarisable. So the London forces are smaller. Consider pentane, 2-methylbutane, and 2,2-dimethylpropane with molecular formula, C_5H_{12}.Pentane is a straight chain alkane. But 2-methylbutane and 2, 2-dimethylpropane are branch chains hydrocarbon. As a result, London forces decrease from pentane through 2-methylbutane to 2-methylbutane.

Thus, the following are factors that affect London or dispersion forces.

(i) Relative molecular mass of the element or compound. The higher the relative molecular ms the higher the London or dispersion forces

(ii) The degree of branching. The higher, the degree of branching, the lower the London or dispersion forces

(iii)The size of the atoms of an element. The higher, the size of an atom, the higher the London or dispersion forces.

Thus, the force holding:

(i) CCl_4 is a covalent force

(ii) Br_2 is London or dispersion force

The correct option is A

18. **Hydrogen bond** is a bond that results when hydrogen atom is directly bonded to highly small electronegative element such as oxygen, nitrogen and fluorine. Hydrogen bond is both an intramolecular and intermolecular bond that comes into play when hydrogen is directly bonded to small highly charged electronegative element.

Hydrogen bond is responsible for the following

(i) The solubility of most organic compounds

(ii) The high solubility of Alkanoic acid, alkanol, amine etc

(iii) The high boiling point of water

(iv) The weak acidity of HF

(v) The existence of water as a liquid at room temperature.

(vi) The walking of insects on water

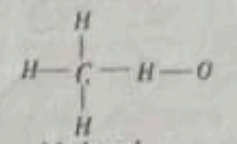
Note the following also

(i) The higher the degree of Hydrogen bonds in a substance, the greater the tendency of the substance to exit as a liquid at ordinary room condition. Thus, H_2O exist as a liquid but H_2S exist as a gas at room temperature

(ii) Alkanoic acids are more soluble than alkanols because of the higher degree of Hydrogen bonding

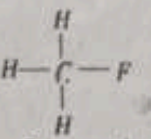
(iii) Methanol, CH_3OH has a higher boiling point than fluoromethane ,CH_3F because methanol contain hydrogen bonding

To determine if a substance contain intramolecular bonding draw the structure of the substance and check for a direct think between Hydrogen and Oxygen, Nitrogen or Fluorine.



Methanol

In the above structure there is a direct link between Hydrogen and Oxygen, hence there is hydrogen bonding in the molecule



fluoromethane

In the above structure there is no direct link between Hydrogen and Fluorine, hence there is no hydrogen bonding in the molecule

The correct option is A

19.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \quad \Delta H = -891kJ/mol$$
$$x \quad 0 \quad -394 \quad -286kJ/mol$$

Note that the enthalpy of formation of an element in the pure state is zero

$$\Sigma H_P = 1mol(-394kJ/mol) + 2mol(-286kJ/mol)$$
$$\Sigma H_P = -394kJ - 572kJ = -966kJ$$
$$\Sigma H_R = 1mol(xkJ/mol) + 1mol(0kJ/mol) = xkJ$$
$$\Delta H = 1mol(-891kJ/mol) = -891kJ$$
$$\Delta H = \Sigma H_P - \Sigma H_R$$
$$-891kJ = -966kJ - xkJ$$
$$x = -966kJ + 891kJ = -75kJ$$
$$\Delta H = x = -75kJ/mol$$

The correct option is D

20. $\Delta H = -45.90kJ/mol$

$$\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightarrow NH_3(g)$$
$$191.6 \quad 130.6 \quad 192.7J/molk$$
$$\Sigma S_P = 1mol(192.7J/molk) = 192.7J/k$$
$$\Sigma S_R = \frac{1}{2}mol(191.6J/molk) + \frac{3}{2}mol(130.6J/molk)$$
$$\Sigma S_R = 95.8J/k + 195.9J/k$$
$$\Sigma S_R = 291.7J/k$$
$$\Delta S = \Sigma S_P - \Sigma S_R$$
$$\Delta S = 192.7J/k - 291.7J/k = -99J/k$$
$$\Delta S = -99J/k = -0.099kJ/k$$
$$\Delta H = 1mol(-45.90kJ/mol) = -45.90kJ$$

$T = 25^0C = 298k$

$\Delta G = \Delta H - T\Delta S$

$\Delta G = -45.90kJ - 298k(-0.099kJ/k)$

$\Delta G = -45.90kJ + 29.502kJ$

$\Delta G = -16.398kJ/mol$

Since there two moles of ammonia formed in the reaction

$\Delta G = 2(-16.398kJ/mol)$

$\Delta G = -32.796kJ \approx -32.8kJ$

The correct option is B

21. One basic rule of the stability of an orbital is that for the transition elements whenever the 3d-orbital require one electron to be half filled or fully filled the 4s-orbital must take one electron.

This is seen in chromium (Cr), Copper (Cu), silver (Ag), Gold (Au) etc.

$_{26}Cr = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

$_{26}Cr = [Ar]4s^1 3d^5$

For the transition elements to form ion, they must lose all the 4s-orbital electrons before losing the 3d-orbital electrons.

$_{26}Fe = 1s^2 2s^2 2p^6 3s^2 3p^s 4s^2 3d^6$

$_{26}Fe = [Ar]4s^2 3d^6$

$_{26}Fe^{+} = [Ar]4s^1 3d^6$

$_{26}Fe^{2+} = [Ar]4s^0 3d^6$

The correct option is B

22.

$C_2H_5OH + 3O_2$

$\rightarrow 2CO_2 + 3H_2O;\ \Delta H = -1264 kJmol^{-1}$

$CH_3CHO + \frac{5}{2}O_2$

$\rightarrow 2CO_2 + 2H_2O;\ \Delta H = -1130 kJmol^{-1}$

Reverse equation two. Note that reversing an equation also reverse it the sign of its ΔH

$C_2H_5OH + 3O_2$

$\rightarrow 2CO_2 + 3H_2O\ \Delta H = -1264 kJmol^{-1}$

$2CO_2 + 2H_2O$

$\rightarrow CH_3CHO + \frac{5}{2}O_2\ \Delta H = +1130 kJmol^{-1}$

$C_2H_5OH + \frac{1}{2}O_2$

$\rightarrow CH_3CHO + H_2O\ \Delta H = -134 kJ/mol$

The correct option is C

23. **Isotopes:-** *Isotope is the name given to atoms of the same element with the same atomic number but different Neutron numbers* e.g. $^{37}_{17}Cl$ and $^{37}_{17}Cl$; $^{1}_{1}H$, $^{2}_{1}H$ and $^{3}_{1}H$; $^{235}_{92}U$ and $^{236}_{92}U$; $^{12}_{6}C$, $^{13}_{6}C$ and $^{14}_{6}C$; $^{16}_{8}O$, $^{17}_{8}O$ & $^{18}_{8}O$ etc. Isotopes of an element, has the same chemical properties but different physical properties.

Isotones *are atoms of different element with the same neutron numbers* e.g. $^{15}_{8}O$ and $^{14}_{7}N$. Isotones show different chemical and physical properties because they are atoms of diff element.

***Isobars** are atoms of different element wit same mass number* e.g. $^{23}_{12}Mg$ and Isobars show different chemical and phy properties because they are atoms of diff element.

A **nuclide** is a nuclear species with spe atomic number and mass number e.g $^{24}_{12}Mg$, $^{23}_{11}Na$ etc.

The correct option is D

24. The wave-particle duality of matter states every small particles such as electrons ex wave properties under certain condit Louis de Broglie predicted that a particle a mass, m and velocity, v will exhib characteristics wavelength associated wit Louis de Broglie derived an equation for wavelength of a small particle of mass, m velocity, v by equating Einstein's equation Planck's equation.

$E = mc^2$ ..... *Einstein's equation*

$E = \frac{hc}{\lambda}$ ..... *Planck's equation*

$mc^2 = \frac{hc}{\lambda}$

$mc = \frac{h}{\lambda}$

$mc\lambda = h$

$\lambda = \frac{h}{mc}$

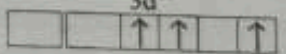
For the particle moving with a speed of u, equation becomes

$\lambda = \frac{h}{mu}$ ..... de broglie's equation

The correct option is A

25. $_{30}Zn \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$

$_{30}Zn \rightarrow [Ar]4s^2\ 3d^{10}$



Number of unpaired electrons = 0

Number of pair electrons

$= \frac{\text{No of } e^- \text{ in the species} - \text{No of unpair}}{2}$

$= \frac{30 - 0}{2} = \frac{30}{2} = 15$

The correct option is D

CHM 001 TEST 2016/2017

TIME ALLOWED: 45 MINUTES

1. Covalent bonds are formed as a result overlapping of atomic orbitals and hybrid orbitals such as: (i) $s - s$ (ii) p (linearly opposed) (iii) $p - p$(parallel) $sp - s$ (v) $sp^2 - s$ (vi)$sp^3 - s$ (vii)sp (linearly opposed) (viii)$sp^2 - p$(Linea opposed) (ix) $sp^3 - p$ (linearly oppos

which of these overlappings are present in carbon (IV)oxide molecule? (a) (iii) and (vii) (b) (i),(iv) and (viii) (c) (i), (ii) and (iv) (d) (v),(vi) and (ix)

2. A mixture contains three colourless solutes A, B and C. The solubility of these solutes in different solvents is as follows

	Ethanol	Water	Petrol
A	Insoluble	Soluble	Insoluble
B	Soluble	Insoluble	Very soluble
C	Soluble	Soluble	Insoluble

What would be the quickest way to get some of the substance A from the mixture of A, B and C? (a) Addition of water to precipitate A followed by decantation (b) Addition of ethanol to precipitate A followed by filtration (c) Addition of petrol and ethanol to sediment A followed by filtration (d) Addition of water and petrol to precipitate A followed by decantation.

3. How many unpaired electrons are there in the ground state of phosphorus atom? (a) Three (b) One (c) Four (d) Two
4. How many oxygen atoms are present in $50g$ of hydrogen sulphide? [H= 1.0; $S = 32.0$; $N_A = 6.022 \times 10^{23}$](a) 8.86×10^{23} (b) 6.022×10^{23}(c) 8.86×10^{24}(d) 1.77×10^{24}
5. Which atom has the highest first ionization energy? (a) Si (b) P (c) S (d) Al
6. The Volume occupied by a certain mass of hydrogen gas collected over water at $28°C$ and $769mmHg$ was $35cm^3$.What would be the volume in $cm^3$of the dry gas at s.t.p if the saturated vapour pressure of water at $28°C$ is $13.5\,mmHg$? (a) 35.00 (b) 17.3 (c) 31.6 (d) 234.2
7. A 2.0gram sample containing Calcium is treated appropriately to precipitate 3.0grams of $Ca_3(PO_4)_2$ (Molecular mass =310) the mass percent of calcium in the original sample is closest to (a) 58% (b) 39% (c) 26% (d) 58%
8. The electronic configuration of two elements with similar chemical properties are represented by
(a)$1s^2\ 2s^2\ 2p^6\ 3s^1$ *and* $1s^2\ 2s^1$,
(b)$1s^2\ 2s^2\ 2p^4$ *and* $1s^2\ 2s^2\ 2p^6\ s^1$
(c)$1s^2\ 2s^2\ 2p^4$ *and* $1s^2\ 2s^1$
(d) $1s^2\ 2s^2\ 2p^5$ *and* $1s^2\ 2s^2\ 2p^4$
9. A substance is described by the following properties (a) a white solid (b) insoluble in water (c) melting point of $79-80°C$ (d) cannot be split up into simpler substances by physical methods (v) homogeneous. Which of these properties show(s) that the substance is pure? (a) (i) and (ii) (b) (iii) only (c) (iii), (iv) and (v) (d) (i),(ii) and (iii)
10. If $5.0dm^3$of gas X weighed $17.32g$ at $27°C$ and 1.2atmospheric pressures, the molar mass of X is? (Molar volume of any gas at s.t.p=$22.4dm^3mol^{-1}$)
(a)71.0 $gmol^{-1}$(b)28.0 $gmol^{-1}$(c) 16.0 $gmol^{-1}$ (d) 35.0 $gmol^{-1}$
11. Arrange the following isoelectronic ions in order of increasing radius: $Al^{+3}, F^-, Mg^{2+}, N^{3-}, Na^+, O^{2-}$
(a)$F^- < O^{2-} < N^{3-} < Al^{3+} < Mg^{2+} < Na^+$
(b) $Na^+ < Mg^{2+} < Al^{3+} < F^- < O^{2+} < N^{3-}$
(c)$Al^{3+} < Mg^{2+} < Na^+ < N^{3-} < O^{2-} < F^-$
(d)$Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$
12. Which of the following are characteristics of beta decay emission? (i) increase in the atomic number (ii)increase in the mass number (iii) decrease in the number of protons (iv) No change in the mass number (v) rays are absorbed by a sheet of paper/aluminium foil (a) i, iv and v (b) i, ii and iv (c) i, iii and v (d) ii, iii and iv
13. Given the atomic masses of sulphur and iron to be $32g$ and $56g$ respectively, consider the following composition: (i) $16g$ of sulphur heated with $28g$ of iron (ii) $32g$ of sulphur heated with $56g$ of iron (iii) $4g$ of sulphur heated with $7g$ of iron (iv) $10g$ of sulphur heated with $18g$ of iron (v) $18g$ of sulphur heated with $44g$ of iron . Which of the lists above forms a mixture? (a) II and III (b) I, II and V (c) III and V (d) IV and V
14. Naturally occurring Lithium consist of 90% ^7_3Li and 10% ^6_3Li.What is the relative atomic mass of Lithium? (a) 6.9 (b) 7.0 (c) 7.1 (d) 6.8
15. The Chromatographic separation of ink or coloured substance is based on which of the following factors? (i) The adsorption of the solutes by the paper (ii) The dissolution of the solutes in the solvent (iii) Mass of the solutes (iv) Nature of the solvent (a) II and III (b) I, II and IV (c) I and IV (d) II, III and IV
16. How many values of azimuthal quantum number, ℓ, are possible in the $n = 5$ main energy level (a) 5 (b) 1 (c) 2 (d) 3
17. If 2.35g of calcium trioxocarbonate IV were treated with$150cm^3$ of a $0.20moldm^{-3}$of hydrochloric acid solution, the percentage of mass of the excess salt is? (a) 56.70% (b) 63.50% (c) 36.20% (d) 78.70%
18. Which of the following postulates of Dalton's atomic theory still hold? (a) Particles of different element combine in a simple whole

number ratio (b) The particles of the same element are exactly alike (c) Atoms can neither be created nor destroyed (d) All elements are made of small indivisible particles

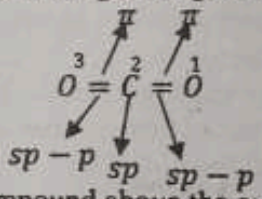
19. $^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + X$ .What is the identity of X (a) $4(^{1}_{0}n) + 2(^{0}_{-1}e)$ (b) $^{3}_{1}H + {}^{1}_{1}P$ (c) $^{4}_{2}He$ (d) $^{4}_{1}H$
20. Listed below are some ionic compounds (i)Caesium Fluoride (ii)Sodium Bromide (iii)Lithium Iodide (iv) Sodium Chloride. The correct order of increasing ionicness is (a) (iv),(i),(iii),(ii) (b) (iii),(ii),(iv),(i) (c)(i),(ii), (iii),(iv) (d) (ii),(iii),(i),(iv)
21. Consider the substances/systems below: (i) Harmattan haze (ii) Sugar solution (iii) Common salt solution (iv) Powered chalk in water (vi) Aqueous solution of ethanol. Which of these substances/systems would exhibit Tyndall's effect? (a) i, iv and v (b) ii, iii and vi (c) ii only (d) i only
22. Which of the following postulate of the kinetic theory of gasses are not strictly obeyed by real gasses, particularly at high pressure and low temperatures? (i) gas molecules are in constant motion (ii) Gas molecules collide with themselves and with the wall of their containers (iii) The volume of gas molecules is negligible (iv) The collision of gas molecules is perfectly elastic (v) The cohesive forces between the gas molecules are negligible (a) i, ii and iii (b) iii and v only (c) ii, iv and v (d) ii, iii and iv
23. What is total number of different values that the magnetic quantum number, m_ℓ, can have for d-orbitals with orbital angular momentum quantum number $\ell = 2$ (a) 3 (b) 7 (c) 5 (d) 14
24. Which of the following orbital designations are incorrect: 1s, 1p, 7d, 3f, 4f, and 2d (a) 3f and 7d (b) 1p, 2d and 7d (c) 1p and 2d (d) 1p, 3f and 2d
25. Phosphorous sulphide, P_4S_3, is used in the heads of wooden matches. This material is manufactured by heating a mixture of red phosphorus and sulphur $8P_4 + 3S_8 \rightarrow 8P_4S_3$. If $10.0g$ of phosphorus and $17.0g$ of sulphur are reacted, how many phosphorus sulphide will be produced? [Atomic mass: $P = 31g/mol$; $S = g/mol$]

(a) $1.78g$ (b) $13.95g$ (c) $38.95g$ (d) $17.74g$

SOLUTION

1. **Sigma bond** (σ) is a bond that is involve in the formation of a new compound. In other words, sigma bond is a bond that is not broken in the formation of a new compound. As a rule, all single bonds are sigma bond. In any multiple bonds (double or triple) there is only one sigma bond the rest are pie (π) bonds. Sigma bonds are formed by
   (i) Hybrid-Hybrid orbital
   (ii) Hybrid-s orbital
   (iii)Hybrid-p orbital
   (iv)s-s orbital
   (v) p-p orbital linearly overlapped

   Pie bond (π) is a bond that is broken down in the formation of a new compound. In other words, pie (π) bond is a bond that is not involved in the formation of a new compound. Pie (π) bonds are formed by $p-p$ orbital that are laterally, parallel or side-way oriented. Sigma (σ) bond is stronger than pie (π) bond because of the higher degree of overlapping.



   In the compound above the overlapping orbital are
   (i) $sp-p$ sigma bond (linearly opposed) between carbon 2 and oxygen atom 1
   (ii) $p-p$ pie bond(parallel or sideway oriented) between carbon 2 and Oxygen atom 1
   (iii) $sp-p$ sigma bond (linearly opposed) between carbon 2 and oxygen atom 3
   (iv) $p-p$ pie bond (parallel or sideway oriented) between carbon 2 and Oxygen atom 3

   Note that the outermost subshell of oxygen is the p-subshell

   The correct option is A
2. A mixture is a substance that contains two or more substance (i.e. elements or compounds) physically combine together. Mixtures are generally divided into two groups.

   Heterogeneous mixture:- It is a mixture without a uniform composition. In other words, heterogeneous mixture is a mixture in which the components of the mixture separate into distinct layers e.g. a mixture of water and sand, a mixture of petrol and water, a mixture of ethanol and iron II tetraoxosulphate VI, sea-water, flooded water,

   Homogeneous mixture:- Is a mixture with a uniform composition. In other words, homogeneous mixture is a mixture in which the components of the mixture do not separate into distinct layer e.g. air, urine, crude oil or petroleum, blood plasma, coca-cola, palm

wine, soil, ripe fruits, stones, clay, gasoline, milk, alloy (e.g. brass, bronze, duralumin etc) honey, rubber latex, vulcanizer's solution etc. The solute A is insoluble in ethanol and petrol but soluble in water. Solute B and C are soluble in ethanol. To separate the solute A from B and C the following are the steps

(i) Addition of ethanol to dissolve B and C leaving behind A. The insoluble solute A in ethanol can be filter off if it is a precipitate or decant if it is a liquid

(ii) Addition of petrol to dissolve B, leaving behind A and C. Addition of ethanol to dissolve C leaving behind A. The insoluble solute A in ethanol can be filter off if it is a precipitate or decant if it is a liquid.

Note that step one is the quickest way to separate A from the mixture

The correct option is B

3. $_{15}P \rightarrow [Ne]\ 3s^2\ 3p^3$

$\rightarrow$ [Ne] $\boxed{\uparrow\downarrow}\ \boxed{\ }\ \boxed{\ }\ \boxed{\ }$

(a) Number of unpaired electrons = 3

(b) Number of pair electrons

$$= \frac{\text{Total no of } e^- - \text{No of unpair } e^-}{2}$$

$$= \frac{15-3}{2} = \frac{12}{2} = 6$$

The correct option is A

4. $R.M.M\ of\ H_2S = 34g/mol$

$mass\ of\ H_2S = 50g$

$$mass\ of\ H\ in\ H_2S = \frac{R.A.M\ of\ H}{R.M.M\ of H_2S} \times mass\ of\ H_2S$$

$$mass\ of\ H\ in\ 50g\ of\ H_2S = \frac{2}{34} \times 50g$$

$= 2.9412g$

$$\cap_H = \frac{mass\ of\ H}{Molar\ mass\ of\ H} = \frac{2.9412}{1}$$

$= 2.9412mol$

$$\cap_H = \frac{No\ of\ atoms\ of\ H}{6.02 \times 10^{23}}$$

$$2.9412mol = \frac{No\ of\ atoms\ of\ H}{6.02 \times 10^{23}}$$

$No\ of\ atoms\ of\ H = 2.9412 \times 6.02 \times 10^{23}$

$No\ of\ atoms\ of\ H = 1.77 \times 10^{24}$

The correct option is D

5. $_{14}Si \rightarrow [Ne]\ 3s^2\ 3p^2$

$_{15}P \rightarrow [Ne]\ 3s^2\ 3p^3$

$_{16}S \rightarrow [Ne]\ 3s^2\ 3p^4$

$_{13}Al \rightarrow [Ne]\ 3s^2\ 3p^1$

All the species above have the same number of shells as denote by the highest principal quantum (i.e. 3). Since the species have the same number of shells (i.e. are in the same period), the stability of the species determine their ionization energy. The species will the most stable orbital will have the highest ionization energy.

species	$P - e^-$	Orbital filling	stability
$_{14}Si \rightarrow [Ne]\ 3s^2\ 3p^2$	2	partial	unstable
$_{15}P \rightarrow [Ne]\ 3s^2\ 3p^3$	3	half	stable
$_{16}S \rightarrow [Ne]\ 3s^2\ 3p^4$	4	partial	unstable
$_{13}Al \rightarrow [Ne]\ 3s^2\ 3p^1$	1	partial	unstable

An orbital is said to be stable if it is fully or half filled with electrons.

The species with stable orbital is P. Hence Phosphorus (P) will have the highest first ionization.

The correct option is B

6. Note that whenever a gas is collected over water, the given pressure is the total pressure exerted by the mixture of the gas and water.

$V_1 = 35cm^3$

$T_1 = 28°C = 301k$

$P_T = 769mmHg$

$P_1 = ?$

$P_{H_2O} = 13.5mmHg$

$V_2 = ?$

$P_2 = 760mmHg\ at\ s.t.p$

$T_2 = 273K\ at\ s.t.p$

$P_T = P_1 + P_{H_2O}$

$769 = P_1 + 13.5$

$P_1 = 769 - 13.5 = 755.50mmHg$

$P_1 = 755.50mmHg$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{755.50 \times 35}{301} = \frac{760 \times V_2}{273}$$

$273 \times 755.50 \times 35 = 760 \times 301 \times V_2$

$$V_2 = \frac{273 \times 755.50 \times 35}{760 \times 301} = 31.556cm^3$$

$V_2 \approx 31.60cm^3$

The correct option is C

7. Mass of sample = $2.0g$

Mass of $Ca_3(PO_4)_2 = 3.0g$

R.M.M of $Ca_3(PO_4)_2 = 310g/mol$

$$Mass\ of\ Ca\ in\ Ca_3(PO_4)_2 = \frac{R.A.M\ of\ Ca}{R.M.M\ of\ Ca_3(PO_4)_2} \times mass\ of\ Ca_3(PO_4)_2$$

$$Mass\ of\ Ca\ in\ 3g\ of\ Ca_3(PO_4)_2 = \frac{3 \times 40}{310} \times 3$$

$Mass\ of\ Ca\ in\ 3g\ of\ Ca_3(PO_4)_2 = 1.1613g$

$$\%\ of\ Ca = \frac{mass\ of\ Ca\ in\ sample}{mass\ of\ sample} \times 100$$

$$\%\ of\ Ca = \frac{1.1613g}{2g} \times 100 = 58.065\%$$

$\%\ of\ Ca \approx 58\%$

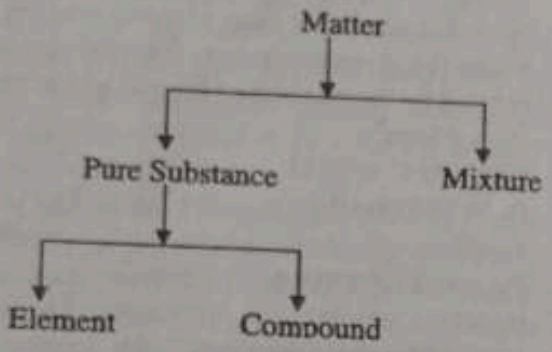
The correct option is A

8. Elements with the same valence electrons show similar chemical properties because they are in the same group. The valence electrons is the number of electrons in the outermost subshell of an element

configuration	Valence electrons	Group	Period
$1s^2\ 2s^2\ 2p^6\ 3$	1	1	3
$1s^2\ 2s^1$	1	1	2
$1s^2\ 2s^2\ 2p^4$	6	6	2
$1s^2\ 2s^2\ 2p^5$	7	7	2

The correct option is A

9.



Characteristics of pure substance

(i) Pure substance are homogeneous
(ii) Pure substance has narrow range of melting point e.g. $79 - 80°C$
(iii) Pure substance has narrow range of boiling point e.g. $120 - 124°C$
(iv) Elements cannot be split into simpler unit by any known chemical or physical process
(v) Compounds have properties have different from their constituent elements
(vi) Pure substance can be represent with symbol(element) or chemical formula (compounds)

The correct option is D

10. $V = 5dm^3, m = 17.32g, T = 27°C = 300k$
$P = 1.2atm, R = 0.0821atmdm^3/molk$

$PV = nRT$

$n = \frac{m}{M}$

$PV = \frac{mRT}{M}$

$M = \frac{mRT}{PV} = \frac{17.32 \times 0.0821 \times 300}{1.2 \times 5}$

$M = 71.0986g/mol \approx 71g/mol$

Method 2

$V_1 = 5dm^3, m = 17.32g, T_1 = 27°C = 300k$
$P_1 = 1.2atm$
$V_2 = ?$
$P_2 = 1atm\ at\ s.t.p$
$T_2 = 273K\ at\ s.t.p$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{1.2 \times 5}{300} = \frac{1 \times V_2}{273}$

$273 \times 1.2 \times 5 = 1 \times 300 \times V_2$

$V_2 = \frac{273 \times 1.2 \times 5}{1 \times 300} = 5.46dm^3$

$n_X = \frac{mass\ of\ X}{Molar\ mass} = \frac{Vol\ at\ s.t.p}{Molar\ gass\ volume}$

$\frac{17.32}{M} = \frac{5.46dm^3}{22.4dm^3/mol}$

$M = \frac{17.32 \times 22.4}{5.46} = 71.0564 \approx 71g/mol$

The correct option is A

11. Isoelectronic ions are ions with the same number of electrons. The size of isoelectronic ion is governs by the rules.
(i) The higher the positive charge on the ion the smaller the atomic size
(ii) The higher the negative charge on the ion the greater the atomic size

$Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-} < N^{3-}$

The correct option is D

12. If a nuclide emits an alpha particle it mass number will decrease by 4 and its atomic number by 2 e.g.

$^{31}_{15}P \rightarrow {}^{27}_{13}P + {}^{4}_{2}He$

An Alpha particle (^4_2He) has the following properties.

- It is positively charge
- It is a heavy molecules
- It has a quality number of 20.(Quality number is the amount of a radioactive radiation which when absorb by a body produces harm)
- It travel at the speed of $\frac{1}{20}$th the speed of light i.e. $1.5 \times 10^7 m/s$
- It has a low penetrating power
- It causes the fluorescence of some substance (e.g. ZnS)
- It is absorb or stop by thin sheet of paper and
- It ionizes the molecule of air

If a nuclide emits a beta particular its mass number remains the same while it atomic number increases by 1 e.g.

$^{23}_{11}Na \rightarrow {}^{24}_{12}Mg + {}^{0}_{-1}\beta$

A beta particle ($^0_{-1}e$ or $^0_{-1}\beta$) has the following properties.

- It is negatively charge
- It is a light particle
- It has a variable speed

- It is absorb or stop by thin sheet of Aluminium
- It produces a less ionization effect on the molecules of air and
- It has a higher penetrating power than the alpha particle.

If a nuclide emits a gamma-ray its mass number and atomic number remain the same. Gamma rays are always emitted along side with either an alpha or beta particle or both. e.g.

$^{236}_{92}U \rightarrow {}^{232}_{90}Th + {}^{4}_{2}He + \gamma$

A gamma ray (γ) has the following properties

- It is electrically neutral
- It travel at the speed of light i.e. $3 \times 10^8 m/s$
- It has quality number of 1
- It has the highest penetrating power
- It is absorb or stop by thick lead block and
- It ionizes gases and penetrates matter.

The correct option is A

13. Sulphur reacts with Iron when heated to form Iron II sulphur (FeS). 1mole of Iron is needed to react with 1mole of Sulphur to form one of Iron II sulphur. Thus, any combination of Sulphur and Iron in which the moles of Sulphur and Iron are not equal will result to the formation of mixture.

$$\cap_{Fe} = \frac{mass\ of\ Fe}{Molar\ mass\ of\ Fe}$$

$$\cap_{S} = \frac{mass\ of\ S}{Molar\ mass\ of\ S}$$

$16g$ of Sulphur heated with $28g$ of Iron

$$\cap_{Fe} = \frac{28}{56} = 0.5mol$$

$$\cap_{S} = \frac{16}{32} = 0.5mol$$

$Fe:S = 0.5:0.5 = 1:1$

Since the ratio of the number of moles of Fe to S is 1 : 1, the composition does not result to mixture.

$32g$ of Sulphur heated with $56g$ of Iron

$$\cap_{Fe} = \frac{56}{56} = 1mol$$

$$\cap_{S} = \frac{32}{32} = 1mol$$

$Fe:S = 1:1$

Since the ratio of the number of moles of Fe to S is 1 : 1, the composition does not result to mixture.

$4g$ of Sulphur heated with $7g$ of Iron

$$\cap_{Fe} = \frac{7}{56} = 0.125mol$$

$$\cap_{S} = \frac{4}{32} = 0.125mol$$

$Fe:S = 0.125:0.125 = 1:1$

Since the ratio of the number of moles of Fe to S is 1 : 1, the composition does not result to mixture.

$10g$ of Sulphur heated with $18g$ of Iron

$$\cap_{Fe} = \frac{18}{56} = 0.3214mol$$

$$\cap_{S} = \frac{10}{32} = 0.3125mol$$

$Fe:S = 0.3214:0.3125 = 1.0286:1$

Since the ratio of the number of moles of Fe to S is not 1 : 1, the composition result to mixture.

$18g$ of Sulphur heated with $44g$ of Iron

$$\cap_{Fe} = \frac{44}{56} = 0.7857mol$$

$$\cap_{S} = \frac{18}{32} = 0.5625mol$$

$Fe:S = 0.7857:0.5625 = 1.3968:1$

Since the ratio of the number of moles of Fe to S is not 1 : 1, the composition result to mixture.

The correct option is D

14. $R.A.M\ of\ Li = \alpha_1 m_1 + \alpha_2 m_2$

$\alpha_1 = 90\% = 0.9\ \&\ m_1 = 7$

$\alpha_2 = 10\% = 0.1\ \&\ m_2 = 6$

$R.A.M\ of\ Li = 0.9 \times 7 + 0.1 \times 6$

$R.A.M\ of\ Li = 6.3 + 0.6 = 6.9$

The relative atomic mass of Li is $6.9g/mol$.

The correct option is A

15. **Chromatography** is a separation technique used to separate mixture of gases, liquids, dissolved substance or complex organic mixture such as ink, chlorophyll etc. A brand of ink containing cobalt II, copper II and iron II ions can best be separated by chromatography. Note that an aqueous solution of cobalt II, copper II and iron II ions can best be separated by fractional crystallization or precipitation. Note the thin line of difference, if the cobalt II, copper II and iron II ions is in a liquid (besides water e.g. ink) the separation technique is chromatography but if cobalt II, copper II and iron II ions are in aqueous solution (i.e. water) the separation technique is fractional crystallization or precipitation.

The principle of chromatography states that if a mixture is allowed to travel through an adsorbent medium, the components of the mixture may travel at different rate which can then be separated. Thus chromatography is based on the different adsorbent power of solvents on the medium and rate of migration of a solute in an adsorbent medium.

The chromatographic separation of substance is base on the following factors

(i) The nature of the solvent

(ii) The adsorption of the solute on the chromatographic plate(e.g. paper)

(iii)Dissolution of the solute on the solvent

The correct option is B

16. **Quantum numbers** *are the numbers given to each energy level in an atom.* The four quantum numbers are listed and explained below:

Principal Quantum (n): *This is the quantum number which indicates the relative size of orbitals and therefore the relative distance of an electron from the nucleus of the peak in the radial probability plot thereby determines or describes the main energy level or shell that an electron occupies in an atom.* In summary, the functions of the principal quantum number are stated below:

(i) It determines the energy possessed by an electron due to its distance from the nucleus.

(ii) It determines the size of an electron cloud

(iii)It determines the distance of an electron from the nucleus and

(iv)It determines the maximum number of electrons in a main shell.

The principal quantum number has an integral value of 1, 2, 3, 4, 5 etc.

Subsidiary or Azimuthal Quantum number (ℓ): *This is the quantum number which determines or defines the shape of orbitals.* It is also known as **angular momentum quantum number.** In summary the functions of the subsidiary or azimuthal quantum number are stated below.

(i) It divides subshell into orbital

(ii) It determines the shapes of orbitals and

(iii)It determines the maximum number of electrons in a subshell

The subsidiary or azimuthal quantum number has an integral value of 0 to $(n-1)$.

n	ℓ
5	0
	1
	2
	3
	4

Thus, when $n = 5$, the subsidiary number have 5 values. This implies that the principal quantum number (n) set a limit on the subsidiary quantum number (ℓ). The table below shows the values of ℓ for given values of n.

Magnetic Quantum Number (M_ℓ): *This is the quantum number which indicates or shows the number of orbitals in a given subshell.* It prescribes the orientation of the orbital in space around the nucleus. Therefore it is sometimes called **orbital orientation quantum number.** The integral values of M_ℓ ranges from $-\ell$ through 0 to $+\ell$. The number of possible M_ℓ in a given subshell determines the number of orbitals in the subshell.

Spin quantum number (M_s): *This is the quantum number which is associated with the spin properties of an electron about it axis and the orientation of the magnetic field produced by the spin.* Since a charged particles spinning about its axis behaves like a magnet, the spin quantum number has two possible values which are $-\frac{1}{2}$ and $+\frac{1}{2}$. The electron with an upward spin takes the value $+\frac{1}{2}$ but the electron with a downward spin takes the value of $-\frac{1}{2}$.

The correct option is A

17. **Step 1:** Write a balance chemical equation of the reaction. There are two reactions that are involve here.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Molar mass of $CaCO_3 = 100g/mol$

Mass of $CaCO_3 = 2.35g$

Vol. of $HCl = 150cm^3 = 0.15dm^3$

Conc. of $HCl = 0.2moldm^{-3}$

Step 2: Determine the number of moles of the reactants or products

$$R.M.M\ of\ CaCO_3 = 100g/mol$$

$$\cap_{CaCO_3} = \frac{Reacting\ mass\ of\ CaCO_3}{Molar\ mass\ of\ CaCO_3}$$

$$= \frac{2.35g}{100g/mol}$$

$$= 0.0235mol$$

$$\cap_{HCl} = vol\ in\ dm^3 \times molar\ conc.$$

$$= 0.15 \times 0.2 = 0.03mol$$

Step 3: Determine the limiting reagent and its active mole.

$\cap_{HCl}$	:	$\cap_{CaCO_3}$	
$\frac{0.03}{2}$	:	$\frac{0.0235}{1}$	Active mole of each reactant
0.015	:	0.0235	The least active mole give the limiting reagent

The limiting reagent is HCl

The excess reagent is $CaCO_3$

Step 4: Use the active mole of the limiting reagent to calculate the mole of the species or

substance in which the question is centre or based. The question is based on the mass of $CaCO_3$

$\cap_{CaCO_3}$ *used up* $= 1 \times 0.015 = 0.015 mole$

Excess $\cap_{CaCO_3}$

$= total\ \cap_{CaCO_3}$

$-\cap_{CaCO_3}$ *used up*

Excess $\cap_{CaCO_3} = 0.0235 - 0.015$

$= 0.0085 mol$

Step 5: Calculate what is required.

$$Excess\ \cap_{CaCO_3} = \frac{Reacting\ mass\ of\ CaCO_3}{molar\ mass\ of\ CaCO_3}$$

$$0.0085 mol = \frac{mass\ of\ CaCO_3}{100 g/mol}$$

$$mass\ of\ CaCO_3 = 0.0085 mol \times 100 g/mol$$

$$mass\ of\ CaCO_3 = 0.85 g$$

$$\%of\ Excess\ Ca = \frac{mass\ of\ Excess}{mass\ of\ CaCO_3} \times 100$$

$$\%of\ Excess\ Ca = \frac{0.85}{2.35} \times 100 = 36.20\%$$

The correct option is C

18. DALTON'S ATOMIC THEORY

In 1808 the English scientist, John Dalton proposed the first modern atomic theory. Dalton's atomic theory is summarized as follows

(i) All elements are made up of small, indivisible particles called atoms.
(ii) Atoms can neither be created nor destroy
(iii) Atoms of the same element are alike in every aspect and differ from atoms of all other elements.
(iv) When atoms combine with other atoms, they do so in simple ratio to each other
(v) All chemical changes result from the combination or separation of atoms.

VERIFICATION OF DALTON'S ATOMIC THEORY

(i) All elements are made up of small indivisible particles called atoms. This postulate deals with the particulate nature of matter. The particulate nature of matter can be inferred from the following experiment evidence: Diffusion of coloured crystal, Dilution of coloured solution, Sublimation, Brownian motion of fluid particles, Tyndall effect etc
(ii) Atoms can neither be created nor destroy. This postulate can be verified by the law of conservation of mass.
(iii) Atoms of the same element are alike in every aspect but differ from atoms of all other elements. This postulate can be verified by the law of constant composition or definite proportion.
(iv) When an atom combines with other atoms they do so in simple ratios. This postulate can be verified by the law of multiple proportions.

MODIFICATION OF DALTON'S ATOMIC THEORY

(i) Atoms contain fundamental particles such as protons, electrons and neutrons
(ii) Atoms can neither be created nor destroy during a chemical reaction. However, atoms can be created or destroy during a nuclear reaction
(iii) Atoms of the same elements may not exactly be the same due to the existence of isotopes.
(iv) When atoms combine with other atoms, they do so in simple ratio to each other in inorganic compounds with few exceptions. In organic compounds atoms combine in large amount.

Note that in chemical reactions, atoms can neither be created nor destroy

The correct option is C

19. $^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$

The correct option is C

20. To obtain a highly ionic substance from a cation and anion, the cation must be small and the anion must be very small with higher charges. The factors that affect the strength of an ionic bonding are:

(i) **The size of the ion**: The smaller the size of an ion the greater the ionic bond formed by the ion
(ii) **The charge on the ion**: The higher the charge on an ion the greater the ionic bond formed by the ion
(iii) **Electropositivity or metallic character**: The more electropositive an element is, the stronger the ionic bond form by the element
(iv) **Electronegativity**: The more electronegative an element is, the stronger the ionic bond form by the element

The greater the size of a metal, the greater its Electropositivity or metallic character. The greater the size of a metal, the greater the ease with which it form jons but the weaker the ionic bond form. The more the electronegativity of the non-metal the more the stronger the ionic bond.

$LiI < NaBr < NaCl < CsF$

Since the electronegativities of the elements are different, the compounds are classified base on the electronegativity between the

metal and the non-metal. If the electronegativities are the same, the ionic character will depend on their size. The smaller, the size, the more the ionic character.

The correct option is B

21. Tyndall effect is the ability of colloid or false solution to scatter light ray

Emulsion is a colloid in which small particles of one liquid are dispersed in another liquid. It involves a dispersion of water in oil or a dispersion of oil in water. Water is a polar solvent that does not dissolve non-polar substance. To use water to wash soiled fabrics. Green dishes or human bodies, the water must be enabled to suspend and remove non-polar substances. Soaps and detergents are two common emulsifying agents that can be used to enable water to suspend and remove non-polar substances. A detergent solution shaken with water will produced emulsion. Emulsion is a false solution.

Dispersed (solute-like) phase		**Dispersing (solvent-like) medium**	**Common name**	**Example**
Solid	in	solid	Solid solution	Many alloys (e.g steel and duralumin), some coloured gems, reinforced rubber, piscelain, pigmented plastic etc.
Liquid	in	solid	Solid emulsion	Cheese, butter, jellies
Gas	in	solid	solid foam	Sponge, rubber, punice styrofoam
Solid	in	liquid	sols and gas	Milk of magnesium $(Mg(OH)_2)$, paints, and puddings
Liquid	in	liquid	emulsion	Milk, face cream, salad dressings, mayonnaise
Gas	in	liquid	foam	Sharing cream, whipped cream, foam on beer
Solid	in	gas	Solid aerosol	Smoke, airborne, Harmattan Haze, viruses and particulate matter from auto exhaust
Liquid	in	gas	Liquid aerosol	Fog, mist, aerosol, spony ,clouds.

The correct option is A

22. **Kinetic theory** of gases is also known as **kinetic molecular theory** of gases. *It states that gases are made of tiny particles (i.e. molecules) which are in continuous motion and as a result possesses kinetic energy.* The kinetic theory or molecular theory can be explained by evaporation, expansion, sublimation, dilution of a colour solution, diffusion of colour crystal, conduction, sublimation, Brownian motion etc. Note that the kinetic theory cannot be explained by radiation.

The basic assumptions of the kinetic theory of gases are stated below:-

(i) A gas is composed of molecules that are separated from each other by distance far greater than their own dimensions. The molecules can be considered to be "points"; that is, they possess mass but have negligible volume or size.

(ii) Molecules of a gas are in constant and rapid motion in straight lines until they collide with one another and with the walls of their container. *The implication of this assumption is that molecules of gases exert pressure on each other and on the wall of their container.*

(iii) The collision between the molecules is perfectly elastic. *The implication of this assumption is that gaseous molecules will continue their motion indefinitely.*

(iv) The actual volume occupied by the gas molecules is negligible compared with the volume of the container. *The implication of this assumption is that gases can be compressed.*

(v) Forces of attraction or repulsion between the molecules of a gas are negligible. *The implication of this assumption is that gaseous molecules (i.e. the molecules of gases) will occupy any available space.*

(vi) The average kinetic energy of the gas molecules is proportional to the absolute temperature of the gas molecules.

In reality, ideal gases do not exist. But at low pressure and high temperature, real gases behave as ideal gases.

Ideal gases are gases that satisfy the following conditions:

(i) The actual volume occupied by the gas molecules is negligible compared with the volume of the container.

(ii) Force of attraction or repulsion between the molecules of gases are negligible and

(iii) Obey the gas laws

The correct option is B

23.

ℓ	m_ℓ	total
2	$-2,-1,0,1,2$	5

The correct option is C

24. The orbital $1s, 2d$ and $3f$ does not exist

The correct option is D

25. **Step 1:** Write a balance chemical equation of the reaction. There are two reactions that are involved here.

$8P_4 + 3S_8 \rightarrow 8P_4S_3$

Molar mass of $P_4 = 124g/mol$

Mass of $P_4 = 10g$

Molar mass of $S_8 = 256g/mol$

Mass of $S_8 = 17g$

Molar mass of $P_4S_3 = 220g/mol$

Step 2: Determine the number of moles of the reactants or products

$$\cap_{P_4} = \frac{Reacting\ mass\ of\ P_4}{Molar\ mass\ of\ P_4}$$

$$\cap_{P_4} = \frac{10g}{124g/mol} = 0.08065mol$$

$$\cap_{S_8} = \frac{Reacting\ mass\ of\ S_8}{Molar\ mass\ of\ S_8}$$

$$\cap_{S_8} = \frac{17g}{256g/mol} = 0.0664mol$$

Step 3: Determine the limiting reagent and its active mole.

$\cap_{P_4}$	$\cap_{S_8}$	
$\frac{0.08061}{8}$	$\frac{0.066}{3}$	Active mole of each reactant
0.01001	0.022	The least active mole give the limiting reagent

The limiting reagent is P_4

The excess reagent is S_8

Step 4: Use the active mole of the limiting reagent to calculate the mole of the species or substance in which the question is centre or based. The question is based on the mass of P_4S_3

$\cap_{P_4S_3} = 8 \times 0.01008 = 0.08064mole$

Step 5: Calculate what is required.

$$\cap_{P_4S_3} = \frac{Reacting\ mass\ of\ P_4S_3}{molar\ mass\ of\ P_4S_3}$$

$$0.08064mol = \frac{mass\ of\ P_4S_3}{220g/mol}$$

$mass\ of\ P_4S_3 = 0.08064mol \times 220g/mol$

$mass\ of\ P_4S_3 = 17.7408g \approx 17.74g$

The correct option is D

CHM 001 TEST 2015/2016

TIME ALLOWED: 45 MINUTES

1. Which of the following shows the equation for the 3rd ionization energy for aluminium? (a) $Al^+ \rightarrow Al^{2+} + e^-$ (b) $Al^{2+} \rightarrow Al^{3+} + e^-$ (c) $Al \rightarrow Al^{3+} + 3e^-$ (d) $Al^{3+} + e^- \rightarrow Al^{2+}$
2. Consider the following molecules: I. O_2 II. H_2O III. CH_3OH IV. CH_4 V. $CHCl_3$ VI. CO_2 VII. NH_3 VIII. HCl. Which of these are non-polar? (a) II, V and VII (b) II, III and V (c) III, VII and VIII (d) I, IV and VI
3. A radioactive isotope has a half-life of 56.6 days. What fraction of the isotope remains after 449 days? (a) 3.2×10^{-4} (b) 3.2×10^{-5} (c) 3.2×10^{-6} (d) 3.2×10^{-7}
4. $50cm^3$ of $0.1moldm^{-3}$ $AgNO_3$ and $50cm^3$ of $0.1moldm^{-3}$ $CaCl_2$ solutions are mixed. Assuming that $AgCl$ is completely insoluble, calculate the mass of $AgCl$ formed in this process. [$Ag = 108$; $Cl = 35.5$; $N = 14$; $O = 16$; $Ca = 40$] (a) $0.98g$ (b) $1.43g$ (c) $0.72g$ (d) $0.36g$
5. A student prepared aspirin in a laboratoy experiment using the reaction

$$C_7H_6O_3 + O(OCCH_3)_2 \rightarrow C_9H_8O_4 + CH_3CO_2H$$

Salicylic acid acid anhydride aspirin acetic acid.

The student reacted $1.50g$ salicylic acid with $2.00g$ of acetic anhydride. The yield obtained was $1.50g$ aspirin. The theoretical yield and the percent yield, respectively, are (a) $1.96g$, 85% (b) $1.96g$, 76.5% (c) $1.96g$, 65.7% (d) $1.96g$, 67.5%

6. $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$. $10.6g$ of sodium carbonate reacted with

hydrochloric acid as shown in the equation. The mass of hydrochloric acid required, the molecules of sodium chloride produced and the volume of carbon dioxide released are respectively expressed as: [$Na = 23$, $C = 12$, $O = 16$, $Cl = 35.5$, $H = 1$, $GMV = 22.4dm^3$, $N_A = 6.02 \times 10^{23}\ mol^{-1}$] (a) 7.30g, 1.204×10^{23} molecules, $4.48dm^3$ (b) 7.30g, 1.204×10^{22} molecules, $2.24dm^3$ (c) 0.73g, 1.204×10^{22} molecules, $0.224dm^3$ (d) 7.30g, 1.204×10^{21} molecules, $2.24dm^3$

7. Which of the following combinations of cation and anion will produce a highly ionic compound? (a) large cation and large anion (b) large cation and small anion (c) small cation and small anion (d) small cation and large anion

8. The atomic radius of Be, Mg and Ca are $0.112mm$, $0.160mm$, and $0.197mm$, respectively. Which of the following explains this graduation in atomic radius? (a) Electropositivity decreases from Be to Mg to Ca (b) Electronegativity decreases from Be to Mg to Ca (c) The screening effect of the core electrons increases from Be to Mg to Ca (d) The elements are in the same period.

9. Radioactive element $^{216}_{84}X$ decays to Y by emission of an alpha particle to give (a) $^{212}_{82}Y$ (b) $^{220}_{86}Y$ (c) $^{216}_{82}Y$ (d) $^{210}_{82}Y$

10. What is the standard free-energy change, $\Delta G°$, for the following reaction at $50°C$? $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$. Given that $\Delta H^o_{f(NH_3)} = -45.9 kJmol^{-1}$, $S^o_{(N_2)} = 191.5J/(mol.K)$, $S^o_{(H_2)} = 130.6J/(mol.K)$, $S^o_{(NH_3)} = 193J/(mol.K)$

(a) $58.6kJ$ (b) $-33.1kJ$ (c) $-28.1kJ$ (d) $137kJ$

11. Real gases tend to show deviation from ideal gas behaviour because (a) Gas molecules move randomly in straight lines (b) The average kinetic energy of real gas molecules is a measure of the gas temperature (c) There are attractive forces between molecules of real gases (d) Collision of gas molecules is perfectly elastic.

12. The formation of which of the following molecules defy the usual attainment of stable electronic configuration similar to those of noble gases by the central atoms? I. PCl_3 II. PCl_5 III. BF_3 IV. SF_6 V. NH_3 (a) I, II, III (b) I, III, V (c) II, IV, V (d) II, III, IV

13. Which of the following sets of quantum numbers are allowed in the boron atom? (a) n = 2, l = 0, $m_l = 3$, $m_s = 1$ (b) (a) n = 3, l = 2, $m_l = 2$, $m_s = -\frac{1}{2}$ (c) (a) n = 2, l = 1, $m_l = 1$, $m_s = +\frac{1}{2}$ (d) (a) n = 1, l = 1, $m_l = 4$, $m_s = -1$

14. The empirical formula of styrene is CH; the molar mass of styrene is 104.14 g/mol. What number of H atoms is present in a 2.00g sample of styrene? (a) $1.56 \times 10^{22} H$ atoms (b) $9.26 \times 10^{22} H$ atoms (c) $5.26 \times 10^{22} H$ atoms (d) $7.62 \times 10^{22} H$ atoms

15. The processes involved in the separation of the mixtures of iron filings, iodine, sand, sodium chloride are: (a) Magnetization, filtration, sublimation, dissolution and evaporation (b) Magnetization, dissolution, sublimation, evaporation and filtration (c) Magnetization, sublimation, dissolution, filtration and evaporation (d) Magnetization, dissolution, sublimation, filtration and evaporation.

16. How much heat is evolved when $9.07 \times 10^5 g$ of ammonia is produced according to the chemical equation? $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}; \Delta H = -92.07J$ (a) $-24.56kJmol^{-1}$ (b) $-245.60kJmol^{-1}$ (c) $-2456.00kJ\ mol^{-1}$ (d) $-24560.00kJmol^{-1}$

17. $45m^3$ of hydrogen is sparked with $15cm^3$ of oxygen at $100°C$ and 1 atmosphere. The total volume of the residual gases is? (a) $60cm^3$ (b) $15cm^3$ (c) $45cm^3$ (d) $75\ cm^3$

18. Below is a list of some substances: I. Satchet water II. Distilled water III. Bronze IV. Gold V. Emulsion paint VI. Calcium trioxocarbonate (iv). Which of these substances are pure? (a) II, III and IV (b) I, III and V (c) I, II and IV (d) II, IV and VI

19. Consider an element R whose electronic configuration is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^8$. Which of the following statements are correct about R? I. It is a p-block element II. It is a transition element III. It forms a colourless salt IV. It has four unpaired electrons V. It is diamagnetic VI. It is paramagnetic (a) I, II and IV (b) I, III and (c) II, III and VI (d) II, IV and VI

20. The pH of a 0.002M sodium hydroxide solution is (a) 46 (b) 2.7 (c) 11.3 (d) 12.6

21. In the discharge tube experiment by J.J. Thompson, for the study of sub atomic particles, which of the particles were represented by the colours reddish and greenish glow, respectively? (a) Electrons and Protons (b) Neutrons and Protons (c) Electrons and Neutrons (d) Protons and Electrons

22. Fungal laccase, a blue protein found in wood-rotting fungi, is 0.390% Cu by mass. If a fungal laccase molecule contains 4 copper atoms, what is the approximate molar mass of

fungal laccase? [Cu = 63.5]. (a) $6.5 \times 10^4 g/mol$ (b) $1.6 \times 10^4 g/mol$ (c) $4.5 \times 10^4 g/mol$ (d) $3.2 \times 10^4 g/mol$

23. Any ionic or molecular species that can accept a lone pair of electrons in the formation of a coordinate covalent bond is (a) a Lewis base (b) a Lewis acids (c) a neutral compound (d) an amphoteric compound

24. The hybridization schemes of the central atoms of the molecules: NH_3, BF_3, CH_4, $BeCl_2$, H_2O and CO_2 are respectively
(a) $sp^3, sp^2, sp^3, sp, sp^3$ and sp
(b) sp, sp^3, sp^2, sp, sp and sp^3
(c) $sp^2, sp^2, sp, sp^3, sp^3$ and sp
(d) sp, sp^2, sp, sp^3, sp^2 and sp^3

25. Which of the following involves a positive entropy change? (a) $Na_{(s)} + Au^+_{(aq)} \rightarrow Na^+_{(aq)} + Au_{(s)}$ (b) $H_2O_{(g)} \rightarrow H_2O_{(l)}$ (c) $C_2H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(g)}$ (d) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

SOLUTION

1. **Ionization energy** or **potential** is the energy required to remove one mole of electron from a gaseous atom to form a cation.
$Al_{(g)} \rightarrow Al^+_{(g)} + e^- \Delta H$ = 1st ionization energy
$Al^+_{(g)} \rightarrow Al^{2+}_{(g)} + e^- \Delta H$ = 2nd ionization energy
$Al^{2+}_{(g)} \rightarrow Al^{3+}_{(g)} + e^- \Delta H$ = 3rd ionization energy
Note that the third ionization energy is greater than the second ionization energy while the second ionization energy is greater than the first ionization energy.

The correct option is B

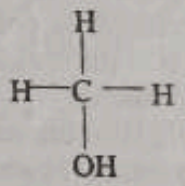
2. Dipole is the name given to a pair of separated opposite electric charges. The dipole moment of a dipole is the product of the positive charge and the distance between the charges. Molecules with dipole moments are called polar molecules. Thus, a polar molecules is a molecule in which there is some separation of charges in the chemical bonds, so that one part of the molecules has a positive charge and the other part has a negative charge e.g. $H_2O\begin{pmatrix}\delta+\ \delta-\\ H-OH\end{pmatrix}$, $HCl\begin{pmatrix}\delta+\ \delta-\\ H-Cl\end{pmatrix}$, $HF\begin{pmatrix}\delta+\ \delta-\\ H-F\end{pmatrix}$ etc'
The polarity of a molecule depends on the nature of the bonds between atoms and the shape of the molecule.
(i) Carbon iv oxide, CO_2. To determine either or not carbon iv oxide is polar, the Lewis structure must be known.

$$\ddot{O}=C=\ddot{O}$$

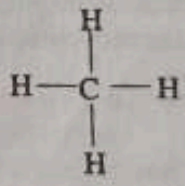
The Lewis structure of carbon iv oxide shows that the molecule is linear and is sp hybridized. The polar bond between carbon and oxygen cancel out because they are opposite to each other. Thus, carbon iv oxide is a non-polar molecule.
Oxygen molecule, O_2. To determine either or not Oxygen molecule is polar, the Lewis structure must be known.

$$\ddot{O}=\ddot{O}$$

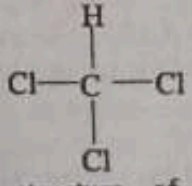
The Lewis structure of Oxygen shows that the molecule is linear. The non-polar bond between oxygen shows that the molecule is non-polar Hence the molecule is non-polar.
Methanol, CH_3OH. To determine either or not Methanol is polar, the Lewis structure must be known.



The Lewis structure of methanol shows that the molecule is tetrahedral and SP^3 hybridized. As a result, the polar bond between carbon and oxygen and carbon and hydrogen does not cancel out since all the bonds are not the same. Hence the molecule is polar.
Methane, CH_4. To determine either or not Methane is polar, the Lewis structure must be known.



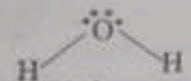
The Lewis structure of Methane shows that the molecule is tetrahedral and SP^3 hybridized. As a result, the non-polar bond between carbon and Hydrogen shows that the molecule is not polar.
Trichloromethane, $CHCl_3$. To determine either or not trihloromethane is polar,the Lewis structure must be known.



The Lewis structure of trichloromethane shows that the molecule is tetrahedral and SP^3 hybridized.As a result, the polar bond between carbon and chlorine and carbon and hydrogen

does not cancel out since all the bonds are not the same. Hence the molecule is polar.

Water, H_2O. To determine either or not water is polar, the Lewis structure must be known



V-shape

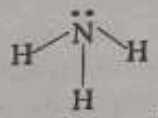
The Lewis structure of water shows that the molecule is V-shape and SP^3 hybridized.As a result, the polar bond between Oxygen and Hydrogen does not cancel. Hence water is be polar

Hydrogen chloride, HCl. To determine either or not Hydrogen chloride is polar, the lewis structure must be known.

$$H — Cl$$

The Lewis structure of Hydrogen chloride shows the molecule is polar because of the difference in the electronegativity of Hydrogen and chlorine

Ammonia, NH_3. To determine either or not ammonia is polar, the Lewis structure must be known.



Trigonal pyramidal

The Lewis structure of ammonia shows that the molecule is Trigonal pyramidal and SP^3 hybridized.As a result, the polar bond between Nitrogen and Hydrogen does not cancel out make the molecule to be polar.

The correct option is D

3. $T_{\frac{1}{2}} = 56.6days$

$t = 449days$

$T_{\frac{1}{2}} = \frac{t}{n}$

$n = \frac{t}{T_{\frac{1}{2}}} = \frac{449}{56.6} = 7.93286$

$N_R = N_0\left(\frac{1}{2}\right)^n$

$N_0 = 1$. For fraction nut N=100 for percentage

$N_R = 1\left(\frac{1}{2}\right)^{7.93286}$

$N_R = 4.0923 \times 10^{-3}$

The fraction of the isotope remaining after 449days is

4.0923×10^{-3}

None of the options is correct

4. **Step 1:** Write a balance chemical equation of the reaction.

Reaction:

$2AgNO_{3(aq)} + CaCl_{2(aq)} \longrightarrow 2AgCl_{(g)} + Ca(NO_3)_{2(aq)}$

Step 2: Determine the number of moles of reactant or products base on the data given.

$\cap_{AgNO_3} = vol\ in\ dm^3 \times molar\ conc$

$= \frac{50}{1000} \times 0.1 = 0.005mol$

$\cap_{CaCl_2} = vol\ in\ dm^3 \times molar\ conc.$

$= \frac{50}{1000} \times 0.1 = 0.005mol$

Step 3: Determine the limiting reagent and active mole.

$\cap_{AgNO_3} : \cap_{CaCl_2}$

$\frac{0.005mol}{2} : \frac{0.005mol}{1}$

$0.0025mol : 0.005mol$

The limiting reagent is $AgNO_3$

The excess reagent is $CaCl_2$

Step 4: Use the active mole of the limiting reagent to calculate the mole of the species substance in which the question is centred based. The question is based on the mass of $AgCl_{(s)}$

$\cap_{AgCl} = 2 \times 0.0025 = 0.005mole$

Step 5: Calculate what is required.

$\cap_{AgCl} = \frac{Reacting\ mass\ of\ AgCl}{molar\ mass\ of\ AgCl}$

$R.m.m\ of\ AgCl = (108 + 35.5)g/mol$

$= 143.50g/mol$

$0.005mol = \frac{mass\ of\ AgCl}{143.5g/mol}$

$mass\ of\ AgCl_{(s)} = 0.005mol \times \frac{143.5g}{mol}$

$= 0.7175g \approx 0.72g$

The correct option is C

5. $C_7H_6O_3 + O(OCCH_3)_2 \longrightarrow C_9H_8O_4 + CH_3CO_2H$

1.50g 2. 0g 1.50g

$R.m.m\ of\ C_7H_6O_3 = 138g/mol$

$R.m.m\ of\ O(OCCH_3)_2 = 102g/mol$

$R.m.m\ of\ C_9H_8O_4 = 180g/mol$

$\cap_{C_7H_6O_3} = \frac{1.50}{138} = 0.01087mol$

$\cap_{O(OCCH_3)_2} = \frac{2.0}{102} = 0.01961mol$

The limiting reagent is $C_7H_6O_3$

The excess reagent is $O(OCCH_3)_2$

Mass of $C_9H_8O_4$ formed

$= 0.01087mol \times 180g/mol$

$= 1.9566g$

Theoretical yield of $C_9H_8O_4 = 1.96g$

$\% yield = \frac{Actual\ yield\ of\ product}{Theoretical\ yield\ of\ product} \times \frac{100}{1}$

$\% yield = \frac{1.5g}{1.9566g} \times \frac{100}{1}$

$$\% \, yield = 76.5\%$$

The correct option is B

$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2 + H_2O$

10.6g

R.M.M of Na_2CO_3 =106g/mol

R.M.M of HCl =36.50g/mol

$$\cap_{Na_2CO_3} = \frac{10.60}{106} = 0.1mol$$

$$\cap_{HCl} = \frac{2mol \, of \, HCl}{1mol \, of \, Na_2CO_3} \times 0.1mol \, of \, Na_2CO_3$$

$$\cap_{HCl} = 0.2mol$$

$$\cap_{HCl} = \frac{Reacting \, mass}{Molar \, mass}$$

$$0.2mol = \frac{Reacting \, mass}{36.5g/mol}$$

$$Reacting \, mass \, of \, HCl = 0.2mol \times 36.5g/mol$$

$$Reacting \, mass \, of \, HCl = 7.30g$$

$$\cap_{NaCl} = \frac{2mol \, of \, NaCl}{1mol \, of \, Na_2CO_3} \times 0.1mol \, of \, Na_2CO_3$$

$$\cap_{NaCl} = 0.2mol$$

$$\cap_{NaCl} = \frac{No \, of \, molecules \, of \, NaCl}{6.02 \times 10^{23} molecules/mol}$$

$$No \, of \, molecules \, of \, NaCl = \cap_{NaCl} \times 6.02 \times 10^{23}$$

$$No \, of \, molecules \, of \, NaCl = 0.2 \times 6.02 \times 10^{23}$$

$$No \, of \, molecules \, of \, NaCl = 1.204 \times 10^{23}$$

$$\cap_{CO_2} = \frac{1mol \, of \, CO_2}{1mol \, of \, Na_2CO_3} \times 0.1mol \, of \, Na_2CO_3$$

$$\cap_{CO_2} = 0.1mol$$

$$\cap_{CO_2} = \frac{Volume \, CO_2 \, at \, s.t.p}{molar \, gas \, volume}$$

$$Volume \, at \, s.t.p = \cap_{CO_2} \times molar \, gas \, volume$$

$$Volume \, CO_2 \, at \, s.t.p = 0.1mol \times 22.4dm^3/mol$$

$$Volume \, CO_2 \, at \, s.t.p = 2.24dm^3$$

$$(m, n, v) = (7.30g, 1.204 \times 10^{23}, 2.24dm^3)$$

None of the option is correct

7. To obtain a highly ionic substance from a cation and anion, the cation must be small and the anion must be very small with higher charges. The factors that affect the strength of an ionic bonding are:
   (i) **The size of the ion**: The smaller the size of an ion the greater the ionic bond formed by the ion
   (ii) **The charge on the ion**: The higher the charge on an ion the greater the ionic bond formed by the ion
   (iii) **Electropositivity or metallic character**: The more electropositive an element is, the stronger the ionic bond form by the element
   (iv) **Electronegativity**: The more electronegative an element is, the stronger the ionic bond form by the element

   The correct option is C
8. Atomic volume is the volume occupy by one mole of an element in the solid state. It deceases with increase in nuclear charge but increases with increase in screening or shielding effect. From Be, Mg to Ca screening effect increases, hence the increase in atomic volume

   The correct option is C
9. $^{216}_{84}X \rightarrow {}^{212}_{82}Y + {}^{4}_{2}He$

   The correct option is A
10. $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)} \Delta H = -45.9kJ/mol$

    $S_{NH_3} = 2mol \times 193J/molK = 386J$

    $S_{NH_3} = 386J = 0.386KJ$

    $S_{H_2} = 3mol \times 130.6J/molK = 391.80J$

    $S_{H_2} = 391.80J = 0.3918kJ$

    $S_{N_2} = 191.5J/molK = 0.1915kJ$

    $T = 50^0C = 323K$

    $\Delta S = \sum S_P - \sum S_R$

    $\sum S_R = 0.3918 + 0.1915 = 0.5833kJ$

    $\sum S_P = 0.386kJ$

    $\Delta S = 0.386 - 0.5833 = -0.1973$

    $\Delta S = -0.1973kJ$

    $\Delta H = 2(-45.9kJ/mol) = -91.8kJ/mol$

    $\Delta G = \Delta H - T\Delta S$

    $\Delta G = -45.9 - 323 \times (-0.1973)$

    $\Delta G = -91.8 + 63.7279$

    $\Delta G = -28.0721kJ$

    $\Delta G = -28.10kJ$

    The negative sign indicate that the reaction is feasible or spontaneous.

    The correct option is C
11. Gases are classified into two; ideal gases and real gases. In reality, ideal gases do not exist. But at low pressure and high temperature, real gases behave as ideal gases. Ideal gases are gases that satisfy the following conditions:
    (i) The actual volume occupied by the gas molecules is negligible compared with the volume of the container.
    (ii) Force of attraction or repulsion between the molecules of gases are negligible and
    (iii) Obey the gas laws

    Thus, real gases tend to deviate from ideal gases behaviour because of the following reasons
    (i) Force of attraction or repulsion between the molecules of gases are not negligible,

as a result the molecules experiences forces of attraction

(ii) The actual volume occupied by the gas molecules is not negligible compared with the volume of the container.

(iii) They do obey the gas laws at high pressure and low temperature

The correct option is C

12. **Noble gas configuration** is a configuration or structure in which the outermost shell of an atom of an element contains two (2) or eight (8) electrons.

Octet Rule: It states that for proper electrons dot structure let eight (8) electrons surround each atom of an element. The octet rule gives rise to the octet structure.

The following deviate from octet rule

(i) Electron deficient molecules or ions e.g. $BF_3, BeCl_2$ etc

Electron deficient molecules or ions are molecules or ions whose central element has less than eight electrons in their Lewis structure.

(ii) Expanded valence shell molecules or ions e.g. PCl_5, SF_6, BrF_5 etc

Expanded valence shell molecules or ions are molecules or ions whose central element has more than eight electrons in their Lewis structure.

(iii) Odd electron species e.g. NO_2

Odd electron molecules or ions are molecules or ions whose central element has odd number of electrons in their Lewis structure.

The correct option is D

13. $_5B \rightarrow 1s^2\ 2s^2\ 2p^1$

The outermost sub-shell is $2p$. The number in the front of P indicates the principal number.

n	$\mathcal{L}$	$m_\mathcal{L}$	m_s
2	0	0	$\pm 1/2$
	1	-1	$\pm 1/2$
		0	$\pm 1/2$
		1	$\pm 1/2$

The table shows that for $n = 2, l = 0,1, m = -1,0,1, m_s = \pm 1/2$

The correct option is C

14. R.M.M of Styrene $= 104.14 g/mol$

Mass of styrene $= 2.0g$

$(CH)_n = 104.14 \approx 104$

$(12 + 1)n = 104$

$13n = 104$

$n = \frac{104}{13} = 8$

$(CH)_n = (CH)_8 = C_8H_8$

$mass\ of\ H\ in\ C_8H_8 = \frac{R.A.M\ of\ H}{R.M.M\ of\ C_8H_8} \times 2$

$mass\ of\ H\ in\ C_8H_8 = \frac{8(1)}{104} \times 2$

$mass\ of\ H\ in\ C_8H_8 = 0.1538g$

$\cap_H = \frac{mass\ of\ H}{molar\ mass} = \frac{0.1538g}{1d/mol} = 0.153$

$\cap_H = \frac{No\ of\ atoms\ of\ H}{6.02 \times 10^{23} atoms/mol}$

$No\ of\ atoms\ of\ H = \cap_{C_8H_8} \times 6.02 \times 10^{23}$

$No\ of\ atoms\ of\ H = 0.1538 \times 6.02 \times 10^{23}$

$No\ of\ atoms\ of\ H = 9.25876 \times 10^{22}$ atoms

$No\ of\ atoms\ of\ H \approx 9.26 \times 10^{22}$ atoms

The difference in value is due to approximation

The correct option is B

15. The steps involve in separating a mixture of iron filling, Iodine, sand and sodium chloride are:

(i) Magnetization to remove iron filling

(ii) Sublimation to remove Iodine

(iii) Dissolution to dissolve NaCl

(iv) Filtration to remove sand

(v) Evaporation to dryness to recover NaCl

Note that magnetization should be carried out before sublimation because the heat during sublimation may affect the iron filling.

The correct option is C

16. Mass of ammonia, $NH_3 = 9.07 \times 10^5 g$

$R.M.M\ of\ NH_3 = 17 g/mol$

$\cap_{NH_3} = \frac{Reacting\ mass}{Molar\ mass}$

$\cap_{NH_3} = \frac{9.07 \times 10^5 g}{17 g/mol} = 5.3353 \times 10^4 mol$

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)} \Delta H = -92.07$

Note that the enthalpy change is in Joule, the enthalpy change is xJ or xKJ it means the energy requires to produce the 2mole ammonia is xJ or xKJ. If the enthalpy change is xJ/mol or xkJ/mol it means that energy requires to produces one mole ammonia is xJ/mol or xkJ/mol

From the chemical equation

2mole of NH_3 requires $92.07J$ of energy

$5.3353 \times 10^4 mol$ of NH_3 require xJ of energy

$\frac{2}{5.3353 \times 10^4} = \frac{92.07}{x}$

$2x = 92.07 \times 5.3353 \times 10^4$

$x = \frac{92.07 \times 5.3353 \times 10^4}{2}$

$x = 2.4561 \times 10^6 J = 2.4561 \times 10^3 KJ$

Since the process is an exothermic reaction enthalpy change is negative.

$x = -2.4561 \times 10^3 KJ = -2456.10KJ$

The correct option is C

17. **Step 1:** write out the chemical equation of the reaction $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

Step 2: Determine the active volume and the resulting volume.

$$\frac{V_{H_2}}{\frac{45cm^3}{2}} : \frac{V_{O_2}}{\frac{15cm^3}{1}}$$

$$22.5cm^3 : 15cm^3$$

The division is done by the co-efficient of each reactant in the balanced equation in step 1. The smallest volume gives the active volume. Therefore, the active volume is $20cm^3$.

Reaction $2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(g)}$

VOR $2(15cm^3)$ $1(15cm^3)$ $2(15cm^3)$

$= 30cm^3$ $15cm^3$ $30cm^3$

Step 3: Set up the volume relationship

Reaction	$2H_{2(g)}$	$+ O_{2(g)}$	$\longrightarrow 2H_2O_{(g)}$
VBR	$45cm^3$	$15cm^3$	-
VOR	$30cm^3$	$15cm^3$	$30cm^3$
VAR	$15cm^3$	-	$30cm^3$

Step 4: Determine the residual volume and the resulting volume.

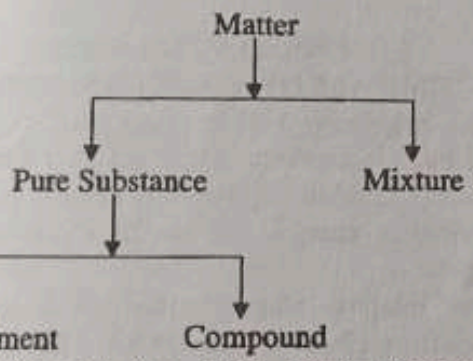
Volume of residual gas $= 15cm^3$

Volume of formed gas $= 30cm^3$

Resulting volume $= 15cm^3 + 30cm^3 = 45cm^3$

The correct option is C

18.



All Elements (e.g. Gold, Silver, Copper etc) and all compounds (e.g. Distilled Water, Silver IV oxide, Copper II oxide, calcium trioxocarbonate iv etc) are pure substance. Note that Satchet water is not pure due to the dissolve substance in it(e.g. Cl_2, F_2, I_2, CaO, O_3 etc)

The correct option is A

19. $R = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$

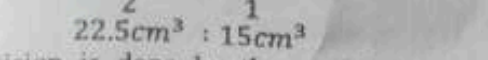
Note that the element has a partially filled d-orbital. Elements with partially filled d-orbital are called transition elements.

(i) The highest quantum number is 5. Hence the elements belong to period 5.

(ii) The number of electron in the sub-shell with the highest quantum number (i.e. 4s) and the partially filled d-orbital (i.e. 3d) is 8 (i.e. $2 + 6 = 8$). Hence the elements belong to group 8B

(iii)Since the element has a partially filled d-orbital it is called d-block element.

$R \rightarrow [Ar]\ 4s^2\ 3d^6$



(a) Number of unpaired electrons = 4

(b) Number of paired electrons =

$$\frac{26-4}{2} = \frac{22}{2} = 11$$

Transition elements are elements that have a partially filled d or f-orbital.

Properties of transition elements

(i) They exhibit variable oxidation states.

(ii) Their ions are coloured

(iii)They formed complex ions

(iv)They are excellent catalyst due to a vacant d-orbital available for the adsorption gases.

Zinc is not regarded as a false transition element (i.e Zinc is not a true transition element) because of the following reasons.

(i) It has completely filled d-orbitals.

(ii) It does not have a variable oxidation state i.e. it has only one oxidation state (+2).

(iii)Its ions are not coloured.

Transition metal ions are coloured because the energy needed for a transition element to be excited happens to be the energy of light. Thus, transition metals undergo excitation by absorbing the energy of the components of light. Therefore, the light emitted by transition metal ion or compound is coloured due to the components of light absorbed during excitation. Hence, the coloured nature of transition metal ions is associated with their partially filled d-orbital. Please note that, all the properties of transition elements are accounted for by their partially filled d-orbital or f-orbital.

The correct option is D

20. $NaOH \longrightarrow Na^+ + OH^-$

$0.002M$ $0.002M$ $0.002M$

$[OH^-] = 0.002M$

$$P^{OH} = -log_{10}^{[OH^-]} = -log_{10}^{0.002}$$

$$= -(-2.6990)$$

$P^{OH} = 2.6990$

$2.6990 + P^H = 14$

$P^H = 14 - 2.6990 = 11.3010 \approx 11.3$

The correct option is C

21. In the discharge tube experiment by J.J. Thompson, for the study of sub atomic particles, greenish glow represent electrons while reddish glow represent protons

The correct option is D

22. % of Cu = 0.39%

No of atoms of Cu = 4

R.A.M of 4 atoms of Cu = $63.5g/mol \times 4$

$= 254 g/mol$

$$\% \text{ of Cu} = \frac{R.A.M \text{ of } Cu}{R.M.M \text{ of } Compound} \times 100$$

$$0.39 = \frac{254}{R.M.M \text{ of } Compound} \times 100$$

$$R.M.M \text{ of } Compound = \frac{254}{0.39} \times 100$$

$= 65128.20513 g/mol$

$= 6.5 \times 10^4 g/mol$

The correct option is A

23. Lewis acid is the name given to any ionic or molecular species that can accept a lone pair of electrons in the formation of a coordinate covalent bond(e.g. BF_3,BeF_2,$AlCl_3$ etc) while Lewis base is the name given to any ionic or molecular species that can donate a lone pair of electrons in the formation of a coordinate covalent bond(e.g. NH_3). Note that all electron deficient molecules or ions(i.e cation) are Lewis acid while all electron rich molecules or ions(i.e. anion) are Lewis base

The correct option is B

24.

Species	Hybridization of central atoms
$BeCl_2$	Sp
BF_3	Sp^2
CH_4	Sp^3
CO_2	Sp
NH_3	Sp^3
H_2O	Sp^3

The correct option is A

25. Entropy is the natural tendency of a substance to achieve a great disorderliness as one of the derivative force in a change of state or in a chemical reaction.

The entropy of a gas is greater than that of an aqueous species. The entropy of an aqueous species is greater than that of a pure liquid and the entropy of a pure liquid is greater than of a pure solid i.e.

$$\underbrace{solid < liquid < aqueous\ species < gas}_{Increase\ in\ entropy}$$

Entropy change (ΔS):- It is the difference between the entropies of the products and the entropies of the reactants.

$$\Delta S = \sum S_P - \sum S_R$$

Negative Entropy Change: A chemical system is said to undergo a negative entropy change. If the system changes from a more disorderly state to a less disorderly state.

$H_2O_{(g)} \rightarrow H_2O_{(l)}\ \Delta S = -ve \text{ or } \Delta S < 0$

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)} \Delta S = -ve \text{ or } \Delta S < 0$

Zero Entropy Change: A chemical system is said to undergo a zero entropy change if the system change from one state to another with the same degree of disorderliness.

For a system to undergo a zero entropy change two conditions must be satisfied.

(i) The number of moles of the reactants must equal to the number of moles of the products.

(ii) The reactants and products must be in the same state.

$A_{(s)} + B_{(g)} \rightarrow C_{(s)} + D_{(g)}\ \Delta S = 0$

$Na_{(s)} + Au^+_{(aq)} \rightarrow Na^+_{(aq)} + Au_{(s)}\ \Delta S = 0$

$I_{2(g)} + H_{2(g)} \rightarrow 2HI_{(g)}\ \Delta S = 0$

Positive Entropy Change: A chemical system is said to undergo a negative entropy change if the system changes from a less disorderly state to a more disorderly state.

$H_2O_{(l)} \rightarrow H_2O_{(g)}\ \Delta S = +ve \text{ or } \Delta S > 0$

$C_2H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(g)} \Delta S = +ve$

The change in entropy is easily determined if the substance are in different states than one that the substance are in the same state. If the substances are in the same state the side with the highest number of moles (either reactant or product) will have the greater entropy.

The correct option is C

CHM 001 TEST 2014/2015
TIME ALLOWED: 45 MINUTES

1. Ionic salts have high melting point due to (a) strong electrostatic force of attraction (b) strong London dispersion forces (c) high hydration energy (d) strong dipole-induced dipole
2. The relative atomic mass of a naturally occurring element A is 69.72. The masses of the naturally occurring isotopes are 68.925 for ^{69}A and 70.9245 for ^{71}(a) What is the isotopic ratio of ^{69}A to ^{71}A? (a) 3:1 (b) 1:2 (c) 3:2 (d) 2:3
3. Which of the following nuclide pair are isotones? (a) $^{20}_{10}Ne$ and $^{18}_{9}F$ (b) $^{14}_{7}N$ and $^{15}_{8}$ (c) $^{14}_{6}C$ and $^{12}_{6}C$ (d) $^{14}_{6}C$ and $^{14}_{7}N$
4. 6.4g of oxygen gas and 4.8g of chlorine gas are mixed with 14.9g of krypton at a total pressure of $6.92 \times 10^7 Nm^{-2}$. What is the partial pressure of krypton it the mixture $[O = 16.0;\ Cl = 35.5;\ Kr = 83.8 gmol^{-1}]$ (a) $2.76 \times 10^7 Nm^{-2}$ (b) $1.72 \times 10^7 Nm^{-2}$ (c) $4.36 \times 10^7 Nm^{-2}$ (d) $1.08 \times 10^7 Nm^{-2}$
5. Consider the equation below: $aCu + bHNO_3 \rightarrow cCu(NO_3)_2 + dNO_2 + eH_2O$. The values of a b, c, d and e, respectively, are: (a) 2,4,2,1,2 (b) 3,2,1,2,3 (c) 1,2,2,4,3 (d) 1,4,1,2,2

6. Given the following ionic equations:
$A_{(g)} + e^- \rightarrow A^-_{(g)} + X$
$M^+_{(g)} + Y \rightarrow M^{2+}_{(g)} + e^-$
$Cd^{2+}_{(g)} + 2I^-_{(g)} \rightarrow CdI_{2(s)} + Z$
In the equations above X, Y and Z respectively stand for (a) Electron affinity, ionization energy and lattice energy (b) ionization energy, electron affinity and hydration energy (c) Dissociation energy, electron affinity and lattice energy (d) Ionization energy, electron affinity and lattice energy

7. What are the orbital overlappings in ethene?
(a) $sp-sp$; $sp-s$ and $p-p$ (b) sp^2-sp^2; sp^2-s and $p-p$ (c) sp^3-sp; sp^2-sp^2 and sp^3-sp^2 (d) sp^3-sp^3; sp^3-s and $p-p$

8. Use the data given below to calculate the standard enthalpy of formation of solid potassium chloride
$K_{(s)} \rightarrow K_{(g)}\ \Delta H^\theta = 90kJmol^{-1}$
$K_{(g)} \rightarrow K^+_{(g)} + e^-\ \Delta H^\theta = 418kJmol^{-1}$
$\frac{1}{2}Cl_{2(g)} \rightarrow Cl_{(g)}\ \Delta H^\theta = 122kJmol^{-1}$
$Cl_{(g)} + e^- \rightarrow Cl^-_{(g)}\ \Delta H^\theta = -348kJmol^{-1}$
$Cl^-_{(g)} + K^+_{(g)} \rightarrow KCl_{(s)}\ \Delta H^\theta = -718kJmol^{-1}$
(a) $-343kJmol^{-1}$ (b) $288kJmol^{-1}$ (c) $-436kJmol^{-1}$ (d) $433kJmol^{-1}$

9. A mixture of iron fillings, sand, sodium chloride and iodine is best separated using one of the following. (a) Magnetization, sublimation, dissolution, filtration and evaporation (b) Magnetization, sublimation, dissolution and crystallization (c) Dissolution, filtration, evaporation, sublimation and magnetization (d) Magnetization, sublimation, and evaporation.

10. Consider the properties of compounds listed below: I. They have high melting and boiling point II. They are usually white crystalline solids III. They conduct electric current either in solution or molten IV. They are soluble in non-polar solvents. Which of these represent the correct properties of $CaCl_2$? (a) II, III and IV only (b) I, II and IV (c) I, II and III (d) I, II, III and IV.

11. Valence shell electron pair repulsion model proposed that repulsions around the central atoms of molecules play a major role in determining shapes of covalent molecules. Such repulsions include: I. bond pair-bond pair repulsion II. bond pair-lone pair repulsion III. lone pair-lone pair repulsion. Which of these repulsions exist(s) in water molecule? (a) I. II and III (b) I and III (c) II and III (d) I and II

12. What is the density of oxygen gas at $2°C$ and $0.850atm$? $[O = 16.0;$ Gas constant $= 0.08206L\,atm/K/mol]$ (a) $5.5 \times 10^{-2}g/mL$ (b) $2.5 \times 10^3 g/mL$ (c) $11.1 \times 10^3 g/mL$ (d) $1.1 \times 10^{-3}g/mL$

13. If a gas is compressed to one-third of its original volume and its temperature is doubled; the final pressure for the gas is how many times the original? (a) 6 (b) $\frac{2}{3}$ (c) 2 (d) $\frac{1}{3}$

14. Which of the following statements are correct? I. The more the number of negative charges on the ion the larger the ionic radius II. The more the number of positive charges on the ion, the smaller the ionic radius III. Ionic radius generally, decreases along period IV. The positive ions have bigger sizes than corresponding neutral atom of the same element V. ionic radius of negatively charged ions have a smaller sizes than that of the neutral atom of the sane element. (a) I, III, IV (b) I and V (c) I, II, III, and IV (d) I, II and III

15. Common separation techniques of mixtures are based on principles such as I. relative rates of migration over an adsorbent II. immiscibility of polar and non-polar solvents III. relative magnetizability of components of mixtures IV. relative sizes of component particles V. relative solubilities of components at different temperatures VI. relative densities of the components. Which of these principles are applicable to the separation of a mixture of water and kerosene using a separatory funnel? (a) III and V (b) II and VI (c) III, IV and V (d) I and II

16. A trioxonitrate (V) salt of iron contains 23.14% iron by mass. What is the formula of the salt? $[Fe = 56;\ N = 14$ and $O = 16]$. (a) $FeNO_3$ (b) $Fe(NO_3)_2$ (c) $Fe(NO_3)_4$ (d) $Fe(NO_3)_3$

17. Consider the equation below:
$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$.
What is the theoretical mass of manganese (II) chloride which could be prepared from 18.50g of manganese (IV) oxide with sufficient acid? $(Mn = 54.94,\ O = 16,\ H = 1,\ Cl = 35.5)$ (a) 40.0g (b) 10.0g (c) 36.6g (d) 26.8g

18. The decay series of $^{234}_{92}U$ is abbreviated a follows: $^{234}_{92}U \xrightarrow{2a} Z \xrightarrow{Q} {}^{214}_{82}Pb \xrightarrow{R} {}^{214}_{84}Pb \xrightarrow{S} {}^{212}_{84}Po$ Identify both the number and types of radiation represented by the letters Q, R and S (a) 2-beta, 3-alpha and 2-gamma (b) 3-alpha, 2-beta and 2-neutron (c) 3-beta, 2-alpha and 3-gamma (d) 2-alpha, 2-beta and 3-neutron

19. How many sodium atoms are present in $27g$ of sodium trioxocarbonate (IV)? [$Na = 23.0$; $C = 12.0$; $O = 16.0$ and $N_A = 6.02 \times 10^{23}$]. (a) 2.14×10^{23} (b) 1.53×10^{23} (c) 1.12×10^{22} (d) 3.07×10^{23}

20. If $20.0g$ of hydrogen reacts with $100.0g$ of oxygen to form steam, which reactant is in excess and by how much? [$H = 1.0, O = 16.0$] (a) Oxygen is in excess by 60.0g (b) Hydrogen is in excess by $7.5g$ (c) Hydrogen is in excess by 67.5g (d) oxygen is in excess by 80g

21. Consider an orbital description as follows: $n = 3, \mathcal{L} = 1$. Which of the following statements are correct? I. it is a 3d-orbital II. it is 3p-orbital III. it is a degenerate orbital IV. it has m_ℓ values of $-1, 0, 1$ V. it has m_ℓ values of $-2, -1, 0, 1, 2$ (a) II, III and V (b) I, III and IV (c) II, III and IV (d) I, III and V

22. What volume in dm^3 of 2.0M $NaCl$ solution would you need to make $250mL$ of $0.15M$ $NaCl$ solution? (a) 1.9 (b) 0.01875 (c) 0.2 (d) 18.75

23. The p^{OH} of a $0.005M$ sulphuric acid solution is (a) 12.0 (b) 12.6 (c) 2.3 (d) 2.0

24. Which of the following involves a decrease in entropy?

(a) $Na_{(s)} + Au^{+}_{(aq)} \longrightarrow Na^{+}_{(aq)} + Au_{(s)}$

(b) $MgCO_{3(s)} \longrightarrow MgO_{(s)} + CO_{2(g)}$

(c) $H_2O_{(g)} \longrightarrow H_2O_{(l)}$

(d) $2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$

25. Which of the following sets of quantum numbers is/are permissible of an electron in an atom

I. $n = 1, \ell = 1, m_\ell = 0, m_s = +\frac{1}{2}$

II. $n = 3, \ell = 1, m_\ell = -1, m_s = -\frac{1}{2}$

III. $n = 2, \ell = 1, m_\ell = 0, m_s = \pm\frac{1}{2}$

IV. $n = 2, \ell = 0, m_\ell = 0, m_s = 1$

(a) II and III (b) III only (c) III and IV (d) I, II and III

SOLUTION

1. **Ionic or electrovalent bonding:** This is the electrostatic force of attraction that holds atoms together in ionic substance. It occurs between a metal and a non-metal as a result of the transfer of electron (e^-) from the metal to the non-metal. Ionic bonds are found in the following compounds $NaCl, MgO, MgCl_2$ etc

Ionic bonding leads to formation of ionic compounds or salts. The following are the properties of ionic compounds or salts.

(i) They are made up of aggregate of ions

(ii) They have high melting and boiling points.

(iii) They are good conductor of heat and electricity.

(iv) They are strong electrolyte

(v) Their reaction in aqueous medium is very fast because they exist completely as ions in aqueous medium.

(vi) They are soluble in water

(vii) They are polar substance i.e. they have positive and negative poles.

(viii) They are solid at room temperature.

The correct option is A

2. **Isotopes** *is the name given to atoms of the same element with the same atomic number but different neutron numbers* e.g. $^{37}_{17}Cl$ and $^{37}_{17}Cl$; $^{1}_{1}H$, $^{2}_{1}H$ and $^{3}_{1}H$; $^{235}_{92}U$ and $^{236}_{92}U$; $^{12}_{6}C$, $^{13}_{6}C$ and $^{14}_{6}C$; $^{16}_{8}O$, $^{17}_{8}O$ & $^{18}_{8}O$ etc. Isotopes of an element have the same chemical properties but different physical properties.

Abundance of an element *is the relative composition of an element on the earth crust.* It is usually express in percentage or ratio. The abundance of an element is used to determine the relative molecular mass of an atom.

R.A.M of element $= \alpha_1 m_1 + \alpha_2 m_2 + \cdots$

Where α = isotopic fraction

m = Isotopic mass

$\alpha_1 + \alpha_2 + \cdots = 1$ (sum of isotopic fraction)

$R.A.M\ of\ A = 69.72$

$m_1 = 68.9251, m_2 = 70.9245$

$R.A.M\ of\ A = \alpha_1 m_1 + \alpha_2 m_2$

$69.72 = 6.925\alpha_1 + 70.9245\alpha_2$

$but\ \alpha_1 + \alpha_2 = 1$

$\alpha_2 = 1 - \alpha_1$

$69.72 = 68.9251\alpha_1 + 70.9245(1 - \alpha_1)$

$69.72 = 68.9251\alpha_1 + 70.9245 - 70.9245\alpha_1$

$69.72 = 70.9245 - 1.9994\alpha_1$

$69.72 - 70.9245 = -1.9994\alpha_1$

$-1.2045 = -1.9994\alpha_1$

$\alpha_1 = \dfrac{-1.2045}{-1.9994} = 0.6024$

$but\ \alpha_2 = 1 - \alpha = 1 - 0.6024 = 0.3976$

$\alpha_1 : \alpha_2 = 0.6024 : 0.3972$

$= 0.6 : 0.4$

$\alpha_1 : \alpha_2 = 3 : 2$

The isotopic ratio of ^{69}A to ^{71}A is 3:2.

The isotope with the greater abundance or isotopic ratio is the lighter isotope while the isotope with the lower abundance or isotopic ratio is the heavier isotope.

The correct option is C

3. **Isotones** *are atoms of different element with the same neutron numbers* e.g. $^{15}_{8}O$ and $^{14}_{7}N$ Isotones show different chemical and physical properties because they are atoms of different element.

Isobars *are atoms of different element with the same mass number* e.g. $^{23}_{12}Mg$ and $^{23}_{11}Na$. Isobars show different chemical and physical properties because they are atoms of different element.

The correct option is B

4. Mass of oxygen $= 6.4g$
Mass of chlorine $= 4.8g$
Mass of krypton $= 14.9g$
Total pressure $= 6.92 \times 10^{-7} N/m^2$
Convert each of the given mass to mole because chemical substance combines in terms of moles not mass.

$$\cap_{O_2} = \frac{\text{Reacting mass}}{\text{Molar mass}}$$
$$= \frac{6.40g}{32g/mol} = 0.2mole$$
$$\cap_{Cl_2} = \frac{\text{Reacting mass}}{\text{Molar mass}}$$
$$= \frac{4.80g}{71g/mol} = 0.067mole$$
$$= 0.0676mol$$
$$\cap_{Kr} = \frac{\text{Reacting mass}}{\text{Molar mass}}$$
$$= \frac{14.90g}{83.8g/mol} = 0.1778mole$$

The number of moles $\cap_T$
$$\cap_T = 0.2mol + 0.0676mol + 0.1778mol$$
$$= 0.445mol$$

Mole fraction of $Kr = X_{Kr}$
$$X_{Kr} = \frac{\cap_{Kr}}{\cap_T}$$

Partial pressure of $Kr = P_{Kr}$
$$P_{Kr} = X_{Kr} P_T$$
$$= \frac{\cap_{Kr}}{\cap_T} \times P_T$$
$$= \frac{0.1778}{0.4454} \times 6.92 \times 10^7$$
$$= 2.7624 \times 10^7 N/m^2$$

Note
$$R.M.M\ of\ O_2 = 32g/mol$$
$$R.M.M\ of\ Cl_2 = 71g/mol$$
$$R.M.M\ of\ Kr = 83.8g/mol$$

The correct option is A

5.
$$a\,Cu + b\,HNO_3 \rightarrow c\,Cu(NO_3)_2 + d\,NO_2 + e\,H_2O$$

Let $b = 1$. This is because HNO_3 is the reactant with the highest number of atoms.
Note that for a chemical reaction to be balanced the number of each atoms at the reactant must equal to that at the production.

$Cu \Rightarrow a = c$

$H \Rightarrow 1 = 2e \left(\Rightarrow e = \frac{1}{2}\right)$

$N \Rightarrow 1 = 2c + d \quad (\Rightarrow d = 1 - 2c)$

$O \Rightarrow 3 = 6c + 2d + e$

Recall that $6c + 2d + e = 3$

$$6c + 2(1 - 2c) + \frac{1}{2} = 3$$
$$6c + 2 - 4c + \frac{1}{2} = 3$$
$$2c + \frac{5}{2} = 3$$
$$2c = 3 - \frac{5}{2} = \frac{1}{2}$$
$$2c = \frac{1}{2} \Rightarrow c = \frac{1}{4}$$
$$but\ d = 1 - 2c = 1 - 2\left(\frac{1}{4}\right)$$
$$= 1 = \frac{1}{2} = \frac{1}{2}$$
$$a = c = \frac{1}{4}, b = 1, d = \frac{1}{2}, e = \frac{1}{2}$$

$$aCu + bHNO_3 \rightarrow cCu(NO_3)_2 + dNO_2 + eH_2O$$

$$\frac{1}{4}Cu + bHNO_3 \rightarrow \frac{1}{4}Cu(NO_3)_2 + \frac{1}{2}NO_2 + \frac{1}{2}H_2O$$

The denominators of the fractions are 2 and 4. Thus, multiply through by the L.C.M of 2 and 4 (i.e. 4)

$$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$
$$\Rightarrow a = 1, b = 4, c = 1, d = 2, e = 2$$

The correct option is D

6. **Electron affinity** is the energy required to add one mole of electron to a gaseous atom to form an anion (i.e. a negative ion).

$$A_{(g)} + e^- \rightarrow A^-_{(g)} \quad \Delta H = X$$

Electron affinity can be positive or negative.
Ionization Energy is the energy required to remove one mole of an electron from a gaseous atom to form a cation (i.e. a positive ion).

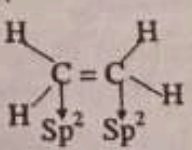
$$M^+ \rightarrow M^{2+} + e^- \quad \Delta H = Y$$

Lattice is the regular arrangement of atoms, ions or molecules in a crystal line solid. Thus, **Lattice energy** release or evolve per mole when atoms, ions or molecules of a crystal are brought together from infinite distance apart to form the Lattice. Lattice energy of a crystal is a measure of the stability of the crystal.

$$Cd^{2+}_{(g)} + 2I^-_{(g)} \rightarrow CdI_{2(g)} \quad \Delta H = Z$$

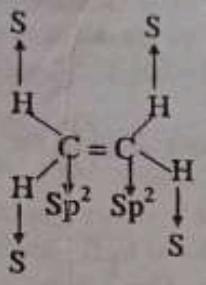
The correct option is A

7. Each carbon atoms in an alkane, alkene and alkyne are sp^3, sp^2 and sp-hydridized respectively.

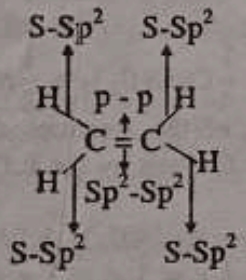


$H \longrightarrow 1s^1$

The outermost subshell of hydrogen atom is S. all single bonds are sigma bonds. In a multiple bond pair (e.g double or triple bond) only one sigma bond is present, the rest are pie (π) bond. Pie (π) bonds are form by two p-orbital that are laterally oriented to each other (i.e. parallel to each other).



The overlapping oribtals in ethene are shown below



Note that $s - sp^2 = sp^2 - s$

Thus, the overlapping orbital in ethene are: $s - sp^2$, $sp^2 - sp^2$ and p-p parallel.

The correct option is B

8. Hess' law states that the total enthalpy change of a chemical reaction is constant regardless of the routes in which a chemical reaction occur provided the conditions at the start of the reaction is equal to the final conditions.

A thermochemical equation is a chemical equation whose enthalpy change is stated.

$K_{(s)} \longrightarrow K_{(g)} \quad \Delta H^o = 90KJ/mol$

Hess' law comes into play when various thermochemical equations are given to calculate the enthalpy change of a reaction.

Note that reversing a chemical equation reverses the sign of the enthalpy change or heat content. If a chemical reaction is multiply by a factor, the enthalpy change for the reaction must be multiply by the same factor.

The chemical reaction for the formation of potassium chloride is

$$K_{(s)} + \frac{1}{2}Cl_{2(g)} \longrightarrow KCl_{(s)}$$

Note also that enthalpy change is measure in mole, hence the chemical equation must be written in such a way that the product form must be one mole.

$K_{(s)} \longrightarrow K_{(g)} \quad \Delta H^o = 90kJ/mol$

$K_{(g)} \longrightarrow K^+_{(g)} + e^- \quad \Delta H^o = 418kJ/mol$

$\frac{1}{2}Cl_{2(g)} \longrightarrow Cl_{(g)} \quad \Delta H^o = 122kJ/mol$

$Cl_{(g)} + e^2 \longrightarrow Cl^-_{(g)} \quad \Delta H^o = -348kJ/mol$

$Cl^-_{(g)} + K^+_{(g)} \longrightarrow KCl_{(s)} \quad \Delta H^o = -718kJ/mol$

$k(s) + \frac{1}{2}Cl(g) \longrightarrow KCl(g) \quad \Delta H^o = -436kJ/mol$

The correct option is C

9. A mixture of iron fillings, sand, sodium chloride and iodine is best separated by the following steps.
   (i) Sublimation to remove Iodine
   (ii) Magnetization to remove the iron fillings
   (iii) Addition of water (i.e. dissolution to dissolve the sodium chloride.
   (iv) Filtration to remove the sand
   (v) Evaporation to dryness to recover sodium chloride.

   Note that sublimation should be carried out first before any other separation methods. However because magnetization has no effect on the subliming substance it can come first before sublimation.

The correct option is A

10. Calcium chloride, $CaCl_2$ is an ionic salt. Hence it possesses all the properties of ionic substances.

    The following are the properties of ionic compounds or salts.
    (i) They are made up of aggregate of ions
    (ii) They have high melting and boiling points.
    (iii) They are good conductor of heat and electricity.
    (iv) They are strong electrolyte
    (v) Their reaction in aqueous medium is very fast because they exist completely as ion in aqueous medium.
    (vi) They are soluble in water
    (vii) They are polar substance i.e. they have a positive and negative poles.
    (viii) They are solid at room temperature.

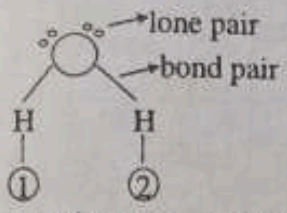
The correct option is C

11. Valence shell electron pair repulsion model or theory state that molecules or ions assumed the shape that best minimize repulsion between lone pair-lone pair, lone pair – bond pair and bond pair-bond pair electrons.

    Note that lone pair-lone pair electrons repulsion is greater than lone pair-bond pair

electrons repulsion. Lone pair-bond pair electrons repulsion is greater than bond pair-bond pair electron repulsion. Thus, lone pair-lone pair electrons repulsion is the greatest while bond pair-bond-pair electrons repulsion is the least.

The Lewis structure of water is as shown below:



Moving clockwise from hydrogen 1 through Oxygen to hydrogen 2 and then to hydrogen 1 will encountered bond pair-lone pair, lone pair-lone pair, lone pair-bond pair and bond pair-bond pair electrons repulsion. Thus, water molecule has the following electrons repulsion.

(i) bond pair – lone pair
(ii) lone pair – lone pair and
(iii)lone pair – bond pair
(iv)bond pair – bond pair

The correct option is A

12. $T = 2°C = 275k,$
$R.M.M\ of\ O_2(M) = 32g/mol$
$P = 0.85atm$
$G = 0.08206L\ atm/kmol$
The ideal gas equation also known as equation of state is given as
$PV = nRT$
But $n = \frac{mass\ (m)}{molar\ mass\ (M)} = \frac{m}{M}$
$PV = \frac{mRT}{M}$
Divide through by V
$P = \frac{mRT}{MV} = \left(\frac{m}{V}\right)\frac{RT}{M}$
But density is given as
$(\rho) = \frac{m}{V}$
$P = \frac{\rho RT}{M}$
$PM = \rho RT$
$\rho = \frac{PM}{RT}$
$= \frac{0.85atm \times 32g/mol}{0.08206atm/molk \times 275k}$
$but\ 1ml = 10^{-3}l$
$\rho = \frac{0.1130g}{1l} \times \frac{10^{-3}l}{1ml}$
$= 1.2053 \times 10^{-3}g/ml$
$\rho = 1.2 \times 10^{-3}g/mol$

The correct option is D

13. $P_1 = P, V_1 = V, T_1 = T$
$P_2 = ?, V_2 = \frac{1}{3}V, T_2 = 2T$
$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
$\frac{PV}{T} = \frac{P_2 \times \frac{1}{3}V}{2T}$
$PV \times 2T = P_2 \times \frac{V}{3} \times T$
$3 \times PV \times 2T = P_2 \times V \times T$
$P_2 = \frac{3 \times PV \times 2T}{V \times T}$
$= 3 \times P \times 2 = 6P$
$P_2 = 6P$
Thus, the final pressure is 6 times the original pressure.

The correct option is A

14. **Fajans' rules** indicate the extent to which an ionic bond has covalent character caused by polarization of the ions. Covalent character is most likely if:
(i) the charge on the ions is high
(ii) the positive ion is small
(iii)the negative ion is large
(iv)The positive ion has an outer electrons configuration that is not a noble gas configuration.

Thus, the following is true
(i) The more the number of positive charges on the ion, the large the ionic radius due to the spreading out the electron clouds
(ii) The more the number of positive charges on the ion, the smaller the ionic radius due to the increase nuclear charge since an element forms a positive ion by electron loss.
(iii)Ionic radius decreases across the period but increases down the group.
(iv)Positive ion has smaller size than corresponding neutral atom of the same element.

Na	Na^+
2,8,1	2,8

(v) Negative ions have bigger size than corresponding neutral atom of the same element due to the spread out electrons cloud.

Cl	Cl^-
2,8,7	2,8,8

The correct option is D

15. **Separation technique** is the systematic (i.e. step by step) process employed in separating the component of a mixture. The **principle of separation** is the physical properties (e.g. boiling point, melting point) of the components of the mixture employed in effecting the separation while the method of

separation is the various separation techniques (e.g. filtration, chromatography, distillation etc) employed in the separation process.

Separation technique is the systematic (i.e. step by step) approach employs in separating the components of mixture. The table below gives the different separation techniques or method of separation and the principle of separation.

Separation techniques or methods	Application of the method of separation	Principles of separation or Properties used
Filtration	It is used to separate insoluble solid from its mixture with a liquid e.g. mixture of sand and water	Insolubility of solute in a solvent.
Decantation	It is used to separate insoluble solid from its mixture with a liquid e.g. mixture of sand and water left standing for some time	Phase difference between the settled solid particles and the supernatant liquid on top.
Centrifugation	Insoluble solid from its mixture with a liquid e.g. suspension of chalk dust, blood plasma or sample	Relative settling of light particles when solid-liquid mixtures are subjected to a circular motion (several thousand revolution per minute) in a centrifuge or ultracentrifuge
Evaporation to dryness	It is used to separate soluble solid (solute) from a solution e.g. salt from aqueous solution	Relative volatility of solute and solvent i.e. boiling point of solvent
Crystallization	It is used to separate soluble solid(solute) that decompose easily on heating from a solution e.g. $CuSO_4$ from its aqueous solution.	solute saturated in solution at different temperature
Fractional crystallization	It is used to separate two or more soluble solids (solutes) from a solution e.g. Two or more solutes in a solution	Relative solubility of constituents at different (low and high) temperature
Simple distillation	It is used to separate miscible liquids	Difference in the boiling point of liquids at different temperature when the boiling points are far apart. For effective distillation, the boiling points of the liquid must differ by 10^oC
Fractional distillation	It is used to separate miscible liquid e.g. separation of crude oil into its components like gasoline, kerosene, gas oil etc.	Difference in the boiling point of liquids at different temperature when the boiling points are very close. For effective distillation, the boiling points of the liquid must differ by 10^oC
Use of separating funnel	It is used to separate immiscible liquid e.g. Kerosene and water	Density or immiscibility of constituents of liquid-liquid mixture.
Sieving	It is used to separate solids of different sizes e.g. to	Different particle sizes of solids mixture.

	obtain fine texture yam-flour	
Sublimation	It is used to separate Solid which sublime from other solids e.g. Iodine from its mixture with sodium chloride	Relative volatility of constituents of solid-solid mixture upon heating. That is, Sublimation properties of a component.
Magnetization	It is used to separate magnetic solids from non-magnetic ones e.g. Mixture of iron fillings and sulphur powder.	Relative magnetizability of constituents of solid-solid mixture.
Chromatography	It used to separate mixture of gases, liquids, dissolved substance or complex organic mixture such as ink, chlorophyll	Rate of migration of a solute in an adsorbent medium. Different adsorbent power of solvents on the medium.
Solvent extraction	Immiscible liquid	Partition of a substance between two immiscible liquid solvent.
Precipitation	It is used to separate a soluble solute from its solution as a result of its solubility in different solvents e.g. An aqueous mixture of copper II ion, cobalt II ion, and Iron II ion	The solubility of the solutes in different medium or solvent

The correct option is B

16. The percentage composition of an element in a compound is the proportion of the element in the compound expressed as a percentage.

Let the formula of the salt be $Fe(NO_3)_x$

$R.M.M\ of\ Fe(NO_3)_x = 56 + 62x$

$\%\ of\ Fe = 23.14\%$

The percentage composition of an element in a compound is the proportion of the element express as a percentage.

$$\%\ of\ Fe = \frac{R.A.M\ of\ Fe}{R.M.M\ of\ Fe(NO_3)_x} \times \frac{100}{1}$$

$$23.14 = \frac{56}{56 + 62x} \times \frac{100}{1}$$

$$23.14 \times (56 + 62x) = 5600$$

$$1295.84 + 1434.68x = 5600$$

$$1434.68x = 5600 - 1295.84$$

$$1434.68x = 4304.16$$

$$x = \frac{4304.16}{1434.68} = 3$$

$Fe(NO_3)_x = Fe(NO_3)_3$

Thus, the iron nitrate is Iron III trioxonitrate V.

The correct option is D

17. $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

The acid, HCl is sufficient, that is, it is in excess. Hence manganese IV oxide is the limiting reagent.

$R.M.M\ of\ MnO_2 = 86.94g/mol$

$$\cap_{MnO_2} = \frac{\text{Reacting mass}}{\text{Molar mass}}$$

$$= \frac{18.50g}{86.94g/mol}$$

$$= 0.2128mol$$

$$\cap_{MnCl_2} = \frac{1mol\ of\ MnCl_2}{1mol\ of\ MnO_2} \times 0.2128mol\ of\ MnO_2$$

$$= 0.2128mol$$

$R.M.M\ of\ MnCl_2 = 125.94g/mol$

$$\cap_{MnCl_2} = \frac{\text{Reacting mass}}{\text{Molar mass}}$$

$$0.2128 = \frac{\text{Mass of } MnCl_2}{125.94g/mol}$$

Mass of $MnCl_2 = 0.2128 \times 125.94$

$= 26.80g$

The correct option is D

18. $^{234}_{92}U \rightarrow {}^{226}_{88}Z + 2{}^{4}_{2}He$

$^{226}_{88}Z \rightarrow {}^{214}_{84}Pb + 3{}^{4}_{2}He$

$^{214}_{82}Pb \rightarrow {}^{214}_{84}Pb + 2{}^{0}_{-1}e$

$^{214}_{84}Pb \rightarrow {}^{212}_{84}Po + 2{}^{1}_{0}n$

$\Rightarrow O \rightarrow \alpha({}^{4}_{2}He), 3\alpha$

$R \rightarrow \beta({}^{0}_{-1}e), 2\beta$

$S \rightarrow {}^{1}_{0}n, 2{}^{1}_{0}n$

The correct option is B

19. Mass of $Na_2CO_3 = 27.0g$

$R.M.M\ of\ Na_2CO_3 = 106g$

$$Mass\ of\ Na = \frac{2(23g/mol)}{106g/mol} \times 27g$$

$= 11.7179g$

$$\cap_{Na} = \frac{mass}{molar\ mass}$$

$$= \frac{11.7170g}{23g/mol} = 0.5094mol$$

$$\cap_{Na} = \frac{No\ of\ atoms}{6.023 \times 10^{23} atoms/mole}$$

$$0.5094mol = \frac{No\ of\ atoms}{6.023 \times 10^{23} atoms/mole}$$

No. of atoms $= 0.5094mol \times 6.023 \times 10^{23} atoms/mol$

$= 3.0681 \times 10^{23} atoms$

$= 3.07 \times 10^{23}$

The correct option is D

20. $2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(g)}$

$20g \quad 100g$

$R.M.M\ of\ H_2 = 2g/mol$

$R.M.M\ of\ O_2 = 32g/mol$

$$\cap_{H_2} = \frac{\text{Reacting mass}}{\text{Molar mass}}$$

$$= \frac{20g}{2g/mol} = 10moles$$

$$\cap_{O_2} = \frac{\text{Reacting mass}}{\text{Molar mass}}$$

$$= \frac{100g}{32g/mol} = 3.125mol$$

$\cap_{H_2} : \cap_{O_2}$

$\frac{10}{2} : \frac{3.125}{1}$

$5 : 3.125$

Note that the division is done by the co-efficient of each of the species in the balanced chemical reaction.

The limiting reagent is oxygen because it gives the lowest value after the division.

$$\cap_{H_2}\ used\ up = \frac{2\ moles\ of\ H_2}{1\ moles\ of\ O_2} \times 3.125mole$$

$= 6.25mole$

Excess $\cap_{H_2} = 10moles - 6.25moles$

$= 3.75moles$

Mass of Excess

$H_2 = 3.75mol \times 2g/mol$

$= 7.50g$

Thus, hydrogen is in excess by 7.50g

The correct option is B

21. **Quantum numbers** *are the numbers given to each energy level in an atom.* The four **quantum numbers** are listed and explained **below:**

Principal Quantum (n): ***This is the quantum number which indicates the relative size of orbitals and therefore the relative distance of an electron from the nucleus of the peak in the radial probability plot thereby determines or describes the main energy level or shell that an electron occupies in an atom.*** **In summary,** the functions of the principal quantum numb... are stated below

(i) It determines the energy possessed by ... electron due to its distance from ... nucleus.

(ii) It determines the size of an electron cl...

(iii) It determines the distance of an elec... from the nucleus and

(iv) It determines the maximum number ... electrons in a main shell.

The principal quantum number has an inte... value of 1, 2, 3, 4, 5, etc.

Subsidiary or Azimuthal Quantum numb... (ℓ): *This is the quantum number wh... determines or defines the shape of orbitals* ... is also known as **angular momentu... quantum number.** In summary the functi... of the subsidiary or azimuthal quantu... number are stated below.

(i) It divides subshell into orbital

(ii) It determines the shapes of orbitals and

(iii) It determines the maximum number ... electrons in a subshell

The subsidiary or azimuthal quantum numb... has an integral value of 0 to (n-1). T... implies that the principal quantum number ... set a limit on the subsidiary quantum numb... (ℓ). The table below shows the values of ℓ f... given values of n.

3. **Magnetic Quantum Number (M_ℓ):** *This ... the quantum number which indicates or sho... the number of orbitals in a given subshell.* ... prescribes the orientation of the orbital ... space around the nucleus. Therefore it ... sometimes called **orbital orientati... quantum number.** The integral values of M ... ranges from $-\ell$ through 0 to $+\ell$. The numb... of possible M_ℓ in a given subshell determin... the number of orbitals in the subshell.

4. **Spin quantum number (M_s):** *This is ... quantum number which is associated with ... spin properties of an electron about it axis a... the orientation of the magnetic field produ... by the spin.* Since a charged particles spinn... about its axis behaves like a magnet, the s... quantum number has two possible va... which are $-\frac{1}{2}$ and $+\frac{1}{2}$. The electron with ... upward spin takes the value $+\frac{1}{2}$ but ... electron with a downward spin takes the v... of $-\frac{1}{2}$.

NOTE:

The subsidiary quantum (l) number div... sub-shell into orbital.

L	Orbital
s	0

p	1
d	2
f	3

The principal quantum number (n) and the subsidiary quantum are used to describe an orbital completely.

n	L	orbital described
3	1	$3p$

Thus, the orbital under consideration is $3p$.
The $3p$-orbital has magnetic quantum number value of $-1, 0, 1$
The following are true for the given orbital
(i) It is a 3p-orbital
(ii) It is three-fold degenerate
(iii)It has a magnetic quantum values of $-1, 0, 1$

The correct option is C

22. $V_1 = ?, C_1 = 2m$
$V_2 = 250ml, C_2 = 0.15m$
$C_1V_1 = C_2V_2$
$2V_1 = 0.15 \times 250$
$V_1 = \dfrac{0.15 \times 250}{2} = 18.75ml$
But $1000ml = 1dm^3 = 1000cm^3$
$V_1 = 18.75ml \times \dfrac{1dm^3}{1000ml}$
$= 0.01875$
Note that:
$V_{H_2O} = V_2 - V_1$
$V_{H_2O} = 250ml - 18.75ml = 231.25ml$

The correct option is B

23. $H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$
$0.005M \quad 2(0.005M) \quad 0.005M$
$[H^+] = 2(0.005) = 0.01M$
$pH = -\log_{10}^{[H^+]}$
$= \log_{10}^{0.01} = 2$
$pH + pOH = 14$
$2 + pOH = 14$
$pOH = 14 - 2 = 12$

The correct option is A

24. Entropy is the natural tendency of a substance to achieve a great disorderliness as one of the derivating force in a change of state or in a chemical reaction.
The entropy of a gas is greater than that of an aqueous species. The entropy of an aqueous species is greater than that of a pure liquid and the entropy of a pure liquid is greater than of a pure solid i.e.

$$\underline{solid < liquid < aqueous\ species < gas}$$
$$Increase\ in\ entropy$$

Entropy change (ΔS):- It is the difference between the entropies of the products and the entropies of the reactants for a given reaction.

$$\Delta S = \sum S_P - \sum S_R$$

TYPES OF ENTROPY CHANGE

(a) **Negative Entropy Change:** A chemical system is said to undergo a negative entropy change, if the system changes from a more disorderly state to a less disorderly state.
$H_2O_{(g)} \longrightarrow H_2O_{(l)}\ \Delta S = -ve\ or\ \Delta S < 0$
$2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}\ \Delta S = -ve$

(b) **Zero Entropy Change:** A chemical system is said to undergo a zero entropy change if the system change from one state to another with the same degree of disorderliness.
For a system to undergo a zero entropy change two conditions must be satisfied.

(iii)The number of moles of the reactants in a given state must equal to the number of moles of moles in the products.

(iv)The reactants and products compared must be in the same state.
$A_{(s)} + B_{(g)} \longrightarrow C_{(s)} + D_{(g)}\ \ \Delta S = 0$
$I_{2(g)} + H_{2(g)} \longrightarrow 2HI_{(g)} \quad \Delta S = 0$
$Na_{(s)} + Au^+_{(aq)} \longrightarrow Na^+_{(aq)} + Au_{(s)}\ \Delta S = 0$

(c) **Positive Entropy Change:** A chemical system is said to undergo a negative entropy change if the system changes from a less disorderly state to a more disorderly state.
$H_2O_{(l)} \longrightarrow H_2O_{(g)}\ \ \Delta H = +ve\ or\ \Delta S > 0$
The change in entropy is easily determined if the substance are in different states than one that the substance are in the same state. If the substances are in the same state the side with the highest number of moles (either reactant or product) will have the greater entropy.
$MgCO_{3(s)} \longrightarrow MgO_{(s)} + CO_{2(g)}\ \Delta S = +ve$

The correct option is C and D

25.

n	l	m_l	m_s
1	0	0	$\pm\frac{1}{2}$
2	0	0	$\pm\frac{1}{2}$
	1	$-1, 0, 1$	$\pm\frac{1}{2}$
3	0	0	$\pm\frac{1}{2}$
	1	$-1, 0, 1$	$\pm\frac{1}{2}$
	2	$-2, -1, 0, 1, 2$	$\pm\frac{1}{2}$

Base on the table above the following sets of quantum number is correct
$n = 1, l = 0, m_l = 0, m_s = \pm\frac{1}{2}$
$n = 2, l = 0, m_l = 0, m_s = \pm\frac{1}{2}$
$n = 2, l = 1, m_l = 0, m_s = \pm\frac{1}{2}$
$n = 3, l = 1, m_l = 0, m_s = \pm\frac{1}{2}$

The correct option is B

2013/2014 CHEMISTRY 001 TEST

1. How many protons, neutrons and electrons are in $^{119}Sn^{2+}$? [Z = 50] (a) 48, 50 and 69 (b)

50, 69 and 50 (c) 50, 69 and 49 (d) 50, 69 and 48

2. The number of hydrogen and carbon atoms in $7.50g$ of methane are respectively $[C = 12.0, H = 1.0, N_A = 6.02 \times 10^{23}]$ (a) 1.13×10^{24} and 2.82×10^{23} (b) 2.41×10^{24} and 6.02×10^{23} (c) 1.88×10^{23} and 4.69×10^{24} (d) 2.82×10^{23} and 1.13×10^{24}
3. Given the following data:
   $NH_{3(g)} \rightarrow \frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)}$ $\Delta H = 46kJ$
   $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$ $\Delta H = -484kJ$
   Calculate ΔH for the reaction
   $2N_{2(g)} + 6H_2O_{(g)} \rightarrow 3O_{2(g)} + 4NH_{3(g)}$
   (a) $-438kJ$ (b) $-1268kJ$ (c) $+1268kJ$ (d) $+438kJ$
4. In the process of forming covalent bond in molecules of substances, orbitals overlap e.g. I. $s-s$ II. $p-p$ (linearly opposed) IV. $p-p$ (parallel) IV. $sp-s$ V. sp^2-s VI. sp^3-s VII. $sp-p$ (linearly opposed). Which of these overlappings are used in the formation of carbon (IV) oxide? (a) III and VII only (b) I, II, V and VI (c) I, II, IV and VI (d) II and V only
5. Which of the following compounds is the most ionic? (a) sodium chloride (b) caesium fluoride (c) potassium iodide (d) lithium bromide
6. Consider the following orderings: I. $Al < Si < P < S$ II. $Be < Mg < Ca < Sr$ III. $I < Br < Cl < F$. Which of these give(s) the correct trend in atomic radii? (a) III only (b) II only (c) I and II only (d) I only
7. What are the respective patterns of hybridization of the central atom in the compounds: CH_4, CO_2, NH_3 and BF_3? (a) sp^3, sp^2, sp^2, sp^3 (b) sp^3, sp^2, sp^3, sp^2 (c) sp^3, sp, sp^3, sp^2 (d) sp^3, sp^3, sp^2, sp^2
8. Boron has two isotopes. If the isotope with mass $10.013amu$ has a 19.78% abundance, determine the atomic weight of boron given that the other isotope has a mass of 11.009amu. (a) $10.81amu$ (b) $9.71amu$ (c) $18.01amu$ (d) $10.09amu$
9. Deuterium bombardment of $^{238}_{92}U$ gives $^{238}_{93}Np$ and (a) an electron (b) two neutrons (c) two protons (d) beta particle
10. The following steps are required for the separation of a mixture comprising barium tetraoxosulphate (VI), iodine and sodium chloride. What is the correct order of the steps? I. Dissolution II. Filtration III. Sublimation IV. Evaporation to dryness (a) I, II, III and IV (b) I, III, II and IV (c) III, I, II and IV (d) III, II, I and IV
11. An ion M^+ has the electronic configuration $1s^22s^22p^63s^23p^4$. The quantum number description of neutral atom of M is (a) $n = 3$, $l = 2$, $m = 1$, $s = \pm\frac{1}{2}$ (b) $n = 3$, $l = 1$, $m = 1$, $s = \pm\frac{1}{2}$ (c) $n = 3$, $= 2$, $m = -1$, $s = \pm\frac{1}{2}$ (d) $n = 3$, $l = 1$, $m = 0$, $s = \pm\frac{1}{2}$
12. A $230cm^3$ sample of $0.275M$ $CaCl_2$ solution was left on a hot plate overnight; the following morning, the solution had a concentration of 1.10M. what volume of water was dried off from the original solution? (a) $58cm^3$ (b) $172.5cm^3$ (c) $0.06325cm^3$ (d) $57.5cm^3$
13. The table below shows the pH values of the aqueous solutions of the named substances.

	Name	pH
I	Tetraoxosulphate (VI) acid	1.5
II	Magnesium nitrate	8.0
III	Ammonia	6.2
IV	Potassium chloride	7.0
V	Sodium hydroxide	14.0

Which of these pH values will you judge to be correct? (a) I, II and III (b) I, III and IV (c) I, II and V (d) I, IV and V

14. If it takes 4 times as long for hydrogen to effuse as it takes for the same volume of a particular diatomic gas under the same conditions, what is the relative atomic mass of the atom of this gas? [H = 1] (a) 32 (b) 64 (c) 44 (d) 16
15. Aluminium metal of mass $5.4g$ reacted with excess hydrochloric acid at s.t.p. what is the volume of hydrogen gas produced at s.t.p. [H=1; Al=27; Molar volume = $22.4dm^3$] (a) $6.72dm^3$ (b) $7.46dm^3$ (c) $5.60dm^3$ (d) $2.99dm^3$
16. Consider the acid – base equation below $HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$. Which of the species in the equation acts as Bronsted-Lowry base and Bronsted-Lowry conjugate base respectively? (a) HSO_4^- and H_2O (b) SO_4^{2-} and H_3O^+ (c) H_2O and H_3O^+ (d) H_2O and SO_4^{2-}
17. Which of the following is NOT correct? I. A substance that melts at $120 - 122°C$ is pure II. Properties of a compound are the resultant properties of the substances from which it is made III. At high temperature and low pressure all gases behave alike IV. Constant boiling point is not a sufficient criterion for a pure liquid V. 1 mole of H_2 and 1 mole of NH_3 both at 273 K and 1atm will contain the same number of molecules but occupy different volume. (a) II and V only (b) II, IV

and V only (c) II, III and V only (d) II and IV only

18. Consider the following compounds: (i) CH_4 (ii) NH_3 (iii) BCl_3 (iv) PBr_3 (v) $BeBr_2$ (vi) H_2O. In which of the molecules above will be central atom be excited before hybridization? (a) iii, iv and vi (b) ii, iii and vi (c) I, iii and iv (d) i, iii and v
19. Given the equation below: $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$ $\Delta H = -114kJ$. What is the enthalpy change per gram of nitrogen (II) oxide? (a) −1.9kJ (b) 54kJ (c) −3.8kJ (d) 19kJ
20. The pH of a 0.005M sodium hydroxide solution is (a) 12.6 (b) 2.3 (c) 4.6 (d) 11.7
21. Which of the following involves a positive entropy change? (a) $H_2O_{(g)} \rightarrow H_2O_{(l)}$ (b) $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$ (c) $Na_{(s)} + Au^{+}_{(aq)} \rightarrow Na^{+}_{(aq)} + Au_{(s)}$ (d) $MgCO_{3(s)} \rightarrow MgO_{(s)} + CO_{2(g)}$
22. Which of the following shows the equation for the second ionization energy for boron? (a) $B^{2+} \rightarrow B^{3+} + e^-$ (b) $B^{2+} + e^- \rightarrow B^+$ (c) $B^+ \rightarrow B^{2+} + e^-$ (d) $B \rightarrow B^{2+} + 2e^-$
23. If 18% of a sample of zinc-65 decays in 69.9 days, what is the half-life of this isotope (in days)? (a) 272.6 (b) 194.2 (c) 28.2 (d) 244.1
24. A sample of gas occupying a volume of $50cm^3$ at 1atm and 25^oC is found to have a mass of 0.0286g. What is the relative molecular mass of the gas? [Ideal gas constant $= 8.314JK^{-1}mol^{-1}$; 1atm $= 101325Nm^{-2}$]. (a) 1523 (b) 10.02 (c) 13.99 (d) 18.77
25. A $300.0dm^3$ flask contains 16g oxygen and 22g carbon (IV) oxide at 27^oC. What is the total pressure exerted by the gases? [O = 16; C = 12; R = 0.082 $atmdm^{-3}mol^{-1}K^{-1}$] (a) 0.041atm (b) 0.123atm (c) none of the other options (d) 0.082atm

SOLUTION

1. Atomic number (Z) is the number of protons in the nucleus of each atom of an element. The atomic number of an element determines the chemical properties of an element. The atom is a neutral spherical entity, it implies that the number of protons (positive charges) is equal to the number of electrons (negative changes). Thus for a neutral atom, the number or proton (NP or Z) is equal to the number of electron (NE). The Neutron Number (NN) is the number of neutrons in the nucleus of each atoms of an element. The neutron number determines the physical properties of an element.

The mass number (M) of an element is the number of protons and neutrons in the nucleus of an element. It is also known as nucleon number.

$$A = NN + NN$$

For a monoatomic ion of change +2, the number of protons exceeds the number of electrons by 2.

$NP = NE + 2$

In $^{119}_{50}Sn^{2+}$

$Z = NP = 50$

But $NP = NE + 2$

$50 = NE + 2$

$NE = 50 - 2$

$NE = 48$

$A = NP + NN$

$119 = 50 + NN$

$NN = 119 - 50$

$NN = 69$

Thus, in $^{119}_{50}Sn^{2+}$, the number of protons is 50, the number of neutrons is 69 and the number of electrons is 48.

The correct option is D

2. Mass of methane $= 7.50g$

R.M.M of methane $(CH_4) = 16g/mol$

$$\cap_{CH_4} = \frac{\text{reacting mass}}{\text{molar mass}}$$

Mass of H in 7.50g of CH_4

$$= \frac{R.A.M\ of\ H}{R.M.M\ of\ CH_4} \times 7.50g$$

$$= \frac{4(1g/mol)}{16g/mol} \times 7.50g$$

$$= \frac{15}{8}g$$

$= 1.875g$

Mass of C in 7.50g of CH_4

$$= \frac{R.A.M\ of\ C}{R.M.M\ of\ CH_4} \times 7.50g$$

$$= \frac{12g/mol}{16g/mol} \times 7.50g$$

$$= \frac{45}{8}g$$

$= 5.625g$

$$\cap_C = \frac{\text{Reacting mass}}{\text{Molar mass}}$$

$$= \frac{5.625g}{12g/mol}$$

$$= \frac{15}{32}mol$$

$$\cap_H = \frac{\text{Reacting mass}}{\text{Molar mass}}$$

$$= \frac{\frac{15}{8}g}{1g/mol}$$

$$= \frac{15}{8}mol$$

$$\cap_C = \frac{\text{No of atoms of C}}{6.02 \times 10^{23}\ \text{atoms/mol}}$$

$$\frac{15}{32}mol = \frac{\text{No of atoms of C}}{6.02 \times 10^{23}\ \text{atoms/mol}}$$

No of atoms of C

$$= \frac{15mol}{32} \times 6.02 \times 10^{23}\ \text{atoms/mol}$$

$$= 2.82 \times 10^{23}\text{atoms}$$

$$\cap_H = \frac{\text{No of atoms of H}}{6.02 \times 10^{23}\ \text{atoms/mol}}$$

$$\frac{15}{8}mol = \frac{\text{No of atoms of H}}{6.02 \times 10^{23}\ \text{atoms/mol}}$$

No of atoms of H

$$= \frac{15mol}{8} \times 6.02 \times 10^{23}\ \text{atoms/mol}$$

$$= 1.12875 \times 10^{24}\text{atoms}$$

$$\simeq 1.13 \times 10^{24} atoms$$

The correct option is A

3. $NH_{3(g)} \rightarrow \frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)}\ \Delta H = 46kJ$

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}\ \Delta H = -484kJ$

Multiply equation 1 by 4, reverse it and each equation 2 by 3, and reverse it.

$6H_{2(g)} + 2N_{2(g)} \rightarrow 4NH_{3(g)}\ \Delta H = 4(-46kJ)$

$6H_2O_{(g)} \rightarrow 6H_{2(g)} + 3O_{2(g)}\ \Delta H = 3(486kJ)$

Note that when a chemical equation is multiply by a factor ΔH must also be multiply by that same factor. If a chemical equation is also reverse the sign of its ΔH is reverse or change.

$6H_{2(g)} + 2N_{2(g)} \rightarrow 4NH_{3(g)}\ \Delta H = -184kJ$

$6H_2O_{(g)} \rightarrow 6H_{2(g)} + 3O_{2(g)}\ \Delta H = 1452kJ$

$6H_2O_{(g)} + 2N_{2(g)} \rightarrow 4NH_{3(g)} + 3O_{2(g)}\Delta H = +1268kJ$

The correct option is C

4. O = C = O

The carbon atom in CO_2 is sp-hybridize. The outermost orbital of oxygen is the p orbital. Hence, the sigma bond between C and O is sp – p. the pie bond between C and O will be p-p laterally overlapped orbital. Hence the over-lapping orbital in CO_2 are sp-p (linearly opposed) & p-p (parallel).

The correct option is A

5.

Atomic properties	Across the period	Down the group
Electropositivity	Decreases	Increases
Atomic volume	Decreases	Increases
Atomic size	Decreases	Increases
Atomic radius	Decreases	Increases
Ionic radius	Decreases	Increases
Electric conductivity	Decreases	Increases
Thermal conductivity	Decreases	Increases
Electronegativity	Increases	Decreases
Ionization energy	Increases	Decreases
Electron affinity	Increases	Decreases
Metallicity	Decreases	Increases
Atomic number	Increases	Increases
Mass number	Increases	Increases
Screening/shielding effect	Increases	Increases
Nuclear charge	Increases	Decreases

The table shows that the electropositivity metallic character of atoms increases down group. In group 1A it increases from through Na, K, Rb, Cs to Fr. Thus the properties of the group 1A element increase from Li, Na, K, Rb, Cs to Fr. Thus, in sodium chloride, Caesum fluoride. Potassium iodide and lithium bromide, Caesum fluoride have the greatest or highest ionic character properties.

The correct option is B

6. The table in solution to question also shows that the atomic radius of element decrease across a period due increase in nuclear charge effect but increase down the group due to increase in screen or shielding effect.

In period 3, Na > Mg > Al > Si > P > S

In group IIA, Be < Mg < Ca < Sr

In group IIIA, F < Cl < Br < I

The correct option is B

7.

Species	Hybridization of central atoms
$BeCl_2$	Sp
BF_3	Sp^2
CH_4	Sp^3
CO_2	Sp
NH_3	Sp^3
H_2O	Sp^3

The correct option is C

8. R.A.M of Boron =?

$m_1 = 10.013amu$, $\alpha_1 = 19.78\% = \frac{19.78}{100} = 0.1978$

$m_2 = 11.009amu$, $\alpha_2 = 100 - 19.78 = 80.22\% = \frac{80.22}{100} = 0.8022$

$R.A.M\ of\ B = \alpha_1 m_1 + \alpha_2 m_2$

$= 10.013 \times 0.1978 + 11.009 \times 0.8022$

$= 1.9805714 + 8.8314198$

$= 10.8119amu$

The correct option is A

9. $^{238}_{92}U + {}^{2}_{1}D \rightarrow {}^{238}_{93}NP + 2\,{}^{1}_{0}n$

Thus, when $^{238}_{92}U$ is bombarded by deuterium It gives $^{238}_{93}NP$ and two neutrons.

The correct option is B

10. A mixture of $BaSO_4$ (insoluble), iodine (sublime) and sodium chloride (water soluble)

and withstand intense heating) can be separated by the steps below

(i) Sublimation to remove iodine

(ii) Addition of water (i.e. dissolution) to dissolve $NaCl$

(iii) Filtration to remove $BaSO_4$

(iv) Evaporation to dryness to recover $NaCl$

The correct option is C

11. $M^+ \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

Since the monoatomic ion, M^+ has a charge of +1, it mean that the number of protons (NP) exceed the number of electrons (NE) by 1.

$NE = 16$

$NP = NE + 1$

The electronic configuration shows that the number of electrons in the monoatomic ion is 16.

$NP = 16 + 1 = 17$

Thus the atomic number of the element M is 17.

$_{17}M \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

The outermost subshell is 3p

n	L	m_L	S
3	1	$-1, 0, 1$	$\pm ½$

Thus, n = 3, L = 1, m = −1, 0, 1 and s = $\pm ½$

The value of m can be −1, 0, or +1 as shown above.

The correct options are B and D

12. $V_1 = 230cm^3$

$C_1 = 0.275M$

$C_2 = 1.10M$

$V_2 = ?$

$C_1V_1 = C_2V_2$

$230 \times 0.275 = 1.10V_2$

$$V_2 = \frac{230 \times 0.275}{1.10}$$

$= 57.5cm^3$

Let the value of water dried off = V_{H_2O}

$V_1 = V_2 + V_{H_2O}$

$V_{H_2O} = V_1 - V_2$

$= 230 - 57.5$

$= 172.50cm^3$

Note that in the case of dilution, $V_2 = V_1 + V_{H_2O}$ but in the case of evaporation $V_1 = V_2 + V_{H_2O}$.

The correct option is B

13.

	Names	P^H
I	H_2SO_4	<7
II	$Mg(NO_3)_2$	<7
III	NH_3	>7
IV	KCl	$=7$
V	$NaOH$	>7

The correct p^H of each of the substance, are given in the table above.

The correct option is D

14. $R_{H_2} = 4R_{gas}$

$R_{gas} = ?$

$$\frac{R_{gas}}{R_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{gas}}}$$

R.M.M of $(M)_{H_2} = 2g/mol$

$$\frac{R_{gas}}{4\,R_{gas}} = \sqrt{\frac{2}{M_{gas}}}$$

$$\frac{1}{4} = \sqrt{\frac{2}{M_{gas}}}$$

Square both side

$$\left(\frac{1}{4}\right)^2 = \left(\sqrt{\frac{2}{M_{gas}}}\right)^2$$

$$\frac{1}{16} = \frac{2}{M_{gas}}$$

$M_{gas} = 16 \times 2$

$= 32g/mol$

The correct option is A

15. Mass of $Al = 5.4g$

$2Al + 6HCl_{(aq)} \rightarrow 2AlCl_{3(s)} + 3H_{2(g)}$

$$\cap_{Al} = \frac{\text{reacting mass}}{\text{Molar mass}}$$

$$= \frac{5.40g}{27g/mol}$$

$= 0.2mol$

$$\cap_{H_2} = \frac{3\text{mole of } H_2}{2\text{mole of Al}} \times 0.2\text{mol}$$

$= 0.3mol$

$$\cap_{H_2} = \frac{\text{vol at s.t.p}}{22.4\text{dm}^3/\text{mol}}$$

$vol\ at\ s.t.p = \cap_{H_2} \times 22.4\text{dm}^3/\text{mol}$

$= 0.3mol \times 22.4\text{dm}^3/\text{mol}$

$= 6.72dm^3$

The correct option is A

16. $HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$

According to Bronsted-lowry, an acid is a substance which donate a proton. In the above reaction HSO_4^- donate a proton to H_2O to form SO_4^{2-} and H_3O^+. Thus HSO_4^- is an acid while H_2O is a base.

Acid-base conjugate pair is a relationship between an acid and a base such that the proton donates by an acid is accepted by a base. **Note that the acid always forms the conjugate base while the base also forms the conjugate acid.**

HSO_4^- + H_2O $\rightleftharpoons$ SO_4^{2-} + H_3O^+

acid base conjugate base conjugate acid

Thus the bronsted-lowry base is H_2O and the bronsted-lowry conjugate base is SO_4^{2-}

The correct option is D

17. The following is true

(i) A substance that melts at $120 - 122^oC$ is pure because its melts as a narrow range of temperature. That is, its has a sharp melting point.

(ii) The properties of a compound differs complete from the properties of its constitute elements.

(iii) At low pressure and high temperature real gases achieve ideality. That is behave alike.

(iv) A constant boiling points is a necessary condition for determining the purity of liquid substance but not sufficient condition or criteria. This is because certain mixture called **Azeotropic mixture** (e.g. A mixture of 98.3% H_2SO_4 and 1.7% of water; H_3O^+ and Cl^- etc) boil at a constant temperature.

(v) For H_2

$n = 1$

$T = 273K$

$P = 1atm$

$PV = nRT$

$V = \frac{nRT}{P}$

$V_{H_2} = \frac{nRT}{P}$

For NH_3

$n = 1$

$T = 273K$

$P = 1atm$

$V = \frac{nRT}{P}$

$V_{NH_3} = \frac{nRT}{P}$

$\Rightarrow V_{H_2} = V_{NH_3}$ since n, R, T and P are the same for both H_2 and NH_3.

Thus, 1 mole of H_2 and 1 mole of NH_3 both at 273k and 1atm will contain the same number of molecules and occupy the same volume at s.t.p.

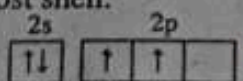
$\Rightarrow \cap_{NH_3} = \cap_{H_2} = \frac{\text{No of molecules}}{6.02 \times 10^{23}\text{molecules/mol}}$

The correct option is A

18. CH_4

Step 1: Write the electronic configuration of the central element. ${}_6C \rightarrow 1s^2\,2s^2\,sp^2$

Step 2: Draw the orbital diagram of the outermost shell.



(i) No of vacant orbital available = 2

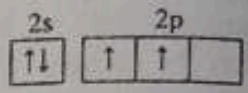
Any orbital with a single electron is available for bonding

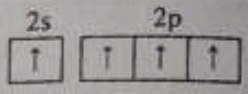
(ii) No of vacant orbital needed

= No of atoms of H × O.N of H

$= 4 \times (+1) = 4$

Since the number of vacant orbital needed is greater than the number of vacant orbital available excitation must occur before bonding. ***Excitation***





is the process of promoting an electron from a lower energy level to a higher energy level.

N.B

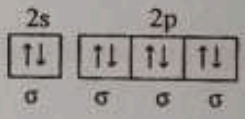
G.S → Ground State electronic configuration

E.S → Excited State electronic configuration

Since electron is excited in CH_4, excitation occur before bonding.

Step 3: Determine the number of sigma (σ) and pie (π) form during bonding.

Since hydrogen has an oxidation state of +1, the four hydrogen atom will form four sigma bonds.



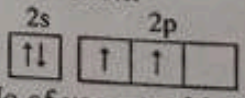
Step 4: The number of sigma bond form determines the hybridization of CH_4

Since four sigma bonds are form, the hybridization of CH_4 is Sp^3.

(ii) CO_2

Step 1: Write the electronic configuration of the central element. ${}_6C \rightarrow 1s^2\,2s^2\,sp^2$

Step 2: Draw the orbital diagram of the outermost shell.



(i) No of vacant orbital available = 2

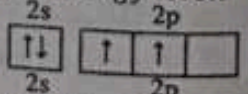
Any orbital with a single electron is available for bonding

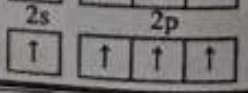
(ii) No of vacant orbital needed =

= No of atoms of O × O.N of O

$= 2 \times 2 = 4$

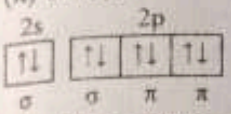
Since the number of vacant orbital needed is greater than the number of vacant orbital available excitation must occur before bonding. ***Excitation is the process of promoting an electron from a lower energy level to a higher energy level.***





Step 3: Determine the number of sigma (σ) and pie (π) form during bonding.
Since oxygen has an oxidation state of −2, each of the oxygen atoms will form one sigma (σ) bond and one pie (π) bond. Therefore the two oxygen atom will form two sigma (σ) bonds and two pie (π) bonds.

All sigma bonds will be form before pie (π) bonds.

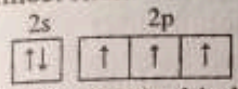


Step 4: The number of sigma bond determine the hybridization of CO_2. Since two sigma bonds are form the hybridization of CO_2 is Sp.

(iii)NH_3

Step 1: Write the electronic configuration of the central element. $_7N \rightarrow 1s^2\ 2s^2\ 2p^3$

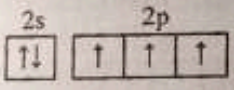
Step 2: Draw the orbital diagram of the outermost shell.



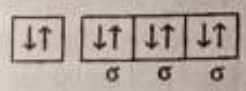
(i) No of vacant orbital available = 3
Any orbital with a single electron is available for bonding

(ii) No of vacant orbital needed =
= No of atoms of H × O.N of H
$= 3 \times 1 = 3$

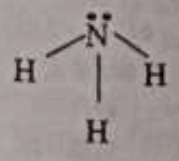
Since the number of vacant orbital needed is equal to the number of vacant orbital available, bonding occurs without excitation.



Step 3: Determine the number of sigma (σ) and pie (π) form during bonding.
Since Hydrogen has an oxidation state of +1, the three hydrogen atoms will form three sigma (σ) bonds.



Step 4: The number of sigma bond determine the hybridization of NH_3. Three sigma bonds are form in the 2p-oribtal (i.e. p^3). Since the hybridization of NH_3 is the mixing of the 2s and 2p orbitals, the hybridization of NH_3 is Sp^3.
Note that, no bonding occur in 2s-orbital. This implies that there is one lone pair of electron on the central atom.



The hybridization of NH_3 is Sp^3.

(iv)$BeBr_2$

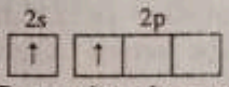
Step 1: Write the electronic configuration of the central element $_4Be \rightarrow 1s^2\ 2s^2$

Step 2: Draw the orbital diagram of the outermost sub-shell.

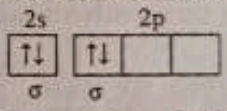
(i) No of vacant orbital available = 0
Any orbital with a single electron is available for bonding

(ii) No of vacant orbital needed
= No of atoms of Br× O.N of Br
$= 2 \times 1 = 2$

Since the number of vacant orbital needed is greater than the number of vacant orbital available, excitation must occur before bonding.



Step 3: Determine the number of sigma (σ) bonds and pie (π) bonds form during bonding.
Since bromine has an oxidation state of −1, the two chlorine atom will form two sigma bonds.

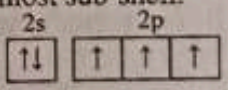


(v) Step 4: The number of sigma bonds determine the hybridization. Two sigma (σ) bonds are form, one in the 2s-orbital and the other in 2p-orbital (i.e. sp). The hybridization of $BeBr_2$ is sp.

(vi)PBr_3

Step 1: Write the electronic configuration of the central element $_{15}P \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

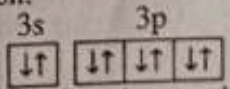
Step 2: Draw the orbital diagram of the outermost sub-shell.



(iii)No of vacant orbital available = 3
Any orbital with a single electron is available for bonding

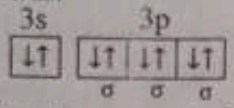
(iv)No of vacant orbital needed
= No of atoms of Br × O.N of Br
$= 3 \times 1 = 3$

Since the number of vacant orbital needed is equal to the number of vacant orbital available, bonding occurs without excitation.



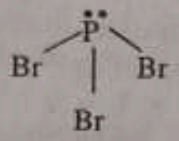
Step 3: Determine the number of sigma (σ) bonds and pie (π) bonds form during bonding.Since bromine has an oxidation state

of −1, the three bromine atoms will form three sigma bonds.



Note that, no bonding occur in 3s-orbital. This implies that there is one lone pair of electron on the central atom

Step 4: The number of sigma bonds determine the hybridization. Three sigma (σ) bonds are form,

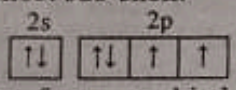


The hybridization of PBr_3 is Sp^3.

(vii) H_2O

Step 1: Write the electronic configuration of the central element ${}_8O \rightarrow 1s^2\ 2s^2\ sp^4$

Step 2: Draw the orbital diagram of the outermost sub-shell.



(i) No of vacant orbital available = 2

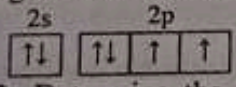
Any orbital with a single electron is available for bonding

(ii) No of vacant orbital needed =

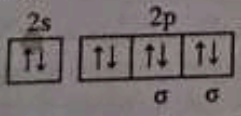
= No of atoms of H × O.N of H

$= 2 \times 1 = 2$

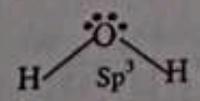
Since the number of orbitals needed is equal to the number of vacant orbital available, bonding without excitation.



Step 3: Determine the number of sigma (σ) and pie (π) bonds form during bonding. Since hydrogen has an oxidation state of +1, the two hydrogen atoms will form two sigma (σ) bonds.



Step 4: The number of sigma bonds determine the hybridization. Two sigma bonds are form in the $2P_y$ and $2P_z$ orbital. This implies that the orbitals involve are $2s$, $2P_x$, $2P_y$&$2P_z$ (i.e. Sp^3). The hybridization of H_2O is Sp^3 with two lone pair of electrons on the central atom.

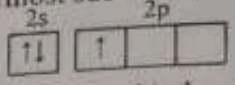


In other word, in H_2O there are two lone pair of electrons and two bond pair of electrons. The two lone pair of electrons is indicated with the completely filled orbital without forming sigma bond. The two bond pair electrons are indicated by the two sigma bonds formed.

(viii) BCl_3

Step 1: Write the electronic configuration of the central element ${}_5B \rightarrow 1s^2\ 2s^2\ 2p^1$

Step 2: Draw the orbital diagram of the outermost sub-shell.



(i) No of vacant orbital available = 1

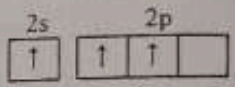
Any orbital with a single electron is available for bonding

(ii) No of vacant orbital needed

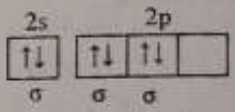
= No of atoms of Cl × O.N of Cl

$= 2 \times 1 = 2$

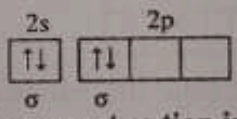
Since the number of vacant orbital needed is greater than the number of vacant orbital available, excitation must occur before bonding.



Step 3: Determine the number of sigma (σ) bonds and pie (π) bonds form during bonding. Since Chlorine has an oxidation state of −1, the three chlorine atoms will form three sigma bonds.



Step 4: The number of sigma bonds determine the hybridization. Three sigma (σ) bonds are form, one in the 2s-orbital and the other two in 2p-orbital (i.e. Sp^2). The hybridization of BCl_3 is Sp^2.



The correct option is D

19. $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}\ \Delta H = -114kJ$

If the above equation is reverse, the sign of ΔH will change.

$2NO_{2(g)} \rightarrow 2NO_{(g)} + O_{2(g)}\ \Delta H = 114kJ$

If a given factor is used to multiply, the above equation the value of ΔH must be multiply by that factor.

$NO_{2(g)} \rightarrow NO_{2(g)} + \frac{1}{2}O_{2(g)}\ \Delta H = \frac{1}{2}(114kf)$

$\Rightarrow \Delta H = 57kJ/mol$

$R.M.M\ of\ NO = 30g/mol$

1 mole of NO = 30g

$\Delta H = 57kJ/mol = 57kJ/30g$

$= 1.9kJ/g$

$\Rightarrow 2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}\ \Delta H$

$= -1.9kJ/g\ of\ NO$

$2NO_{2(g)} \rightarrow 2NO_{2(g)} + O_{2(g)}\ \Delta H = -1.9kJ/g\ of\ NO$

The correct option is A

20. $NaOH \rightarrow Na^+ + OH^-$

0.005M 0.005M 0.005M

$P^{OH} = -Log_{10}^{[OH^-]}$
$= -Log_{10}^{0.005}$
$= 2.3010$
$P^H + P^{OH} = 14$
$P^H + 2.3010 = 14$
$P^H = 14 - 2.3010$
$P^H = 11.6990$
$P^H = 11.7$

The correct option is D

21. **Enthalpy change (ΔH):** Is the heat evolved or absorbed in a chemical reaction at a constant pressure. It is the difference between the summation of the enthalpies of the products and the reactants.

$\Delta H = \sum H_p - \sum H_r$

Where $\sum H_p$= Summation (or addition) of the enthalpies of the products

$\sum H_R$= Summation (or addition) of the enthalpies of the reactants

If ΔH is negative ($i.e. \Delta H < 0$) the reaction is an exothermic reaction. Exothermic reaction is a reaction in which heat is liberated to the surrounding. All combination reaction are exothermic in nature. Combination reactions are reaction in which two substance combine to form a product(s)

(i) $H_2O_{(g)} \longrightarrow H_2O_{(l)} \quad \Delta H = -ve$

(ii) $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)} \Delta H = -ve$

(iii) $Na_{(s)} + Au^+_{(aq)} \rightarrow Na^+_{(aq)} + Au_{(s)} \Delta S = 0$

(iv) $MgCO_{3(s)} \rightarrow MgO_{(s)} + CO_{2(g)} \Delta S = +ve$

The correct option is D

22. Ionization energy is the energy require to remove one mole of electron from gaseous atom to form a cation.

$$Na_{(g)} \longrightarrow Na^+ + e^-$$

Ionization energy increases across the period and decreases down the group. if number of subshells are held constant, the greater the valence electrons of an element the greater the ionization energy.

(i) $B_{(g)} \rightarrow B^+_{(g)} + e^-$ 1st ionization energy

(ii) $B^+_{(g)} \rightarrow B^{2+}_{(g)} + e^-$ 2nd ionization energy

The correct option is C

23. $t = 69.9\ days$
$T_{\frac{1}{2}} = ?$
$N_o = 100\%$
$A_o = 18\%$
$A_o = N_o - N_R$
$18 = 100 - N_R$
$N_R = 100 - 18$
$= 82\%$

Where N_R = Amount of radioisotope remaining

N_o = Original amount of a radioisotope

$N_o = 1$ for fraction but $N_o = 100\%$ for percentage.

$N_R = N_o \left(\frac{1}{2}\right)^n$
$82 = 100 \left(\frac{1}{2}\right)^n$
$\left(\frac{1}{2}\right)^n = \frac{82}{100}$
$\left(\frac{1}{2}\right)^n = 0.82$
$0.5^n = 0.82$

Take the logarithm of both sides

$Log 0.5^n = Log 0.82$
$n Log_{10}^{0.5} = Log_{10}^{0.82}$
$n = \frac{Log_{10}^{0.82}}{Log_{10}^{0.5}}$
$n = \frac{-0.0862}{-0.3010}$
$= 0.2864$
$But\ T_{\frac{1}{2}} = \frac{t}{n}$
$= \frac{69.9}{0.2864}$
$= 244.0642 days$
$T_{\frac{1}{2}} \simeq 244.1 days$

The correct option is D

24. $V = 50cm^3 = 50 \times 10^{-6} m^3$
$T = 25^oC = 298k$
$m = 0.0286g \quad M = ? \quad R = 8.314 J/molk$
$P = 1atm = 101325 N/m^2$
$PV = nRT$
$But\ n = \frac{mass}{molar\ mass} = \frac{m}{M}$
$PV = nRT = \frac{mRT}{M}$
$PV = \frac{mRT}{M}$
$M = \frac{mRT}{PV}$
$= \frac{0.0286g \times 8.314 J/molk \times 298k}{101325 N/m^2 \times 50 \times 10^{-6} m^3}$
$= \frac{70.8585592}{5.06625} g/mol$
$M = 13.9864 g/mol$
$M \simeq 13.99 g/mol$

The correct option is C

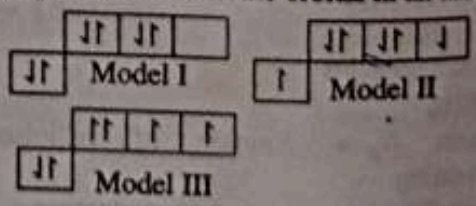
25. $R.M.M\ of\ O_2 = 32g/mol$
$Mass\ of\ O_2 = 16g$
$\cap_{O_2} = \frac{Reacting\ mass}{Molar\ mass}$
$= \frac{16g}{32g/mol} = 0.5mol$
$T = 27^oC = 300k$
$R.M.M\ of\ CO_2 = 44g/mol$
$Mass\ of\ CO_2 = 22g$

$$n_{CO_2} = \frac{Reacting\ mass}{Molar\ mass}$$
$$= \frac{22g}{44g/mol} = 0.5mol$$
The volume of $O_2 = 300dm^3$
The volume of $CO_2 = 300dm^3$
$PV = nRT$
$$P_{O_2} = \frac{nRT}{V}$$
$$= \frac{0.5mol \times 0.082atmdm^3/molk \times 300k}{300dm^3}$$
$$= \frac{12.3}{300}\ atm$$
$P_{O_2} = 0.041atm$
$$P_{CO_2} = \frac{nRT}{V}$$
$$= \frac{0.5mol \times 0.082atmdm^3/molk \times 300k}{300dm^3}$$
$= 0.041atm$
$P_T = P_{O_2} + P_{CO_2}$
$= 0.041atm + 0.041atm$
$= 0.082atm$

The correct option is D

2012/2013 CHEMISTRY 001 TEST

1. Determine the identity of "a" and "b" in the following equations;
$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + \text{"}a\text{"}$
$^{214}_{82}Pb \longrightarrow {}^{214}_{83}Bi + \text{"}b\text{"}$
(a) a= Gamma ray; b = Island of stability (b) a = Electron; b = Positron (c) a = Alpha particle; b = Electron
(d) a = Positron; b = Alpha particle
2. How many molecules are present in 15.43g of butyl alcohol, C_4H_9OH? (Avogadro constant = 6.022×10^{23} molecules/mol). (a) 12.5×10^{23} molecules (b) 1.255×10^{23} molecules (c) 1.272×10^{23} molecules (d) 12.72×10^{23} molecules.
3. A mixture of common salt, ammonium chloride and barium sulphate can best be separated by (a) Addition of water, followed by sublimation and then filtration (b) Addition of water, followed by filtration and then sublimation (c) Fractional distillation. (d) Sublimation, followed by addition of water and then filration
4. A gas took 231 seconds to stream through a small hole. Under the same condition, an equal volume of argon took 238 seconds. Calculate the molecular weight and the vapour density of the gas respectively [Molar mass of Ar = 40 $gmol^{-1}$). (a) 32 and 16 respectively (b) 16 and 8 respectively (c) 8 and 4 respectively (d) 64 and 32 respectively
5. A radioactive isotope of an element Q of mass number 235 and atomic number 91, decays by alpha particle emission to give an element X, which then absorb a neutron and loses a beta particle to form an element Y, which also loses an alpha particle and a gamma radiation to give an element Z. What are the respective mass number and the atomic number of element Z? (a) 229 and 89 (b) 228 and 86 (c) 227 and 87 (d) 228 and 88
6. Calculate the heat of formation of methane given that the heat of combustion of methane is $-891kJmol^{-1}$. The heat of formation of CO_2 and H_2O are -393 and $-286kJmol^{-1}$ respectively [$C = 12, H = 1, O = 16$]. (a) $-74\ k.Jmol^{-1}$(b) $+80kJmol^{-1}$ (c) $+74kJmol^{-1}$ (d) $-80kJmol^{-1}$
7. Which of the following supports the conclusion that a solid sample is a mixture? (a) The density of the solid is $1.3gdm^{-1}$ (b) The solid absorbs moisture from the atmosphere (c) The solid can be ground to a fine powder (d) The solid has a melting point range of 220-262°C
8. What type of bonding do you expect in the compound, PF_5? (a) Dative (b) Electrovalent (c) Metallic (d) Covalent
9. An ion X^+ has 14 electrons. How many unpaired electrons are there in the neutral atom of X? (a) 4 (b) 3 (c) 2 (d) 1
10. Consider the following combination of atoms: I. Na & Cl II. H & Cl III. Cl & Cl IV. N & H V. Ca & F. Which of the following information derived from the combinations above is NOT correct as regards the possible type of bonding between each pair of atom? (a) The covalent bonds in II and IV will be polar (b) I and V will form ionic bonding (c) None of the options given (d) II, III and IV will form covalent bonding
11. Methyl salicylate is prepared by heating salicylic acid, $C_7H_6O_3$, with methanol, CH_3OH, as shown in the equation: $C_7H_6O_3 + CH_3OH \rightarrow C_8H_8O_3 + H_2O$. In an experiment, 1.50g salicyclic acid is reacted with 11.20g methanol. What mass of methyl salicylate will be produced? (a) 1.65g (b) 11.20g (c) 53.19g (d) 1.50g
12. The models/sketches below represent the filing of electrons in the orbital in an atom.



Which of the above models violate Pauli, Hund and Aufbau rules/ principles respectively? (a) I, III and II (b) II, I and III (c) III, I and II (d) I, II and III

13. Which of the following deductions correlate with the observations J.J. Thompson experiment?

Observation	Deduction
I. Cathode rays cast shadows on objects placed in their path	They travel in a straight line
II. The rays are deflected towards the positive plate	They are negatively charged
III. The rays pass through a thin sheet of aluminum foil	They are bigger than atoms
IV. The rays cause the wheel of a small paddle to rotate	They possess momentum/ energy

(a) I, II and IV (b) I, III and IV (c) I, II and III (d) II, III and IV

14. Potassium trioxochlorate $V, KClO_3$ decomposes on heating to form potassium chloride and oxygen as the only products. What is the volume of oxygen that would be collected at standard temperature and pressure, if $24.50g$ of potassium trioxochiorate (V) was heated? $[K = 39;\ O = 16;\ Cl = 35.5;$ Molar volume of gas at standard state = $22.4dm^3]$. (a) $8.10dm^3$ (b) $5.33dm^3$ (c) $3.74dm^3$ (d) $6.72dm^3$

15. Given that standard heat of formation of CO_2 is $\Delta H_f^o(CO_2) = -94.05$Kcal; $\Delta H_f^o(CH_4) = -17.89$Kcal, $\Delta H_f^o(|H_2O) = -68.32Kcal$ and $\Delta H_f^o(CuO) = -37.6$Kcal. Calculate the standard enthalpy change at 298K for the reaction: $CH_{4(g)} + 4CuO_{(s)} \rightarrow CO_{2(g)} + 2H_2O_{(1)} + 4Cu_{(s)}$ (a) $-62.4\ Kcal$ (b) $+97.3\ Kcal$ (c) $+62.4\ Kcal$ (d) $-97.3\ Kcal$

16. One isotope of Br has a half life of 16.5 hours. How much of a $2.00\ g$ sample remains at the end of 1.00 day. (a) $1.525g$ (b) $0.730\ g$ (c) $0.780\ g$ (d) $0.500\ g$

17. Increasing the pressure of a gas (a) Decreases the density of the gas (b) Lowers the average kinetic energy of the molecules (c) Increases the density of the gas (d) Decreases the temperature of the gas

18. Which of the following atomic properties increase across the period but decrease down the group? I. Atomic radius II. Ionization energy III. Electron affinity and IV. Electro negativity (a) II, III and IV (b) I and IV (c) I, III and IV (d) I, II and III

19. What mass of $Mg(OH)_2$ is precipitated when 9.5g of $MgCl_2$ reacts with 4.0g of $NaOH$ (Assume complete precipitation) $[Mg = 24, Na = 23, H = 1, O = 16]$ (a) 3.9g (b) 2.2g (c) 2.9g (d) 2.5g

20. Consider the following nuclides: I. ${}^{12}_{6}C$ II. ${}^{14}_{6}C$ III. ${}^{14}_{7}C$ IV. ${}^{15}_{8}C$ Which of them are neither isotopic nor isobaric? (a) I, III and IV (b) I, II and III (c) II, III and IV (d) III and IV

21. Dissolution of non-volatile impurities affects which of the following properties of the liquid? I. Vapourization II. Boiling point III. Vapour pressure IV. Freezing point. (a) I, III and IV. (b) I, II and III (c) I, II. III and IV (d) II, III and IV

22. A mixture of gases containing 80.5% N_2, 14%O_2, 5.5% CO_2. If the total pressure is 1.01×10^5 pascals and the vapour pressure of water is 6.25×10^3 pascals. Calculate the partial pressure of the major constituents respectively.

(a) (76.27, 15.55 and 3.21) $\times 10^3$ pascals (b) (90.27,15.00 and 6.25) $\times 10^3$ pascals (c) (80.00,13.27 and 4.21) $\times 10^3$ pascals (d) (76.27,13.27 and 5.21) $\times 10^3$ pascals

23. You are provided with two miscible liquids A and B and a salt C which is soluble in one of the liquids. State the separation technique(s) you will use to obtain pure sample of C, if C dissolves in one of the liquids without the application of heat. (a) decantation and filtration (b) crystallization (c) precipitation and filtration (d) sedimentation and crystallization

24. Calculate the mass of solute in 250.0mL of 2.05 M Na_2SO_4 $[Na = 23,\ S = 32,\ O = 16]$ (a) 72.8g (b) 7.28g (c) 22.8g (d) 145.5g

25. What volume of CO_2 measured at STP will be produced when 21g of $NaHCO_3$ is completely decomposed (a) $2.4dm^3$ (b) $2.6dm^3$ (c) $2.2dm^3$ (d) $2.8dm^3$

SOLUTION

1. ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$
${}^{214}_{82}Pb \rightarrow {}^{214}_{83}Br + {}^{0}_{-1}e$

From the balanced equations above, it can be infer that a is an alpha particle $({}^{4}_{2}He)$ and b is a Beta particle $({}^{0}_{-1}e)$. A beta particle is a fast moving stream of electron. This implies that a beta particle is an electron. Therefore, a =

alpha particle and b = electron. Note that, positron is a positively charge electron.

The correct option is C

2. $R.M.M\ of\ C_4H_9OH = [4(12) + 9(1) + 16 + 1]g/mol = 74g/mol$

Reacting mass of $C_4H_9OH = 15.43g$

$$\cap_{C_4H_9OH} = \frac{15.43g}{74g/mol} = 0.20851mol$$

$$\cap_{C_4H_9OH} = \frac{Number\ of\ molecules}{6.02 \times 10^{28} molecules/mol}$$

Number of molecules
$= 0.20851 \times 6.02 \times 10^{23}$ molecules
$= 1.2552 \times 10^{23}$ molecules

The correct option is B

3. A mixture of common salt ($NaCl$), ammonium chloride (NH_4Cl) and Barium sulphate ($BaSO_4$) can be separated by the following processes.
   (i) Addition of heat to allow NH_4Cl to undergoes thermal dissociation. Note that NH_4Cl does not undergo sublimation but thermal association.
   (ii) Addition of water to dissolve $NaCl$ i.e. dissolution
   (iii) Filtration to remove $BaSO_4$
   (iv) Evaporation to dryness to recover $NaCl$.

   Therefore, the processes are:
   Thermal dissociation → dissolution → filtration → evaporation
   Since many people hold that NH_4Cl sublime which is not true, the processes involve in the separation of the mixture, can be written as sublimation → dissolution → filtration → evaporation

The correct option is D

4. $\frac{t_{gas}}{t_{Ar}} = \sqrt{\frac{M_{gas}}{M_{Ar}}}$ (for equal volume of gases)

$t_{gas} = 231s,\ t_{Ar} = 238s$

$$\frac{231}{238} = \sqrt{\frac{M_{gas}}{40}}$$

Square both side

$$\left(\frac{231}{238}\right)^2 = \left(\sqrt{\frac{M_{gas}}{40}}\right)^2$$

$$\frac{1089}{1156} = \frac{M_{gas}}{40}$$

$$M_{gas} = \frac{1089 \times 40}{1156} = 37.6817g/mol$$

$M_{gas} \approx 38g/mol$

Molar mass = 2 × vapour density

$38 = 2 \times V_D$

$$V_D = \frac{38}{2} = 19$$

$(M_{gas}, V_D) = (38, 19)$

None of the option is correct

5. $^{235}_{91}Q \rightarrow {}^{231}_{89}X + {}^{4}_{2}He$

$^{231}_{89}X + {}^{1}_{0}n \rightarrow {}^{232}_{90}Y + {}^{0}_{-1}e$

$^{232}_{90}Y \rightarrow {}^{228}_{88}Z + {}^{4}_{2}He + Y$

The correct option is D

6. (i) $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2$
$\Delta H = -891kJ/mol$

(ii) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$
$\Delta H = -393kJ/$

(iii) $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}$
$\Delta H = -286kJ/$

(iv) $C_{(s)} + 2H_{2(g)} \rightarrow CH_{4(g)}\ \Delta H = ?$

To obtain equation iv, the equation of formation of methane must be reve equation iii must be multiple by 2 be adding equations i, ii, iii up. Note that if equation is multiply by a factor, its ΔH also be multiply with the same factor, but if equation is reverse the sign of its ΔH also be reversed.

$CO_{2(g)} + 2H_2O_{(g)} \rightarrow CH_{4(g)} + 2O_{2(g)}\ \Delta H = 89$
$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}\ \Delta H = -393kJ/mol$
$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}\ \Delta H = 2(-286kJ/mo$
$C_{(s)} + 2H_{2(g)} \rightarrow CH_4\ \Delta H = -74kJ/mo$

The correct option is A

7. All mixture meets at a wide range temperature e.g. $220 - 262°C$

The correct option is D

8. The bond form between two non-metals is a covalent bond. However, if one of the non-metals is an hydrogen atom (e.g. HCl), the type of covalent bond form is polar covalent bond. Therefore the bond in PF_5 is a covalent bond.

The correct option is D

9. For the element X to form X^+ it must lose an electron. Since X^+ contain 14 electrons, the X will contain 15 electrons ${}_{15}X$ –
$1s^2 2s^2 2p^6 3s^2 3p^3$
$\rightarrow [Ne]3s^2 3p^3$
$\rightarrow [Ne]$ 3s: ↑↓ 3p: ↑ ↑ ↑

No of unpaired electron = 3
No of paired electrons =

$$\frac{15-3}{2} = \frac{12}{2} = 6$$

The correct option is B

10. (i) Na & Cl → ionic or electrovalent bond
    (ii) H & Cl → polar covalent bond
    (iii) Cl & Cl → pure covalent bond
    (iv) N & H → polar covalent bond
    (v) Ca & F → ionic or electrovalent bond

The correct option is D

11. $C_7H_6O_3 + CH_3OH \rightarrow C_8H_8O_3 + H_2O$

1.50g 11.20g

$R.m.m\ of\ C_7H_6O_3 = 138g/mol$

$R.m.m\ of\ CH_3OH = 32g/mol$

$\cap_{C_7H_6O_3} = \frac{1.5}{138} = \frac{1}{92}mol = 0.01087mol$

$\cap_{CH_3OH} = \frac{11.20}{32} = \frac{7}{20}mol = 0.35mol$

The limiting reagent is $C_7H_6O_3$

The excess reagent is CH_3OH

$\cap_{C_8H_8O_3} = \frac{1}{92}mol$

$R.M.M.of\ C_8H_8O_3 = 152g/mol$

Mass of $C_8H_8O_3$ formed

$= \frac{1}{92}mol \times 152g/mol = 1.65g$

The correct option is A

12. The mode I disobey Hund's rule because each degenerate orbital must contain a single electron before electron pairing occur.
The mode II disobey Aufbau principle because the lower orbital S is not completely fill before filling the higher orbital P.
The mode III disobey Pauli's exclusion principle because of the same spin of the two electrons in the p-orbital.

The correct option is C

13. The observations i, ii & iv and their deduction are in accordance with J.J. Thompson's experiment.

The correct option is A

14. $2KClO_{3(s)} \xrightarrow{\Delta} 2KCl_{(s)} + 3O_{2(g)}$

$24.50g$

$R.M.M\ of\ KClO_3 = 122.50g/mol$

$\cap_{KClO_3} = \frac{24.50g}{122.50g/mol} = 0.2mol$

$\cap_{O_2} = \frac{3}{2} \times 0.2mol = 0.3mol$

$\cap_{O_2} = \frac{vol\ at\ s.t.p}{22.4dm^3/mol}$

Vol at s.t.p. $= 0.3mol \times 22.4dm^3/mol$

$= 6.72dm^3$

The correct option is D

15. $CH_{4(g)} + 4CuO_{(s)} \rightarrow CO_{2(g)} + 2H_2O_{(g)} + 4Cu_{(s)}$

The heat of formation of an element in it pure state is zero. All enthalpy of formation are measure for one mole of the species

$\Sigma H_R = (-17.89Kcal) + 4(-37.6Kcal)$

$= -17.89Kcal - 150.4Kcal$

$= -168.29Kcal$

$\Sigma H_P = -94.05Kcal + 2(-68.32Kcal) + 4(0)$

$= -230.69Kcal$

$\Delta H = \Sigma H_P - \Sigma H_R$

$= -230.69Kcal - (-168.29Kcal)$

$= -230.69Kcal + 168.29Kcal$

$= -62.40Kcal$

The correct option is A

16. $T_{1/2} = 16.5hrs$

$N_o = 2g$

$t = 1day = 24hrs$

$N_R =$

$n = \frac{t}{T_{1/2}} = \frac{24}{16.5} = \frac{16}{11} = 1.4546$

$N_R = N_o\left(\frac{1}{2}\right)^n$

$= 2\left(\frac{1}{2}\right)^{1.4546}$

$= 0.7297g$

$\simeq 0.73g$

The correct option is B

17. $PV = nRT = \frac{mRT}{M}$

$P = \frac{\rho RT}{M} = CRT$

The pressure of a gas is directly proportional to its absolute temperature and density. But the density of a gas is inversely proportional to its absolute temperature provided the parameters are measure one at a time. Therefore increasing the pressure of a gas increases its absolute temperature and kinetic energy but decreases it density.

The correct option is A

18. **The correct option is A**

19. $MgCl_2 + 2NaOH \rightarrow 2NaCl + Mg(OH)_2$

$R.M.M\ of\ MgCl_2 = 95g/mol$

$R.M.M\ of\ NaOH = 40g/mol$

$R.M.M\ of\ Mg(OH)_2 = 58g/mol$

$\cap_{MgCl_2} = \frac{9.50g}{95g/mol} = 0.1mol$

$\cap_{NaOH} = \frac{4g}{40g/mol} = 0.1mol$

$\cap_{MgCl_2} : \cap_{NaOH}$

$\frac{0.1}{1} \quad \frac{0.1}{2}$

$0.1 : 0.05$

The limiting reagent is $NaOH$

The excess reagent is $MgCl_2$

$\cap_{Mg(OH)_2} = 1 \times 0.05mol = 0.05mol$

Mass of $Mg(OH)_2 = 0.05mol \times 58g/mol = 2.90g$

The correct option is C

20. Isotopes have the atomic number e.g. $^{37}_{17}Cl$ & $^{35}_{17}Cl$
Isotones have the same neutron number e.g. $^{14}_{7}N$ & $^{15}_{8}O$
Isobars have the same mass number e.g. $^{14}_{6}C$ & $^{14}_{7}C$
Note that $^{12}_{6}C$, $^{14}_{7}C$ & $^{15}_{8}O$ an neither isotopic nor isobaric
$^{14}_{7}C$ & $^{15}_{8}O$ are neither isotopic nor isobaric

Many students will go for option D but the most correct option is A.

The correct option is A

21. Dissolution of non-volatile impurities affects in a liquid affect its I. boiling point II. freezing point III. vapour pressure IV. vapourization.

The correct option is C

22. $X_{N_2} = \frac{80.5}{100} = 0.805$

$X_{O_2} = \frac{14}{100} = 0.14$

$X_{CO_2} = \frac{5.5}{100} = 0.055$

$P_{N_2} = X_{N_2} P_T$

Since the gases are collected over water

$P_T = P_{gas} + P_{H_2O}$

$1.01 \times 10^5 = P_{gas} + 6.25 \times 10^3$

$P_{gas} = 1.01 \times 10^5 - 6.25 \times 10^3$

$= 9.475 \times 10^4$ pascals

$P_{N_2} = 0.805 \times 9.475 \times 10^3$

$= 76.27 \times 10^3$ pascals

$P_{O_2} = X_{O_2} P_T$

$= 0.14 \times 9.475 \times 10^4$

$= 13.265 \times 10^3$

$= 13.27 \times 10^3$ pascals

$P_{CO_2} = X_{CO_2} P_T$

$= 0.055 \times 9.475 \times 10^4$

$= 5.21125 \times 10^3$

$= 5.21 \times 10^3$ pascals

$(P_{N_2}, P_{O_2}, P_{CO_2}) = (76.27, 13.27, 5.21) \times 10^3$ pascals

The correct option is D

23. Precipitation is a separation technique use to separate a solute from its solution by the addition of another solvent which is miscible with the solvent in the first solution but in which the solute is insoluble. The precipitate form is then filter off.

The correct option is C

24. $\cap_{Na_2SO_4} = \frac{V(cm^3)}{1000} \times molar\ conc$

$= \frac{250}{1000} \times 2.05$

$= 0.5125mol$

$\cap_{Na_2SO_4} = \frac{Reacting\ mass}{molar\ mass}$

$R.M.M\ of\ Na_2SO_4$

$= [2(23) + 32 + 4(16)]g/mol$

$= 142g/mol$

$mass\ of\ Na_2SO_4$

$= 142g/mol \times 0.5125mol$

$= 72.775g$

$\simeq 72.80g$

The correct option is A

25. $2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$

$21g$

$R.M.M\ of\ NaHCO_3 = 84g/mol$

$\cap_{NaHCO_3} = \frac{Reacting\ mass}{molar\ mass}$

$= \frac{21g}{84g/mol} = 0.25mol$

$\cap_{CO_2} = 1 \times 0.25mol = 0.125mol$

$\cap_{CO_2} = \frac{volume\ at\ s.t.p}{molar\ gas\ volume}$

volume at s.t.p

$= 0.125mol \times 22.4dm^3/mol$

$= 2.8dm^3$

The correct option is D

2011/2012 CHEMISTRY 001 TEST

1. Consider the under-listed types of bond: electrovalent bond II. covalent bond metallic bond IV. Hydrogen bond V. da bond VI. Van der Waal's forces. Which them affects the physical properties compounds containing them only? (a) II, IV and VI (b) IV and VI (c) I, II, III and IV (d) IV and VI
2. Which of the following statements is/are fal I. covalent liquids are more volatile than io liquid II. covalent molecules are characteris by high value of electronegativity differe III. metallic character of elements decreas down the group IV. oxygen is mo electronegative than nitrogen (a) I and II on (b) II and III only (c) III and IV only (d) only
3. Four students were given a solid substanc each to determine the melting point. t following values were obtained respectivel 119 – 121°C; 124 – 125°C; 110 – 120°C a 130 – 139°C. How many of these so substances are pure? (a) 3 (b) 4 (c) 1 (d) 2
4. If 12.0g of a gas occupies 20.97dm^3 at 25 and 0.50 atmosphere, then the molecular ma of the gas in [R = 0.0821 atmdm^{3}mol^{-1}K^{-1}] 32.9 (b) 16.0 (c) 8.0 (d) 28.0
5. What is the mass of five atoms of copper [Cu 63.5; $N_A = 6.02 \times 10^{23}$] (a) $3.01 \times 10^{-23}g$ $5.27 \times 10^{-22}g$ (c) $1.30 \times 10^{-23}g$ (d) 4.74 $10^{-22}g$
6. 2.2g of propane raised the temperature of 10 of water in a bomb calorimeter by 75°C a burning completely. The heat of combustion propane as obtained from this experiment (specific heat capacity of water is C_w $4.2J\ g^{-1}\ {}^0C^{-1}$; $C = 12$; $H = 1$). $-661500kJmol^{-1}$ (b) $6615kJmol^{-1}$ $661500kJmol^{-1}$ (d) $-661.5kJmol^{-1}$

7. $20cm^3$ of portions of $0.1moldm^{-3}$ solution of sodium trioxocarbonate (IV) were titrated with a solution of tetraoxosulphate (VI) acid using phenolphthalein as indicator. If the average titre was $26.80cm^3$, what is the concentration ($moldm^{-3}$) of the acid? (a) 0.0746 (b) 0.0373 (c) 0.119 (d) 0.0562
8. Which of the following are factors that determine the radius of an atom? I. the number of shells occupied by electrons II. the shielding of the outer electrons by the inner electrons III. the energy released when an election is added to a gaseous atom IV. the attracting forces between the nucleus and the outermost electrons (a) I, II and IV (b) I, II and III (c) II and IV only (d) I – IV
9. A sample of helium gas is collected in a container with a tiny hole in it. The helium gas effuses at a rate of 0.20 moles per minute. If a sample of methane gas is allowed to effuse under the same conditions, the rate of effusion of methane is (a) 0.14 mole per minute (b) 0.10 mole per minute (c) 2.00 mole per minute (d) 0.05 mole per minute
10. At room temperature chlorine exists as a gas, bromine as a liquid and iodine as a solid. The physical states of these elements indicate that boiling point (a) increases from top to bottom of a group (b) is independent of periodic positions (c) decreases from top to bottom of a group (d) is constant within a group element.
11. $aCr_2O_7^{2-} + bSO_3^{2-} + cH^+ \rightarrow dCr^{3+} + eSO_4^{2-} + fH_2O$. When the ionic equation above is correctly balanced, the respective values of a, b, c, d, e and f are (a) 1, 3, 5, 1, 3 and 4 (b) 2, 3, 5, 1, 3 and 4 (c) 1, 3, 1, 10, 53 and 4 (d) 1, 3, 8, 2, 3 and 4
12. Which of the following is the correct order for the degeneracy in the d-, p- and s-orbitals respectively? (a) 5-fold degenerate, 3-fold degenerate and non-degenerate (b) non-degenerate, 3-fold degenerate and 5-fold degenerate (c) non-degenerate, 5-fold degenerate and 3-fold degenerate (d) 3-fold degenerate, 5-fold degenerate and non-degenerate.
13. Which of these statements refer to gamma radiation I. it has very short wavelength II. it cannot be stopped by a thin sheet of Al III. it could travel up to 5cm upward in the atmosphere IV. it is non-particulate. (a) I, II, III and IV (b) I only (c) I and II only (d) I, II and III only
14. Below is a list of some attractive forces binding chemical species together I. positive-negative ion attractions II. permanent dipole-permanent dipole attractions III. temporary dipole-temporary dipole attractions IV. ion-dipole attractions V. permanent dipole-temporary dipole attractions VI. permanent atom-highly electronegative atom attractions. Which of these attractive forces constitute Van der-Waal's forces? (a) I, IV and VI (b) I, and IV (c) IV and VI (d) II, III and V
15. Which separation techniques will respectively separate the components of mixtures of I. KNO_3 and $KClO_3$ II. iodine and sodium chloride III. kerosene, petrol and diesel oil and IV. dyes (a) chromatography, distillation, fractional crystallization and decantation (b) fractional crystallization, sublimation, fractional distillation and chromatography (c) fractional distillation, fractional crystallization, sublimation and chromatography (d) precipitation, volatilization, distillation and dissolution in ethanol.
16. Consider the following compounds. I. BCl_3 II. NH_3 III. H_2O IV. CO_2.In which of them is/are the central atoms not excited before being hybridized? (a) I, and II (b) II and III (c) I, II and IV (d) I, II, III and IV
17. The quantum number that indicates the position of an orbital about the three axes in space (orientation) is the (a) spin quantum number (b) angular momentum quantum number (c) principal quantum number (d) magnetic quantum number
18. The values of the oxidation number of oxygen in water, hydrogen peroxide, oxygen molecular and sodium superoxide respectively are: (a) $-2, -1, 0$ and $-1/2$ (b) $-1, -2, 0, -4$ (c) $-2, -1, -2$ and 0 (d) $-2, -1, 0$ and -4
19. $200cm^3$ of $0.10mol\,dm^{-3}$ $AgNO_3$ and $250cm^3$ of $0.10mol\,dm^{-3}$ $CaCl_2$ are mixed. What is the mass of the precipitate that will be formed in the reaction? (Ag = 108, Ca = 40, Cl = 35.5). (a) $2.77g$ (b) $2.67g$ (c) $2.57g$ (d) $2.87g$
20. Sodium chloride can be separated from rock salt by first adding water to the mixture to dissolve the sodium chloride. The further separation stages are
    (a) filtration followed by decanting
    (b) evaporation followed by filtration
    (c) distillation followed by decanting
    (d) filtration followed by evaporation
21. An element X has two major isotopic forms ($^{10}X_5$ and $^{11}X_5$). How many atoms are of the lighter isotope in an isotopic mixture containing 2000 atoms if the R.A.M of X is 10.2? (a) 1800 (b) 400 (c) 800 (d) 1600
22. Given that the heat of formation of CO_2 is $-394\ kJmol^{-1}$ and the heat of combustion of

CO is $-282kJmol^{-1}$, what is the heat of formation of CO? (a) $-676\ kJmol^{-1}$ (b) $-112\ kJmol^{-1}$ (c) $+676\ kJmol^{-1}$ (d) $+112\ kJmol^{-1}$

23. Which of the following is NOT TRUE of a neutral element in its ground state with atomic number 19? I. it has no d-orbitals at all II. it has empty d-orbitals III. it has a total of 7 and 12 electrons in its s- and p-orbitals respectively IV. it has four quantum or energy level V. it is a p-block element (a) I and V only (b) II, III and IV (c) I, II and III (d) I, II, III and V
24. Below is a list of some chemical species which could act as acids or bases: I. HSO_4^- II. Cl^- III. Cu^{2+} IV. OH^-. Pick the Bronsted Lowry acid and Lewis acid respectively: (a) I, and IV (b) III and I (c) IV and I (d) I and III
25. Covalent bonding involves overlapping of pure and/or hybrid orbitals such as I. s-s II. p-p (linearly opposed) III. p-p (parallel) IV. sp-s V. sp-p (linearly opposed) VI. sp-sp. Which of these overlapping are present in carbon (IV) oxide molecule? (a) II, IV and VI (b) III and V (c) I and VI (d) I, II, IV and VI.

SOLUTION

1. **Electrovalent compounds** have a high degree of dissociation in aqueous solution. Hence the reaction in aqueous medium or solution is very fast (i.e. high rate of reaction). Therefore electrovalent bond affects both the physical and chemical properties of the compound that contain it.

   Covalent compounds have a low degree of dissociation in aqueous solution. Hence their reaction in aqueous medium or solution is very slow (i.e. low rate of reaction). Therefore covalent bond affects both physical and chemical properties of the compound containing it.

   The only difference between dative compounds and covalent compound is that dative compounds are less volatile. Therefore dative bond affect both the physical and chemical properties of the compounds that contain them.

   Compounds containing hydrogen bonding have a high degree of ionization in aqueous solution. Hence their reaction in aqueous medium or solution is very fast (i.e. high rate of reaction). Therefore hydrogen bond affects both the physical and chemical properties of the compounds containing it.

   However metallic bond and Van der Waals forces affect only the physical properties of the compound that contain them.

   A careful look at the question, will reveal that the examiner who set the question have option D in his mind as the correct option. But a student of chemistry will know that options are not absolutely correct. However for the level of our study, it is save to choose option D as the correct answer

   The correct option is D

2. The statements in i and iv are correct but ii and iii are wrong.

   The correct option is B

3. All pure substance melt at a narrow range of temperature e.g. 119°-121°C, 124°-125°C. From the range of temperature give only one of the substance are pure.

   The correct option is D

4. $m = 12g, \quad V = 20.97dm^3, \quad T = 25°C$ $298k \quad P = 0.5atm, \quad R = 0.0821$

   $$PV = \frac{mRT}{M}$$

   $$where\ n = \frac{m}{M}$$

   $$0.5 \times 20.97 = \frac{12 \times 0.0821 \times 298}{M}$$

   $$M = \frac{12 \times 0.0821 \times 298}{0.5 \times 20.97}$$

   $$= 28g/mol$$

   Therefore the gas is either CO or N_2 because their relative molecular mass is $28g/mol$

   The correct option is D

5. No of atoms = 5

   $$\cap_{Cu} = \frac{No\ of\ atoms}{6.02 \times 10^{23}} = \frac{Mass\ of\ Cu}{Molar\ mass}$$

   $$\frac{5}{6.02 \times 10^{23}} = \frac{Mass\ of\ Cu}{63.5}$$

   $$Mass\ of\ Cu = \frac{5 \times 63.5}{6.02 \times 10^{23}}$$

   $$= 5.27 \times 10^{-22}g$$

   The correct option is B

6. R.M.M of propane, $C_3H_8 = 44g/mol$

   $$Mass\ of\ C_3H_8 = 2.2g$$

   $$\cap_{C_3H_8} = \frac{2.2g}{44g/mol} = 0.05mol$$

   $$Mass\ of\ H_2O = 105g$$

   $$\Delta\theta = 75°C$$

   $$C_w = 4.2J/g°C$$

   Heat absorb by $H_2O(Q) = mC\Delta\theta$

   $$= 105 \times 4.2 \times 75$$

   $$= 330.75J$$

   $$= 33.075kJ$$

   Heat liberated by burning C_3H_8 = Heat absorbed by H_2O

   0.05mol of propane liberate $33.075kJ$ of energy

   1mole of propane liberate xkJ of energy

$$\frac{0.05}{1} = \frac{33.075}{x}$$

$$x = \frac{33.075}{0.05} = 661.5kJ$$

The enthalpy of combustion of C_3H_8 is $-661.5kJ/mol$. The negative sign indicate that the process is an exothermic process.

The correct option is D

7. The use of phenolpthalein implies that the resultant solution is basic. This implies that Na_2CO_3 is in excess.

$$2Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2NaHCO_3$$

Note that if the indicator is methyl orange the reaction would be

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$$

CO_2 and H_2O $(i.e. H_2CO_3)$ indicate that the resultant solution is acidic.

$$2Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2NaHCO_3$$

$20cm^3, 0.1M \quad 26.80cm^3$

$$\cap_{Na_2CO_3} = \frac{Vol\ in\ cm^2}{1000} \times molar\ conc$$

$$= \frac{20}{1000} \times 0.1$$

$$= 0.002mol$$

$$\cap_{H_2SO_4} = \frac{1\ mol\ of\ H_2SO_4}{2\ mol\ of\ Na_2CO_3} \times 0.002\ mole\ of\ Na_2CO_3$$

$$= 0.001mol$$

$$\cap_{H_2SO_4} = \frac{Vol\ in\ cm^2}{1000} \times molar\ conc$$

$$0.001 = \frac{26.8}{1000} \times molar\ conc$$

$$\frac{0.001 \times 1000}{26.8} = molar\ conc$$

$$Molar\ conc\ of\ H_2SO_4 = \frac{0.001 \times 1000}{26.8}$$

$$= 0.0373M$$

$$\simeq 0.04M$$

The correct option is B

8. The radius of an atom (i.e. atomic radius) depends on:
   (a) The number of shells occupied by electrons
   (b) The shielding of the outer electrons by the inner electrons.
   (c) The attracting force between the nucleus and the outermost electrons. That is the nuclear charge effect.

The correct option is A

9. $$\frac{R_{CH_4}}{R_{He}} = \sqrt{\frac{M_{He}}{M_{CH_4}}}$$

$$R_{He} = 0.2, R_{CH_4} = ?, M_{He} = 4, M_{CH_4} = 16$$

$$\frac{R_{CH_4}}{0.2} = \sqrt{\frac{4}{16}}$$

$$\frac{R_{CH_4}}{0.2} = \frac{1}{2}$$

$$R_{CH_4} = \frac{0.2}{2} = 0.1$$

The correct option is B

10. The boiling points of solids are higher than the boiling point of liquids while the boiling points of liquids are higher than the boiling point of gases. Therefore, the boiling points of the Halogen increase from chlorine to iodine through bromine. This implies that the boiling points of the halogen increase down the group (i.e. from top to down).Note that it is not a general rule that the boiling point and melting point of the elements in a group increase down. From group I-IV the boiling point of the element decreases down the down while from group V-VII the boiling point of the elements increases down the group.

The correct option is A

11. $$Cr_2O_7^{2-} + SO_3^{2-} + H^+ \rightarrow Cr^{3+} + SO_4^{2-} + H_2O$$

The hydrogen ion, H^+ indicate that the reaction is to be balance in acidic medium.

$$Cr_2O_7^{2-} \rightarrow Cr^{3+} \quad \text{(red)}$$

$$SO_3^{2-} \rightarrow SO_4^{2-} \quad \text{(ox)}$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

$$SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e^-$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O \ldots \times 1$$

$$SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e^- \ldots\ldots\ldots \times 3$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

$$3SO_3^{2-} + 3H_2O \rightarrow 3SO_4^{2-} + 6H^+ + 6e^-$$

$$3SO_3^{2-} + Cr_2O_7^{2-} + 8H^+ \rightarrow 2Cr^{3+} + 3SO_4^{2-} + 4H_2O$$

$$\Rightarrow a = 1, b = 3, c = 8, d = 2, e = 3, f = 4$$

The correct option is D

12. Degenerate orbitals are atomic orbitals with the same energy level. It is the number of orbitals with the same energy or quantum level in a given sub-shell.

Sub-shell	No of orbital	Degenerate orbital
s	1	Non-degenerate
p	3	3-fold degenerate
d	5	5-fold degenerate
f	7	7-fold degenerate

The correct option is A

13. A gamma ray (γ) has the following properties
   (i) It is electrically neutral
   (ii) It travel at the speed of light i.e. $3 \times 10^8 m/s$
   (iii) It has a quality number of 1
   (iv) It has the highest penetrating power about 100m in air.

(v) It is absorb or stop by thick lead block. That is, it cannot be stop by thin sheet of Aluminium or paper.
(vi) It ionized gases and penetrate matter
(vii) It is has a short wavelength
(viii) It has a high frequency
(ix) It is non-particulate (i.e. is a ray)

The correct option is A

14. Dipole-Dipole attraction. Dipole-Induced dipole attraction and dispersion forces are collectively known as Van der Waal forces.
Dipole-Dipole attractions forces are attractive forces between polar molecules.
Dipole-Induced dipole interaction/ attraction is the force of attraction/ interaction between a polar molecule and the induced dipole.
Dispersion forces are attractive forces that arise as a result of temporary dipoles induced in atoms or molecules.

The correct option is D

15.

Mixtures	Separation techniques
KNO_3 and $KClO_3$	Fractional crystallization
Iodine and sodium chloride	Sublimation
Kerosene, petrol and diesel oil	Fractional distillation
Dyes	Chromatography

The correct option is B

16. In NH_3 and H_2O the central atoms are not excited before hybridization. But in CO_2 and BCl_3 the central atoms are excited before hybridization.

The correct option is B

17. Check solution to question 9 Test 2010/2011 session for detail explanation

The correct option is D

18.

Compound	Name	Oxidation of oxygen
H_2O	Water	-2
H_2O_2	Hydrogen peroxide	-1
O_2	Oxygen molecules	0
NaO_2	Sodium super-oxide	$-\frac{1}{2}$

The correct option is A

19. $2AgNO_{3(aq)} + CaCl_{2(aq)} \rightarrow$
$200cm^3, 0.1M \quad 250cm^3, 0.1M$
$2AgCl_{(s)} + Ca(NO_3)_{2(aq)}$
$R.M.M.of\ AgCl = 143.5g/mol$
$\cap_{AgNO_3} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc$
$= \frac{200}{1000} \times 0.1 = 0.02mol$
$\cap_{CaCl_2} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc$
$= \frac{250}{1000} \times 0.1 = 0.025mol$
$\cap_{AgNO_3} : \cap_{CaCl_2}$
$\frac{0.02}{2} : \frac{0.025}{1}$
$0.01 : 0.025$
$\cap_{AgCl} = 2 \times 0.01mol$
$= 0.02mol$
$\cap_{AgCl} = \frac{Reacting\ mass}{Molar\ mass}$
$0.02 = \frac{Mass\ of\ AgCl}{143.5}$
$Mass\ of\ AgCl = 0.02 \times 143.5$
$= 2.87g$

The correct option is D

20. Rock salt is a mineral form of sodium chloride. It is commonly known as halite. It is more of rock than a mineral. Therefore sodium chloride is separated from rock salt by dissolution, filtration and evaporation to dryness.

The correct option is D

21. $R.A.M\ of\ X = \alpha_1 m_1 + \alpha_2 m_2$
$\alpha_1 + \alpha_2 = 1$
$m_1 = 10$ and $m_2 = 11$ and $R.A.M\ of\ X = 10.2$
$10.2 = 10\alpha_1 + 11\alpha_2$
$10.2 = 10(1 - \alpha_2) + 11\alpha_2$
$10.2 = 10 - 10\alpha_2 + 11\alpha_2$
$10.2 - 10 = \alpha_2$
$0.2 = \alpha_2$
$\alpha_1 = 1 - \alpha_2$
$= 1 - 0.2 = 0.8$
Total number of atoms = 2000
No of atoms of $^{10}_{5}X = \alpha_1 \times 2000atoms$
$= 0.8 \times 2000atoms$
$= 1600atoms$
No of atoms of $^{10}_{5}X = \alpha_2 \times 2000atoms$
$= 0.2 \times 2000atoms$
$= 400atoms$
The lighter isotope is the isotope with highest abundance.
The number of atoms of the lighter isotopes is 1600 atoms.

The correct option is D

22. $C + O_2 \rightarrow CO_2 \quad \Delta H = -394kJ/mol$
$CO + \frac{1}{2}O_2 \rightarrow CO_2 \quad \Delta H = -282kJ/mol$
$C + \frac{1}{2}O_2 \rightarrow CO \quad \Delta H = ?$
Reverse equation 2. Note that reversing an equation reverses the sign of ΔH
$C + O_2 \rightarrow CO_2 \quad \Delta H = -394kJ/mol$
$CO_2 \rightarrow CO + \frac{1}{2}O_2 \quad \Delta H = -282kJ/mol$

$C + \frac{1}{2}O_2 \rightarrow CO \quad \Delta H = -112kJ/mol$

The correct option is B

23. Let the element be represented by X
$_{19}X \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$
(i) It has an empty or vacant d-orbitals
(ii) It has a total of 7 electrons in the s-subshell/orbitals
(iii) It has a total of 12 electrons in the p-subshell/orbitals
(iv) It has 4 quantum or energy level
(v) It is a not p-block elements
(vi) Its belong to group 1
(vii) Its belong to period 4

The correct option is A

24. According to Bronsted-lowry an acid is a substance that can donate a proton while a base is a substance which accepts a proton. A lewis acid is an substance which accept a share pair of electron during bonding. All Lewis acids are electron deficient e.g $AlCl_3$, BF_3, $BeCl_2$, cations,etc.

The correct option is D

25. $\ddot{O} = C = \ddot{O}$

The carbon atom in CO_2 is sp-hybridize. The outmost orbital of oxygen is the p orbital. Hence the sigma bond between C and O is sp – p. the pie bond between C and O will be p-p laterally overlapped orbital. Hence the over-lapping orbital in CO_2 are sp-p (linearly opposed) & p-p (parallel).

The correct option is B

2010/2011 CHEMISTRY 001 TEST

1. Two solid substances P and Q of about the same relative molecular mass melt at $78 - 81°C$ and $120 - 122°C$ respectively. Which of the following will you consider as reasonable for the mixed melting point of the homogeneous mixture of 1g of P and 12g of Q? I. 70-75°C II. 82-88°C III. 110-118°C IV. 125-130°C (a) IV only (b) I only (c) II only (d) II only
2. One of the postulates of the kinetic theory of gases is that 'the collision between the molecules is perfectly elastic'. This implies that: (a) Gas molecules will continue their motion indefinitely (b) Gases can be compressed (c) Gases can expand (d) Gas molecules can occupy any available space.
3. Analysis of a metal chloride MCl_3 shows that it contains 67.2 percent chlorine by mass. Determine the atomic mass of the element M [Cl = 35.5]. (a) 65.5 (b) 52.0 (c) 32.0 (d) 40.0
4. The respective pattern of hybridization of the central atom in the compounds: CO_2, NH_3, $BeCl_2$ and BF_3 are (a) sp, sp^3, sp^2 and sp, (b) sp^3, sp, sp^2 and sp, (c) sp, sp^2, sp and sp^3 (d) sp, sp^3, sp and sp^2.
5. H_2S is a gas at room temperature while H_2O is a liquid. What can explain the difference? (a) H_2S is flammable (b) H_2S is a heavier molecule (c) H_2O is amphoteric (d) The electronegativity of oxygen allows hydrogen bonding.
6. The following deductions were made during the investigation into the properties of cathode rays except: I. Cathode rays cause fluorescent screen to glow II. The rays are bent towards the negative electrode when an electric field is placed in their path III. The rays can cause motion on a paddle wheel IV. The rays are bent towards the N-pole of a magnet V. An object placed behind a perforated anode casts a shadow on the screen. (a) IV and V only (b) I and V only (c) IV only (d) II only.
7. In the bid to complete and balance the equation:
$CrO_4^{2-}(aq) + Br^-(aq) \rightarrow Cr^{3+}(aq) + BrO^-(aq)$ in alkaline medium, a student obtained:
$aCrO_4^{2-}(aq) + bBr^-(aq) + cOH^-(aq) + dH_2O(l) \rightarrow wCr^{3+}(aq) + xBrO^-(aq) + yOH^-(aq) + zH_2O(l)$ The values of a, b, c, d, w, x, y and z are respectively: (a) 2, 3, 0, 10, 3, 2, 5 & 0 (b) 2, 3, 0, 5, 2, 3, 10, & 0 (c) 2, 3, 10, 0, 2, 3, 0 & 5 (d) 5, 2, 3, 0, 2, 0, 10 & 3
8. How many moles of air at STP are in a room measuring 4.11m wide by 5.36m long and 2.58m high?(1000L= $1m^3$) (a) 1.33×10^{-3} (b) 2.79×10^{-3} (c) 1.52×10^{-3} (d) 2.54×10^{-3}
9. The principal quantum number n represents average I. size of an electron cloud II. Energy of an electron III. distance of an electron from the nucleus. (a) I, II and III (b) I, and II only (c) III only (d) II and III only
10. Inspect the following nuclear reactions and identify which of the reactions exhibit nuclear fusion, nuclear fission and beta emission respectively:
I. $^6Li_3 + {}^1n_o \rightarrow {}^4He_2 + {}^3H_1 + Energy$
II. $^{14}N_7 + {}^4He_1 \rightarrow {}^{17}O_8 + {}^1H_1 + Energy$
III. $^{28}Al_{13} \rightarrow {}^{28}Si_{14} + {}^0_{-1}e + Energy$
(a) II, III and I (b) I, II and III (c) III, II and I (d) II, I and III
11. Listed below are some important covalent molecules: I. CH_4 II. CO_2 III. BF_3 IV. NH_3 V. H_2O VI. $BeCl_2$
Which of these molecules has/have sp^3 hybridized central atom? (a) I, II and V only (b) II, V, VI only (c) I only (d) III and IV only
12. Arrange the following elements: K, Rb, Cs in order of increasing first ionization potential.

(a) K, Rb, Cs (b) Cs, K, Rb (c) Cs, Rb, K (d) Rb, Cs, K

13. Which of the following is/are a mixture? I. Blood II. Honey III. Air IV. Palm wine (a) I, II and IV only (b) II and III only (c) I, II, III and IV (d) III and IV only.
14. The partial pressure of a gas in a sample of air is 0.59atm and the total pressure of all gases in the air sample is 1.03atm. What is the mole fraction of the gas? (a) 5.73 (b) 0.573 (c) 0.287 (d) 2.87
15. Which orbital is occupied by an electron described by the quantum numbers: n=2, ℓ= 1? What are the allowed values of magnetic quantum number for the orbital? (a) 3p-orbital; m = −1,0,+1 (b) 2p-orbital; m = +1, 0, −1 (c) p-orbital; m = −1.0, +1 (d) 2s-orbital; m = −2, −1.0, +1,+2
16. Which of the following species are capable of intermolecular hydrogen bonds? I. HCl II. H_2O III. CH_3COOH IV. KF (a) I and II only (b) II and III only (c) I, II and III only (d) II, III and IV only.
17. Which of the following would most likely have the highest boiling point? (a) NH_3 (b) HF (c) LiCl (d) CH_4
18. A monatomic ion has a charge of +1. The nucleus of the ion has a mass number of 133. The number of neutrons in the nucleus is 1.42 times that of the number of protons. How many electrons are in the ion?

(a) 54 (b) 56 (c) 55 (d)53

19. What volume of 0.225M sodium nitrate ($NaNO_3$) solution contains 5g of solute? [$Na = 23$, $N = 14$, $O = 16$]. (a) $0.261litre$ (b) $232litres$ (c) $0.232litre$ (d) $261litres$
20. When magnesium metal is heated in air, one of the products is found to contain 72.2% magnesium and 27.8% nitrogen by mass. What is the empirical formula of the product?

(a) MgN (b) Mg_2N_3 (c) Mg_2N (d) Mg_3N_2

21. The following statements are made to describe the relationship between pairs obtainable from nuclides listed below: $^{12}C_6$, $^{14}N_7$, $^{14}C_6$, $^{20}Ne_{10}$, $^{15}O_8$ I. $^{12}C_6$ and $^{14}C_6$ are isotopic II. $^{15}O_8$ and $^{14}C_6$ are isotonic III. $^{14}C_6$ and $^{14}N_7$ are isobaric IV. $^{12}C_6$ and $^{14}C_6$ are isoelectronic. Which of these statements is/are correct? (a) I, II and IV only (b) II, IV and VI only (c) I only (d) I, III and IV only
22. For the types of radiation given, which of the following is the correct order of increasing penetrability? (a) Gamma rays < alpha particles < beta particles (b) Beta particles < gamma rays <alpha particles (c) Alpha particles < beta particles < gamma rays (d) Beta particles < Alpha particles < gamma rays
23. Which of the following atoms has the largest first ionization potential: Nitrogen? Boron, Aluminum and Phosphorous? (a) Boron (b) Phosphorous (c)Nitrogen (d) Aluminum
24. Calculate the mass of carbon in grams needed to reduce 15.9g of copper (II) oxide [C = 12,Cu = 63.5,O = 16] (a) 2.56g (b) 2.40g (c) 1.20g (d) 2.50g
25. Barium and copper ions in aqueous can be separated by the addition of tetraoxosulphate (VI) acid to the solution. This method of separation is known as: (a) Precipitation (b) Chromatography (c) Crystallization (d) Solvent Extraction

SOLUTION

1. If P (melting point range, 78-81°C) and Q (melting point range, 120-122°C) are mixed together, they will act as impurities to each other. Impurity lower melting points but raise boiling point.

If P and Q are present in equal amount say 10g. P and Q will act as impurities to each other. Therefore, the presence of P as impurity will lower the melting point and raise the boiling point of Q. the presence of Q as impurity will lower the melting point of P. In this case, the melting point of the homogenous mixture of P and Q will be:

I. 70 – 75°C, Q acting as impurity to P

(ii) 110-118°C, P acting as impurity to Q.

But the boiling point of the homogenous mixture of P and Q when they are present in equal amount will be:

I. 82-88°C, Q acting as impurity to P

(ii)125-130°C,P acting as impurity to Q

But if 1g of P and 12g of Q are mixed together P will act as impurity to Q because P is present in small amount but Q is present in large amount. In this case P will lower the melting point but raise the boiling point of Q. Hence the melting of a homogenous mixture of 1g of P and 12g of Q will be 110-118°C but the boiling point will be 125-130°C.

The correct option is D

2. Kinetic theory of gases is also known as kinetic molecular theory of gases. It states that gases are made of tiny particles (i.e molecules) which are in continuous motion and as a result possesses kinetic energy. The basic assumptions of the kinetic theory of gases are:-

i. A gas is composed of molecules that are separated from each other by distances far greater than their own dimensions. The

bt6gvtfcdz\molecules can be considered to be "points"; that is, they possess mass but have negligible volume or size.

ii. Molecules of a gas are in constant and rapid motion in straight lines until they collide with one another and with the walls of their container. The implication is that molecules of gases exert pressure on each other and on the wall of their container

iii. The collision between gaseous molecules is perfectly elastic. The implication is that gaseous molecules will continue their motion indefinitely.

iv. The actual volume occupied by the gas molecules is negligible compared with the volume of the container. The implication of this assumption is that gases can be compressed

v. Forces of attraction or repulsion between the molecules of gases are negligible. The implication of this assumption is that gaseous molecules will occupy any available space.

vi. The average kinetic energy of the gas molecules is proportional to the absolute temperature of the gas molecules.

The correct option is A

3. Let the relative atomic mass of M be x.

R.M.M of $MCl_3 = x + 3(35.5) =$
$(x + 106.5)g/mol$ % of $Cl = 67.2\%$

$$\% \text{ of } Cl = \frac{R.A.m \text{ of } Cl}{R.M.m \text{ of } Mcl_3} \times \frac{100}{1}$$

$$67.2 = \frac{3(35.5)}{x + 106.5} \times \frac{100}{1}$$

$$67.2(x + 106.5) = 3(35.5) \times 100$$
$$67.2x + 7156.8 = 106.5 \times 100$$
$$67.2x + 7156.8 = 10650$$
$$67.2x = 10650 - 7156.8$$
$$67.2x = 3493.2$$
$$x = \frac{3493.2}{67.2} = 51.98g/mol$$
$$x \simeq 52g/mol$$

Therefore, the relative atomic mass of M is $52g/mol$ .The metal is chromium because chromium has a relative atomic mass of $52g/mol$.

The correct option is B

4.

Molecules	Hybridization	Shapes	Bond angles
CO_2	Sp	Linear	180
NH_3	Sp^3	Trigonal pyramidal	107
$BeCl_2$	Sp	Linear	180
BF_3	Sp^2	Trigonal planar	120

The correct option is D

5. The hydrogen bond in H_2O is stronger than the polar bond in H_2S.Note that the greater the hydrogen bonds in a molecule, the greater the tendency of the molecule to exist as a liquid and the lesser the volatility of the substance but the higher the boiling point. Also note that the greater the hydrogen bond or polar bond in a molecular the greater the difference in electronegativity of the elements that made up the molecule. Therefore, the electronegativity of oxygen allows hydrogen bonding in water (H_2O) molecules.

The correct option is D

6. Cathode rays are false ray because they possess mass and charge. Cathode ray have the following properties.

(i) When place in an electromagnetic field they move toward the positive part or north pole of the field. This shows that they are negatively charge.

(ii) They cast shadows on an opaque object place on their paths. This shows that they travelled on a straight line.

(iii)They are capable of producing mechanical motion of a paddle place on their parths. This shows that they possesses mass or they are massive.

(iv)Their charge to mass ratio is constant. This shows that they are fundamental particle of all atoms.

The correct option is D

7. $CrO^{2-}_{4(aq)} + Br^{-}_{(aq)} \rightarrow Cr^{3+}_{(aq)} + BrO^{-}_{(aq)}$

Step 1: Assign oxidation state to all species that undergo change in oxidation state.

$$\overset{+6}{Cr}O_4^{2-} + \overset{-1}{Br}^- \rightarrow \overset{+3}{Cr}^{3+} + \overset{+1}{Br}O^-$$

Step 2: Separate the reaction into oxidation reduction halve reaction. Oxidation is a process that involves increase in oxidation number but reduction is a process that involves decrease in oxidation number.

$CrO_4^{2-} \rightarrow Cr^{3+}$ (red)
$Br^- \rightarrow BrO^-$ (ox)

Step 3: Balance each half reaction atomically and electrically.

$3e^- + CrO_4^{2-} + 8H_2O \rightarrow Cr^{3+} + 4H_2O + 8OH^-$
$3e^- + CrO_4^{2-} + 4H_2O \rightarrow Cr^{3+} + 8OH^-$
$2OH^- + Br^- + H_2O \rightarrow BrO^- + 2H_2 + 2e^-$
$2OH^- + Br^- \rightarrow BrO^- + H_2O + 2e^-$

Step 4: Balance the number of electrons in the two half reactions.

$3e^- + CrO_4^{2-} + 4H_2O \rightarrow Cr^{3+} + 8OH^- \ldots x\,2$
$2OH^- + Br^- \rightarrow BrO^- + H_2O + 2e^- \ldots x\,3$
$6e^- + 2CrO_4^{2-} + 8H_2O \rightarrow 2Cr^{3+} + 16OH^-$
$6OH^- + 3Br^- \rightarrow 3BrO^- + 3H_2O + 6e^-$
$2CrO_4^{2-} + 3Br^- + 5H_2O \rightarrow 2Cr^{3+} + 3BrO^- + 10OH^-$

$\therefore a = 2, b = 3, c = 0, d = 5, w = 2, x = 3, y = 10, z = 0$

The correct option is B

8. Volume of air in the room

$(V_a) = 4.11m \times 5.36m \times 2.58m$
$= 56.836368m^3 \simeq 56.84m^3$

$V_a = 56.84m^3 \times \frac{1000dm^3}{1m^3}$
$= 56.84 \times 10^3 dm^3$

$\cap_{Air} = \frac{vol\ at\ s.t.p}{22.4dm^3/mol} = \frac{56.84 \times 10^3 dm^3}{22.4dm^3/mol}$
$= 2537.5mol$

$\cap_{Air} = 2.5375 \times 10^3 moles$
$\simeq 2.54 \times 10^3 moles$

None of the option is correct

9. **Quantum numbers:** These are the numbers that are given to each energy level of an atom. They are I. principal quantum number represented by n (ii) Azimuthal or subsidiary quantum number represented by ℓ (iii) magnetic quantum number represented by m and (iv) spin quantum number represented by s.

Significance of the quantum numbers

(a) Principal quantum number

i. It determines the energy possesses by an electron due to its distance from the nucleus
ii. It determines the size of an electron cloud
iii. The distance of an electron from the nucleus
iv. The maximum number of electron in a main shell

The principal Quantum number (n) has an integral value of 1,2,3,4…

(b) Subsidiary or azimuthal quantum

i. It divides sub-shell into orbitals.
ii. It determines the maximum number of electron in the sub-shell.
iii. It determine the shape of orbital

Subsidiary or azimuthal quantum (ℓ) has an integral values of 0 to (n-1).

(c) Magnetic quantum number

i. It deals with the orientation of electrons in orbital or space.

Magnetic quantum number (m) has an integral value of $-\ell$ to $+\ell$

(d) Spin quantum number

(e) It deals with the spinning properties of an electron in an orbital. Spin quantum number(s) has an integral value of $\pm 1/2$

The correct option is A

10. (i) $^6_3Li + ^1_0n \longrightarrow ^4_2He + ^3_1H$ + energy nuclear fission

(ii) $^{14}_7N + ^4_2He \longrightarrow ^{17}_8He + ^1_1H$ + energy nuclear fission
(iii) $^{28}_{13}Al \longrightarrow ^{28}_{14}S_1 + ^0_{-1}e$ + energy Beta decay

The correct option is D

11.

Species	Hybridization of central atoms
$BeCl_2$	Sp
BF_3	Sp^2
CH_4	Sp^3
CO_2	Sp
NH_3	Sp^3
H_2O	Sp^3

None of the option is correct

12. Ionization energy is the minimum energy required to remove an electron from an isolated atom (or an ion) in its ground state. It increases across a period and decrease down the group for the group 1 metal, the first ionization energy decreases in the order

$Li \longrightarrow Na \longrightarrow K \longrightarrow Rb \longrightarrow Cs \longrightarrow Fr$
$Li > Na > K > Rb > Cs > Fr$

The correct option is A

13. A mixture is a substance that contain two or more elements or compounds physically combine together e.g. Air, Blood plasma, coca-cola, palm wine, soil, sand, flooded water, alloys, honey, banana, ripe fruits, petroleum or crude oil, stones, clay, soil, gasoline ,flooded water etc.

The correct option is C

14. Let the gas be X

$P_x = 0.59atm$
$P_T = 1.03atm$

$X = \frac{V_X}{V_T} = \frac{n_X}{n_T} = \frac{P_X}{P_T}$

$X = \frac{P_X}{P_T} = \frac{0.59}{1.03} = 0.5728$

The correct option is B

15. If n = 2, $\ell = 0$, 1 and $m_l = -1, 0, 1$. If n = 2 and $\ell = 1$ the orbital describe is 2P.

The correct option is B

16. Hydrogen bonding is a fairly strong dipole-dipole interaction between molecules containing hydrogen directly bonded to a small highly charge electronegative element such as N, O and F. Hydrogen bond is a type of polar covalent bond, hence by characteristics it is a covalent bond. Hydrogen bonding is responsible for the high boiling point and low volatility of H_2O, HF, NH_3, alkanols & alkanoic acid.

The correct option is B

17.

Molecules	Bonding
CH_4	Covalent
LiCl	Ionic(strongest)
HF	Hydrogen bonding
NH_3	Hydrogen bonding

The stronger the hydrogen bonding that exist within a molecule the higher the boiling point. The strongest Hydrogen bond is found in HF. Note that ionic bond is stronger than hydrogen bonding.

The correct option is C

18. For the ion to be +1. It means that it has lost one of its electrons. Since the mass number is 133

$A = NN + NP$

Where $A = mass\ number$

$NN = neutron\ number$

$NP = number\ of\ proton$

Since the number of neutron in the nucleus is 1.42times that of protons.

$\Rightarrow NN = 1.42NP$

$133 = 1.42NP + NP$

$133 = 2.42NP$

$$NP = \frac{133}{2.42} = 54.9587$$

$NP \simeq 55$

Since the ion is +1, it means that the number of proton in the ion exceed the number of electron by 1

Number of Electron

$(NE) = 55 - 1$

$= 54$

The correct option is A

19. R.M.M of $NaNO_3$

$= 23g/mol + 14g/mol + 3(16g/mol)$

$= 85g/mol$

$$\cap_{NaNO_3} = \frac{5g}{85g/mol} = \frac{1}{17}mol$$

$molar\ conc = 0.225M$

$\cap_{NaNO_3} = v(mL\ or\ dm^3) \times molar\ conc$

$$\frac{1}{17} = v \times 0.225$$

$1 = v \times 0.225 \times 17$

$$v = \frac{1}{0.225 \times 17} = \frac{1}{3.825} = 0.2614L$$

The correct option is A

20. % of Mg = 72.2%

% of N = 27.8%

Assuming 100g of the substance

Mass of Mg = 72.2% of 100g

$$= \frac{72.2}{100} \times 100g = 72.20g$$

Mass of N = 27.8% of 100g

$$= \frac{27.8}{100} \times 100g = 27.80g$$

Mg	:	N
$\frac{72.2}{24}$	:	$\frac{27.8}{14}$
3.0083	:	1.9857
$\simeq 1.5$		1
$\frac{3}{2}$	:	1

Multiply through by 2

3 : 2

The empirical formula is Mg_3N_2

The correct option is D

21. Note that:

(i) Isotones are atoms of different elements with the same neutron number. Such atoms have different chemical and physical properties e.g. $^{15}_{8}O$ and $^{14}_{7}N$;

(ii) Isobars are atoms of different elements with the same mass number e.g. $^{14}_{7}N$ and $^{14}_{6}C$

(iii) Isotopes are atoms of the same element with the same atomic number e.g. $^{14}_{6}C$ and $^{12}_{6}C$

(iv) Ions, or atoms that possess the same number of electrons in the same ground state electron configuration, are said to be isoelectronic e.g. $^{12}_{6}C$ and $^{14}_{6}C$

The correct option is D

22. The order of the penetrating powers of gamma rays, alpha particles and beta particles is: alpha particles < beta particles < gamma rays.

The correct option is C

23. $_7N \rightarrow 1s^2\ 2s^2\ 2p^3$

$_{15}P \rightarrow 1s^2\ 2s^2\ 2p^6\ 2s^2\ 3p^3$

$_5B \rightarrow 1s^2\ 2s^2\ 2p^1$

$_{13}Al \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^1$

The first ionization energy is affected by atomic radius and stability of orbital; however stability of orbital takes precedence over atomic radius. Orbitals that are fully or half filled are more stable than orbital that are less than or more than half filled. Nitrogen and phosphorus have a stable orbital because their outer most orbital is half filled.

$_7N \rightarrow 1s^2\ 2s^2\ 2p^3$

$_{15}P \rightarrow 1s^2\ 2s^2\ 2p^6\ 2s^2\ 3p^3$

Since Nitrogen and phosphorus has a stable orbital, to determine the element with the highest first ionization energy we have to consider their atomic radius. The smaller the atomic radius, the greater the first ionization energy provided the stability or orbital is held constant. Since Nitrogen has a smaller atomic radius compare to phosphorus because it contain two shells while phosphorus contain 3 shells. The smaller the number of shells the smaller the atomic radius. Therefore, nitrogen atom has the highest ionization energy.

The correct option is C

24. $2CuO + C \rightarrow 2Cu_{(s)} + CO_{2(g)}$

R. M. M of CuO

$= 63.5g/mol + 16g/mol = 79.5g/mol$

$$\cap_{CuO} = \frac{15.9g}{79.5g/mol} = 0.2mol$$

$$\cap_C = \frac{1mole\ of\ C}{2\ mole\ of\ CuO} \times 0.2mol\ of\ CuO$$

$$= 0.1mole$$

$$\cap_{Cu} = \frac{mass\ of\ C}{molar\ mass}$$

$$0.1mol = \frac{mass\ of\ C}{12g\ /\ mol}$$

Mass of C = 0.1mole × 12g/mol = 1.20g

Note that the reaction of carbon and copper II oxide (CuO) produce carbon IV oxide (CO_2) not carbon II oxide (CO)

The correct option is C

25. Barium and Copper ions in aqueous can be separated by the addition of tetraoxosulphate VI acid to the solution. This method of separation is known as precipitation.

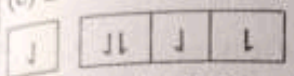
The correct option is A

2009/2010 CHEMISTRY 001 TEST

1. What is the ratio of oxygen atoms to that of hydrogen atoms in ammonium tetraoxosulphate (VI)? (a) 1:1 (b) 3:4 (c) 4:3 (d) 1:3
2. How many nitrogen atoms are there in $4.00g$ of nitrogen I. oxide molecules? [$N = 14$; $O = 16$; $N_A = 6.02 \times 10^{23}$particles/mol] (a) 1.09×10^{23} (b) 1.23×10^{23} (c) 2.46×10^{23} (d) 6.16×10^{22}
3. An element X has three naturally occurring isotopes X_1, X_2 and X_3 with respective isotopic mass and fractional abundance of 38.964 and 0.9326 for X_1, 39.964 and 1.000×10^{-4} for X_2 and 40.962 and 0.0673 for X_3. What is the atomic mass of X (to 4 significant figures)? (a) 40.96 (b) 39.96 (c) 39.10 (d) 38.10
4. A monatomic ion has a charge of +2. The nucleus of the ion has a mass number of 62. The number of neutrons in the nucleus is 1.21 times that of the number of protons. How many electrons are in the ion? (a) 24 (b) 26 (c) 28 (d) 30
5. A fixed mass of a gas has a volume of $300cm^3$ at 20^0C. What temperature rise would produce a 5% increase in volume if the pressure remain s constant? (a) 20.65^0C (b) 18.65^0C (c) 186.5^0C (d) 14.65^0C
6. Which of the following is/are mixture (s)? I. Blood II. Gasoline III. Banana IV. Stones (a) I and II only (b) III and IV only (c) II, III and IV only (d) I, II, III and IV only.
7. Which of the following is a/are chemical change(s)? I. Fruit ripening, II. A leaf turning yellow, III. Water vapour in air on a cold day forming frost, IV. water decomposition during electrolysis (a) I, II and III (b) I, II and IV (c) I and IV only (d) I and II only.
8. In which of the following is filtration not use? I. Separation of a solute form the sol II. Water purification plants III. Removal dirt from the air used in the car engine Separation of suspended particles from liquid (a) II and III only (b) I only (c) I and only (d) II only
9. In which shell and orbital respectively is electron having the quantum numbers n =3, 2 and m = +2? (a) K shell and d-orbital (b) shell and p-orbital (c) M shell and d-orbital N shell and d-orbital.
10. An element X has the electronic configuration $1s^22s^22p^63s^23p^2$.To which Group; Peri and Block does this element belong? (a) II and p (b) III, 2 and p (c) IV, 3 and p (d) III and p
11. The maximum number of electrons in a sub-shell depends on (a) Azimuthal quantum number (b) principal quantum numbe (c) spin quantum number (d) magneti quantum number.
12. Laboratory coats and gloves can only guarantee effective shielding from (a) alpha radiation (b) beta radiation (c) gamma radiation (d) alpha and gamma radiations.
13. Phosphorus-32, a radioisotope used in leukemia therapy, has a half-life of 14 days Approximately what percent of sample remains after 8 weeks? (a) 93.75% (b) 2.00% (c) 6.25% (d) 8.25%
14. The principal quantum number 'n' represents an average I. size of the electron cloud II. energy of the electron III. distance of the electron from the nucleus (a) II and III only (b) I, II and III only (c) I and III only (d) III only.
15. The molecule of NH_3 is (a) tetrahedral with bond angle $109^028'$ (b) pyramidal with bond angle $107^020'$ (c) trigonal planar with bond angle 120^0 (d) linear with bond angle 180^0
16. Which of the following can be used to describe the valency of an element? I. The combining capacity of one atom of it II. The number of bonds formed by one atom of it III. The number of hydrogen atoms that combine with one atom of it (a) I, II and III (b) II and III (c) I and III (d) I and II
17. The types of bonds present in $CaCO_3$ molecules are I. covalent bonds II. ionic bonds III. coordinate covalent bonds (a) I only (b) II only (c) III only (d) I and II only
18. When the pressure of a gas is reduced to one-third at a constant temperature, its volume (a) is reduced one-third, (b) is increased to three

times (c) remains the same (d) cannot be predicted.

19. What volume of 0.225M sodium trioxonitrate (V), $NaNO_3$, solution contains 5g of the solute? [Na = 23, O = 16, N = 14]. (a) 261mL (b) 251mL (c) 200mL (d) 150mL

20. 

I. Pauli Exclusion Principle II. Aufbau Principle III. Hund's Rule of Maximum Multiplicity. Which of these is/are disobeyed by the above filling of orbital?(a) I and III only (b) I and II only (c) II and III only (d) III only.

21. I. Tetrahedral, II. Trigonal pyramidal, III. Trigonal planar, IV. Angular, V. Linear. With reference to I to V above, the shapes of water, beryllium dichloride, ammonia and boron trifluoride respectively are (a) IV, V, II and III (b) I, II, III and IV (c) V, IV, III and I (d) II, III, IV and V.

22. Which of the following are true properties of electrovalent compounds? I. They are solids with high melting points, II. They conduct electricity as electrolytes, III. They are generally soluble in water, IV. They exist as aggregate ions, V. They are usually volatile at room temperature. (a) II, III and IV (b) II, III, IV and V (c) I, II, III and IV (d) I, III, IV and V

23. The respective pattern of hybridization of the central atom in the components of CO_2, NH_3, $BeCl_2$ and BF_3 are (a) sp, sp^3, sp^2 and sp (b) sp^3, sp, sp^2 and sp (c) sp, sp^3, sp and sp^2 (d) sp, sp^2, sp and sp^3.

24. 0.54g of a metal, M, (relative atomic mass 27) completely reacted with dilute tetraoxosulphate (VI) acid to liberate $672cm^3$ of hydrogen gas at s.t.p. Use this information to deduce the stoichiometry of the reaction between M and H_2SO_4 (a) 3:1 (b) 2:3 (c) 3:2 (d) 1:3

25. The partial pressure of oxygen in a sample of air is 452 mmHg and the total pressure is 780 mmHg. Determine the mole fraction of oxygen in the mixture. (a) 5.790 (b) 0.579 (c) 2.030 (d) 0.203

26. I. Cure of cancer, II Preparation of medicinally active compounds, III. Determination of the ages of ancient tools. Which of the above is/are uses of radioactive isotopes? (a) I, II and III (b) I and II (c) I and III (d) II and III.

27. I. α-particle, II. β-particle, III. γ-ray. Which of these can be stopped by a thin sheet of Aluminium? (a) I only, (b) II only (c) III only (d) I and II only.

28. $60cm^3$ of 0.1M solution of silver trioxonitrate (V) and $50cm^3$ of a $0.05M$ sodium trioxocarbonate (IV) solution are mixed. Assuming the insoluble component is completely insoluble, determine the maximum mass of precipitate obtained. [$C = 12$, $N = 14$, $O = 16$, $Na = 23$, $Ag = 108$]. (a) 0.710g (b) 0.690g (c) 0.828g (d) 1.38g

29. A mixture of sodium chloride and ammonium chloride was placed on a watch-glass covered with cold inverted funnel. The set-up was warmed on a water bath resulting in the separation of the mixture components. The chemical principle involves is (a) precipitation (b) thermal decomposition (c) thermal dissociation (d) sublimation.

30. A neutral atom has 2 electrons with n=1; 8 electrons with n=2; 8 electrons with n=3; 1 electron with n=4. Which of the following cannot be deduced from the information provided? I. The number of p electrons II. The number of d-electrons III. The atomic number, IV. The number of neutrons in the nucleus V. The atomic mass. (a) I, III and IV (b) II, III and IV (c) IV and V (d) I, II and III

31. A mixture of sugar granules and sulphur can be separated by (a) dissolution in water, evaporation and filtration, (b) filtration, evaporation and dissolution in water (c) dissolution in water, filtration and evaporation (d) evaporation, dissolution in water and filtration.

32. 0.0075mole of calcium trioxocarbonate (IV) is added to 0.015 mole of a solution of hydrochloric acid. The volume of gas evolved at s.t.p is (a) $168cm^3$ (b) $224cm^3$ (c) $112cm^3$ (d) $100cm^3$

33. The basic assumption in the kinetic theory of gases that the collisions of the gaseous molecules are perfectly elastic implies that the (a) forces of attraction and repulsion are in equilibrium (b) gaseous molecules can occupy any available space (c) gaseous molecules will continue their motion indefinitely (d) gases can be compressed.

34. What volume of 1.5M solution of KOH would contain 0.045 moles? (a) $67.50cm^3$ (b) $30.00cm^3$ (c) $6.75cm^3$ (d) $3.00cm^3$

35. Which of the following statements is/are true of the elements in the Period Table? I. Ionization energy increases down the group II. Ionic radius increases across a period from left to right III. Metallic properties decrease from bottom to top within a given group. (a) I and II only (b) II and III (c) I only (d) III only

36. What is the chemical formula of a compound containing 6.02×10^{23} atoms of hydrogen, 35.5g of chlorine and 4.0moles of oxygen atoms? $[H = 1, O = 16, Cl = 35.5]$ (a) HCl_2O_4 (b) HCl_4 (c) $HClO_4$ (d) HClO

37. $1000cm^3$ of gas X diffused through a porous plug in 7.5s. An equal volume of nitrogen, under the same conditions, took 10 s to diffuse through the same porous plug. What is the relative molar mass of X? [N = 14]. (a) 16 (b) 28 (c) 42 (d) 84

38. $25cm^3$ of a gas X contains p – molecules at 288K and 750 $mmHg$. Calculate the number of molecules which $100cm^3$ of another gas Y will contain at 576K (a) 2p (b) p (c) 3p (d) 4p

39. A mixture of 0.20 mole of oxygen, 0.20 mole of nitrogen and 0.30 mole of hydrogen exerts a total pressure of 2.1atm. The partial pressure of hydrogen in the mixture is (a) 0.40atm (b) 0.90atm (c) 0.60atm (d) 0.50 atm.

40. 2.8g of iron fillings is heated while a stream of dry chlorine is passed over it until the necessary reaction is complete. Determine the mass of the product formed. [Cl] 35.5, Fe=56]. (a) 4.1g (b) 8.1g (c) 12.2g (d) 16.3g

SOLUTION

1. Ammonium tetraoxosulphate (vi), $(NH_4)_2SO_4$, contain 8 hydrogen atoms and 4 oxygen atoms. The ratio of oxygen atoms to hydrogen atoms = 4:8 = 1:2.

None of the option is correct.

2. R.M.M of $N_2O = [2(14) + 16]g/mol$
$= [28 + 16]g/mol = 44g/mol$
$mass\ of\ N\ in\ 4.00g\ of\ N_2O$
$= \frac{28}{44} \times 4.00g = 2.5454g$
$N_N = \frac{2.5454}{14} = 0.1818$
$N_N = \frac{No\ of\ atoms\ of\ N}{6.02 \times 10^{23}}$
$0.1818 = \frac{No\ of\ atoms\ of\ N}{6.02 \times 10^{23}}$
$No\ of\ atoms\ of\ N$
$= 0.1818 \times 6.02 \times 10^{23}$
$= 1.09 \times 10^{23} atoms$

The correct option is A

3. $R.A.M.of\ X = a_1m_1 + a_2m_2 + a_3m_3$
Where a = fractional abundance
$R.A.M\ of\ X$
$= 0.9326 \times 38.964 + 1.000 \times 10^{-4}$
$\times 39.964 + 0.0673 \times 40.962$
$= 36.3378 + 3.196 \times 10^{-3} + 2.757$
$= 39.10$

The correct option is C

4. For the ion to be +2, it means that it has lost two of its electrons. Since the mass number is 62.
$\Rightarrow A = NN + NP$
$where\ A = mass\ number$
$NN = Neutron\ Number$
$NP = Proton\ Number$
$NN + NP = 62$
Since the number of Neutron
$= 1.21 \times the\ number\ of\ protons$
$NN = 1.21NP$
$\Rightarrow NN + NP = 62$
$1.21NP + NP = 62$
$2.21NP = 62$
$NP = \frac{62}{2.21} = 28.0543$
Since the ion is +2, it means that the number of proton in the ion exceed the number of electron by 2
Number of Electron
$(NE) = 28.0543 - 2$
$= 26.0543$
$\simeq 26$

The correct option is B

5. $V_1 = 300cm^3$
$T_1 = 20^0C = 20 + 273 = 293K$
$V_2 = 300 + 5\%\ of\ 300$
$= 300 + \frac{5}{100} \times 300$
$= 300 + 15$
$= 315cm^3$
$T_2 = ?$
According to Charles law
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
$\frac{300}{293} = \frac{315}{T_2}$
$T_2 = \frac{315 \times 293}{300} = 307.65K$
$= 34.65^0C$
The temperature rise $= \theta_2 - \theta_1$
$= 34.65 - 20 = 14.65^0C$

The correct option is D

6. A mixture is a substance that contain two or more substance which are physical combine together e.g. blood plasma,flooded water,rubber latex,cocacola, water,banana, stones, gasoline,crude oil (or petroleum),alloy, soil, honey, palm wine, clay etc

The correct option is D

7. A chemical changes is a change in which new substance is form and which is not easily reversible e.g. rusting of ion, dissolution of metal in acid, ripening of fruits, formation

yellow colour on plant's leaves, water decomposition during electrolysis.

The correct option is B

8. Filtration is a separation technique employed in the separation of an insoluble solute from a solvent. The following process employ filtration e.g. water purification plants, removal of dirt from the air used in the car engine. Note that suspended particles are remove from a liquid by coagulation and only insoluble solute can be remove from a solution by filtration

The correct option is C

9. The quantum number $n = 3$ & $l = 2$ describes the main shell M and 3d-orbital.

The correct option is C

10. $X \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^2$
    (i) The period correspond to the highest principal quantum number i.e. 3. Hence the element is in period 3.
    (ii) The group corresponds to the number of electron in the highest principal quantum number i.e. $4(2 + 2 = 4)$. Hence the element is in group 4.
    (iii) The blocks the element belongs correspond to the outermost sub-shell (i.e. P). Hence the element is a p-black element

The correct option is C

11. The maximum numbers of electron in a given sub-shell depend on the Azimuthal quantum number. This is because the sub-shells are divided into the orbitals by the azimuthal quantum number. Note that the number of electrons in a main shell depend on the principal quantum number.

The correct option is A

12. Laboratory coats and gloves can only guarantees effective shielding from alpha radiations because alpha particles are stop by paper. Since beta particle are stop by thin sheet of Aluminium and gamma ray are stop by thick lead block, they will travel through the laboratory coats and gloves

The correct option is A

13. $T_{\frac{1}{2}} = 14 days$

$t = 8\,weeks = 8 \times 7 = 56 days$

$$n = \frac{t}{T_{\frac{1}{2}}} = \frac{56}{14} = 4$$

$$N_R = No\left(\frac{1}{2}\right)^4$$

$No = 1\ or\ 100\%$

$$N_R = 100\left(\frac{1}{2}\right)^4 = \frac{100}{16} = 6.25\%$$

The correct option is C

14. **Quantum numbers:** These are the numbers that are given to each energy level of an atom. They are I. principal quantum number represented by n (ii) Azimuthal or subsidiary quantum number represented by ℓ (iii) magnetic quantum number represented by m and (iv) spin quantum number represented by s.

    Significance of the quantum numbers

    (f) Principal quantum number
    i. It determines the energy possesses by an electron due to its distance from the nucleus
    ii. It determines the size of an electron cloud
    iii. The distance of an electron from the nucleus
    iv. It determine the number of electrons in a main shell

    The principal Quantum number (n) has an integral value of 1,2,3,4...

    (g) Subsidiary or azimuthal quantum
    i. It divides sub-shell into orbitals.
    ii. It determines the maximum number of electron on a sub-shell.
    iii. It determine the shape of orbital

    Subsidiary or azimuthal quantum (ℓ) has an integral values of 0 to (n-1).

    (h) Magnetic quantum number
    i. It deals with the orientation of electrons in orbital or space.

    Magnetic quantum number (m) has an integral value of $-\ell$ to $+\ell$

    (i) Spin quantum number

    It deals with the spinning properties of an electron in an orbital. Spin quantum number(s) has an integral value of $\pm 1/2$

The correct option is B

15. The molecules of NH_3 is Trigonal pyramidal with bond angle $107^0 20^1$ or 107.33^0.

The correct option is B

16. The valency of an element can be defined in any of the following way.
    (i) It is the number of electron in the shell of one atom of the elements.
    (ii) It is the combining power of one atom of the element.
    (iii) It is the number of bonds formed by one atom of it.
    (iv) It is the number of hydrogen atoms that combine with one atom of it.

The correct option is A

17. The bond found in $CaCO_3$ is
    (i) Ionic or electrovalent bonding between Ca^{2+} and CO_3^{2-}
    (ii) Covalent bond in CO_3^{2-}

The correct option is D

18. $V_1 = V$
$P_1 = P$
$P_2 = \frac{1}{3}P$
$V_2 = ?$
$P_1V_1 = P_2V_2$
$P \times V = \frac{1}{3}PV_2$
$V_2 = 3V$
Note that there is a difference between **reduce to** and **reduce by.** To reduce a pressure of say 300atm to 200atm means that the new pressure is $200atm$. But to reduce a pressure of $300atm$ by 200atm means that the new pressure is 100atm (that is $300 - 200atm = 100atm$)

The correct option is B

19. $R.M.M.of\ NaNO_3$
$= (23 + 14 + 48)\ glmol = 85glmol$
$\cap_{NaNO_3} = \frac{5}{85} = \frac{1}{17}mol$
$\cap_{NaNO_3} = \frac{V\ in\ cm^3\ or\ ml}{1000} \times molar\ conc$
$\frac{1}{17} = \frac{V}{1000} \times 0.225$
$V = \frac{1000}{17 \times 0.225}$
$= 261.4379ml \approx 261ml$

The correct option is A

20. (i) Since the S-orbital is not completely filled before filling P-orbital, Aufbau principle is disobeyed.
(ii) Since the spin of the electron is the same, Pauli's Exclusion principle is disobeyed.

The correct option is B

21.

Molecules	Shapes	Bond angle	hybridization
H_2O	Angular	105^0	Sp^3
$BeCl_2$	Linear	180^0	Sp
NH_3	Trigonal pyramidal	107^0	Sp^3
BF_3	Trigonal planar	120^0	Sp^2

The correct option is A

22. Option i-iv is correct about electrovalent compounds.

The correct option is C

23.

Molecules	hybridization
H_2O	Sp^3
$BeCl_2$	Sp
NH_3	Sp^3
BF_3	Sp^2

The correct option is C

24. $2M + 3H_2SO_4 \rightarrow M_2(SO_4)_3 + 3H_2$
$\cap_M = \frac{0.54}{27} = 0.02mol$
$\cap H_2 = \frac{672}{22400} = 0.03mol$
Note that one mole of H_2SO_4 will liberate one mole of Hydrogen gas but two mole of HCl will liberate one mole of Hydrogen gas.
$\cap_{H_2SO_4} = 0.03mol$
$\cap_M : \cap_{H_2SO_4}$
$0.02 : 0.03$
$2 : 3$

The correct option is B

25. $P_T = 780mmHg$
$P_{O_2} = 452mmHg$
$P_{O_2} = XP_T$
$X = \frac{P_{O_2}}{P_T} = \frac{452}{780} = 0.5795$

The correct option is B

26. The cure of cancer and determination of the ages of ancient tools or rocks are uses of radioactive isotopes.

The correct option is C

27. An alpha particle is stop by thin sheet of paper but a beta particle is stop by a thin sheet of Aluminium. Therefore a thin sheet of Aluminium will stop or prevent α and β – particles.

The correct option is D

28. $2AgNO_3 + Na_2CO_3 \rightarrow Ag_2CO_3 + 2NaNO_3$
$\cap_{AgNO_3} = \frac{60}{1000} \times 0.1 = 0.006mol$
$\cap_{Na_2CO_3} = \frac{50}{1000} \times 0.05 = 0.0025mol$
$\cap_{AgNO_3} : \cap_{Na_2CO_3}$
$\frac{0.006}{2} \quad \frac{0.0025}{1}$
$0.003 \quad 0.0025$
The limiting reagent is Na_2CO_3
The excess reagent is $AgNO_3$
$\cap_{AgNO_3} = 0.0025 \times 1 = 0.0025mol$
$R.M.M.of\ Ag_2CO_3 = 2(108) + 12 + 48$
$= 276g/mol$
$mass\ of\ Ag_2CO_3$
$= \cap_{Ag_2CO_3} \times R.M.M\ of\ Ag_2CO_3$
$= 0.0025 \times 276$
$= 0.69g$

The correct option is B

29. $NH_4Cl \underset{}{\overset{\Delta}{\rightleftharpoons}} NH_3 + HCl$
The above reaction is rightly called thermal dissociation.

The correct option is C

30. I. Number of electrons
$= 2 + 8 + 8 + 1 = 19$
(ii) Electronic configuration
$= 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

(iii) Number of P-electrons
$= 6 + 2 = 12$
(iv) Number of d-electrons = 0
(v) The atomic number is 19
(vi) The number of neutron in the nucleus cannot be determined. To determine the number of neutron in the nucleus of the atom more information is required
(vii) The atomic mass cannot be determined. To determine the atomic mass more information is required.
Note that to obtain the neutron number and the atomic mass further information needed to be supplied.

The correct option is C

31. I. Dissolution in water will remove the sugar from the sulphur
(ii) Filtration will separate the sulphur from the sugar.
(iii) Evaporation to dryness will recover the sugar.

The correct option is C

32. $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$
$\cap CaCO_3 : \cap HCl$
$\frac{0.0075}{1} : \frac{0.015}{2}$
$0.0075 : 0.0075$
None of the reagent is in excess
$\cap CO_2 = 0.0075mol \times 1 = 0.0075mol$
$\cap CO_2 = \frac{V}{22400}$
$V = 22400 \times 0.0075$
$V = 168cm^3$

The correct option is A

33. The implication of the kinetic theory of gases which states that the collisions of the gaseous molecules are perfectly elastic implies that the gaseous molecules will continue in their motion indefinitely.

The correct option is C

34. $\cap_{KOH} = \frac{V}{1000} \times molar\ conc$
$V = \frac{\cap_{KOH} \times 1000}{molar\ conc} = \frac{0.045 \times 1000}{1.5} = 30cm^3$

The correct option is B

35.

Atomic properties	Across the period	Down the group
Electropositivity	Decrease	Increase
Active volume	✓	✓
Atomic radius	✓	✓
Ionic radius	✓	✓
Electronegativity	Increase	Decrease
Ionization energy	✓	✓
Electron affinity	✓	✓
Atomic number	Increase	Increase
Mass number	✓	✓

The correct option is D

36. (i) 6.02×10^{23} atoms of Hydrogen = 1 mole of H
(ii) $35.5g$ of chlorine = 1mole of Chlorine
A compound with 1 mole of H atoms, 1 mole of Cl atoms and 4 moles of O atoms is $HClO_4$

The correct option is C

37. $\frac{t_X}{t_N} = \sqrt{\frac{M_X}{M_N}}$
$\frac{7.5}{10} = \sqrt{\frac{M_X}{28}}$
$\left(\frac{7.5}{10}\right)^2 = \frac{M_X}{28}$
$M_X = 28 \times \left(\frac{7.5}{10}\right)^2 = 15.75$
$M_X \simeq 16$

The correct option is A

38. $PV = nRT$
$P_1V_1 = n_1RT_1$
$P_2V_2 = n_2RT_2$
$\frac{P_1V_1}{P_2V_2} = \frac{n_1T_1}{n_2T_2}$
Since the question contains only one pressure it means that the pressure is constant.
$\frac{P_1V_1}{P_2V_2} = \frac{n_1T_1}{n_2T_2}$
$\Longrightarrow \frac{V_1}{V_2} = \frac{n_1T_1}{n_2T_2}$
$V_1 = 25cm^3, T_1 = 288K \ \cap_1 = P$
$V_2 = 100cm^3, T_2 = 576 \ \cap_2 = ?$
$\frac{25}{100} = \frac{P \times 288}{576 \times \cap_2}$
$25 \times 576 \times \cap_2 = 100 \times P \times 288$
$\cap_2 = \frac{100 \times P \times 288}{25 \times 576} = 2P$

The correct option is A

39. $\cap_T = 0.2 + 0.2 + 0.3 = 0.7mol$
$P_T = 2.1atm$
$P_H = X_HP_T$
$= \frac{0.3}{0.7} \times 2.1 = 0.9atm$

The correct option is B

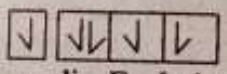
40. $2Fe + 3Cl_2 \rightarrow 2FeCl_3$
$\cap_{Fe} = \frac{2.8}{56} = 0.05$
$\cap FeCl_3 = 0.05mol$
$R.M.M\ of\ FeCl_3 = 56 + 3(35.5)$
$= 162.5glmol$
Mass of $FeCl_3 = 0.05 \times 162.5$
$= 8.125g$
Note that whenever chlorine gas react with a metal that can form more than one chloride, the higher chloride is always form but if it is HCl the lower chloride is always form.
$2Fe + 3Cl_2 \rightarrow 2FeCl_3$

$Fe + 2HCl \rightarrow FeCl_2 + H_2$

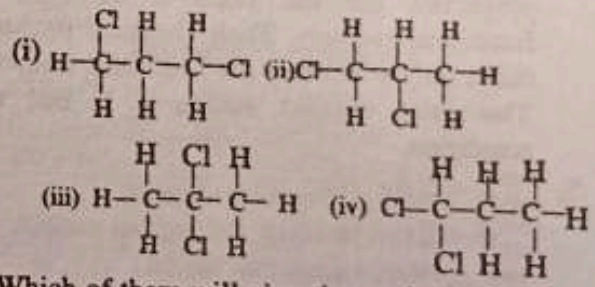
The correct option is B

2008/2009 CHEMISTRY 001 TEST

1. Consider the reactions $XCO_3 + 2HCl \rightarrow XCl_2 + H_2O + CO_2$. If $1.2g$ of the metal trioxocarbonate (iv) reacted with acid to produce 240 cm^3 of CO_2 at s.t.p, calculate the molar mass of the metal trioxocarbonate (iv). (a) 112 (b) 160 (c) 168 (d) 150
2. It took 7.5 seconds for 1000cm^3 of gas A to diffuse through the outlet of an apparatus. With the same apparatus and conditions, it takes 10 seconds for 1000cm^3 of nitrogen gas to diffuse out. What is the relative molar mass of gas (a) (N =14). (a) 28 (b) 16 (c) 84 (d) 42
3. Which of the following postulate in the Kinetic theory of gas is/are not needed in upholding Boyle's law. I. Gas molecules move randomly in straight lines. II. Forces of attraction between gas molecules are negligible. III. The actual volume occupied by the gas molecules is negligible compared to the volume of the vessel. IV. Gas molecules collide with the wall of the container resulting to pressure. (a) II and IV only (b) III and IV only (c) I and III only (d) I and II only
4. Two compounds may be isomers if they have I. same molecular formula II. same chemical properties III. different physical properties IV. different chemical properties V. same physical properties (a) I, III and IV (b) I, III and V (c) I, IV and V (d) I, II and V
5. Below is part of a radioactive decay series. $^{232}_{90}A \rightarrow ^{228}_{88}B + P$; $^{228}_{88}B \rightarrow ^{228}_{89}C + q$; $^{228}_{89}C \rightarrow ^{224}_{87}D + r$; $^{224}_{87}D \rightarrow ^{224}_{88}E + s$. The rays p, q, r and s are respectively.(a) α, α, β and β (b) α, β, α and β (c) β, α, β and α (d) β, α, α and β
6. Which of the following compound will not rotate the plane of polarization of polarized light? I. butan-2-ol II. 2-methylhaxan-2-ol III. 2-methylpropan-2-ol IV. 3-methylpentan-3-ol. (a) I and IV only (b) I and III only (c) III and IV only (d) I and II only
7. Which of the following is true of a sample of hydrogen gas whose mass is 4.00g under a pressure of 2atm and a temperature of 27^0C ? [H=1; R =0.082 litresatmmol^{-1}deg^{-1}] I. its volume is 24.6 litres II. It contains 1.20×10^{24} molecules III. it exist as atoms because of the temperature. (a) i and (iii) only (b) i and ii only (c) i only (d) i, ii and iii
8. Given the heat of combustion of methane, carbon and hydrogen to be-891, -393 and -286 kjmol^{-1} respectively, calculate the standard enthalpy of formation for methane. (a) $-74\ Kjmol^{-1}$ (b) $-111Kjmol^{-1}$ (c) $-66Kjmol^{-1}$ (d) $-60Kjmol^{-1}$
9. The correct IUPAC name of the polyhaloalkane $CCl_3CH(Br)(I)$ is (a) 2-bromo−1,1,1 −trichloro-2-iodoethane (b) 2-bromo−1, 1,1 −trichloro-2-iodomethane (c) 1-bromo−2,2,2 −trichloro-1-iodoethane (d) bromo−2,2,2 −trichloro-1-triodomethane
10. Consider the following overlapping of orbitals in covalent molecules. I. p- p (linearly opposed) II. sp^3-sp^3 III. sp^2-sp^2 IV. sp-sp V. sp-p (linearly opposed) VI. p-p (parallel) which of these are present in the carbon (iv) oxide molecule. (a) V and VI only (b) I and IV only (c) II and V only (d) I, II and III only
11. Which of the following terminologies is/are not common to both column and paper chromatographies. I. mobile phase II. stationary phase III. retention time IV. chromatographic tank. (a) I and II only (b) I, II and III only (c) III and IV only (d) I, II, III and IV
12. A student evolved the following for the separation of the components of some mixtures. I. components of kerosene and water; principle used is immiscibility II. components of petrol, kerosene and diesel; principle used is Fractional distillation III. components of ink; principle used is Rate of migration IV. components of dye mixture; principle used is chromatography V. components of $KClO_3$ and KCl; principle used is fractional crystallization, which of them is/are correct (a) I & III (b) II and IVonly (c) I, II and III only (d) I, III and V
13. I. ionization potential II. electron affinity III. metallic character IV. Atomic radius. Which of the following decreases along the period but increases down the group? (a) I and II only (b) III and IV only (c) I and III (d) II and IV only
14. I. Tetrahedral II. trigonal pyramidal III. trigonal planar IV. angular V. linear. With reference to I – V above the shapes of water, beryllium dichloride, ammonia and boron trifluoride are respectively. (a) IV, V, II and III (b) I, II, III and IV (c) V, IV, III and I (d) II, III, IV and V
15. 100cm^3 of each of 1 mol/dm^{-3} solutions of Sodium trioxocarbonate (iv) and hydrochloric acid are made to react with each other. Determine the stoichiometry of sodium trioxocarbonate (iv) to that of hydrochloric acid. (a) 1:3 (b) 2:1 (c)1:1 D 1:2

16. I. β-particle II. γ-ray III. α-particle, which of these will penetrate both sheet of paper and 2mm thick of alumimium. (a) I and II only (b) I and III only (c) II only (d) I, II and III only.
17. I. CH_4 II. BF_3 III. NH_3 IV. $BeCl_2$ V. H_2O. In which of these is the central atom not subjected to excitation before hybridization. (a) I, II and IV only (b) III and IV only (c) I, II and III only (d)III, IV and V
18. I. principal quantum number II. Azimuthal quantum number III. magnetic quantum number IV. spin quantum number. Which of the above respectively; (a) divides shells into orbitals and (b) corresponds with the energy derived from the orientation of electron in space? (a) I and II (b) I, II and IV (c) III and IV (d) II and III
19. I. 3-methylhex-2-ene II. 3-methylhex-3-ene III. 2-ethylpent-1-ene. Which of the above is /are formed when 3-chloro-3-methylhexane is heated with alcoholic KOH. (a)I and II only (b) I, II and III only (c) I and III only (d) II and III
20. $200cm^3$ of $0.100M\ AgNO_{3_{aq}}$ and $250cm^3$ of $0.100M\ CaCl_{2(aq)}$ are mixed. What is the mass of the precipitate that will be formed in the reaction.[Ag=108; Cl=35.5] (a) $2.77g$ (b) $2.57g$ (c) $2.87\ g$ (d) $2.67\ g$
21. Carbon burns in oxygen to give two oxides: I. $C_{(s)} + ½O_{2(g)} \rightarrow CO_{(g)}$; $\Delta H = -111KJ$ (ii) $C(s) + O_{2(g)} \rightarrow CO_{2(g)} \Delta H = -394$ KJ. What will be the value of ΔH for the reaction $CO_g + ½O_{2_g}$ CO_{2_g} (a) -505KJ (b) +505KJ (c) -283KJ (d) +283 KJ
22. 

I. pauli Exclution principle II. Aufbau principle III. Hund's rule of maximum Multiplicity. Which of these is /are disobeyed by the above filling of orbitals? (a) II and III (b) I, II and III (c) I and III (d) I only
23. I. The mass of a proton is one-twelfth the molar mass of carbon II. The mass of a proton is 1840 times the mass of an electron III. The mass of a proton is 1.0008g. Which of these statements is/are false of a proton? (a) II and III (b) I and III (c) I only (d) II only.
24. I. Diffusion of a coloured solution II. Sublimation III. Dilution of coloured crystal IV. Brownian motion. Which of these cannot be used to justify the particulate nature of matter? (a) II only (b) I, II and III (c) I and III only (d) I only
25. What is the chemical formula of the compound containing $.6.02 \times 10^{23}$ atoms of hydrogen; $35.5g$ of chlorine; and 4moles of oxygen atoms. [H=1; Cl= 35.5; O=16] (a) HCl_4O (b) $HClO_4$ (c) $HClO$ (d) HCl_2O_4
26. Consider the following molecular equation. $6Cl_{2(g)} + 6Ca(OH)_{2(aq)} \rightarrow Ca(ClO_3)_{2(aq)} + 5CaCl_{2(aq)} + 6H_2O_{(l)}$
The coefficient of ClO_3^- in the balanced net ionic equation is. A 3 (b) 6 (c) 1 (d) 2
27. The position of a condenser fitted to a reaction system or a liquid mixture can be described as: I. horizontal II. vertical III. slanting. Which of these descriptions is applicable to an organic reaction under reflux? (a) none (b) I (c) II (d) III
28. The representation Na + Cl → NaCl implies one atom of each of sodium and chlorine reacting. What charge(s) are carried by Na and Cl respectively, as written? (a) +, + (b) −, − (c) +, − (d) none, none
29. Constant boiling is a necessary but not sufficient criterion for the purity of a liquid means; I. if a liquid is pure it will boil at a constant temperature II. An impure liquid does not boil at a constant temperature III. A constant boiling liquid may not be pure IV. A constant boiling mixture is azeotropic. (a) I, II and III only (b) I, and II only (c) I, only (d) I and III only
30. The following are the isomeric dichloropropanes.



Which of them will give rise to three trichloro derivatives? (a) II and IV only B I, and III only (c) I, only (d) II only
31. Sodium in liquid ammonia just saturated with ethyne produces. (a) $Na(H)C = CH_2$ (b) $Na(H)C = C(H)Na$ (c) $NaC \equiv CH$ (d) $NaC \equiv CNa$
32. $12cm^3$ of butane and $100cm^3$ of oxygen at room temperature and pressure are combusted. Determine the volume, in cm^3, of gaseous mixture after bringing them to the original conditions of measurements. (a) 75 (b) 70 (c) 80 (d) 85

SOLUTION

1. $XCO_2 + 2HCl \rightarrow XCl_2 + H_2O + CO_2$

$$\cap_{CO_2} = \frac{vol\ at\ s.p.t}{22.4dm^3/mol} = \frac{240cm^3}{22400cm^3/mol}$$

$$\cap_{XCO_2} = \frac{1\ mol\ of\ XCO_2}{1\ mol\ of\ CO_2} \times 0.0107 mol\ of\ CO_2$$

$= 0.0107 mol$

$$\cap_{XCO_2} = \frac{Reacting\ mass}{Molar\ mass}$$

$$\cap_{XCO_2} = \frac{1.2g}{0.0107mol} = 112g/mol$$

The correct option is A

2. $\frac{t_1}{t_2} = \sqrt{\frac{m_1}{m_2}}$ Graham's law of diffusion (provided volume remain the same).

$\frac{7.5}{10} = \sqrt{\frac{m_A}{28}}$

$0.75^2 = \frac{m_A}{28}$

$M_A = 0.75^2 \times 28 = \frac{15.75g}{mol} \cong 16g/mol$

The correct option is B

3. PV = K

Since Boyle's law contain only volume and pressure, the assumption of the kinetic theory of gas that are relative to volume and pressure are needed/required to uphold Boyle's law. Assumption (i) & (ii) are not needed in upholding Boyle's law.

The correct option is D

4. Isomers have the same molecular formula but different structural formula. Their physical properties always differ but their chemical properties are the same if they are not functional isomers. Their chemical properties differ only when they are functional isomers.

The most correct option is A but with condition.

5. $^{232}_{90}A \rightarrow ^{228}_{88}B + ^{4}_{2}He$

$^{228}_{88}B \rightarrow ^{228}_{89}C + ^{0}_{-1}e$

$^{228}_{89}C \rightarrow ^{224}_{87}D + ^{4}_{2}He$

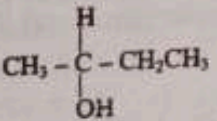
$^{224}_{87}D \rightarrow ^{224}_{88}E + ^{0}_{-1}e$

Hence, $p \rightarrow ^{4}_{2}He(\alpha)$, $q \rightarrow ^{0}_{-1}e(\beta)$, $r \rightarrow ^{4}_{2}He(\alpha)$ and $s \rightarrow ^{0}_{-1}e(\beta)$

The correct option is B

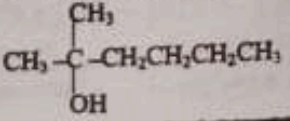
6. For a compound to be optically active (i.e. rotate the plane of polarized light), it must have at least one chiral centre. A chiral centre is a carbon atom surrounded by four different groups.

i

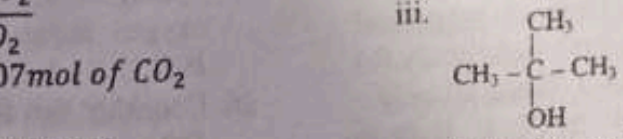


Butan-2-ol (It has a chiral centre)

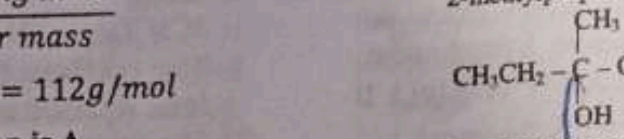
ii



iii.



2-methylpropan-2-ol (No chiral centre)



3-methylpentan-3-ol (No chiral centre)

The correct option is C

7. $I_{H_2} = \frac{4.00g}{2g/mol} = 2mol$

$PV = nRT$

$v = \frac{I\ RT}{P} = \frac{2 \times 0.082 \times 300}{2} = 24.6 litres$

No of molecules of $H_2 = 2 \times 6.02 \times 1023$

$= 1.204 \times 1024$

At room temperature (27^0C) hydrogen exists as molecules.

The correct option is B

8. Write the chemical equation of the combustion of methane, carbon and hydrogen for one mole of each of methane, carbon and hydrogen.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ $\Delta H = -89kJ/mol$

$C + O_2 \rightarrow CO_2$ $\Delta H = -398kJ/mol$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H = -286kJ/mol$

The equation of formation of methane is $C + 2H_2 \rightarrow CH_4$. Hence re-arrange the equation of combustion of CH_4, C & H to form the equation of formation of methane. To do this, reverse equation 1 and multiply equation 3 by 2. Add the equations together. Note that if an equation is reverse the sign of ΔH is also reverse, while if an equation is multiplied by a factor, ΔH is also multiply by that factor.

$CO_2 + 2H_2 \rightarrow CH_4 + 2O_2\ \Delta H = 891kJ/mol$...(i)

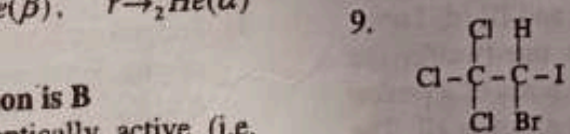
$C + O_2 \rightarrow CO_2\ \Delta H = -393kJ/mol$...(ii)

$2H_2 + O_2 \rightarrow H_2O\ \Delta H = 2(-286kJ/mol)$

$C + 2H_2 \rightarrow H_2O\ \Delta H = -393kJ/mol$

The correct option is A

9.



2-bromo-1,1,1-trichloro-2-iodoethane

The correct option is A

10. $\ddot{O} = C = \ddot{O}$

The carbon atom in CO_2 is sp-hybridize. The outermost orbital of oxygen is the p orbital. Hence the sigma bond between C and O is sp – p. the pie bond between C and O will be p-p laterally overlapped orbital. Hence the overlapping orbital in CO_2 are sp-p (linearly opposed) & p-p (parallel).

The correct option is A

11. Retention time and chromatographic tank are used in column chromatography. While mobile and stationary phase are use in both paper and column chromatography.

The correct option is C

12. The physical properties of the components of a mixture that is employed in separating the mixture is called the principle of separation. While the type of separation technique used is called the method of separation. For example in the separation of $KClO_3$ and KCl. The method of separation is fractional crystallization while the principle of separation is the solubility's of the solutes at different temperature.

The correct option is A

13. Metallic character, atomic volume, atomic radius and ionic radius all decreases across the period and increase down the group. While electronegativity, election affinity and ionization energy increases across the period and decrease down the group. Note that atomic number and mass number increases across the period and increases down the group.

The correct option is B

14.

Molecules	Shapes
H_2O	Angular
$BeCl_2$	Linear
NH_3	Trigonal pyramidal
BF_3	Trigonal plamar

The correct option is A

15. $\cap_{Na_2CO_3} = \left(\frac{100}{1000}\right) dm^3 \times 1 moldm^{-3}$

$= 0.1mol$

$\cap_{HCl} = \left(\frac{100}{1000}\right) dm^3 \times 1 moldm^{-3} = 0.1mol$

$\cap_{Na_2CO_3} : \cap_{HCl}$

$0.1 : 0.1$

$1 : 1$

The correct option is C

16. A gamma ray penetrates both sheet of paper and 2mm thick aluminum but stopped by lead block.

The correct option is C

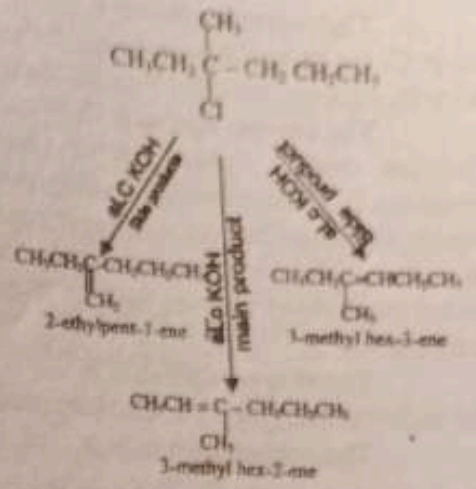
17. In CH_4, BF_3 and $BeCl_2$ excitation occur before bonding while NH_3 and H_2O there is no excitation before bonding.

The correct option is E meaning that none the option is correct.

18. Subsidiary quantum number divide subshell into orbitals while the magnetic quantum number deals with the energy derived from the orientation of election in space.

The correct option is D

19.



The correct option is B

20. $2AgNO_3 + CaCl_2 \rightarrow 2AgCl + Ca(NO_3)_2$

$\cap_{AgNO_3} = \left(\frac{200}{1000}\right) \times 0.1 = 0.02mol$

$\cap_{CaCl_2} = \left(\frac{250}{1000}\right) \times 0.1 = 0.025mol$

$\cap_{AgNO_3} : \cap_{CaCl_2}$

$\frac{0.02mol}{2} : \frac{0.025mol}{1}$

$0.01 : 0.025$

The limiting reagent is $AgNO_3$

The excess reagent is $CaCl_2$

$\cap_{AgNO_3} = 2(0.01) = 0.02mol$

R.M.M of $AgCl = 143.5g/mol$

Mass of AgCl formed $= 0.02 \times 143.5 = 2.87g$

The correct option is C

21. $CO \rightarrow C + \frac{1}{2}O_2 \quad \Delta H = 111kJ/mol$

$C + O_2 \rightarrow CO_2 \quad \Delta H = -394kJ/mol$

$CO + \frac{1}{2}O_2 \rightarrow CO_2 \quad \Delta H = -283kJ/mol$

The correct option is C

22. Aufbau and pauli's exclusion principle.

The correct option is E

23. A proton is 1840 times the mass of an electron.

The correct option is B

24. Particulate nature of matter are justify by
    i. diffusion of colour crystal
    ii. Sublimation
    iii. Dilution of colour solution
    iv. Brownian moton

The correct option is C

25. $I_{Cl} = \frac{35.5}{35.5} = 1mol$

$I_{O_4} = 4moles$

Hence the compound is $HClO_4$

The correct option is B

26. $6Cl_2 + 12OH^- \rightarrow 2ClO^-_3 + 10Cl^- + 6H_2O$

The correct option is D

27. Reflux means condensation in vertical position.

The correct option is C

28. Na & Cl are neutral species hence they do not carry charges.

The correct option is D

29. Constant boiling points is a necessary condition for determine the boiling points of liquids substance but not sufficient conditions or criteria. This is because certain mixture called Azeotropic mixture boil at a constant temperature.

The correct option is D

30. (ii) and (iv) will give three trichloro products

The correct option is A

31. $H-C=C-H+2Na \xrightarrow{liq.NH_3} Na-C\equiv C-Na$

The correct option is D

32. $C_4H_{10} + 13/2O_2 \rightarrow 4CO_2 + 5H_2O$

Vol of O_2 used up = 13/2 x 12 = $78cm^3$

Vol of CO_2 formed = 4 x 12 = $48cm^3$

Vol of O_2 left after reaction = 100-78 = $22cm^3$

Volume of gaseous mixture = 48+22 = $70cm^3$

The correct option is B

2007/2008 CHEMISTRY 001 TEST

1a. 0.24g of Magnesium completely reacted with Hydrochloric acid to liberate $224cm^3$ of Hydrogen at s.t.p.

(i)Use these results to obtain the stoichiometry of the reaction between Magnesium and H^+ from the acid.

(ii)Obtain the equation for the reaction between magnesium and hydrochloric acid. [Mg = 24; H=1; molar volume of gas = $22.4dm^3$ at s.t.p]

b. Each of the following assumption in the kinetic Theory of gas has an implication on the property of gas. Relate each assumption to specific implication.

(i) The actual space occupied by the gas molecules is negligible compared to the volume of the gas.

(ii) Forces of attraction and repulsion between molecules are negligible.

(iii)Collisions between molecules are perfectly elastic.

c. For H_2O molecule:

(i) Is the ground state electronic configuration subjected to excitation before bonding? Yes or No

(ii) Give a reason for your answer in (i)

(iii)Whether the orbital are used, excited or not excited, draw these orbitals together with their shape on the said atom.

(iv)Which of the orbitals, shown in (iii) is not actually used?

(v) Name the orbitals that are used.

2(a) For each of the following mixtures, state one physical property which could be used as the basis for their separation.

(i) Sodium Chloride and Sodium trioxonitrate (V)

(ii) Kerosene and water

(iii) Components of black ink.

b. Given that the heat of combustion of ethyne $(C_2H_2) = -1300kJ$, Carbon graphite (c) = $-398.5kJ$, Hydrogen = $-285.8kJ$. Calculate the heat of formation of ethyne.

c. Use the Avogadro constant to calculate the number of tetraoxosulphate (VI) ions in 3 moles of Aluminium tetraoxosulphate (VI). Leave your answer in standard form. [N_A = 6.02×10^{23} particles/mole].

d. Below is part of a radioactive decay chain:

Stage I stage II stage III

$$^{239}_{92}U \rightarrow {}^{239}_{93}Np + x \rightarrow {}^{239}_{94}Pu + y \rightarrow {}^{235}_{92}U + z$$

Write the appropriate nuclear equation for each stage and identify x, y and z.

3a. Considering the CO_2 molecule give the:

(i) Hybridization of the central atom.

(ii) Overlapping orbitals and their orientations.

(iii) Bond angle of the molecule.

b. What is the value of x in the molecular formula, $Pb(NO_3)_x$, if the percentage by mass of nitrogen in the compound is 8.46%? [Pb = 207; N = 14; O = 16].

c(i)Consider an element with the electronic configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$. State the group, period and block in the Periodic Table to which it belongs.

(ii) Why can't we have a 3f orbital?

Which orbital has n = 3 and $\ell = 2$

d(i)If a gas diffuses at a rate half as fast as oxygen, find the molar mass of the gas.

(ii) Given the relationship: $\Delta G = \Delta H - T\Delta S$. what can you say of a reaction for which ΔH is negative and greater than $T\Delta S$.

SOLUTIONS

1. R.M.M. of Mg = 24g/mol

R.M.M. of H_2 = 2g/mol

$$\cap_{H_2} = \frac{\text{vol at s.t.p}}{22.4dm^3/mol} = \frac{224cm^3}{22400cm^3/mol} = 0.01mol$$

$$\cap_{Mg} = \frac{\text{Reacting mass}}{\text{Molar mass}} = \frac{0.24g}{24g/mol} = 0.01mol$$

$\cap_{Mg} : \cap_{H_2}$

$0.01mol : 0.01mol$

$1 : 1$

It implies that 1 mole of Mg produced 1 mole of H_2.

Therefore 1mole of Mg require 2mole of H^+ i.e.

$Mg_{(s)} + 2H^+_{(aq)} \rightarrow Mg^{2+}_{(aq)} + H_{2(g)}$

(ii) $Mg_{(s)} + 2H^+_{(aq)} \rightarrow Mg^{2+}_{(aq)} + H_{2(g)}$

1b. Implications of the assumptions

(i) Gases can be compressed

(ii) Gas molecules can occupy any available spaces.

(iii) It means that no energy is lost on collision and hence, gas molecules will continue their motion indefinitely.

1c.(i) No

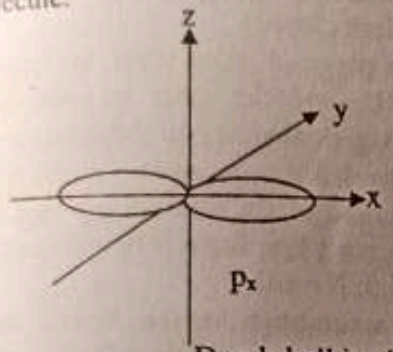
(ii) $1s^2 2s^2 2p^4$ electronic configuration

1s	2s	2p		
↿⇂	↿⇂	↿⇂	↿	↿

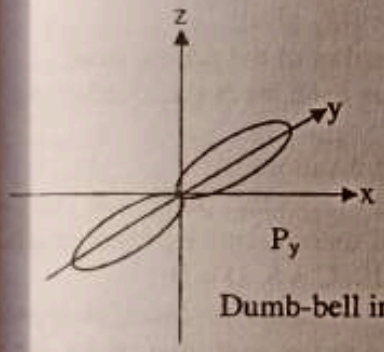
Orbital diagram

The p-orbital require two electrons to be filled. These two electrons are provided by the two hydrogen atoms. Hence oxygen atom does not require excitation before bonding in a water molecule.

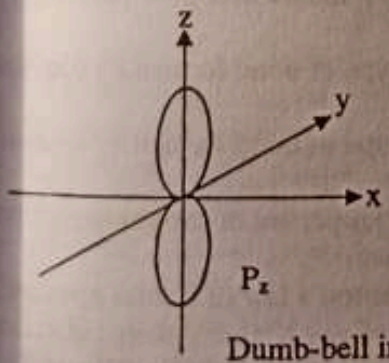
(iii)



Dumb-bell in shape

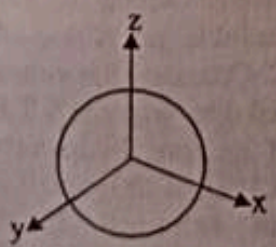


Dumb-bell in shape



Dumb-bell in shape

A P-orbital in an x,y,z-cartessian axes



Spherical in shape

S-orbital in an x,y,z-cartessian axes

(iv) The 1s-orbital

(v) The 2s and 2p-orbitals

2a(i)Difference in solubility

(iii)Immiscibility of the solvents or difference in densities

(iv)Rate of migration of solute on absorbent medium

2b. $C_2H_2 + \frac{5}{2}O_2 \rightarrow 2CO_2 + H_2O \quad \Delta H = -1300kJ$

$C + O_2 \rightarrow CO_2 \quad \Delta H = -398.5kJ$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O \quad \Delta H = -285.8kJ$

Reversing equation I

$2CO_2 + H_2O \rightarrow C_2H_2 + \frac{5}{2}O_2 \quad \Delta H = 1300kJ$

$2C + 2O_2 \rightarrow 2CO_2 \quad \Delta H = 2(-398.5kJ)$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O \quad \Delta H = -285.8kJ$

$2C + H_2 \rightarrow C_2H_2 \quad \Delta H = 217.2kJ$

The heat of formation of ethyne (C_2H_2) is 217.2kJ/mol

2c. $3Al_2(SO_4)_3 \rightarrow 6Al^{3+} + 9SO_4^{2-}$

No of mole of SO_4^{2-} ($\cap_{SO_4^{2-}}$) = 9moles

$$\cap_{SO_4^{2-}} = \frac{No\ of\ ions\ of\ SO_4^{2-}}{6.02 \times 10^{23}\ ions/mol}$$

$$No\ of\ ion\ of\ SO_4^{2-} = \cap_{SO_4^{2-}} \times 6.02 \times 10^{23} ions/mol$$

$$= 9mol \times 6.0 \times 10^{23} ions/mol$$

$$= 5.418 \times 10^{23} ions.$$

Stage 1

$$^{239}_{92}U \rightarrow {}^{239}_{93}Np + {}^{0}_{-1}e \rightarrow$$

Stage 2

$$^{239}_{92}Np \rightarrow {}^{239}_{94}Pu + {}^{0}_{-1}e \rightarrow$$

Stage 3

$$^{235}_{92}U + {}^{4}_{2}He$$

X = $^{0}_{-1}e$, Y = $^{0}_{-1}e$ and Z = $^{4}_{2}He$

3a(i) Sp (ii)

- S and P-orbital linearly Oriented
- P and P-orbital laterally oriented.

(iii) 180^0

3b.R.M.M of $Pb(NO_3)_x$=207+ x(14+40)

= 207 + 62x

$$\%\ of\ N = \frac{R.m.m\ of\ N}{R.m.m\ of\ Pb(NO_3)} \times \frac{100}{1}$$

$$8.46 = \frac{14x}{207 + 62x} \times \frac{100}{1}$$

$$8.46(207 + 62x) = 1400x$$

$$1751.22 = 1400x - 524.52x = 875.48x$$

$$X = \frac{1751.22}{875.40} = 2$$

The value of x is 2

3c. The highest quantum number is 3. Hence the element belongs to period 3.

The number of electrons in the highest principal quantum number is 5 (i.e. 2+3). Hence the element belongs to group 5.

The outermost electron of the element is found in the p-orbital. Hence the element is a p-block element.

Therefore the element belongs to group 5 and period 3 of the periodic table. Also it is a p-block element.

(ii) Electron with $\ell = 0,1,2$, and 3, are called s,p,d and f electrons. When $n = 3$, $\ell = 0, 1, 2$. This implies that when $n = 3$ there can only be s, p & d-orbitals only but not f-orbitals. This is because f-orbital is denoted by $\ell = 3$.

(iii) $n = 3$, $\ell = 2$ describes a 3d-orbitals.

3d. Let the gas be donated by X

$R_x = \frac{1}{2}RO_2$

$$\frac{R_x}{RO_2} = \frac{1}{2} = \sqrt{\frac{M_{O_2}}{M_x}}$$

1 square both side

$$\left(\frac{1}{2}\right)^2 = \frac{M_{O_2}}{M_x}$$

$$\frac{1}{4} = \frac{32}{M_x}$$

$M_x = 4(32) = 128$g/mol

The molar mass of the gas is 128g/mol

If ΔH is negative and $\Delta H > T\Delta S$ then $\Delta G > 0$ (i.e. positive) which means that the reaction is non-spontaneous.

2006/2007 CHEMISTRY 001 TEST

1. Give one line reason why:

(i) Hydrogen chloride is more volatile than hydrogen fluoride.

(ii) Oxygen hydride is a liquid while sulphur hydride is a gas

(iii) To get Cu in the reaction, $CuO + H_2 \xrightarrow{\Delta} Cu + H_2O$, the source of heat must be withdrawn long before the supply of hydrogen is cut off.

(b) What is the implication of each of the statements below?

(i) Cathode rays are observed to cast a shadow when they fall on an object

(ii) Cathode rays can impact a mechanical motion on a tiny paddle.

(c) (i) An element M has three naturally occurring isotopes, ${}^{2}_{x}M$, ${}^{3}_{x}M$, ${}^{5}_{x}M$, if ${}^{2}_{x}M$, and ${}^{3}_{x}M$ occur with equal percentage abundances and the average relative atomic mass of element M is 3.50. Calculate the percentage abundance of the isotope ${}^{5}_{x}M$.

(ii) State two limitations of Bohr's model of atom.

(d) Diborane reacts with water according to the equation, $aB_2H_6 + bH_2O \rightarrow cH_3BO_3 + dH_2$

(i) If $a = 1$ what are the values of b, c, and d

(ii) Given that 5.24g of Diborane reacts with 19.62g of water, how many moles of boric acid are produced? [B = 11, H = 1, O = 16]

2.(a) State the method(s) you will adopt to separate the following mixtures;

(i) NaCl and $CaCO_3$ (ii) Kerosene and water (iii) mixture of petroleum products (iv) KNO_3 and $KClO_3$.

(b)(i) Beta particle emission by atom A produced atom B. Alpha particle emission by atom B gave atom C. Identify the nuclei B and C.

(c) Give the formula of:

(i) Calcium hydrogen trioxocarbonate (iv)

(ii) Aluminium carbide

(d)(i) Two plugs of glass wool, are soaked into conc. NH_3 and the other in conc. HCl, are placed simultaneously at opposite ends of a long tube 1.5 meters apart. Obtain the whole number ratio of the distance covered by NH_3 HCl when a white fume is first noticed [H = 1, Cl = 35.5; N = 14]

(ii) Which assumption in the kinetic theory of gases can be used to explain the fact that gases can be compressed?

(e) For molecule BF_3 give;

(i) The hybridization of the central atom

(ii) The orbital on each atom that overlap plus any orientation

(iii) The shape of the molecule

3.(a). You are provided with the following elements and their atomic numbers as follows; A = 16, B = 12, C = 8, D = 11

(i) Arrange the elements in order of increasing atomic size / radius and give reason for your answer.

(ii) Name the type of bond formed by combination of A and B

(iii) Name the type of bond formed by combination of C and D

(iv) State three properties of the compound formed in (iii) above

(b). (i) State Dalton's law of Partial pressure.

(ii) A mixture of gas X and Y were collected over water at a pressure of 745mmHg at 15°C. If the pressure of Y at 15°C is twice the vapor pressure of water which is 13mmHg, and 100cm^3 of insoluble gas X was collected over water at 15°C. Calculate the volume of the dry gas X collected over water at S.T.P.

(c). 0.202g of gaseous hydrocarbon gave on combustion 0.361g of CO_2 and 0.147g of H_2O. What is the empirical formula of the compound? [C = 12, O = 16, H = 1].

4.a (i) Explain what is meant by limiting reagent in a chemical reaction.

(iii) What is the percentage purity of a sample of zinc ore if a 91.50g sample of the impure ore produces 2.25g of hydrogen when it reacts with dilute hydrochloric acid?
[H = 1, Cl = 35.5, Zn = 65]

(b) State (i) Charles' law

(ii) Explain Charles' law using kinetic theory of matter.

(c) What are quantum numbers?

(i) Choose the set(s) of quantum numbers that correctly describe an electron in an atom from the following and state which electron is / are described by the quantum numbers.

(a) $n = 4, \ell = 4, m_\ell = 3, ms = \pm\frac{1}{2}$

(b) $n = 3, \ell = 2, m_\ell = -3, ms = -\frac{1}{2}$

(c) $n = 0, \ell = 0, m_\ell = 0, ms = +\frac{1}{2}$

(d) $n = 3, \ell = 1, m_\ell = 0, ms = -\frac{1}{2}$

Give reasons why others are wrong

(d) A mixture of $KClO_3$ and KCl weighing 33.08 g was strongly heated to give a residue of constant weight, 28.90 g. Calculate the percentage KCl in the mixture. [K = 39, Cl = 35.5, O = 16].

SOLUTIONS

1a.(i) The polar bond in HCl is weaker than the hydrogen bond in HF. The weaker the bond in a molecule the greater its volatility

(ii) The hydrogen bond in H_2O is stronger than the polar bond in H_2S

Note that the stronger the hydrogen bonds in a molecule, the greater the tendency of that molecule to exist as a liquid and the lesser the volatility of the substance but the higher the boiling point

(iii) To prevent the re-oxidation of copper by steam i.e.

(iv) $CuO + H_2 \xrightarrow{\Delta} Cu + H_2O$

1b.(i) Cathode rays traveled on a straight line

(ii) Cathode rays has mass

1c. R.M.M. of $M = m_1\alpha_1 + m_2\alpha_2 + m_3\alpha_3$

Where m_1, m_2 & m_2 are the mass number of the isotopes while α_1, α_2&α_3 are the fractions of the isotopes.

$3.50 = 2\alpha_1 + 3\alpha_2 + 5\alpha_3$

$\alpha_1 + \alpha_2 + \alpha_3 = 1$ (sum of all fractions)

But $\alpha_1 = \alpha_2$

$\alpha_1 + \alpha_1 + \alpha_3 = 1$

$2\alpha_1 + \alpha_3 = 1$

$\alpha_3 = 1 - 2\alpha_1$

$3.50 = 2\alpha_1 + 3\alpha_1 + 5(1-2\alpha_1)$

$3.50 = 2\alpha_1 + 3\alpha_1 + 5-10\alpha_1$

$3.50 = 5 - 5\alpha_1$

$5\alpha_1 = 5 - 3.50 = 1.50$

$\alpha_1 = \frac{1.5}{5} = 0.3$

$\Rightarrow \alpha_1 = \alpha_2 = 0.30$

$\alpha_3 = 1 - 2(0.3) = 1 - 0.6 = 0.4$

$\alpha_1 = \alpha_2 = 0.30$ or 30%

$\alpha_3 = 0.4 = 40\%$

Therefore the percentage of the abundance of the isotope ${}^{5}_{x}M$ is 40%

(ii).

- The model could not be applied successful to atoms or ions with more than one electron.
- The model could not explain satisfactory certain line structures observed in the spectra of hydrogen atom.
- The model specified the exact position and velocity of electron in an atom which is contrary to the uncertainty principle
- The model ignore the wave nature of electron
- The model does not give the reason why a stable orbital where the electrons do not radiate energy was chosen

1d.(i) $aB_2H_6 + bH_2O \rightarrow cH_3BO_3 + dH_2$

Let a=1

$B \Rightarrow 2 = c$

$H \Rightarrow 6 + 2b = 3c + 2d$

$O \Rightarrow b = 3c$

$b = 3(2) = 6$

$6 + 2b = 3c + 2d$

$6 + 2(6) = 3(2) + 2d$

$6 + 12 = 6 + 2d$

$18 - 6 = 2d$

$12 = 2d$

$d = 6$

$a = 1, b = 6, c = 2$ and $d = 6$

$B_2H_6 + 6H_2O \rightarrow 2H_3BO_3 + 6H_2$

(ii) R.M.M. of $B_2H_6 = 28g/mol$

R.M.M. of $H_2O = 18g/mol$

No of mole of $B_2H_6 (I_{B_2H_6})$

$= \frac{\text{Reacting Mass}}{\text{Molar Mass}}$

$= \frac{5.24g}{28g/mol} = 0.1871mol$

No of mole of H_2O (I_{H_2O})

$= \frac{19.62g}{18g/mol} = 1.0900mol$

$\cap B_2H_6$:	$\cap_{H_2O}$
$\frac{0.1871}{1}$	$\frac{1.09}{6}$
0.1871	0.1817

H_2O is the limiting reagent, since it has the smallest numbers of moles

$I\ H_3BO_3 = \frac{2 \text{ mole of } H_3BO_3}{6 \text{ mole of } H_2O} \times 1.09 mol H_2O$

$= 0.3633mol$

The number of mole of boric acid produce is 0.3633mol

2a(i) Addition of water follow by filtration

(ii) Separating funnel

(iii)Fractional distillation

(iv)Fractional crystallization

2b. $^{231}_{90}A \rightarrow ^{231}_{91}B + ^{0}_{-1}e$

$^{231}_{91}B \rightarrow ^{227}_{89}C + ^{4}_{2}He$

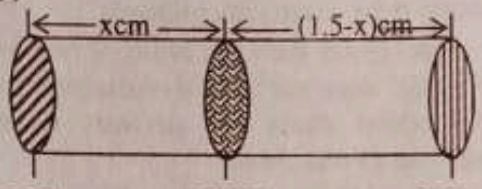
$^{231}_{91}B$ is protactinium

$^{277}_{89}C$ is actinium

2c (i)$Ca(HCO_3)_2$

(ii)Al_4C_3

2d(i)



NH_3 NH_4Cl HCl

The rate of diffusion of NH_3 = (x/t)cm/s

The rate of diffusion of HCl = (1.5-x/t)cm/s

$$\frac{R_{NH_3}}{R_{HCl}} = \sqrt{\frac{M_{HCl}}{M_{NH_3}}}$$

$$\frac{\frac{x}{t}}{\frac{1.5-x}{t}} = \sqrt{\frac{36.5}{17}}$$

$$\frac{x}{1.5-x} = 1.4653$$

The ratio of the distance covered by NH_3 to HCl is 1.4653

(iii)The actual volume occupied by the gas molecules is negligible compared with the volume of the container.

2e (i) Sp^2

(ii)

- Sp^2 and P-orbital linearly oriented
- P and p –orbital laterally oriented

(iii)Trigonal planar

3a(i) $C < A < B < D$

Reason: Atomic radius decreases with increase in nuclear charge

(ii) Ionic bond

(iii)Ionic bond

(iv)It has high melting point and boiling point

(v) It is a solid at room temperature

(vi)It is soluble in water

3b(i) It states that when there is a mixture of gases that do not react chemically together, then the total pressure exerted by the mixture is the sum of the partial pressure of the individual gases that make up the mixture.

(ii) $P_T = 745mmHg$

$T = 15^0C = 288k$

$P_Y = 2(13mmHg) = 26mmHg$

$V_1 = 100cm^3$

$T_2 = 273k$

$V_2 = ?$

$P_2 = 760mmHg$

$P_T = P_x + P_y + PH_2O$

$745 = P_x + 26 + 13$

$745 - 26 - 13 = P_x$

$P_x = 706mmHg$

$P_1 = P_x = 706mmHg$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{706 \times 100 \times 273}{760 \times 288}$$

$= 88.0565cm^3$

$\simeq 88.06cm^3$

3c. Mass of C in 0.361g of CO_2 =

$$\frac{12g/mol}{44g/mol} \times 0.361g$$

$= 0.0985g$

Mass of H in 0.147g of H_2O =

$$\frac{2g}{18g/mol} \times 0.147g$$

$= 0.0163g$

C	:	H
$\frac{0.0985}{12}$		$\frac{0.0163}{1}$
0.0082		0.0163
1	:	2

Empirical formula of the hydrocarbon is CH_2

4a(i) A limiting reagent is a reagent which is first used up in a chemical reaction. It determines the amount of the product form and the amount of the rest reactant used up.

(ii) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

$$\cap_{H_2} = \frac{2.25g}{2g/mol} = 1.1250mol$$

$$\cap_{Zn} = \frac{1mol\ of\ Zn}{1mol\ of\ H_2} \times 1.1250mol\ of\ H_2$$

$= 1.1250mol$

$Mass\ of\ Zn = 65g/mol \times 1.1250mol$

$= 73.1250g$

%purity of zinc are =

$$\frac{73.1250g}{91.50g} \times \frac{100}{1} = 79.9180 \approx 80\%$$

(b)(i) Charles' law state that the volume of a gas is directly proportional to the absolute temperature provided pressure remains constants.

(ii)When a gas in a container is heated the molecules gain kinetic energy, move faster and collide more frequently with themselves and the wall of the container thereby increasing the pressure. To keep the pressure

constant, the increase pressure is then reduced with the aid of a movable piston, to its original value. This is done by allowing the piston to move upward, for the molecules of the gas to spread out, so that the molecules of the gas become as far apart as possible in order to minimize the collisions between the molecules and the wall of the container. The result is that, the volume increase due to the spreading out of the gas to compensate for the reduce pressure. Therefore at constant pressure, the volume of a gas is directly proportional to its absolute temperature which is in accordance to Charles law.

(c)(i) Quantum numbers are the numbers given to each energy level of an atom. They are four in number, which are:

Principal(n),Azimuthal or Subsidiary(ℓ), magnetic (m) and Spin(S) quantum numbers.

(ii) if:

(a) n=4,ℓ=0,1,2,3 then m=-3 to+3 and s=$\pm\frac{1}{2}$

(b) n=3,ℓ=0,1,2 then m = -2 to +2and s=$\pm\frac{1}{2}$

(c) n≠0,because it only takes integral values of 1,2,3...

(d) n=3,ℓ=0,1,2 then m= -2 to +2and s=$\pm\frac{1}{2}$

The correct options is D

(d) Mass of the mixture ($KClO_3$ + KCl) =33.08g

Let the mass of $KClO_3$ = xg

Then the mass of KCl = (33.08 −x)g

R.M.M of $KClO_3$ =122.50g/mol

R.M.M of KCl = 74.50g/mol

$2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$

No of mole of $KClO_3$ ($\cap_{KClO_3}$)

$$= \frac{reacting\ mass}{molar\ mass} = \frac{xg}{122.5g} = 0.0082x mol$$

No of mole of KCl produced ($\cap_{KCl}$)

$$= \frac{2 mole\ of\ KCl}{2\ mole\ of KClO_3} \times 0.0082x mole\ of\ KClO_3$$

$= 0.0082x mol$

Mass of KCl produced =

$No\ of\ mole\ of\ KCl \times Molar\ mass\ of\ KCl$;

$= 0.0082x mole \times 74.50\ g/mol = 0.6109xg$

But the sum of the Original mass of KCl in the Mixture and the mass of KCl form is 28.90g

$\Rightarrow (33.08 - x) + 0.6109x = 28.90g$

$33.08 - .3891x = 28.90$

$33.08 - 28.90 = .3891x$

$33.08 - 28.90 = 0.3891x$

$x = \frac{4.1800}{.0.3891} = 10.7427g$

The mass of $KClO_3$ in the mixture =10.7422g

The mass of KCl = (33.08 − x)g

= 33.08 − 10.7427 g = 22.3373 g

$$\%\ of\ KCl\ in\ the\ mixture = \frac{mass\ of\ KCl}{mass\ of\ the\ mixture} \times 10$$

$$= \frac{22.3373g}{33.08g} \times 100 = 67.53\%$$

2005/2006 CHEMISTRY 001 TEST

1(a) Name the separation techniques you will employ to effect the separation of the following binary mixtures

(i) Kerosene and diesel

(ii) Potassium chloride and potassium trioxochlorate (V)

(iii) Calcium trioxocarbonate (IV) and sodium trioxocarbonate (IV)

(b)i. Write the electronic configuration of the ion S^{2-}.

ii. What is the atomic number of the element that gives rise to the ion S^{2-}?

iii. Why is the energy of formation of S^{2-} ion favorable?

iv. Write down the formula of ammonium sulphate and name the type of bonds that exist in the salt.

(c)(i) State the conditions under which the assumptions of the Kinetic theory of gases are applicable to real gases

(ii) If 300cm^3 of oxygen diffused through an orifice in 12 seconds and 150cm^3 of gas X diffused through the same orifice in nine (9) seconds, calculate the relative molar mass of gas X [O=16].

(iii) The atomic number of elements A, B and C are 8, 11 and 17 respectively. What is the nature of bond exhibited by the compound: (i) AB (ii) BC and (iii) AC.

2(a)i. What are the main deductions made from Rutherford's alpha-particles scattering experiment?

(ii) Fe + S $\longrightarrow$ X

5.6g 3.2g

Fe + S $\xrightarrow{Heat}$ Y

5.6g 3.2g

From the equations above, give two difference between X and Y in a tabular form.

(iv) Which of the following increase(s) across the period: (i) Atomic radius (ii) Ionization potential (iii) Electron affinity (iv) Electronegativity (v) Metallic character

(b)i Copy and complete the following table as appropriate:

Molecules	Hybridization scheme of the central atom	Bond angle	Shape
CF_4			
CS_2			
PF_3			
PF_5			
BF_3			

(ii) Balance the following equation and identify Q

$$^{28}_{13}Al \longrightarrow {}^{28}_{14}Si + {}^{0}_{-1}Q$$

(iii)What is meant by half life of a radioactive element?

(c)(i) Balance the following reaction using any standard procedure

$Cl_{2(g)}+NaOH_{(aq)} \rightarrow NaCl_{(aq)}+NaClO_{3(aq)}+ H_2O_{(l)}$

(ii) $1.12dm^3$ of Chlorine gas at s.t.p. is bubbled into $100cm^3$ of 0.200M $NaOH_{(aq)}$. Calculate the mass of Sodium trioxochlorate (V) produced in the reaction [1 mole of gas occupies $22.4dm^3$ at s.t.p].

3(a) With the aid of graphical sketches only illustrate Charles law.

(iii). What are the changes you would observe in atomic number and mass number when a nuclide emits:.- (i) an alpha particle (ii) a beta particle (iii) a Gamma ray?

(iv) State the chemical and physical properties associated with ionic and covalent bonds.

(b)(i) A fixed mass of gas has a volume of $450cm^3$ at 25°C. What temperature rise would produce a 15% increase in volume of the gas if the pressure remains constant?

(ii) In tabular form only classify the following compounds as either ionic or covalent: NaH, CH_4, O_2, Li_2O, Na_2S, BF_3, NH_3 and $CC1_4$

(iii) Arrange the following in order of increasing ionic character F-H, B-H,C-H, O-H, S-H

(c) (i) 0.07g of a hydride of carbon occupies $56.0cm^3$ at S.T.P. When vaporized and contain 14.29% by mass of hydrogen. Calculate the molecular formula of the hydride [1 mole of gas occupies $22400cm^3$ at s.t.p].

(ii) Using the kinetic theory of matter explain Charles' law

(i) Write down the values of the four quantum numbers which describes the seventh (7^{th}) electron.

4(a) In accordance with Hund's rule, write down the electronic configurations and identify the periodic group for each of the atoms. (i) $^{16}_{8}A$ (ii) $^{14}_{7}B$

(b)(i) Identify and draw the shapes of all the orbitals described by the following quantum numbers. (a) n =2, ℓ=0 (b)n =5, ℓ=

(ii) What values for m and the spin quantum number could each electron have (Hint you may wish to provide your answers in a tabular form)

(iii)Find the volume occupied by 8.0g of oxygen under pressure of $6\times10^5 Nm^{-2}$ at a temperature of 37°C[O=16, R=8.2Jmol^{-1}k^{-1}]

(c) In a typical experiment for the preparation of methyl ethanoate, 23.41g of ethanoic acid was reacted with 40.00g of methanol to give 26.54g of methyl ethanoate according to the following equation:

$CH_3COOH_{(l)}+CH_3OH \rightarrow CH_3COOCH_3+H_2O$

(i) Determine which of the reagent is in excess and by how much?

(ii) Which of the reactants is the limiting reagent? [C=12,H=1.008,O=16.01]

(iii)Select from the following nuclides a pairs of (i) isotones (ii) isobars

(iii) Isoelectronics; $^{32}_{16}A^+, {}^{14}_{7}B, {}^{31}_{15}X^+, {}^{18}_{10}Z^{2-}, {}^{14}_{6}Y$

SOLUTION

1a.

(i) fractional distillation

(ii) Fractional crystallization

(iii)Filtration

1b.(i) $_{16}S^{2-} \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

(ii) 16

(iii)S^{2-} is more stable and has a lower energy than S atom from which it was form.

(iv)$(NH_4)_2\ SO_4$

Ionic bonds (between NH_4^+ & SO_4^{2-}), covalent bond (between S & O; and N & H) and co-ordinate bond (between NH_3& H^+)

1c. Low pressure and high temperature.

(ii) Rate of diffusion of oxygen (Ro_2) = $\frac{300}{12}cm^3/s = 25cm^3/s$

Rate of diffusion of gas x (Rx) = $\left(\frac{150}{9}\right)cm^3/s = \frac{50}{3}cm^3/s$

Graham's law state that:

$$\frac{Ro_2}{Rx} = \sqrt{\frac{Mx}{Mo_2}}$$

$Mo_2 = 32gl/mol$

$$\frac{25}{50/3} = \sqrt{\frac{Mx}{32}}$$

$\frac{25\times3}{50} = \frac{\sqrt{Mx}}{32}$

$\frac{3}{2} = \frac{\sqrt{Mx}}{32}$

Take the square of both sides

$\left(\frac{3}{2}\right)^2 = \frac{Mx}{32}$

$\frac{9}{4} = \frac{Mx}{32}$

$Mx = \frac{9\times32}{4} = 72g/mol$

(ii)

Elements	Electron configuration	Nature of element
A	$1s^2\ 2s^2\ 2p^4$	Non-metal
B	$1s^2\ 2s^2\ 2p^6\ 3s^1$	Metal
C	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$	Non-metal

Therefore:

AB is ionic (bond between a metal & a non-metal).

BC is ionic (bond between a metal & a non-metal).

AC is covalent (bond between two non-metals).

2a.(i) The assumption is that the atom is an empty space with a centrally dense portion called the nucleus where most of the mass of the atom is concentrated or located. The proton and neutron are found in the nucleus while electrons revolve around the nucleus.

(ii)

X	Y
1. It is a mixture	It is a compounds
2. It will form $FeCl_2$, H_2 and yellow deposit of S on addition of HCl	It will form H_2S, and $FeCl_2$ on addition of HCl

Note that Iron and Sulphur only react when they are heated together

(iv) Ionization energy, Electron affinity and Electronegativity

2b(i)

Molecules	Hybridization scheme of the central atom	Bond angle (deg)	Shape
CF_4	Sp^3	109.5	Tetrahedral
CS_2	Sp^2	180	Linear
PF_3	Sp^3	107	trigonal pyramidal
PF_5	Sp^3d	120,90	trigonal bipyramid
BF_3	Sp^2	120	trigonal planar

(ii) $^{28}_{13}Al \rightarrow {}^{28}_{14}Si + {}^{0}_{-1}e$

$^{0}_{-1}e$ is βeta particle $\left({}^{0}_{-1}\beta\right)$

(iii) The half life of a radioactive element is the time taken for half of the original sample of the radioactive element to disintegrate.

2c(i) $3Cl_{2(g)} + 6NaOH_{(aq)} \rightarrow 5NaCl_{(aq)} + NaClO_{3(aq)} + 3H_2O$

(ii) $\cap_{Cl_2}$

$= \frac{\text{vol of s.t.p}}{22.4dm^3/mol} = \frac{1.12dm^3}{22.4dm^3/mol} = 0.05mol$

$\cap_{NaOH}$ = vol.(dm^3) x molar conc(M)

= (100/1000)dm^3 x 0.2moldm^{-3} = 0.02mol

Divide the calculated moles with their co-efficient in the balance chemical equation. The smallest value, given the limiting reagent.

$\cap_{Cl_2}$: $\cap_{NaOH}$

0.05/3 0.02/6

0.0167 0.0033

The limiting reagent is NaOH

The excess reagent is Cl_2

$\cap NaClO_3$

= 1mole of $NaClO_3$ x 0.02mole of NaOH / 6mole of NaCl

= 0.0033mol.

The relative molecular mass of $NaClO_3$ = 106.5glmol

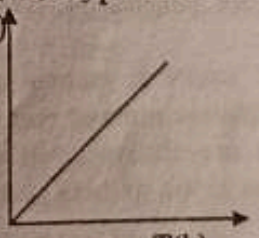
Mass of $NaClO_3$ produced = $\cap NaClO_3$ x 106.5g/mol

= 0.0033mol x 106.5glmol

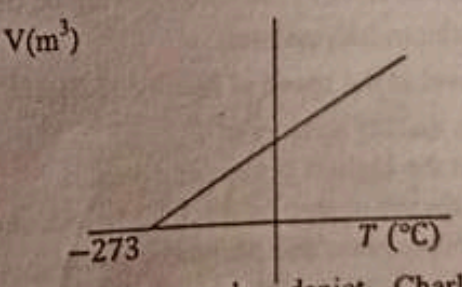
= 0.35145g.

The mass of $NaClO_3$ produced is 0.35g

3a(i) V(m^3)



and



Note that both graphs depict Charles law depending on the scale in which the temperature is measured.

(ii) If a nuclide emits an alpha particle it mass number will decrease by 4 and its atomic number by 2 e.g.

$^{31}_{15}P \rightarrow {}^{27}_{13}Al + {}^{4}_{2}He$

An Alpha particle ($^{4}_{2}He$) has the following properties.

- It is positively charge
- It is a heavy molecules
- It has a quality number of 20.(Quality number is the amount of a radioactive radiation which when absorb by a body produces harm)
- It travel at the speed of $\frac{1}{20}$ th the speed of light i.e. $1.5\times10^{7}\ m/s$
- It has a low penetrating power
- It causes the fluorescence of some substance (e.g. ZnS)
- It is absorb or stop by thin sheet of paper and
- It ionizes the molecule of air

If a nuclide emits a beta particular its mass number remains the same while it atomic number increases by 1 e.g. $^{23}_{11}Na \rightarrow {}^{23}_{12}Mg + {}^{0}_{-1}e$

A beta particle ($^{0}_{-1}e$ or $^{0}_{-1}\beta$) has the following properties.

- It is negatively charge
- It is a light particle
- It has a variable speed
- It is absorb or stop by thin sheet of Aluminium
- It produces a less ionization effect on the molecules of air and
- It has a higher penetrating power than the alpha particle.

If a nuclide emits a gamma-ray its mass number and atomic number remain the same. Gamma rays are always emitted along side with either an alpha or beta particle or both. e.g.

$$^{236}_{92}U \rightarrow {}^{232}_{90}Th + {}^{4}_{2}He + \gamma$$

A gamma ray (γ) has the following properties

- It is electrically neutral
- It travel at the speed of light i.e. $3.0\times10^{8}\ m/s$
- It has quality number of 1
- It has the highest penetrating power
- It is absorb or stop by thick lead block and
- It ionizes gases and penetrates matter.

(iii)Chemical properties associated with ionic bonding. They conduct electricity in the aqueous or molten state with a resultant decomposition to produce substance (elements or compound) when a direct current is passed through them. Besides, reactions involving ionic bonds are very fast because they exist as ion in aqueous solution.

Physical properties associated with ionic bonding.

1 They have high melting and boiling points.
2 They usually exist as solid at room temperature.
3 They are usually soluble in H_2O

Physical properties associated with covalent bonding.

1. They have low boiling and melting points.
2. They usually exist as volatile liquid or gases at room temperature.
3. They are usually insoluble in water but soluble in non-polar solvent.

Chemical properties associated with covalent bonding.

- Reaction involving covalent bond are very slow because of their covalent nature

3b(i) $V_1 = 450cm^3$ $T_1 = 25^0C = 298k$

$V_2 = V_1 + 15\%$ of V_1 $T_2 = ?$

$V_2 = 450cm + 15\%$ of $450cm^3$

$= 450cm^3 + 15/100 \times 450cm^3 = 450cm^3 + 67.50cm^3$

$V_2 = 517.50cm^3$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow T_2 = \frac{V_2T_1}{V_1}$$

$$T_2 = \frac{517.50cm^3 \times 298k}{450cm^3} = 342.70k$$

$T_2 = 342.70k$

Temperature rise $= T_2 - T_1$

$= 342.7 - 298 = 44.7k$

(ii)

Substance	Ionic	Covalent
CH_4		Covalent
NaH	Ionic	
O_2		Covalent
Li_2O	Ionic	
Na_2S	Ionic	
BF_3		Covalent
NH_3		Covalent
CCL_4		Covalent

(iii) C – H < B – H < S – H < O – H < F - H

The bonds show indicate the bonds form by hydride of the elements C, S, B, O & F. C and B form covalent hydride but the hydride of B is less covalent because it is metalloid

S, O and F form polar hydride, with F hydride having the strongest bond follow by O hydride while S hydride the least.

Relative molecules mass of hydride = $\frac{\text{mass of hydride}}{\text{No of mass of hydride}}$

∴ R.M.M of hydride = 28g/mol

% of hydrogen in hydride = 14.29%

% of carbon in hydride = 85.71%

Since the measurement is done in percentage, we have to consider 100g of the analyte.

Mass of carbon in 100g of hydride =

$\frac{85.71}{100} \times 100g = 85.71g$

Mass of hydrogen in 100g of hydride =

$\frac{14.29}{100} \times 100g = 14.2g$

C	:	H
$\frac{85.71}{12}$		$\frac{14.2}{1}$
7.1425		14.2
1	:	2

Empirical formula = CH_2

Let $(CH_2)n = 28$

$(12+2)n = 28$

$14n = 28$

$n = 2$

$(CH_2)n = (CH_2)2 = C_2H_4$

The molecular formula of the hydride is C_2H_4

(ii) When a gas in a container is heated the molecules gain kinetic energy, move faster and collide more frequently with themselves and the wall of the container thereby increasing the pressure. To keep the pressure constant, the increase pressure is then reduced with the aid of a movable piston, to its original value. This is done by allowing the piston to move upward, for the molecules of the gas to spread out, so that the molecules of the gas become as far apart as possible in order to minimize the collisions between the molecules and the wall of the container. The result is that, the volume increase due to the spreading out of the gas to compensate for the reduce pressure. Therefore at constant pressure, the volume of a gas is directly proportional to its absolute temperature which is in accordance to Charles law.

(iii) Let the atom be represented by $_7X$

$_7X \rightarrow 1s^2\ 2s^2\ 2p^3$

The seventh election is in the 2p – orbital. Hence

n	L	m	S
2	0	0	+½
	0	0	-½
	1	-1	+½
		-1	-½
		0	+½
		1	-½
		1	-½

n=2; l=0,1; m=-1,-0,1; $s=\pm\frac{1}{2}$

4a.(i) $^{16}_{8}A \rightarrow$ 1s: ↑↓ 2s: ↑↓ 2p: ↑↓ ↑ ↑

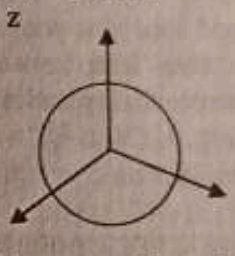
The element $^{16}_{8}A$ belong to period 2 and group 6 of the periodic table and it is a p-block element

(ii) $^{14}_{7}B \rightarrow$ 1s: ↑↓ 2s: ↑↓ 2p: ↑ ↑ ↑

The $^{14}_{7}B$ element belongs to period 2 and group 4 of the periodic table and it is a p-

4b.(i) $n = 2,\ \ell = 0$

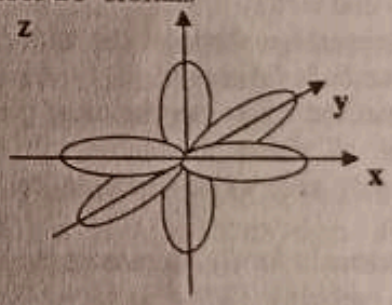
Describe 2s – orbitals



S-orbital in x, y, z- Cartesian co-ordinates

$n = 5,\quad \ell = 1$

Describes a P-orbitals



P-orbital in x, y, z Cartesian co-ordinate.

(ii) If $n = 2,\ \ell = 0$ then:

$M = 0,\ S = \pm ½$

If $n = 5, \ell = 1$ then

$M = -1, 0, +1$ and $S = \pm ½$

(iii) $\frac{\text{Reacting mass}}{\text{molar mass}} = \frac{8.0g}{32g/mol} = 0.25mol$

$Pv = nRT$

$V = \frac{nRT}{P} = \frac{0.25mol \times 8.2J/molk \times 310k}{6\times10^5 N/m^2}$

$V = 1.0592 \times 10^{-3} m^3$

4c(i) R.M.M of CH_3COOH = 60g/mol

R.M.M of CH_3OH = 32g/mol

R.M.M of CH_3COOCH_3 = 74g/mol

$I_{CH_3COOH} = \frac{23.41g}{60g/mol} = 0.3902mol$

$I_{CH_3OH} = \frac{40.00g}{32g/mol} = 1.2500mol$

1 $CH_3COOCH_3 = \frac{26.54g}{74g/mol} = 0.3586mol$

$CH_3COOH_{(L)} + CH_3OH_{(L)} \rightarrow CH_3COOCH_{3(L)} + H_2O$

0.3902mol 1.2500mol 0.3588mol

Since the reactant are mixed in 1:1

CH_3OH is the excess reagent.

Excess mole of CH_3OH =

1.2500mol – 0.3902mol

= 0.8598mol

Mass of CH_3OH =0.859mol x 32g/mol

= 27.4880g

(ii) The limiting reagent is CH_3COOH

(iii)Isotones have the same neutron number

$^{32}_{16}A^- \& ^{31}_{15}X^+; ^{18}_{10}Z^{2-} \& ^{14}_{6}Y$

Isobars have the same mass number

$^{14}_{7}B \& ^{14}_{6}Y$

(v) Ions, or atoms and ions that possess the same number of electrons and hence the same ground state electron configuration, are said to be isoelectronic e.g. $^{12}_{6}C$ and $^{14}_{6}C$

:. None of them is Isoelectronic

2004/2005 CHEMISTRY 001 TEST

1(a) Give the respective pattern of hybridization of the central atom in: CCl_4, NH_3, H_2O and $BeCl_2$

(b) Give the respective shape of the molecule of the compounds in (a) above

(c) State a method that can be used for the preparation of either a soluble salt or an insoluble salt and write equation for each preparation.

(d) Write the formula for (i) Aluminum nitride (ii) Aluminum carbide

(e) Give the IUPAC name for $Ca(HCO_3)_2$

(f) Consider the titrations according to the following equations:

i. $Na_2CO_3 + HCl \rightarrow NaHCO_3 + NaCl$

ii. $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

Also consider the following indicators:A- pH change 3-5; B - pH change 8-10

Pair indicators A and B with titrations I & II giving a reason for each choice.

(g) Two plugs of glass wool soaked one into conc. NH_3 and the other into conc. HCl are placed at opposite ends of a long tube at 150cm apart. Calculate the ratio of the distances covered by HCl and NH_3 just before noticing a white smoke [N = 14; Cl =35.5; H= 1].

2(a) State the logical' order of operations that will effect the separation of a mixture of K_2SO_4, NH_4Cl and $PbSO_4$ into the respective components.

(b) Iron fillings. 14g and Sulphur powder 8g are thoroughly mixed together. The mixture is divided into two parts A and B. Part B is heated in a test tube cooled and ground into powder. Explain with the 'aid of equations. Your observations when dilute HCl is added to A and heated B.

(c). Fill electrons into the orbitals of an element with z = 24. Comment briefly on your electronic structure

(d) What particle is produced from the decay of $^{31}P_{15}$ to $^{30}P_{15}$

(e) Predict the other product and write the balanced equation for bombardment of $^{9}_{4}Be$ with deuterium to produce $^{10}_{5}Be$

(f) Predict the entropy change for the following reaction.

(i) $C_2H_6(g) + \frac{7}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

(ii) $H^+ + OH^- \rightarrow H_2O(l)$

(g) 3.0g of a mixture of potassium trioxocarbonate (IV) and potassium chloride were dissolved in $250cm^3$ standard flask. $25cm^3$ of this solution required $40.00cm^3$ of a $0.1moldm^{-3}$ solution of HCl using methyl oranges as indicator, calculate the percentage of potassium trioxocarbonate.(V) in the mixture $[H = 1, C = 12, O = 16, Cl = 35.5; K = 39]$.

3.(a) Write the net ionic equation for the reactions:

$6Ca(OH)_2(aq) + 6Cl_2(g) \rightarrow Ca(ClO_3)_2(aq) + 5CaCl_2(aq) + 6H_2O(l)$

(b) Using chemical equations only, show whether an aqueous solution of Aluminum chloride is acid or alkaline

(c) The reaction between copper and aqueous solution of HNO_3 is represented as:

$Cu(s) + HNO_3 \rightarrow Cu(NO_3)_2(aq) + NO(g) + H_2O$ Write the balanced equation for the reaction (just one line answer). 6.40g of copper is dropped into $250cm^3$ of a $1.0\ moldm^{-3}$ HNO_3 determine the limiting reagent $[Cu = 64; H = 1; N = 14; O = 16]$

(d) Identify all the orbitals described by the following quantum numbers.

i. $n = 3, \ell = 0$

ii. $n = 4, \ell = 1$

What are the values for m and the spin quantum number for each electron?

HNT: you may wish to present your answer in tabular form

(e) Consider the following properties of gases: (i) gases can be compressed; (ii) gases continue their motion indefinitely (iii) gaseous

molecules will occupy any available space.

(e) Quote the assumption in the kinetic theory of gases that can be used to explain each of the above properties

(f) Balance the following equation: $O_{2(g)} \rightarrow O_{3(g)}$

(g) If the absolute entropies of oxygen and Ozone are 204.8 and 237.4 J mol^{-1} K^{-1} respectively, calculate standard entropy change in the reaction in the reaction cited.

(h) Which of the following experimental evidence can be used to explain the particulate nature of matter (i) sublimation (ii) dilution of coloured crystal (iii) diffusion of coloured solution?

SOLUTIONS

1a and 1b

Molecules	hybridization	shapes	Bond angles
CCl_4	SP^3	Tetrahedral	109.5^0
NH_3	SP^3	Trigonal pyramidal	107^0
H_2O	SP^3	Angular or bent or V-shape	105^0
$BeCl_2$	SP	Lnear	180^0

1c. Direct combination of constituent elements.

$2Fe_{(s)} + 3Cl_{2(g)} \rightarrow 2FeCl_3$(soluble salts)

$Fe_{(s)} + S_{(s)} \rightarrow FeS$ (insoluble salts)

1d. (i) AlN (ii) Al_4C_3

1e. $Ca(HCO_3)_2$ → calcium hydrogen trioxocarbonate IV

(i) Indicator B is suitable for titration I. This is because the resultant solution is alkaline due to the fact that the hydrolysis of $NaHCO_3$ gives alkaline solution.

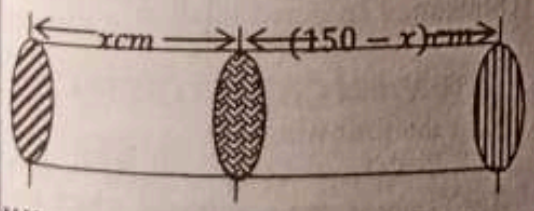
$NaHCO_3 + H_2O \rightarrow NaOH + H_2CO_3$

The use of indicator B is due to the fact that it is sensitive to alkaline medium as a result of its pH range i.e. $8 - 10$

(ii) Indicator A is suitable for titration II. This is because the resultant solution is acidic due to the presence of H_2O and CO_2 i.e. $H_2O + CO_2 \rightarrow H_2CO_3$

H_2CO_3 is a weak acid; hence an indicator with a pH range of $3 - 5$ is suitable.

1g.



NH_3 NH_4Cl HCl

Let the distance covered by $NH_3 (d_{NH_3}) = xcm$

Let the distance covered by $HCl\ (d_{HCl}) = (150 - x)\ cm$

Relative molecular mass of $NH_3 (M_{NH_3}) = 17 g/mol$

Relative molecular mass of $HCl\ (M_{HCl}) = 36.5 g/mol$

Rate of diffusion of $NH_3\ (R_{NH3}) = \left(\frac{x}{t}\right) cm/s$

Rate of diffusion of $HCl\ (R_{HCl}) = \left(\frac{150-x}{t}\right) cm/s$

According to Graham's law of diffusion

$$\frac{RHCl}{RNH_3} = \sqrt{\frac{MNH_3}{MHcl}}$$

$$\frac{dHCl}{dNH_3} = \sqrt{\frac{17}{36.5}}$$

$$\Rightarrow \frac{dHCl}{dNH_3} = 0.6825$$

The ratio of the distance covered by HCl to NH_3 is 0.6825.

2a. Sublimation (Thermal Dissociation)→ addition of water → filtration → evaporation to dryness.

2b. A →Is a mixture of Fe & S. When HCl is added, the reaction below occur

$$Fe + S + 2HCl \rightarrow FeCl_2 + H_2 + S$$

Observations

- A colourless gas (H_2) is given off
- A green solution ($FeCl_2$) is form
- A yellow deposits of sulphur (S) is form

B → Is a compound

$Fe + S + Heat \rightarrow FeS$

When HCl is added to the compound form, the reaction below occur

$FeS + 2HCl \rightarrow FeCl_2 + H_2S$

Observations

- A green solution ($FeCl_2$) is form
- A gas with a rotten eggs smells (H_2S) is liberated

2c. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

The element is a d-block metal or transition metal because its d-orbital is partially filled with electrons.

Note that the 4s-orbital contain only one electron for the 3d-orbital to contain five. This is because less than half or more than half filled orbital is less stable compare to half or fully filled orbital

2d. ${}^{31}_{15}P \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$

The particle produced is neutron

2e. ${}^{9}_{4}Be + {}^{2}_{1}H \rightarrow {}^{10}_{5}B + {}^{1}_{0}n$

Note that the symbol of deuterium is ${}^{2}_{1}H$ or ${}^{2}_{1}D$

The other product is neutron $\left({}^{1}_{0}n\right)$

2f. (i) Negative (ii) negative

2g. Mass of K_2CO_3 + KCl = 3.0g

Let the mass of K_2CO_3 = xg

Let the mass of KCl = (3-x)g

Volume of solution = $250cm^3$

Relative molecular mass of K_2CO_3 = 138g/mol

Relative molecular mass of KCl = 74.5g/mol

$K_2CO_3 + 2HCl \rightarrow 2KCl + CO_2 + H_2O$

No of mole of HCl ($\cap_{HCl}$)

=vol (dm^3)×molar conc.

$= \frac{40}{1000} dm^3 \times 0.1 mol.1m^{-3}$

= 0.004mol

No of mol of K_2CO_3 ($\cap K_2CO_3$) = $\frac{1 mol \text{ of } K_2CO_3}{2 \text{ mole of HCl}} \times 0.004 mol \text{ of HCl}$

= 0.002mol

$25cm^3$ of the solution contain 0.002mol of K_2CO_3

$250cm^3$ of the solution contain ymol of K_2CO_3

$\frac{25cm^3}{25cm^3} = \frac{0.002 mol}{ymol}$

$y = \frac{0.002 \times 250}{25} = 0.02mol$

No of mole of K_2CO_3 in the solution is 0.02mol

Mass of K_2CO_3 in the solution

$= I\ K_2CO_3 \times MK_2CO_3$

= 0.02mol x 138g/mol

= 2.76g

Mass of KCl = (3 – x)g = (3-2.76)g

= 0.24g

Percentage of $K_2CO_3 = \frac{2.76g}{3.0g} \times \frac{100}{1} = 92\%$

3a. $6Ca(OH)_{2(aq)} + 6Cl_{2(g)} \rightarrow Ca(ClO_3)_{2(aq)} + 5CaCl_{2(aq)} + 6H_2O_{(L)}$

Break all compounds in the aqueous state into their component ions, gases and liquid are never broken down.

$6Ca^{2+} + 12OH^- + 6Cl_{2(g)} \rightarrow Ca^{2+} + ClO_3^- + 5Ca^{2+} + 10Cl^- + H_2O_{(l)}$

Note that we deliberately remove the word aqueous from all ions because a species cannot carry charges except in aqueous medium. To form the net ionic equation we remove species that occur on both sides.

$12OH^- + 6Cl_{2(g)} \rightarrow 2ClO_3^- + 10Cl^- + 6H_2O_{(l)}$

Divide through by 2

$6OH^- + 3Cl_{2(g)} \rightarrow ClO_3^- + 5Cl^- + 3H_2O_{(l)}$

3b. $AlCl_3 + 3H_2O \rightarrow Al(OH)_3 + 3HCl$

An aqueous solution of $AlCl_3$ is acidic due to the presence of the strong acid, HCl. Though $Al(OH)_3$ is also a product but it is a very weak base.

3c. $3Cu_{(s)} + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$

No of mole of Cu($\cap$cu) =

$\frac{\text{reacting mass}}{\text{molar mass}} = \frac{6.4g}{64m/mol} = 0.1mol$

No of mole of HNO_3 = vol.(dm^3) x molar conc.

$= \left(\frac{250}{1000}\right) dm^3 \times 1.0 mol/dm^3$

= 0.25mol

To determine the limiting reagent, divides the calculated mole for Cu & HNO_3 with their coefficient in the balance equation(i.e the stoichiometry mole).

$\cap_{Cu}$	I_{HNO_3}
$\frac{0.1}{3}$	$\frac{0.25}{8}$
0.0333	0.0313

The smaller value gives the limiting reagent

Hence:

HNO_3 is the limiting reagent

Cu is the excess reagent

3d. An orbital is describes by the principal (n) and subsidiary (ℓ) quantum numbers. Electrons with $\ell = 0, 1, 2, 3$ are called s, p, d and f – electrons.

(i) $n = 3, \ell = 0$

Describe 3s-Orbital

(ii) $n = 4, \ell = 1$

Describe 4p-Orbitals

When $n = 3, \ell = 0, M = 0, S = \pm ½$

When $n = 4, \ell = 1, M = -1, 0, 1,$

$S = \pm ½$

3e.(i) The actual volume occupied by the gas molecules is negligible compared with the volume of the container.

(ii) The collision between the gaseous molecules is perfectly elastics.

(iii) The forces of attraction or repulsion between the molecules of a gas are negligible.

$3O_{2(g)} \rightarrow 2O_{3(g)}$

3f. $3/2O_{2(g)} \rightarrow O_{3(g)}$

$\Delta s = \Sigma Sp - \Sigma S_R$

=237.4J/molk –3/2x 204.8J/molk

= -69.8J/molk

3g. Sublimation

Note that, the other evidences should have been

(i) Diffusion of coloured crystal

(ii) Dilution of coloured solution

2003/2004 CHEMISTRY 001 TEST

1a. From the following list:

H_2O, $CaCO_3$, CCl_4, H_3NBF_3 $NaCl$ and $BeCl_2$ name one compound which contains (i) a coordinate covalent bond (ii) an electron deficient centre (iii) ionic bond predominantly (iv) ionic and covalent bond in the same molecule. Copy and complete the table

Species	Hybridization	Shape	Bond

	of central atom		ang le
BF_3			
H_2O			
CH_4			
NH_3			
$BeCl_2$			

(c) List the various inter-atomic bond(s) present in each of the following compounds/elements (i) Na_2SO_4 (ii) NH_4Cl (iii) Cu (iv) O_2

2a. Copy and complete the following table concerning the variation of the stated property.

Properties	Along the periods	Down the groups
(i) Atomic Number		
(ii) Ionization energy		
(iii) Electronegativity		
(iv) Metallic character		

(b) Consider the following nuclides (i) $^{14}A_6$ (ii) $^{14}B_7$ (iii) $^{15}C_8$ (iv) $^{12}C_6$ state which of them are (i) isotopes (ii) isobars (iii) isotones

(c) The relative atomic mass of element Z is 10.2 if the element exists naturally in two forms $^{10}Z_5$ and $^{11}Z_5$. Calculate the relative abundance of ^{10}Z

3a Name the techniques by which each of the following processes can be achieved

(i) Getting rid of impurities from a solid substance

(ii) Detection of the components in an organic mixture.

b. Give the formula for each of the following compounds

(i) Calcium hydrogentrioxocarbonate (IV)

(ii) Aluminium carbide

(iii) Ammonium trioxocarbonate (IV)

(c) $100cm^3$ of 1.0M solution of each of Lead (II) trioxonitrate (V) and Sodium chloride are mixed. Assuming that Lead (II) chloride is completely insoluble. Calculate the weight of Lead (II) chloride formed.

(d) Evaluate for a, b, x and y in the following balanced equation

$aFe_2O_3 + bC \rightarrow xFe + yCO_2$

SOLUTION

1a (i) H_3NBF_3 (ii) $BeCl_2$ (iii) NaCl (iv) $CaCO_3$

b.

Species	Hybridization of central atom	Shape	Bond angle
BF_3	Sp^2	Trigonal planar	120^0
H_2O	Sp^3	Bent, angular or v-shape	105^0
CH_4	Sp^3	Tetrahedral	109.5^0
NH_3	Sp^3	Trigonal pyramidal	107^0
$BeCl_2$	Sp	Linear	180^0

1c.

Species	Inter-atomic bonds
Na_2SO_4	Ionic and covalent
NH_4Cl	Ionic, covalent and dative bonds
Cu	Metallic bond
O_2S	Pure covalent bond

2a.

S/N	properties	Along the periods	Down the groups
i.	Atomic number	Increase	Increase
ii.	Ionization energy	Increase	Decrease
iii.	Electro-negativity	Increase	Decrease
iv.	Metallic character	Decrease	Increase

2b.I. Isotopes have the same atomic number e.g. $^{14}_{6}A$ & $^{12}_{6}D$

II. Isobars have the same mass number e.g. $=^{14}_{6}A$ & $^{14}_{7}B$

III. Isotones have the same neutron number e.g. $^{14}_{7}B$ & $^{15}_{8}C$

2c. R.M.M of $z = \alpha_1 m_1 + \alpha_2 m_2$

Where: $\alpha_1 + \alpha_2 = 1$ (sum of fractions)

m_1 and m_2 are the mass number of each isotope.

$10.2 = \alpha_1(10) + 11\ \alpha_2 = 10\alpha_1 + 11\alpha_2$

But $\alpha_2 = 1 - \alpha_1$

$10.2 = 10\alpha_1 + 11(1-\alpha_1)$

$10.2 = 10\alpha_1 + 11 - 11\alpha_1$

$10.2 - 11 = -\alpha_1$

$-0.8 = -\alpha_1$

$\alpha_1 = 0.8$ or 80%

$\alpha_2 = 1-\alpha_1 = 1-08 = 0.2$ or 20%

∴ The relative abundance of $^{10}_{5}Z$ is 80%

3a. Sublimation

(ii) Chromatography

3b.(i) $Ca(HCO_3)_2$

(ii) Al_4C_3

(iii)$(NH_4)_2CO_3$

3c. R.M.M. of $PbCl_2 = 278g/mol$

$Pb(NO_3)_2 + 2NaCl \rightarrow PbCl_2 + 2NaNO_3$

$\cap Pb(NO_3)_2$=

Vol.(dm^3)xmolar conc.($moldm^{-3}$)

$= \left(\frac{100}{1000}\right) dm^3 \times 1.0\ moldm^{-3}$

$= 0.1mol$

$\cap_{NaCl}$ = Vol.(dm^3) x molar conc.($moldm^{-3}$)

$= \left(\frac{100}{1000}\right) dm^3 \times 0.1\ moldm^{-3}$

$= 0.1mol$

$\cap Pb(NO_3)_2$	:	$\cap_{NaCl}$
$\frac{0.1}{1}$	:	$\frac{0.1}{2}$
0.1	:	0.05

Note that the division is done by the co-efficient of each reactant in the balance equation.

The limiting reagent is NaCl

The excess reagent is $Pb(NO_3)_2$

$I_{PbCl_2} = \frac{1moleofPbCl_2}{2moleofNaCl} \times 0.1 moleofNaCl$

$= 0.05mol$

Mass of $PbCl_2$ formed

$= I_{PbCl_2}$ x molar mass of $PbCl_2$

$= 0.05mol \times 278g/mol$

$= 13.9g$

3d. $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

Therefore, a = 2,b = 3,x = 4 and y = 3

OBAFEMI AWOLOWO UNIVERSITY,
ILE-IFE, NIGERIA

CENTRE FOR DISTANCE LEARNING
PRE-DEGREE PROGRAMME

FIRST CONTACT PERIOD EXAMINATION
PRE-DEGREE CHEMISTRY
(CHM 001)
2003/2004 SESSION-TILL DATE

CHMISTRY 001 EXAMINATION 2016/2017

1. In which of the following device is nuclear fission applicable? (i) Atomic pile (ii) Cathode ray tube (iii) Hydrogen bomb (iv) Atomic bomb (v) Geiger Muller counter
(a) ii and iii only (b) ii and v only (c) I and iv only (d) iii, iv, and v
2. The relative rate of diffusion of a gas as compared with sulphur (vi) oxide is 5 : 2, then the relative molecular mass of the gas is? $\{S = 32, O = 16\}$ (a) 80 (b) 40 (c) 32 (d) 64
3. What is the temperature at which the reaction below is at equilibrium? $2NO(g) + O_2(g) \rightarrow 2NO_2(g)\ \Delta H = -113kJmol^{-1}, \Delta S^{\circ}_{rxn} = -145JmolK^{-1}$(a) $-195℃$ (b) $77.9℃$ (c) $506℃$ (d) $779℃$
4. Which of the following does not represent the arrangement of electrons in the p-subshell in the ground state of any gas phase atom?
(a) ↑↓ ↓ ☐ (b) ↑ ↑ ↑ (c) ↑↓ ↓ ↓ (d) ☐ ☐ ☐
5. Consider the table below.

	Salt to be prepared	Starting Material	Method of preparation
i	$PbCl_2$	$Pb(NO_3)_2(aq)$	_____
ii	$FeCl_2$	$Fe(s)$	Displacement
iii	KCl	K_2O	_____
iv	PbS	$Pb(s)$	_____
v	$CuSO_4$	CuO	Neutralization

Which of the options below identify method of preparation of i, iii and iv?(a) neutralization, displacement and precipitation (b) neutralization, combination and precipitation (c) precipitation, neutralization and combination (d) combination, displacement and double decomposition
6. The ions X^- and Y^+ are isoelectronic, each containing a total of electrons. How many protons are in the nuclei of the neutral atoms of X and Y respectively. (a) 10and 9 (b) 9 and 9 (c) 10 and 10 (d) 9 and 11
7. If a mixture of 1.25 moles of nitrogen gas, 2.0 moles of oxygen and an unspecified amount of hydrogen gas sealed in a vessel at 25℃ exerts a pressure of $9.6Nm^{-2}$ and the partial pressure of hydrogen is $2.35Nm^{-2}$, calculate the mass of hydrogen in the mixture. $\{H = 1\}$ (a) $29.40g$ (b) $33.60g$ (c) $1.05g$ (d) $2.10g$
8. Consider the following chemical reaction equations

$$SO_3(g) + O^{2-} \rightarrow SO_4^{2-}(aq) \quad \text{(i)}$$

$$BF_3(g) + NH_3(g) \rightarrow BF_3 \leftarrow NH_3 \quad \text{(ii)} \quad \text{(iii)}$$

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+ \quad \text{(iv)} \quad \text{(v)}$$

$$Cu^{2+}(aq) + 4NH_3(aq) \rightarrow [Cu(NH_3)_4]^{2+} \quad \text{(vi)}$$

Which of the following numbered chemical specie react like Lewis acid? (a) i, ii and vi (b) ii, iv and vi (c) i, ii and iii (d) iii, iv and v
9. Which of the following samples will react fastest with dilute trioxonitrateV acid? (a) $5g$ of lumps of marble at $50℃$ (b) $5g$ of lumps of marble $25℃$ (c) $5g$ of powder of marble at $25℃$ (d) $5g$ of powder marble at $50℃$
10. For the reaction:
$2H_2(g) + 2NO(g) \rightarrow N_2(g) + 2H_2O(g)$
The rate law is $R = K[H_2][NO]^2$. At a given temperature, what is the effect on the reaction rate if the concentration of H_2 is doubled and the concentration of NO is halved? (a) the reaction rate is doubled (b) the reaction rate increase eightfold (c) the reaction rate is halved (d0 the reaction rate is unchanged
11. The sample of a radioactive element with a half-life of 6hours has an initial mass of 250g. Calculate the time it will take for the mass of the sample to remain $20g$. (a) 13.45hours (b) 10.67hours (c) 21.85hours (d) 9.22hours
12. Which of the following are the reason why reaction rate increase as temperature increase (i) collisions are more frequent between molecules at higher temperature (ii) a greater fraction of collision have sufficient energy to exceed Ea at higher temperatures (iii) reactant concentration are higher at temperatures (a) i only (b) i, ii and iii (c) i and ii (d) ii only
13. An aqueous solution of a substances turns acidified $K_2Cr_2O_7$ solution from orange to green. The aqueous solution also decolourizes acidified $KMnO_4$ solution. It can therefore be inferred that the substance in the aqueous solution is? (a) a colour changing agent (b) disproportionating agent (c) oxidizing agent (d) a reducing agent
14. The solubility of calcium fluoride at 37℃ is $3.9gdm^3$. what is the solubility product of the salt at this temperature? $\{Ca = 40.0; F = 19.0g/mol\}$
(a)$2.5 \times 10^{-4}mol^3dm^{-9}(b)2.2 \times 10^{-3}mol^3dm^{-9}(c)1.5 \times 10^{-6}mol^3dm^{-9}$(d) $5.0 \times 10^{-4}mol^3dm^{-9}$
15. An element X, consisting of two isotopes of mass number 35 and 37, has an atomic

number of 35.5, what is the relative abundance of the isotope of the mass number 37? (a) 100% (b) 75% (c) 25% (d) 50%

16. Calcium carbonate, $CaCO_3$, decomposes on heating to calcium oxide and carbon dioxide. What mass of solid calcium carbonate is required to produce $2.40dm^3$ of carbon dioxide measured at stp. $\{GMV = 22.4dm^3\}$ (a) $100g$ (b) $50g$ (c) $21.4g$ (d) $10.7g$

17. Below is a list of forces that bond molecules or formula unit together to form substances: (i) ionic lattice force (ii) temporary dipole-temporary dipole attraction (ii) permanent dipole-permanent dipole attraction (iv) hydrogen bond. Which of these forces exist in water? (a) ii and iii only (b) i, ii, iii and iv only (c) iv only (d) ii. iii, iv only

18. Preparation of ammonia by the herbal process uses equilibrium reaction.
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
The equilibrium constant for this reaction is $K_c = 0.00237$ at 727℃. What is the value of K_p? (a) 2.37×10^{-3} (b) 3.52×10^{-7} (c) 3.52×10^{-9} (d) 3.43×10^{11}

19. $0.15g$ sample of a mixture of KNO_3 and $NaCl$ required $22.25cm^3$ of $0.100moldm^{-3}$ $AgNO_3$ solution for complete precipitation. What is the percentage of $NaCl$ in the mixture? $\{Na = 23; Cl = 35.5; O = 16; K = 108; N = 14\}$ (a) 13.6% (b) 86.6% (c) 92.7% (d) 66.9%\

20. Consider the following properties of matters: (i) conversion of rhombic sulphur to monoclinic sulphur (ii) cracking of octane (iii) chromatographic separation of amino acids (iv) thermal decomposition of calcium trioxocarbonateIV. Which of the list above is/are chemical change (a) ii and v only (b) ii and iv (c) iii and iv (d) ii, iii and iv

21. Identify the oxidizing and reducing agents in the reaction: $BrO^{3-} + 10VO^{2+} + 2Bro_3^- + 4H_2O(l) \rightarrow 10VO_2^+ + Br_2 + 8H^+$(a) VO^{2+} is the oxidizing agent and BrO_3^- is the reducing agent (b) VO^{2+} is the reducing agent and BrO_3^- is the oxidizing agent (c) VO^{2+} is the oxidizing agent and Br_2 is the reducing agent (d) VO^{2+} is the reducing agent and BrO_3^- is the oxidizing agent

22. Below is the list of some substances commonly used in the precipitation of solutions in volumetric analysis: (i) Hydrated sodium trioxocarbonate (iv) crystals (ii) Anhydrous sodium trioxocarbonate (iv) solid (iii) sodium pellets (iv) concentrated hydrochloric acid (v) potassium hydrogen phthalate (vi) concentrated tetraoxosulphate (iv) acid. Which of these substances are suitable for preparing standard solutions? (a) ii, iii and v (b) i. iv and v (c) iv and vi (d) ii and v

23. A $5.37g$ sample of a liquid hydrocarbon burned in excess oxygen produces $17.48g$ CO_2. What is the formula of the hydrocarbon? (a) C_6H_6 (b) C_5H_{12} (c) C_6H_{10} (d) C_6H_{12}

24. The following system is in equilibrium
$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$
In what direction will equilibrium shift after each of the following concentration changes? (i) the concentration of NO_2 is increased (ii) concentration of O_2 is decrease (iii) concentration of NO is increased (a) i = reversed; ii = reverse; iii = reverse (b) i = forward ii = reverse iii = forward (c) i = forward ii = forward iii = reverse (d) i = reverse ii = reverse iii = forward

25. $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$
The reaction above is carried out at 25℃. If the $\Delta H = -72KJmol^{-1}$ and $\Delta S = -101J/molK$, the reaction will (a) proceed spontaneously at the given temperature (b) proceed in the reverse direction at the given temperature (c) proceed spontaneously at lower temperature (d) not proceed at the given temperature

26. Which gas-phase atom has the largest radius? (a) K (b) Mg (c) Ca (d) Na

27. Given the following equilibrium constant
$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g) K_1 = 0.62$
$FeO(s) + H_2(g) \rightleftharpoons Fes + H_2O(g) K_2 = 0.42$
find the equilibrium constant K at the same temperature for the reaction:
$FeO(s) + CO(g) \rightleftharpoons Fe(s) + CO_2(g)$
(a)0.68 (b) 0.12 (c) 0.26 (d) 1.48

28. Given the following list of salt (i) $NaCl$ (ii) K_2CO_3 (iii) NH_4Cl (iv) K_2SO_4 (v) CH_3COONa Which of the list above will hydrolyze in solution (a) i ii and iv (b) i and iv (c) ii iii and v (d) iv and v only

29. The ΔH_f° of MgO is $-602KJ/mol$ when $20.15g$ of MgO is decompose at constant pressure according to the equation below, how much heat will be transferred $2MgO(s) \rightarrow 2Mg(s) + O_2(g)$ (a) $1.20 \times 10^3 KJ$ of heat is released (b) $3.01 \times 10^2 KJ$ of heat is absorbed (c) $6.02 \times 10^2 KJ$ of heat is absorbed (d) $6.02 \times 10^2 KJ$ of heat is released

30. Which of the following statement is correct about the periodic table? (a) element in the same group have the same numbers of valence electron shell (b) the various electron of the element in the same period increases

progressively across the group (c) element in the same period have the same number of valence electron (d) the non metallic properties of the element tends to decrease across each period

31. Which of the following equation represent non redox reactions?
(a) $2Cu + O_2 \rightarrow 2CuO$
(b) $2H_2S + SO_2 \rightarrow 3S + 2H_2O$
(c) $C_2H_2 + O_2 \rightarrow 2H_2O$
(d) $2CrO_4^{2-} + 2H^+ \rightarrow CrO_4^{2-} + H_2O$

32. $200cm^3$ of $0.75moldm^{-3}$ lead (ii) trioxonitrate (v) solution and $250cm^3$ of $0.75moldm^{-3}$ magnesium chloride solution are mixed. Calculate the mass of the precipitate formed $\{Pb = 208; Mg = 24; O = 16; N = 14\ Cl = 35.5\}$ (a) $17.81g$ (b) $14.25g$ (c) $52.31g$ (d) $41.25g$

33. The reaction between one molecule and another molecule of water is represented by the equation: $H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$. The properties show by water in the reaction is (a) acidity (b) amphoterism (c) neutrality (d) basicity

34. A $512cm^3$ sample of a gas weigh $1.236g$ at 20℃ and a pressure of $1atm$. The relative molecular mass of the gas is $\{R = 8.314J/molk,\ 1atm = 101325Jm^3\}$ (a) 58.03 (b) 588,367 (c) 5.88 (d) 197.9

35. When a solution of salt of a metal of relative atomic mass 70.0 was electrolysed for 25minutes with a current of 2.5amp; $0.907g$ of the metal was deposited. What is the valency of the metal in this salt? (a) 2 (b) 4 (c) 3 (d) 1

36. Consider the following acid base reaction and their suggested indicator for their complete neutralization reaction:
(i) Ethanedioc acid vs potassium hydroxide – phenolphthalein
(ii) Tetraoxosulphate VI acid vs sodium hydroxide – methyl orange
(iii) Aqueous ammonia vs hydrochloric acid – phenolphthalein
(iv) Aluminium hydroxide vs trioxonitrate V acid – methyl orange
Which of the list have suitable indicator match with the acid-base reaction? (a) iii and iv only (b) i, ii and iv (c) i, ii and iii (d) ii and iii only

37. Balance the equation for the following reaction in acidic solution and determine the coefficient a-d
$aCrO_7^{2-} + bBr^- \rightarrow cCr^{3+} + Br_2(aq)$
(a) $a = 6; b = 1; c = 2; d = 3$
(b) $a = 1; b = 6; c = 3; d = 2$
(c) $a = 1; b = 6; c = 2; d = 3$
(d) $a = 2; b = 6; c = 3; d = 2$

38. How molecules of CO_2 gas are produced when $5.0g$ of $CaCO_3$ is treated with $100cm^3$ of $0.10moldm^{-3}$ HCl? $\{C = 12; Ca = 40; O = 16; N_A = 6.02 \times 10^{23}\}$ (a) 1.20×10^{22} (b) 6.02×10^{22} (c) 6.02×10^{21} (d) 3.01×10^{21}

39. Which of the following properties is common to both electrochemical and electrolytic cells? (a) oxidation at anode and reduction at cathode (b) production of electrical energy (c) the signs of the poles (d) the sign of free energy change

40. The electrolysis cells are connected in series, one containing $AgNO_3(aq)$ and the other $CuSO_4(aq)$. If $5.38g$ Ag is deposited in the cell containing $AgNO_3$, how much Cu will be deposited in the cell containing $CuSO_4$? (a) $1.58g$ (b) $23g$ (c) $105.8g$ (d) $15.8g$

SOLUTION

1. Nuclear fission is a process in which the nucleus of a heavy element is split into two nuclei of nearby equal mass with a release of energy and radiation.
$^{235}_{9}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^{0}_{1}n$
In nuclear fission the following holds
(i) Energy is release
(ii) large nucleus disintegrate
(iii)there is a loss in mass
(iv)the number of neutrons release in fission is greater than the number of neutrons needed to cause fission
(v) it lead to chain reaction
(vi)It products are radioactive
(vii) It is applicable in atomic pile and atomic bomb
Note that Hydrogen bomb works on the principle of fusion not fission.
The correct option is C

2. Let the gas be X
$M_{SO_3} = 80g/mol$
$M_X = xg/mol$
$$\frac{R_X}{R_{SO_3}} = \sqrt{\frac{M_{SO_3}}{M_X}}$$
$R_X : R_{SO_3} = \sqrt{5} : 2$
$$\frac{R_X}{\sqrt{5}} = \frac{R_{SO_3}}{2} = k$$
$$\frac{R_X}{\sqrt{5}} = k$$
$R_X = k\sqrt{5}$
$$\frac{R_{SO_3}}{2} = k$$
$R_{SO_3} = 2k$
$$\frac{R_X}{R_{SO_3}} = \sqrt{\frac{M_{SO_3}}{M_X}}$$

$$\frac{k\sqrt{5}}{2k} = \sqrt{\frac{80}{M_X}}$$

$$\frac{\sqrt{5}}{2} = \sqrt{\frac{80}{M_X}}$$

Square both sides

$$\left(\frac{\sqrt{5}}{2}\right)^2 = \left(\sqrt{\frac{80}{M_X}}\right)^2$$

$$\frac{5}{4} = \frac{80}{M_X}$$

$$M_X = \frac{80 \times 4}{5} = 64g/mol$$

The correct option is D

3. $2NO(g) + O_2(g) \rightarrow NO_2(g)$

$$\Delta H = -113kJ/mol$$

$$\Delta S = -145J/molk = -0.145kJ/molk$$

At equilibrium

$$\Delta S = \frac{\Delta H}{T}$$

$$T = \frac{\Delta H}{\Delta S} = \frac{-113kj/mol}{-0.145kj/molk} = 917.2414k$$

$$T = 779.3103k = 506.3103°C$$

$$T \approx 506°C$$

The correct option is C

4. The p-subshell contains three orbital. According to Hund's rule the following are the possible way of arranging electrons in a p-subshell.

Note that the direction of the spin is not important for a single electron in an orbital.

The correct option is A

5. Salt is the name given to a compound formed when all or part of the ionizable hydrogen of an acid is replaced by metallic or ammonium ions.

Salts are generally divided into the following groups

(i) **Normal salts** are salts formed when all the replaceable hydrogen ions in an acids is completely replaced by metallic or ammonium ion. Examples of normal salt are $NaCl, KBr, Na_2SO_4, NH_4Cl$

(ii) **Acid salts** are salts that still contain replaceable hydrogen ion. They are form by the partial neutralization of an acid with a base. It results from the insufficient supply of metallic ions to replace all the replaceable hydrogen ions in an acids. Examples of acid salt are $NaHSO_4, KHSO_4, NaHCO_3, KHCO_3, KHCO_3, NaHS$ etc

$$NaHS + NaOH \rightarrow Na_2S + H_2O$$

Note that the solution of acid salt is necessarily acidic. In other words, some acid salt ($NaHCO_3, KHCO_3, KHCO_3$) dissolve in water to form alkaline solution.

$$NaHCO_3 + H_2O \rightarrow H_2CO_3 + NaOH$$

The above equation shows that aqueous solution of $NaHCO_3$ is a strong alkaline or base

(iii) **Basic salts** are salt that are formed by the partial neutralization of a base by an acid. Basic salt still contain hydroxide ion (OH^-). Example of basic salts are $Zn(OH)Cl, Zn(OH)NO_3, Ba(OH)Br, Bi(OH)NO_3$ etc.

(iv) **Double salt** is a compound of two salts formed by crystallization from a solution containing both of them i.e. it is a mixture. A double salt has the general formulae

$M^{3+}M^{+}(SO_4)_2.12H_2O$ or

$M^{2+}(M^{+})_2(SO_4)_2.12H_2O$ e.g.

$Fe(NH_4)_2(SO_4)_2.12H_2O, NaAl(SO_4)_2.6H_2O$

(v) **Complex salts** are salts that contain a complex ion. Complex ion is an a ion that contain charge group of atoms such that the central element is a transition element. Example of complex ions are, $[Fe(CN)_6]^{3-}, [Zn(OH)_4]^{2-}$. Examples of complex salts are $K_4[Fe(CN)_6], Na_3[Fe(CN)_6], Cu(NH_3)_4Cl_2, Na_2[Zn(OH)_4]$ etc

Note that the following terms are usually associated with salts

(i) **Deliquescence** is the phenomenon or process whereby certain substances known as deliquescent substances absorb large amount of moisture (water vapour) from the atmosphere on exposure to form a solution. All deliquescent substances are also hygroscopic in nature e.g. $NaOH, FeCl_3, KOH, CaCl_2, MgCl_2, P_4O_{10}$ etc.

(ii) **Hygroscopy** is the phenomenon or process whereby certain substances known as hygroscopic substances absorb moisture from the atmosphere without forming a solution but become sticky to touch e.g. $CuO, NaNO_3, CaO$, conc. H_2SO_4. They are mainly used as drying agent.

(iii) **Efflorescence** is the phenomenon where certain substances known as efflorescent substances lose some or all of their water of crystallization on exposure to the atmosphere e.g. $Na_2CO_3.10H_2O \rightarrow Na_2CO_3.H_2O + 9H_2O$

(iv) **Decrepitation** is the phenomenon whereby a crystalline solid gives a cracking noise on heating due to the removal of water of

crystallization e.g. $NaCl$, $KClO_3$, 2moles of $Pb(NO_3)_2$

(v) **Water of crystallization** is the amount of water that is associated with substance on crystallizing out of solution. In other words, water of crystallization is the amount of water that react chemically with a substance on crystallizing out of solution. Water of crystallization is also known as **hydration**.

Methods of preparing salts

Soluble salts are prepare by

(i) Neutralization
(ii) Double decomposition
(iii)Direction combination of constituent elements
(iv)Displacement

Insoluble salts are prepare by

(i) Double decomposition
(ii) Precipitation
(iii)Direct combination of constituent elements

Salt to be prepared	Starting material	Method of preparation
$PbCl_2$	$Pb(NO_3)_2$	precipitation
$FeCl_2$	Fe	Displacement
KCl	K_2O	neutralization
PbS	Pb	combination
$CuSO_4$	CuO	Neutralization

The correct option is C

6. The species X^- and Y^+ contains 10 electrons

Since the species X^- has a charge of -1 the number of electrons (NE) in the species is greater than the number of protons (NP) by one (1)

$NE = NP + 1$
$10 = NP + 1$
$NP = 10 - 1 = 9$

Thus, the following is true of the species X^-

(i) It contains 10 electrons
(ii) It contains 9 protons
(iii)It atomic number is 9
(iv)Its neutral atom contain 9 electrons
(v) It is a group VIIA element
(vi)It is a p-block element

Since the species Y^+ has a charge of $+1$ the number of electrons (NE) in the species is less than the number of protons (NP) by one (1)

$NE + 1 = NP$
$10 + 1 = NP$
$NP = 10 + 1 = 11$

Thus, the following is true of the species Y^+

(i) It contains 10 electrons
(ii) It contains 11 protons
(iii)It atomic number is 11
(iv)Its neutral atom contain 11 electrons
(v) It is a group IA element
(vi)It is a s-block element

The correct option is D

7. Number of moles of oxygen$(\cap_{O_2}) = 2$ mole
Number of moles of Nitrogen$(\cap_{N_2}) = 1.25$ mole
Number of moles of Hydrogen$(\cap_{H_2}) = x$ mole
Total number of moles of the mixture(n_T)
$= 2 + 1.25 + x = (3.25 + x)moles$
Total pressure of mixture$(P_T) = 9.6Nm^{-2}$
Partial pressure of Hydrogen $(P_{H_2}) = 2.35Nm^{-2}$

$$P_{H_2} = X_{H_2}P_T = \frac{\cap_{H_2}}{\cap_T} \times P_T$$

$$2.35 = \frac{x}{3.25 + x} \times 9.6$$

$$2.35(3.25 + x) = 9.6x$$

$$7.6375 + 2.35x = 9.6x$$

$$7.6375 = 9.6x - 2.35x = 7.25x$$

$$x = \frac{7.6375}{7.25} = 1.0534mol \approx 1.05mol$$

$$\cap_{H_2} = \frac{mass\ of\ H_2}{Molar\ mass\ of\ H_2}$$

$$1.05mol = \frac{mass\ of\ H_2}{2g/mol}$$

$$mass\ of\ H_2 = 1.05mol \times 2g/mol = 2.10g$$

The correct option is D

8. A **Lewis acid** is an acid that accept unshared paired of electron during bonding. They are usually electrons deficient and act as electrophiles or electrophilic reagent.

Electrophiles are reagents that attach electron rich centre. The following are Electrophiles.

(i) Electron deficient molecules e.g. $AlCl_3$, BF_3, BeF_2, $RCOCl$, RX etc.
(ii) Polarized neutral molecules e.g. $HX, RX, RCOX, RCHO, RCOR^1, RCOOR^1$, RCN, acid anhydride etc. Where X stands for halogens
(iii)All cations e.g. Ca^{2+}, NH_4^+, Mg^{2+} etc.
(iv)All oxidizing agents e.g $KMnO_4$, $K_2Cr_2O_7$, non-metals
(v) All molecules that are easily polarized and attack electron cloud with their positive pole (halogens) e.g. bromine $\overset{\delta+}{Br} - \overset{\delta-}{Br}$ chlorine $\overset{\delta+}{Cl} - \overset{\delta-}{Cl}$

A **Lewis base** is a substance that donates unshared paired of electron during bonding. They are usually electrons rich and act as nucleophiles or nucleophilic reagent.

Nucleophiles are reagents that attack electron deficient centre. They are also known as **nucleophilic reagent**. The following are Nucleophiles.

(i) All electron rich molecules e.g. H_2O, NH_3, PH_3, RNH_2, $RCONH_2$, ROH etc.
(ii) All anions e.g CN^-, OH^-, SCN^-, Cl^- etc.
(iii)All reducing agent e.g. H_2S, SO_2 etc.

(iv) All molecules that are easily polarized and attack electron deficient centre with it negative pole e.g. $RMgX$ (i.e. Grignard reagent).

Reactions	Acid	Base
$SO_3 + O^{2-} \rightarrow SO_4^{2-}$	SO_3	O^{2-}
$BF_3 + NH_3 \rightarrow BF_3 \leftarrow NH_3$	BF_3	NH_3
$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$	CH_3COOH	H_2O
$Cu^{2+} + 4NH_3 \rightarrow [Cu(NH_3)_4]^{2+}$	Cu^{2+}	NH_3

The table above gives the acid and base for the forward reaction.

Note that all acids are not Lewis acid. A lewis acid must be electron defficient e.g. BF_3 and Cu^{2+}

Note that for the reversible reaction:

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

CH_3COOH . The acid and base for the backward reaction are H_3O^+ and CH_3COO^- respectively.

Thus, the table below gives the Lewis acid and Lewis base

	species	
(i)	SO_3	Acid
(ii)	BF_3	Lewis Acid
(iii)	$BF_3 \leftarrow NH_3$	–
(iv)	CH_3COOH	Acid
(v)	CH_3COO^-	Base
(vi)	Cu^{2+}	Lewis Acid

Note that SO_3 is not a Lewis acid because it is not electron deficient. It is a resonant molecul. However, the option A is the most correct among the options

The correct option is A

9. Powder marble is more reactive than lumps marble due to the greater surface area. The higher the temperature, the higher the rate of reaction due to the increase in effective collision which in turn increases the rate of reaction. Thus, 5g of powdered marble at 50^oC will have a higher rate of reactions.

The correct option is D

10. $R = K[H_2][NO]^2$

If the concentration of H_2 is double, the new concentration of B is $2[H_2]$. That is, $[H_2]_1 = 2[H_2]$

If the concentration of NO is half, the new concentration of NO is $\frac{1}{2}[NO]$. That is, $[NO]_1 = \frac{1}{2}[NO]$

Let $R = R_1$

$$R_1 = K[H_2]_1[NO]_1^2$$

$$R_1 = K(2[H_2])\left(\frac{1}{4}[NO]\right)^2$$

$$= K(2[A])\left(\frac{1}{4}[B]^2\right)$$

$$= \frac{1}{2}K[H_2][NO]^2$$

$$But\ R = K[H_2][NO]^2$$

$$R_1 = \frac{1}{2}R$$

Therefore, the rate of reaction will decrease twofold. That is, the reaction rate is half.

The correct option is C

11. $N_o = 250g, N_R = 20g, T_{\frac{1}{2}} = 6hrs$

$$N_R = N_o\left(\frac{1}{2}\right)^n$$

$$20 = 250\left(\frac{1}{2}\right)^n$$

$$\left(\frac{1}{2}\right)^n = \frac{20}{250}$$

$$0.5^n = 0.08$$

Take the logarithm of both sides

$$log0.5^n = log0.08$$

$$nlog0.5 = log0.08$$

$$n = \frac{log0.08}{log0.5} = 3.6439$$

$$T_{\frac{1}{2}} = \frac{t}{n}$$

$$t = nT_{\frac{1}{2}} = 3.6439 \times 6 = 21.8634hrs$$

The correct option is C

12. The rate of reaction increases as temperature increases because increase in temperature increases:

(i) The rate of collision of reacting particles

(ii) The rate of effective collision and

(iii) The energy of the reacting particles

The correct option is C

13. A substance that changes the orange colour of $K_2Cr_2O_7$ to green and decolourize $KMnO_4$ is a reducing agent. Examples of reducing agent are SO_2, H_2S etc

$$3H_2S + K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3S$$

$K_2Cr_2O_7$ is orange in colour but $Cr_2(SO_4)_3$ is green in colour. Thus, reducing agent changes $K_2Cr_2O_7$ to $Cr_2(SO_4)_3$

$$5SO_2 + 2KMnO_4 + 2H_2O \rightarrow K_2SO_4 + 2MnSO_4 + 2H_2SO_4$$

$KMnO_4$ is purple in colour but $MnSO_4$ is. Thus, reducing agent changes $KMnO_4$ to $2MnSO_4$ Note that H2S always leave a yellow deposit of sulphur when its react with oxidizing agent.

The correct option is D

14. $R.m.m\ of\ CaF_2 = 78g/mol$

$mass\ conc.of\ CaF_2 = 3.9gdm^{-3}$

$molar\ conc.of\ CaF_2 = \frac{mass\ conc}{Molar\ mass}$

$C_{CaF_2} = \frac{3.9gdm^{-3}}{78g/mol} = 0.05mol$

$CaF_2(s) \rightleftharpoons Ca^{2+} + 2F^-$

$0.05M \quad 0.05M \quad 2(0.05M)$

$K_{sp} = [Ca^{2+}][F^-]^2$

$[Ca^{2+}] = 0.05M, [F^-] = 2(0.05M) = 0.1M$

$K_{sp} = (0.05)(0.1)^2 =$

$= 5 \times 10^{-4}mol^3dm^{-9}$

The correct option is D

15. R.A.M of X = $\alpha_1 m_1 + \alpha_2 m_2$

$\alpha_1 + \alpha_2 = 1$ (Sum of all isotopic fractions)

$\alpha_1 = 1 - \alpha_2$

$m_1 = 35$ and $m_2 = 37, R.A.M\ of\ Z = 35.5$

$35.5 = 35\alpha_1 + 37\alpha_2$

But $\alpha_1 = 1 - \alpha_2$

$35.5 = 35(1 - \alpha_2) + 37\alpha_2$

$35.5 = 35 - 35\alpha_2 + 37\alpha_2$

$35.5 - 35 = 37\alpha_2 - 35\alpha_2$

$0.5 = 2\alpha_2$

$\alpha_2 = \frac{0.5}{2} = 0.25 = 25\%$

$\alpha_1 = 1 - \alpha_1 = 1 - 0.25 = 0.75 = 75\%$

$(\alpha_1, \alpha_2) = (25\%, 75\%)$

The relative abundance of the isotope ^{35}X is 75% and ^{37}X is 25%.

The correct option is C

16. **Step 1:** Write a balance chemical equation of the reaction. There are two reactions that are involve here.

$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

Molar mass of $CaCO_3 = 100g/mol$

Vol. of $CO_2 at\ s.t.p = 2.4dm^3$

Step 2: Determine the number of moles of the reactants or products

$\cap_{co_2} = \frac{Vol.at\ s.t.p}{Molar\ gas\ Vol.} = \frac{2.4dm^3}{22.4dm^3/mol}$

$= 0.1071mol$

Step 3: Determine the limiting reagent and its active mole. The limiting reagent is $CaCO_3$ because it is the only reagent

Step 4: Use the active mole of the limiting reagent to calculate the mole of the species or substance in which the question is centre or based. The question is based on the mass of $CaCO_3$

$\cap_{CaCO_3} = 1 \times 0.1071mol = 0.1071mol$

Step 5: Calculate what is required.

$\cap_{CaCO_3} = \frac{Reacting\ mass\ of\ CaCO_3}{molar\ mass\ of\ CaCO_3}$

$0.1071mol = \frac{mass\ of\ CaCO_3}{100g/mol}$

$mass\ of\ CaCO_3 = 0.1071mol \times 100g/mol$

$mass\ of\ CaCO_3 = 10.71g$

The correct option is D

17. Intra-molecular and intermolecular forces that exit in water is Hydrogen Bonding

The correct option is D

18. $N_2(g) + 3H_2 \rightleftharpoons 2NH_3(g)$

$\Delta n = (2) - (1+3) = 2 - 4 = -2$

$T = 727°C = 1000k$

$R = 8.314J/kmolk$ or $R = 0.0821atmdm^3/kmolk$

Since K_p is measured in atm, $R = 0.0821atmdm^3/kmolk$

$K_c = 0.00237$

$K_p = K_c(RT)^{\Delta n}$

$K_p = 0.00237 \times (0.0821 \times 1000)^{-2}$

$K_p = 0.00237 \times 1.4836 \times 10^{-4}$

$K_p = 3.5161 \times 10^{-7}$

$K_p \approx 3.52 \times 10^{-7}$

The correct option is B

19. **Step 1:** Write a balance equation of the reaction. Two substances with the same anions do not react together. Since the mixture (KNO_3 and $NaCl$) is to react with $AgNO_3$ then the component of the mixture that will react with $AgNO_3$ is $NaCl$ not KNO_3 because $AgNO_3$ and KNO_3 contain the same anion, NO_3^-.

$NaCl(aq) + AgNO_3(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$

$mass\ of\ mixture = 0.15g$

Vol. of $AgNO_3 = 22.15cm^3$

Conc. of $AgNO_3 = 0.1M$

Let the mass of $NaCl$ in the mixture = xg

$mass\ of\ KNO_3 = (0.15 - x)g$

Step 2: Determine the number of moles of the reactants or products.

$\cap_{AgNO_3} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc$

$\cap_{AgNO_3} = \frac{22.15}{1000} \times 0.1 = 0.002215mol$

Step 3: Determine the limiting reagent and its active moles. The limiting reagent is $AgNO_3$ because it is the only reagent that we can calculate its number of mole.

$Active\ \cap_{AgNO_3} = \frac{calculate\ moles}{stoichiometry\ mole}$

$= \frac{0.002215mol}{1} = 0.002215mol$

The stoichiometry mole of $AgNO_3$ is it co-efficient in the balance chemical equation.

Step 4: Determine the number of moles of the species or substance in which the question is centre. The question is centre on $NaCl$.

$n_{NaCl} = stoich.mole\ of\ NaCl \times active\ n_{AgNO_3}$

$n_{NaCl} = stoich.mole\ of\ NaCl \times active\ n_{AgNO_3}$

$= 1 \times 0.002215mol = 0.002215mol$

Step 5: calculate what is required

$n_{NaCl} = 0.002215mol$

$n_{NaCl} = \frac{reacting\ mass}{molar\ mass_x}$

$0.002215mol = \frac{}{58.5g/mol}$

$mass\ of\ NaCl = 0.002215mol \times 58.5g/mol.$

$mass\ of\ NaCl = 0.1296g$

$mass\ of\ KNO_3 = 0.15 - x = 0.15 - 0.1296 = 0.0204g$

$\%\ of\ NaCl = \frac{mass\ of\ NaCl\ in\ the\ mixture}{mass\ of\ the\ mixture} \times \frac{100}{1}$

$= \frac{0.1296g}{0.15g} \times \frac{100}{1} = 86.4\%$

The correct option is B

20. A chemical change is a change which is not easily reversible and in which a new substance is form. Chemical change is also known as chemical reaction. The examples of chemical changes are:

(i) Bubbling of chlorine into a jar containing hydrogen

$Cl_{2(g)} + H_{2(g)} \rightarrow 2HCl_{(g)}$

(ii) Bubbling of chlorine into water

$Cl_{2(g)} + H_2O_{(l)} \rightarrow HOCl_{(aq)} + Hcl_{(aq)}$

(iii) The decaying of plants and leaves

(iv) The rusting of metal(e.g. iron)

$4Fe_{(s)} + 3O_{2(g)} + 2xH_2O_{(l)} \rightarrow 2Fe_2O_3.xH_2O$

(v) The passing of steam over heating iron

$2Fe_{(s)} + 3H_2O_{(g)} \rightarrow 2Fe_2O_3 + 3H_{2(g)}$

(vi) Thermal cracking of alkanes

(vii) Thermal decomposition of trioxocarbonate IV

(viii) Dissolution of calcium in water

$Ca + 2H_2O_{(l)} \rightarrow Ca(OH)_2 + H_2$

Note heating of ammonium chloride can be considered as a physical properties as well as chemical properties.

Ammonium chloride undergoes thermal dissociation when heated to form hydrogen chloride and ammonia. Thermal dissociation is a thermal decomposition reaction that is reversible.

$NH_4Cl_{(s)} \rightleftharpoons NH_3 + HCl$

The above equation shows that the heating of ammonium chloride is a chemical process because a new product is formed. However the above reaction is reverse if the process is cooled to room temperature.

$NH_3 + HCl \rightleftharpoons NH_4Cl_{(s)}$

Therefore, the heating and cooling of ammonium chloride is a physical process while the heating of ammonium chloride without cooling is a chemical process.

The correct option is B

21. $10VO^{2+} + 2BrO_3^- + 4H_2O \rightarrow 10VO_2^+ + Br_2 + 8H^+$

In the above reaction, the oxidation state of Vanadium (V) changes from +4 in VO^{2+} to +5 in VO_2^+ thus, VO^{2+} is the reducing agent. While the oxidation state of Bromine (Br) changes from +5 in BrO_3^- to 0 in Br_2 thus, BrO_3^- is the oxidizing agent

The correct option is B

22. Primary standards are substances that can be obtained in a high degree or state of purity. They are use to prepare standard solutions. The followings are true of primary standard.

(i) They are non deliquescent substance

(ii) They are highly soluble in water

(iii) They are non hygroscopic substance

(iv) They are non efflorescent substance

(v) They are anhydrous substance. That is, they must not contain water of crystallization. An exception is $C_2H_2O_4.2H_2O$ because is it not efflorescence

(vi) They must have a fair high molecular weight

(vii) Their weight must not be altered during weighing

(viii) Examples are $Na_2CO_3, C_2H_2O_4.2H_2O$,potassium hydrogen phthalate ,etc

$NaOH$ is not a primary standard because it is deliquescent and its weight can be altered during weighing.

The correct option is D

23. $C_xH_y + \left(x + \frac{y}{4}\right)O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$

Mass of $C_xH_y = 5.73g$

Mass of $CO_2 = 17.48g$

$Mass\ of\ C\ in\ 17.48g\ of\ CO_2 = \frac{R.A.M\ of\ C}{R.M.M\ of\ CO_2} \times 17.48g$

$= \frac{12}{44} \times 17.48g = 4.7673g$

$Mass\ of\ H = 5.73 - 4.7673 = 0.9627g$

$\frac{C}{\frac{4.7673}{12}} : \frac{H}{\frac{0.9627}{1}}$.

0.3973	0.9627	Divide by the smallest
1	2.4	
1	$\frac{12}{5}$	Multiply by 5
5	12	

$$C_xH_y = C_5H_{12}$$

The correct option is B

24. Equilibrium shift indicate the direction of the reaction. Reaction moves to the direction where there is lower concentration. If the concentration of the reactant is increased, then the concentration of the product will decrease. Thus, the reaction move forward while if the concentration of the product is increased the concentration of the reactant will decrease. Thus, the reaction will move backward.
    (i) If the concentration of NO_2 (i.e. the concentration of the product) is increased, the concentration of the reactant will decrease. Thus, the reaction will move backward(i.e. the reverse direction)
    (ii) If the concentration of O_2 (i.e. the concentration of the reactant) is decreased, the concentration of the product will increase. Thus, the reaction will move backward(i.e. the reverse direction)
    (iii) If the concentration of NO (i.e. the concentration of the reactant) is increased, the concentration of the product will decrease. Thus, the reaction will move forward.

The correct option is D

25. $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$
$\Delta G = ?, \Delta H = -72kJ/mol, T = 25^oC = 298k$
$\Delta S = -101J/molk = -0.101kJ/molk$
$\Delta G = \Delta H - T\Delta S$
$\Delta G = -72 - 298 \times (-0.101)$
$\Delta G = -72 + 298 \times (0.101)$
$\Delta G = -72 + 30.098 = -41.902kJ/mol$
Since ΔG is negative the reaction will occur spontaneously at the given temperature

The correct option is A

26. Atomic radius is generally divided into two which are metallic radius and covalent radius. Atomic radius is measured in Armstrong (Å) or picometer (pm)
    (i) **Metallic Radius** is the average distance between metal atoms in solid metal crystals

$$Metallic\ Radius(MR) = \frac{dist.bet.metallic\ atoms\ in\ crystals}{2}$$

    (ii) **Covalent Radius** is the average distance between the nuclei in adjacent atom in a molecule. It is also known as **van der waal radius**

$$Covalent\ Radius(CR) = \frac{distance\ between\ nuclei\ in\ molecule}{2}$$

The greater the number of subshell, the greater the atomic radius. For two atoms with the same number of sub-shells, the higher the number of valence electrons, the smaller the atomic radius. Potassium and Calcium has four sub-shells compare to Sodium and Magnesium which have three sub-shells. Thus, Calcium and potassium have greater atomic radius compare to Sodium and Magnesium. The atomic radius of potassium is greater than that of calcium and the atomic radius of sodium is greater than that of magnesium due to the higher lesser number of valence electrons of potassium and sodium.
$Mg < Na < Ca < K$

The correct option is A

27. To find the equilibrium constant for a given reaction giving several reactions, arrange the reactions in such a way that they combine to give the given reactions. If a reaction is multiply by any factor, the equilibrium constant of that reaction must be raise to the power of that factor. If a reaction is reverse, the equilibrium constant becomes the inverse of the equilibrium constant of the forward reaction

$$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g) K_1 = 0.62$$
$$FeO(s) + H_2(g) \rightleftharpoons Fe(s) + H_2O(g) K_2 = 0.42$$

To obtain the reaction $FeO + CO \rightleftharpoons Fe + CO_2$, reverse reaction 1 and combine it with reaction 2

$$H_2O(g) + CO(g) \rightleftharpoons H_2(g) + CO_2(g) K_{1a} = \frac{1}{0.62}$$
$$FeO(s) + H_2(g) \rightleftharpoons Fe(s) + H_2O(g) K_2 = 0.42$$
$$FeO + CO \rightleftharpoons Fe + CO_2 \quad K_3 = K_2K_{1a}$$

$$K_3 = K_2K_{1a} = 0.42 \times \frac{1}{0.62} = 0.68$$

The correct option is A

28. **Solvolysis** is the process whereby a solvent react with a solute. If the solvent is water, the process is called hydrolysis.
Hydrolysis:- hydrolysis is derived from two words; hydro which means water and lysis which means splitting apart. **Hydrolysis** therefore, is the process whereby solutes are split apart into their component ions when they react with water.

RULES OF HYDROLYSIS

(i) Salts formed by strong acid and weak base on hydrolysis give acidic medium e.g. $AlCl_3$, $FeCl_3$, NH_4Cl, etc

$$AlCl_3 + 3H_2O \rightarrow Al(OH)_3 + 3HCl$$
Weak Strong

$$FeCl_3 + 3H_2O \rightarrow Fe(OH)_3 + 3HCl$$
Weak Strong

$$NH_4Cl + H_2O \rightarrow NH_4OH + HCl$$
Weak Strong

In each of the above example, the resulting solution is acidic. This is due to the presence of the strong acid HCl. In the titration of a weak base and strong acid, the indicator use is methyl orange, if there is complete neutralization.

(ii) Salts formed by weak acid and strong base on hydrolysis give alkaline medium e.g. $NaHCO_3$, Na_2CO_3, $NaHCO_3$, $NaHCOO$ K_2CO_3, $NaCH_3COO$, etc.

$$Na_2CO_3 + 2H_2O \rightarrow 2NaOH + H_2CO_3$$
Strong Weak

$$NaHCO_3 + H_2O \rightarrow NaOH + H_2CO_3$$
Strong Weak

$$NaCH_3COO + H_2O \rightarrow NaOH + CH_3COOH$$
Strong Weak

$$NaHCOO + H_2O \rightarrow NaOH + HCOOH$$
Strong Weak

In each of the above example, the resulting solution is basic or alkaline. This is due to the presence of the strong base, NaOH. In the titration of a weak acid and strong base or alkaline, the indicator use is phenolphthalein, if there is complete neutralization.

(iii) The hydrolysis of salt formed by strong acid and strong base will give a neutral medium e.g. Na_2SO_4, $NaCl$, K_2SO_4

$$Na_2SO_4 + 2H_2O \rightarrow 2NaOH + H_2SO_4$$
Strong Strong

In the example above, the resulting solution is neutral due to the presence of the strong acid, H_2SO_4 and the strong base, $NaOH$. In the titration of a strong acid and strong base or alkaline, the indicator use is litmus solution, if there is complete neutralization.

(iv) The hydrolysis of salt formed by weak acid and weak base will give either an alkaline, acidic or neutral solution e.g.

NH_4CH_3COO, NH_4CN, NH_4F etc

$$NH_4CH_3COO + H_2O \rightarrow NH_4OH + CH_3COOH$$
Neutral solution

$$NH_4CN + H_2O \rightarrow NH_4OH + HCN$$
Basic solution

$$NH_4F + H_2O \rightarrow NH_4OH + HF$$
Acidic solution

All the salts undergo hydrolysis, but K_2CO_3, NH_4Cl, $NaCH_3COO$, hydrolyse to produce a solution that is not neutral but $NaCl$ and K_2SO_4, hydrolyse to produce a neutral solution. The fact that $NaCl$ and K_2SO_4 produce a neutral solution do not mean they don't hydrolyse.

The correct option is C

29. $2MgO(s) \rightarrow 2Mg(s) + O_2(g)$

The above reaction is a decomposition reaction; hence heat will not be released but absorbed

$R.M.M\ of\ MgO = 40g/mol$

$$n_{MgO} = \frac{Reacting\ mass}{Molar} = \frac{20.15}{40}$$
$$= 0.50375mol$$

$\Delta H = -602kJ/mol$

$1mol$ of ..... $602kJ/mol$

$0.50375mol$ of ..... xkJ

$$\frac{1}{0.50375} = \frac{-602}{x}$$

$$x = 602 \times 0.50375 = 303.2575$$
$$= 3.03 \times 10^2$$

$x = 3.03 \times 10^2 KJ$

The correct option is B

30. The following are the properties of the periodic table.

(i) It has 8 groups

(ii) It has seven periods

(iii) Elements in the same group have the same valence electrons

(iv) Elements in the same period have the same number of shells

(v) Metallic character increases down the group

(vi) Non-metallic character decreases down the group but increases across the period

(vii) Valence electrons increases across the periods

Periodicity is the variation in the atomic properties at a regular interval both down the groups and across the periods

Atomic properties	Across the period	Down the group
Electropositivity	Decreases	Increases
Atomic volume	Decreases	Increases
Atomic size	Decreases	Increases
Atomic radius	Decreases	Increases
Ionic radius	Decreases	Increases
Electric conductivity	Decreases	Increases
Thermal conductivity	Decreases	Increases
Electronegativity	Increases	Decreases
Ionization energy	Increases	Decreases
Electron affinity	Increases	Decreases
Metallicity	Decreases	Increases
Atomic number	Increases	Increases

Mass number	Increases	Increases
Screening/shielding effect	Decreases	Increases
Nuclear charge	Increases	Decreases

The correct option is B

31. Redox reaction is a reaction in which oxidation and reduction occur simultaneous. Examples of redox reaction are:

(i) $Cu + O_2 \rightarrow 2CuO$

(ii) $2H_2S + SO_2 \rightarrow 3S + 2H_2O$

(iii) $2H_2 + O_2 \rightarrow 2H_2O$ etc

The correct option is D

32. **Step 1:** Write a balance chemical equation of the reaction.

$$Pb(NO_3)_2(aq) + MgCl_2(aq) \rightarrow PbCl_2(s) + Mg(NO_3)_2(aq)$$

Step 2: Determine the number of moles of the reactant or products base on the data given.

$$\cap_{Pb(NO_3)_2} = vol\ in\ dm^3 \times molar\ conc.$$

$$= \frac{200}{1000} \times 0.75 = 0.15mol$$

$$\cap_{MgCl_2} = vol\ in\ dm^3 \times molar\ conc.$$

$$= \frac{250}{1000} \times 0.75 = 0.1875mol$$

Step 3: Determine the limiting reagent and its active mole.

$$\cap_{Pb(NO_3)_2} : \cap_{MgCl_2}$$

$$\frac{0.15mol}{1} : \frac{0.1875mol}{1}$$

$$0.15mol : 0.1875mol$$

The limiting reagent is $Pb(NO_3)_2$

The excess reagent is $MgCl_2$

Step 4: Use the active mole of the limiting reagent to calculate the mole of the species or substance in which the question is centred or based. The question is based on the mass of $PbCl_2$

$$\cap_{PbCl_2} = 1 \times 0.15 = 0.15mole$$

Step 5: Calculate what is required.

$$\cap_{AgCl} = \frac{Reacting\ mass\ of\ AgCl}{molar\ mass\ of\ AgCl}$$

$$R.m.m\ of\ PbCl_2 = 278g/mol$$

$$0.15mol = \frac{mass\ of\ AgCl}{278g/mol}$$

$$mass\ of\ PbCl_2 = 0.15mol \times 278g/mol$$

$$= 41.70g$$

Note that the difference is due to the fact that the examiner use wrong value for the relative atomic mass of lead. The relative atomic mass of lead is $207g/mol$ not $208g/mol$

The correct option is D

33. **Amphoterism** is the ability of metals or oxides of metal (also some non-metallic oxide e.g. B_2O_3) to react with base as well as acid to form salt.

Amphiprotism is the ability of some substance to donate a proton as well as accept a proton. Water and ethanol are amphiprotic.

$$H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$$

In the above reaction, one of the water molecules donates a proton and the other accepts a proton. This behaviour of water is rightly called amphiprotism not amphoterism. This is because water is a bronsted-lowry acid as well as base.

The examiner mismatches amphoterism with amphiprotism.

The correct option is B

34. $V = 512cm^3 \times \left(\frac{1m}{100cm}\right)^3$

$$= 512cm^3 \times \frac{1m^3}{10^6cm^3}$$

$$= 512 \times 10^{-6}m^3$$

$$m = 1.236g$$

$$P = 1atm = 101325J/m^3$$

$$(1J/m^3 = 1Nm\ or 1Pa)$$

$$T = 20^oC = 293K$$

$$R = 8.314J/molK$$

$$PV = \frac{mRT}{M}$$

$$M = \frac{mRT}{PV} = \frac{1.236 \times 8.314 \times 293}{101325 \times 512 \times 10^{-6}}$$

$$= \frac{3010.898472}{51.8784} = 58.037g/mol$$

The correct option is A

35. $R.M.M\ of\ metal = 70g/mol$

$$I = 2.5A, m = 0.907g$$

$$t = 25mins = 1500s$$

$$m = ZIt$$

$$m = \frac{R.A.M\ of\ Metal}{charge\ on\ metal \times 96500} \times It$$

$$0.907 = \frac{70}{x \times 96500} \times 2.5 \times 1500$$

$$x = \frac{70}{0.907 \times 96500} \times 2.5 \times 1500$$

$$x = 2.9991 \approx 3$$

The correct option is C

36. Indicators are organic compound that changes colour according to the P^H of the medium. It is use to determine the point in which the reaction between two solutes is complete.

TYPES OF INDICATOR

Methyl Orange:- it is an indicator that is used in titrations in which the end point is acidic. This is because it is sensitive to acidic medium. The colour change of methyl orange in various media is given by PANOYA which means

PA→ Pink in Acid

NO→ Orange in Neutral

YA→ Yellow in Alkaline

Note that many people confuse the colour pink with red; as a result you might come across textbook that says that the colour of methyl orange in acid is red. Methyl orange is pink in acid not red. However, in an examination where the pink is not in the option but red, you have to choose red as the correct answer.

Phenolphthalein:- It is an indicator used in titration in which the end point is basic or alkaline in nature. This is because phenolphthalein is sensitive to basic or alkaline indicator. The colour change of phenolphthalein on different media is given by CANCAP, which means

CA→ Colourless in Acid
NC→ Colourless in Neutral
AP→ Pink in Alkaline

Litmus solution:- It is an indicator used in titration in which the end point is neutral. This is because litmus solution is sensitive to neutral medium. The colour change of litmus in different media is given by **RANPAB** i.e.

RA → red in acid
NP → purple in neutral
AB → blue in alkaline

Methyl red:- It is an indicator used in titration in which the end point is neutral. This is because it is sensitive to neutral medium. The colour change of methyl red in various media is given by **YANORA** which means

YA→ Yellow in Acid
NO→ Orange in Neutral
YA→ Red in Alkaline

The choice of an indicator is based on the end point of the titration. If the end point is acidic, methyl orange is use, if the end point is basic or alkaline, phenolphthalein is use and if the end point is neutral, litmus solution or methyl red is used.

Acid	Base	Nature of salt	Indicators
$COOH$ $-COOH$	KOH	alkaline	phenolphthalein
H_2SO_4	$NaOH$	Neutral	Methyl Red or litmus solution
NH_4OH	HCl	Acidic	Methyl Orange
HNO_3	$Al(OH)_3$	Acidic	Methyl Orange

None of the options is correct

37. $Cr_2O_7^{2-} + Br^- \rightarrow Cr^{3+} + Br_2(g)$

Step 1: Assign oxidation state to all species that undergo change in oxidation state.

$$\overset{+6}{Cr_2O_7^{2-}} + \overset{-1}{Br^-} \rightarrow \overset{+3}{Cr^{3+}} + \overset{0}{Br_2}$$

Step 2: Separate the reaction into oxidation reduction halve reaction. Oxidation is a process that involves increase in oxidation number but reduction is a process that involves decrease in oxidation number.

$$Cr_2O_7^{2-} \rightarrow Cr^{3+} \text{ (red)}$$
$$Br^- \rightarrow Br_2 \text{ (ox)}$$

Step 3: Balance each half reaction atomically and electrically.

$$6e^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$$
$$2Br^- \rightarrow Br_2 + 2e^-$$

Step 4: Balance the number of electrons in the two half reactions.

$$6e^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O \ldots \times 1$$
$$2Br^- \rightarrow Br_2 + 2e^- \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \times 3$$
$$6e^- + CrO_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$$
$$6Br^- \rightarrow 3Br_2 + 6e^-$$
$$Cr_2O_7^{2-} + 6Br^- + 14H^+ \rightarrow 2Cr^{3+} + 3Br_2 + 7H_2O$$

$$\therefore a = 1, b = 6, c = 2, d = 3$$

The correct option is C

38. **Step 1:** Write a balance chemical equation of the reaction.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$
$$5.0g \quad 100cm^3, 0.1M$$

R.M.M of $CaCO_3 = 100g/mol$

Step 2: Determine the number of moles of the reactant or products base on the data given.

$$\cap_{CaCO_3} = \frac{Reacting\ mass}{Molar\ Mass}$$
$$\cap_{CaCO_3} = \frac{5g}{100g/mol} = 0.05mol$$
$$\cap_{HCl} = vol\ in\ dm^3 \times molar\ conc.$$
$$= \frac{100}{1000} \times 0.1 = 0.01mol$$

Step 3: Determine the limiting reagent and its active mole.

$$\cap_{CaCO_3} : \cap_{HCl}$$
$$\frac{0.05mol}{1} : \frac{0.01mol}{2}$$
$$0.05mol : 0.005mol$$

The limiting reagent is HCl

The excess reagent is $CaCO_3$

Step 4: Use the active mole of the limiting reagent to calculate the mole of the species or substance in which the question is centred or based. The question is based on the mass of CO_2

$$\cap_{CO_2} = 1 \times 0.005 = 0.005mole$$

Step 5: Calculate what is required.

$$\cap_{CO_2} = \frac{No\ of\ molecules\ of\ CO_2}{6.02 \times 10^{23} molecules/mol}$$

$$No\ of\ molecules\ of\ CO_2 = 0.005 \times 6.02 \times 10^{23}$$
$$= 3.01 \times 10^{21}$$

The correct option is D

39. D

Electrolytic cell	Electrochemical cell
It converts electrical energy to chemical energy	It converts chemical energy to electrical energy
Its positive terminal is the anode	Its positive terminal is the cathode
Its negative terminal is the cathode	Its negative terminal is the anode.

In both electrolytic cell and electrochemical cell oxidation occurs at the anode and reduction at the cathode. The free energy change for a feasible electrochemical and electrolytic cell is negative.

The correct option is A

40. $m_{Ag} = 5.38g, m_{Cu} = ?, c_{Ag} = 1, c_{Cu} = 2$

$M_{Ag} = 108g/mol, M_{Cu} = 63.5g/mol$

$$\frac{m_1}{m_2} = \frac{M_1 \times C_2}{M_2 \times C_1}$$

Where m = mass of the substance deposited

M = relative atomic mass

C = charge on ion

$$\frac{m_{Cu}}{m_{Ag}} = \frac{M_{Cu} \times C_{Ag}}{M_{Ag} \times C_{Cu}}$$

$$\frac{m_{Cu}}{5.38} = \frac{64 \times 1}{108 \times 2}$$

$$m_{Cu} = \frac{64 \times 1 \times 5.38}{108 \times 2} = 1.58g$$

The correct option is A

CHM 001 EXAM 2015/2016
TIME ALLOWED: 65 MINUTES

1. A quantity of PCl_5 was heated in a 10litre vessel at 250°C. At equilibrium, the vessel contains 0.20 mole of PCl_5, 0.30 mole of PCl_3 and Cl_2. Compute the equilibrium constant K_c for the dissociation of PCl_5 at 250°C. Given that: $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_2$ (a) 0.004 (b) 0.045 (c) 0.45 (d) 0.041
2. The collision theory of the rate of chemical reaction depends on which of the following? I. frequency of the collision II. Collision energy or energy of the colliding particles III. Correct orientation of the colliding particles IV. Medium of the reaction V. size of the reacting vessel (a) I, II, III, IV, V (b) I, II, III only (c) I and III only (d) I, II, and IV only
3. Consider the electrolysis of copper II tetraoxosulphate (VI) salt, using a platinum electrode which of the following statements is/are correct? I. Copper ions are discharge at cathode II. Copper dissolves at anode III. Oxygen gas is produced at the anode IV. The pH of the resulting solution at the end of the process is less than 7. (a) I, II, and IV (b) II, III and IV (c) I,III and IV (d) I and IV only
4. A certain volume of hydrogen gas diffused through a porous partition in 30 seconds. Calculate the required time (in seconds) for the same volume of hydrogen chloride gas to diffuse under the same condition. $[H = 1, Cl = 35.5]$ (a) 106.80 (b) 128.16 (c) 56.50 (d) 7.02
5. What current in ampere would be required to produce 18.0g of Aluminum in 1 hour 30 minutes? $[Al = 27.0; 1F = 96{,}500\ C]$ (a) 27.8A (b) 11.9A (c) 56.50A (d) 35.7A
6. Which of the following are a mixed anhydride and an anhydride for a dibasic acid respectively? I. CO_2 II. NO_2 III. SO_3 IV. NO A. I & II (b) III & V (c) V & I (d) II & IV
7. The table below consists of different sets of electrolytes, which of the options correctly classify the electrolyte as strong, weak and non-electrolyte?

	Strong electrolyte	Weak electrolyte	Non-electrolyte
A	$NaOH_{(aq)}$	Aqueous ammonia	Sugar solution
B	Oxalic acid	$HCl_{(aq)}$	$NaCl_{(aq)}$
C	$H_2SO_{4(aq)}$	Chloroform	H_2O
D	Aqueous ammonia	$KCl_{(aq)}$	$KOH_{(aq)}$

8. Arrange the solution of the following salts in order of increasing acidity: I. Na_3PO_4 II. NaH_3PO_4 III. $NaHPO_4$ (a) I, II, II (b) I, III, II (c) II, III, I (d) III, I, II
9. The following data were obtained from the reaction: $X + Y \rightarrow Z$

Expt. No	X ($Moldm^{-3}$)	Y ($Moldm^{-3}$)	Rate ($Moldm^{-3}\ s^{-1}$)
1	0.2	0.2	0.06
2	0.2	0.4	0.24
3	0.4	0.4	0.24

The overall order of the reaction is? (a) 1 (b) 3 (c) 2 (d) 0

10. Below is a table which represents five types of salts. Which of the options describes correct example under each type?

	Acid salt	Normal salt	Basic salt	Double salt	Complex
A	K_2SO_4	$NaCl$	KOH	$Cu(NH_3)_4Cl_2$	$Mg(OH)Cl$
B	$KHSO_4$	Na_2CO_3	$Zn(OH)NO_3$	$NaAl(SO_3)_2.6H_2O$	$Cu(NH_3)_4Cl_2$
C	Na_2SO_4	KCl	$Mg(OH)Cl$	$K_4Fe(CN)_6$	$NH_4Fe(SO_3)_2.6H_2O$
D	HCl	$CaHPO_4$	$Ba(OH)Cl$	$NH_4Fe(SO_3)_2.6H_2O$	$Cu(H_2O)_4Cl_2$

11. Consider the following chemical reactions is equilibrium:

I. $3H_{2(g)} + N_{2(g)} \rightleftharpoons NH_{3(g)} \quad \Delta H = -ve$

II. $2N_2O_{5(g)} \rightleftharpoons 2N_2O_{4(g)} + O_{2(g)}$ $\Delta H = +ve$

III. $3Fe_2O_{3(s)} + 4H_2O_{(g)} \rightleftharpoons Fe_2O_{5(s)} + 4H_{2(g)}$ $\Delta H = -ve$

IV. $H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)}$ $\Delta H = 0$

In which of the above equilibrium reaction will increasing the temperature shift equilibrium position to the right and also increase equilibrium constant value? (a) I only (b) II only (c) I and III only (d) IV only

12. The rate of chemical reactions and equilibrium position of reversible reactions are commonly dependent on which of the following factors?
I. Concentration
II. Light
III. Temperature
IV. Catalyst
V. Intimacy of reactants
VI. Pressure of the gaseous reactants and products
(a) I, III & VI (b) II, V & VI (c) II, IV & V (d) I, II & III

13. A typical chemical bond formed between atoms of $_{19}X$ and $_{17}Y$ will not confer which of the following properties on the compound?
I. High vapour pressure
II. Conductivity of electricity in the molten form
III. Solubility in Benzene and Ether
IV. High melting point
V. High density
(a) I & II only (b) III, IV & V (c) I, III, & V (d) II & IV only

14. According to the valences shell electron pair theory, boron trifluoride is (a) Lewis acid (b) Arrhenius base (c) Bronsted-Lowry acid (d) Lewis base

15. Sodium hydroxide is not considered a typical example of primary standard reagent for titration because (a) It is not very soluble in water (b) It is not easily obtained with high degree of purity (c) It cannot be easily preserved (d) Its weight can be altered during weighing

16. A mole of a compound contains 48g of magnesium atoms, 1.806×10^{24} silicon atoms and 128g of oxygen atoms. The molecular formula of the compounds is [Mg = 24; Si = 28; O = 16; $N_A = 6.02 \times 1023$ mol–1(a) $MgSi3O8$ (b) . $MgSiO3$ (c) $Mg_2Si_3O_8$ (d) $Mg_2Si_3O_6$

17. The oxidation number of silicon in $Ca_2Si_3O_8$ is (a) +8 (b) +6 (c) +4 (d)+2

18. The net ionic equation for the reaction between $K_2CO_{3(aq)}$ and dilute HCl is
(a) $K_2CO_3 + 2HCl \rightarrow 2KCl + H_2O + CO_2$
(b) $2K^+ + CO_3^{2-} + 2H^+ 2Cl^- \rightarrow H_2O + CO_2 + 2K^+ + 2Cl^-$
(c) $2H^+ + 2Cl^- \rightarrow 2KCl$
(d) $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$

19. A chemist dissolved ammonia in distilled water to produce a solution of ammonium hydroxide having a density of $1.20\ gcm^{-3}$ and percentage purity of 82%. How many cm^3 of this solution must be diluted with distilled water to give $250cm^3$ of $2.0moldm^{-3}$ ammonium hydroxide solution? [$N = 14; H = 1; O = 16$ (a) 14.6 (b) 17.9 (c) 20.5 (d) 41.6

20. Below are some chemical equations representing some reactions:
I. $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
II. $6Cl_2 + 6Ca(OH)_2 \rightarrow Ca(ClO_3)_2 + 5CaCl_2 + 6H_2O$
III. $HCl + NaOH \rightarrow NaCl + H_2O$
IV. $CaCO_3 \rightarrow CaO + CO_2$
V. $2H_2O_2 \rightarrow H_2O + O_2$
In which of these reactions is a single species acting as both oxidizing agent and reducing agent(a) I and III (b) II and V (c) IV only (d) V only

21. The electrical carriers in an aqueous solution of sodium chloride, molten sodium chloride and iron rod are respectively (a) Free mobile electron, free mobile ions and hydrated ions. (b) Free mobile ions, free mobile electrons and hydrated ions. (c) Hydrated ions, free mobile ions and free mobile electrons and (d) Hydrated ions, lattice and bonded electrons

22. An electrochemical cell is formed by coupling hydrogen electrode with zinc electrode. Which of the following statements is totally correct about the cell? (a) Hydrogen electrode is the anode and it is positively (b) Hydrogen electrode is the cathode and it is negatively (c) Zinc electrode is the cathode and it is positively charge (d) Zinc electrode is the cathode and it is negatively charge

23. Below is a list of some bond type in nature:
I. Hydrogen bond
II. Coordinate covalent bond
III. Covalent bond
IV. Ionic bond
Which of these bond types join atom to atom and also molecule to molecule respectively in methanol? (a) I and II (b) III and I (c) IV and II (d) IV and I

24. A hydrated salt of formula $FeSO_4.xH_2O$ contains 45.3% of water crystallization. Calculate the value of x. [$Fe = 56; S = 32; O = 16\ H = 1$ (a) 7 (b) 8 (c) 5 (d) 6

25. Boron has two isotopes. If the isotope with mass 10.013 amu has 19.78% abundance, determine the atomic weight of boron given that the other isotope has a mass of

11.009 *amu*. (a) 10.09 amu (b) 18.01 amu (c) 10.81 amu (d) 9.71 amu

26. Bromide ion is oxidized by bromated ion in acidic solution. $5Br^-_{(aq)} + BrO_3^-{}_{(aq)} + 6H^+_{(aq)} \rightarrow 3Br_{2(aq)} + 3H_2O_{(l)}$
The experimentally determined rate law is $Rate = k[Br^-][BrO_3^-]^2[H^+]$
What is the overall order of the reaction?(a) 4 (b) 0 (c) 1 (d) 3

27. Consider the equilibrium $FeO_{(s)} + CO_{(g)} \rightleftharpoons Fe_{(s)} + CO_{2(g)}$
When CO_2 is remove from the equilibrium mixture (by passing the product through lime water), what is the direction of net reaction as the new equilibrium is achieved? (a) The reaction moves in the forward direction (b) The reaction moves in the backward direction (c) The equilibrium is static (d) The reaction is quenched

28. Given the following. I. Haze II. Aerosol spray III. Harmattan IV. Fogs V. Milk VI. Paints
Which of these statements is correct? (a) II, IV and V are colloidal particles (b) I and III are colloidal particles (c) II, III and VI are suspended particles (d) II, III and IV are suspended particles

29. A brand of Orange juice has a pH of 3.16. What is the hydronium ion $[H_3O^+]$ concentration of the beverage? $A.6.9 \times 10^{-4} B.7 \times 10^{-5} C.8.0 \times 10^{-4} D.3.16 \times 10^{-4}$

30. Consider the reaction:
$6Fe^{2+} + Cr_2O_7^{2-}{}_{(aq)} + 14H^+_{(aq)} \rightarrow 6Fe^+_{(aq)} + 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$
Which substance is the reducing agent?
$A.Fe^{2+} B.Cr_2O_7^{2-}\ C.Fe^{3+} D.Cr^{3+}$

31. Which of the following sets of quantum numbers is permissible for an electron in an atom?
(a) $n = 3,\ l = 2,\ m_l = 3, m_s = +\frac{1}{2}$
(b) $n = 2,\ l = 1,\ m_l = -1,\ m_s = -\frac{1}{2}$
(c) $n = 2,\ l = 1,\ m_l = 0,\ m_s = 0$
(d) $n = 2,\ l = 2,\ m_l = 0,\ m_s = +\frac{1}{2}$

32. Which of the following statements is not correct about the 4p orbital? (a) Is defined by the quantum number $l = 1$ (b) Is of higher energy than the 3d orbital (c) Contains a maximum of ten electrons (d) Contains degenerate suborbital

33. Which of the following procedure will completely separate the mixture of sand, potassium chloride and ammonium chloride?
(a) Add water, filter, sublime and evaporate
(b) Add water, sublime, filter and evaporate
(c) sublime, filter, add water and evaporate (d) sublime, add water, filter and evaporate

34. 4.6 g of ethanol released heat increase the temperature of 100 g of water from 28°C to 58°C. What is the heat of combustion of ethanol? $[C = 12, H = 1, O = 16, c = 4.2\ Jg{-}1K{-}1\ A.\ -1273\ KJmol{-}1B.\ -1260\ KJmol^{-1}C.\ -1200\ KJmol^{-1}D.\ -1560\ KJmol^{-1}$

35. A saturated solution of Ag_2CO_3 contains $0.003588\ gdm^{-3}$. The solubility product of the solution is? $[Ag = 108, C = 12, O = 16]$
(a) 8.79×10^{-15} (b) 1.69×10^{-10} (c) 5.37×10^{-12} (d) 5.37×10^{-15}

36. The pOH of a solution is 11.73. What is the hydrogen ion concentration of the solution?
$A.5.37 \times 10^{-4} moldm^{-3} B.5.37 \times 10^{-3} moldm^{-3} C.1.07 \times 10^{-3} moldm^{-3} D.1.82 \times 10^{-4} moldm^{-3}$

37. The standard enthalpies of formulation of $CO_{2(g)}$, $H_2O_{(g)}$ and $CO_{(g)}$ are $-394, -242$ and $-110\ KJmol^{-1}$. If the enthalpy change for the reaction below is $82.65\ Jmol^{-1}K^{-1}$. What is the free energy change? $CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$
$A.-42.0\ KJmol^{-1}\ B.-76.93\ KJmol^{-1}$
$C.+76.93\ KJmol^{-1} D.-17.07\ KJmol^{-1}$

38. Given the two half-cell reactions occurring in a cell as:
$X_{(s)} \rightarrow X^{2-}{}_{(aq)} + 2e^{2-}\ E^0_{X/X^{2+}} = +2.38\ V$
$Y^{2-}{}_{(aq)} + 2e^{2-} \rightarrow Y_{(s)} + E^0_{Y^{2+}/Y} = +0.34\ V$
Calculate the e.m.f of the cell $X/X^{+2}//Y^{+2}/Y$ and hence determine whether the reaction is spontaneous or not? (a) +2.72 V, spontaneous (b) +2.72 V, not spontaneous (c) −2.72 V, spontaneous (d) +2.04 V, spontaneous

39. An organic compound containing carbon, hydrogen and oxygen has 40.1% C, 6.67% H composition. Another oxide ore contain 72.36% iron. What are the empirical formulas of the compounds respectively? (a) CH_2O and FeO $B.C_2H_4O_2$ and Fe_2O_2
$C.CH_2O$ and $Fe_2O_3 D.CH_3O$ and FeO

40. The concentration of calcium ion in blood plasma is 0.025 M. If the concentration of oxalate ion is $1.0 \times 10^{-5} M$, will calcium oxalate precipitate out? Solubility product, Ksp for calcium oxalate is 2.3×10^{-9}. (a) Yes (b) No (c) Only if blood plasma is diluted (d) System remains at equilibrium

SOLUTION

1.

Reaction	PCl_5	→	PCl_3	+	Cl_2
At equi	0.2mol		0.3mol		0.3mol

$Volume\ of\ vessel\ (V) = 10L = 10dm^3$

$[PCl_5]_{equi} = \frac{n}{V} = \frac{0.2mol}{10dm^3} = 0.02M$

$[PCl_3]_{equi} = \frac{n}{V} = \frac{0.3mol}{10dm^3} = 0.03M$

$[Cl_2]_{equi} = \frac{n}{V} = \frac{0.3mol}{10dm^3} = 0.03M$

$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{(0.03M)(0.03M)}{0.02M}$

$K_c = 0.045M$

The correct option is B

2. Collision theory states that for a chemical reaction to occur there must be effective collision between the reacting particles. **Effective collision** is a type collision in which molecules collide with sufficient energy and proper orientation so that a chemical reaction can occur. Effective collision is also called successful collision. The following are the factors in which collision theory depends

(i) Collisions of the reacting particles

(ii) Frequency of collisions

(iii) Collision energy (i.e. kinetic energy) or energy of the colliding particles.

(iv) Orientation of the colliding particle

Note that medium of the reaction and size of the reacting particles are factors that affect the rate of reaction.

The correct option is B

3. Electrolysis of aqueous copper II tetraoxosulphate VI, $CuSO_4$ using platinum Electrodes.

The electrode is inert and the electrolyte is not concentrated. Therefore, the only factor to be considered is the position of the ion in the electron chemical series.

Ionization	Anode (+)	Cathode (-)
$CuSO_{(aq)} \rightarrow Cu^{2+} + SO_4^{2-}$	SO_4^{2-}	Cu^{2+}
$H_2O \rightarrow H^+ + OH^-$	OH^-	H^+

Anode: At the anode, OH^- is discharged.

$$4OH^- \rightarrow 2H_2O_{(l)} + O_{2(g)} + 4e^-$$

Cathode: At the cathode, Cu^{2+} is discharged.

$$4e^- + 2Cu^{2+} \rightarrow 2Cu_{(s)}$$

Resulting solution: The resulting solution is H_2SO_4 (i.e. acidic). Note that the prolong passage of electricity through the electrolyte will lead to the electrolysis of the resulting solution, H_2SO_4 to produce $H_2 \& O_2$.

In the Electrolysis of aqueous copper II tetraoxosulphate VI, $CuSO_4$ using platinum Electrodes the following are true

(i) Oxygen is formed at the Anode

(ii) Copper ions are discharge at the cathode.

(iii) The resulting solution is acidic. Thus, the P^H of the resulting solution will be less than 7

(iv) Prolong passage of electricity through the electrolyte will lead to the electrolysis of the resulting solution.

The correct option is C

4. $t_{H_2} = 30sec$

$R.M.M\ of\ H_2\ (M_{H_2}) = 2g/mol$

$R.M.M\ of\ HCl (M_{HCl}) = 36.5g/mol$

Since the volume of the two gases is equal let the volume of each of the gas be V

$R_{H_2} = \frac{V}{30} = 4$ and $R_{HCl} = \frac{V}{t}$

$$\frac{R_{H_2}}{R_{HCl}} = \sqrt{\frac{M_{HCl}}{M_{H_2}}}$$

$$\frac{\frac{V}{30}}{\frac{V}{t}} = \sqrt{\frac{35.6}{2}}$$

$$\frac{Vt}{30V} = \sqrt{\frac{36.5}{2}}$$

$$\frac{t}{30} = \sqrt{\frac{36.5}{2}}$$

Square both side

$$\left(\frac{t}{30}\right)^2 = \left(\sqrt{\frac{36.5}{2}}\right)^2$$

$$\frac{t^2}{900} = \frac{36.5}{2}$$

$2t^2 = 900 \times 36.5 = 32850$

$t^2 = \frac{32850}{2} = 16425$

$t^2 = 16425$

$t = \sqrt{16425} = 128.16secs$

The correct option is B

5. $m = 18.0g$

$Z_{Al} = \frac{R.A.M\ of\ Al}{Charge\ on\ Al \times 1F} = \frac{27}{3 \times 96500}$

$t = 1hr, 30min = 1 \times 3600 + 30 \times 60$

$= 5400s$

$m = ZIt$

$18 = \frac{27}{3 \times 96500} \times I \times 5400$

$18 \times 3 \times 96500 = 27 \times I \times 5400$

$I = \frac{18 \times 3 \times 96500}{27 \times 5400} = 35.7407$

$I = 35.7A$

The correct option is D

6. Acid anhydrides are substances that dissolve in water to produce an acid. Acid anhydride are generally divided into two:

(i) **Inorganic or mineral acid anhydride**: These are oxides of non-metal that dissolve in water to produce acid. e.g. $CO_2, SO_2, SO_3, NO_2, NO$ etc. Inorganic or mineral acid anhydrides that dissolve in water to produce two acids is known as **mixed acid anhydride**.

$H_2O + 2NO_2 \longrightarrow HNO_3 + HNO_2$

$CO_2 + H_2O \longrightarrow H_2CO_3$

$SO_2 + H_2O \longrightarrow H_2SO_3$

$SO_3 + H_2O \longrightarrow H_2SO_4$

$NO + H_2O \longrightarrow HNO_2$

(ii) **Organic acid anhydride:** These are organic compounds that dissolve in water to produce organic acids.

$(CH_3CO)_2O + H_2O \longrightarrow 2CH_3COOH$

In other words, acid anhydrides are oxides or compound which dissolves in water to produce a solution with P^H less than 7. Note that CO_2, SO_2 and SO_3 are anhydride of a dibasic acid. Dibasic acids are acids with a basicity of two. That is, an acid that contain two ionizable hydrogen atom

None of the option is correct

7. **Electrolytes:** *These are substance that conductor electricity in the aqueous or molten state with a resultant decomposition.* Electrolytes are of two types which are listed and explained below.

(a) ***Strong Electrolytes:*** These are electrolytes which undergo complete ionization in aqueous solution. Strong electrolytes are also known as **IONOGEN.** The following compounds always act as strong electrolyte.

(i) All strong acids e.g. H_2SO_4, HNO_3, HCl, HBr, HI, $HClO_4$

(ii) All strong base e.g. $NaHCO_3, NaOH, KOH$ and

(iii) All ionic salt e.g. $Na_2SO_4, NaCl, KCl, KNO_3, NaNO_3$ etc.

(b) ***Weak Electrolytes:*** These are electrolytes which undergo partial ionization in aqueous solution. Weak electrolytes are also known as **IONOSPHORE**. The following compounds always act as a weak electrolyte.

(i) All weak acids e.g. $H_2CO_3, H_2S, HF, H_2SO_3$etc.

(ii) All weak bases e.g. NH_4OH and

(iii) All covalent salt e.g. $PbCl_2, AgCl, BaSO_4$ etc.

The correct option is A

8. The acidity of $Na_3PO_4, Na_2HPO_4, NaH_2PO_4$ depends on the number of replaceable hydrogen atoms. The higher the number of replaceable hydrogen atoms the more the acidity. The order of increasing acidity of the salts are:

$Na_3PO_4 < Na_2HPO_4 < NaH_2PO_4$

The correct option is A

9. $X + Y \rightarrow Z$

Expt	$X(Moldm^{-3})$	$Y(Moldm^{-3})$	$R(Moldm^{-3}$
1	0.2	0.2	0.06
2	0.2	0.4	0.24
3	0.4	0.4	0.24

Step 1: Write an expression for the rate law

$let\ R = K[X]^m[Y]^n$

(Since X & Y are the only reactants)

$$K = \frac{R_1}{[A]^m[B]^n}$$

$$\Rightarrow \frac{R_1}{[X]_1^m[Y]_1^n} = \frac{R_2}{[X]_2^m[Y]_2^n}$$

$$\frac{R_2}{R_1} = \frac{[X]_2^m[Y]_2^n}{[X]_1^m[Y]_1^n}$$

$$\frac{R_2}{R_1} = \left(\frac{[X]_2}{[X]_1}\right)^m \left(\frac{[Y]_2}{[Y]_1}\right)^n$$

Step 2: To determine m choose any two experiments in which the concentration of Y remain the same or constant. That is experiment 2 and 3.

$$\frac{R_3}{R_2} = \left(\frac{[X]_3}{[X]_2}\right)^m \left(\frac{[Y]_3}{[Y]_2}\right)^n$$

$[X]_3 = 0.4, [X]_2 = 0.2, [Y]_3 = 0.4, [Y]_2 = 0.4,$

$R_3 = 0.24$ and $R_2 = 0.24$

$$\frac{R_3}{R_2} = \left(\frac{[X]_3}{[X]_2}\right)^m \left(\frac{[Y]_3}{[Y]_2}\right)^n$$

$$\frac{0.24}{0.24} = \left(\frac{0.4}{0.2}\right)^m \left(\frac{0.4}{0.4}\right)^n$$

$1 = 2^m \times 1^n (1^n = 1)$

$2^0 = 2^m$

$m = 0$

Step 3: To determine n choose any two experiments in which the concentration of X remains the same or constant. That is experiment 1 and 2.

$$\frac{R_2}{R_1} = \left(\frac{[X]_2}{[X]_1}\right)^m \left(\frac{[Y]_2}{[Y]_1}\right)^n$$

$[X]_2 = [X]_1 = 0.2, [B]_2 = 0.4, [B]_1 = 0.2$

$R_1 = 0.06$ and $R_2 = 0.24$

$$\frac{0.24}{0.06} = \left(\frac{0.2}{0.2}\right)^m \left(\frac{0.40}{0.20}\right)^n$$

$4 = 1^m \times (2)^n (But\ 1^m = 1)$

$2^2 = (2)^n$

$n = 2$

Step 4: Write out the rate law expression

$R = K[X]^m[Y]^n$

$R = K[X]^0[Y]^2$

The reaction is a second order reaction

Step 5: Using any experiment to determine K.

Let use experiment 1

$0.06 = k(0.2)^0(0.2)^2$

$0.06 = k \times 1 \times 0.04$

$k = \frac{0.06}{0.04} = 1.5$

The unit of k for a second order reaction in which time is measure in second is $L/mols$

$k = 1.5L/mols$

The complete rate law is given as

$R = 1.5M^{-1}s[X]^0[Y]^2$

The overall order of reaction $= 0 + 2 = 2$;

The correct option is C

10. Salt is the name given to a compound formed when all or part of the ionizable hydrogen of an acid is replaced by metallic or ammonium ions.

Salts are generally divided into the following groups

(i) **Normal salts** are salts formed when all the replaceable hydrogen ions in an acids is completely replaced by metallic or ammonium ion. Examples of normal salt are $NaCl, KBr, Na_2SO_4, NH_4Cl$

(ii) **Acid salts** are salts that still contain replaceable hydrogen ion. They are form by the partial neutralization of an acid with a base. It result from the insufficient supply of metallic ions to replace all the replaceable hydrogen ions in an acids. Examples of acid salt are $NaHSO_4, KHSO_4$ $NaHCO_3$, $KHCO_3$, $KHCO_3$, $NaHS$ etc

$$NaHS + NaOH \longrightarrow Na_2S + H_2O$$

Note that the solution of acid salt is necessarily acidic. In other words, some acid salt ($NaHCO_3$, $KHCO_3$, $KHCO_3$) dissolve in water to form alkaline solution.

$$NaHCO_3 + H_2O \longrightarrow H_2CO_3 + NaOH$$

The above equation shows that aqueous solution of $NaHCO_3$ is a strong alkaline or base

(iii) **Basic salts** are salt that are formed by the partial neutralization of a base by an acid. Basic salt still contain hydroxide ion (OH^-). Example of basic salts are $Zn(OH)Cl$, $Zn(OH)NO_3$, $Ba(OH)Br$, $Bi(OH)NO_3$ etc.

(iv) **Double salt** is a compound of two salts formed by crystallization from a solution containing both of them i.e. it is a mixture. A double salt has the general formulae

$M^{3+}M^{+}(SO_4)_2.12H_2O$ or

$M^{2+}(M^{+})_2(SO_4)_2.12H_2O$ e.g.

$Fe(NH_4)_2(SO_4)_2.12H_2O$,

$NaAl(SO_4)_2.6H_2O$

(v) **Complex salts** are salts that contain a complex ion. Complex ion is an a ion that contain charge group of atoms such that the central element is a transition element. Example of complex ions are, $[Fe(CN)_6]^{3-}$, $[Zn(OH)_4]^{2-}$. Examples of complex salts are $K_4[Fe(CN)_6]$, $Na_3[Fe(CN)_6]$, $Cu(NH_3)_4Cl_2$, $Na_2[Zn(OH)_4]$ etc

Note that the following terms are usually associated with salts

(vi) **Deliquescence** is the phenomenon or process whereby certain substances known as deliquescent substances absorb large amount of moisture (water vapour) from the atmosphere on exposure to form a solution. All deliquescent substances are also hygroscopic in nature e.g. $NaOH$, $FeCl_3$, KOH, $CaCl_2$, $MgCl_2$, P_4O_{10} etc.

(vii) **Hygroscopy** is the phenomenon or process whereby certain substances known as hygroscopic substances absorb moisture from the atmosphere without forming a solution but become sticky to touch e.g. CuO, $NaNO_3$, CaO, conc. H_2SO_4. They are mainly used as drying agent.

(viii) **Efflorescence** is the phenomenon where certain substances known as efflorescent substances lose some or all of their water of crystallization on exposure to the atmosphere e.g. $Na_2CO_3.10H_2O \longrightarrow Na_2CO_3.H_2O + 9H_2O$

(ix) **Decrepitation** is the phenomenon whereby a crystalline solid gives a cracking noise on heating due to the removal of water of crystallization e.g. $NaCl$, $KClO_3$,2moles of $Pb(NO_3)_2$.

(x) **Water of crystallization** is the amount of water that is associated with substance on crystallizing out of solution. In other words, water of crystallization is the amount of water that react chemically with a substance on crystallizing out of solution. Water of crystallization is also known as **hydration**.

The correct option is B

11. The **equilibrium constant**, k_c is defined as the product of the equilibrium concentration of the products, each raised to the power that corresponds to its coefficient in the balanced chemical equation, divided by the product of the equilibrium concentrations of reactants each raised to the power that corresponds to its co-efficient in the balanced chemical equation. In any k_c expression for heterogeneous system, only gaseous and aqueous species must be present. Solids and liquids must not be present because their activity is one.

Increase in temperature will shift the equilibrium forward for an endothermic reaction but decrease in temperature will shift

the equilibrium backward for an exothermic reaction. The word equilibrium shift forward means that the forward reaction is favoured while equilibrium shift backward means that the backward reaction is favoured.

Increase in temperature increases the equilibrium constant k_c for an endothermic reaction while decrease in temperature increases k_c for an exothermic reaction.

The **equilibrium position** is not the same as equilibrium constant. **Equilibrium position** of a reversible reaction refers to the relative amounts of reactants and products in the reacting system at a given time.

Le-chatelier's principle states that if an external constraint such as temperature, pressure and concentration is imposed on a chemical system at equilibrium, the equilibrium position will shift so as to annul or neutralize the constraint. Le-chatelier's principle is also known as

(i) The law of mobile equilibrium

(ii) Henri's rule

Le-chatelier's principle implies that the equilibrium position moves in opposite direction to the direction of the reaction. If the reaction moves forward, equilibrium position will move backward but if the reaction moves backward equilibrium position will move forward.

Thus, increase in temperature will shift the equilibrium forward or move the reaction forward but equilibrium position will move backward for an endothermic reaction while decrease in temperature will shift the equilibrium backward or move the reaction backward but equilibrium position will move forward for an exothermic reaction.

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}\ \Delta H = -ve$

(i) Increase in temperature will favour the backward reaction because it is endothermic. Therefore, equilibrium position will move forward or right.

(ii) Decrease in temperature will favour the forward reaction because it is exothermic. Therefore, equilibrium position will move backward or left.

(iii)Since the forward reaction is exothermic increase in temperature will decreases Equilibrium constant, K_c while decrease in temperature will increases Equilibrium constant, K_c

$2N_2O_{5(g)} \rightleftharpoons 2N_2O_{4(g)} + O_{2(g)}\ \Delta H = +ve$

(i) Increase in temperature will favour the forward reaction because it is endothermic. Therefore, equilibrium position will move backward or left.

(ii) Decrease in temperature will favour the backward reaction because it is exothermic. Therefore, equilibrium position will move forward or right.

(iii)Since the forward reaction is endothermic increase in temperature will increases Equilibrium constant, K_c while decrease in temperature will decreases Equilibrium constant, K_c

$3Fe_{(s)} + 4H_2O_{(g)} \rightleftharpoons Fe_3O_{4(s)} + 4H_{2(g)}\ \Delta H = -ve$

(i) Increase in temperature will favour the backward reaction because it is endothermic. Therefore, equilibrium position will move forward or right.

(ii) Decrease in temperature will favour the forward reaction because it is exothermic. Therefore, equilibrium position will move backward or left.

(iii)Since the forward reaction is exothermic increase in temperature will decreases Equilibrium constant, K_c while decrease in temperature will increases Equilibrium constant, K_c

$H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)}\ \Delta H = 0$

Since the reaction is an adiabatic reaction(i.e. $\Delta H = 0$) ,temperature has no effect on equilibrium constant, K_c, and on equilibrium position.

In this question, I think the examiner is mismatching equilibrium shift and equilibrium position. Equilibrium shift is a term used to describe the direction of the reaction. If the direction of the reaction is forward then equilibrium shift forward or toward the right but if the direction of the reaction is backward then equilibrium shift backward or toward left.

None of the option is correct

12. **Equilibrium constant** K_c is the value of the reaction quotient when a chemical system has reached equilibrium. In other words, **Equilibrium constant**, k_c is defined as the product of the equilibrium concentration of the products, each raised to the power that corresponds to its coefficient in the balanced chemical equation, divided by the product of the equilibrium concentrations of reactants each raised to the power that corresponds to its co-efficient in the balanced chemical equation. The only factor that affects equilibrium constant is temperature.

Equilibrium position of a reversible reaction refers to the relative amounts of reactants and products in the reacting system at a given

time. The factors that affect the equilibrium position are:
(i) Concentration
(ii) Pressure and
(iii) Temperature

The rate of a chemical reaction also known as reaction rate is the change in the concentrations of a reactant or a product with time (M/s).

The factors that affect the rate of reactions are:
(i) Concentration
(ii) Pressure
(iii) Temperature
(iv) Catalyst
(v) Light
(vi) Nature of reactant
(vii) Medium of reaction
(viii) Surface area etc

The correct option is A

13

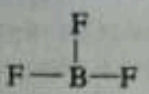
Species	Elements	Nature
$_{19}X \rightarrow 2,8,8,1$	K	Metal
$_{17}Y \rightarrow 2,8,7$	Cl	Non Metal

The bond between X and Y is an ionic or electrovalent bond. Ionic or electrovalent bonding is the electrostatic force of attraction that holds atoms together in ionic substance. It occurs between a metal and a non-metal as a result of the transfer of e^- from the metal to the non-metal. Ionic bonds are found in the following compounds $NaCl, MgO, MgCl_2$ etc

Ionic bonding leads to formation of ionic compounds. The following are the properties of ionic compounds.
(i) They are made up of aggregate of ions
(ii) They have high melting and boiling points.
(iii) They are good conductor of heat and electricity.
(iv) They are strong electrolyte
(v) Their reaction in aqueous medium is very fast because they exist completely as ion in aqueous medium.
(vi) They are soluble in water
(vii) They are polar substance i.e. they have a positive and negative poles.
(viii) They are solid at room temperature.
(ix) They are brittle
(x) They are non conductor of heat and electricity in the solid state

The correct option is C

14 The valence shell electron pair repulsion theory states that molecules or ion assumed the shape that best minimize repulsion between lone pair-lone pair, lone pair-bond pair and bond pair- bond pair electrons. Thus, the basic tenet of valence shell electron pair repulsion theory is that the pairs of electrons making the sigma bonds dictate the shape of molecules. The pi-bonds often encounter in some molecules serve to distort the shape of the molecules.



The Lewis structure of Boron trifluoride shows that Boron trifluoride is an electron deficient molecule. Electron deficient molecules or ions are molecules or ions in which their central element has less than eight electrons in their Lewis structure. All electron deficient molecules are Lewis acid.

The correct option is A

15. Primary standards are substances that can be obtained in a high degree or state of purity. They are use to prepare standard solutions. The followings are true of primary standard.
(i) They are non deliquescent substance
(ii) They are highly soluble in water
(iii) They are non hygroscopic substance
(iv) They are non efflorescent substance
(v) They are anhydrous substance. That is, they must not contain water of crystallization. An exception is $C_2H_2O_4.2H_2O$ because is it not efflorescence
(vi) They must have a fair high molecular weight
(vii) Their weight must not be altered during weighing
(viii) Examples are $Na_2CO_3, C_2H_2O_4.2H_2O$ etc

$NaOH$ is not a primary standard because it is deliquescent and its weight can be altered during weighing.

The correct option is D

16. Mass of Mg = $48g$
R.A.M of Mg = $24g/mol$

$$\cap_{Mg} = \frac{Reacting\ mass}{Molar\ mass}$$

$$\cap_{Mg} = \frac{48g}{24g/mol} = 2mol$$

Atoms of Si = $1.806 \times 10^{24} atoms$

$$\cap_{Si} = \frac{No\ of\ atoms}{6.02 \times 10^{23} atoms/mol}$$

$$\cap_{Si} = \frac{1.806 \times 10^{24}\ atoms}{6.02 \times 10^{23} atoms/mol} = 3mol$$

Mass of O = $128g$
R.A.M of O = $16g/mol$

$$\cap_{Mg} = \frac{Reacting\ mass}{Molar\ mass}$$

$$\cap_{Mg} = \frac{128g}{16g/mol} = 8mol$$

The compound under consideration contains 2mol of Mg, 3mol of Si and 8mol of O. Hence the compound is $Mg_2Si_3O_8$

The correct option is C

17. The oxidation number of Si in $Ca_2Si_3O_8$ be x. The oxidation of Ca is $+2$ and O in oxo compounds is -2

The sum of the oxidation number of each elements in a compound is zero.

$2(+2) + 3x + 8(-2) = 0$

$4 + 3x - 16 = 0$

$3x - 12 = 0$

$3x = 12$

$x = \frac{12}{3} = +4$

The correct option is C

18. $K_2CO_{3(aq)} + 2HCl_{(aq)} \rightarrow 2KCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

To obtained the net ionic equation, dissociate each of the aqueous species into their components ions

$[2K^+ + CO_3^{2-}] + [2H^+ + 2Cl^-] \rightarrow [2K^+ + 2Cl^-] + H_2O_{(l)} + CO_{2(g)}$

Remove all species that appear on both side e.g. K^+ and Cl^-

$CO_3^{2-} + 2H^+ \rightarrow H_2O_{(l)} + CO_{2(g)}$ net ionic equation

The correct option is D

19. **Stock solution:-** It is a commercially produced solution for any stock solution, the mass concentration and the molar concentration is given by:

$mass\ conc = 10pd$

$molar\ conc = \frac{10pd}{M}$

Where $P = \%\ by\ mass\ for\ solution$

For pure solution $P = 100$

$d = density\ in\ g/cm^3$,

$M = molar\ mass\ of\ solute$

Note that any solution whose density in g/cm^3 and percentage concentration is known is a stock solution. Note that density in g/cm^3 is also known as relative density or specific gravity

$P = 82\%$

$d = 1.20g/cm^3$

$V_1 = ?$

$C_1 = ?$

$V_2 = 250cm^3$

$C_2 = 2.0M$

$R.M.M(M)ofNH_4OH = 35g/mol$

$molar\ conc = \frac{10pd}{M}$

$molar\ conc(C_1) = \frac{10 \times 82 \times 1.20}{35}$

$= 28.1143M$

$C_1 \approx 28M$

$C_1V_1 = C_2V_2$

$28 \times V_1 = 250 \times 2$

$V_1 = \frac{250 \times 2}{28} = 17.8571cm^3 \approx 17.9cm^3$

The correct option is B

20. A redox reaction is a reaction in which oxidation and reduction occur simultaneously. Such reaction usually contain an oxidizing agent (i.e. the substance that undergoes reduction) and a reducing agent (i.e. the substance that undergoes oxidation).

In all the reactions given only two of them is a redox reaction. They are:

$6Cl_2 + 6Ca(OH)_2 \rightarrow Ca(ClO_3)_2 + 5CaCl_2 + 6H_2O$

$2H_2O_2 \rightarrow 2H_2O + O_2$

Oxidation is a process that involved increase in oxidation number while reduction is a process that involved decrease in oxidation number.

$\overset{0}{6Cl_2} + 6Ca(OH)_2 \rightarrow \overset{+5}{Ca(ClO_3)_2} + 5\overset{-1}{CaCl_2} + 6H$

In the above reaction, the only substance that undergoes change in oxidation number is Chlorine, Cl. The oxidation number of Cl change from 0 in Cl_2 to $+5$ in $Ca(ClO_3)_2$ (i.e. increase in oxidation number) and also changes from 0 in Cl_2 to -1 in $CaCl_2$ (i.e. decrease in oxidation number). Chlorine, Cl undergoes oxidation (i.e. increase in oxidation number) and reduction (i.e. decrease in oxidation number) simultaneously.

Therefore, the reaction is a redox reaction.

$\overset{-1}{2}H_2\overset{-2}{O_2} \rightarrow 2H_2\overset{-2}{O} + \overset{0}{O_2}$

In the reaction above, the oxidation number of Oxygen ,O_2 changes from -1 in H_2O_2 to 0 in O_2 (i.e. increase in oxidation number) and also changes from -1 in $H_2O_2$to -2 in H_2O (i.e. decrease in oxidation number). Hydrogen Peroxide, H_2O_2 undergoes oxidation (i.e. increase in oxidation number) and reduction (i.e. decrease in oxidation number) simultaneously.

Therefore, the reaction is a redox reaction.

In each of the following reaction a single species undergoes both oxidation and reduction.

Reaction	Species that undergoes oxidation and reduction
$6Cl_2 + 6Ca(OH)_2 \rightarrow Ca(ClO_3)_2 + 5CaCl_2 + 6H_2O$	Cl_2
$2H_2O_2 \rightarrow 2H_2O + O_2$	H_2O_2

The correct option is B

21. Carriers of electricity are the component of a substance that conducts electricity. Different substance have different carrier of electricity as shown in the table below:

Substance	Carrier of electricity
Electrolyte	Ions
Conductor	Mobile or valence electrons
Ionizing gases	Mobile electrons & ions
Semi conductors	Ions and hole

Note that hole is the partial positive charge left behind when electron are liberated from the surface of a semi-conductor.

Molten Sodium chloride is an electrolyte as a result its carrier of electricity is the ion.

Substance	Carrier of electricity
Aqueous Sodium chloride	Hydrated ions
Molten Sodium chloride	Mobile ions
Iron Rod	Mobile electrons

The correct option is C

22. In an electrochemical cell in which hydrogen electrode is coupled with zinc rod. The following holds:

(i) The zinc electrode is the anode because it is higher than hydrogen the electrochemical series

(ii) The anode decreases in size

(iii)Electrons flows from the anode to the cathode

(iv)The anode is the negative terminal

(v) The hydrogen electrode is the cathode

(vi)The cathode is the positive terminal

In an electrochemical cell in which hydrogen electrode is couple with copper rod. The following holds:

(i) The copper electrode is the cathode because it is lower than hydrogen the electrochemical series

(ii) Electrons flow from the anode to the cathode

(iii)The cathode increases in size

(iv)The cathode is the positive terminal

(v) The hydrogen electrode is the anode

(vi)The anode is the negative terminal

The correct option is D

3. In methanol, CH_3OH the following is true

) The bond between $C-H$ is covalent bond

(ii) The bond between $C-O$ is polar covalent bond

(iii)The bond between $O-H$ is hydrogen bond

(iv) The bond between two molecules of methanol is hydrogen bond

(v) The bond between methanol and water is hydrogen bond

(vi)Hydrogen bond is responsible for the fairly high boiling point of methanol.

The correct option is B

24. $\%\ of\ hydrated\ salt = 100\%$

$\%\ of\ water\ of\ crystalization = 45.3\%$

$\%\ of\ anhydrous\ salt = 100 - 45.3$

$= 54.7\%$

Since the value of the masses are in percentage, it means that the analyst (i.e. the person that carry out the experiment) is working with 1g of $FeSO_4.xH_2O$. Therefore assumed 100g of $FeSO_4.xH_2O$

Mass of hydrated salt = 100% of 100g

$= \frac{100}{100} \times 100g = 100g$

$mass\ of\ water = 45.3\%\ of\ 100g$

$= \frac{45.3}{100} \times 100 = 45.30g$

$mass\ of\ anhydrous\ salt$

$= (100\% - 45.3\%) of 100g$

$= 54.7\%\ of 100g$

$= \frac{54.7}{100} \times 100 = 54.70g$

Let the number of molecules of water of crystallization in the hydrated salt be x

$R.m.m\ of\ xH_2O = 18xg/mol$

$R.m.m\ of\ anhydrous\ salt, FeSO_4 = 152g/mol$

$\Rightarrow \frac{mass\ of\ anhydrous\ salt}{mass\ of\ water} = \frac{R.m.m\ of\ anhydrous\ salt}{R.m.m\ of\ water}$

$\frac{54.70}{45.30} = \frac{152}{18x}$

$54.70 \times 18x = 152 \times 45.30$

$984.6x = 6885.6$

$x = \frac{6885.6}{984.6} = 6.9933$

$x \approx 7$

Method 2

From the calculation above:

Mass of water = $45.30g$

Mass of anhydrous salt, $FeSO_4 = 54.70g$

$FeSO_4$	:	H_2O
$\frac{54.7}{152}$	:	$\frac{45.3}{18}$
0.3599	:	2.5167
1	:	6.9928

The correct option is A

25. R.A.M of B $= \alpha_1 m_1 + \alpha_2 m_2 + \alpha_3 m_3$
$\alpha_1 = 19.78\% = 0.1978$ $m_1 = 10.013$
$\alpha_2 = 100 - 19.78 = 80.22\% = 0.8022$
$m_2 = 11.009$
R.A.M of B $= \alpha_1 m_1 + \alpha_2 m_2$
R.A.M of B $=$
$0.1978 \times 10.013 + 0.8022 \times 11.009$
R.A.M of B $= 1.9806 + 8.8314$
$= 10.8120$
$\simeq 10.81\ (3.s.f)$

The correct option is C

26. The overall order of a reaction is the sum of the powers to which all reactant concentrations appearing in the rate law are raised. The overall order of the reaction is simply called the order of the reaction. If the order of the reaction is 0, the reaction is a zero order reaction, if it is 1, it is a first order reaction, if it is 2, it is a second order reaction, if it is 3, it is a third order reaction and so on.
For the rate law, $R = K[A]^x[B]^y$
x = The order of the reaction with respect to reactant A
y = The order of the reaction with respect to reactant B
$x + y$ = Overall order of the reaction
k = Rate constant
Thus $R = K[Br^-][BrO_3^-]^2[H^+]$. The overall order of the reaction 4 (i.e. $1 + 2 + 1 = 4$)

The correct option is A

27. $FeO_{(s)} + CO_{(g)} \rightleftharpoons Fe_{(s)} + CO_{2(g)}$
If CO_2 is remove from the reaction as soon as it is form, the reaction will proceed only in the forward reaction. This is because the backward reaction require CO_2 and Fe to proceed.

The correct option is A

28. The following is true of Haze, Aerosol spray, Harmattan, Fogs, Milk and paints
(i) Haze and Harmattan are suspensions
(ii) Aerosol spray, Fogs, paints and milk are colloids

The correct option is A

29. P^H stands for hydrogen ion potential. The hydrogen ion potential (P^H) of a medium is the negative logarithm of the hydrogen ion concentration to base 10.
$P^H = -log_{10}^{[H^+]}$ ..... Logarithmic form
$[H^+] = 10^{-P^H}$ ..... Index form
Experiment shows that the hydrogen ion, H^+ donated by an acid combine with water molecules to form hydroxonium or oxonium ion. In other word, hydrogen ion, exists in a solution as hydroxonium, H_3O^+
$P^H = -log_{10}^{[H^+]} = -log_{10}^{[H_3O^+]}$
$[H_3O^+] = 10^{-P^H}$
P^H is define in term of the concentration of hydrogen or hydroxonium ion not on the concentration of the acid. In any question, we must calculate the hydrogen or hydroxonium ion concentration from the concentration of the acid given.
$P^H = 3.16$
$[H_3O^+] = 10^{-3.16} = 6.9183 \times 10^{-4} M$

The correct option is A

30. $6\overset{+2}{Fe^{2+}} + \overset{+6}{Cr_2O_7^{2-}} + 14H^{2+} \rightarrow 2\overset{+3}{Cr^{3+}} + 6\overset{+3}{Fe^{3+}} + 7H_2O$
In the above reaction, the oxidation number of Iron changes from $+2$ in Fe^{2+} to $+3$ in Fe^{3+} (i.e. increase in oxidation number) while the oxidation number of Chromium changes from $+6$ in $Cr_2O_7^{2-}$ to $+3$ in Cr^{3+} (i.e. decrease in oxidation number). Iron, Fe^{2+} undergoes oxidation (i.e. increase in oxidation number) and $Cr_2O_7^{2-}$ undergoes reduction (i.e. decrease in oxidation number) simultaneously.
Therefore, the reaction is a redox reaction. The substance that undergoes oxidation is the reducing agent (i.e. Fe^{2+}) while the substance undergoes reduction is the oxidizing agent(i.e. $Cr_2O_7^{2-}$).

The correct option is A

31.

n	$\mathcal{L}$	$m_{\mathcal{L}}$	m_s
1	0	0	$\pm 1/2$
2	0,1	$-1,0,1$	$\pm 1/2$
3	0,1,2	$-2,-1,0,1,2$	$\pm 1/2$

The correct option is B

32. The following is true for the 4p orbital
(i) It is dumb bell in shape
(ii) It principal quantum number is 4
(iii) It is subsidiary quantum number is 1
(iv) It magnetic quantum number is $-1,0,$ or 1
(v) It spin quantum number is $\pm 1/2$
(vi) It is three fold degenerate
(vii) It has a higher energy than the 3d orbital
(viii) It contains maximum of 6 electrons

The correct option is C

33. The steps involve in separating a mixture of sand, potassium chloride and ammonium chloride are:
(i) Thermal dissociation to remove NH_4Cl
(ii) Dissolution to dissolve KCl
(iii) Filtration to remove sand
(iv) Evaporation to dryness to recover KCl
$NH_4Cl(g) \rightleftharpoons NH_3(g) + HCl(g)$

For a substance to sublime it must change from the solid state direct to the gaseous state without passing through the liquid state and the substance must not decompose along the line. NH_4Cl does not sublime because it decomposes along the process. Since the reaction is reversible, it is rightly called thermal dissociation.

Therefore, the processes are:

Thermal dissociation → dissolution → filtration → evaporation

Since many people hold that NH_4Cl sublime which is not true, the processes involve in the separation of the mixture, can be written as sublimation → dissolution → filtration → evaporation

The correct option is D

34. Mass of ethanol, $CH_3CH_2OH = 4.60g$

Mass of water, $H_2O = 100g$

$$\Delta T = 58 - 28 = 30^0C$$

Specific heat capacity of water $= 4.2J/gk$

No of mole of ethanol $(\cap_{CH_3CH_2OH})$

$$= \frac{Reacting\ mass}{Molar\ mass} = \frac{4.6g}{46g/mol}$$

$= 0.1$ mole

Heat liberated in burning ethanol is equal to heat gain by water provided no heat is loss to the surrounding.

Heat gained by water (Q) $= mc\Delta\theta$

$= 100g \times 4.2J/gk \times 30$

$= 12600J = 12.6kJ$

⇒ Heat liberated by burning 4.6g of ethanol is $12.6kJ$

⇒ 0.1mol of ethanol liberated …$12.6kJ$

1mol of ethanol liberated ……xkJ

$$\frac{0.1}{1} = \frac{12.6}{x}$$

$$0.1x = 12.6$$

$$x = \frac{12.6}{0.1} = 1260$$

Hence the heat of combustion of ethanol is $-1260kJ/mol$. The negative sign is because combustion process is an exothermic process

The correct option is B

35. Solubility product is the point whereby a slightly soluble salt will tends to precipitate. Extremely soluble salt such as $NaCl$ and NH_4Cl do not have solubility product.

Mass conc. $= 0.003588gdm^{-3}$

R.M.M of $Ag_2CO_3 = 276g/mol$

$$molar\ conc. = \frac{mass\ conc.}{molar\ mass}$$

$$molar\ conc. = \frac{0.003588gdm^{-3}}{276}$$

$$= 1.3 \times 10^{-5}M$$

$$Ag_2CO_{3(s)} \rightleftharpoons 2Ag^+ + CO_3^{2-}$$

$$\underset{xm}{} \quad \underset{2xm}{} \quad \underset{xm}{}$$

$$K_{sp} = [Ag^+]^2[CO_3^{2-}]$$

$$K_{sp} = (2x)^2(x)$$

$$K_{sp} = 4x^2(x)$$

$$= 4x^3$$

$$K_{sp} = 4x^3$$

$$But\ x = 1.3 \times 10^{-5}$$

$$K_{sp} = 4(1.3 \times 10^{-5})^3$$

$$= 8.788 \times 10^{-15}$$

$$= 8.788 \times 10^{-15} mol^3dm^{-9}$$

The correct option is A

36. $P^{OH} = 11.73$

$$P^{OH} + P^H = 14$$

$$11.73 + P^H = 14$$

$$P^H = 14 - 11.73 = 2.27$$

$$[H^+] = 10^{-P^H} = 10^{-2.27} = 5.37 \times 10^{-3}M$$

The correct option is B

37. The formation of an element in its pure state is zero

$$CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)} \Delta S = 82.65Jmol^{-1}K^{-1}$$

$$-110 \quad -242 \quad -394 \quad 0$$

$$\Delta H = \sum H_P - \sum H_R$$

$$\sum H_P = -394kJ/mol$$

$$\sum H_R = -110\ kJ/mol + (-242\ kJ/mol)$$

$$\sum H_R = -110\ kJ/mol + (-242\ kJ/mol)$$

$$\sum H_R = -352\ kJ/mol$$

$$\Delta H = -394 - (-352)$$

$$\Delta H = -394 + 352 = -42kJ/mol$$

$$\Delta S = 82.65Jmol^{-1}K^{-1} = 0.08265Jmol^{-1}K^{-1}$$

$$\Delta G = \Delta H - T\Delta S$$

At thermodynamic standard condition,

$$T = 298k$$

$$\Delta G = -42 - 298(0.08265)$$

$$\Delta G = -42 - 24.6297 = -66.6297kJ$$

None of the options is correct.

38. $X_{(s)}/X^{2+}//Y^{2+}/Y_{(s)}$

The oxidation and reduction half reactions are:

$X_{(s)} \rightarrow X^{2+} + 2e^-$ ... ...Oxidation half rxn

$Y^{2+} + 2e^- \rightarrow Y_{(s)}$ ... ...Reductionhalf rxn

$$X_{(s)} \rightarrow X^{2+} + 2e^-\ E^0 = +2.38V$$

Note that the reaction above can be written as shown below.

$$X^{2+} + 2e^- \rightarrow X_{(s)}\ E^0 = -2.38V$$

$$Y^{2+} + 2e^- \rightarrow Y_{(s)}\ E^0 = +0.34V$$

Note that if an electrochemical equation is multiply by a factor, its E^0 is not affected, but if an electrochemical equation is reverse the sign of its E^0 must also be reversed.

$X_{(s)}/X^{2+}//Y^{2+}/Y_{(s)}$

Consider the cell notation above. X moves from solid state to aqueous state while Y moves from aqueous state to solid state. As a

result its electrochemical equation must be reverse while that of Y remains the same.

$X_{(s)} \rightarrow X^{2+} + 2e^- \; E^0 = +2.38V$

$Y^{2+} + 2e^- \rightarrow Y_{(s)} \; E^0 = +0.34V$

Balanced the number of electrons in the two half reactions. From the equations the number of electrons is naturally balanced. Hence add up the two half

Reactions

$X_{(s)} \rightarrow X^{2+} + 2e^- \; E^0 = +2.38V$

$Y^{2+} + 2e^- \rightarrow Y_{(s)} \; E^0 = +0.34V$

$X_{(s)} + Y^{2+} \rightarrow X^{2+} + Y_{(s)} \; E^0 = 2.72V$

The E.M.F of the cell is $2.72V$

Method 2

In a redox reaction, the substance that undergoes oxidation process is the reductant while the substance that undergoes reduction process is the oxidant

$E.M.F\ of\ cell = E^0_{oxidant} - E^0_{reductant}$

For the above formula to give correct answer the cell reaction must be feasible

$E^0_{reductant} = -2.38V$

$E^0_{oxidant} = +0.34V$

$E.M.F\ of\ cell = +0.34V - (-2.38V)$

$E.M.F\ of\ cell = +0.34V + 2.37V = 2.72V$

Since $E^0$is positive the reaction is spontaneous

The correct option is A

39. Assuming 100g of each of the compound

$\%\ of\ C = 40.10\%$

$\%\ of\ H = 6.67\%$

Since the sum of the $\%\ of\ C$ and $\%\ of\ H$ is less than 100, Oxygen is present in the compound

$\%\ of\ O = 100 - (40.1\% + 6.67\%)$

$\%\ of\ O = 100 - 46.77 = 53.23\%$

$mass\ of\ C = 40.10\%\ of\ 100g$

$mass\ of\ C = \frac{40.10}{100} \times 100g = 40.10g$

$mass\ of\ H = 6.67\%\ of\ 100g$

$mass\ of\ H = \frac{6.67}{100} \times 100g = 6.67g$

$mass\ of\ O = 53.23\%\ of\ 100g$

$mass\ of\ O = \frac{53.23}{100} \times 100g = 53.23g$

C	:	H	:	O
$\frac{40.10}{12}$	:	$\frac{6.67}{1}$	:	$\frac{53.23}{16}$
3.3417	:	6.67	:	3.3269
1	:	2	:	1

The empirical formula is CH_2O

$\%\ of\ Fe = 72.36\%$

An oxide is a binary compound of Oxygen. An oxide of Iron contain Iron and Oxygen

$\%\ of\ O = 100 - 72.36\%$

$\%\ of\ O = 27.64\%$

$mass\ of\ Fe = 72.36\%\ of\ 100g$

$mass\ of\ C = \frac{72.36}{100} \times 100g = 72.36g$

$mass\ of\ O = 27.64\%\ of\ 100g$

$mass\ of\ O = \frac{27.64}{100} \times 100g = 27.64g$

Fe	O
$\frac{72.36}{56}$	$\frac{27.64}{16}$
1.2921	1.7275
1	1.3367
1	1.34
1	$\approx \frac{3}{4}$
4	3

The empirical formula is Fe_4O_3.

None of the options is correct

40. Conc. of $Ca^{2+} = 0.025M$

Conc. Of $C_2O_4^{2-} = 1.0 \times 10^{-5}M$

$K_{sp}\ of\ CaC_2O_4 = 2.3 \times 10^{-9}$

$CaC_2O_{4(s)} \rightleftharpoons Ca^{2+} + C_2O_4^{2-}$

$0.025M \quad 1.0 \times 10^{-5}M$

$Q = [Ca^{2+}][C_2O_4^{2-}]$

$= 0.025 \times 1.0 \times 10^{-5}$

$Q = 2.5 \times 10^{-7}$

Where Q is reaction quotient. The reaction quotient is a ratio of the concentration or pressure of the products of a reaction to the concentration or pressure of the reactants, each raise to the power indicated by the co-efficient in the balance chemical equation.

The reaction quotient is used to determine if a precipitate will occur in a given reaction or not.

(i) If $K_{sp} > Q$. The forward reaction will be favoured. Thus, no precipitation will occur; if solid is present, more solid can dissolve.

(ii) If $K_{sp} = Q$. The solution is just saturated. solid and solutions are in equilibrium, neither forward nor reverse process is favoured.

(iii)If $K_{sp} < Q$. The reverse process will be favoured. Thus precipitation occurs to form more solid. In the above calculation $Q = 2.5 \times 10^{-10}$ and $K_{sp} = 2.3 \times 10^{-9}$ (i.e. $K_{sp} > Q$). Therefore no precipitation will occur. Thus, calcium oxalate will not precipitate out of the blood plasma.

The correct option is B

CHM 001 EXAM 2014/2015
TIME ALLOWED: 65 MINUTES

Which of the following molecules are trigonal planar in shape? I. CCl_4 II. C_2H_4 III. NH_3 IV. BF_3 V. CO_2 (a) II and IV (b) II, III and IV (c) IV and V (d) I, II and III

Which of the following solution is acidic? (a) Calcium carbonate (b) Ammonia (c) Magnesium nitrate (d) Potassium chloride

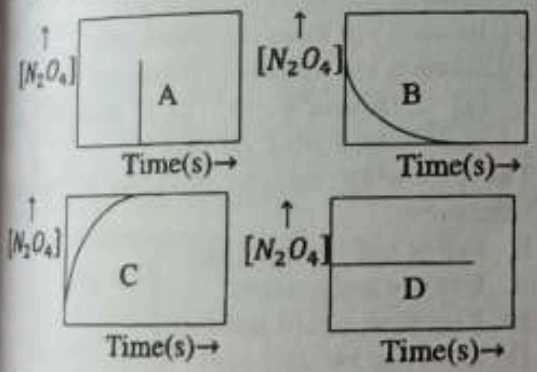
When 0.25 g sample of a hydrocarbon is burnt in excess oxygen, it yield 0.7636 g of carbon (IV)oxide. What is the empirical formula of the hydrocarbon? (a) CH_2 (b) CH_3 (c) C_5H_{12} (d) C_2H_3

Which of the following compounds is the least ionic? (a) Caesium fluoride (b) Caesium iodide (c) Lithium fluoride (d) Lithium iodide

Fungal laccase, a blue protein found in wood-rotting fungi, is 0.39% copper by mass. If a fungal laccase molecule contains 4 copper atoms, what is the molar mass of fungal laccase? $[Cu = 63.5\,g/mol]$ (a) 65.1 g / mol (b) 65128.2 g / mol (c) 254.5 g / mol (d) 254325.6 g/mol

Which of the following represents the correct pre-equilibrium progression in the concentration of N_2O_2 as indicated in the equation below?

$N_2O_4 \rightarrow 2NO_{2\,(g)}$



Real gases tend to deviate from ideal gas behavior because of which the following? I. they can be liquefied II. Their molecules experience forces of attraction III. Collisions of gas molecules are perfectly elastic IV. The actual volume occupied by gas molecules is not negligible V. Gas molecules are always in continuous motion (a) II and IV (b) I, II and III (c) III, III and V (d) III, IV and V

Which of these is not an example of a colloid? (a) Smoke (b) Brine (c) Milk (d) Glue

A brand of carbonated beverage has a pH of 3.16. What is the hydroxonium ion concentration of the beverage? (a) 8.0×10^{-4} (b) 7×10^{-4} (c) 6.9×10^{-4} (d) 3.16×10^{-4}

If hydrogen diffuses 8 times it takes for the same volume of a particular diatomic gas under the same conditions, what is the vapor density of this gas? $[H = 1]$ (a) 32 (b) 16 (c) 64 (d) 128

What is the mass of calcium hydride that would react with excess water to liberate 4.25×10^{24} molecules of hydrogen gas? The unbalanced chemical equation of the reaction involved is: $CaH_2 + H_2O \rightarrow Ca(OH)_2 + H_2O$ $[Ca = 40; H = 1; N_A = 6.02 \times 10^{23}]$ (a) 148.3 g (b) 444.8 g (c) 74.1 g (d) 296.5 g

Aspirin ($C_9H_8O_4$) is prepared by treating salicylic acid, $C_7H_6O_3$, with acetic anhydride, $C_4H_6O_3$, as shown in the equation below:

$C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + C_2H_4O_2$

In an experiment, 2.50 g salicylic acid is reacted with 1.50 g acetic anhydride. What mass of aspirin will be produced? (a) 2.65g (b) 3.26 g (c) 2.19 g (d) 4.50 g

The half life of a radioactive element is 2 days, calculate its decay constant (a) $6.05 \times 10^{-3}s^{-1}$ (b) $4.01 \times 10^{-6}s^{-1}$ (c) $2.01 \times 10^{-2}s^{-1}$ (d) $2.02 \times 10^{6}s^{-1}$

Which of the following is the balanced form of the redox reaction below in acidic medium?

$MnO^-_{4\,(aq)} + S_2O^{2-}_{3\,(aq)} \rightarrow Mn^{2+}_{(aq)} + S_4O^{2-}_{6\,(aq)}$

A. $2MnO^-_{4\,(aq)} + 8S_2O^{2-}_{3\,(aq)} + 16H^+_{(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 2S_4O^{2-}_{6\,(aq)} + 8H_2O_{\,(aq)}$

B. $2MnO^-_{4\,(aq)} + 10S_2O^{2-}_{3\,(aq)} + 16H^+_{(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 5S_4O^{2-}_{6\,(aq)} + 8H_2O_{\,(aq)}$

C. $2MnO^-_{4\,(aq)} + 10S_2O^{2-}_{3\,(aq)} + 12H^+_{(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 5S_4O^{2-}_{6\,(aq)} + 6H_2O_{\,(aq)}$

D. $MnO^-_{4\,(aq)} + 2S_2O^{2-}_{3\,(aq)} + 10H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + S_4O^{2-}_{6\,(aq)} + 5H_2O_{\,(aq)}$

Determine the enthalpy of combustion of solid carbon to form carbon dioxide is $-393.7\,KJ/mol$ carbon, and the enthalpy of combustion of carbon monoxide to form carbon dioxide is $-283.3\,KJ/mol$. Use these data to calculate ΔH for the reaction below:

$2C_{(s)} + O_{2\,(g)} \rightarrow 2CO_{(g)}$ (a) $220.8KJ$ (b) $-283.3KJ$ (c) $-220.8KJ$ (d) $-110.4KJ$

50 g of a mixture of $KClO_3$ and KCl were strongly heated. If 0.06 mole of oxygen is produced, calculate the percentage by mass of potassium trioxochlorate(V) in the mixture $[KClO_3 = 122.5, KCl = 74.5]$ (a) 75.38% (b) 24.62% (c) 38.91% (d) 55.83%

Calculate the free energy change for the formation hydrogen iodide gas at 25°C, if the enthalpy change is $-265.86KJmol^{-1}$? Given that the absolute entropy for hydrogen iodide is $181.45\,Jmol^{-1}K^{-1}$, for hydrogen is $255.68\,Jmol^{-1}K^{-1}$ and for iodide is 169.93 $Jmol^{-1}K^{-1}$. (a) $+314.35KJmol^{-1}$ (b)

$+256.52KJmol^{-1}$ (c) $-314.35KJmol^{-1}$ (d) $-256.52KJmol^{-1}$

18. A 36% solution of hydrochloric acid has a density of $0.80\,gcm^{-3}$. How much of this acid solution must be diluted to give $200cm^3$ of $0.25\,moldm^{-3}$ HCl solution? $H = 1; Cl = 35.5$ (a) $4.56\,cm^3$ (b) $8.17cm^3$ (c) $6.34cm^3$ (d) $2.28cm^3$

19. What are the oxidation half cell and overall e.m.f., respectively, of the cell represented below: $Mg_{(s)}/Mg^{2+}_{(aq)}\,//\,Sn^{2+}_{(aq)}/Sn_{(s)}$
If $Mg^{2+} + 2e^- \rightarrow Mg \quad E^\circ = -2.37V$
$Sn^{2+} + 2e^- \rightarrow Sn \quad E^\circ = -0.14V$
(a) $Mg_{(s)}/Mg^{2+}_{(aq)}$ and $+2.23V$
(b) $Sn^{2+}_{(aq)}/Sn_{(s)}$ and $-2.23V$
(c) $Sn^{2+}_{(aq)}/Sn_{(s)}$ and $-2.51V$
(d) $Mg_{(s)}/Mg^{2+}_{(aq)}$ and $+2.51V$

20. What is the pH of a solution obtained by mixing $50cm^3$ of $0.2\,M$ solution of sulphuric acid with $50cm^3$ of $0.2\,M$ solution of sodium hydroxide? (a) 13 (b) 11.7 (c) 12.7 (d) 1.3

21. Bromide ion is oxidized by bromated ion in acidic solution.
$5Br^-_{(aq)} + BrO^-_{3\,(aq)} + 6H^+_{(aq)} \rightarrow 3Br_{2(aq)} + 3H_2O_{(l)}$
The experimentally determined rate law is $Rate = k[Br^-]^2[Br_3^-][H^+]$
What is the overall order of the reaction? (a) 0 (b) 4 (c) 3 (d) 1

22. Calculate the enthalpy change for the reaction
$C_2H_{4\,(g)} + H_{2(g)} \rightarrow C_2H_{6\,(g)}$
Given:
$C_2H_{4\,(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{\,(g)}\ \Delta H = -1410.9KJ$
$2C_2H_{6(g)} + 7O_{2(g)} \rightarrow 4CO_{2(g)} + 6H_2O_{\,(g)}\ \Delta H = -3119.4KJ$
$2H_{2(g)} + O_{2(g)} \rightarrow +2H_2O_{\,(g)}\ \Delta H = -571.6KJ$
(a) $-285.8KJ$ (b) $137.0KJ$ (c) $1559.7KJ$ (d) $-137.0KJ$

23. Which of the following statement about the reaction A with B as shown in the chemical equation is not correct?
$A_{2(g)} + 3B_{2(g)} \rightleftharpoons 2AB_{3(g)}\ \Delta H = -78.92KJ$
I. Decreasing pressure will favour the formation AB_3
II. Increasing the temperature will favour A and B
III. The presence of Fe will lower the activation energy of the reaction
IV. Decreasing the temperature will favour the formation of AB_3
V. Reaction of AB_3 with another compound D will favour the formation of AB_3 (a) *I, IV and V* (b) *I and IV* (c) *I only* (d) *I, II and III*

24. Given the following half-reaction and their potentials
$Mg^{2+}_{(aq)} + 2e^- \rightarrow Mg_{(s)} \quad E^\circ = -2.37V$
$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)} \quad E^\circ = +0.34V$
Will copper metal spontaneously reduce Mg^{2+} in aqueous solution?
$Cu_{(s)} + Mg^{2+}_{\ (aq)} \rightarrow Cu^{2+}_{\ (aq)} + Mg_{(s)}$
(a) The reduction will not take place because E°_{rxn} is $-2.71\,V$
(b) The reduction will occur because E°_{rxn} is $+2.71\,V$
(c) The reduction will occur because E°_{rxn} is $+2.71\,V$
(d) The reduction will not occur because E°_{rxn} is $-2.03\,V$

25. In the electrolysis of concentrated calcium chloride solution using graphite electrodes, which of the following statements are correct?
I. Hydroxide ions are discharge at the anode
II. Chloride ions are discharge at the anode
III. Calcium is deposited at the cathode
IV. Solution left is neutral to litmus
V. solution left turns litmus to red
VI. solution left turns red litmus blue
VII. solution left turns blue litmus red
(a) *I, III and V* (b) *II, IV and VII* (c) *II, IV and V* (d) *I, III and V*

26. The following are the mixtures of various substances,
I. Iodine and common salt
II. Oxygen and nitrogen
III. Kerosene, petrol and diesel
IV. Common salt and sand
Which of the following represents the correct techniques of separation for these substances, respectively? (a) Sublimation, evaporation, distillation, dissolution followed by evaporation (b) Sublimation, chromatography, fractional distillation, dissolution followed by filtration and evaporation (c) Sublimation, liquefaction followed by fractional distillation, dissolution followed by filtration and evaporation (d) Sublimation, ordinary distillation, fractional distillation, filtration followed by evaporation

27. Consider the 2 postulates below:
Atoms can neither be created nor destroyed.
Atoms of a particular element are all exactly alike in every respect but different from atoms of other elements. Which chemical law can be

used to verify these postulates, respectively? (a) Law of constant composition and law of multiple proportions (b) The law of conservation of mass and law of multiple proportion (c) Law of conservation of mass and law of constant composition. (d) Law of multiple proportion and law of chemical combine.

28. Which of the following carriers is responsible for electrical conduction in molten sodium chloride? (a) Free mobile electrons (b) Free mobile hydrated ions (c) Free mobile ions (d) Pi-electrons

29. At 985°C, the equilibrium constant for the reaction below is 1.63. What is the equilibrium constant for the reverse reaction at the same temperature?
$H_{2(g)} + CO_{2(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$ (a) 2.66 (b) 0.815 (c) 0.613 (d) 1.63

30. What mass of $K_2Cr_2O_7$ will crystallize out if 620 g of a saturated $K_2Cr_2O_7$ solution at 60°C is cooled to 20°C. The solubility of $K_2Cr_2O_7$ is $12.0\ g\ per\ 100\ g$ of water at 20°C and $43.0\ g\ per\ 100\ g$ of water at 60°C. (a) 134.4 g (b) 55.0 g (c) 120.0 g (d) 31.0 g

31. You are given a solution of 14.8 M NH_3. How many milliliters of this solution do you require to give $100mL$ of 1.00 M NH_3 when diluted? (a) $6.7Ml$ (b) $6.00Ml$ (c) $6.76Ml$ (d) $7.67mL$

32. The cost of electricity required to produce $448mL$ of chlorine at s.t.p is $N9.00$. How much would it cost to deposit 5 g of calcium? $[Molar\ volume = 22.4dm^3; Ca = 40]$ (a) $N225.00$ (b) $N56.25$ (c) $N28.13$ (d) $N112.50$

33. Consider the following chemical equations representing some common reactions:
I. $2H_2 + O_2 \rightarrow 2H_2O$
II. $Cl_2 + 2NaOH \rightarrow NaClO + Nacl + H_2O$
III. $3Br_2 + 6KOH \rightarrow KBrO_3 + 5KBr + 3H_2O$
IV. $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
V. $2H_2O \rightarrow 2H_2 + O_2$
Which of these equations has/have species acting as both oxidizing agent(s) and reducing agent(s)? (a) $V\ only$ (b) $I\ and\ IV$ (c) $I\ only$ (d) $II, III\ and\ V$

34. Given that the solubility product of $Mg(OH)_2$ is $8.9 \times 10^{-12} mol^3 dm^{-9}$, its solubility in $0.05 moldm^{-3}$ sodium hydroxide solution is (a) $1.75 \times 10^{-10} moldm^{-3}$ (b) $3.56 \times 10^{-9} moldm^{-3}$ (c) $2.23 \times 10^{-4} moldm^{-3}$ (d) $2.23 \times 10^{-12} moldm^{-3}$

35. Consider the following substances
(I) Gold
(II) Bronze
(III) Distilled water
(IV) Harmattan haze
(V) Copper(II)oxide
(VI) Silver
(VII) Coca cola drink
Which of these are pure substances? (a) $I, II, IV, VI\ and\ VII$ (b) $III, IV, VI\ and\ VII$ (c) $I, III, V\ and\ VI$ (d) $II, IV\ and\ VII$

36. A binary ionic compound is known to contain a cation (M^{a+}) with 51 protons and 48 electrons. The anion (X^{b-}) contains one-third the number of protons as the cation. The number electrons in the anion are equal to its number of protons plus 1. What is the formula of this compound? (a) M_3X_2 (b) M_2X_3 (c) MX_3 (d) MX

37. Given the following hypothetical elements of the periodic table and their atomic numbers: $_{19}A$, $_8B$, $_{11}C$, $_1D$, $_{17}E$ and $_6F$. Predict the types of bonding, you would expect in the compounds listed below, respectively. I. AB II. B_2C III. B_2C IV. $[D_2BH]^+$ (a) Electrovalent, metallic, covalent followed by coordinate (b) Electrovalent, coordinate, covalent, metallic and dative (c) Covalent, electrovalent, metallic, covalent followed by coordinate (d) Electrovalent, covalent metallic, covalent followed by coordinate

38. Which of the following particles has the longest wavelength? (a) A neutron travelling at x meters per second (b) A proton travelling at x meters per second (c) An electron travelling at x meters per second (d) A proton travelling at $2x$ meters per second

39. A 0.100 M solution of acetic acid is found to be 1.33% ionized at 25°C. What is the dissociation constant of the acid? (a) 1.79×10^{-7} (b) 1.33×10^{-2} (c) 2.04×10^{-5} (d) 1.09×10^{-5}

40. An electrochemical cell is represented symbolically as:
$M_{(s)}/M^{2+}_{(aq)}//Cu^{2+}_{(aq)}/Cu_{(s)}$ $E^\circ_{cell} = +0.78\ V$.
What is $E^\circ_{M^{2+}/M}$ if $E^\circ_{Cu^{2+}/Cu}$ is $+0.34\ V$? (a) $+1.12\ V$ (b) $+0.44\ V$ (c) $-0.44\ V$ (d) $-1.12\ V$

SOLUTION

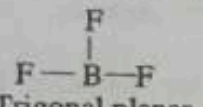
1. The shape of a molecule or ion is the geometric structure of the molecule or ion. The shapes of molecules or ions are determined by isoelectric rule.
ISOELECTRIC RULE states that molecules or ions with the same valence electrons possess the same shapes. All two atoms molecules or ions are linear in shape with bond angles of 180° e.g. $CO, HCl, HBr, HF, HI, CN^-, OH^-$ etc.

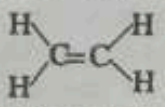
The shapes of molecules or ions with more than two atoms are determined majorly by hybridization. The hybridization of the central element reveals the orbital that overlap and consequently the region of high electron density. The region of high electron density shows the distribution of bond and lone pair of electrons on the central element, which in turn determine the shape of the molecules or ions. Hence each hybrid orbital shows a specific shape.

(i) **SP-hybridized molecules or ions**:- These are molecules or ions whose central elements are SP-hybridized. All Sp-hybridized molecules or ions are linear in shape and their bond angle is 180° e.g. CO_2,$BeCl_2$,CS_2,$HgBr_2$ CdI_2, C_2H_2 etc.

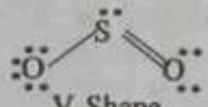
(ii) **SP^2-hybridized molecules or ions**:- These are molecules or ions whose central elements are Sp^2 –hybridized. All Sp^2-hybridized molecules or ions have two possible shapes.

(a) If the Sp^2 –hybridized molecules or ions have no lone pair of electrons on the central element the shape is **TRIGONAL PLANAR** and their bond angle is 120° e.g. BF_3


Trigonal planar

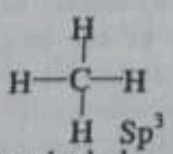

Trigonal planar

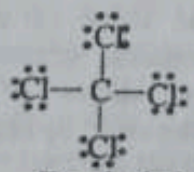
(b) If the Sp^2-hybridized molecules or ions contain a lone pair of electron on their central element, the shape is ANGULAR, BENT or V-SHAPE and their bond angle is less than 120° e.g. SO_2


V-Shape

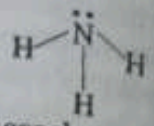
(iii)**Sp^3-hybridized molecules or ions**:- These are molecules or ions whose central elements are Sp^3-hybridized. Sp^3-hybridized molecules or ions have three possible shapes.

(a) If the Sp^3-hybridized molecules or ions have no lone pair of electrons on the central element, the shape is TETRAHEDRAL and their bond angle is 109° 28^1 or 109.5° e.g. CH_4, CCl_4 etc.

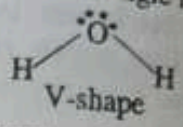

Tetrahedral


Tetrahedral

(b) If the Sp^3-hybridized molecules or ions have one lone pair of electrons on their central element, the shape is TRIGONAL PYRAMIDAL and their bond angle is 107° e.g. NH_3

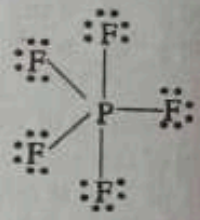

Trigonal pyramidal

(c) If the Sp^3-hybridized molecules or ions have two lone pair of electrons on the central element the shape is ANGULAR, BENT or V-SHAPE and the bond angle is 105° e.g. H_2O


V-shape

(iv)**Sp^3d-hybridized molecules or ions**: These are molecules or ions whose central elements are Sp^3-hybridized. Sp^3-hybridized molecules or ions have four possible shapes.

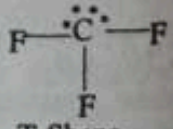
(a) If the Sp^3d-hybridized molecules or ions have no lone pair of electrons on the central element, the shape is TRIGONAL BIPYRAMIDAL and the bond angle are 90° 120°& 180° e.g. PF_5


Trigonal bipyramidal

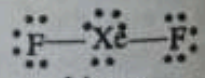
(b) If the Sp^3d-hybridized molecules or ions have one lone pair elements on the central element the shape is SEESAW e.g. SF_4


Seesaw

(c) If the Sp^3d-hybridized molecules or ions have two lone pair elements on the central element the shape is T-SHAPE e.g. ClF_3


T-Shape

(d) If the Sp^3d-hybridized molecules or ions have three lone pair of electrons on the central element, the shape is LINEAR e.g. XeF_2


Linear

The correct option is A

2. The acidity or alkalinity of a substance in aqueous medium depends on the hydrolysis of the substance on the medium.
Hydrolysis is the process whereby solutes are split apart into their component ions when

they react with water. The following are the rules of hydrolysis of a substance.

(i) Salts formed by strong acid and weak base on hydrolysis give acidic medium e.g. $AlCl_3$, $FeCl_3$, NH_4Cl, etc

$$AlCl_3 + 3H_2O \rightarrow Al(OH)_3 + 3HCl$$
Weak Strong

$$FeCl_3 + 3H_2O \rightarrow Fe(OH)_3 + 3HCl$$
Weak Strong

$$NH_4Cl + H_2O \rightarrow NH_4OH + HCl$$
Weak Strong

$$Mg(NO_3)_2 + 2H_2O \rightarrow Mg(OH)_2 + 2HNO_3$$
Weak Strong

In each of the above example, the resulting solution is acidic. This is due to the presence of the strong acid, HCl or HNO_3

(ii) Salts formed by weak acid and strong base on hydrolysis give alkaline medium e.g. $NaHCO_3$, Na_2CO_3, $NaHCO_3$, $NaHCOO$ etc.

$$Na_2CO_3 + 2H_2O \rightarrow 2NaOH + H_2CO_3$$
Strong Weak

$$NaHCO_3 + H_2O \rightarrow NaOH + H_2CO_3$$
Strong Weak

$$NaCH_3COO + H_2O \rightarrow NaOH + CH_3COOH$$
Strong Weak

$$NaHCOO + H_2O \rightarrow NaOH + HCOOH$$
Strong Weak

In each of the above example, the resulting solution is basic or alkaline. This is due to the presence of the strong base, $NaOH$

(iii) The hydrolysis of salt formed by strong acid and strong base will give a neutral medium e.g. Na_2SO_4, KCl, $NaCl$ etc

$$Na_2SO_4 + 2H_2O \rightarrow 2NaOH + H_2SO_4$$
Strong Strong

$$KCl + H_2O \rightarrow KOH + HCl$$
Strong Strong

In the example above, the resulting solution is neutral due to the presence of the strong acid, H_2SO_4 or HCl and the strong base, $NaOH$ or KOH

(iv) The hydrolysis of salt formed by weak acid and weak base will give either an alkaline, acidic or neutral solution e.g. NH_4CH_3COO, NH_4CN, NH_4F, $CaCO_3$ etc

$$NH_4CH_3COO + H_2O \rightarrow NH_4OH + CH_3COOH$$
Neutral solution

$$NH_4CN + H_2O \rightarrow NH_4OH + HCN$$
Alkaline solution

$$NH_4F + H_2O \rightarrow NH_4OH + HF$$
Acidic solution

$$CaCO_3 + H_2O \rightarrow Ca(OH)_2 + H_2CO_3$$
Alkaline solution

Note that ammonia, NH_3 is a weak base.

The correct option is C

3. Hydrocarbons are compounds that are made of carbon and hydrogen only. Hydrocarbon are generally represented by C_xH_y

Mass of hydrocarbon = $0.25g$

Mass of CO_2 = $0.7636g$

Mass of C in $0.7636g$ of CO_2

$$= \frac{R.m.m\ of\ C}{R.m.m\ of\ CO_2} \times mass\ of\ CO_2$$

$$= \frac{12g/mol}{44g/mol} \times 0.7636g\ of\ CO_2$$

$$= 0.2083g$$

Mass of C = $0.2083g$

Mass of H = mass of C_xH_y − mass of C

Mass of H = $0.25g - 0.2083g = 0.0417g$

C	:	H	
$\frac{0.2083}{12}$	:	$\frac{0.0417}{1}$	
0.0174	:	0.0417	
1	:	2.3966	Round to 2d.p
1	:	≈ 2.40	
1	:	$\frac{12}{5}$	Multiply by 12
5	:	12	

The empirical formula is C_5H_{12}

The correct option is C

4. The ionic character of a compound depends on the atomic volume or size of the elements that made up the compound and the difference in the electronegativities of the elements that made up the compounds.

The term ionic character can be interpreted in two ways. It can be view as the ease with which a substance loses electrons to form compound. Based on this view ionic character increases down any group.

On the other hands, ionic character can be view as the degree of the strength of the bond in an ionic compound. The smaller the cation and the larger the anion in an ionic compound the more the ionic character of the compound.

Consider the group 1A element-Li, Na, K, Rb, Cs and Fr. Francium, Fr is radioactive. The ionic character (i.e. their degree or ease of losing electrons) increases down the group. That is, Cs is more ionic than the other elements without considering Fr.

Consider, the chloride of the group 1A element- $LiCl$, $NaCl$, KCl, $RbCl$ and $CsCl$. The ionic character decrease from $NaCl$ to $CsCl$ meaning that the ionic character of NaCl is greater than CsCl. This is the reason the melting point and boiling point of NaCl is greater than that of CsCl. Note that the small size of Li and the unavailability of a vacant d-

orbital makes it to behave abnormally. Hence LiCl is less ionic compared to CsCl.

Consider CsF, CsI, LiF and LiI. CsF is ionic than than CsI due to the fact that F is more electronegative than I. In the same vein, LiF is more ionic than LiI. But CsI is more ionic than LiF due to the abnormal behaviour of Li as a result of it small size and no vacant d-orbital.

The correct option is D

5. % of Cu = 0.39%

No of atoms of Cu = 4

R.A.M of Cu = $63.5g/mol \times 4$

$= 254g/mol$

$$\% \text{ of Cu} = \frac{R.A.M\ of\ Cu}{R.M.M\ of\ Compound} \times 100$$

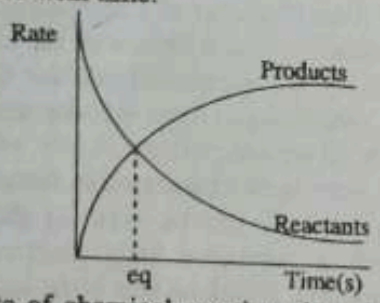
$$0.39 = \frac{254}{R.M.M\ of\ Compound} \times 100$$

$$R.M.M\ of\ Compound = \frac{254}{0.39} \times 100$$

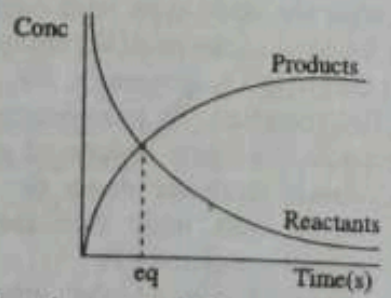
$= 65128.20513g/mol$

The correct option is B

6. The rate of a chemical reaction also known as reaction rate is the change in the concentrations of a reactant or a product with time (M/s).In any given reaction, the rate of reaction of the reactants decreases with time but the rate of reaction of the product increases with time.

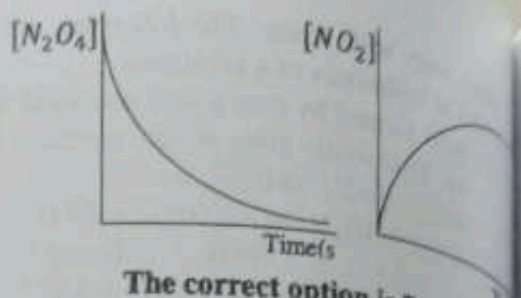


The rate of chemical reactions is proportional to the concentration of the reactants or products. Therefore the graph of concentration against time is as shown below:



Thus the graph of the reaction:

$N_2O_{4(g)} \rightarrow 2NO_{2(g)}$ before equilibrium is establish is as shown below



The correct option is B

7. Gases are classified into two; ideal gases and real gases. In reality, ideal gases do not exist. But at low pressure and high temperature, real gases behave as ideal gases. Ideal gases are gases that satisfy the following conditions:
   (i) The actual volume occupied by the gas molecules is negligible compared with the volume of the container.
   (ii) Force of attraction or repulsion between the molecules of gases are negligible and
   (iii)Obey the gas laws

   Thus, real gases tend to deviate from ideal gases behaviour because of the following reasons
   (i) Force of attraction or repulsion between the molecules of gases are not negligible as a result the molecules experiences forces of attraction
   (ii) The actual volume occupied by the gas molecules is not negligible compared with the volume of the container.
   (iii)They do obey the gas laws at high pressure and low temperature

The correct option is A

8. Emulsion is a colloid in which small particles of one liquid are dispersed in another liquid. It involves a dispersion of water in an oil or a dispersion of oil in water. Water is a polar solvent that does not dissolve non-polar substance. To use water to wash soiled fabrics, Green dishes or human bodies, the water must be enabled to suspend and remove non-polar substances. Soaps and detergents are two common emulsifying agents that can be used to enable water to suspend and remove non-polar substances. A detergent solution shaken with water will produced emulsion. Emulsion is a false solution.

The table below gives various type of false solutions also known as colloid.

Dispersed (solute-like) phase		Dispersing (solvent-like) medium	Common name	Example
Solid	in	solid	solid solution	Many alloys (e.g steel and duralumin), some colour

				gems, reinforced rubber, piscelain, pigmented plastic etc.
Liquid	in	solid	solid emulsion	Cheese, butter, jellies
Gas	in	solid	solid foam	Sponge, rubber, punice styrofoam
Solid	in	liquid	sols and gas	Milk of magnesium $(Mg(OH)_2)$, paints, and puddings
Liquid	in	liquid	emulsion	Milk, face cream, salad dressings, mayonnaise
Gas	in	liquid	foam	Sharing cream, whipped cream, foam on beer
Solid	in	gas	Solid aerosol	Smoke, airborne, viruses and particulate matter from auto exhaust
Liquid	in	gas	liquid aerosol	Fog, mist, aerosol spony, clouds.

Note that brine is the name given to concentrated aqueous sodium chloride, $NaCl$. Hence brine is a compound.

The correct option is B

9. P^H stands for hydrogen ion potential. The hydrogen ion potential (P^H) of a medium is the negative logarithm of the hydrogen ion concentration to base 10.

$p^H = -log_{10}^{[H^+]}$ ..... Logarithmic form

$[H^+] = 10^{-p^H}$ ..... Index form

Experiment shows that the hydrogen ion, H^+ donated by an acid combine with water molecules to form hydroxonium or oxonium ion. In other word, hydrogen ion, exists in a solution as hydroxonium, H_3O^+

$p^H = -log_{10}^{[H^+]} = -log_{10}^{[H_3O^+]}$

$[H_3O^+] = 10^{-p^H}$

p^H is define in term of the concentration of hydrogen or hydroxonium ion not on the concentration of the acid. In any question, we must calculate the hydrogen or hydroxonium ion concentration from the concentration of the acid given.

P^{OH} is the negative logarithm of the hydroxide ion concentration to base 10.

$p^{OH} = -log_{10}^{[OH^-]}$ ..... $logarithmic\ form$

$[OH^-] = 10^{-PH}$ ..... $index\ form$

P^{OH} is defined in term of the concentration of hydroxide ion not concentration of the base. In any question, we must calculate the hydroxide ion concentration from the concentration of the base given.

$P^H = 3.16$

$[H^+] = 10^{-3.16} = 6.9183 \times 10^{-4} M$

The correct option is C

10. Let the gas be represented with X

Let the rate of diffuse of the X $(R_x) = x$

Rate of diffusion of hydrogen $(R_{H_2}) = 8x$

Vapour density of X $= D_x$

Vapour density of H $= 1$

$$\frac{R_X}{R_{H_2}} = \sqrt{\frac{D_{H_2}}{D_X}}$$

$$\frac{x}{8x} = \sqrt{\frac{1}{D_X}}$$

$$\frac{1}{8} = \sqrt{\frac{1}{D_X}}$$

Square both side

$$\left(\frac{1}{8}\right)^2 = \frac{1}{D_X}$$

$$\frac{1}{64} = \frac{1}{D_X}$$

$D_X = 64 g/mol$

The correct option is C

11. $CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$

No of molecules of $H_2 = 4.25 \times 10^{24}$

$$\cap_{H_2} = \frac{\text{No of molecules of } H_2}{6.02 \times 10^{23}}$$

$$\cap_{H_2} = \frac{4.25 \times 10^{24}}{6.02 \times 10^{23}} = 7.05980 mol$$

$$\cap_{CaH_2} = \frac{1 mol \text{ of } CaH_2}{2 mol \text{ of } H_2} \times 7.05980 mol \text{ of } H_2$$

$\cap_{CaH_2} = 3.5299 mol$

$$\cap_{CaH_2} = \frac{mass\ of CaH_2}{R.M.M\ of\ CaH_2}$$

$R.M.M\ of\ CaH_2 = 40 g/mol + 2(1 g/mol)$

$R.M.M\ of\ CaH_2 = 42 g/mol$

$$3.5299 = \frac{mass\ of CaH_2}{42}$$

$mass\ of CaH_2 = 3.5299 \times 42 = 148.2558 g$

$mass\ of CaH_2 = 148.30 g$

The correct option is A

12. $C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + C_2H_4O_2$

2.50g 1.50g

$R.m.m\ of\ C_7H_6O_3 = 138g/mol$
$R.m.m\ of\ C_4H_6O_3 = 102g/mol$
$R.m.m\ of\ C_9H_8O_4 = 180g/mol$

$$\cap_{C_7H_6O_3} = \frac{2.50}{138} = 0.0181mol$$

$$\cap_{C_4H_6O_3} = \frac{1.50}{102} = 0.0147mol$$

The limiting reagent is $C_4H_6O_3$
The excess reagent is $C_7H_6O_3$
Mass of $C_9H_8O_4$ formed

$$= 0.0147mol \times 180g/mol$$
$$= 2.646g$$

The correct option is A

13. $T_{\frac{1}{2}} = 2days = 172800s$
$\lambda = ?$

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda}$$

$$\lambda = \frac{0.693}{T_{\frac{1}{2}}} = \frac{0.693}{172800} = 4.0104 \times 10^{-6}s^{-1}$$

The correct option is B

14. $MnO_4^- + S_2O_3^{2-} \rightarrow Mn^{2+} + S_4O_6^{2-}$
Step 1: Assign oxidation number or state to Mn and S
Oxidation state: +7 +4 +2 +5
Ionic equation: $MnO_4^- + S_2O_3^{2-} \rightarrow Mn^{2+} + S_4O_6^{2-}$
Step 2: Separate the reaction into oxidation-reduction half reaction. Oxidation is a process that involves increase in oxidation number but reduction is a process that involves decrease in oxidation number.
$MnO_4^- \rightarrow Mn^{2+}$ (red)
$S_2O_3^{2-} \rightarrow S_4O_6^{2-}$ (ox)
Step 3: Balance each of the half reactions atomically and electrically.
$S_2O_3^{2-} \rightarrow S_4O_6^{2-}$
(i) Balance S atomically
$2S_2O_3^{2-} \rightarrow S_4O_6^{2-}$
(ii) Oxygen is atomically balanced
(iii) To balance electrical charges add electrons to the side with excess positive charge or less negative charge.
$2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e^-$
These steps are employed in balancing the other half reaction.
$MnO_4^- \rightarrow Mn^{2+}$
(i) Mn is atomically balanced
(ii) To balance oxygen use water molecules
$MnO_4^- \rightarrow Mn^{2+} + 4H_2O$
(iii) To balance hydrogen atoms use hydrogen ion
$MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$
(iv) To balance electrical charges add electrons to the side with excess positive charge or less negative charge.
$5e^- + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$
Step 4: Balance the number of electrons in the two half reactions.
$2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e^- \ \ldots\ldots\ldots\ldots\ldots \times 5$
$5e^- + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O \ \ldots\ldots\ldots \times 2$
$10S_2O_3^{2-} \rightarrow 5S_4O_6^{2-} + 10e^-$
$10e^- + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O$
Step 5: Cancel similar species and add up the two half reactions.
$10S_2O_3^{2-} \rightarrow 5S_4O_6^{2-} + 10e^-$
$10e^- + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O$

$$2MnO_4^- + 10S_2O_3^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 5S_4O_6^{2-} + 8H_2O$$

The correct option is B

15. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}\ \Delta H = -393.7kJ/mol$

$$CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}\ \Delta H = -283.3kJ/mol$$

$2C_{(s)} + O_{2(g)} \rightarrow 2CO_{(g)}\ \Delta H = ?$
To obtain equation 3, multiply equation 1 with 2 and equation 2 with 2 and reverse it after which combine the equations. Note that if an equation is multiply by a factor, its ΔH must also be multiply with the same factor, while if an equation is reverse the sign of its ΔH must also be reversed.

$$2C_{(s)} + 2O_{2(g)} \rightarrow 2CO_{2(g)}\ \Delta H = 2(-393.7kJ/mol)$$
$$2CO_{2(g)} \rightarrow 2CO_{(g)} + O_{2(g)}\ \Delta H = 2(283.3kJ/mol)$$

$$2C_{(s)} + O_{2(g)} \rightarrow 2CO_{(g)}\ \Delta H = -220.8\ kJ/mol$$

The correct option is C

16. **Step 1:** write a chemical equation of the reaction. Note that chlorides are stable to heat, hence KCl will not decomposed on heating.
$2KClO_{3(g)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$
$Mass\ of\ mixture = 50g$
$Let\ the\ mass\ of\ KClO_3 = xg$
$Mass\ of\ KCl = (50 - x)g$
$let\ the\ mass\ of\ KCl\ formed = yg$
Step 2: Determine the moles of the reactants or products
$2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$
$xg \qquad yg$
$R.m.m\ of\ KClO_3 = 122.50g/mol$
$R.m.m\ of\ KCl = 74.50g/mol$
$\cap_{O_2} = 0.06mol$

$$\cap_{KClO_3} = \frac{2mol\ of\ KClO_3}{3mol\ of\ O_2} \times 0.06mol\ of\ O_2$$

$$\cap_{KClO_3} = 0.04mol$$

$$No\ of\ moles = \frac{Reacting\ mass}{molar\ mass}$$

$$0.04mol = \frac{Reacting\ mass}{122.50g/mol}$$

$$Reacting\ mass\ of\ KClO_3 = 0.04mol \times 122.50g/mol$$

$$Reacting\ mass\ of\ KClO_3 = 4.90g$$

$$mass\ of\ KClO_3 = x = 4.90g$$

$$mass\ of\ KCl = (50 - x) = 50 - 4.90 = 45.10g$$

$$\%\ of\ KClO_3 = \frac{mass\ of\ KClO_3}{mass\ of\ mixture} \times \frac{100}{1}$$

$$= \frac{4.90g}{50g} \times \frac{100}{1} = 9.8\%$$

$$\%\ of\ KClO_3 = 9.8\%$$

None of the options is correct

17. The reaction for the formation of one HI is given as:

$$\frac{1}{2}H_{2(g)} + \frac{1}{2}I_{2(g)} \rightleftharpoons HI_{(g)}\ \Delta H = -265.86kJ/mol$$

$$S_{HI} = 181.45J/molK = 0.18145kJ/molK$$

$$S_{H_2} = \frac{1}{2} \times 255.68J/molK = 127.84J/molK$$

$$S_{H_2} = 127.84J/molK = 0.12784J/molK$$

$$S_{I_2} = \frac{1}{2} \times 169.93J/molK = 84.965J/molK$$

$$S_{I_2} = 84.965J/molK = 0.084965KJ/molK$$

$$T = 25^0C = 298K$$

$$\Delta S = \sum S_P - \sum S_R$$

$$\sum S_R = 0.12784 + 0.084965 = 0.212805kJ/molK$$

$$\sum S_P = 0.18145kJ/molK$$

$$\Delta S = 0.18145 - 0.212805 = -0.031355$$

$$\Delta S = -0.031355kJ/molK$$

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G = -265.86 - 298 \times (-0.031355)$$

$$\Delta G = -265.86 + 9.34379$$

$$\Delta G = -256.51621kJ/mol$$

The negative sign indicate that the reaction is feasible or spontaneous.

The correct option is D

18. **Stock solution:-** It is a commercially produced solution for any stock solution, the mass concentration and the molar concentration is given by:

$$mass\ conc = 10pd$$

$$molar\ conc = \frac{10pd}{M}$$

Where $P = \%\ by\ mass\ for\ solution$

For pure solution $P = 100$

$d = density\ in\ g/cm^3$,

$M = molar\ mass\ of\ solute$

Note that any solution whose density in g/cm^3 and percentage concentration is known is a stock solution. Note that density in g/cm^3 is also known as relative density or specific gravity

$P = 36\%$

$d = 0.80g/cm^3$

$V_1 = ?$

$C_1 = ?$

$V_2 = 200cm^3$

$C_2 = 0.25M$

$R.M.M(M)of HCl = 36.5g/mol$

$$molar\ conc = \frac{10pd}{M}$$

$$molar\ conc(C_1) = \frac{10 \times 36 \times 0.80}{36.5} = 7.8904M$$

$$C_1V_1 = C_2V_2$$

$$7.8904 \times V_1 = 200 \times 0.25$$

$$V_1 = \frac{200 \times 0.25}{7.8904} = 6.3368cm^3 \approx 6.34cm^3$$

The correct option is C

19. *Cell notation is a shorthand way of representing a cell.* To write a cell notation, the following steps must be fully comprehended.

(i) The oxidation half-cell reaction is written first or at the left hand side.

(ii) The reduction half-cell reaction is written at the right hand side.

(iii) A salt-bridge must separate the oxidation-reduction half reaction. A salt bridge is denoted in a cell notation by //. Hence a cell notation is written as:
Oxidation half reaction // reduction half reaction.

(iv) In a cell notation the oxidation half reaction are written as followed.

(a) The electrode must be written first. If the electrode is in a different state from the species in the half cell an inter-phase symbol (/) must be used to separate it from the species. If the electrode is in the same state with the species in the half cell, a comma (,) must separate it from the species.

(b) The solutions are written with their concentration indicated. If the species in the solution are more than one, a comma must separate species in the same phase.

(v) In a cell notation, the reduction half reactions are written as followed.

(a) The species in the solution are written first with their concentration indicated. Note that if the species are more than one, a comma must separate species in the same phase. An inter-phase symbol (/) must separate species in different phase or state.

(b) The electrode is written last. If the electrode is in the same state with the species in the solution, a comma must be used to separate it

from the species in the solution. If it is in different state, an inter-phase symbol (/) must be use to separate it from the species in the solution.

Thus, in the cell notation, $Mg_{(s)}/Mg^{2+}//Sn^{2+}/Sn_{(s)}$ the oxidation and reduction half reactions are:

$Mg_{(s)} \rightarrow Mg^{2+} + 2e^-$ .....Oxidation half rxn

$Sn^{2+} + 2e^- \rightarrow Sn_{(s)}$ ....Reduction half rxn

$Mg^{2+} + 2e^- \rightarrow Mg_{(s)}\ E^0 = -2.37V$

$Sn^{2+} + 2e^- \rightarrow Sn_{(s)}\ E^0 = -0.14V$

Note that if an electrochemical equation is multiply by a factor, its E^0 is not affected, but if an electrochemical equation is reverse the sign of its E^0 must also be reversed.

$Mg_{(s)}/Mg^{2+}//Sn^{2+}/Sn_{(s)}$

Consider the cell notation above. Magnesium move from solid state to aqueous state while Tin moves from aqueous state to solid state. As a result its electrochemical equation must be reverse white that of tin remains the same.

$Mg_{(s)} \rightarrow Mg^{2+} + 2e^-\ E^0 = 2.37V$

$Sn^{2+} + 2e^- \rightarrow Sn_{(s)}\ E^0 = -0.14V$

Balanced the number of electrons in the two half reactions. From the equations the number of electrons is naturally balanced. Hence add up the two half

Reactions

$Mg_{(s)} \rightarrow Mg^{2+} + 2e^-\ E^0 = 2.37V$

$Sn^{2+} + 2e^- \rightarrow Sn_{(s)}\ E^0 = -0.14V$

$Mg_{(s)} + Sn^{2+} \rightarrow Mg^{2+} + Sn_{(s)}\ E^0 = 2.23V$

The E.M.F of the cell is 2.23V

Method 2

In a redox reaction, the substance that undergoes oxidation process is the reductant while the substance that undergoes reduction process is the oxidant

$E.M.F\ of\ cell = E^0_{oxidant} - E^0_{reductant}$

For the above formula to give correct answer the cell reaction must be feasible

$E^0_{reductant} = -2.37V$

$E^0_{oxidant} = -0.14V$

$E.M.F\ of\ cell = -0.14V - (-2.37V)$

$E.M.F\ of\ cell = -0.14V + 2.37V = 2.23V$

The correct option is A

20. **Step 1:** write a balance chemical equation of the reaction

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

$50cm^3, 0.2M \quad 50cm^3, 0.2M$

Step 2: Determine the number of moles of the reactant or products.

$\cap_{NaOH} = vol\ in\ dm^3 \times molar\ conc$

$= \frac{50}{1000} \times 0.2 = 0.01mol$

$\cap_{H_2SO_4} = vol\ in\ dm^3 \times molar\ conc$

$= \frac{50}{1000} \times 0.2 = 0.01mol$

Step 3: Determine the limiting reagent and its active moles.

$\cap_{NaOH} : \cap_{H_2SO_4}$

$\frac{0.01}{2} : \frac{0.01}{1}$

$0.005 : 0.01$

Limiting reagent is $NaOH$

The excess reagent is H_2SO_4

Since H_2SO_4 is in excess, the resulting solution will be acidic

$\cap_{H_2SO_4}$ used up $= 1 \times 0.005mol = 0.005mol$

Excess of $\cap_{H_2SO_4}$ = calculated moles of $\cap_{H_2SO_4} - \cap_{NH_2SO_4}$ used up

$= 0.01mol - 0.005mol = 0.005mol$

$Vol\ of\ solution$

$= 50m^3\ of\ NaOH + 50cm^3 of\ HCl$

$= 100cm^3 = 0.1dm^3$

$conc\ of\ excess\ H_2SO_4 = \frac{excess\ \cap_{H_2SO_4}}{vol\ of\ solution}$

$= \frac{0.005mol}{0.1dm^3} = 0.05M$

$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

$0.05M \quad 2(0.05M) \quad 0.05M$

$[H^+] = 2(0.05M) = 0.1M$

$P^H = -log_{10}^{[H^+]} = -log_{10}^{0.1} = -(-1) = 1$

$P^H + P^{OH} = 14$

$1 + P^{OH} = 14$

$P^{OH} = 14 - 1 = 13$

None of the options is correct

21. The overall order of a reaction is the sum of the powers to which all reactant concentrations appearing in the rate law are raised. The overall order of the reaction is simply called the order of the reaction. If the order of the reaction is 0, the reaction is a zero order reaction, if it is 1, it is a first order reaction, if it is 2, it is a second order reaction, if it is 3, it is a third order reaction and so on.

For the rate law, $R = K[A]^x[B]^y$

x = The order of the reaction with respect to reactant A

y = The order of the reaction with respect to reactant B

$x + y$ = Overall order of the reaction

k = Rate constant

Thus $R = K[Br^-]^2[BrO_3^-][H^+]$. The overall order of the reaction 4 (i.e. $2 + 1 + 1 = 4$)

The correct option is B

22. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O\ \Delta H = -571.6KJ$

$C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O\ \Delta H = -1410.9KJ$

$2C_2H_{6(g)} + 7O_{2(g)} \rightarrow$

$4CO_{2(g)} + 6H_2O\ \Delta H = -3119.4KJ$

To obtain the equation $C_2H_{4(g)} + H_{2(g)} \rightarrow C_2H_{6(g)}$ multiply equation 2 by 2 and reverse equation 3 and combine the equations. Note that if an equation is multiply by a factor, its ΔH must also be multiply with the same factor, but if an equation is reverse the sign of its ΔH must also be reversed.

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O\ \Delta H = -571.6KJ$

$2C_2H_{4(g)} + 6O_{2(g)} \rightarrow 4CO_{2(g)} + 4H_2O\ \Delta H = 2(-1410.9KJ)$

$4CO_{2(g)} + 6H_2O \rightarrow 2C_2H_{6(g)} + 7O_{2(g)}\ \Delta H = 3119.4KJ$

$2C_2H_{4(g)} + 2H_{2(g)} \rightarrow 2C_2H_{6(g)} \Delta H = -274KJ$

Divede through the equation by 2

$C_2H_{4(g)} + H_{2(g)} \rightarrow C_2H_{6(g)}\ \Delta H = -137.0KJ/mol$

The correct option is D

23. $A_{2(g)} + 3B_{2(g)} \overset{Fe}{\rightleftharpoons} 2AB_{2(g)} \Delta H = -78.92Kj$

For pressure to affect the equilibrium position of a reversible reaction two conditions must be satisfied.

(i) A gaseous species must be present

(ii) The number of gaseous moles at the reactant must be different from the number of gaseous moles at the product.

In the above reaction, the number of gaseous moles at the reactant is three (i.e. 1mole of A_2 and $2moles\ B_2$) while the number of gaseous moles at the product is two ($i.e. 2moles\ of\ AB_3$). Since the number of gaseous moles at the product is lesser than that at the reactant:

(i) Increase in pressure will favour the formation of AB_3 while decrease in pressure will favour the formation of A_2 and B_2

(ii) Decrease in volume will favour the formation of AB_3 while increase in volume will favour the formation of A_2 and B_2

(iii) Increase in temperature will favour the formation of A_2 and B_2 while decrease in temperature will favour the formation of AB_3

(iv) The presence of the catalyst(Fe) will lower the activation energy

(v) The equilibrium position is not affected by the catalyst but allow equilibrium to be reach quickly.

(vi) The reaction of AB_3 with another compound say D will consume it, thus causing the reaction to move in the forward direction only thereby favouring the formation of AB_3

The correct option is C

24. $Mg^{2+} + 2e^- \rightarrow Mg_{(s)}\ E^0 = -2.37V$

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}\ E^0 = +0.34V$

The values of the redox potential show that Magnesium is a reducing agent and copper is an oxidizing agent.

$Cu_{(s)} + Mg^{2+} \rightarrow Cu^{2+} + Mg_{(s)}$ rxn1

In the reaction 1 above copper moves from the solid state to the aqueous state. Hence its electrochemical reaction must be reverse. Reversing the electrochemical reaction of copper reverses the sign of its standard electrode potential.

$Cu_{(s)} \rightarrow Cu^{2+} + 2e^-\ E^0 = -0.34V$ rxn2

In the reaction 1 above Magnesium moves from the aqueous state to the solid state. Hence its electrochemical reaction must remain the same.

$Mg^{2+} + 2e^- \rightarrow Mg_{(s)}\ E^0 = -2.37V$.....rxn3

Combine the reactions 2 and 3

$Cu_{(s)} \rightarrow Cu^{2+} + 2e^-\ E^0 = -0.34V$

$Mg^{2+} + 2e^- \rightarrow Mg_{(s)}\ E^0 = -2.37V$

$Cu_{(s)} + Mg^{2+} \rightarrow Cu^{2+} + Mg_{(s)}\ E^0 = -2.71V$

The reaction is not feasible because E^0 is negative.

The correct option is A

25. Electrolysis of concentrated aqueous $CaCl_2$ using Graphite cathodes.

The electrode is inert and the electrolyte is concentrated. Therefore, the factors to be considered are: position of the ion in the electrochemical series and the concentration of the ion

Ionization	Anode (+)	Cathode (-)
$CaCl_{2(aq)} \rightarrow Ca^{2+} + 2Cl^-$	Cl^-	Ca^{2+}
$H_2O_{(l)} \rightarrow H^+ + OH^-$	OH^-	H^+

Anode: At the anode, Cl^- is discharged because of its high concentration, since Cl^- and OH^- are very close in the electrochemical series.

$2Cl^- \rightarrow Cl_2 + 2e^-$

Cathode: At the cathode, H^+ is discharged in preference to Ca^{2+}

$2H^+ + 2e^- \rightarrow H_2$

Resulting solution: The resulting solution is $Ca(OH)_2$ (Alkaline). Hence it will red moist litmus blue.

The correct option is B

26.

Mixture	Methods of separation
Iodine and Common salt	Sublimation
Oxygen and Nitrogen	Liquefaction followed by Fractional Distillation
Kerosene, Petrol and diesel	Fractional Distillation
Common salt and Sand	Dissolution, filtration and Evaporation

The correct option is C

27.

(i) Atoms can neither be created nor destroy. This postulate can be verified by the laws of conservation of mass.

(ii) Atoms of the same element are alike in every aspect but differ from atoms of all other elements. This postulate can be verified by the law of constant or definite proportion.

(iii) When an atom combines with other atoms they do so in simple ratios. This postulate can be verified by the law of multiple proportions.

The correct option is C

28. Carriers of electricity are the component of a substance that conducts electricity. Different substance have different carrier of electricity as shown in the table below:

Substance	Carrier of electricity
Electrolyte	Ions
Conductor	Mobile or valence electrons
Ionizing gases	Mobile electrons & ions
Semi conductors	Ions and hole

Note that hole is the partial positive charge left behind when electron are liberated from the surface of a semi-conductor. Molten Sodium chloride is an electrolyte as a result its carrier of electricity is the ion.

Also note that the carrier of electricity in electrolyte in aqueous form is mobile hydrated ion while the carrier of electricity in electrolyte in molten form is mobile ion

The correct option is C

29. The product of the equilibrium constant of the forward reaction (k_f) and the backward reaction (k_b) is one (1). That is $k_f k_b = 1$

$H_{2(g)} + CO_{2(g)} \rightarrow 2H_2O + CO_{(g)}\ k_b = 1.63$

$1.63k_f = 1$

$$k_f = \frac{1}{1.63} = 0.613$$

The correct option is C

30. Solubility of $K_2Cr_2O_7$ at $60^0C = 43.0g/100g$

Solubility of $K_2Cr_2O_7$ at $20^0C = 12.0g/100g$

Mass of solution at $60^0C = 43g + 100g = 143g$

Mass of solution at $20^0C = 12g + 100g = 112g$

Loss in weight of solution in cooling from 60^0C to $20^0C = 143g - 112g = 31g$

The fraction of the weight of solution loss

$$= \frac{loss\ is\ weight}{weight\ of\ solution\ at\ 60^0C}$$

$$= \frac{31g}{143g} = \frac{31}{143}$$

The amount of salt crystallize out of 620g of salt

$$= \frac{31}{143} \times 620g = 134.40g$$

The correct option is A

31. $C_1V_1 = C_2V_2$

$C_1 = 14.8M, V_1 = ?$

$C_2 = 1.0M, V_2 = 100ml$

$14.8V_1 = 1 \times 100$

$$V_1 = \frac{1 \times 100}{14.8} = 6.76ml$$

The correct option is C

32. **Step 1:** Determine the quantity of electricity that cost ₦9.00

$Mass\ of\ Ca = 5g$

Volume of Cl at STP $= 448ml = 448cm^3$

Volume of Cl at STP $= 448cm^3 = 0.448dm^3$

$$\cap_{Cl_2} = \frac{Volume\ at\ STP}{Molar\ gas\ Volume}$$

$$= \frac{0.448}{22.4} = 0.02mol$$

$$\cap_{Ca} = \frac{Reacting\ mass}{Molar\ mass} = \frac{5g}{40g/mol}$$

$$= 0.125mol$$

$1mole\ of\ Cl_2 = 2F$

$0.02mole\ of\ Cl_2 = xF$

$$\frac{1}{0.02} = \frac{2}{x}$$

$x = 0.04F$

The quantity of electricity that cost ₦9.00 is $0.04F$

$\Rightarrow 0.04F = ₦9$

$$1F = \frac{₦9}{0.04} = ₦225$$

$1F = ₦225$

Therefore, 1 faraday of electricity cost ₦225

Step 2: Determine the cost of electricity require to deposit 5g of Calcium

$1mol\ of\ Ca^{2+} = 2F$

$0.125mol\ of\ Ca^{2+} = yF$

$$\frac{1}{0.125mol} = \frac{2}{y}$$

$y = 0.125 \times 2 = 0.25F$

Cost of $0.25F = 0.25 \times 1F$ (But $1F = ₦225$)

$= 0.25 \times ₦225 = ₦56.25$

Therefore, it cost ₦56.25 to deposit 5g of Calcium

The correct option is B

33. A redox reaction is a reaction in which oxidation and reduction occur simultaneously. Such reaction usually contain and oxidizing agent (i.e. the substance that undergoes reduction) and a reducing agent (i.e. the substance that undergoes oxidation).
Oxidation is a process that involved increase in oxidation number while reduction is a process that involved decrease in oxidation number.

$$\overset{0}{2H_{2(g)}} + \overset{0}{O_{2(g)}} \rightarrow \overset{+1\ -2}{2H_2O}$$

In the reaction above, the oxidation number of hydrogen, H_2 changes from 0 in H_2 to +1 in H_2O (i.e. increase in oxidation number) while the oxidation number of Oxygen, O_2 changes from 0 in O_2 to -2 in H_2O (i.e. decrease in oxidation number). Hence H_2 undergoes oxidation process (i.e. the reducing agent) while O_2 undergoes reduction process (i.e. the oxidizing agent). Therefore, the reaction is a redox reaction.

$$\overset{0}{Cl_2} + 2NaOH \rightarrow \overset{+1}{NaClO} + \overset{-1}{NaCl} + H_2O$$

In the above reaction, the only substance that undergoes change in oxidation number is Chlorine, Cl. The oxidation number of Cl change from 0 in Cl_2 to +1 in $NaClO$ (i.e. increase in oxidation number) and also changes from 0 in Cl_2 to -1 in $NaCl$ (i.e. decrease in oxidation number). Chlorine, Cl undergoes oxidation (i.e. increase in oxidation number) and reduction (i.e. decrease in oxidation number) simultaneously.
Therefore, the reaction is a redox reaction.

$$3\overset{0}{Br_2} + 6KOH \rightarrow \overset{+5}{NaBrO_3} + 5\overset{-1}{NaBr} + 3H_2O$$

In the above reaction, the only substance that undergoes change in oxidation number is Bromine, Br. The oxidation number of Br change from 0 in Br_2 to +5 in $NaBrO_3$ (i.e. increase in oxidation number) and also changes from 0 in Br_2 to -1 in $NaBr$ (i.e. decrease in oxidation number). Bromine, Br undergoes oxidation (i.e. increase in oxidation number) and reduction (i.e. decrease in oxidation number) simultaneously. Therefore, the reaction is a redox reaction.

$$\overset{0}{Zn} + \overset{+2}{CuSO_4} \rightarrow \overset{+2}{ZnSO_4}\overset{0}{Cu}$$

In the reaction above, the oxidation number of Zinc, Zn changes from 0 to +2 (i.e. increase in oxidation number) while the oxidation number of Copper, Cu changes from +2 to 0 (i.e. decrease in oxidation number). Hence Zn undergoes oxidation process (i.e. the reducing agent) while Cu undergoes reduction process (i.e. the reducing agent). Therefore, the reaction is a redox reaction.

In the reaction above, the oxidation number of hydrogen, H_2 changes from +1 to 0 (i.e. decrease in oxidation number) while the oxidation number of Oxygen, O_2 changes from -2 to 0 (i.e. increase in oxidation number). Hence H_2 undergoes reduction process (i.e. the oxidizing agent) while O_2 undergoes oxidation process (i.e. the reducing agent). Therefore, the reaction is a redox reaction.
In each of the following reaction a single species undergoes both oxidation and reduction.

Reaction	Species that undergoes oxidation and reduction
$Cl_2 + 2NaOH \rightarrow NaClO + NaCl + H_2O$	Cl_2
$3Br_2 + 6KOH \rightarrow NaBrO_3 + 5NaBr + 3H_2O$	Br_2
$2H_2O \rightarrow 2H_{2(g)} + O_{2(g)}$	H_2O

The correct option is D

34. K_{sp} of $Mg(OH)_2 = 8.9 \times 10^{-12} mol^3 dm^{-9}$

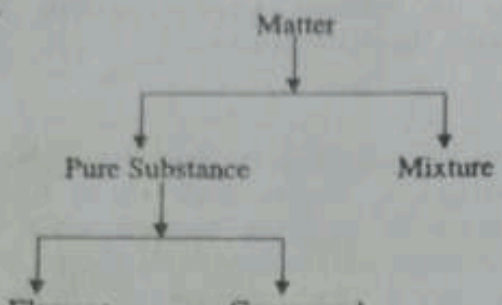
$$Mg(OH)_2 \rightleftharpoons Mg^{2+} + 2OH^-$$
$$xM \qquad xM \qquad 2xM$$
$$NaOH \rightleftharpoons Na^{2+} + OH^-$$
$$0.05M \qquad 0.05M \quad 0.05M$$
$$[Mg^{2+}] = xM, [OH^-] = (2x + 0.05)M$$
$$K_{sp} = [Mg^{2+}][OH^-]^2$$
$$8.9 \times 10^{-12} = x(2x + 0.05)^2$$

Since the power of K_{sp} is < -10 and the concentration of $NaOH$ is < 0.5, then $2x + 0.05 \approx 0.05$ since x is much more less than 0.05. If this condition is not true, you will have to expand and open the bracket to obtain a cubic equation from which the value of x is obtain.

$$8.9 \times 10^{-12} = x(2x + 0.05)^2$$
$$(2x + 0.05)^2 \approx (0.05)^2$$
$$8.9 \times 10^{-12} = x(0.05)^2$$
$$x = \frac{8.9 \times 10^{-12}}{(0.05)^2} = 3.56 \times 10^{-9} M$$

The correct option is B

35.



All Elements (e.g. Gold, Silver, Copper etc) and all compounds (e.g. Distilled Water, Silver IV oxide, Copper II oxide etc) are pure substance.

The correct option is C

36. A binary compound is a compound that contains two elements only e.g. $NaCl, KBr, HF$ etc.

Since the cation M^{a+} contain 51 protons and 48 electrons, the value of a is obtained as:

$a = 51 - 48 = +3$

The number of proton in the anion X^{b-} is one-third the number of proton in M^{a+}. Since the number of proton in M^{a+} is 51 then, number of proton in X^{b-}

$NP = \frac{1}{3} \times 51 = 17$

Since the number of electron in the anion, X^{b-} is equal to the number of proton in it plus 1(i.e. 17 + 1 = 18) then the number of electron(NE) in the anion is 18.

Since the cation, X^{b-} contain 17 protons and 18 electrons, the value of b is obtained as:

$b = 17 - 18 = -1$

If an ion A^x (where x is its oxidation number or net charge) combine with B^y (where y is its oxidation state or net charge), the compound form is as given below

$A^x + B^y \longrightarrow A_yB_x \ (If\ x \neq y)$

$A^x + B^y \longrightarrow AB \ (If\ x = y)$

Note that x and y must be in their basic or lowest form, that is x and y must be express in the simplest ratio (e.g. 2:1, 3:2, 1:3 etc). Also note that the most electropositive element must be written first.

$M^{a+} + X^{b-} \longrightarrow M_bX_a$

But $a = +3$ and $b = -1$

$M^{3+} + X^{-} \longrightarrow MX_3$

The correct option is C

37.

Species	Elements	Nature
$_{19}A \rightarrow 2,8,8,1$	K	Metal
$_{8}B \rightarrow 2,6$	O	Non Metal
$_{11}C \rightarrow 2,8,1$	Na	Metal
$_{1}D \rightarrow 1$	H	Non Metal
$_{17}E \rightarrow 2,8,7$	Cl	Non Metal
$_{6}A \rightarrow 2,4$	C	Non Metal

Species	Types of Bond	Reason
AB	Electrovalent or ionic	Bonds between a metal and a non metal
B_2	Pure covalent	Bond two atoms of the same non metal
A	Metallic	Bond within a metal
$[D_2BH]^+$	Coordinate or dative	Bonds between non metals in an a ion which Hydrogen is a part

The correct option is D

38. The wave-particle duality of matter states that every small particles such as electrons exhibit wave properties under certain conditions. Louis de Broglie predicted that a particle with a mass, m and velocity, v will exhibit a characteristics wavelength associated with it. Louis de Broglie derived an equation for the wavelength of a small particle of mass, m and velocity, v by equating Einstein's equations to Planck's equation.

$E = mc^2$ ..... *Einstein's equation*

$E = \frac{hc}{\lambda}$ ..... *Planck's equation*

$mc^2 = \frac{hc}{\lambda}$

$mc = \frac{h}{\lambda}$

$mc\lambda = h$

$\lambda = \frac{h}{mc}$

For the particle moving with a speed of u, the equation becomes

$\lambda = \frac{h}{mu}$ ..... de broglie's equation

The above equation shows that the wavelength λ of the particle is inversely proportional to the speed of the particle provided h and m are held constant.

For proton

$M = 1.67 \times 10^{-27} kg$

$h = 6.626 \times 10^{-34} J/s$

$u = xm/s$

$\lambda = ?$

$$\lambda = \frac{6.626 \times 10^{-34}}{1.67 \times 10^{-27} \times x} = \frac{3.9677 \times 10^{-7}}{x} m$$

If $u = 2x$

$$\lambda = \frac{6.626 \times 10^{-34}}{1.67 \times 10^{-27} \times 2x} = \frac{1.9839 \times 10^{-7}}{x} m$$

For Neutron

$M = 1.67 \times 10^{-27} kg$
$h = 6.626 \times 10^{-34} J/s$
$u = xm/s$
$\lambda = ?$

$$\lambda = \frac{6.626 \times 10^{-34}}{1.67 \times 10^{-27} \times x} = \frac{3.9677 \times 10^{-7}}{x} m$$

For Electron

$M = 9.11 \times 10^{-31} kg$
$h = 6.626 \times 10^{-34} J/s$
$u = xm/s$
$\lambda = ?$

$$\lambda = \frac{6.626 \times 10^{-34}}{9.11 \times 10^{-31} \times x} = \frac{7.2733 \times 10^{-4}}{x} m$$

From the calculation the electron has the longest wavelength due to its mass. In general, the smaller the mass of a particle and its speed the longer its wavelength according to de-broglie equation

The correct option is C

39. The percentage of ionization of a substance is the proportion of the substance that ionized express in percentage.

$$\%\ ionization\ of CH_3COOH = \frac{[CH_3COO^-]_{ionized}}{[CH_3COOH]_{initial}} \times 100$$

$$1.33 = \frac{x}{0.1} \times 100$$

$$1.33 \times 0.1 = 100x$$

$$x = \frac{1.33 \times 0.1}{100} = 1.33 \times 10^{-3} M$$

$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

	$0.1M$	0	0
	$-x$	x	x
	$0.1 - x$	x	x

$$K_a = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]}$$

$$K_a = \frac{(x)(x)}{0.1 - x} = \frac{x^2}{0.1 - x}$$

But $x = 1.33 \times 10^{-3} M$

$$K_a = \frac{(1.33 \times 10^{-3})^2}{0.1 - 1.33 \times 10^{-3}} = \frac{1.7689 \times 10^{-6}}{0.09867}$$

$$K_a = 1.7927 \times 10^{-5}$$

None of the options is correct.

40. In the cell notation, $M_{(s)}/M^{2+}//Cu^{2+}/Cu_{(s)}$ the oxidation and reduction half reactions are:

$M_{(s)} \rightarrow M^{2+} + 2e^-$ ..... oxidation half rxn

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}$ ..... reduction half rxn

Since the cell notation shows that M removes Cu from aqueous solution, it means that M is more reactive than Cu. That is, M is a reducing agent. As a result it standard electrode potential will be negative.

$M^{2+} + 2e^- \rightarrow M_{(s)}\ E^0 = -xV$

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}\ E^0 = +0.34V$

Note that if an electrochemical equation is multiply by a factor, its E^0 is not affected, but if an electrochemical equation is reverse the sign of its E^0 must also be reversed.

$M_{(s)}/M^{2+}//Cu^{2+}/Cu_{(s)}$

Consider the cell notation above. M moves from solid state to aqueous state while Cu moves from aqueous state to solid state. As a result its electrochemical equation must be reverse while that of Cu remains the same.

$M_{(s)} \rightarrow M^{2+} + 2e^-\ E^0 = xV$

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}\ E^0 = +0.34V$

Balanced the number of electrons in the two half reactions. From the equations the number of electrons is naturally balanced. Hence add up the two half

Reactions

$Mg_{(s)} \rightarrow Mg^{2+} + 2e^-\ E^0 = xV$

$Sn^{2+} + 2e^- \rightarrow Sn_{(s)}\ E^0 = +0.34V$

$Mg_{(s)} + Sn^{2+} \rightarrow Mg^{2+} + Sn_{(s)}\ E^0 = x + 0.34$

The E.M.F of the cell as given the question is 0.78V

$x + 0.34 = 0.78$

$x = 0.78 - 0.34 = 0.44V$

$M^{2+} + 2e^- \rightarrow M_{(s)}\ E^0 = -0.44V$

The correct option is C

2013/2014 CHEMISTRY 001

1. When one mole of pure ethanol is mixed with one mole of ethanoic acid at room temperature, the equilibrium mixture contains $\frac{2}{3}$ of a mole each of ester and water. What is the equilibrium constant? (a) 6 (b) 5 (c) 4 (d) 2
2. A neutral atom of an element has 2 electrons with principal quantum number $n = 1$, 8 electron with $n = 2$ and 7 electrons with $n = 3$. Which of the following can be deduced from the data provided? I. Group of the element II. Number of unpaired electrons III. Number of neutrons in the nucleus IV. Relative atomic mass V. Combining power of its atom (a) II, IV and V (b) III, IV and V (c) I, II and III (d) I, II and V
3. Calculate the molar solubility of $Cu(IO_3)_2$ if the solubility product constant, $K_{sp} = 1.08 \times 10^{-7}$ (a) 3.0×10^{-3} (b) 2.7×10^{-7} (c) 3.2×10^{-7} (d) 2.7×10^{-3}
4. A gold-copper cell is represented as: $Au_{(s)}/Au^{3+}_{(aq)}//Cu^{2+}_{(aq)}/Cu_{(s)}$. Given that $E^o_{Au/Au^{3+}} = 1.50V$ and $E^o_{Cu/Cu^{2+}} = -0.34V$, calculate the E^o_{cell} and state whether the cell reaction is spontaneous or not in this arrangement. (a) $+1.84V$, reaction is spontaneous (b) $1 - 16V$, reaction is

spontaneous (c) $-1.84V$, reaction not spontaneous (d) $-1.16V$, reaction not spontaneous

5. The equilibrium constant, K_p for the reaction below is 7.73×10^{-4} at 623K. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ $\Delta H = -92.4kJ$. Which of the following information about the equilibrium system is/are NOT true? I. Increase in pressure will favour forward reaction II. K_p will be greater than 7.73×10^{-4} at 298K. III. Passing a stream of $HCl_{(g)}$ through the system will shift equilibrium position to the left IV. Use of finely divided iron as catalyst will shift equilibrium position to the right. (a) II and III only (b) II, III and IV only (c) III and IV only (d) I and II only
6. $25cm^3$ portions of $0.052moldm^{-3}$ sodium trioxocarbonate (IV) solution are titrated with a solution of tetraoxosulphate (VI) acid using phenolphthalein as indicator. If the average titre value is $32.80cm^3$, what is the concentration of the acid in $moldm^{-3}$? (a) 0.0849 (b) 0.0198 (c) 0.0396 (d) 0.0792
7. Consider the following chemical changes: I. Thermal decomposition of $CaCO_3$ II. Radioactive decay of thorium-234 III. Hydrolysis of sucrose in water IV. Alkaline hydrolysis of esters. In which of these is the reaction rate a function of only one reactant? (a) I, II and III (b) I and IV only (c) I, III and IV (d) II, III and IV
8. Consider the reaction $6Fe^{2+}_{(aq)} + Cr_2O_7^{2-}{}_{(aq)} 14H^+_{(aq)} \rightarrow 6Fe^{3+}_{(aq)} + 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$. Which substance is oxidized and which is the oxidizing agent, respectively? (a) Fe^{2+}, $Cr_2O_7^{2-}$ (b) Fe^{3+}, $Cr_2O_7^{2-}$ (c) Cr^{3+}, Fe^{3+} (d) $Cr_2O_7^{2-}$, Fe^{2+}
9. A 25g sample of potassium trioxochlorate (V) was added to $50cm^3$ of water to give a saturated solution at 25^oC. If the solubility of the salt is 2.50M at the same temperature, what percentage of the salt is left undissolved? [K = 39, Cl = 35.5, O = 16] (a) 38.75 (b) 9.69 (c) 61.25 (d) 15.31
10. Calculate the enthalpy change for the hydrogenation reaction below:
$C_2H_{4(g)} + H_{2(g)} \rightarrow C_2H_{6(g)}$.
Given that:
$C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(l)}$
$\Delta H = -1401kJ$
$C_2H_{6(g)} + \frac{7}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$
$\Delta H = -1550kJ$
$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$
$\Delta H = -286kJ$
(a) 137kJ (b) -137kJ (c) 2665kJ (d) -2665kJ
11. A gaseous hydrocarbons with a mass of 0.281g and volume of $150cm^3$ forms $450cm^3$ of carbon (IV) oxide and 0.362g of water on combustion. Assuming all volumes are measured at s.t.p., determine the molecular formula of the hydrocarbon? (a) C_3H_6 (b) C_3H_8 (c) C_3H_7 (d) C_3H_4
12. Determine the solubility of lead (II) trioxonitrate (V) in $mol\,dm^{-3}$ using the results presented below (all data collected at the same temperature):
Mass of empty flask = 54.5g
Mass of flask and saturated solution = 87.7g
Mass of flask and solute (after careful evaporation) = 66.7g[$Pb(NO_3)_2 = 331g/mol$](a) 1.46M (b) 1.76M (c) 1.11M (d) 2.31M
13. The concentration of calcium ion in blood plasma is 0.0025M. if the concentration of oxalate ion is $1.0 \times 10^{-7}M$, will calcium oxalate precipitate out from a blood plasma sample? Solubility product, K_{sp} for calcium oxalate is 2.3×10^{-9} (a) No (b) Yes (c) system remains at equilibrium (d) only if blood plasma is dilute.
14. Which of the following statements is not correct about the 4s orbital? (a) is filled before 3d orbital (b) is of higher energy than the 4p orbital (c) contains a maximum of two electrons (d) is defined by the quantum number l = 0
15. Study the nuclear reactions below and predict the nuclear particle represented as X, Y and Z, respectively. I. $^{238}_{92}U \rightarrow {}^{234}_{90}Th + X$ II. $^{234}_{90}Th \rightarrow {}^{234}_{91}Pa \times Y$ III. $^{14}_{7}N + Z \rightarrow {}^{16}_{6}C + {}^{1}_{1}H$ (a) alpha, beta and proton (b) alpha, neutron and beta (c) alpha, beta and gamma (d) alpha, beta and neutron
16. The solubility of Ag_2CrO_4 is $0.024gdm^{-3}$. Determine its solubility product. [$Ag_2CrO_4 = 331.7g/mol$] (a) $2.4 \times 10^{-14}mol^3dm^{-9}$ (b) 1.5×10^{-12} mol^3dm^{-9} (c) $7.6 \times 10^{-13}mol^3dm^{-9}$ (d) $3.8 \times 10^{-12}mol^3dm^{-9}$
17. The following are the electronic configuration of some elements of the periodic table. I. $[He]2s^1$ II. $[He]2s^2$ III. $[Ne]3s^1$ IV. $[Ne]3s^2$ IV. $[Ar]4s^1$. Which of the following is a correct order of increasing first ionization energy? (a) V<III<II<IV<I (b) V<IV<III<II<I (c) V<III<IV<I<II (d) V<IV<II<III<I
18. What volume of oxygen at s.t.p. is liberated at the anode in the electrolysis of aqueous $CuSO_4$ by a current of 0.750 A in 10.0minutes? [Molar volume of a gsa at s.t.p. is 22.4L. 1 faraday = 96,500C] (a) $43.5cm^3$ (b) $26.1cm^3$ (c) $52.2cm^3$ (d) $2.61cm^3$

19. Consider following reaction in equilibrium: $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ $\Delta H = +58kJ$

	Change	Equilibrium shift
I	Addition of $NO_{2(g)}$	Right
II	Removal of $N_2O_{4(g)}$	Left
III	Addition of $He_{(g)}$	None
IV	Increase volume of the container	Left
V	Decrease the temperature	Left

Which of the following prediction is not correct when the equilibrium system is subjected to the following changes? (a) II and IV (b) I and V (c) II and III (d) I and IV

20. Below is a list of some chemical agents and their colour changes during actions: I. Aqueous iron (II) Salts change from green to brown II. Chlorine gas changes from greenish yellow to colourless III. Acidified $KMnO_4$ solution changes from purple to colourless IV. Aqueous potassium iodide changes from colourless to reddish brown V. Acidified $K_2Cr_2O_7$ solution changes from orange to green. Which of these chemical agents/colour changes could be used to identify a reducing agent? (a) III and V only (b) II, III and IV (c) I, II and IV (d) II and III only

21. Consider the decomposition of N_2O_5 as shown in the equation below: $2N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$. At time t = 600s, concentration of N_2O_5 is $1.24 \times 10^{-2}M$ and at $t = 1200s$ the concentration of N_2O_5 is $0.93 \times 10^{-2}M$. Calculate the average rate of decomposition during the given time intervals. (a) $2.6 \times 10^{-6}M/s$ (b) $-2.6 \times 10^{-6}M/s$ (c) $5.2 \times 10^{-6}M/s$ (d) $-5.2 \times 10^{-6}M/s$

22. A certain amount of gas occupies $5.00dm^3$ at a pressure of 3 atmospheres and $25°C$ temperature. Calculate the number of molecules of the gas. $[R = 0.082\ atmdm^3K^{-1}mol^{-1}]$. (a) 3.70×10^{-23} (b) 3.70×10^{23} (c) 61 (d) 3.64×10^{22}

23. The following represents the balancing in acidic medium of the reduction of NO_3 to NO. $aNO_3^- + bH^+ + ce^- \rightarrow dNO + eH_2O$. What do the coefficient a, b, c, d and e represent? (a) a = 2, b = 8, c = 6, d = 2, e = 4 (b) a = 1, b = 4, c = 3, d = 1, e = 4 (c) a = 3, b = 2, c = 4, d = 5, e = 4 (d) a = 1, b = 4, c = 3, d = 1, e = 2

24. Why is H_2S a gas and H_2O a liquid at room temperature? (a) H_2S has a higher molar mass (b) H_2S has acidic properties (c) H_2O is a universal solvent (d) H_2O contains hydrogen bonds in its molecules.

25. Calculate the free energy change for the electrochemical cell represented below at $25°C$ and unit concentration. $Zn/Zn^{2+}//Cu^{2+}/Cu$. Given that standard reduction potentials $E°_{Zn^{2+}/Zn} = -0.763V$ and $E°_{Cu^{2+}/Cu} = +0.337V$ (a) -332kJ/mol (b) -212 kJ/mol (c) +231 kJ/mol (d) +201 kJ/mol

26. Which of the following sets of quantum numbers is permissible for an electron in an atom? (a) $n = 1,\ \ell = 1,\ m_1 = 0,\ ms = +\frac{1}{2}$ (b) $n = 2,\ \ell = 0,\ m_1 = 0,\ ms = +\frac{1}{2}$ (c) $n = 2,\ \ell = 1,\ m_1 = 0,\ ms = 0$ (d) $n = 3,\ \ell = 1,\ m_1 = -2,\ ms = -\frac{1}{2}$

27. What is the pOH of a solution obtained by mixing $100cm^3$ of 0.2M solution of hydrochloric acid with $100cm^3$ of 0.1M solution of sodium hydroxide? (a) 5 (b) 1.3 (c) 13 (d) 12.7

28. Consider the table below on some salt solutions

	Salt solution	Effect on litmus paper
I	Potassium ethanoate	Red litmus to blue
II	Ammonium chloride	Red litmus to blue
III	Sodium trioxocarbonate (IV)	Red litmus to blue
IV	Magnesium tetraoxosulphate (VI)	Blue litmus to red
V	Potassium tetraoxosulphate (VI)	Red litmus to blue
VI	Aluminium chloride	Neutral

Which of the above effects on litmus are correct? (a) I, III and IV (b) II, V and VI (c) II, IV and V (d) I, III, V and VI

29. Below is a list of some possible attractions that can bind molecules or units together in substances: I. positive ion-negative ion attractions II. Temporary dipole – temporary dipole attraction III. Temporary dipole – ion attractions IV. Permanent dipole – permanent dipole attractions V. temporary dipole – permanent dipole attractions VI. Permanent dipole – ion attractions. Which of these attractions exist in a mixture of argon and hydrogen chloride? (a) II, IV and V (b) I, III and VI (c) I, II, III, IV, V and VI (d) I, II and IV

30. Calculate the entropy change for the formation of carbon (IV) oxide at $25°C$. The absolute

entropy of C (graphite) is $5.694 Jmol^{-1}K^{-1}$, of oxygen is $205.03\ Jmol^{-1}K^{-1}$ and of $CO_{2(g)}$ is $197.9\ Jmol^{-1}K^{-1}$. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ (a) $14.38 Jmol^{-1}K^{-1}$ (b) $-12.82 Jmol^{-1}\ K^{-1}$ (c) $18.20 Jmol^{-1}K^{-1}$ (d) $-7.13\ Jmol^{-1}K^{-1}$

31. The three-step mechanism of a chemical reaction is given as: $Cl_{2(g)} \rightleftharpoons 2Cl_{(g)}$
$N_2O_{(g)} + Cl_{(g)} \rightarrow N_{2(g)} + ClO_{(g)}$
$ClO_{(g)} + ClO_{(g)} \rightarrow Cl_{2(g)} + O_{2(g)}$
Indicate the species acting as a catalyst. (a) Cl_2 (b) N_2 (c) ClO (d) O_2

32. The bond angles of CH_4, NH_3 and H_2O are approximately 109^o, 107^o and 105^o respectively even though the central element in each molecule is sp^3 hybridized. This observation is consistent with the progressive (a) increase in the atomic number of the central elements (b) increase in the electronegativity of the central elements (c) increase in the number of lone pairs around the central elements (d) increase in the ionization energy of the central elements.

33. $Co^{3+} + 6H_2O \rightleftharpoons [Co(H_2O)_6]^{3+}$. In the reaction above, Co^{3+} acts as a(an) (a) Arrhenius acid (b) Lewis acid (c) conjugate acid (d) Bronsted – Lowry acid

34. What is the standard free–energy change, ΔG^o, for the following reaction at 25°C?
$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$
Given that
$\Delta H^o_{f(NH_3)} = -45.9 kJmol^{-1}$,
$S^o_{(N_2)} = 191.5 J/(mol.K)$,
$S^o_{(H_2)} = 130.6\ J/(mol.K)$,
$S^o_{(NH_3)} = 193\ J/(mol.K)$
(a) $58.6kJ$ (b) $-33.1\ kJ$ (c) $-26kJ$ (d) 137kJ

35. The rate of an hypothetical reaction with the overall equation: $2A + B \rightarrow P$ was found to double when the concentration of A was doubled and B kept constant. The same reaction rate was found to be quadrupled upon doubling the concentration of B, keeping A constant. Which of the following statements is/are true about the reaction? I. The reaction is third order overall II. The reaction is second order with respect to A III. The reaction rate is independent of concentration of (a) IV. The reaction is second order with respect to (b) (a) I and II only (b) I and IV only (c) II and IV only (d) I and III only

36. What are the concentrations of $H^+_{(aq)}$ and $OH^-_{(aq)}$ respectively in a solution of $0.100\ mol$ of HNO_3 in 125ml of water (a) $0.9M$, $0.25 \times 10^{-13}M$ (b) $0.8M$, $0.25 \times 10^{-14}M$ (c) $0.8M$, $1.25 \times 10^{-14}M$ (d) $0.6M$, $1.25M$

37. Which of the following statements is/are correct? I. Galvanic cells involve conversion of chemical energy into electrical energy. II. Cathode is the positive electrode in a voltaic cell. III. Cathode is the positive electrode in an electrolytic cell. IV. All electrochemical cells require an external source of electric current for operation. (a) I and III only (b) I and II only (c) I, II and IV only (d) I, II and III only

38. Two electrolysis cells are connected in series, one containing $AgNO_{3(aq)}$ and the other $CuSO_{4(aq)}$. If 5.38g Ag is deposited in the cell containing $AgNO_3$, how much Cu will be deposited in te cell containing $CuSO_4$? [Ag = 108, Cu = 63.5] (a) 11.7 (b) 85.2g (c) 2.69g (d) 1.58g

39. Consider the following substances: I. Petrol II. Water III. Solid sodium chloride IV. Aqueous potassium chloride V. Zinc rod VI. candle stick VII. sodium chloride melt. Which of these substances would conduct an electric current? (a) II, IV, V and VII (b) I, II and V (c) II, III, V and VI (d) II, IV, V and VII

40. An aqueous solution of tetraoxosulphate (VI) acid has a density of $1.80 g/cm^3$ and 98% purity level. What volume of this solution must be diluted to give $250cm^3$ of $0.500 moldm^3$ H_2SO_4 solution? (a) $6.88cm^3$ (b) $6.67cm^3$ (c) $6.92cm^3$ (d) $6.94cm^3$

SOLUTION

1. $CH_3CH_2OH + CH_3COOH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$

1mol	1mol	–	–
$-\alpha\ mol$	$-\alpha\ mol$	$\alpha\ mol$	$\alpha\ mol$
$(1-\alpha)$	$(1-\alpha)$	$(1-\alpha)$	$(1-\alpha)$

Since the equilibrium mixture contains $\frac{2}{3}$ mole each of ester and water.

$$\alpha = \frac{2}{3} moles$$

$$K_C = \frac{[CH_3COOCH_2CH_3][H_2O]}{[CH_3CH_2OH][CH_3COOH]}$$

$\Rightarrow$ Let the volume be $V\ dm^3$

$$[CH_3COOCH_2CH_3] = \frac{n}{V} = \frac{\alpha}{V} = \frac{\frac{2}{3}}{V}\ moldm^{-3}$$

$$[H_2O] = \frac{\alpha}{V} = \frac{\frac{2}{3}}{V}\ moldm^{-3}$$

$$[CH_3CH_2OH] = \frac{1-\alpha}{V} = \frac{1-\frac{2}{3}}{V} = \frac{\frac{1}{3}}{V} moldm^{-3}$$

$$[CH_3COOH] = \frac{1-\alpha}{V} = \frac{1-\frac{2}{3}}{V} = \frac{\frac{1}{3}}{V} moldm^{-3}$$

$$K_c = \frac{\left(\frac{2}{3}V\right)\left(\frac{2}{3}V\right)}{\left(\frac{1}{3}V\right)\left(\frac{1}{3}V\right)}$$

$$= \frac{\frac{4}{9}V^2}{\frac{1}{9}V^2}$$

$$= \frac{4 \times 9V^2}{1 \times 9V^2}$$

$$K_c = 4$$

The correct option is C

2. No of electrons $= 2 + 8 + 7 = 17$

Let the atom be represented by X

$_{17}X \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

(i) **Period:** These correspond to the highest principal quantum number in the electronic configuration of the element. The principal quantum numbers are 1, 2 and 3. The highest principal number is 3. Thus, the element belongs to period 3.

(ii) **Group:** These correspond to the number of electrons in the subshell with the highest quantum numbers ($3s^2$, $3p^5$) i.e. $2 + 5 = 7$. Thus, the element belongs to group VII.

(iii) **Block:** These correspond to the outermost subshell (i.e. 3p). Thus the element is a p-block element.

(iv) **Atomic number:** This is the number of protons in the nucleus of the atom. For a neutral atom the number of protons is equal to the number of electrons. Thus, the atomic number of the atom is 17.

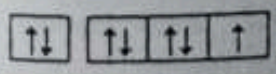
(v) **Number of Neutron:** This is the number of neutrons in the nucleus of the atom. To obtain the number of neutrons, the mass number of the atom must be known. Thus, the neutrons number cannot be determine.

(vi) **Relative atomic mass:** The relative atomic mass of an element is the number of times the average mass of one atom of the element is heavier than one-twelfth the mass of one atom of carbon-12. It is not given for the element under consideration.

(vii) **Combining power:** Is the number of hydrogen atoms that combine with one atom of an element. The difference between combine power and oxidation number is that combining power does not carried electrical charge but oxidation number does the combine power of the atom is 1.

(viii) $_{17}X \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

3s 3p



No of unpaired electron = 1

No of paired electron

$$= \frac{\text{atom No} - \text{unpaired electron}}{2}$$

$$= \frac{17 - 1}{2}$$

$$= \frac{16}{2}$$

$$= 8$$

Thus, for the atom, the group of the element, the number of unpaired electrons and the combining power can be deduced.

The correct option is D

3. Solubility product is the point whereby a slightly soluble salt tend to precipitate. Extremely soluble salts such as $NaCl, KNO_3$, NH_4Cl etc do not have solubility product.

$Cu(IO_3)_{2(s)} \rightleftharpoons Cu^{2+} + 2IO_3^-$

$xM \qquad xM \qquad 2xM$

$K_{sp} = [Cu^{2+}][IO_3^-]^2$

$= x(2x)^2$

$= x(4x^2)$

$K_{sp} = 4x^3$

But $K_{sp} = 1.08 \times 10^{-7}$

$1.08 \times 10^{-7} = 4x^3$

$$x^3 = \frac{1.08 \times 10^{-7}}{4}$$

$x^3 = 27 \times 10^{-9}$

$x = \sqrt{27 \times 10^{-9}}$

$= 3 \times 10^{-3}M$

The molar solubility of the salt $Cu(IO_3)_2$ is $3 \times 10^{-3} moldm^{-3}$

The correct option is A

4. $Au_{(s)} \rightarrow Au^{3+} + 3e^- \quad E^\circ = -1.50V$

$Cu_{(s)} \rightarrow Cu^{2+} + 2e^- \quad E^\circ = -0.34V$

In the cell notation $Au_{(s)}/Au^{3+}_{(aq)}//Cu^{2+}_{(aq)}/Cu_{(s)}$; gold moves from the solid states to the aqueous state.

$Au_{(s)} \rightarrow Au^{3+} + 3e^- \quad E^\circ = -1.50V$

But copper moves from the aqueous state to the solid state.

$$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}$$

Note that when a chemical reactions is reverse the sign of standard electrode potential (E°) is also reverse the value of the standard electrode potential is not affect if a given equation is multiply by a factor

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)} \quad E^\circ = +0.34V$

$3[Cu^{2+} + 2e^- \rightarrow Cu_{(s)}]\ E^\circ = +0.34V$

$2[Au_{(s)} \rightarrow Au^{3+} + 3e^-]\ E^\circ = -1.50V$

$3Cu^{2+} + 2Au_{(s)} \rightarrow 3Cu_{(s)} + 2Au^{3+}\ E^\circ = -1.16V$

For a reaction to be spontaneous the value of the standard electrode potential (E°) must be positive. But for a reaction to be non-

spontaneous the value of the standard electrode potential must be negative.

Since $E^{\circ} = -1.16V$ the reaction is non-spontaneous. That is the reaction is not feasible, meaning that the reaction cannot occur as it is written.

The correct option is D

5. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)\ \Delta H = -92.4kJ$

(i) In the above reaction, increase in pressure will shift the equilibrium forward. That is the forward reaction is favoured.

(ii) K_P is the equilibrium constant in terms of partial pressure of reacting species. It is affected by the temperature of the reacting species. For exothermic process, the higher the temperature, the lower the equilibrium constant while the reverse is the case for an endothermic process. Thus, the value of K_P at 623k is smaller than the value of K_P at 298k.

(iii) Passing a stream of $HCl(g)$ through the system will not affect the equilibrium position. It will cuase the reaction to go in one direction. This is because HCl will consum or react with $NH_3(g)$. Thus,remove NH_3 as soon as it is form.

(iv) A catalyst allows equilibrium to be attained easily but does not affect equilibrium position.

The correct option is C

6. The uses of phenolphthalein as an indicator for the reaction indicate or show that the resulting solution is basic or alkaline. This is because phenolphthalein is sensitive to basic or alkaline medium. Methyl orange on the other hand is sensitive to acidic medium. The colour change of **phenolphthalein** to different media is given by **CANCAP**, which implies **colourless in acid (CA), colourless in neutral (NC)** and **pink in alkaline (AP)**. The colour change of methyl orange in different media is given by **PANOYA** which implies **pink in acid (PA), orange in neutral (NO)** and **yellow in alkaline (YA)**. Note that many people confused pink with red.

$$2NaCO_{3(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2NaOH_{(aq)} + 2CO_{2(g)}$$

$25cm^3, 0.052M, \quad 32.80cm^3$

$$\cap_{Na_2CO_3} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc$$

$$= \frac{25}{1000} \times 0.052$$

$$= 0.0013mol$$

$$\cap_{H_2SO_4} = \frac{1mole\ of\ H_2SO_4}{2mole\ of\ Na_2CO_3} \times 0.0013mol\ of\ Na_2CO_3$$

$$= 0.00065mol$$

$$\cap_{H_2SO_4} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc$$

$$0.00065 = \frac{32.8}{1000} \times molar\ conc$$

$$molar\ conc = \frac{0.00065 \times 1000}{32.8}$$

$$= 0.0198moldm^{-3}$$

Note that if the indicator used is methyl orange the reaction will be as given below.

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$$

$25cm^3, 0.052M \quad 32.80cm^3$

$$\cap_{Na_2CO_3} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc$$

$$= \frac{25}{1000} \times 0.052$$

$$= 0.0013mol$$

$$\cap_{H_2SO_4} = \frac{1mole\ of\ H_2SO_4}{2mole\ of\ Na_2CO_3} \times 0.0013mol\ of\ Na_2CO_3$$

$$= 0.0013mol$$

$$\cap_{H_2SO_4} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc$$

$$0.0013 = \frac{32.8}{1000} \times molar\ conc$$

$$molar\ conc = \frac{0.0013 \times 1000}{32.8}$$

$$= 0.0396M$$

Thus, the concentration of H_2SO_4 with phenolphthalein as indicator is $0.0198M$ but the concentration of H_2SO_4 with methyl orange as indicator is $0.0396M$.

The correct option is B

7. (i) $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

$$R = -\frac{d[CaCO_3]}{dt} = \frac{d[CaO]}{dt} = \frac{d[CO_2]}{dt}$$

(ii) $^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + {}^{0}_{-1}\beta$

$$R = -\frac{d[Th]}{dt} = \frac{d[Pa]}{dt} = \frac{d[\beta]}{dt}$$

(iii) $C_{12}H_{22}O_{11} + H_2O \rightarrow 2C_6H_{12}O_6$

glucose

$$R = -\frac{d[C_{12}H_{22}O_{11}]}{dt} = \frac{d[H_2O]}{dt} = \frac{1}{2}\frac{d[C_6H_{12}O_6]}{dt}$$

(iv) $CH_3COOCH_3 + NaOH \rightarrow CH_3COONa + CH_3OH$

$$R = -\frac{d[CH_3COOCH_3]}{dt} = \frac{d[NaoH]}{dt} = \frac{d[CH_3COONa]}{dt} = \frac{d[CH_3OH]}{dt}$$

Thus, in reaction I and II the expression of reaction rate contain only one reactant. In reaction III & IV the expression for reaction rate contain two reactants.

Note that, reaction III can be considered as a reaction with single reactant since it is a hydrolysis of sucroce.

The correct option is A

$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

8. In the reaction above the oxidation number of Fe changes from $+2\,(in\ Fe^{2+})$ to $+3(in\ Fe^{3+})$. It shows that iron (Fe) undergoes increase in oxidation number. Oxidation is a process that involves increase in oxidation number. In the above reaction, the oxidation number of chromium (Cr) changes from +6 (in $Cr_2O_7^{2-}$) to $+3(in\ Cr^{3+})$. It shows that chromium (Cr) undergoes decreases in oxidation number.

Thus iron (Fe) undergoes oxidation process while chromium undergoes reduction process. The substance that undergoes oxidation process is the reducing agent or reductant while the substance that undergoes reduction process is the oxidizing agent or oxidant. Therefore, Fe^{2+} is the reducing agent while $Cr_2O_7^{2-}$ is the oxidizing agent.

Characteristics of the reducing agent

(i) It always undergoes oxidation process
(ii) It is always oxidized
(iii)It donates electrons
(iv)It has increase in oxidation number

Characteristics of the oxidizing agent

(i) It always undergoes reduction process
(ii) It is always reduced
(iii)It has decrease in oxidation number
(iv)It accepts electrons

Thus, the oxidizing agent is always reduced while the reducing agent is always oxidized. In the reaction the oxidizing agent is $Cr_2O_7^{2-}$ but the substance that is oxidized is Fe^{2+}.

The correct option is A

9. $Mass\ of\ KClO_3 = 25g$

Volume of solution $= 50cm^3 = 0.05dm^3$

Solubility $= 2.50moldm^{-3}$

$$\text{Solubility} = \frac{\text{mass of dissolve solute}}{\text{molar mass}} \times \frac{1000}{\text{vol in cm}^3}$$

$R.M.M\ of\ KClO_3 = 122.50g/mol$

$$2.5 = \frac{x}{122.5} \times \frac{1000}{50}$$

$$x = \frac{2.5 \times 50 \times 122.5}{100}$$

$= 15.3125g$

Mass of salt = mass of dissolve salt + mass of undissolved salt

$25g = 15.3125g + y$

$y = 25g - 15.3125g$

$= 9.6875g$

$$\%\ of\ undissolved\ salt = \frac{mass\ of\ undissolved\ salt}{mass\ of\ salt} \times \frac{100}{1}$$

$$= \frac{9.6875g}{25g} \times 100$$

$= 38.75\%$

The correct option is A

10. $C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(l)} \Delta H = -1401kJ$

$C_2H_{6(g)} + \frac{7}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$

$\Delta H = -1550kJ$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}\ \Delta H - 286kJ$

To obtain the equation: $C_2H_4 + H_2 \rightarrow C_2H_6$ from the above equations, the 2nd equation must be reverse before combining the three equations together. Note that, if an equation is reverse the sign of ΔH is also reverse.

$C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(l)}\Delta = -1401kJ$

$2CO_{2(g)} + 3H_2O \rightarrow C_2H_{6(g)} + \frac{7}{2}O_{2(g)}\ \Delta H = 1550kJ$

$C_2H_{6(g)} + \frac{7}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}\Delta H = -1550kJ$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}\ \ \Delta H = -286kJ$

$C_2H_{4(g)} + H_{2(g)} \rightarrow C_2H_{6(g)}\ \ \Delta H = -137kJ$

The correct option is B

11. Let the hydrocarbon be C_xH_y

Volume of $C_xH_y = 150cm$

Mass of $C_xH_y = 0.281g$

Mass of H_2O formed $= 0.362g$

Volume of CO_2 formed at s.t.p $= 450cm^3$

$C_xH_{y(g)} + \left(x + \frac{y}{4}\right)O_{2(g)} \rightarrow xCO_{2(g)} + \frac{y}{2}H_2O_{(l)}$

$150cm^3$ $450cm^3$ 0.362g

The above reaction shows that 1mole of C_xH_y give xmoles of CO_2 and $150cm^3$ of C_xH_y gives $450cm^3$ of CO_2

$$\frac{1}{150} = \frac{x}{450}$$

$$x = \frac{450}{150} = 3$$

R.M.M of $C_xH_y = 12x + y$ (But $x = 3$)

$= 36 + y$

Mass of H in 0.281g in C_xH_y

$$= \frac{R.A.m\ of\ H}{R.m.m\ of\ C_xH_y} \times 0.281$$

$$= \frac{y}{36 + y} \times 0.281$$

$$= \frac{0.281y}{36 + y}$$

$$\cap_H = \frac{reacting\ mass\ of\ H}{molar\ mass} = \frac{0.281y}{\frac{36+y}{1}}$$

$$\cap_H = \frac{0.281y}{36+y}$$

mass of H_2O formed $= 0.362g$

mass of H in 0.362g of H_2O

$$= \frac{2g/mol}{18g/mol} \times 0.362g$$

$$= 0.04022g$$

$$\cap_H formed = \frac{Reacting\ mass}{Molar\ mass}$$

$$\cap_H = \frac{0.040225}{1g/mol} = 0.04022mol$$

The number of moles of hydrogen in the hydrocarbon will be equal to the number of moles of hydrogen formed.

$$\frac{0.281y}{36+y} = 0.04022$$

$$0.281y = 0.04022\,(36+y)$$

$$0.281y = 1.44792 + 0.04022y$$

$$0.281y - 0.04022y = 1.44792$$

$$0.24078y = 1.44792$$

$$y = \frac{1.44792}{0.24078}$$

$$y = 6.0135$$

$$y \simeq 6$$

Method 2

$$C_xH_y + \left(x + \frac{y}{4}\right)O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$$

From the equation 1mole of C_xH_y gives $\frac{1}{2}$ moles of water. But the mass of one mole of a substance is the molar mass.

$$1mole\ of\ C_xH_y\ (36+y) = \frac{y}{2} mole\ of\ H_2O\ \left[\frac{y}{2} \times 18\right]$$

$$0.281g\ of\ C_xH_y = 0.362g\ of\ H_2O$$

$$\frac{36+y}{0.281} = \frac{\frac{y}{2} \times 18}{0.362}$$

$$\frac{36+y}{0.281} = \frac{9y}{0.362}$$

$$0.281\,(9y) = 0.362(36+y)$$

$$2.529y = 13.032 + 0.362y$$

$$2.529y - 0.362y = 13.032$$

$$2.167y = 13.032$$

$$y = \frac{13.032}{2.167}$$

$$y = 6.01384$$

$$y \simeq 6$$

$$\Rightarrow C_xH_y = C_3H_6$$

Method 3

From method 1, $x = 3$

$$\cap_{C_xH_y} = \frac{Reacting\ mass}{molar\ mass} = \frac{vol\ at\ s.t.p\ (cm^3)}{22400cm^3}$$

$$\frac{0.281}{molar\ mass} = \frac{150}{22400}$$

$$molar\ mass\ of\ C_xH_y = \frac{0.281 \times 22400}{150}$$

$$= 41.9627g/mol = 42g/mol$$

$$R.M.M\ C_xH_y = 42$$

$$x(12g/mol) + y(1g/mol) = 42$$

$$12x + y = 42$$

but $x = 3$

$$12(3) + y = 42$$

$$36 + y = 42$$

$$y = 42 - 36 = 6$$

$$y = 6$$

$$C_xH_y = C_3H_6$$

The correct option is A

12. Mass of empty flask $= 54.50g$

Mass of flask and saturated solution $87.70g$

Mass of flask and solute $= 66.7g$

Mass of saturated solution $= 87.7 - 54.5 = 33.20g$

Mass of dissolve solute $= 66.7g - 54.50g = 12.20g$

Mass of water $= 33.20g - 12.20g = 21g$

1g of water $= 1cm^3$ of water

Volume of water $= 21m^3$

$R.m.m\ of\ Pb(NO_3)_2 = 331g/mol$

$$\text{Solubility} = \frac{\text{mass of dissolved solute}}{\text{molar mass}} \times \frac{1000}{\text{V in cm}^3}$$

$$= \frac{12.20}{331} \times \frac{1000}{21}$$

$$= 1.76moldm^{-3}$$

The correct option is B

13. Conc. of $Ca^{2+} = 0.0025M$

Conc. Of $C_2O_4^{2-} = 1.0 \times 10^{-7}M$

$K_{sp}\ of\ CaC_2O_4 = 2.3 \times 10^{-9}$

$$CaC_2O_{4(s)} \rightleftharpoons \underset{0.0025M}{Ca^{2+}} + \underset{1.0 \times 10^{-7}M}{C_2O_4^{2-}}$$

$$Q = [Ca^{2+}][C_2O_4^{2-}]$$

$$= 0.0025 \times 1.0 \times 10^{-7}$$

$$Q = 2.5 \times 10^{-10}$$

where Q is reaction quotient. The reaction quotient is a ratio of the concentration or pressure of the products of a reaction to the concentration or pressure of the reactants, each raise to the power indicated by the co-efficient in the balance chemical equation.

The reaction quotient is used to determine if a precipitate will occur in a given reaction or not.

(i) If $K_{sp} > Q$. The forward reaction will be favoured. Thus, no precipitation will occur; if solid is present, more solid can dissolve.

(ii) If $K_{sp} = Q$. The solution is just saturated, solid and solutions are in equilibrium, neither forward nor reverse process is favoured.

(iii) If $K_{sp} < Q$. The reverse process will be favoured. Thus precipitation occurs to form more solid. In the above calculation $Q = 2.5 \times 10^{-10}$ and $K_{sp} = 2.3 \times 10^{-9}$ (i.e. $K_{sp} > Q$). Therefore no precipitation will occur. Thus, calcium oxalate will not precipitate out of the blood plasma.

The correct option is A

14. 1s 2s 2p 3s 3p 4s 3d

The following is true of the 4s-orbital

(i) It is filled before 3d orbital

(ii) It is of a lower energy than the 3d orbital and 4p-orbital

(iii) It contains a maximum of two electrons

(iv) It is defined by the subsidiary quantum number, L = 0 and the principal quantum number n = 4

(v) It has a degeneracy of zero (0)

(vi) It is spherical in shape

The correct option is B

15. $^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$

$^{234}_{90}U \rightarrow {}^{234}_{91}Pa + {}^{0}_{-1}\beta$

$^{14}_{7}N + 3^{1}_{0}n \rightarrow {}^{16}_{6}C + {}^{1}_{1}H$

$X \rightarrow$ alpha particles $({}^{4}_{2}He)$

$Y \rightarrow$ alpha particles $({}^{0}_{-1}\beta)$

$Z \rightarrow$ Neutrons

The correct option is D

16. $R.M.M\ of\ Ag_2CrO_4 = 331.7g/mol$

Mass concentration of $Ag_2CrO_4 = 0.024g/dm^3$

$$\text{molar conc} = \frac{\text{mass conc}}{\text{molar mass}}$$

$$= \frac{0.024g/dm^3}{331.7g/mol}$$

$$= 0.00007235453moldm^{-3}$$

$$Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+ + CrO_4^{2-}$$

$$xM \quad 2xM \quad xM$$

$$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$$

$$= (2x)^2(x)$$

$$= 4x^2(x)$$

$$K_{sp} = 4x^3$$

$$But\ x = 0.00007235453moldm^{-3}$$

$$K_{sp} = 4(0.00007235453)^3$$

$$= 1.52 \times 10^{-12}mol^3dm^{-9}$$

The correct option is B

17. Ionization energy is the energy require to remove one mole of electron from a gaseous atom to form a cation

$$Na_{(g)} \rightarrow Na^+_{(g)} + e^-$$

Factors that affect ionization energy

(i) **Nuclear charge effect:** The greater the nuclear charge effect the greater the ionization energy.

(ii) **Screening or shielding effect:** The higher the shielding effect the lower the ionization energy

(iii) **Atomic radius:** The smaller the atomic radius, the higher the ionization energy.

(iv) **Stability of orbital:** The greater the stability of an orbital the greater the ionization energy. Note that an orbital are said to be stable if they are fully filled or half filled. The s-orbital is always stable.

I. $_3Li \rightarrow 1s^2\ 2s^1$

$\rightarrow$ [He] $2s^1$

II. $_4Be \rightarrow 1s^2\ 2s^2$

$\rightarrow$ [He] $2s^2$

III. $_{11}Na \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^1$

$\rightarrow$ [Ne] $3s^1$

IV. $_{12}Mg \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2$

$\rightarrow$ [Ne] $3s^2$

V. $_{19}K \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$

$\rightarrow$ [Ar] $4s^1$

Li and *Be* has two shells

Na and *Mg* has three shells

K has four shell

The number of shells in an atom is equal to the highest principal quantum number e.g. $_{17}X \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

The highest principal quantum number is 2. thus, X has three shells. The number of shells in an atom is a measure of its size. The greater the size of an atom (i.e. atomic radius) the smaller its ionization energy.

Thus, *K* has the least ionization energy, followed by *Na* and *Mg* and then *Li* and *Be*

$\Rightarrow K < Mg, Na < Li, Be$

$Mg \rightarrow [Ne]3s^2$

$Na \rightarrow [Ne]3s^1$

Since *Mg* and *Na* have the same number of shells, *Mg* will be more stable than *Na* because it has two electrons in its outer most subshell while *Na* has one electron in its outer most subshell. The greater the stability of an atom the greater the ionization energy (that is $Na < Mg$).

Since *Li* and *Be* have the same number of shells, *Be* will be more stable than *Li* because it has two electrons in its outer most subshell while *Li* has one electron in its outermost subshell. The greater the stability of an atom the greater the ionization energy (i.e. $Li < Be$)

$K < Mg, Na < Li, Be$

$K < Na < Mg < Li < Be$

$\Rightarrow V < III < IV < I < II$

The correct option is C

18.

Ionization	Anode (+)	Cathode (-)
$CuSO_4 \rightarrow Cu^{2+} + SO_4^{2-}$	SO_4^{2-}	Cu^{2+}
$H_2O \rightarrow H^+ + OH^-$	OH^-	H^+

At the anode OH^- is discharge

$4OH^- \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e^-$

At the anode Cu^{2+} is discharge

$2Cu^{2+} + 4e^- \longrightarrow 2Cu_{(s)}$

The resulting solution is acidic (i.e. H_2SO_4)

Note that prolong passage of electricity through the solution will cause the H_2SO_4 formed to undergoes electrolysis.

$I = 0.75A, IF = 96500C$

$t = 10mins = 10 \times 60s = 600s$

$Q = It$

$= 0.75 \times 600$

$= 450C$

$1mole\ of\ O_2 = 4F$

$xmole\ of\ O_2 = 450C$

$\frac{1}{x} = \frac{4F}{450}$

$\frac{1}{x} = \frac{4 \times 96500}{450}$

$x = \frac{450}{4 \times 96500}$

$x = 0.0011658031mole$

$\cap_{O_2} = \frac{vol\ at\ s.t.p}{22.4dm^3/mol}$

$Vol\ at\ s.t.p = 0.0011658031 \times 22.4$

$= 0.02611dm^3$

$= 26.11cm^3$

The correct option is B

19. $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)} \quad \Delta H = +58kJ$

	Change	Equilibrium shift
I	Addition of $NO_{2(g)}$	Left
II	Removal of N_2O_4	Left
III	Addition of $He_{(g)}$	None
IV	Increase volume of the container	None
V	Decrease in temperature	Left

Addition of NO_2 increases the concentration of the product, causing the equilibrium to shift left. Removal of N_2O_4 prevent the forward reaction $N_2O_4 \longrightarrow 2NO_2$ and favour the backward reaction $N_2O_4 \longrightarrow 2NO_2$. Thus, the equilibrium to shift backward (i.e. left).

Addition of He has not effect on the system because none of the reacting species is He.

Increase in the volume of the container will cause a change in the volume of N_2O_4 and NO_2 simultaneously in an equal amount. As a result the net change in volume of the reacting species will be zero. Thus, there will be no effect in the equilibrium of the system. However the rate of reaction may be slower due to the increase in distance between reacting particles.

Decreasing in temperature will favour the backward reaction which is exothermic but increase in temperature will favour the forward reaction which is endothermic.

The correct option is D

20. (i) $Fe^{2+} \longrightarrow Fe^{3+}$
green reddish-brown

(ii) $Cl_{2(g)} \longrightarrow 2Cl^-$
greenish yellow colourless

(iii) $MnO_4^- \longrightarrow Mn^{2+}$
purple colourless

(iv) $KI \longrightarrow K^+ + I_2$
colourless reddish brown

(v) $Cr_2O_7^{2-} \longrightarrow Cr^{3+}$
orange green

Reducing agent decolourize $KMnO_4$ and changes the orange colour of $K_2Cr_2O_7$ to green (due to Cr^{3+})

The correct option is A

21. $2N_2O_{5(g)} \longrightarrow 4NO_{2(g)} + O_{2(g)}$

$R = -\frac{1}{2}\frac{\Delta[N_2O_5]}{\Delta t} = \frac{1}{4}\frac{\Delta[NO_2]}{\Delta t} = \frac{\Delta[O_2]}{\Delta t}$

when $C_{N_2O_5} = 1.24 \times 10^{-2}M, t = 600s$

$C_{N_2O_5} = 0.93 \times 10^{-2}M, t = 1200s$

$\Delta[N_2O_5] = \Delta C_{N_2O_5}$

$= 0.93 \times 10^{-2} - 1.24 \times 10^{-2}$

$= -0.31 \times 10^{-2}M$

$\Delta t = 1200 - 600 = 600s$

$R_{avg} = -\frac{\Delta[N_2O_5]}{\Delta t}$

$= -\frac{(0.31 \times 10^{-2})}{600}$

$R = 5.1667 \times 10^{-6}M/s$

$= 5.2 \times 10^{-6}M/s$

Note that the rate of a reaction is always a positive value. In other words, the rate of a reaction cannot be negative.

The correct option is C

22. $V = 5dm^3, P = 3atm, T = 250^oC = 298k$

$n = ?\ R = 0.082atmdm^3/molk$

$PV = nRT$

$n = \frac{PV}{RT}$

$= \frac{3atm \times 5dm^3}{0.082atmdm^3/molk \times 298}$

$n = 0.6138moles$

$n = \frac{No.of\ molecules}{6.02 \times 10^{23}}$

No. of molecules

$= 0.6138 \times 6.02 \times 10^{23}$

$= 3.695 \times 10^{23}$

$= 3.70 \times 10^{23}$

The correct option is B

23. $3e^- + NO_3^- + 4H^+ \longrightarrow NO + 2H_2O$

$NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O$

$\Rightarrow a = 1, b = 4, c = 3, d = 1$ and $e = 2$

The correct option is D

24. Hydrogen bonding is a fairly strong dipole-dipole interaction between molecules containing hydrogen directly bonded to a small highly charge electronegative element such as N, O and F. Hydrogen bond is a type of polar covalent bond, hence by characteristics it is a covalent bond. Hydrogen bonding is responsible for the high boiling point and low volatility of H_2O, HF, NH_3, alkanols & alkanoic acid. The hydrogen bond in H_2O is stronger than the polar bond in H_2S. Note that the greater the hydrogen bonds in a molecule, the greater the tendency of the molecule to exist as a liquid and the lesser the volatility of the substance but the higher the boiling point. Also note that the greater the hydrogen bond or polar bond in a molecular the greater the difference in electronegativity of the elements that made up the molecule. Therefore, the electronegativity of oxygen allows hydrogen bonding in water (H_2O) molecules.

The correct option is D

25. $Zn^{2+} + 2e^- \rightarrow Zn_{(s)}\ E^o = -0.763V$

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}\ E^o = +0.337V$

In the cell rotation $Zn/Zn^{2+}//Cu^{2+}/Cu$. Zn changes from solid to aqueous. Hence the equation I above must be reverse. If an equation is reverse the sign of standard electrode potential will also be reverse.

$Zn_{(s)} \rightarrow Zn^{2+} + 2e^-\ E^o = +0.763V$

In the cell notation, copper changes from aqueous to solid

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}\ E^o = -0.337V$

$Zn_{(s)} \rightarrow Zn^{2+} + 2e^-\ E^o = +0.763V$

$Cu^{2+} + 2e^- \rightarrow Cu_{(s)}\ E^o = -0.337V$

$Zn_{(s)} + Cu^{2+} \rightarrow Zn^{2+} + Cu_{(s)}\ E^o = 1.1V$

In the reaction the number of electrons (n) transfer is two (2)

$\Rightarrow n = 2$

$\Delta G = -nFE^o$

$= -2 \times 96500 \times 1.1V$

$\Delta G = -212.3kJ/mol$

The correct option is B

26.

n	l	m_l	m_s
1	0	0	$\pm\frac{1}{2}$
2	0	0	$\pm\frac{1}{2}$
3	1	-1, 0, 1	$\pm\frac{1}{2}$
	0	0	$\pm\frac{1}{2}$
	1	-1, 0, 1	$\pm\frac{1}{2}$
	2	-2, -1, 0, 1, 2	$\pm\frac{1}{2}$

Base on the table above the following sets of quantum number is correct

$n = 1, l = 0, m_l = 0, m_s = \pm\frac{1}{2}$

$n = 2, l = 0, m_l = 0, m_s = \pm\frac{1}{2}$

$n = 2, l = 1, m_l = 0, m_s = \pm\frac{1}{2}$

$n = 3, l = 1, m_l = 0, m_s = \pm\frac{1}{2}$

The correct option is B

27. $\underset{100cm^3,\ 0.1M}{NaOH} + \underset{100cm^3,\ 0.1M}{HCl} \rightarrow NaCl + H_2O$

$\cap_{NaOH} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc$

$= \frac{100}{1000} \times 0.1$

$= 0.01mol$

$\cap_{HCl} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc$

$= \frac{100}{1000} \times 0.2$

$= 0.02mol$

$\cap_{NaOH} : \cap_{HCl}$

$\frac{0.01}{1} : \frac{0.02}{1}$

$0.01 : 0.02$

Note that the division is done by the co-efficient of the species in the balance chemical reaction. The smaller number of moles gives the limiting reagent.

The limiting reagent is $NaOH$

The excess reagent is HCl

$\cap_{HCl}$ used up

$= \frac{1mole\ of\ HCl}{1mole\ of\ NaOH} \times 0.01mole\ of\ NaoH$

$= 0.01mole$

excess $\cap_{HCl}$

$=$ Original $\cap_{HCl} - \cap_{HCl}$ used up

$= 0.02mole - 0.01mole$

$= 0.01mole$

$\text{Conc. of excess} = \frac{\text{excess } \cap_{HCl}}{\text{vol of solution}}$

Volume of sol

$= 100cm^3\ of\ NaOH + 100cm^3\ of\ HCl$

$= 200cm^3$ of solution

$= 0.2dm^3$

$C_{HCl} = \frac{0.01mol}{0.2dm^3}$

$= 0.05M$

$\underset{0.05M}{HCl_{(aq)}} \rightarrow \underset{0.05M}{H^+} + \underset{0.05M}{Cl^-}$

$P^H = -Log_{10}^{[H^+]}$

$= -Log_{10}^{0.05}$

$= 1.3010$

$P^H + P^{OH} = 14$

$1.3010 + P^{OH} = 14$

$P^{OH} = 14 - 1.3010$

$= 12.699$

$P^{OH} = 12.7$

The correct option is D

28. (i) $KCH_3COO + H_2O \rightarrow KOH + CH_3COOH$
strong weak
The hydrolysis of potassium ethanoate gives KOH and CH_3COOH. Since the base formed is strong and the acid formed is weak the resulting solution is basic or alkaline. It will turns red litmus paper blue.

(ii) $NH_4Cl + H_2O \rightarrow NH_4OH + HCl$
weak strong
The hydrolysis of ammonium chloride gives NH_4OH and HCl. Since the base formed is weak and the acid formed is strong, the resulting solution is acidic. It will turns blue litmus paper red.

(iii) $Na_2CO_3 + 2H_2O \rightarrow 2NaOH + H_2CO_3$
strong water
The hydrolysis of sodium trioxocarbonate IV gives $NaOH$ and H_2CO_3. Since the base formed is strong and the acid formed is weak, the resulting solution is basic or alkaline. It will turns red litmus paper blue.

(iv) $MgSO_4 + 2H_2O \rightarrow Mg(OH)_2 + H_2SO_4$
weak strong
The hydrolysis of magnesium tetroxosulphate VI gives $Mg(OH)_3$ and H_2SO_4. Since the base formed is weak and the acid formed is strong, the resulting solution is acidic. It will turns blue litmus paper red.

(v) $K_2SO_4 + 2H_2O \rightarrow 2KOH + H_2SO_4$
strong strong
The hydrolysis of potassium tetraoxosulphate VI gives KOH and H_2SO_4. Since the base formed is strong and the acid formed is strong. The resulting solution is neutral. It will have no effect on litmus paper.

(vi) $AlCl_3 + 3H_2O \rightarrow Al(OH)_3 + 3HCl$
weak strong
The hydrolysis of aluminium chloride gives $Al(OH)_3$ and HCl. Since the base formed is weak and the acid formed is strong, the resulting solution will be acidic. It will turn blue litmus paper red.

The correct option is A

29. Dipole-Dipole attraction, Dipole-Induced dipole attraction and dispersion forces are collectively known as Van der Waal forces.
Dipole-Dipole attractions forces are attractive forces between polar molecules.
Dipole-Induced dipole interaction/ attraction is the force of attraction/ interaction between a polar molecule and the induced dipole.
Dispersion forces are attractive forces that arise as a result of temporary dipoles induced in atoms or molecules.
Thus the forces of attraction that exist in a mixture of argon (non-polar) and hydrogen chloride (polar) are dipole-induced dipole attraction and dispersion forces. That is temporary dipole-permanent dipole attraction and dispersion forces.

The correct option is C

30. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ at 25°C
5.694J/mol 205.03J/molk 197.9J/molk
$\Delta S = \Sigma S_P - \Sigma S_R$
$\Sigma S_P = 197.9 J/molk$
$\Sigma S_R = 5.694 + 205.03$
$= 210.724 J/molk$
$\Delta S = 197.9 - 210.724$
$= -12.824 J/molk$

The correct option is B

31. To determine the catalyst add up the reaction ensuring all species are balanced. The species that reformed at the end of the reaction and is cancels out at the end of the reaction is the catalyst.
$Cl_{2(g)} \rightleftharpoons 2Cl_{(g)}$
$2N_2O_{(g)} + 2Cl_{(g)} \rightarrow 2N_{2(g)} + 2ClO_{(g)}$
$2ClO_{(g)} \rightarrow Cl_{2(g)} + O_{2(g)}$
$2N_2O_{(g)} \longrightarrow 2N_{2(g)} + O_{2(g)}$
When the reactions are combine Cl_2, Cl and ClO are cancels out. But only Cl_2 initiate the reaction and is reformed at the end of the reaction as seen by the reaction.
$2ClO_{(g)} \longrightarrow Cl_{2(g)} + O_{2(g)}$
Thus, Cl_2 is the catalyst in the reaction?

The correct option is A

32. The observation is due to the increase in the number of lone pairs of electron from carbon through nitrogen to oxygen.

The correct option is C

33. $Co^{3+} + 6H_2O \rightleftharpoons [Co(H_2O)_6]^{3+}$
Note that all cations (Co^{3+}, Ca^{2+}, Mg^{2+}, Cr^{3+} etc) and electron deficient molecules (BF_3, $AlCl_3$, BeF_2, $BeCl_2$ etc) are Lewis acids. All anions (S^{2-}, SO_4^{2-}, CO_3^{2-} etc) and electron rich molecules (H_2O, NH_3, CH_3NH_2, PH_3 etc) are Lewis base. Thus, Co^{3+} is a Lewis acid and H_2O is a Lewis base.
According to Lewis an acid is a substance that accepts shared electron pair require for bonding while a base is a substance that donate a shared electron paired require for bonding.

The correct option is B

34. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$
0kJ/mol 0kJ/mol -45.9kJ/mol
Note that the enthalpy of formation of an element in the free state (i.e. N_2, H_2, O_2 etc) is zero.
$\Delta H = \Sigma H_P - \Sigma H_R$
$\Sigma H_P = 2mole\ (-45.9 kJ/mol)$
$= -91.8 kJ$

$\Sigma H_R = 1mole\ (0kJ/mol) + 3moles(0kJ/mol) = 0$

$\Delta H = \Sigma H_P - \Sigma H_R$

$= -91.8 - 0$

$= -91.8kJ$

$S^o_{(N_2)} = 171.5J/molk$

$S^o_{(H_2)} = 130.6J/molk$

$S^o_{(NH_3)} = 193J/molk$

$T = 25^oC = 298k$

$\Delta S = \Sigma S_P - \Sigma S_R$

$\Sigma S_P = 2mole\ (193J/molk) = 386J/k$

$\Sigma S_R = 1mole\ (191.5J/molk) + 3mole(130.6J/molk)$

$= 191.5J/k + 391.8J/k$

$= 583.3J/k$

$\Delta S = \Sigma S_P - \Sigma S_R$

$= 386 - 583.3$

$= -197.3J/k$

$= -0.1973kJ/k$

$\Delta G = \Delta H - T\Delta S$

$= -91.8 - 298\ (-0.197.3)$

$= -91.8 + 58.7954$

$= -33.0046kJ$

Note that this method of solving this question is not standard enough because in thermal calculation we are suppose to work with one mole of the product.However working will one mole of the product does not give the answere in the option.

The correct option is B

35. $2A + B \longrightarrow P$

$R = K[A]^m[B]^n$

$if\ [A] = 2[A], R_1 = 2R$

$R_1 = k(2[A])^m[B]^n$

$= 2^m\ k[A]^m[B]^n$

$But\ R = k[A]^m[B]^n$

$R_1 = 2^mR$

$But\ R_1 = 2R$

$2R = 2^mR$

$2^1 = 2^m \Longrightarrow m = 1$

$If\ [B] = 2[B], R_2 = 4R$

$R_2 = k[A]^m(2[B])^n$

$= 2^nk[A]^m[B]^n$

$R_2 = 2^nR$

$But\ R_2 = 4R$

$4F = 2^nR$

$2^2 = 2^n \Longrightarrow n = 2$

Note that if the concentration [X] of a species X doubles it becomes 2[X]. If the rate R doubles it becomes 2R but if it quadruples it becomes 4R.

$R = k[A]^m[B]^n$

$m = 1\ and\ n = 2$

$R = k[A][B]^2$

Order of reaction $= m + n$

$= 1 + 2$

$= 3$

The following is true of the reaction

(i) The reaction is a third order reaction. This is because $m + n = 3$

(ii) The reaction is a first order reaction will respect to reactant A. This is because $m = 1$

(iii) The reaction is a second order reaction will respect to reactant (b) this is because $n = 2$

(iv) The reaction is dependent on the concentration of reactant A and (b) this is because $m \neq 0$ and $n \neq 0$.

The correct option is B

36. Concentration (c) $= \frac{n}{v}$

$C = \frac{0.1mol}{125ml} = \frac{0.1mol}{125cm^3} = \frac{0.1mol}{0.125dm^3}$

$C = 0.8M$

$HNO_{3(aq)} \longrightarrow H^+ + NO_3^-$

0.8M 0.8M 0.8M

$[H^+] = 0.8M$

$P^H = -Log_{10}^{[H^+]}$

$= -Log_{10}^{0.8}$

$= 0.0969M$

$P^H + P^{OH} = 14$

$0.0969 + P^{OH} = 14$

$P^{OH} = 14 - 0.0969$

$P^{OH} = 13.9031$

$[OH^-] = 10^{-P^{OH}}$

$= 10^{-13.9031}$

$= 1.2500 \times 10^{-14}M$

$([H^+], [OH^-]) = (0.8M, 1.25 \times 10^{-14}M)$

The correct option is C

37. (i) Galvanic cells are electrochemical cell. They convert chemical energy to electrical energy.

(ii) The cathode is the positive electrode in a voltanic cell (i.e. electrochemical cell)

(iii) The cathode is the negative electrode in an electrolytic cell

(iv) All electrochemical cells do not require an external source of electric current for operation.

(v) All electrolytic cells require an external source of electric current for operation.

The correct option is B

38. $m_{Ag} = 5.35g$

$M_{Ag} = 108g/mol$

$C_{Ag} = +1$

$m_{Cx} = ?$

$M_{Cx} = 63.5$

$C_{Cx} = +2$

$\frac{M_{Cx}}{m_{Ag}} = \frac{M_{Cx} \times C_{Ag}}{M_{Ag} \times C_{Cx}}$

$\frac{m_{Cx}}{5.38} = \frac{63.5 \times 1}{108 \times 2}$

$$m_{Cu} = \frac{63.5 \times 1 \times 5.38}{108 \times 2}$$
$$= 1.58g$$

The correct option is D

39. Water, aqueous potassium chloride, zinc rod and molten sodium chloride will conductor heat and electricity.

The correct option is D

40. $\rho = d = 1.80g/cm^3$
$p = 98\%$
$v_2 = 250cm^3$
$c_2 = 0.50moldm^{-3}$

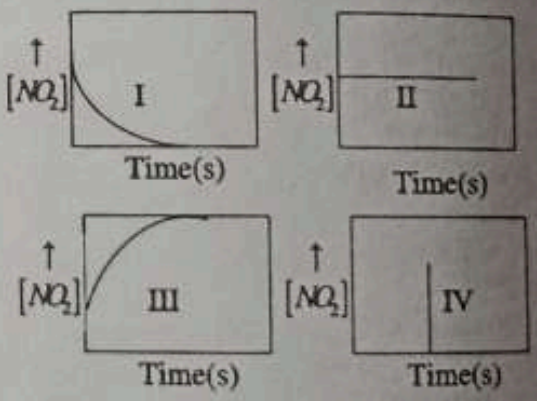
Solution with percentage purity (P) and density (d) are stock solution. For a stock solution.

$$molar\ conc\ (c) = \frac{10pd}{M}$$
$$mass\ conc = 10pd$$
$$R.M.M\ of\ H_2SO_4 = 98g/mol$$
$$molar\ conc = \frac{10pd}{M}$$
$$= \frac{10 \times 98 \times 1.80}{98}$$
$$= 18M$$
$$G = 18M$$
$$C_1V_1 = C_2V_2$$
$$18V_1 = 0.5 \times 250$$
$$V_1 = \frac{0.5 \times 250}{18}$$
$$= 6.9444cm^3$$

The correct option is D

2012/2013 CHEMISTRY 001 EXAMINATION

1. If $H_3PO_4, H_2PO_4^-, NH_3, HS^-$ and H_2SO_4 are all Bronsted-Lowry acids, their respective conjugate bases will be:
(a) $HPO_4^-, H_3PO_4, NH_4^+, H_2S$ and H_2SO_3
(b) $H_2PO_4^-, HPO_4^{2-}, NH_2^-, S^{2-}$ and HSO_3^-
(c) $PO_4^{3-}, PO_4^{2-}, N_3^-, S^{2-}$ and SO_4^{2-}
(d) $H_2PO_4, HPO_4^{2-}, H_2S$ and H_2SO_3
2. $0.202g$ of a compound gave on combustion $0.361g$ of CO_2 and $0.147g$ of H_2O. What is the empirical formula of the compound? (a) $C_6H_{12}O_4$ (b) $C_{12}H_{24}O_8$ (c) $C_2H_4O_6$ (d) $C_3H_6O_2$
3. What substance can be used to oxidize fluoride to fluorine? (a)Cl_2 (b) fluorides can only be oxidized electrolytically but not chemically by any substance (c) I_2 (d) Br_2
4. Which of the following statements are correct about electrochemical cells? I. anode is positive while cathode is negative II. cathode is positive while anode is negative III. chemical energy is converted to electrical energy IV. electrodes are in the same compartment V. electrons are forced by an external force VI. porous partition is required (a) I, IV and V (b) II, III and VI (c) I, II and V (d) I, III and VI
5. A current of 15 amperes is employed to plate nickel in a $NiSO_4$ bath. Both Ni and H_2 are formed at the cathode. The current efficiency with respect to formation of nickel is 80%. How many grammes of nickel are plated on the cathode per hour? [Ni = 58.7; Faraday's constant = 96500C]. (a) $15.17g$ (b) $34.09g$ (c) $5490g$ (d) $13.14g$
6. $8.28\ g$ of ethanol was heated with $60g$ of ethanoic acid, $49.74g$ of the acid remains at equilibrium. Calculate the value of concentration equilibrium constant [C = 12.00, H = 1.00, 0 = 16.0 g/mol]. (a) 3.92 (b) 5.23 (c) 7.92 (d) 12.4
7. In the reaction $SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3$ $\Delta G(1000k) = -5.19kJ$. What is the equilibrium constant Kp for the reaction at $1000k$ ($R = 8.314\ J/mol.K$). (a) -1.87 (b) $0.270g$ (c) -453 (d) 1.87
8. On introduction of N_2O_4 into an evacuated flask, the following reaction takes place$N_2O_4(g) \rightarrow 2NO_2(g)$. By observing the concentration change of product with time, which of the following curves reflects the data collected for this reaction.



(a) III (b) IV (c) I (d) II

9. The solubility of a saturated solution of lead (II) chloride at 25^0 is $0.1681moldm^{-3}$. What is the solubility product of the salt at the same temperature? (a) $1.9 \times 10^{-2}mol^3dm^{-9}$ (b) $2.8 \times 10^{-2}mol^3dm^{-9}$ (c) $1.9 \times 10^{-4}mol^2dm^{-6}$ (d) $2.8 \times 10^{-4}mol^2dm^{-6}$
10. A $0.55moldm^{-3}$ ammonia solution is found to be 0.58% ionized. Calculate the base equilibrium constant for the dissociation of the base. (a) $1.8 \times 10^{-3}moldm^{-3}$ (b) $5.2 \times 10^{-5}moldm^{-3}$ (c) $1.86 \times 10^{-5}moldm^{-3}$ (d) $2.3 \times 10^{-3}moldm^{-3}$

11. Calculate the molar solubility of $AgBr$ in $0.15M\ NaBr$ at 25^0C (k_{sp} of $AgBr = 5.0 \times 10^{-13} moldm^{-6}$ at 25^0C (a) $6.66 \times 10^{-12} moldm^{-3}$ (b) $3.33 \times 10^{-5} moldm^{-3}$ (c) $6.66 \times 10^{-5} moldm^{-3}$ (d) $3.33 \times 10^{-12} moldm^{-3}$

12. Which of the following reaction will have the fastest reaction rate? (a) A lump of $10g\ CaCO_3 + 0.05M\ HCl \rightarrow products$ (b) A powered of $5g\ CaCO_3 + 0.01M\ HCl \rightarrow products$ (c) A lump of $5g\ CaCO_3 + 0.01M\ HCl \rightarrow product$ (d) A powered of $10g\ CaCO_3 + 0.05M\ HCl \rightarrow product$

13. Consider the hypothetical reaction equation: $A + B \rightarrow C$. If the rate law is Rate $= k[A]^2[B]$, what effect would doubling the concentration of A while keeping the concentration B constant has on the reaction rate? (a) Rate will increase by two folds (b) Rate will remain constant (c) Rate will reduce by two folds (d) Rate will increase by four folds.

14. Calculate the heat of formation of methane (CH_4) given that the heat of combustion of methane is $-891kJ/mol$. The heat of formation of CO_2 and H_2O are -393 and $-286kJ/mol$ respectively. (a) $+74kJ/mol$ (b) $-74kJ/mol$ (c) $+148kJ/mol$ (d) $-148kJ/mol$

15. What is the e.m.f. and cell notation of a cell containing Zn^{2+}/Zn, and Cu^{2+}/Cu electrodes? If the electrode potential of Zn^{2+}/Zn and Cu^{2+}/Cu are $-0.763V$ and $+0.337V$ respectively. (a) $+1.100V, Zn^{2+}/Zn//Cu^{2+}/Cu$ (b) $+1.100V, Cu^{2+}/Cu//Zn^{2+}/Zn$ (c) $+1.500V, Zn^{2+}/Zn//Cu^{2+}/Cu$ (d) $-1.100V, Zn^{2+}/Zn//Cu^{2+}/Cu$

16. The subsidiary or azimuthal quantum number 1 = 2 describe the orbital: (a) s (b) d (c) f (d) p

17. Given the solubility product of $Ca_3(PO_4)^{2-}$ to be 2.07×10^{-23} at 25^0C, calculate the solubility of the salt at 25^0C. (a) $\sqrt{1.9 \times 10^{-35}}M$ (b) $(1.9 \times 10^{-35})^5 M$ (c) $\sqrt[5]{1.9 \times 10^{-35}}$ (d) none of the other options.

18. Consider the following scientists: I. Crooke II. Goldstein III. Chadwick IV. Millikan V. Mosley. Conclusions drawn from these scientists experiment led to the respective discoveries of: (a) neutron, electron, charge on electron, proton and atomic number (b) proton, neutron, electron, atomic number and charge on electron (c) electron, proton, neutron, charge on electron and atomic number (d) atomic number, neutron, electron, proton and charge on electron

19. Which of the following represents the correct order of increasing acid strength of hydrogen halides? (a) $HI, HBr, HC1, HF$ (b) HF, HBr, HCl, HI (c) HBr, HI, HCl, HF (d) HI, HCl, HBr, HF

20. Given the following lists of salts solutions: I. Potassium trioxocarbonate (IV); II. Sodium tetraoxosulphate (VI); III. Ammonium tetraoxosulphate (VI); IV. Aluminum chloride; V. Sodium ethanote; VI. Potassium trioxonitrate (V). Which of the salts listed above hydrolyse to produce solution with $pH > 7$ or $pH < 7$? (a) II, IV and V (b) I, III, IV and V (c) I, II, III and VI (d) II, III and VI

21. Calculate the reaction potential, E^0rxn, for the reaction: $3Fe^{2+}_{aq} + 2Cr_s \rightarrow 3Fe_s + 2Cr^{3+}$, Given $Fe^{2+}_{aq} + 2e^- \rightarrow Fe_s E^0_{red} = -0.44V$; $Cr^{3+} + 3e^- \rightarrow Cr_s E^0_{red} = -0.74V$. (a) $-1.18V$ (b) $+0.30V$ (c) $+1.18V$ (d) $-0.30V$

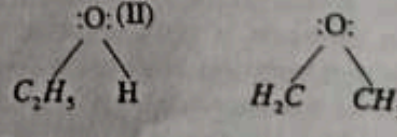
22. An element T of relative atomic mass 56 was deposited by electrolysis. If $1.99g$ of the element was deposited on the cathode when 1.90 A of current flows for 1 hrs 30 minutes, what is the charge on the element T? (a) +2 (b) −2 (c) −3 (d) +3

23. If $25cm^3$ of $0.16moldm^{-3} KOH$ is added to $50.0cm^3$ $0.1006moldm^{-3} HNO_3$, what is the pH of the resulting solution? (a) 7.00 (b) 1.00 (c) 2.10 (d) 1.88

24. The mass of $789.19cm^3$ of a diatomic gas Q at 0^0C and one atmospheric pressure was found to be $2.53g$. Determine the relative atomic mass of Q. [$R = 8.314 JK^{-1}mol^{-1}, 1atm = 101325 Jm^{-3}$]. (a) 7.2 (b) 14.4 (c) 36 (d) 3.6

25. The following half cell reaction takes place in an acidic medium: $V^{2+}(aq) \rightarrow VO^{2+}(aq)$. If the coefficients of $V^{2+}(aq)$ H_2O, VO^{2+} and H^+ in the **BALANCED EQUATION** are a, b, c and d respectively. Supply the coefficients a, b, c, and d, respectively. (a) 1, 2, 1, 4 (b) 4, 1, 2, 1 (c) 1, 2, 3, 4 (d) 4, 3, 2, 1

26. The intermolecular forces of attraction present in the molecules below are;

(I) 

(II)

(a) I-Magnetic force II-Dipole-Dipole force (b) I-Hydrogen bonding II-Electromagnetic force (c) I-Hydrogen bonding II-Dipole-Dipole force (d) I- Hydrogen bonding II-Hydrogen bonding

27. For the reaction: $Ba(O)_2(aq) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O$. $25.0cm^3$ sample of a

solution of barium hydroxide, $Ba(OH)_2$ requires $37.3cm^3$ of $0.150M$ solution of hydrochloric acid, HCl for complete reaction. What is the molarity of $Ba(OH)_2$ solution? (a) $0.211M$ (b) $0.112M$ (c) $0.012M$ (d) $0.002M$

28. A mixture of three salts consisting of Na_2SO_3, $BaSO_4$ and $AgCl$ was put in water at room temperature. Which of the following would you expect as free ions in solution?
(a) Na^+, SO_4^{2-}, Ag^+ (b) $Na^+, Ag^+, SO_3^{2-}, Cl^-$
(c) $Ba^{2+}, Na^+, Ag^+, SO_3^{2-}$ (d) None of the options given

29. A Chloride of Sulphur was found to have a molecular weight of $135g/mol$. A $5.4g$ sample was found to contain $2.84\,g$ of chlorine. What is the molecular formula? [S =32.00, Cl = 35.5 g/mol]. (a) S_8Cl (b) SCl (c) SCl_2 (d) S_2Cl_2

30. What will be the final concentration of the solution when an aqueous solution of $500cm^3 CuCl_2$ solution ($0.5M$) is electrolysed by passing a current of $5A$ through it for 2 hours? (a) $0.06M$ (b) $0.18M$ (c) $2.22M$ (d) $1.27M$

31. At a certain temperature, the equilibrium constant K_p has a value of 2.4×10^{-8} for the reaction: $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$. Calculate a value for the K_c for this reaction. (a) 0.00 (b) none of the options (c) 24×10^{-8} (d) 2.4×10^{-8}

32. Which of these statements of Dalton can be verified by laws of chemical combination? I. Matter is made up of small indivisible particles called atoms II. Atoms can neither be created nor destroyed III. All atoms of a given element are all exactly alike in every respect and differ from atoms of all other elements IV. Atoms combine chemically in small whole numbers. (a) II, III and IV (b) I, II and III (c) I, II and IV (d) I, III and IV

33. Carbon (II) Oxide, $C \equiv O$, and Nitrogen molecule, $N \equiv N$, are both triply bonded. Carbon (II) Oxide is reactive while nitrogen molecule is unreactive. The reason is: (a) Nitrogen molecule is polar (b) Carbon (II) Oxide is non-polar (c) Nitrogen molecule is abundant in the atmosphere (d) Carbon (II) Oxide is polar

34. Consider the reaction: $6Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) + 14H^+(aq) \rightarrow 6Fe^{3+}(aq) + 2Cr^{3+}(aq) + 7H_2O(l)$. Which substance is, I. oxidized II. reduced III. the oxidizing agent IV. the reducing agent. (a) (i) $Cr_2O_7^{2-}$ (ii) Fe^{2+} (iii) Fe^{2+} (iv) $Cr_2O_7^{2-}$ (b) (i) Fe^{2+} (ii) $Cr_2O_7^{2-}$ (iii) $Cr_2O_7^{2-}$ (iv) Fe^{2+} (c) (i) $Cr_2O_7^{2-}$ (ii) Fe^{2+} (iii) $Cr_2O_7^{2-}$ (iv) Fe^{2+} (d) (i) Fe^{2+} (ii) $Cr_2O_7^{2-}$ (iii) Fe^{2+} (iv) $Cr_2O_7^{2-}$

35. Consider the following equilibrium systems:
I. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
II. $C(g) + CO_2(g) \rightleftharpoons CO(g)$
III. $O_2(g) + 2H_2(g) \rightleftharpoons 2H_2O(l)$
IV. $H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$
V. $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$
VI. $H_2(g) + I_2 \rightleftharpoons 2HI(g)$
Which of the systems above are not affected by change in pressure? (a) I, II and IV (b) I, and VI (c) II and IV (d) II, IV and V

36. A $2.5\,g$ sample containing a mixture of sodium hydrogen carbonate and potassium chloride is dissolved in $25ml$ of $0.437M$ sulphuric acid. If it takes $35.4ml$ of $0.108M$ sodium hydroxide to neutralize the excess sulphuric acid, what was the percent composition of sodium hydrogen carbonate in the original sample? [$Na = 22.98, H = 1.008, C = 12.01, S = 32.06, O = 15.99$]
(a) 60.5% (b) 71.4% (c) 23.9% (d) 11.9%

37. The oxides of which of the following metals could only be indirectly prepared but are easily decomposed on heating into the corresponding metals and oxygen? I. Fe II. Hg III. Pb IV. Ag V. Au. (a) II, III and IV (b) II, IV and V (c) I, IV and V (d) I, II and III

38. Which of the following by Lewis concept are acids? I. Cu^{2+} II. SO_3 III. BF_3 IV. HCl V. NH_4^+ (a) I, II and III (b) II, III and IV (c) II, IV and V (d) II, IV and V.

39. Which of the following is not a possible ground state electronic configuration:
(a) $1s^2 2s^2 2p_x^0 2p_y^0 2p_z^1$ (b) $1s^2 2s^1 2p^0$
(c) $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$ (d) $1s^2 2s^1 2p_x^0 2p_y^1 2p_z^1$

40. The decay constant for the beta decay of was found to be $1.0 \times 10^{-13}/s$. What is the half-life of this isotope in years? (a) $6.9 \times 10^{12}y$ (b) $1.6 \times 10^6 y$ (c) $1.2 \times 10^8 y$ (d) $2.2 \times 10^5 y$

SOLUTION

1. Acid base conjugate pair is a relationship between an acid and a base such that the proton donated by an acid is accepted by a base. The acid will form the conjugate base while the base will form the conjugate acid.

$$\underset{\text{Acid}}{HCl} + \underset{\text{Base}}{NH_3} \rightarrow \underset{\text{Conjugate acid}}{NH_4^+} + \underset{\text{Conjugate base}}{Cl^-}$$

When an acid loses a proton it forms a conjugate base and when a base accepts a proton it forms a conjugate acid.

$H_3PO_4 \rightarrow H_2PO_4^- + H^+$
$H_2PO_4^- \rightarrow HPO_4^- + H^+$
$NH_3 \rightarrow NH_2^- + H^+$
$HS^- \rightarrow S^{2-} + H^+$

$H_2SO_4 \rightarrow HSO_4^- + H^+$

Therefore, the conjugate bases of H_3PO_4, $H_2PO_4^-$, NH_3, Hs^- and H_2SO_4 are $H_2PO_4^-$, HPO_4^-, NH_2^-, S^{2-} and HSO_4^- respectively.

The correct option is B

2. Mass of compound $= 0.202g$

Mass of $CO_2 = 0.361g$

Mass of $H_2O = 0.147g$

Mass of C in 0.361g of CO_2

$$= \frac{12g/mol}{44g/mol} \times 0.361g = 0.0985g$$

Mass of H in 0.147g of H_2O

$$= \frac{2g/mol}{18g/mol} \times 0.147g = 0.0163g$$

Mass of O

$$= 0.202 - (0.0985 + 0.0163)$$
$$= 0.0872g$$

C	:	H	:	O
$\frac{0.0985}{12}$	:	$\frac{0.0163}{1}$	:	$\frac{0.0872}{16}$
0.008208	:	0.0163	:	0.00545
1.5081	:	2.9908	:	1
≈1.5	:	3	:	1
$\frac{3}{2}$	:	3	:	1

Multiply through by 2

∴ 3 : 6 : 2

Therefore the empirical formula is $C_3H_6O_2$

The correct option is D

3. Fluorine is the most reactive non-metal, as a result it can only be oxidized to fluoride ion using electrolysis.

The correct option is B

4. In electrochemical cell, the following holds
   (i) The cathode is positive while the anode is negative
   (ii) Oxidation occur at the anode and reduction occur at the cathode
   (iii) Chemical energy is converted to electrical energy
   (iv) The electrodes are not in the same compartment
   (v) Electrons are not force by an external force electrons moves from the anode to the cathode
   (vi) Porous partition is required

The correct option is B

5. $I = 15A$

$e = 80\%$

$m = ?$

$t = 1hr = 3600s$

$$\text{Current efficient} = \frac{\text{current output}}{\text{current input}} \times \frac{100}{1}$$

$$80 = \frac{I}{15} \times 100$$

$$I = \frac{80 \times 15}{100} = 12A$$

$$m = ZIt$$

$$= \frac{587}{2 \times 96500e} \times 12 \times 3600s$$

$$= 13.14g$$

The correct option is D

6. Mass of ethanol $(C_2H_5OH) = 8.28g$

Mass of ethanoic acid $(CH_3COOH) = 60g$

Mass of CH_3COOH at equilibrium $= 49.74g$

$R.m.m\ of\ C_2H_5OH = 46g/mol$

$R.m.m\ of\ CH_3COOH = 60g/mol$

$$\cap_{C_2H_5OH} = \frac{8.23g}{46g/mol} = 0.18mol$$

$$\cap_{CH_3COOH} = \frac{60g}{60g/mol} = 1mol$$

$\cap_{CH_3COOH}$ at equilibrium

$$= \frac{49.74g}{60g/mol} = 0.829mol$$

$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$

1mol	0.18mol	-	-
0.171mol	0.171mol	0.171mol	0.171mol
At equilibrium 0.829mol	0.009mol	0.171mol	0.171mol

Notethat:

$1mol - 0.829mol = 0.171mol$

$$K_c = \frac{[CH_3COOC_2H_5][H_2O]}{[CH_3COOH][C_2H_5OH]}$$

$$[CH_3COOC_2H_5] = \frac{0.171}{V}$$

$$[H_2O] = \frac{0.171}{V}$$

$$[CH_3COOH] = \frac{0.829}{V}$$

$$[C_2H_5OH] = \frac{0.009}{V}$$

Where V = volume of solution

$$K_c = \frac{\frac{0.171}{V} \times \frac{0.171}{V}}{\frac{0.829}{V} \times \frac{0.009}{V}} = \frac{\frac{0.029241}{V^2}}{\frac{7.461 \times 10^{-3}}{V^2}}$$

$$K_c = \frac{0.029241V^2}{7.461 \times 10^{-3}V^2}$$

$$K_c = 3.92$$

The correct option is A

7. $\Delta G = -5.19kJ = -5.19 \times 10^3 J$

$T = 1000k, R = 8.314J/molk$

$\Delta G = -RT1nK_p$

$-5.19 \times 10^3 = -8.314 \times 1000 \ln K_p$

$$\ln K_p = \frac{-5.19 \times 10^3}{-8.314 \times 1000}$$

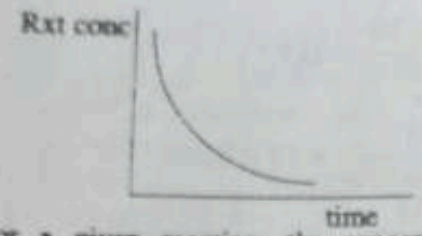
$\ln K_p = 0.6242$

$K_p = e^{0.6242}$

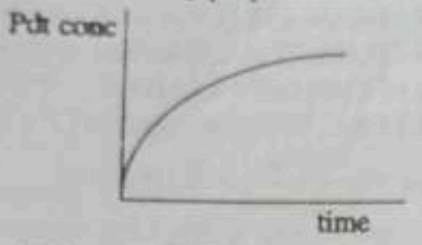
$K_p = 1.87$

The correct option is D

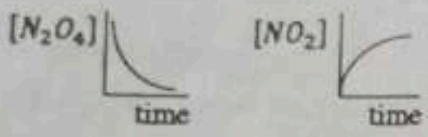
8. For a given reaction, the concentration of reactant is inversely proportional to time.



For a given reaction, the concentration of product is directly proportional to time



$N_2O_{4(g)} \rightarrow 2NO_{2(g)}$



The correct option is A

9. $PbCl_{2(g)} \rightleftharpoons Pb^{2+} + 2Cl^-$

$xM \quad xM \quad 2xM$

$K_{sp} = [Pb^{2+}][Cl^-]^2$

$= x(2x)^2$

$K_{sp} = 4x^3$

$but\ x = 0.1681M$

$K_{sp} = 4(0.1681)^3$

$= 1.9 \times 10^{-2} mol^3 dm^{-9}$

The correct option is A

10. $\%\ ionized = \frac{x}{0.55} \times \frac{100}{1}$

$0.58 = \frac{x}{0.55} \times \frac{100}{1}$

$x = \frac{0.58 \times 0.55}{100} = 0.00319M$

	$NH_4OH_{(aq)} \rightleftharpoons$	NH_4^+	+ OH^-
Initial conc	0.55M	-	-
Δin conc	0.00319	0.00319	0.00319
At equi	0.54681	0.00319	0.00319

$K_b = \frac{[NH_4^+][OH^-]}{[NH_4OH]} = \frac{0.00319 \times 0.00319}{0.54681}$

$K_b = 1.86 \times 10^{-5}M$

The correct option is C

11. $AgBr \rightarrow Ag^+ + Br^-$

$xM \quad xM \quad xM$

$NaBr \rightarrow Na^+ + Br^-$

$0.15M \quad 0.15M \quad 0.15M$

$[Br^-] = (x + 0.15)M,\ [Ag^+] = xM$

$K_{sp} = [Ag^+][Br^-]$

$K_{sp} = x(x + 0.15)$

But $K_{sp} of\ 5.0 \times 10^{-13}$

$5.0 \times 10^{-13} = x(x + 0.15)$

$5.0 \times 10^{-13} = x^2 + 0.15x$

$x^2 + 0.15x - 5 \times 10^{-13} = 0$

$x = 3.33 \times 10^{-12}M$

Note that you can avoid the quadratic equation by approximating $x + 0.15$ to 0.15

The correct option is D

12. Greater surface area and higher concentration increases the rate of reaction.

The correct option is D

13. $R = K[A]^2[B]$

If the concentration of A doubles,

New conc of $A = 2[A]$

$R_1 = K(2[A])^2[B]$

$= 4K[A]^2[B]$

But $R = K[A]^2[B]$

$R_1 = 4R$

Doubling the concentration of A increases the rate of reaction 4 times or 4 fold.

The correct option is D

14. Go to solution 6 of test question

The correct option is B

15. The cell notation is $Zn_{(s)}/Zn^{2+}//Cu^{2+}/Cu_{(s)}$

e.m.f. $= E_{oxidant} - E_{reductant}$

$= 0.337 - (-0.763)$

$= 0.337 + 0.763$

$= 1.10V$

The correct option is A

16.

ℓ	Orbital described
0	S
1	P
2	D
3	F

The correct option is B

17. $Ca_3(PO_4)_{2(s)} \rightleftharpoons 3Ca^{2+} + 2PO_4^{3-}$

$xM \quad 3xM \quad 2xM$

$K_{sp} = [Ca^{2+}]^3[PO_4^{3-}]^2$

$= (3x)^3(2x)^2$

$= 27x^3 \times 4x^2$

$K_{sp} = 108x^5$

But $K_{sp} = 2.07 \times 10^{-23}$

$2.07 \times 10^{-23} = 108x^5$

$x^5 = \frac{2.07 \times 10^{-23}}{108}$

$= 1.9167 \times 10^{-25}$

$x = \sqrt[5]{1.9167 \times 10^{-25}}$

The correct option is D

18. The electron was discovered by William Crooke, the proton by Huygen Goldstein, the neutron by James Chadwick, the charge on the electron and the mass of the electron by Millikan and the atomic number by Henry Moseley.

The correct option is C

19. The surest way to quantify or classify relative acid strength is using a table of acid

dissociation. The acidity of the Hydrohalic acid increases down the group, from HF through HCl, HBr to HI as shown below.

$$\underset{increasing\ acid\ strength}{HF \ll HCl < HBr < HI}$$

The most common way people classify the Hydrohalic acid in order of acid strength is HF < HBr < HI < HCl.
HF<HBr<HI<HCl or HF<HBr<HCl<HI.
These classifications are wrong. It is only on theoretical basis not on the acid dissociation data obtain experimentally. The examiner who set the question has option B in his mind as the correct option but this classification is wrong. None of the given classification is actually correct but we will go with option B as the examiner's choice though wrong.

None of the option is correct

20. (i) $K_2CO_3, PH > 7$
(ii) $Na_2SO_4, P^H = 7$
(iii) $(NH_4)_2SO_4, P^H < 7$
(iv) $NH_4Cl, P^H < 7$
(v) $NaCH_3COO, P^H > 7$
(vi) $KNO_3, P^H = 7$

The correct option is B

21.
$$3[Fe^{2+} + 2e^- \rightarrow Fe_{(s)}] \quad E^o_{red} = -0.44V$$
$$2[Cr_{(s)} \rightarrow Cr^{3+} + 3e^-] \quad E^o_{ox} = +0.74V$$
$$3Fe^{2+} + 2Cr_{(s)} \rightarrow 3Fe_{(s)} + 2Cr^{3+} \quad E^o = 0.30V$$

The correct option is B

22. $R.A.M\ of\ T = 56$
Mass of T = 1.99g
$I = 1.90A$
$t = 1hr + 30mins = 3600s + 30 \times 60s$
$= 3600s + 1800s$
$= 5400s$
$m = ZIt$

$$1.99 = \frac{56}{x \times 96500} \times 1.9 \times 5400$$
$$1.99 \times x \times 96500 = 56 \times 1.9 \times 5400$$
$$x = \frac{56 \times 1.9 \times 5400}{1.99 \times 96500}$$
$$= 2.99$$
$$x \approx 3$$

The correct option is D

23. $\underset{25cm^3, 0.16M}{KOH} + \underset{50cm^3, 0.1M}{HNO_3} \rightarrow KNO_3 + H_2O$

$$\cap_{KOH} = \frac{25}{1000} \times 0.16 = 0.004mol$$
$$\cap_{HNO_3} = \frac{50}{1000} \times 0.1 = 0.005mol$$

The limiting reagent is KOH
The excess reagent is HNO_3
$\cap_{HNO_3}$ used up
$$= 1 \times 0.004mol = 0.004mol$$
Excess $\cap_{HNO_3}$
$$= 0.005mol - 0.004mol$$
$$= 0.001mol$$
Volume of solution $= 25cm^3 + 50cm^3$
$$= 75cm^3 = 0.075dm^3$$
$$Conc\ of\ HNO3 = \frac{excess\ \cap_{HNO_3}}{Vol.of\ solution}$$
$$= \frac{0.001mol}{0.075dm^3} = 0.0133M$$
$$HNO_3 \rightarrow H^+ + NO_3^-$$
$$0.0133M \quad 0.0133M \quad 0.0133M$$
$$P^H = -Log^{H^+}_{10}$$
$$= -Log^{0.0133}_{10}$$
$$= 1.8761$$
$$= 1.88$$

The correct option is D

24. $V = 789.19cm^3 \times \frac{1m^3}{10^6cm^3}$
$= 789.19 \times 10^{-6}m^3$
$T = 0^oC = 273k$
$P = 1atm = 101325N/m^2$
$= 101325J/m^3$
$m = 2.53g$
$PV = nRT$
$n = \frac{m}{M}$
$PV = \frac{mRT}{M}$
$M = \frac{mRT}{PV}$
$$= \frac{2.53g \times 8.314J/kmol \times 273k}{101325J/m^3 \times 789.19 \times 10^{-6}m^3}$$
$= 71.8g/mol$
$= 72g/mol$

None of the option is correct

25. $V^{2+} + H_2O \rightarrow VO^{2+} + 2H^+ + 2e^-$
$a = 1, \quad b = 1, \quad c = 1, \quad d = 2$

None of the option is correct

26. The bond in I is Hydrogen bond while the bond in II is Dipole-Dipole force

The correct option is C

27. $Ba(OH)_2 + 2HCl \rightarrow BaCl_2 + 2H_2O$
$25cm^3 \quad 37.3cm^3, 0.15M$
$$\cap_{HCl} = \frac{37.3}{1000} \times 0.15 = 5.595 \times 10^{-3}mol$$
$$\cap_{Ba(OH)_2} = \frac{1}{2} \times 5.595 \times 10^{-3}mol$$
$$= 2.7975 \times 10^{-3}mol$$
$$\cap_{Ba(OH)_2} = \frac{Vmcm^3}{1000} \times molar\ conc$$
$$2.7975 \times 10^{-3} \times 1000 = 25 \times molar\ conc$$
$$molar\ conc = \frac{2.7975 \times 10^{-3} \times 1000}{25}$$
$$= 0.1119M$$
$$\approx 0.112M$$

The correct option is B

28. $BaSO_4$ and $AgCl$ are insoluble in water but Na_2SO_4 is water soluble. If $BaSO_4$, $AgCl$ and Na_2SO_4 are added to water. The solution will contain $BaSO_4$, $AgCl$, Na^+ and SO_4^{2-}

The correct option is D

29. R.M.M of chloride of sulphur = $135g$
Mass of compound = $5.40g$
Mass of chlorine = $2.84g$
Mass of sulphur = $5.40 - 2.84 = 2.56g$

S	:	Cl
$\frac{2.56}{32}$	:	$\frac{2.84}{35.5}$
0.08	:	0.08
1	:	1

Empirical formular is SCl
$(SCl)_n = 133$
$(32 + 35.5)_n = 135$
$67.5n = 135$
$n = \frac{135}{67.5} = 2$
$(SCl)_n = S_2Cl_2$
Note that you can avoid the calculation by just checking the option for the chloride with relative molecular mass of 135g/mol.

The correct option is D

30. Original $\cap_{cucl_2} = \frac{500}{1000} \times 0.5 = 0.25mol$
$t = 2hrs = 7200s \quad I = 5A$
$m = ZIt$
$= \frac{63.5}{2 \times 96500} \times 5 \times 7200$
$= 11.8446g$
Original mass of $CuCl_2 = 0.25mol \times 134.50 = 33.625g$
Mass of $CuCl_2$ remaining = $33.625 - 11.8446 = 21.7804g$
$\cap_{CuCl_2}$ remaining $= \frac{21.7804}{134.50} = 0.1619mol$
Conc. of $\cap_{CuCl_2}$ remaining $= \frac{0.1619mol}{500cm^3}$
$= \frac{0.1619mol}{0.5dm^3}$
$= 0.3239M$
Note that the final concentration is 0.3239M while the lost in concentration is 0.18M.

None of the option is correct

31. $K_p = 2.4 \times 10^{-8}$
$K_c = ?$
$2NO_{(g)} \rightleftharpoons N_{2(g)} + O_{2(g)}$
$\Delta n = 2 - 2 = 0$
If $\Delta n = 0$, $K_p = K_c$

The correct option is D

32. (i) Atoms can neither be created nor destroyed can be verify by the law of conservation of matter.
(ii) All atoms of a given element are all exactly alike in every respect and differ from atoms of all other elements can be verify by the law of definite proportion or constant composition.
(iii) Atoms combine chemically in small whole numbers can be verify by the law of multiple proportions.
(iii)Matter is made up of small individuals particles called atom can be verify by experiment evidence, such as diffusion of colour crystal, Brownian motion, dilution of colour solution etc.

The correct option is A

33. CO is polar but N_2 is non-polar

The correct option is D

34. (i) Fe^{2+} is oxidized
(ii) $Cr_2O_7^{2-}$ is reduced
(iii) $Cr_2O_7^{2-}$ is the oxidizing agent
(iv) Fe^{2+} is the reducing agent

The correct option is B

35. $H_{2(g)} + CO_{2(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$ and $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ are not affect by pressure because there is no change in gaseous moles.

The correct option is B

36. Mass of mixture = $2.50g$
Let the mass of $NaHCO_3 = xg$
Mass of $KCl = (2.50 - x)g$
$2NaHCO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + 2CO_2 + 2H_2O$
Original $\cap_{H_2SO_4} = \frac{25}{1000} \times 0.437$
$= 10.925 \times 10^{-3}mol$
$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$
35.4mol, 0.108M
$\cap_{NaOH} = \frac{85.4}{1000} \times 0.108$
$= 3.8232 \times 10^{-3}mol$
$\cap_{H_2SO_4} = \frac{1}{2} \times 3.8232 \times 10^{-3}mol$
$= 1.9116 \times 10^{-3}mol$
The amount of H_2SO_4 that react with $NaOH$ is $1.9116 \times 10^{-3}mol$.
$\cap_{H_2SO_4}$ that react with $NaHCO_3 = 10.925 \times 10^{-3}mol - 1.9116 \times 10^{-3}mol$
$= 9.0134 \times 10^{-3}mol$
$2NaHCO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + 2CO_2 + 2H_2O$
$xg \quad 9.0134 \times 10^{-3}mol$
$\cap_{NaHCO_3} = 2 \times 9.0134 \times 10^{-3}mol$
$= 0.0180268mol$
$R.M.M\ of\ NaHCO_3 = 84g/mol$
Mass of $NaHCO_3 = x = 84g/mol \times 0.0180268mol = 1.5143g$
$\%\ of\ NaHCO_3 = \frac{1.5143g}{2.50g} \times \frac{100}{1}$
$= 60.572\%$
$\simeq 61\%$

The correct option is A

37. The oxides of Hg, Ag and Au decomposes into the corresponding element.

The correct option is B

38. According to Lewis all electron rich species are base (e.g. anions, H_2O, PH_3, NH_3 etc) and all electron deficient species are acid (e.g. cations, BF_3, $AlCl_3$, BeF_2, $BeCl_2$. cations,etc)

None of the option is correct

39. $1s^22s^12p_x^02p_y^12p_z^1$ is not a ground state electronic configuration because an election is promoted from the 2s-orbital to the 2p-orbital.

The correct option is A and D

40. $\lambda = 1.0 \times 10^{-13}s^{-1}$

$$T_{1/2} = \frac{0.693}{\lambda}$$

$$= \frac{0.693}{1.0 \times 10^{-13}s^{-1}}$$

$$= 6.93 \times 10^{-12}s \times \frac{1min}{60s} \times \frac{1hr}{60min} \times \frac{1day}{24hr} \times \frac{1yr}{365days}$$

$$= 2.1975 \times 10^5 yrs$$

$$= 2.2 \times 10^5 yrs$$

The correct option is D

2011/2012 CHEMISTRY 001 EXAMINATION

1. What is the concentration (in moldm^{-3}) of a commercially available tetraoxosulphate (VI) acid solution if its density is 1.80gcm^{-3} and the purity level is 98%? [H =1, S = 32, O = 16] (a) 17.8 (b) 18.4 (c) 18.2 (d) 18.0
2. Urea $(NH_2)_2CO$ is commonly used as a fertilizer, in animal feed and in the manufacture of polymers. How many hydrogen atoms are present in 25.6g of urea? The molar mass of urea is 60.06g.mol^{-1} $[N_A = 6.02 \times 10^{23}]$ (a) 1.03×10^{24} (b) 1.03×10^{24} (c) 2.78×10^{24} (d) 6.55×10^{24} (e) 2.73×10^{23}
3. 4.23g of potassium hydroxide reacts with 2.70g of tetraoxosulphate (VI) acid to produce potassium tetraoxosulphate (VI) and water. Which of the reactants is in excess and by how much? $[K = 39, H = 1, O = 16, S = 32]$

(a) $KOH, 1.14g$ (b) $H_2SO_4, 0.9g$
(c) $KOH, 1.53g$ (d) $H_2SO_4, 0.39g$

4. Many chemical compounds have some of the properties listed below: I. pure solid II. soluble in water III. insoluble in water IV. deliquescent V. high molecular mass VI. fumes when exposed to air VII. stoichiometric reaction with an acid or a base or oxidizing/reducing agent. Which of these properties must a compound have to make it suitable for preparing a standard solution? (a) I, II and V. (b) III, IV V and VII (c) III, V and VI (d) I, II, IV and VII
5. Which of the mixtures below are colloidal systems? I. Harmattan haze II. An aqueous solution of sugar III. starch in boiling water IV. a dispersion of oil in water V. muddy water VI. smoke. (a) I and II only (b) II and III only (c) III, IV and VI (d) I, II and V
6. The respective oxidation numbers of the transition elements in $KMnO_4$, $K_2Cr_2O_7$, K_2CrO_4 and V_2O_5 are (a) +7, +4, +6 and +3 (b) +7, +4, +6 and +5 (c) +7, +6, +6 and +5 (d) +7, +6, +4 and +5
7. Which of the following reactions involves the largest increase in entropy? (a) $AgNO_{3(aq)} + HCl_{2(aq)} \rightarrow AgCl_{(s)} + HNO_3(aq)$ (b) $2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$ (c) $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$ (d) $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$
8. The following are particles present in or derivable from substances: I. molecules II. free mobile electrons III. free immobile electrons IV. hydrated positive ions V. bonded electrons VI. hydrated negative ions. Which of these particles could serve as a carrier of an electric current. (a) II, IV and VI (b) I, II and V (c) II only (d) I, II, III, IV, V and VI
9. Covalent bonding in molecules involves overlapping of orbits such as I. s-s II. p-p (linearly opposed) III. hybrid-s IV. hybrid-hybrid V. p-p(parallel) VI. hybrid-p(linearly opposed). Which of these overlapping are present in nitrogen gas? (a) I, III and IV (b) I and VI only (c) II, IV and VI (d) II and V only.
10. Which of the compounds/ion in the list below contain at least two types of inter-atomic bonds? I. H_3O^+ II. $POCl_3$ III. $NaCl$ IV. NH_4Cl V. CH_4 (a) III and V only (b) II, III and V (c) I, II and IV (d) I and III only.
11. Which of the following is the pH of the solution obtained by mixing $50.0cm^3$ of 0.100 $moldm^{-3}$ HA and $50.0cm^3$ of $0.100moldm^{-3}$ $NaOH$? I. $pH < 7$ if HA is a strong acid II. $pH > 7$ if HA is a weak acid III. $pH = 7$ if HA is a weak acid. (a) II only (b) I and III (c) I and II (d) I only
12. Consider the cell:

$$Ag_{(s)}/Ag^+_{(aq)}//Ca^{2+}_{(aq)}/Ca_{(s)}$$

Given that $E^o_{Ca^{2+}/Ca} = -2.76V$ and $E^o_{Ag^+/Ag} = +0.76V$, calculate the $E^o cell$ and state whether the cell reaction is feasible or not as written. (a) $-2.00V$, reaction no feasible (b) $-3.52V$, reaction not feasible (c) $+2.00V$, reaction is feasible (d) $+3.52V$, reaction is feasible.

13. A solution, X, turned acidified $KMnO_4$ solution to colourless while another solution Y turn KI Solution from colourless to reddish

brown respectively. It can therefore be concluded that: (a) X is a reducing agent while Y is an oxidizing agent (b) X and Y are both reducing agents (c) X is an oxidizing agent while Y is a reducing agent (d) X and Y are both oxidizing agents.

14. A gas exerts a pressure of 1.5atm at 30°C. What is the molar mass of the gas if its density is 2.65gdm^{-3}? $[R = 0.0821 atm\ dm^3\ mol^{-}\ K^{-1}]$ (a) 28 (b) 44 (c) 32 (d) 17
15. Consider the following reactions:
(i) $2H_2 + O_2 \rightarrow 2H_2O$
(ii) $2SO_3 + 4Sn \rightarrow SnS_2 + 3SnO_2$
(iii) $NaCl + H_2O \rightarrow HCl + NaOH$
(iv) $Cu_2S + 2HBr \rightarrow 2CuBr + H_2S$
(v) $2AgNO_3 + CaCl_2 \rightarrow 2AgCl + Ca(NO_3)_2$.
Which of these reactions are redox? (a) ii and v only (b) i and ii only (c) i and iv only (d) ii, iv and v only
16. Which off the following statements is false? (a) randomness decreases from solid to gas (b) disorderliness increases from solid to gas (c) randomness decreases from gas to solid (d) orderliness increases from gas to solid
17. I methy-orange (pKa:3-5) and II phenolphthalein (pKa:8-10) are two important indicators commonly used in titrimetric analysis. Choose from I and II the suitable indicator(s) that ensure(s) complete reaction for the following titrations respectively: I. CH_3COOH versus NH_4OH II. H_2SO_4 versus KOH III. CH_3COOH versus $NaOH$ IV. HCl versus Na_2CO_3 (a) III, II and I (b) I and II, I, None, (I and II) (c) None I, None, I (d) None, (I and II), II, I
18. What happens when copper (II) tetraoxosulphate (VI) solution is electrolyzed using copper electrode I. There is a colour change from blue to colourless II. The colour remains unchanged III. The anode decreases while the cathode increases in mass IV. The resultant solution becomes more acidic. (a) I, II and III (b) II and III (c) II, III and IV (d) III and IV
19. The table below shows the periodic properties of elements across a period and down a group in the periodic table.

	Periodic Property	Across a period	Down a group
i	Electronegativity	Increase	Decrease
ii	Atomic radius	Decrease	Increase
iii	Electron affinity	increase	Decrease
iv	Metallic character	Decrease	Increase
v	Ionization potential	Increase	Decrease

Which of the options above are correctly stated? (a) I, II and IV (b) I, II, IV and V (c) I, II and IV (d) I, II, III and IV
20. For the reaction $A + B \rightarrow C + D$ $\Delta H^o = +40kJ$ and $\Delta S^o = 50J/K$ Therefore the reaction under standard conditions is (a) spontaneous at temperature less than 10K (b) spontaneous at temperature greater than 800K (c) spontaneous at all temperature (d) spontaneous only at temperature between 10K and 800K
21. Consider the following molecules I. CH_4 II. NH_3 III. HF IV. HCl V. H_2O Which of them have intermolecular hydrogen bonds? (a) II, III, IV and V only (b) I and IV only (c) II, III and V only (d) II and V only
22. Which of the following best explains the increase in the rate of a chemical reaction as the temperature rises? (a) the amount of molecules having the required minimum energy for reaction decreases (b) the bonds in the reacting molecule are more readily broken (c) the activation energy becomes lower (d) the molecular collision frequency becomes more frequent and effective.
23. $A + B \rightarrow C$ The rate law for the reaction above is: Rate $= k[A]^x[B]^y$. In a kinetic study, the rate of formation of C is found to be independent on the concentration of B and to quadruple which the concentration of A is doubled. What are the value of x and y? (a) 2 and 0 (b) 0 and 1 (c) 0 and 2 (d) 1 and 0
24. An electrician has the materials below in his workshop: I. a polythene string II. a copper wire III. a rock salt rod IV. a wet wooden stick V. a urea rod VI. a melt of potassium chloride. Which of the materials are conductor of electricity (a) I, II, III and V (b) II, III, V and VI (c) II, IV and VI (d) II and VI
25. Water was added to 60.0g of a salt of YCl_2 to produce 30cm^3 of saturated solution at 29°C. The solubility of the salt at 29°C is 5.0mol. Calculate the mass of the salt that remained undissolved? $[Y = 29.0, Cl = 35.5]$ (a) 15g (b) 46g (c) 5g (d) 45g
26. The respective rates of diffusion R_O, R_{Cl}, R_H, R_M of oxygen, chlorine, hydrogen and methane will follow the order (a) $R_O > R_{Cl} > R_H > R_M$ (b) $R_H < R_M < R_O < R_{Cl}$ (c) $R_H > R_M > R_O > R_{Cl}$ (d) $R_O < R_{Cl} < R_H < R_M$
27. The sum of electrons and protons present in a particle is 33. If the charge on the particle is −3, then the number of electrons in the shell is (a) 30 (b) 24 (c) 18 (d) 36

28. What is the maximum volume of gas evolved at s.t.p when 2.0g of calcium trioxocarbonate (IV) is added to 200cm^3 of 0.10 mol.dm^{-3} hydrochloric acid? [H=1, C =12, O=10, Cl = 35.5, Ca = 40; GMV of a gas at s.t.p = 22.4dm^3] (a) $22.4dm^3$ (b) $2.24dm^3$ (c) $224dm^3$ (d) $0.224dm^3$

29. 0.4647g sample of a compound containing carbon, hydrogen and oxygen only was burned in an excess of pure oxygen to yield 0.8635g of CO_2 and 0.1767g of H_2O. What is the empirical formula of the compound? $[C = 12, H = 1, O = 16]$ (a) $C_3H_6O_2$ (b) CHO (c) $C_3H_3O_2$ (d) C_2H_2O

30. $2Cl_{2(g)} + 2H_2O_{(g)} \rightleftharpoons 4HCl_{(g)} + O_{2(g)}$; $\Delta H^\circ = +114.5kJ/mol$. In the equilibrium reaction above, an increase in temperature will I. decrease the concentration of HCl II. decrease the concentration of Cl_2 III. increase the concentration of O_2 IV. increase the concentration of HCl V. have no resultant effect on the position of equilibrium. Which of the statements in I – V are correct? (a) II, III and IV (b) III, IV and V (c) II, III, IV and V (d) I, II, III and IV

31. Consider the following statements: I. Efflorescence is a process by which a crystalline compound loses all or part of its water of crystallization II. All deliquescent substances are hygroscope III. All hygroscopic substances are deliquescent IV. Deliquescent is the absorption of moisture from atmosphere with Subsequent dissolution. Which of the statements above are absolutely correct? (a) I and IV (b) I, HI and IV (c) I, II and IV (d) I, II, III and IV

32. How long will it take to electrolyze aqueous solution of lead (II) bromide and deposit 69g of lead using platinum electrodes and a current of 5A? $[Pb = 207; 1F = 96500C]$ (a) 3.4h (b) 3.6h (c) 3.8 (d) 3.2h

33. Given the thermochemical equation

$SO_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow SO_{3(g)}\ \Delta H = -99.1\ kJmol^{-1}$

Calculate the heat evolved when 74.6g of SO_2 is converted to $SO_3[S = 32, O = 16]$. (a) -155.5kJ (b) -13.8kJ (c) +13.8kJ (d) +15.5kJ

34. What mass of $Pb(NO_3)_2$ (molar mass = 331.2 g.mol^{-1}) required to prepare 250cm^3 of 0.10mol dm^{-3} solution of the salt? (a) 0.828g (b) 3.112g (c) 8.28g (d) 3.312g

35. Calculate the solubility of the salt, $[(Ca_3(PO_4)_2]$ at 35°C in gdm^{-3}, if its solubility product at 35°C is $1.08 \times 10^{-14}\ mol^5dm^{-15}$ [Ca = 40, P = 31, O = 16]. (a) 0.81 (b) 0.01 (c) 0.10 (d) 0.18

36. The hybridization schemes of the central atoms of the molecules: $CO_2, BF_3, H_2O, BeCl_2$ and CCl_4 respectively are (a) sp, sp^2, sp^3 and sp^3 (b) sp, sp^2, sp^3,sp and sp^3 (c) sp, sp^3, sp^3 and sp^3 (d) sp, sp^3, sp^2 and sp^3

37. In a nuclear transmutation, the nuclide $^{227}_{89}X$ absorbs neutron and a beta particle and emits two particles to form another $^{a}_{b}Y$. What is the respective values of a and b? (a) 220 and 80 (b) 220 and 86 (c) 224 and 26 (d) 224 and 84

38. $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$ What are the roles of H_2O and H_3O^+ respectively in the reaction above? (a) acid and conjugate base (b) base and conjugate base (c) acid and conjugate acid (d) base and conjugate acid

39. Consider the following nuclides: $^{40}_{18}R$ $^{15}_{8}T$ $^{40}_{20}X$ $^{16}_{8}Y$ $^{15}_{7}Z$ I. X is an alkaline earth metal II. Y and Z are isoelectronic III. Z is a p-block element IV. T and Y are isotopes V. R and Y are noble gases. Which of these statements I – V are correct? (a) I, III and IV (b) I, II and IV (c) I and II only (d) I, IV and V

40. Which of the following are not true for both electrochemical and electrolytic cells? I. Oxidation takes place at the anode II. Anode is an oxidizing agent III. The cathode is positively charged IV. reduction takes place at cathode V. The anode is negatively charged VI. Cathode is a reducing agent (a) II, III, V and VI (b) I, II, IV and VI (b) I, III and VI (d) I, II,III and V

SOLUTION

1. $Molar\ conc = \frac{10pd}{M}$

Where $p = \%\ by\ mass = 98\%$

$d = density\ in\ g/cm^3 = 1.80g/cm^3$

$M = R.M.M\ of\ H_2SO_4 = 98g/mol$

$Molar\ conc = \frac{10pd}{M} = \frac{10 \times 98 \times 1.8}{98}$

$= 18moldm^{-3}$

The correct option is D

2. $R.M.M.of\ Urea, (NH_2)_2CO = 60.06g/mol$

$mass\ of\ Urea = 25.6g$

$mass\ of\ H\ in\ 25.6g\ of\ Urea$

$= \frac{R.A.M\ of H}{R.M.M\ of\ urea} \times 25.6g$

$= \frac{4 \times 1g/mol}{60.06g/mol} \times 25.6g$

$= \frac{4}{60.06} \times 25.6g$

$= 1.7050g$

$\cap_H = \frac{Reacting\ mass}{Molar} = \frac{No\ of\ H\ atoms}{6.02 \times 10^{23}}$

No of H atoms $= 1.7050 \times 6.02 \times 10^{23} atm$

$= 1.03 \times 10^{24}\ atoms$

The correct option is A

3. Rxn: $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

Given: 4.23g 2.70g

$R.M.M.\ of\ KOH = 56g/mol$

$R.M.M.of\ H_2SO_4 = 98g/mol$

$$\cap_{KOH} = \frac{Reacting\ mass}{Molar\ mass} = \frac{4.23g}{56g/mol}$$

$$= 0.0755mol$$

$$\cap_{H_2SO_4} = \frac{Reacting\ mass}{Molar\ mass} = \frac{2.70g}{98g/mol}$$

$$= 0.0276mol$$

$$\frac{\cap_{KOH}}{2} : \frac{\cap_{H_2SO_4}}{1}$$

$$\frac{0.0755}{2} : \frac{0.0276}{1}$$

$$0.03775 : 0.0276$$

Note that the division is done by the coefficient of the resultant in the balance chemical equation. The smaller mole gives the limiting reagent.

The limiting reagent is H_2SO_4

The excess reagent is KOH

$\cap_{KOH}$ used up $= 2 \times 0.0276mol = 0.0552mol$

Excess $\cap_{KOH}$ = calculated $\cap_{KOH} - \cap_{KOH}$ used up

$= 0.0755mol - 0.0552mol$

$= 0.0203mol$

$$excess\ \cap_{KOH} = \frac{Reacting\ mass}{Molar\ mass}$$

$$0.0203mol = \frac{Mass\ of\ excess\ KOH}{56g/mol}$$

Mass of excess $\cap_{KOH}$

$= 0.0203mol \times 56g/mol$

$= 1.1368g$

$\simeq 1.14g$

The excess reactant is KOH and by 1.14g

The correct option is A

4. A standard solution is a solution with accurately known concentration. For a substance or compound to be suitable to prepare standard solution; it must have the criteria/properties below.

(i) It must be a pure solid

(ii) It must have a high solubility at ordinary temperature

(iii) It must have a fair high molar mass

(iv) It must react stoichiometrically with an acid, base or oxidizing agent or reducing agent.

The correct option is D

5. A colloid or colloidal system is a dispersion of particles of one substance (the dispersed phase) throughout a dispersing medium made of another substance. Examples of colloidal system are smoke, fog, mist, certain alloy (steel and gemstones), whipped cream, milk of magnesia, starch in boiling water, dispersion of oil in water etc.

Sometime, most students confuse suspension with colloidal system. A suspension is a heterogeneous mixture of undissolved particles in a given medium usually the particles are large enough to be seen by the eyes e.g. muddy water, harmattan haze etc.

The correct option is C

6. The oxidation of Mn in $KMnO_4$ is+7, the oxidation number of Cr in $K_2Cr_2O_7$ and K_2CrO_4 is +6 and the oxidation number of V in V_2O_5 is +5.

The correct option is C

7. Entropy is the natural tendency of a system to achieve a great disorderliness as one of the derivating forces in a change of state or in a chemical reaction. Gaseous species has the largest entropy followed by aqueous species, liquids and solids species has the least entropy.

Entropy change (ΔS) is said to be positive when a substance change from a less disorderly state to a more disorderly state

$$H_2O_{(s)} \longrightarrow H_2O_{(g)} \quad \Delta S = +ve$$

Entropy change (ΔS) is said to be negative with a substance changes from a more disorderly state to a less disorderly state.

$$H_2O_{(g)} \longrightarrow H_2O_{(l)} \quad \Delta S = -ve$$

Entropy change (ΔS) is said to zero if the two conditions below are satisfy.

(i) All species must be in the same state and

(ii) The number of moles of species at the reactant must be equal to those at the product.

$$I_{2(g)} + H_{2(g)} \rightleftharpoons 2HI_{(g)} \quad \Delta S = 0$$

1mol 1mol 2moles

2moles

(i) $AgNO_{3(aq)} + HCl_{(aq)} \longrightarrow AgCl_{(s)} + HNO_{3(aq)} \quad \Delta S = -ve$

(ii) $2KClO_{3(s)} \longrightarrow 2kCl_{(s)} + 3O_{2(g)}\ \Delta S = +ve$

(iii) $2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}\ \Delta S = -ve$

(iv) $N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}\ \Delta S = 0$

Therefore, the reactant with the largest increase in entropy is

$2KClO_{3(s)} \longrightarrow 2KCl_{(s)} + 3O_{2(g)}$

The correct option is B

8. Carrier of electricity is the name given to the component of a substance that allows that substance to conductor electricity. Examples are given in the table below.

Substance	Carrier of electricity
Conductors	Mobile electrons
Electrolyte	Ions (+ve or –ve)
Ionizing gases	Mobile electrons and ions
Semi-conductors	Mobile electrons and hole
Aqueous solution	Mobile hydrated ions
Molten substance	Mobile ions

The correct option is A

9. In the Nitrogen molecules there is a triple bond pairs. For any multiple bonds only one sigma bond is present the remaining are pie bonds. A sigma bond is form as a result of overlapping of the following orbital.

I. s-s II. p-p (linearly opposed)
II. hybrid-hybrid
III. hybrid-s
IV. hybrid-p

Pie bonds are form by the lateral or side way overlapping of two p-orbitals (i.e. p-p laterally or sideway).

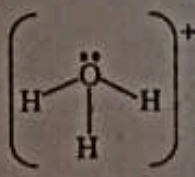
Therefore the overlapping orbital in N_2 are

(i) p-p (linearly opposed) and
(ii) p-p (laterally opposed)

The correct option is D

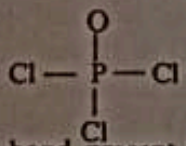
10. Inter-atomic bond is the name give to the bond between two different atom e.g.
$Na-Cl$, $H-Cl$, $H-Br$ etc.
The inter-atomic bonds in H_3O^+, $POCl_3$, $NaCl$, NH_4Cl and CH_4 are shown below:

(i) H_3O^+



The inter-atomic bond present in H_3O^+ is $O-H$. Therefore the number of inter-atomic bond present in H_3O^+ is 1.The nature of the inter-atomic bond is covalent and dative.

(ii) $POCl_3$

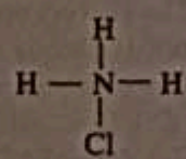


The inter-atomic bond present in $POCl_3$ are $O-P$ and $P-Cl$. Therefore, the inter-atomic bond present in $POCl_3$ is 2. The nature of the inter-atomic bond is covalent and dative.

(iii) $NaCl$ $\quad Na-Cl$

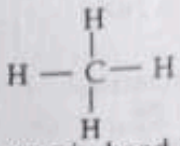
The inter-atomic bond present in $NaCl$ in $Na-Cl$. Therefore, the inter-atomic bond present in $NaCl$ is 1. The nature of the inter-atomic bond is ionic.

(iv) NH_4Cl



The inter-atomic bond present in NH_4Cl are $N-H$ and $N-Cl$. Therefore, the inter-atomic bond present in NH_4Cl is 2. The nature of the inter-atomic bond is covalent and dative.

(v) CH_4



The inter-atomic bond presentation in CH_4 is $C-H$. Therefore, the inter-atomic bond present in CH_4 is 1. The nature of the inter-atomic bond is covalent.

A close look at the question suggests that the examiner, interest is the nature of the inter-atomic bond not the number of the inter-atomic bond.

The correct option is C

11. $HA \quad + \quad NaOH \longrightarrow NaA + H_2O$
$50cm^3, 0.1M \quad 50cm^3, 0.1M$

$$\cap_{HA} = \frac{vol\ in\ cm^3}{1000} \times molar\ conc.$$

$$= \frac{50}{1000} \times 0.1 = 0.005mol$$

$$\cap_{NaOH} = \frac{50}{1000} \times 0.1 = 0.005mol$$

$$\cap_{HA} : \cap_{NaOH}$$

$$\frac{0.005}{1} : \frac{0.005}{1}$$

$$0.005 : 0.005$$

Since the active number of moles of HA and $NaOH$ is the same (i.e. 0.005) none of the species is in excess. This implies that HA and $NaOH$ are present in stoichiometric amount. Therefore the resulting solution will be neutral (i.e. $PH = 7$). Note that if the active moles of HA and $NaOH$ are different then the resulting solution will not be neutral. If HA is in excess the resulting solution will be acidic but if $NaOH$ is in excess the resulting solution will be basic or alkaline.

The above analysis is true only if HA is a strong acid. If HA is a weak acid then the salt form will be basic in nature. That is the resulting solution is basic or alkaline. For the reaction between $50cm^3$, 0.1M HA & $50cm^3$, 0.1M $NaOH$ the following is true.

(i) $pH = 7$ if HA is a strong acid
(ii) $pH > 7$ if HA is a weak acid

The correct option is A

12. $E^o_{cell} = E^o_{oxidant} - E^o_{reductant}$

If the Standard Electrode Potential ($E°$) value of a substance is positive the substance will act as an oxidant. But if the standard electrode potential of a substance is negative the substance will act as a reductant.

However, according to the cell notation determines the oxidant and the reductant. In the cell notation: $Ag_{(s)}/Ag^+//Ca^{2+}/Ca_{(s)}$. Ag undergoes oxidant process, hence it is the reductant while Ca undergoes reduction process, hence it is the oxidant.

$E^o_{cell} = -2.76V - 0.76V$
$= -3.52V$
The sign of E^o_{cell} determines if the reaction is feasible or not. If E^o_{cell} is positive (+ve) the reaction is feasible but if E^o_{cell} is negative (-ve) the reaction is not feasible.

The correct option is B

13. A substance that decolourize the purple colour of $KMnO_4$ or changes the orange colour of $K_2Cr_2O_7$ to green is a reducing agent.e.g SO_2 or H_2S.
Note that H_2S give a yellow deposite of sulphur in the process. Hence X is a reducing agent.
A substance that turned KI solution from colourless to reddish brown is either $Cl_{2(g)}$ or $F_{2(g)}$. Both chlorine and fluorine are non-metal in general all non-metal are oxidizing agent (also known as oxidant). Therefore Y is an oxidizing agent. Note that, the oxidizing agent undergoes reduction process hence it is always reduced while the reducing agent undergoes oxidation process hence it is always oxidized.

The correct option is A

14. The ideal gas equation states that
$pv = nRT$ ……(1)
Divide through equation 1 by V
$\frac{pv}{v} = \left(\frac{n}{v}\right)RT$
$but\ conc\ (c) = \frac{n}{v}$
$P = CRT$ ……(2)
Recall that number of moles (n) is given as:
$n = \frac{Reacting\ mass\ (m)}{Molar\ mass\ (m)}$
$pv = nRT$
$pv = \frac{m}{M}RT$ ……(3)
Divide through equation 3 by V
$\frac{pv}{v} = \left(\frac{m}{v}\right)\left(\frac{RT}{M}\right)$
$but\ density\ (\rho) = \frac{m}{v}$
$P = \frac{\rho RT}{M}$ ……(4)
$p = 1.5atm, T = 30^oC = 393k,$ $M = 2.65g/dm^{-3}$ $R = 0.0821atmdm^3mol^{-1}k^{-1}$
$P = \frac{\rho RT}{M}$
$PM = \rho RT$
$M = \frac{\rho RT}{P}$
$= \frac{2.65g/dm^3 \times 0.0821atmdm^3/molk \times 303k}{1.5atm}$
$= 43.9841g/mol$
$M \simeq 44g/mol$
The gas is either CO_2 or C_3H_8 because their relative molecular mass is $44g/mol$

The correct option is B

15. A redox reaction is a reaction in which oxidation and reduction occur simultaneously e.g.
(i) $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$
(ii) $2SO_3 + 4Sn \rightarrow SnS_2 + 3SnO_2$

The correct option is B

16. Entropy is the natural tendency of a system to achieve a great disorderliness as one of the derivating force in a change of state or chemical reaction.

The correct option is A

17. The choice of an indicator is determine by the nature of the solution at the end point. If the solution at the end point is acidic the indicator should be methyl orange because it is sensitive to an acid. But if the solution at the end point is basic or alkaline, the indicator should be phenolphthalein because it is sensitive to alkaline. The nature of the salt form is to determine the nature of the solution at end point.
$CH_3COOH + NH_4OH \rightarrow NH_4CH_3COO + H_2O$
$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$
$CH_3COOH + NaOH \rightarrow NaCH_3COO + H_2O$
$2HCl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O$
On hydrolysis, K_2SO_4 produce a neutral solution, $NaCH_3COO$ produce a basic solution, NH_4CH_3COO produce s either acidic or basic solution. Note that H_2CO_3 $(i.e.\ CO_2\ and\ H_2O)$ is acidic. Hence there is no suitable indicator for reaction one, any indicator (I or II) can be use for reaction two, indicator II is suitable for reaction three while indicator I is suitable for reaction four. Therefore, the order of indicator for the four reactions is none, (I and II), II and I.

The correct option is D

18. Copper anode dissolve (i.e. decrease in size) at the anode (i.e. dissolution) and it deposited (i.e. deposition) at the cathode (i.e. increase in size) while the electrolyte, $CuSO_4$ remains unchanged. Therefore the colour (i.e. blue) of $CuSO_4$ remains unchanged.

The correct option is B

19. This question is already solved

The correct option is B

20. $A + B \rightarrow C + D$ $\Delta H = 40kJ$ and $\Delta S = 50J/k, \Delta G = \Delta H - T\Delta S$
at thermodynamic standard condition $T = 25^oC = 298k$
$\Delta G = 40kJ - 298(50J/k)$
$= 40kJ - 298(0.05KJ/k)$
$= 40 - 14.9$
$= 25.10kJ$

If $T = 10k$
$\Delta G = 40kJ - 10(50J/k)$
$= 40kJ - 10(0.05KJ/k)$
$= 40 - 0.5$
$= 39.5kJ$
If $T = 800k$
$\Delta G = 40kJ - 800(50J/k)$
$= 40kJ - 800(0.05KJ/k)$
$= 40 - 40$
$= 0kJ$

Therefore, the reaction is non-spontaneous at 25°C (298k) & 10K. The reaction is at equilibrium at 800K but spontaneous at temperature greater than 800K.

The correct option is B

21. NH_3, HF and H_2O contain intra-molecular (not inter-molecular) hydrogen bond.

The correct option is C

22. Increase in temperature; increase the rate of collision of reactant particle due to the high energy of the molecules. The greater the rate of effective collision, the greater the rate of reaction.

The correct option is D

23. $R = k[A]^x[B]^y$
Since the rate of formation of C is in depend of the concentration of B, then y = 0
If $[A]_{new} = 2[A]$ then $R = 4R$ (i.e. quadruple)
$R_1 = k(2[A])^x[B]^y$
$R_1 = 2^x k[A]^x[B]^y$
$R = k[A]^x[B]^y$
$R_1 = 2^x R$
But $R_1 = 4R$
$4R = 2^x R$
$2^2 = 2^x \Rightarrow x = 2$
$(x, y) = (2,0)$

The correct option is A

24. Copper wire, molten potassium chlorides, solution of rock salt and solution of urea are conductor of electricity. Therefore, rock salt rod (rock salt in solid state) and urea rod (urea in solid state) will not conductor electricity.

The correct option is C

25. $Solubility = \frac{mass\ of\ solute\ dissolve}{molar\ mass\ os\ lute} \times \frac{1000}{v\ in\ cm^3}$
$R.M.M.of\ Cl_2 = 100g/mol$
$S = \frac{x}{100} \times \frac{1000}{30}$
$S = \frac{x}{3}$
$x = 15g$
Mass of salt = mass of salt that dissolve + mass of salt undissolve (y)
$60 = 15 + y$
$y = 60 - 15 = 45g$

The correct option is D

26. The higher the molar mass of a substance, the lower it rate of diffusion.

$R_{Cl} < R_o < R_m < R_H$
That is $R_H > R_m > R_o > R_{Cl}$

The correct option is C

27. $NE + NP = 33$
Since the charge on the particle is -3 then $NE + NP = 33$. Note that if the charge on the particle is +3,
$NE = NP - 3$
$NP - 3 + NP = 33$
$2NP = 33 + 3$
$2NP = 36$
$NP = 18$
For a neutral species
$NE = NP = 18$

The correct option is C

28. $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$
2g 200cm³, 0.1M
$R.m.m.of\ CaCO_3 = 100g$
$\cap_{CaCO_3} = \frac{2g}{100g/mol} = 0.02mol$
$\cap_{HCl} = \frac{200}{1000} \times 0.1$
$= 0.02mol$
$\cap_{CaCO_3} : \cap_{HCl}$
$\frac{0.02}{1} : \frac{0.02}{2}$
$0.02 : 0.01$
The limiting reagent is HCl
$\cap_{CO_2} = 1 \times 0.01mol$
$= 0.01mol$
$\cap_{CO_2} = \frac{vol\ at\ s.t.p}{22.4dm^3/mol}$
$0.01 = \frac{vol\ at\ s.t.p}{22.4}$
$vol\ at\ s.t.p = 0.01 \times 22.4$
$= 0.2240dm^3$
$= 224cm^3$

The correct option is D

29. Mass of compound = $0.4647g$
Mass of $CO_2 = 0.8635g$
Mass of $H_2O = 0.1767g$
Mass of C in $0.8635g\ of\ CO_2$
$= \frac{12}{44} \times 0.8635 = 0.2355g$
Mass of H in $0.176g\ of\ H_2O$
$= \frac{2}{18} \times 0.1767 = 0.0196g$
Mass of
$O = 0.4647g - (0.2355 + 0.0196)g$
$= 0.4647g - 0.2551g$
$= 0.2096g$

C	:	H	:	O
$\frac{0.2355}{12}$	:	$\frac{0.0196}{1}$	:	$\frac{0.2096}{16}$
0.0196	:	0.0196	:	0.0131
1.4962	:	1.4962	:	1
≃ 1.5		1.5		1

$\frac{3}{2}$ $\frac{3}{2}$ 1

Multiply through by 2

3 : 3 : 2

The empirical formula is $C_3H_3O_2$

The correct option is C

30. The reaction is an endothermic reaction. Therefore increase in temperature will favour the forward reaction. That is, the concentration of HCl and O_2 will increase but the concentration of Cl_2 and H_2O will decrease.

The correct option is A

31. The statements in I, II and IV are absolutely correct.

The correct option is C

32. $m = 69g \quad R.A.M = 207g/mol \quad I = 5A$

$M = ZIt$

$Z_{pb} = \frac{207}{2 \times 96500}$

$69 = \frac{207}{2 \times 96500} \times 5 \times t$

$t = \frac{69 \times 2 \times 96500}{207 \times 5} = 12866.6667s$

$t = 3.5741hrs$

$t \simeq 3.6hrs$

The correct option is B

33. $SO_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow SO_{3(g)} \; \Delta H = -99.1kJ/mol$

$R.M.M. of \; SO_2 = 64g/mol$

$\cap_{SO_2} = \frac{74.6g}{64g/mol} = 1.1656mol$

From the reaction:

1mole of SO_3 required $99.1kJ$ for formation

$1.1656mol \; of \; SO_3$ required xkJ for formation

$\frac{1}{1.1656} = \frac{99.1}{x}$

$x = 99.1 \times 1.1656$

$= 115.5134kJ$

$x \simeq 115.5kJ$

The enthalpy of reaction is $-115.5kJ$

The correct option is A

34. $\cap_{pb(NO_3)_2} = \frac{vol \; in \; cm^3}{1000} \times molar \; conc$

$= \frac{250}{1000} \times 0.1$

$= 0.025mol$

$\cap_{pb(NO_3)_2} = \frac{Reacting \; mass}{Molar \; mass}$

$0.025 = \frac{Mass \; of \; Pb(NO_3)_2}{331.2}$

$Mass \; of \; Pb(NO_3)_2 = 0.025 \times 331.2$

$= 8.28g$

The correct option is C

35. $Ca_3(PO_4)_{2(s)} \rightleftharpoons 3Ca^{2+} + 2PO_4^-$

$xm \qquad 3xm \qquad 2x$

$K_{sp} = [Ca^{2+}]^3[PO_4^-]^2$

$= (3x)^3(2x)^2$

$= 27x^3(4x^2)$

$K_{sp} = 108x^5$

$1.08 \times 10^{-14} = 108x^5$

$x^5 = \frac{1.08 \times 10^{-14}}{108}$

$x^5 = 1 \times 10^{-16}$

$x = \sqrt[5]{1 \times 10^{-16}}$

$= 6.3096 \times 10^{-4} moldm^{-3}$

$Molar \; Conc. = \frac{Mass \; Conc}{Molar \; mass}$

$R.m.m. of \; Ca_3(PO_4)_2 = 310g/mol$

$6.3096 \times 10^{-4} = \frac{mass \; conc}{310}$

$Mass \; conc = 6.3096 \times 10^{-4} \times 310$

$= 0.1956g$

$Mass \; conc = 0.19g/dm^3$

None of the option is correct

36.

Molecules	Hybridization
CO_2	Sp
BF_3	Sp^2
H_2O	Sp^3
$BeCl_2$	Sp
CCl_4	Sp^3

The correct option is B

37. $^{227}_{89}X + ^{1}_{0}n + ^{0}_{-1}e \longrightarrow ^{220}_{84}Y + 2^{4}_{2}He$

$^{a}_{b}Y = ^{220}_{84}Y$

$\Longrightarrow (a, b) = (220, 84)$

None of the option is correct

38. $\underset{\text{acid}}{CH_3COOH} + \underset{\text{base}}{H_2O} \rightleftharpoons \underset{\text{conjugate base}}{CH_3COO^-} + \underset{\text{conjugate acid}}{H_3O^+}$

The correct option is D

39. (i) $^{40}_{20}X$ is an alkaline earth metal because it belongs to group two.

(ii) $^{15}_{7}Z \longrightarrow 1s^2\,2s^2\,2p^3$. Z is a p-block element.

(iii) $^{15}_{8}T$ and $^{16}_{8}Y$ are isotopes because they have the same atomic number.

The correct option is A

40. The statements contain in ii, iii, v and vi are not true for both electrochemical cell and electrolytic cell.

The correct option is A

2010/2011 CHEMISTRY 001 EXAMINATION

1. One of the postulates of kinetic theory of gases is that "forces of attraction or repulsion between the molecules of a gas are negligible". This implies that: (a) molecules will continue their motion indefinitely (b) molecules cannot move from place to place (c) a gas cannot be compressed (d) a gas can be subjected to compression or expansion.
2. Which of the following transmutation entails absorption of an alpha particle and release of a

proton? (a) $^{27}_{13}Al \rightarrow ^{30}_{15}P$ (b) $^{238}_{92}U \rightarrow ^{234}_{91}Pa$ (c) $^{238}_{92}U \rightarrow ^{234}_{90}Th$ (d) $^{14}_{7}N \rightarrow ^{17}_{8}O$

3. Which of the following statements is (are) true of an electrolytic cell? I. A cation lower in the e.c.s is discharged preferentially to those above it if the electrolyte is dilute II. An anion lower in the e.c.s is discharged preferentially to those above it if the solution is dilute III. the cathode is positively charged IV. Oxidation takes place at the anode [e.c.s = electrochemical series). (a)I and IV (b) II and III (c) I only (d) None

4. Given that $E^0_{M^{2+}/M} = -0.76V$ and $E^0_{X^{3+}/X} = +1.50V$, calculate the standard cell potential of the cell: $M(s)/M^{2+}(aq)//X^{3+}(aq)/X(s)$ (a) -0.80V (b) +0.80V (c) +2.26V (d) -2.26V

5. Which of the following statements is/are true of the elements in the Periodic Table? I. Ionization energy increases down the group II. Atomic radius increases across the period III. Metallic properties decrease from bottom to top within a given group. (a) III only (b) I only (c) II and III (d) I and II

6. Calculate ΔS in $Jmol^{-1}K^{-1}$ for the conversion of one mole of liquid water to vapour at 100°C, given that the heat of vaporization of water is $2260.87Jg^{-1}$. (a) 100.7 (b) 209.1 (c) 99.7 (d) 109.1

7. Calculate the pH of a solution containing 1.48g NaOH in 100mL of aqueous solution. (a) 13.67 (b) 3.70 (c) 13.57 (d) 3.56

8. A neutral atom of an element has 2 electrons with n = 1; 8 electrons with n = 2; 8 electrons with n = 3 and 1 electron with n = 4. How many p – electrons are there in this atom? (a) 6 electrons B 12 electrons (c) 7 electrons (d) 19 electrons.

9. If 4.0g of a gas occupies 11.2L at 0°C and 0.25 atmosphere, then the molecular mass of the gas is (a) $16g$ (b) $32g$ (c) $49g$ (d) $8g$ [R = $0.0821\ L\ atm, mol^{-1}\ K^{-1}$]

10. Which of the following statements correctly describes a chemical property? I. Silver salts discoloured the skin by reacting with skin protein II. Milk sours when kept for a long period of time III. Salt solution is separated from a colloidal solution using dialysis IV. Seashells fizz when immersed in vinegar V. Zinc metal dissolves in dilute acids liberate hydrogen. (a) I, II, IV and V (b) II, III, IV and V (c) I, II and IV (d) I, and II

11. $2SO_{2_g} + O_{2_g} \rightleftharpoons 2SO_{3_g}; \Delta H = -188kJ$ Which of the following combination of factors would favour the production of sulphur (VI) oxide in the above reaction? I. High pressure II. Low pressure III. High temperature IV. Low temperature V. Use of excess air. (a) I and III (b) I, II and IV (c) II and V (d) I, IV and V

12. 1g of hydrogen gas reacts with 1g of oxygen gas to give stream. What is the mass of steam formed? [H= 1, O = 16]. (a) $2.250g$ (b)$1.150g$ (c)$9.000g$ (d) $1.125g$

13. Which of the following arrangements order of increasing electropositivity? (a) F,B. Be, N and Li (b) F, N, B, Be and Li (c) Li, N, B, F and Be (d) Li, Be, B, N and F

14. The following are chemical equations representing some reactions:
(i) $2CrCO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$
(ii) $2H_2 + O_2 \rightarrow 2H_2O$
(iii)$U_3O_8 \rightarrow UO_2^{2+} + U^{4+}$
(iv)$HCl + NaOH \rightarrow NaCl + H_2O$
Which of the reactions is (are) redox reaction (a) (i) and (iv) (b) All (c) (ii) and (iii) (d) (i) only

15. Calculate the number of copper atoms in a coin that weighs 5g, assuming it contains 86% copper [Cu = 63.5, $N_A = 6.02 \times 10^{23}$]. (a) 4.11×10^{21} (b) 4.08×10^{22} (c) 4.30×10^{23} (d) 4.74×10^{20}

16. $100cm^3$ of 0.100M H_2SO_4 solution is mixed with $150cm^3$ of 0.100M NaOH solution. What is the pOH of the resulting solution? (a) 12.25 (b) 12.30 (c) 12.66 (d) 12.46

17. The reaction between $SO_2(g)$ and $K_2Cr_2O_7(aq)$ in an acid medium is represented by the unbalance net ionic equation: $SO_2 + Cr_2O_7^{2-} + H^+ \rightarrow SO_4^{2-} + Cr^{3+} + H_2O$
If this equation is balanced, the coefficients of H_2O and SO_2 respectively will be: (a) 1 and 3 (b) 1 and 2 (c) 2 and 5 (d) 2 and 4

18. During the electrolysis of a salt of metal X, a current of 1.0A flowing for 16mins 10s deposit 0.565g of X. what is the charge on the metal is [X = 112.41; 1F = 96500C]. (a) +3 (b) +6 (c) +2 (d) +1

19. If the elementary step A → B has a reaction enthalphy of $-50\ kJ$ and an activation energy of 10 kJ, the activation energy for the reverse step B → A is (a) 10kJ (b) 60kJ (c) 40kJ (d) 0kJ

20. Given that the enthalpies of formation for FeO and Fe_2O_3 are -266kJmol^{-1} and -821kJmol^{-1} respectively. The standard enthalpy change for the reaction, $2FeO_s + \frac{1}{2}O_{2_g} \rightarrow Fe_2O_{3_s}$ is: (a) +270kJ (b) -289kJ (c) +269kJ (d) -269kJ

21. What will be the respective entropy changes (positive, negative or zero) for the following processes? I. Condensation of water vapour II. $H_2(g) + I_2(g) \rightarrow 2HI(g)$ III. Melting of candle

wax IV. $4Fe(s) + 3O_2(g) \rightarrow Fe_2O_3(s)$. (a) Positive, Negative Positive, Zero (b) Zero, Zero, Negative, Positive (c) Negative, Zero, Positive, Negative (d) Negative, Positive, Negative, Zero.

22. Phosphorus-32, a radioisotope used in leutemia therapy, has a half-life of 14 days. Approximately what percent of a sample remains after 8 weeks? (a) 12.50% (b) 93.75% (c) 6.25% (d) 2.00%
23. Elemental analysis of nicotine gives the following data: C = 74.0%, H=8.65%, N = 17.35%. The molar mass of nicotine is 162 $g.mol^{-1}$ of nicotine. What is the molecular formula of nicotine? [H = 1, O=16, N=14] (a) C_5H_8N (b) C_5H_7N (c) $C_{10}H_{14}N_2$ (d) $C_{10}H_8N_2$
24. With reference from I to V below, the shapes of water, beryllium dichloride, ammonia and boron triflouride are respectively. I. Tetrahedral II. Trigonal pyramidal III. Trigonal planar IV. Angular V. Linear (a) II, III, IV and V (b) IV, V, II and III (c) V, IV, III and I (d) I, II, III and IV
25. If the molar solubility of cobalt (II) hydroxide is 5.4×10^{-6} mol/L in distilled water, what is its K_{sp} value? (a) 6.3×10^{-32} (b) 6.3×10^{-16} (c) 5.4×10^{-16} (d) 5.4×10^{-32}
26. The following are possible carriers of electricity during conduction in substances I. free mobile electrons II. free hydrated ions III. free mobile ions. Which of these are responsible for conduction in molten $PbBr_2$ and aqueous $CuSO_4$ respectively? (a) III and I (b) I and III (c) III and II (d) I and II
27. The respective pattern of hybridization of the central atom in the components of H_2O, CO_2, NH_3, $BeCl_2$ and BF_3 are: (a) sp^3, sp^3, sp, sp^2 and sp (b) sp, sp^3, sp^2, sp^3 and sp (c) sp^3, sp, sp^3, sp and sp^2 (d) sp, sp^2, sp, sp^3, and sp^3
28. Consider the following substances: I. Fe_2O_3 II. ZnO III. NO_2 IV. CO V. $(CH_3CO)_2O$. Acid anhydrides are: A I and II (b) I, II and IV (c) III and V (d) I and IV
29. Which of the terms I. heteroatomic II. homoatomic III. diatomic IV. triatomic V. element and VI. compound. Apply to the chemical substance X – Q – X? (a) I, IV, V and VI (b) I, IV and V (c) II, IV and V (d) I, IV and VI
30. Which of the following is a Lewis base? I. NH_3 II. BF_3 III. NH_4^+ IV. NH_2^- (a) All (b) II and IV (c) II and III (d) I and IV
31. The rate law for the reaction $2A + B \rightarrow C$ was found to be Rate = $k[A][B]^2$. If the concentration of B is tripled, what will happened to the rate of the reaction? (a) It will increase by nine times (b) It will stay the same (c) It will increase by six times (d) It will increase by three times.
32. Nickel is electroplated from a $NiSO_4$ solution. If a constant current of 5.00 amp is applied to a $NiSO_4$ solution, how long will it take to deposit $100.0g$ of Ni? [Ni = 58.7, F = 96500 $Cmol^{-1}$]. (a) 57.2s (b) 62.9min (c) 18.3hr (d) 1.22s
33. $1.31g$ of a metal, X, (relative atomic mass 65.41) completely reacted with dilute hydrochloric acid to liberate $448.62cm^3$ of hydrogen gas at s.t.p. Use this information to deduce the stoichiometry of the reaction between X and HCl. (a) 3:2 (b) 1:2 (c) 3:1 (d) 1:3
34. If the cost of electricity required to deposit 1.0g of copper in an electrolytic process is N200.00, how much will it cost to deposit 10.8g of aluminium? [Al = 27, Cu = 64]. (a) N439.00 (b) N584.00 (c) N678.00 (d) N768.00
35. The contact process of making H_2SO_4 is represented by the following schemes: $S \xrightarrow{I} SO_2 \xrightarrow{II} SO_3 \xrightarrow{III} H_2S_2O_7 \xrightarrow{IV} H_2SO_4$ What are the oxidation numbers changes of sulphur at stages I to IV? (a) +2, 0, +4, 0 (b) -4, -2, 0, 0 (c) +4, +2, 0, 0 (d) 0, 0, -4, -2
36. Separation of a mixture into its constituents is based on physicochemical properties such as I. solubility at different temperatures II. density III. immiscibility of two solvents IV. adsorption rates V. ion-combination. The separation of kerosene from water using a separating funnel is based on: (a) II and III (b) I and IV (c) I, IV and V (d) V only
37. $2C_5H_{11}OH + 15O_2 \longrightarrow 10CO_2 + 12H_2O$. The above equation represents the combustion reaction of pentanol ($C_5H_{11}OH$), how many moles of water are formed for each mole of oxygen from the reaction? (a) 0.08mole (b) 0.80mole (c) 0.66mole (d) 1.25moles
38. Listed below are aqueous solutions of some common normal salts: I. CH_3COONa II. Na_2SO_4 III. $FeCl_3$ IV. Na_2CO_3 V. NH_4Cl VI. $NaCl$. Which of these aqueous solutions could turn red litmus paper blue? (a) II, III, and V (b) I and IV (c) II, III and VI (d) III and V
39. The volume of distilled water that must be added to 10.0ml of 12.0M HCl in order to prepare a 1.00M HCl solution is approximately. (a) 120.0ml (b) 60.0ml (c) 50.0ml (d) 110.0ml
40. From the following list: I. $H_3N.BF_3$ II. $BeCl_2$ III. H_2O IV. NaCl and V. $CaCO_3$ select one compound which contains: ionic and covalent

bonds in the same molecule, two lone pairs of electrons in one molecule and a coordinate covalent compound respectively. (a) III, IV and II (b) I, III and V (c) V, III and I (d) II, III and I

SOLUTION

1. Kinetic theory of gases is also known as kinetic molecular theory of gases. It states that gases are made of tiny particles (i.e. molecules) which are in continuous motion and as a result possesses kinetic energy. The basic assumptions of the kinetic theory of gases are:-

i. A gas is composed of molecules that are separated from each other by distances far greater than their own dimensions. The molecules can be considered to be "points"; that is, they possess mass but have negligible volume or size.

ii. Molecules of a gas are in constant and rapid motion in straight lines until they collide with one another and with the walls of their container. The implication is that molecules of gases exert pressure on each other and on the wall of their container

iii. The collision between gaseous molecules is perfectly elastic. The implication is that gaseous molecules will continue their motion indefinitely.

iv. The actual volume occupied by the gas molecules is negligible compared with the volume of the container. The implication of this assumption is that gases can be compressed

v. Forces of attraction or repulsion between the molecules of gases are negligible. The implication of this assumption is that gaseous molecules will occupy any available space.

vi. The average kinetic energy of the gas molecules is proportional to the absolute temperature of the gas molecules.

The correct option is D

2. Absorption of an alpha particle and a release of a proton is a type of nuclear reaction in which an element combine with an alpha particle and liberate a proton e.g. $^{14}_{7}N + {}^{4}_{2}He \longrightarrow {}^{17}_{8}O + {}^{1}_{1}H$

The correct option is D

3. Characteristics of electrolytic cell

i. It converts electrical energy to chemical energy

ii. Oxidation occurs at the anode

iii. Reduction occurs at the cathode

iv. The anode is the positive terminal

v. The cathode is the negative terminal

vi. Non-metals that are higher in the electrochemical series are discharge compare to those lower in the series.

vii. Metals that are lower in the electrochemical series are discharge compare to those higher in the series.

Note that this is not a strict rule because it's only base on the way the elements are arranged.

The correct option is A

4. $E^{o}_{oxidant} = 1.50v$
$E^{o}_{reductant} = -0.76v$
$E^{o}_{cell} = E^{o}_{oxidant} - E^{o}_{reductant}$
$= 1.5 - (-0.76)$
$= 1.5 + 0.76$
$= 2.26V$

The correct option is C

5.

Atomic properties	Across the period	Down the group
Metallic properties or electropositivity	Decreases	Increases
Atomic volume	Decreases	Increases
Ionic radius	Decreases	Increases
Atomic radius	Decreases	Increases
Electronegativity	Increases	Decreases
Ionization energy	Increases	Decreases
Electron affinity	Increases	Decreases
Atomic number	Increases	Increases
Mass number	Increases	Increases

From the table metallic properties decreases across the period and increases down the group (from top to bottom). In order word metallic properties decreases from bottom to top within a given group.

The correct option is A

6. $H_2O_{(L)} \rightleftharpoons H_2O_{(g)}\ \Delta H = 2260.87J/g$
$T = 100C^{\circ} = 373K$
At equilibrium $\Delta S = \frac{\Delta H}{T}$
$\Delta S = \frac{2260.87J/g}{373K} = 6.0613J/gK$
$R.m.m\ of\ water = 18g/mol$
$\Delta S = \frac{6.06135}{gK} \times 18g/mol$
$= 109.1034J/molK$

The correct option is D

7. R.M.M of NaOH $= 40g/mol$
$V_{NaOH} = 100mL = 100cm^3 = 0.1dm^3$
$\cap_{NaOH} = \frac{1.48g}{40g/mol} = 0.0370mol$
$C_{NaOH} = \frac{\cap_{NaOH}}{Vol} = \frac{0.0370mol}{0.1dm^3}$
$= 0.37moldm^{-3}$
$NaOH \longrightarrow Na^{+} + OH^{-}$

$0.37M \quad 0.37M \quad 0.37M$

$P^{OH} = -Log_{10}^{[OH^-]} = -Log_{10}^{0.37} = -(0.4318)$

$P^{OH} = 0.4318$

But $P^{OH} + P^{H} = 14$

$0.4318 + P^{H} = 14$

$P^{H} = 14 - 0.4318 = 13.5682$

$P^{H} \simeq 13.57$

The correct option is C

8.

(i) Atomic number = 2 + 8 + 8 + 1 = 19

(ii) For a neutral atom the number of proton is equal to the number of electron. Therefore the number of proton is 19.

(iii). $\rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

Total number of p-electrons is 12

Total number of s-electrons is 7

(iv). Total number of d electrons is 0

(v). The atomic mass is unknown.

The correct option is B

9. Mass of gas = 4.0g

$V_1 = 11.2L \quad T_1 = 0°C = 273K,$

$P_1 = 0.25atm$

$R = 0.0821\ atm\ mol^{-1}k^{-1}$

$PV = nRT$

$$\cap = \frac{PV}{RT} = \frac{0.25 \times 11.2}{0.0821 \times 273} = \frac{2.8}{22.4133}$$

$$= 0.1249mol$$

$$\cap_{gas} = \frac{m_{gas}}{M_{gas}}$$

$$0.1249 = \frac{4}{M_{gas}}$$

$$M_{gas} = \frac{4}{0.1249}$$

$$= 32.0256$$

$$M_{gas} = 32g\ /\ mol$$

The correct option is B

10. A chemical properties, is also known as chemical reaction or changes. A chemical changes is a type of changes in which a new substance is form and it is not easily reversible e.g.

(i) Silver salts discolouring the skin by reacting with skin protein

(ii) The souring of milk when kept for a long period of time

(iii) The fizzing of Seashells when immersed in vinegar

(iv) The liberation of hydrogen gas when Zinc metal dissolves in dilute acids.

The correct option is A

11. $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} \Delta H = -188kJ$

The above reaction is an exothermic reaction, hence the forward reaction will be favoured by lower temperature, increase in the concentration of either $SO_{2(g)}$ and $O_{2(g)}$ (from air) will favoured the forward reaction. Hence the use of excess air will favoured the forwared reaction (i.e. the formation of $SO_{3(g)}$). The number of gaseous volume in the reactant is 3 and in the product is 2 from the reactant to product gaseous volume decrease hence pressure should increase according to boyle's law. In summary the forward reaction will be favoured by:

(a) Low temperature

(b) Use of excess air

(c) High pressure

The correct option is D

12. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

$1g \qquad 1g$

$R.m.m\ of\ H_2 = 2g/mol$

$R.m.m\ of\ O_2 = 32g/mol$

$$\cap_{H_2} = \frac{1}{2} = 0.5mol$$

$$\cap_{O_2} = \frac{1}{32} = \frac{1}{32}mol$$

$$\cap_{H_2} \quad : \quad \cap_{O_2}$$

$$\frac{0.5mol}{2} \quad \frac{\frac{1}{32}mol}{1}$$

$0.25mol \quad \frac{1}{32}mol = 0.0313$

Note that the division is done by the stoichiometry mole in the balance chemical equation.

The limiting reagent is O_2

The excess reagent is H_2

$$\cap_{H_2O} = \frac{2\text{mole of } H_2O}{1\ mole\ of\ O_2} \times \frac{1}{32}\ mole\ of\ O_2$$

$$= \frac{1}{16}mole$$

$R.m.m\ of\ H_2O = 18g/mol$

$$\cap_{H_2O} = \frac{\text{mass of water}}{\text{molar mass}}$$

$$\frac{1}{16} = \frac{M_{H_2O}}{18}$$

$$M_{H_2O} = 18 \times \frac{1}{16} = \frac{18}{16} = 1.1250g$$

The correct option is D

13. An electropositivity or metallic property is the tendency of an element to easily loose or donate electrons during bonding. It decreases across the period and increases down the group. A simple guide rule is that an element in a lower group (say group 2) will be more electropositive then an element in a higher group (say group 4). F, N, B, Be and Li.

The correct option is B

14. A redox reaction is a reaction in which oxidation and reduction occur simultaneously e.g.

(a) $2H_2 + O_2 \rightarrow 2H_2O$

In this reaction the oxidation state of hydrogen changes from 0 to +1 (i.e. oxidation process) but the oxidation state of oxygen changes from

0 to -2 (i.e. reduction process) since oxidation and reduction occur simultaneously in the reaction, it is redox reaction.

(b) $U_3O_8 \rightarrow UO_2^{2+} + U^{4+}$

In the U_3O_8 (the oxidation state of U is +5), UO_2^{2+} (the oxidation state of U is +6) and U^{4+} (the oxidation state of U is +4). Hence the oxidation state of Uranium (U) changes from +5 to +6 (i.e. oxidation process) and +5 to +4 (i.e. reduction process). Therefore the reaction is a redox reaction.

The correct option is C

15. Mass of Coin = 5g

% of Cu in the coin = 86%

Mass of Cu in the coin = $86\%\ of\ 5g$

$= \frac{86}{100} \times 5g = 4.30g$

$\cap_{Cu} = \frac{mass\ of\ Cu}{molar\ mass} = \frac{4.30g}{63.5g/mol}$

$= 0.0677mol$

$\cap_{Cu} = \frac{No\ of\ atoms\ of\ Cu}{6.02 \times 10^{23}}$

No of atoms of Cu = $0.0677 \times 6.02 \times 10^{23}$

$= 4.0765 \times 10^{22}$

$\simeq 4.08 \times 10^{23}$

The correct option is B

16. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

$100cm^3, 0.1M$ $150cm^3, 0.1M$

$\cap_{H_2SO_4} = \frac{V\ in\ cm^3}{1000} \times molar\ conc$

$= \frac{100}{1000} \times 0.1 = 0.01mol$

$\cap_{NaOH} = \frac{V\ in\ cm^3}{1000} \times molar\ conc$

$= \frac{150}{1000} \times 0.1 = 0.015mol$

$\cap_{NaOH} : \cap_{H_2SO_4}$

$\frac{0.01}{1} : \frac{0.015}{2}$

$0.01 : 0.0075mol$

Note that the division is done by the stoichiometry mole in the balance equation. The smallest mole gives the limiting reagent.

The limiting reagent is NaOH

The excess reagent is H_2SO_4

Also note that, the excess reagent determine the nature of the resultant solution. Since H_2SO_4 is the excess reagent, the resultant solution is acidic.

$\cap_{H_2SO_4}\ used\ up$

$= \frac{1\ mole\ of\ H_2SO_4}{2\ mole\ of\ NaOH} \times 0.015 mole\ of\ NaOH$

$= 0.0075mol$

$excess\ \cap_{NaOH} = 0.01 - 0.0075$

$= 0.0025mol$

Volume of resulting solution (V_{sol})

$= 100cm^3 + 150cm^3 = 250cm^3$

$= 0.25dm^3$

Concentration of excess H_2SO_4

$= \frac{excess\ H_2SO_4}{volume\ of\ solution}$

$= \frac{0.0025mol}{0.25dm^3}$

$= 0.01moldm^{-3} = 0.01M$

$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

$0.01M \quad 2(0.01M) \quad 0.01M$

$[H^+] = 2(0.01) = 0.02M$

$P^H = -Log_{10}^{[H^+]} = -Log_{10}^{0.02}$

$= -(-1.6990)$

$= 1.6990$

$But\ P^H + P^{OH} = 14$

$1.699 + P^{OH} = 14$

$P^{OH} = 14 - 1.699 = 12.3010$

The correct option is B

17. $SO_2 + Cr_2O_7^{2-} \rightarrow SO_4^{2-} + Cr^{3+}$

$SO_2 \rightarrow SO_4^{2-}\ (OX)$

$Cr_2O_7^{2-} \rightarrow Cr^{3+}\ (red)$

$SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^- \ldots . x3$

$6e^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O \ldots x1$

$3SO_2 + 6H_2O \rightarrow 3SO_4^{2-} + 12H^+ + 6e^-$

$6e^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$

$3SO_2 + Cr_2O_7^{2-} + 2H^+ \rightarrow 3SO_4^{2-} + 2Cr^{3+} + H_2O$

The co-efficient of water is 1 and that of SO_2 is 3.

The correct option is A

18. $I = 1A$

$t = 16mins, 10s$

$= 16mins \times \frac{60s}{1min} + 10s$

$= 960s + 10s = 970s$

$m = 0.565g$

$m = zIt$

$Z_X = \frac{R.m.m\ of\ x}{Charge\ of\ X \times 96500}$

$= \frac{112.41}{x \times 96500}$

$0.565 = \frac{112.41}{96500x} \times 1 \times 970$

$0.565 \times 96500x = 112.41 \times 970$

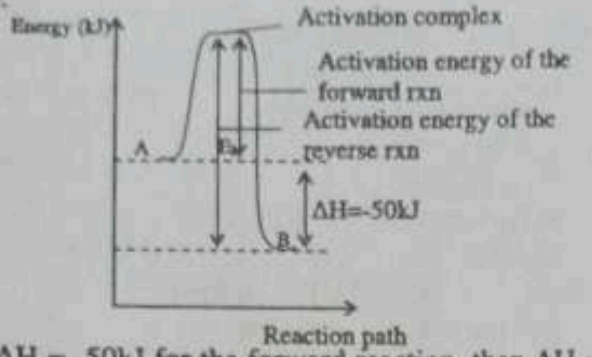
$x = \frac{112.41 \times 970}{0.565 \times 96500} = 1.9999$

$x \simeq 2$

The relative charge on the metal is +2

The correct option is C

19.



If ΔH = -50kJ for the forward reaction, then ΔH = 50kJ for the reverse reaction.

$E_r = E_f + \Delta H_{rev}$

$= 10 + 50$

$= 60kJ$

The correct option is B

20. $2FeO_{(s)} + \frac{1}{2}O_{2(g)} \rightarrow Fe_2O_{3(g)}$

$-266kg/mol \quad - \quad -821kJ/mol$

Note that the enthalpy of formation of an element in its pure state is zero.

$\Delta H = \sum H_P - \sum H_R$

$= 1\ mole\ (-821kJ/mol)$

$= -2mole\ (-266kJ/mol)$

$= -821kJ + 532kJ$

$= -289kJ$

The correct option is B

21.

Processes	Entropy changes
Condensation of water	-ve
$H_{2(g)}+I_{2(g)} \rightarrow 2HI_{(g)}$	0
Melting of candle wax	+ve
$4Fe_{(s)}+3O_{2(g)} \rightarrow Fe_2O_{3(s)}$	-ve

The correct option is C

22. $T_{1/2} = 14days$

$t = 8weeks = 8 \times 7days = 56days$

$n = \frac{t}{T_{\frac{1}{2}}} = \frac{56}{14} = 4$

$N_R = No\left(\frac{1}{2}\right)^n$

$N_R = No\left(\frac{1}{2}\right)^4$

$N_R = \frac{1}{16}No$

$\frac{N_R}{No} = \frac{1}{10}$

$\frac{N_R}{No} \times 100 = \frac{1}{16} \times 100 = 6.25\%$

The percentage of the sample remaining after 8weeks is 6.25%.

The correct option is C

23. $\%\ of\ C = 74\%$

$\%\ of\ H = 8.65\%$

$\%\ of\ N = 17.35\%$

$R.m.m\ of\ nicotine = 162$

Assuming 100g of nicotine

$mass\ of\ C = 74\%\ of\ 100g$

$= \frac{74}{100} \times 100g = 74g$

$mass\ of\ H = 8.65\%\ of\ 100g$

$= \frac{8.65}{100} \times 100g = 8.65g$

$mass\ of\ N = 17.35\%\ of\ 100g$

$= \frac{17.35}{100} \times 100g = 17.35g$

C	:	H	:	N
$\frac{74}{12}$	:	$\frac{8.65}{1}$	:	$\frac{17.35}{14}$
6.1667	:	8.65	:	1.2393
4.9760	:	6.9798	:	1
$\simeq$ 5	:	7	:	1

The empirical formula is C_5H_7N

$R.m.m.of\ (C_5H_7N)_n = 162$

$[5(12g/mol) + 7(1g/mol) + 14g/mol]_n = 162g/mol$

$n[60g/mol + 7g/mol + 14g/mol] = 162g/mol$

$81n = 162$

$n = \frac{162}{81} = 2$

$(C_5H_7N)_2 = C_{10}H_{14}N_2$

The correct option is C

24.

species	Hybrization of central atom	Orbitals on each atom that overlap plus their orientation	Shape
$BeCl_2$	Sp	Sp- P	Linear
H_2O	Sp^3	$Sp^3 - S$	Angular
NH_3	Sp^3	$Sp^3 - S$	Trigonal pyramidal
BF_3	Sp^2	$Sp^3 - P$	Trigonal planar
CH_4	Sp^3	$Sp^3 - S$	Tetrahedral
CO_2	Sp	Sp – P	Linear

The correct option is B

25. $Co(OH)_{2(s)} \rightleftharpoons Co^{2+} + 2OH^-$

$5.4 \times 10^{-6}M \quad 5.4 \times 10^{-6}M \quad 2(5.4 \times 10^{-6}M)$

$K_{sp} = [Co^{2+}][OH^-]^2$

$= (5.4 \times 10^{-6})[2(5.4 \times 10^{-6})]^2$

$= 5.4 \times 10^{-6} \times 4(2.916 \times 10^{-11})$

$= 5.4 \times 10^{-6} \times 1.1664 \times 10^{-10}$

$= 6.29856 \times 10^{-16}m^3$

$K_{sp} \simeq 6.3 \times 10^{-16}$

The correct option is B

26. The carrier of electivity is the component of a substance that conducts electricity.

Substance	Carrier of electricity
Conductor	Mobile electrons
Ionizing gases	Mobile electrons and ions
Semi-conductor	Hole and mobile electrons
Aqueous solution	Mobile hydrated ion
Molten substance	Free or mobile ions

The correct option is C

27. Refer to solution to question 24 above.

The correct option is C

28. Acid anhydride are substance which when dissolve in water produce an acid
(a) $2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$
(b) $(CH_3CO)_2O + H_2O \rightarrow 2CH_3COOH$

The correct option is C

29. $X - Q - X$ has the following properties
(a) It is a compound
(b) It is hetero-atomic because of X and Q
(c) It is tri-atomic

The correct option is D

30. A Lewis base is a substance that contains a lone pair of electron on its central atom e.g. $NH_3, NH_2^-, SOCl_2, PH_3$ etc

The correct option is D

31. $R = K[A][B]^2$
If the concentration of B is triple, the new concentration of B is 3[B] and R = R_1
$R_1 = K[A](3[B])^2$
$= K[A](9[B])^2$
$= 9K[A][B]^2$
But $R = K[A][B]^2$
$R_1 = 9R$
Therefore, the rate of reaction will increases nine (9) times.

The correct option is A

32. $I = 5A, t = ? m = 100g$
$m = ZIt$

$$Z_{N1} = \frac{\text{R.M.M of N1}}{\text{charge in } Ni^{2+} \times 96500} = \frac{58.7}{2 \times 96500}$$

$$100 = \frac{587}{2 \times 96500} \times 5 \times t$$

$$100 \times 2 \times 96500 = 58.7 \times 5 \times t$$

$$t = \frac{100 \times 2 \times 96500}{58.7 \times 5}$$

$$t = 65758.091995 \times \frac{1min}{605}$$

$$= 1095.9682 \text{ min} = 18.8hrs$$

The correct option is C

33. $\cap_{H_2} = \frac{\text{vol at s.t.p}}{22.4dm^3} = \frac{448.62cm^3}{22400cm^3/mol} = 0.02mol$

$2HCl \rightarrow 2Cl^- + H_{2(g)}$

2mole of HCl will liberate 1 mole of H_2
x mole of HCl will liberate 0.02mole of H_2

$$\frac{2}{x} = \frac{1}{0.02}$$

$$x = 2(0.02) = 0.04mole$$

$$\cap_{HCl} = 0.04mole$$

$$\cap_x = \frac{reacting\ mass}{molar\ mass} = \frac{1.31g}{65.41g/mol}$$

$$= 0.02mol$$

$\cap_x$	:	$\cap_{HCl}$
0.02	:	0.04
1	:	2

The correct option is B

34. Mass of Cu = 1.0g

$$\cap_{Cu} = \frac{\text{reacting mass of Cu}}{\text{molar mass}} = \frac{1}{64}\text{mol}$$

$1mole\ of\ Cu^{2+} = 2F$

$$\frac{1}{64} mole\ of\ Cu^{2+} = xF$$

$$\frac{1}{\frac{1}{64}} = \frac{2}{x}$$

$$64 = \frac{2}{x}$$

$$x = \frac{2}{64} = \frac{1}{32}F$$

But the cost of electricity require to depositing 1.0g of the (i.e. $\frac{1}{64}$ mole of Cu^{2+}) is ₦200

$$\Rightarrow \frac{1}{32}F = ₦200$$

$1F = ₦200 \times 32$
$1F = ₦6400$
Mass of Al = 10.8g

$$\cap_{AL} = \frac{\text{Reacting mass of Al}}{\text{molar mass}}$$

$$= \frac{10.8}{27} = 0.4mole$$

1mole of $Al^{3+} = 3F$
$0.4mole\ of\ Al^{3+} = yF$

$$\frac{1}{0.4} = \frac{3}{y}$$

$$y = 3(0.4) = 1.2F$$

Cost of depositing 10.8g or 0.4mole of
$Al = 1.2F$
$= 1.2 \times 1F$
$= 1.2 \times ₦6400$
$= ₦7680$

None of the option is correct

35.

Species	Oxidation state of S
S	0
SO_2	+4
SO_3	+6
$H_2S_2O_7$	+6

H_2SO_4	+6

(a) Change in oxidation number stage I = 4 - 0 = +4

(b) Change in oxidation number stage II = 6 – 4 = +2

(c) Change in oxidation number stage III = 6 – 6 = 0

(d) Change in oxidation number stage IV = 6 – 6 = 0

The changes are +4, +2, 0, 0

The correct option is C

36. The physical properties employ in separating the components of the mixture of kerosene and water is different densities or immiscibility of the two solvents.

The correct option is A

37. $2C_5H_{11}OH + 15O_2 \rightarrow 10CO_2 + 12H_2O$

From the reaction

15 moles of O_2 is require to form 12moles of water

1 moles of O_2 will be require to form x moles of water

$$\frac{15}{1} = \frac{12}{x}$$

$$15x = 12$$

$$x = \frac{12}{15} = 0.8$$

The correct option is B

38.

Aqueous solution	Nature of solution	Action of solution on litmus
CH_3COONa	Basic	Turn red litmus blue
Na_2SO_4	Neutral	No action
$FeCl_3$	Acidic	Turn blue litmus red
Na_2CO_3	Basic	Turn red litmus blue
$NaHCO_3$	Basic	Turn red litmus blue
NH_4Cl	Acidic	Turn blue litmus red
NaCl	Neutral	No action

The correct option is B

39. $v_1 = 10ml, c_2 = 12m, c_2 = 1M\ v_2 = ?$

$c_1v_1 = c_2v_2$

$10 \times 12 = 1 \times v_2$

$v_2 = 120mL$

$But\ v_2 = v_1 + v_{H_2O}$

$\Rightarrow 120 = 10 + v_{H_2O}$

$v_{H_2O} = 120 - 10 = 110cm^3$

The correct option is D

40.

Compound	Bond type
$H_3N.BF_3$	Danve and covalent
$BeCl_2$	Covalent
H_2O	Hydrogen bond
NaCl	Ionic
$CaCO_3$	Ionic and covalent

(a) $CaCO_3$ contain ionic and covalent bond

(b) H_2O contain two lone pair of electrons

(c) $H_3N.BP_3$ contain co-ordinate covalent bond

The correct option is C

2009/2010 CHEMISTRY 001 EXAMINATION

1. What volume of $0.05M$ sodium trioxonitrate (V), $NaNO_3$, solution contains $2.5g$ of the solute?

[Na = 23, O=16, N=14]

(a) 0.59mL (b) 5.88mL (c) 588.20mL (d) 58.82mL

2. The respective pattern of hybridization of the central atom in the compounds of CO_2, NH_3, $BeCl_2$ and BF_3 are (a) sp^3, sp, sp^2 and sp (b) sp, sp^3, sp^2 and sp (c) sp, sp^2, sp and sp^3 (d) sp, sp^3, sp and sp^2.

3. What orbital is described by the quantum numbers n=2 and ℓ=0? (a) 2s-orbital (b) 1s-orbital (c) 2p-orbital (d) 4d-orbital

4. Which of the following will give an aqueous solution with pH greater than 7? I. NH_4Cl II. CH_3COONa III. Na_2CO_3 IV. $NaHCO_3$

(a) II, III and IV only (b) I, and II only (c) I, II and III only (d) II and III only

5. What type of chemical bonding exists between BF_3 and NH_3? (a) Dative bonding (b) Metallic bonding (c) Ionic bonding (d) Hydrogen bonding.

6. A mixture of 0.30mole of oxygen, 0.20mole of nitrogen and 0.40mole of hydrogen exerts a total pressure of 3.6 atm. The partial pressure of hydrogen in the mixture is (a) 1.60atm (b) 1.90atm (c) 0.90atm (d) 0.40atm

7. Analysis of a metal chloride MCl_3 shows that it contains 67.2 percent chlorine by mass. Determine the atomic mass of the element M [Cl = 35.5]. (a) 65.5 (b) 32.0 (c) 52.0 (d) 40.0

8. What is the standard enthalpy of reaction, ΔH^θ, for the manufacture of hydrogen when carbon (II) oxide and steam react to give carbon (IV) oxide and hydrogen? $\Delta H_f^\theta(CO_2) = -393$ kJ/mol; $\Delta H_f^\theta(CO) = -111$kJ/mol; $\Delta H_f^\theta(H_2O) = -242$ kJ/mol.

(a) -40 kJ/mol (b) 80 kJ/mol (c) -746 kJ/mol (d) 80 kJ/mol

9. What is the chemical formula of a compound containing 6.02×10^{23} atoms of hydrogen, 35.5g of chlorine and 4.0 moles of oxygen atoms? [H = 1, O = 16, Cl = 35.5]. (a) HCl_2O_4 (b) $HClO_4$ (c) HCl_4 (d) HClO

10. $60cm^3$ of a 1M solution of silver trioxonitrate (V) and $50cm^3$ of a 0.05M sodium trioxocarbonate (IV) solution are mixed. Assuming the insoluble component is completely insoluble; determine the maximum mass of precipitate obtained. [C = 12, N=14, O=16, Na=23, Ag=108]. (a) 0.828g (b) 0.690g (c) 1.38g (d) 0.710g
11. The net ionic equation for the reaction when solution of calcium chloride and sodium carbonate are mixed is
(a) $Ca^{2+}_{(aq)} + CO_3{}^{2-}_{(aq)} \rightarrow CaCO_3(s)$
(b) $Ca^{2+}_{(aq)} + 2Cl^- + 2Na^+_{(aq)} + CO_3{}^{2-}_{(aq)} \rightarrow CaCO_3(s) + 2Na^+_{(aq)} + 2Cl^-(aq)$
(c) $Ca^{2+}_{(aq)} + 2Cl^-_{(aq)} + 2Na^+_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow Ca^{2+}_{(aq)} + CO_3{}^{2-}_{(aq)} + 2Na^+_{(aq)} + 2Cl^-_{(aq)}$
(d) $CaCl_{2(aq)} + Na_2CO_{3(aq)} \rightarrow CaCO_{3(s)} + 2NaCl_{(aq)}$
12. Which of the following will most likely have the highest boiling point? (a) PCl_5 (b) LiCl (c) HF (d) NH_3
13. 6.4g of oxygen gas and 4.8g of chlorine gas are mixed with 14.9g of krypton at a total pressure of $6.92 \times 10^7 Nm^{-2}$. Calculate the partial pressure of chlorine gas. [O = 16.0, Cl = 35.5, Kr = 83.8]. (a) $1.04 \times 10^7 Nm^{-2}$ (b) $10.4 \times 10^7 Nm^{-2}$ (c) $4.63 \times 10^6 Nm^{-2}$ (d) $9.36 \times 10^6 Nm^{-2}$
14. The partial pressure of oxygen in a sample of air is 452 mmHg and the total pressure is 780 mmHg. Determine the mole fraction of oxygen in the mixture. (a) 0.579 (b) 5.790 (c) 2.030 (d) 0.203
15. Which of the following cannot respectively represent the set of quantum numbers n, l, m_l and m_s? (a) 1, 1, 0, ½ (b) 2, 1, -1, ½ (c) 1, 0, 0, -½ (d) 1, 0, 0, ½
16. How much heat is evolved when 500kg of ammonia is produced to the following equation? $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$; $\Delta H = -91.8kJ$. [N=14.0; H=1.0]. (a) $.1.35 \times 10^6 J$ (b) $.2.70 \times 10^6 kJ$ (c) $.2.70 \times 10^6 J$ (d) $.1.35 \times 10^6 kJ$
17. Copper is electroplated from a $CuSO_4$ solution. A constant current of $2.00 amps$ is applied by an external power supply. How long will it take to deposit 100g of Cu? [Cu = 63.5, F = 96500C]. (a) 21.1 hours (b) 42.2 hours (c) 11.2 seconds (d) 10.0minutes.
18. Supply the respective values of x and y in the following redox half equation taking place in an acidic medium: $MnO_4^- + 8H^+ + xe^- \rightarrow Mn^{2+} + yH_2O$. (a) 4 and 5 (b) 7 and 4 (c) 5 and 4 (d) 5 and 2
19. Which of the following shapes are respectively the shapes of beryllium dichloride, water, ammonia, boron trifluride and methane respectively are I. Tetrahedral, II. Trigonal pyramidal, III. Trigonal planar, IV. Angular V. Linear. (a) I, II, III and IV (b) V, IV, II, III and I (c) II, III, IV and V (d) IV, V, II and III.
20. The hydrated form of aluminium tetraoxosulphate (VI) contains 8.20 percent of Al by mass. Calculate the number of water molecules associated with each aluminium tetraoxosulphate (VI) unit. (a) 12 (b) 14 (c) 18 (d) 16
21. The maximum number of electrons in a subshell depends on (a) principal quantum number (b) magnetic quantum number (c) azimutal quantum number (d) spin quantum number.
22. Nitrogen forms various gaseous oxides. One of them has a density of 1.33g/L measured at 764 mmHg and 150°C. What is the formula of the compound? (a) N_2O (b) NO (c) N_2O_5 (d) NO_2
23. A saturated solution of $BaSO_4$ at 25°C was found experimentally to have a concentration of 5.0 x 10^{-5} mol/L. What is the solubility product of this salt? (a). $2.5 \times 10^{-9} mol^2 dm^{-6}$ (b) $10 \times 10^{-9} mol^2 dm^{-6}$ (c) $52 \times 10^{-9} mol^2 dm^{-6}$ (d) $25 \times 10^{-9} mol^2 dm^{-6}$
24. A 325 mL sample solution of HCl contains 0.593g of the acid. Calculated the respective molar concentration of H^+ ions in and the pH of the solution. (a) 0.04M, 1.40 (b) 0.03M, 1.52 (c) 0.06M, 1.22 (d) 0.05M, 1.30
25. If 30.0 mL of 0.150 M $CaCl_2$ is added to 15.0 mL of 0.100M $AgNO_3$, what is the mass (in grams) of the precipitate formed? (a) 0.861 (b) 0.431 (c) 0.215 (d) 0.646
26. Phosphorus-32, a radioisotope used in leukemia therapy, has a half-life of 14 days. Approximately what percent of a sample remains after 8 weeks? (a) 6.25% (b) 8.25% (c) 2.00% (d) 93.75%
27. The rate law for the reaction 2A+B→C was found to be Rate = $k[A][B]^2$. If the concentration of B is tripled, what will happen to the rate of the reaction? (a) It will increase by three times (b) It will stay the same (c) It will increase by nine times (d) It will increase by two times.
28. If 25mL of 0.75M HCl are added to 100 mL of 0.25M NaOH, what is the final pH of the solution? (a) 1.20 (b) 12.80 (c) 1.30 (d) 12.70
29. How many hydrogen atoms are there in 5.94g of ammonium tetraoxosulphate (VI)

molecules? [H = 1; N = 14; O = 16; S = 32; NA = 6.02×10^{23} particles/mole]. (a) 2.17×10^{23} (b) 4.82×10^{23} (c) 2.17×10^{25} (d) 2.86×10^{25}

30. A monatomic ion has a charge of +1. The nucleus of the ion has a mass number of 133. The number of neutrons in the nucleus is 1.42 times that of the number of protons. How many electrons are in the ion? (a) 56 (b) 53 (c) 55 (d) 54
31. What is the p^{OH} of a solution of 1.3 x 10^{-4} mol/L of HCl? (a) 14.11 (b) 10.11 (c) 3.89 (d) 13.11
32. What is the standard emf you would obtain from a cell at 25°C using an electrode in which $I^-(aq)$ is in contact with $I_2(s)$ and an electrode in which Cr strip dips into a solution of $Cr^{3+}(aq)$?
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq); E^\theta = +0.54V$
$Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr(s); E^\theta = -0.74V$
(a) 2.28V (b) 0.28V (c) 3.28V (d) 1.28V
33. Which of these can be stopped by a thin sheet of aluminium? I. α-particle, II. β-particle, III. γ-ray. (a) I and II only (b) III only (b) I only (d) II only.
34. What quantity of Cu will be deposited by the same quantity of electricity that deposited 9.0g of Al? [Al = 27; Cu = 64] (a) 64.0g (b) 9.0g (c) 32.0g (d) 27.0g
35. When the equation below is balanced, how many water molecules will be produced?
$\ldots C_6H_5OH + \cdots O_2 \rightarrow \cdots CO_2 + \ldots H_2O$ (a) 3 (b) 4 (c) 2 (d) 1
36. The types of bonds present in $CaCO_3$ molecules are I. covalent bonds II. ionic bonds III. coordinate covalent bonds. (a) III only (b) II only (c) I and II only (d) I only
37. What is the percentage composition of Mg in $Mg_3(PO_4)_2$? (a) 21.92% (b) 23.57% (c) 32.32% (d) 27.48%
38. Calculate the heat of formation of methane given its heat of combustion as $-891\ kJ\ mol^{-1}$ and the heats of formation of carbon dioxide and water are $-394\ kJ\ mol^{-1}$ and $-286\ kJ\ mol^{-1}$ respectively. (a) $+75\ kJ\ mol^{-1}$ (b) $+75\ J\ mol^{-1}$ (c) $-75\ kJ\ mol^{-1}$ (d) $-75\ J\ mol^{-1}$
39. During the electrolysis of a salt of metal X, a current of 1.0A flowing for 16mins 10s deposited 0.329g of X. what is the charge of the metal ion? [X = 65.41]. (a) +3 (b) +6 (c) +1 (d) +2
40. Which of the following can be achieved by the application of distillation techniques? I. Desalination of sea water II. Separation of low-melting metals from other metals III. Separation of a dye into its colour components IV. Obtaining ethanol from palm wine. (a) ii, iii and iv only (b) iii and iv only (c) i, iii and iv (d) i and ii only.

SOLUTION

1. $R.M.M\ of\ NaNO_3$
$= \frac{(23+14+48)g}{mol} = 85g/mol$
$\cap NaNO_3 = \frac{2.5}{85} = 0.0294mol$
$\cap NaNO_3 = \frac{v}{1000} \times molar\ conc$
$V = \frac{\cap_{NaNO_3} \times 1000}{\text{molar conc}} = \frac{0.0294 \times 1000}{0.05}$
$= 588.2353ml$
The correct option is C

2.

Molecules	Hybridization	Shapes	Bond angles
CO_2	Sp	Linear	180^0
NH_3	Sp^3	Trigonal pyramidal	107^0
$BeCl_2$	Sp	Linear	180^0
BF_3	Sp^2	Trigonal planar	120^0

The correct option is D

3. n = 2 and $\ell = 0$, describes 2s – orbital
The correct option is A

4.

Solution of salts	Nature of solution	pH of solution
$NH_4Cl + H_2O \rightarrow NH4OH + HCl$	Acidic	<7
$NaCH_3COO + H_2O \rightarrow CH_3COOH + NaOH$	Basic	>7
$Na_2CO_3 + 2H_2O \rightarrow 2NaOH + H_2CO_3$	Basic	>7
$NaHCO_3 + H_2O \rightarrow NaOH + H_2CO_3$	Basic	>7

The correct option is A

5. The bond between BF_3 and NH_3 is dative or coordinate bond.
The correct option is A

6. $\cap_T = 0.3 + 0.2 + 0.4 = 0.9mol$
$P_T = 3.6atm$
$P_H = X_H P_T$
$= \frac{0.4}{0.9} \times 3.6 = 1.6atm$
The correct option is A

7. Let the $R.A.M\ of\ M = x$
$R.M.M\ of\ MCl_3 = x + 3(35.5)$
$= (x + 106.5)g/mol$
$\%\ of\ Cl = \frac{R.A.M\ of\ Cl}{R.m.m.of\ MCl_3} \times \frac{100}{1}$
$62.7 = \frac{3 \times 35.5}{x + 106.5} \times 100$
$67.2(x + 106.5) = 10650$
$67.2x + 7156.8 = 10650$
$67.2x = 10650 - 7156.8$

$67.2x = 3493.2$

$x = \frac{3493.2}{67.2} = 51.9821$

$x = 52$

The correct option is C

8. $CO + H_2O \rightarrow CO_2 + H_2$

$\Delta H = \Sigma Hp - \Sigma H_R$

$\Sigma H_R = -111 - 242 = -353$

$\Sigma H_p = -393$

$\Delta H = -393\text{-}(-353)$

$\Delta H = -393+353$

$= -40kJ/mol$

Note that the enthalpy of formation of an element in its pure state is zero.

The correct option is A

9. The compound that contains 6.02×10^{23} atoms of hydrogen (i.e. 1mole of Hydrogen atom),35.5g of chlorine (i.e. 1mole of Chlorine atom) and 4.0moles of oxygen atoms is $HClO_4$.

The correct option is B

10. $2AgNO_3 + Na_2CO_3 \rightarrow Ag_2CO_3 + 2NaNO_3$

$\cap_{AgNO_3} = \frac{60}{1000} \times 0.1 = 0.006mol$

$\cap_{Na_2CO_3} = \frac{50}{1000} \times 0.05 = 0.0025mol$

$\cap_{AgNO_3}$:	$\cap_{Na_2CO_3}$
$\frac{0.006}{2}$	$\frac{0.0025}{1}$
0.003	0.0025

The limiting reagent is Na_2CO_3

The excess reagent is $AgNO_3$

$\cap_{Ag_2CO_3} = 0.0025mol \times 1 = 0.0025mol$

$R.M.M\ of\ Ag_2CO_3$

$= [2(108) + 12 + 48]g/mol$

$= 276g/mol$

$Mass\ of\ Ag_2CO_3$

$= 276g/mol \times 0.0025mol$

$= 0.69mol$

The correct option is B

11. $CaCl_{2(aq)} + Na_2CO_{3(aq)} \rightarrow CaCO_{3(s)} + 2NaCl_{(aq)}$

Ionize all aqueous species.

$[Ca^{2+} + 2Cl^-] + [2Na^+ + CO_3^{2-}]$

$\rightarrow CaCO_{3(s)} + 2Na^+ + 2Cl$

Remove species that appear on both sides of the equation.

$Ca^{2+} + CO_3^{2-} \rightarrow CaCO_{3(s)}$

The correct option is A

12.

Molecules	Bonding
PCl_5	Covalent
LiCl	Ionic(strongest)
HF	Hydrogen bonding
NH_3	Hydrogen bonding

The stronger the hydrogen bonding that exist within a molecule the higher the boiling point. The strongest Hydrogen bond is found in HF. Note that ionic bond is stronger than hydrogen bonding

The correct option is B

13. $\cap_{O_2} = \frac{6.4}{32} = 0.2mol$

$\cap_{Cl_2} = \frac{4.8}{71} = 0.0676mol$

$\cap_{Kr} = \frac{14.9}{83.8} = 0.1778mol$

$\cap_T = 0.2 + 0.0676 + 0.1778 = 0.4454mol$

$P_{Cl_2} = \frac{0.0676}{0.4454} \times 6.92 \times 10^7$

$= 1.05 \times 10^7 N/m^2$

The correct option is A.

14. $P_{O2} = X_{O2}P_T$

$X_{O2} = \frac{P_{O2}}{P_T} = \frac{452}{780} = 0.5795$

The correct option is A

15.

N	L	M_l	M_s
1	0	0	$\pm$ ½
2	1	-1, 0, 1	$\pm$ ½

The correct option is A

16. $R.M.M\ of\ NH_3 = 17g/mol$

$= 17kg/kmol$

$\cap NH_3 = \frac{500kg}{17kg/kmol} = \frac{500}{17}kmol$

$= \frac{500}{17} \times 10^3 mol$

From the equation

$2mole\ of\ NH_3 \ldots\ldots\ldots\ldots\ldots 91.8kJ$

$\frac{500}{17} \times 10^3 mol\ of\ NH_3 \ldots\ldots\ldots xkJ$

$\frac{2}{\frac{500 \times 10^3}{17}} = \frac{91.8}{x}$

$x = \frac{91.8 \times 500 \times 10^3}{2 \times 17} = 1.35 \times 10^6 kJ$

The correct option is D

17. $M = Zit$

$100 = \frac{63.5}{2 \times 96500} \times 2 \times t$

$t = \frac{100 \times 2 \times 96500}{64 \times 2} = 1519685039s$

$= 2532.8mins = 42.2135hrs$

The correct option is B

18. $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

$\Rightarrow x = 5\ and\ y = 4$

The correct option is C

19.

Molecules	Shapes
$BeCl_2$	Linear
H_2O	Angular
NH_3	Trigonal pyramidal
BF_3	Trigonal planar

CH_4	Tetrahedral

The correct option is B

20. Let the hydrated Aluminium Tetraoxosulphate (VI) be $Al_2(SO_4)_3.xH_2O$

R.M.M of $Al_2(SO_4)_3.xH_2O$

$= 2(27) + 3(96) + x(18)$

$= 54 + 288 + 18x$

$= 342 + 18x.$

$$\%\ of\ Al = \frac{R.A.M\ of\ Al}{R.M.M.of\ Al_2(SO_4)_3.xH_2O} \times \frac{100}{1}$$

$$8.2 = \frac{2(27)}{342 + 18x} \times \frac{100}{1}$$

$8.2(342 + 18x) = 5400$

$2804.4 + 147.6x = 5400$

$147.6x = 5400 - 2804.4$

$147.6x = 2595.6$

$$x = \frac{2595.6}{147.6} = 17.5854$$

$x \simeq 18$

The correct option is C

21. Note that the maximum number of electron in a main shell is determines by the principal quantum number but the maximum number of electron in a sub-shell is determine by the subsidiary or Azimuthal quantum number.

The correct option is C

22. $PV = nRT$

$But\ n = \frac{m}{M}$

$Pv = \frac{m}{M}RT$

$P = \left(\frac{m}{v}\right)\frac{RT}{M}$

$\rho = \frac{m}{v}$

$P = \frac{\rho RT}{M}$

$M = \frac{\rho RT}{P}$

$\rho = \frac{1.33g}{L} = 1.33g/dm^3$

$T = 150^0 = 423K$

$P = 764mmHg = 1.0053atm$

$R = 0.0821\ atmdm^3/molK$

$$M = \frac{1.33g/dm^3 \times 0.0821atmdm^3/molK \times 423K}{1.0053atm}$$

$= 45.9451$

$M \simeq 46$

The oxide of nitrogen with a relative molecular mass of 46 is NO_2

The correct option is D

23. Molar conc. $= 5.0 \times 10^{-5}mol/L = 5 \times 10^{-5}mol/dm^3$

$BaSO_{4(s)} \rightleftharpoons Ba^{2+}_{(aq)} + SO_4^{2-}$

$xm \qquad xm \qquad xm$

$Ksp = [Ba^{2+}][SO_4^{2-}]$

$= x.x$

$Ksp = x^2$

$= (5 \times 10^{-5}mol/dm^3)^2$

$= 2.5 \times 10^{-9}mol^2/dm^6$

The correct option is A

24. $R.M.M.of\ HCl = 36.50g$

$$\cap_{HCl} = \frac{0.593}{36.5} = 0.0162mol$$

$$C_{HCl} = \frac{0.0162mol}{0.325dm^3} = 0.0498M$$

$HCl_{(aq)} \rightarrow H^+ + Cl^-$

$0.0498M \quad 0.0498M \quad 0.0498M$

$P^H = -Log_{10}^{0.0498} = 1.3028$

$[H^+] = 0.0498M = 0.05$

$P^H = 1.3028 = 1.30$

The correct option is D

25. $CaCl_2 + 2AgNO_3 \rightarrow Ca(NO_3)_2 + 2AgCl_{(s)}$

$$\cap_{CaCl_2} = \frac{30}{1000} \times 0.15 = 0.0045mol$$

$$\cap_{AgNO_3} = \frac{15}{1000} \times 0.1 = 0.0015mol$$

$\cap_{CaCl_2} : \cap_{AgNO_3}$

$\frac{0.0045}{1} : \frac{0.0015}{2}$

$0.0045 : 0.0008$

The limiting reagent is $AgNO_3$

$\cap_{AgCl} = 0.0008 \times 2 = 0.0016mol$

R.M.M of $AgCl = 108 + 35.5 = 143.50g/mol$

$Mass\ of\ AgCl = 143.5 \times 0.0016$

$= 0.2296g$

The correct option is C

26. $T_{1/2} = 14days$

$t = 8\ weeks = 56days$

$n = \frac{t}{T_{1/2}} = \frac{56}{14} = 4$

$NR = No\left(\frac{1}{2}\right)^n$

$No = 100\%$

$NR = 100\left(\frac{1}{2}\right)^4 = \frac{100}{16} = 6.25\%$

The correct option is A

27. $R = K[A][B]^2$

If $[B] = 3[B]$

$R_1 = K[A](3[B])^2$

$= K[A]9[B]^2$

$= 9\ K[A][B]^2$

But $R = K[A][B]^2$

$R_1 = 9R$

Therefore the rate will increase by 9 folds.

The correct option is C

28. $HCl + NaOH \rightarrow NaCl + H_2O$

$$\cap_{HCl} = \frac{25}{1000} \times 0.75 = 0.0188mol$$

$$\cap_{NaOH} = \frac{100}{1000} \times 0.25 = 0.025mol$$

$\cap_{HCl} : \cap_{NaOH}$

$\frac{0.0188}{1} : \frac{0.025}{1}$

$0.0188 : 0.025$

The limiting reagent is HCl
The excess reagent is NaOH
$\cap_{NaOH}$ used up $= 0.0188 \times 1 = 0.0188mol$
Excess $\cap_{NaOH} = 0.025 - 0.0188$
$= 0.0062mol$

Since the excess reagent is $NaOH$, then the resultant solution will be alkaline.
Concentration of excess

$$NaOH = \frac{Excess\ \cap_{NaOH}}{Volume\ of\ solution}$$

$$= \frac{0.0062mol}{25ml + 100ml} = \frac{0.0062mol}{125ml}$$

$$= \frac{0.0062}{0.125} = 0.0496M$$

$$NaOH \rightarrow Na^+ + OH^-$$
$$0.0496M \quad 0.0496M \quad 0.0496M$$

$$P^{OH} = -Log_{10}^{0.0496} = 1.3045$$
$$P^{OH} + P^H = 14$$
$$P^H = 14 - P^{OH}$$
$$P^H = 12.6955$$

The correct option is D

29. $R.M.M\ of\ (NH_4)_2SO_4 = 2(18) + 96 = 132g/mol$

$$\cap_{(NH_4)_2SO_4} = \frac{5.94}{132} = 0.045mol$$

$1mol\ of\ (NH_4)_2SO_4\ contain\ 8moles\ of\ H$
$0.045mol\ of\ (NH_4)_2SO_4 \ldots\ldots xmoles\ of\ H$

$$\frac{1}{0.045} = \frac{8}{x}$$

$$x = 0.045(8) = 0.36mol$$

$$\cap_H = \frac{No\ of\ atoms\ of\ H}{6.0 \times 10^{23}}$$

$$No\ of\ atoms\ of\ H = 0.36 \times 6.02 \times 10^{23}$$
$$= 2.1672 \times 10^{23} atoms$$

The correct option is A

30. For the ion to be +1. It means that it has loss two of its electrons. Since the mass number is 133.

$$A = NN + NP$$

Where $A = mass\ number$
$NN = neutron\ number$
$NP = number\ of\ proton$

Since the number of neutrons in the nucleus is 1.42times that of protons.

$$\Rightarrow NN = 1.42NP$$
$$133 = 1.42NP + NP$$
$$133 = 2.42NP$$

$$NP = \frac{133}{2.42} = 54.9587$$

$$NP \simeq 55$$

Since the ion is +1, it means that the number of proton in the ion exceed the number of electron by 1
Number of Electron
$(NE) = 55 - 1$
$= 54$

The correct option is D

31. $HCl \rightarrow H^+ + Cl^-$
$1.3 \times 10^{-4}M \quad 1.3 \times 10^{4}M \quad 1.3 \times 10^{-4}M$

$$P^H = -Log_{10}^{1.3 \times 10^{-4}}$$
$$= 3.8861$$
$$P^H + P^{OH} = 14$$
$$P^{OH} = 14 - P^H$$
$$= 14 - 3.8861$$
$$P^{OH} = 10.1139$$

The correct option is B

32. $Emf = E_{oxidant} - E_{reductant}$
For oxidant $E^\theta = +ve$ while for reductant $E^\theta = -ve$

$$emf = 0.54 - (-0.74)$$
$$= 0.54 + 0.74$$
$$= 1.28V$$

The correct option is D

33. Alpha can be stop by paper and Beta particles are stop by thin sheet of Aluminium. Hence a thin sheet of Aluminium will stop both alpha and beta particles

The correct option is A

34.

$$\frac{M_{Cu}}{M_{Al}} = \frac{R.M.M\ of\ Cu \times charge\ of\ Al}{R.M.M.of\ Al \times charge\ of\ Cu}$$

$$\frac{M_{Cu}}{9} = \frac{64 \times 3}{27 \times 2}$$

$$M_{Cu} = \frac{9 \times 64 \times 3}{27 \times 2} = 32g$$

The correct option is C

35. $C_6H_5OH + \cdots 4O_2 \rightarrow 3CO_2 + 3H_2O$

The correct option is A

36. The bond present in $CaCO_3$ is ionic and covalent.

The correct option is C

37. $R.M.M.of\ Mg_3(PO_4)_2$
$= 3(24) + 2[31 + 64]$
$= 72 + 190$
$= 262glmol$

$$\%\ of\ Mg = \frac{R.A.M\ of\ Mg}{R.m.m.of\ Mg_3(PO_4)_2} \times \frac{100}{1}$$

$$= \frac{3 \times 24}{262} \times \frac{100}{1}$$
$$= 27.4809\%$$

The correct option is D

38. $CH_4 + 2CO_2 \rightarrow CO_2 + 2H_2O$
$\Delta H = -891kJ/mol$
$C + O_2 \rightarrow CO_2 \quad \Delta H = -394kJ/mol$
$H_2 + \frac{1}{2}O_2 \rightarrow H_2O \quad \Delta H = (-286kJ/mol$

Reverse reaction1, multiply reaction 3 by 2. Then add up the three reactions. Note that when a reaction is reversed the sign of ΔH is also reverse. If a reaction is multiply by a factor, ΔH must also be multiply by that factor.

$2H_2O + 2CO_2 \rightarrow CH_4 + 2O_2 \quad \Delta H = 891kJ/mol$

$C + O_2 \rightarrow CO_2 \quad \Delta H = -394kJ/mol$

$2H_2 + O_2 \rightarrow 2H_2O \quad \Delta H = 2(-286)kJ/mol$

$C + 2H_2 \rightarrow CH_4 \quad \Delta H = -75kJ/mol$

The correct option is C

39. $t = 16mms, 10s = 970S,\ I = 1.0A,$
$M = 0.329g,\ M = ZIt$

$$0.329 = \frac{65.41}{x \times 96500} \times 1 \times 970$$

$$x = \frac{65.41 \times 970}{0.329 \times 96500} = 1.9984$$

$x \simeq 2$

The correct option is D

40. Distillation is applicable in
(i)Desalination of sea water
(ii)Obtaining ethanol from palm wine
(iii)Separation of low-melting metals from other metals.
NB: Metals that have low boiling points, such as mercury, magnesium and zinc can be separate from other metals by fractional distillation. One well-known method of fractional distillation is the MOND PROCESS for the purification of nickel.

None of the options is correct

2008/2009 CHEMISTRY 001 EXAMINATION

1. 0.54g of a metal, M (relative atomic mass 27) completely reacted with dilute tetraoxosulphate VI acid to liberate 672cm^3 of hydrogen gas at s.t.p. Use these results to deduce the stoichiometry of the reaction between M and tetraoxosulphate VI acid. (a) 1:3 (b) 3:1 (c) 2:3 (d) 3:2
2. An organic compound A has molecular formula $C_5H_{12}O$. To what family or families of compound can A belong? I. Alkoxy-alkane II. Alkanone III. Alkanal IV. Alkanol (a) I & III only (b) II & III only (c) I & II only (d) I & IV only
3. The partial pressure of oxygen gas in a sample of air is 452mmHg and the total pressure is 780 mmHg. What is the mole fraction of oxygen? (a) 0.203 (b) 2.030 (c) 5.790 (d) 0.579
4. Decide on the fate of the reactions with the following sets of conditions: use sp for spontaneous; nsp for non-spontaneous; -eq for equilibrium. I. ΔH negative and less than $T\Delta S$ II. ΔH negative and greater than $T\Delta S$ III. ΔH positive and equal to $T\Delta S$ IV. ΔH negative and equal to $T\Delta S$. The respective fate for I, II, III & IV are (a) sp, sp, nsp, eq (b) sp, nsp, eq, eq (c) eq, eq, sp, sp (d) sp, nsp, eq, eq
5. Which alkanol(s) can be dehydrated to 3-methylbut-2-ene? I. 3-methylbutan-2-ol II. 2-methylbutan-1-o1 III. 2-methylbutan-2-o1 IV. 3-methylbutan-1-o1 (a) I & II only (b) II & III only (c) I & III only (d) I & IV only
6. Which of the following is/are true of an electrolytic cell? I. Non-metals ions lower in ecs are preferentially discharged to those above them II. the cathode is positively charged III. reduction takes place at the cathode IV. metal ions lower in the ecs are preferentially discharged to those above them. (a) I & III only (b) II & IV (c) III & IV only (d) I & IV
7. $150cm^3$ of $0.120MH_2SO_4$ solution is mixed with $200cm^3$ of 0.100 M NaOH solution. What is the P^{OH} of the resulting solution obtained? (a) 12.20 (b) 12.46 (c) 12.30 (d) 12.15
8. Which of the following will react with ammoniacal silver oxide? I. but-2-yne II. butanal III. butanone IV. but-1-yne. (a) I & III only (b) I & II only (c) II & IV only (d) III & IV only
9. The structural component that makes soapless detergents dissolve more quickly in water than soap is (a)$-COO^-Na^+$ (b)$-COO^-K^+$ (c)$-SO_3^-Na^+$ (d) $-SO^-_4Na^+$
10. 2ampere of current was passed through sufficient quality of dilute tetraoxosulphate (vi) acid for one hour. Determine the volume (cm^3) at s.t.p., of the gas evolved at the anode. [molar volume of gas at s.t.p. = 22.4dm^3]. (a) 522.3 (b) 208.9 (c) 313.4 (d) 417.8
11. Arrange in order, the conversion of propan-1-o1 to propan-2-o1 involves (a) Hydrolysis, Dehydration and Hydrohalogenation (b) Hydrohalogenation, Hydrolysis and Dehydration (c) Dehydration, Hydrolysis and Hydrohalogenation (d) Dehydration, Hydrohalogenation and Hydrolysis.
12. I. Preparation of medically active compounds II. Determination of the ages of ancient tools III. Cure of cancer. Which of the above is/are uses of radioactive isotopes (a) I & III only (b) I, II & III (c) I & II only (d) II & III only
13. Calculate the volume in cm^3 of 1.4moldm^{-3} solution of hydrochloric acid that will react with 3.35g of 1-aminobutane. (a) 28.7 (b) 32.8 (c) 38.2 (d) 34.2
14. I. α-particle II. β-particle III. γ-ray. Which of these cannot be stopped by a thin sheet of aluminum (a) III only (b) I only (c) II only (d) I & II only
15. Consider the following titrations for which either indicator A (pH change 3-5) or indicator B(pH change 8-10) is suitable. I. NH_4OH with HCl II. $NaOH$ with CH_3COOH III. NH_4OH against HCl. Decide whether the wrong tires will respectively be greater than or less than

expected if the wrong indicator is used. (a) >, <, < (b) <, <, > (c) <, >, < (d) >, >, <

16. If the complete combustion of 1 mole of an alkanol is represented by the equation $C_nH_{2n+1}OH + xO_2 \rightarrow yCO_2 + zH_2O$, then which of the following is/are correct. I. $x = \frac{3n}{2}$, II. $y = n$ III. $x + y = \frac{5n}{2}$ IV. $y + z = 2n + 2$ (a) III only (b) III & IV only (c) I, II and III only (d) I & III only

17. $2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$. The above equation can be described as: I. redox reaction II. ionic reaction III. oxidation reaction IV. reduction reaction (a) II only (b) I,II & III only (c) II & III only (d) III & IV only

18. Which of the following is/are true about ammonium chloride? I. It evolves ammonia when warned with alkalis II. Its aqueous solution is neutral to litmus III. It is sparingly soluble in water IV. It undergoes thermal decomposition (a) I & IV (b) II & III (c) III & IV (d) II & IV

19. Consider the following reactions already in equilibrium: $A_{(s)} + 3B_{(g)} \leftrightharpoons 3C_{(s)} + D_{(g)}$; ΔH + ve which of the following factors: I. Increase in temperature II. Increase in pressure III. Addition of a positive catalyst, will increase the rate of forward reaction. (a) II & III (b) I only (c) I, II & III (d) III only

20. Arrange the following compounds in order of their decreasing R_f values. I. $Ph.CH_2.CH(OH).Ph$ II. $Ph.CH_2.CH_2.Ph$ III. $Ph.CO.CH_2.Ph$ IV. $Ph.CH(OH).CH(OH)Ph$ (a) II, III, I, IV (b) III, I, IV, II (c) I, II, III, IV (d) IV, II, III, I

21. $25cm^3$ portions of solution of sodium trioxocarbonate (IV) were titrated with $0.12\,moldm^{-3}$ solution of hydrochloric acid using phenolphthalein as indicator. The average titre was $15.40cm^3$. Determine the molarity of the trioxocarbonate (IV) solution. (a) 0.0739 (b) 0.0744 (c) 0.0732 (d) 0.0854

22. An alkanol upon dehydration yielded 2-methylbtu-2-ene. The alkanol may be I. pentan-2-o1 II. 2-methylbutan-2-o1 III. 3-methylbutan-2-o1 (a) I & II only (b) I & III only (c) II & III only (d) I, II & III

23. Which of the following properties of iodine are jointly used in making the spots of colourless compounds visible on plates? I. It is coloured II. It readily sublimes III. It has empty d-orbitals IV. It is a halogen (a) I & II only (b) I, II, III only (c) II & III only (d) II, III & IV only

24. 0.46g of ethanol when burned raised the temperature of 50g of water by 14.3K. Calculate the heat of combustion of ethanol in $KJmol^{-1}$. [H = 1, C = 12, O = 16; specific heat capacity of water = $4.2Jg^{-1}K^{-1}$] (a) $-300.3KJmol^{-1}$ (b) $+300KJmol^{-1}$ (c) $-3000KJmol^{-1}$ (d) $+3000KJmol^{-1}$

25. In an attempt to complete and balance the equation: $CrO_2^- + ClO^- \rightarrow CrO_4^{2-} + Cl^-$ in alkaline medium, the following was obtained, $yCrO_2^- + zClO^- + yOH^- \rightarrow yCrO_4^{2-} + zCl^- + xOH^- + sH_2O$ Determine the values of x, y, z and s respectively. (a) 0, 2, 3 & 1 (b) 2,3,1 & 0 (c) 1,2,3 & 0 (d) 3,2,0 & 1

26. $60cm^3$ of a $0.1\,mol\,dm^{-3}$ solution of silver trioxonitrate (V) and $50cm^3$ of a $0.05\,moldm^{-3}$ solution of sodium trioxocarbonate(IV) are mixed. Assuming the insoluble component is completely insoluble, determine the maximum mass of precipitate obtained. [Na = 23, Ag = 108, C = 12, O = 16, N = 14] (a) 0.690g (b) 0.710g (c) 0.690g (d) 1.38g

27. Equal moles of an alkene and an alkanol, each containing 'n' carbon atoms per molecule, were separately made to undergo complete combustion. The volumes of steam produced were in the ratio 2:3 respectively. What are the respective molecular formulas of the compounds? (a) C_2H_4, C_2H_5OH (b) C_4H_8, C_4H_9OH (c) C_3H_6, C_3H_7OH (d) $C_5H_{10}, C_5H_{11}OH$

28. Below is a list of aqueous solution of some common normal salts: I. NH_4Cl II. Na_2SO_4 III. H_3COONa IV. Na_2CO_3 V. $FeCl_3$ VI. KCl. Which of these aqueous solutions could turn blue litmus red? (a) I & V (b) II & VI (c) III & IV (d) none

29. Alkanals and/or alkanones react with following reagents: I. HCN II. Tollen's reagent III. $LiAlH_4$/Dry Ether IV. 2, 4-Dinitrophenylhydrazine IV. Fehling' solution V. I_2/NaOH, 70°C. Which of these reactions is/are common to both alkanals and alkanones? (a) II & V only (b) I & IV only (c) II, III, IV & V (d) I, III & IV

30. Given that: $M^{2+}_{(aq)} + 2e^- \rightarrow M_{(g)}$, $E^o = -0.76V$; $Y^{3+}_{(aq)} + 3e^- \rightarrow Y_{(s)}$, $E^o = +1.50V$. Calculate the standard cell potential of the cell; $M_{(s)}/M^{2+}(aq) \parallel Y^{3+}{}_{(aq)}/Y_{(s)}$ (a) +0.80V (b) -0.80V (c) -2.26V (d) +2.26V

31. I. Positively charged II. Negatively charged III. oxidation takes place there IV. Reduction takes place there. Which of these statements is/are all true of the anode of an electrochemical cell? (a) I & III (b) II & III (c) I & IV (d) II & IV

32. A mixture of sodium chloride and ammonium chloride, placed on a watch-glass covered with inverted funnel and the set-up warned on a water bath resulted in the separation of the components of the mixture. The chemical principle involved is: (a) Sublimation (b) decomposition (c) thermal dissociation (d) thermal decomposition

33. A neutral atom of an element has 2 electrons with n = 1; 8 electrons with n = 2; 8 electrons with n = 3; 1 electron with n = 4. Which of the followings can be deduced from these information? I. the number of neutrons in the nucleus II. the atomic mass III. the number of p-electrons IV. the number of d-electrons V. the atomic number (a) III, IV & V only (b) I & II only (c) I, III & V only (d) IV & V only

34. Which of the following of chemical substances are given below: I. sour taste II. slippery to touch III. yields alkaline gas with ammonium salts IV. has pH less than 7 (v) turns phenolphthalein yellow. Which of these are typical of alkalis? (a) II, IV & V only (b) I, IV & V only (c) II & III only (d) (iv) & (v) only

35. Which of the following equations can be regarded as double decomposition reaction? I. $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$ II. $BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$ III. $NaCl_{(s)} + H_2SO_{4(l)} \rightarrow NaHSO_{4(s)} + HCl_{(g)}$ (a) I & II only (b) I, II & III only (c) I & III only (d) II & III only

36. The solubility product of lead (II) bromide is $9.0 \times 10^{-6}\ mol^3dm^{-9}$ at 25°C. What is the solubility of this salt in mol dm^{-3} at 25°C? (a) 1.31×10^{-2} (b) 1.33×10^{-2} (c) 1.34×10^{-2} (d) 1.35×10^{-2}

37. The reaction scheme below shows the conversion of carboxylic acid derivative to four other compounds:

$$E+F \xleftarrow[\text{Reflux}]{KOH_{(aq)}} CH_3CH_2OCOCH_2CH_3 \xrightarrow[\text{Reflux}]{H_2O/H^+} G + H.$$

E, F, G, H are respectively. (a) CH_3CH_2OH, CH_3CH_2COOH, CH_3CH_2OH and CH_3CH_2COOK (b) CH_3CH_2OH, CH_3CH_2COOK, CH_3CH_2OH and CH_3CH_2COOH (c) CH_3CH_2COOK, CH_3CH_2OH, CH_3CH_2COOH and CH_3CH_2OH (d) $CH_3CH_2CH_2OH$, CH_3COOH, $CH_3CH_2CH_2OH$ and CH_3COOK

38. Concentrated tetraoxosulphate (VI) acid is 98% pure. If its density is 1.80g per cm^3, what is its concentration in mol/dm^{-3}? (a) 18.0 (b) 18.2 (c) 18.4 (d) 18.6

39. Consider the following nuclides: $^{12}A_6$, $^{14}B_7$, $^{14}C_6$, & $^{15}E_8$ I. A & C are isotopic II. B & C are isotonic III. C & E are isobaric IV. D is a noble gas. Which of these I – IV is/are correct? (a) I, II, & IV (b) I & IV only (c) I, II & III only (d) III & IV only

40. A given quantity of electricity was passed through each of two cells in series. The cells contain Cu^{++} and Al^{3+} ions respectively. It was found that 3.2g of Cu had been deposited in one cell. How much aluminium was deposited in the other cell? (a) 0.90g (b) 1.35g (c) 0.96g (d) 1.46g

41. Which of the following has/have sp^3 hybridization of the central atom? I. $BeCl_2$ II. BF_3 III. CH_4 IV. CO_2 V. NH_3 VI. H_2O (a) I, II & VI (b) II, III & V (c) III, V & VI (d) IV, V & VI

42. Which of the following can undergo hydrolysis under appropriate conditions I. glucose II. starch III. ethanoic acid IV. ethanoyl chloride V. amino ethanoic acid VI. chloroethane (a) I, II & III only (b) II, IV & VI only (c) IV, V& VI only (d) II, III & VI only

43. Which of the following descriptions is/are all applicable to BF_3 molecule? I. trigonal pyramidal II. trigonal planar III. Lewis acid IV. Lewis base V. sp^2 hybridization VI. sp^3 hybridization VII. a nucleophile VIII. an electrophile (a) I, III, V & VII (b) II, IV, VI & VII (c) II, III, V & VIII (d) I, IV, VI & VIII

44. Consider the reaction already equilibrium: $2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$. Which of the following will displace the equilibrium to the direction of the product? I. increase in pressure II. decrease in pressure III. decrease in volume IV. addition of a catalyst (a) I & II (b) III & IV (c) I & III (d) IV & V

45. Which of the following are possible products of a dry distillation of a mixture of calcium butanoate and calcium propanoate I. hexan-3-one II. propanone III. heptan-4-one IV. pentan-2-one V. pentan-3-one (a) I, III & V (b) I, II & III (c) II, III & V (d) III, IV & V

46. For the reaction: 2A + B ⟶ C + (d) The following observations are made. I. doubling the concentration of A doubles the rate II. doubling the concentration of B doubles the rate. Determines the rate law for the reaction. (a) rate = k[A] (b) rate =$k[A]^2[B]$ (c) rate = $k[A^2][B]^2$ (d) rate = k[A][B]

SOLUTION

1. $\cap_M = \dfrac{Reaction\ Mass}{Molar\ Mass} = \dfrac{0.54g}{27glmol}$

$= 0.02mol$

$\cap_{H_2} = \dfrac{Volume\ at\ s.t.p}{22.4dm^3/mol}$

$$= \frac{672cm^3}{22400cm^3/mol} = 0.03mol$$

Since M completely reacts with the dilute H_2SO_4 then M is the limiting reagent. It means that the amount of H_2 gas liberated from H_2SO_4 is determined by M. One mole of H_2SO_4 will liberated one mole of hydrogen gas. Hence the number of mole of H_2 form is equal to the number of mole of H_2SO_4 present.

$$\therefore \cap H_2SO_4 = 0.03mol$$

$$\cap H_2SO_4 : \cap_M$$

$$0.03 : 0.02$$

$$3 : 2$$

Hence the stoichiometry of M to H_2SO_4 is 2:3.

The correct option is C

2. The organic compound, $C_5H_{12}O$ satisfy the general formula, $C_nH_{2n+1}OH$. Hence the compound is an alkanol. But alkanol are functional isomers to alkoxyl alkane (ether). Therefore the organic compound belongs to the alkanol or a alkoxyalkane family.

The correct option is D

3. $P_{O_2} = 452mmHg$

$P_T = 780mmHg$

According to Dalton's law of partial pressure

$P_{O_2} = XP_T$ (where X = mole fraction)

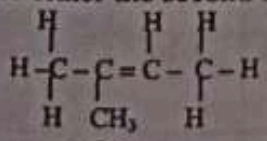
$$X = \frac{P_{02}}{P_T} = \frac{452mmHg}{780mmHg} = 0.5795$$

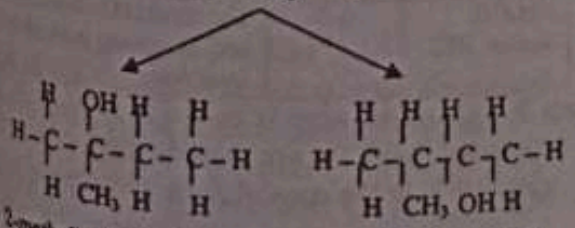
The correct option is D

4. (i) If ΔH is negative and less than TΔS then ΔG = -ve i.e. spontaneous reaction (sp)
   (ii) If ΔH is negative and greater than TΔS the ΔG = +ve i.e. non-spontaneous reaction (nsp)
   (iii) If ΔH is positive and equal to TΔS then ΔG = 0 i.e. the reaction is at equilibrium (eq)
   (iv) if ΔH is negative and equal to TΔS the ΔG = 0 i.e. the reaction is at equilibrium.

The correct ZW`1 option is B

5. Whenever an alkanol is dehydrated to form alkene, the carbon that bear the bond in the alkene indicated where the hydroxyl (-OH) group is attached in the origin alkanol.
   Since the alkene form is 3-methylbut-2-ene it means that to form the alkanol we attached the -OH group to either the second or third carbon atom.





2-methylbutan-2-ol 3-methylbutan-2-ol

Note that 3-methylbut-2-ene is a wrong IUPAC nomenclature. The right nomenclature is 2-methylbut-2-ene.

The correct option is C.

6. Characteristics of electrolytic cell
   i. It converts electrical energy to chemical energy
   ii. Oxidation occurs at the anode
   iii. Reduction occurs at the cathode
   iv. The anode is the positive terminal
   v. The cathode is the negative terminal
   vi. Non-metal that are higher in the electrochemical series are discharge compare to those lower in the series.
   vii. Metal that are lower in the electrochemical series are discharge compare to those higher in the series.

   Note that this is not a strict rule because it is only base on the way the elements are arranged.

The correct option is C.

7. $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

   $150cm^3, 0.12M \quad 200cm^3, 0.1M$

$$\cap_{H_2SO_4} = \left(\frac{150}{1000}\right)dm^3 \times 0.12mol/dm^3 = 0.018mol$$

$$\cap_{NaOH} = \left(\frac{200}{1000}\right)dm^3 \times 0.1mol/dm^3 = 0.02m$$

$$\cap_{H_2SO_4} : \cap_{NaOH}$$

$$\frac{0.018}{1} : \frac{0.02}{2}$$

$$0.018 : 0.01$$

The limiting reagent is NaOH

Since the excess reagent is H_2SO_4, the resultant solution will be acidic. Since the resultant solution is acidic, we calculate P^H from which we obtained P^{OH}.

Excess $\cap_{H_2SO_4} = (0.018 - 0.01)mol = 0.008mol$

Concentration of excess

$$H_2SO_4 = \frac{excess \cap_{H_2SO_4}}{volume\ of\ solution}$$

Volume of solution =

$150cm^3 + 200cm^3 = 350cm^3 = 0.35dm^3$

Concentration of excess

$$H_2SO_4 = \frac{0.008mol}{0.35dm^3} = 0.0229M$$

$H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$

$0.0229 \quad 2(0.0229M$

Concentrating of $H^+ = 2(0.0229M)$

$= 0.0458M$

$$P^H = -Log_{10}^{[H^+]} = -Log_{10}^{0.0458} = 1.3391$$

But $P^H + P^{OH} = 14$

$P^{OH} = 14 - P^{H} = 14 - 1.3391$
$= 12.6609$

The correct option is E meaning none of the option is correct.

8. Note that Ammoniacal silver oxide is also called Tollen's reagents, it reacts with both alkanal and terminal alkyne.

The correct option is C

9. Soapless detergent is a detergent which does not form scum with hard water. Soapless detergent have the general formula of

where $SO_3^-Na^+$ is responsible for its solubility in water.

The correct option is C

10. $I = 2A, t = 1h = 3600s$
$Q = It = 2(3600) = 7200C$
Hence the quantity of electricity pass through the solution is 7200C

Ionization	anode (+)	Cathode (-)
$H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$	SO_4^{2-}	$2H^+$
$H_2O \longrightarrow H^+ + OH^-$	OH^-	H^+

At the anode OH^- is discharge

$$4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$$

1mole of O_2 = 4mole of e^- = 4F
= 4 (96500C)
$x$mole of O_2 = 7200C

$$\frac{1}{x} = \frac{4(96500)}{7200}$$

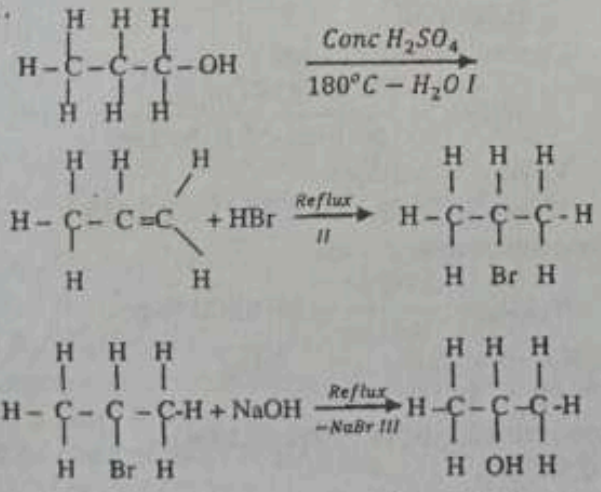
$$x = \frac{7200}{4(96500)} = \frac{7200}{386000} = 0.0187mole$$

$$\cap_{O_2} = \frac{vol\ of\ O_2\ at\ s.t.p}{22.4\ dm^3/mol}$$

$$vol\ of\ O_2\ at\ s.t.p\ (cm^3) = 0.0187mol \times 22400cm^3/mol$$
$$= 417.8238cm^3$$

The correct option is D

11.



I - dehydration
II - Hydrohalogenation
III - Alkaline hydrolysis

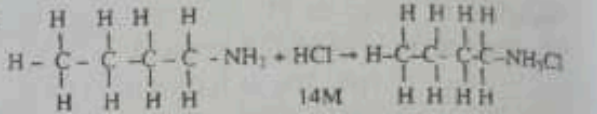
Propan-2-ol

The correct option is D

12. Uses of radioactive isotopes
(i) Gamma radiation from cobalt – 60 is used to destroy cancerous growths
(ii) The radioactive isotope carbon-14 is use in determining the age of rocks.

The correct option is D

13.



1-aminobutane (3.35g)

R.M.M of 1-aminobutane
$= [4(12) + 11(1) + 14]g/mol = 73g/mol$

$$\cap_{C_4H_{11}N} = \frac{3.35g}{73glmol} = 0.0459mol$$

$$\cap_{HCl} = \frac{1mol\ of\ HCl}{1mol\ of\ \cap_{C_4H_{11}N}} \times 0.0459mol\ of\ \cap_{C_4H_{11}N}$$
$$= 0.0459mol\ of\ HCl$$

$$\cap_{HCl} = \frac{V\ in\ cm^3 \times 1.4M}{1000}$$

$$0.0459 = \frac{Vol\ of\ HCl\ in\ cm^3}{1000} \times 1.4M$$

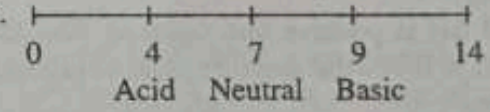
$$Vol\ of\ HCl\ in\ cm^3 = \frac{0.0459 \times 1000}{1.4}$$
$$= 32.7857cm^3$$

The correct option is B

14. (i) α-particle is stop by thin sheet of paper
(ii) β-particle is stop by thin sheet of aluminium
(iii) γ-ray is stop by thick lead block

The correct option is A

15.



(i) P^H change of 8-10 i.e. averagely 9
(ii) P^H change of 3-5 i.e. averagely 4

Step 1: Determine the right indicator to be use in each case.

Titrations	Right indicator P^H	Reason
NH_4OH with HCl	3 – 5	The resultant solution is acidic i.e. strong acid with weak base
NaOH with CH_3COOH	8-10	The resultant solution is basic i.e. strong base with weak base
NH_4OH against HCl	3-5	The resultant solution is acid i.e. strong acid with weak base

Step 2: Determine what is on the conical flask. If the word "with" is use then the first substance mention is in the conical flask while the

second is in the burette. But if the word "against" is used the second substance mention is in the conical flask while the first in the burette.

Titrations	Components in conical flask	Component in burette
NH_4OH with HCl	NH_4OH	HCl
NaOH with CH_3COOH	NaOH	CH_3COOH
NH_4OH against HCl	HCL	NH_4OH
NaOH against CH_3COOH	CH_3COOH	NaOH

Step 3: Calculate the titre value

(i) NH_4OH with HCl: The right indicator average P^H is 4(3-5) NH_4OH is in the conical flask. Since NH_4OH is a base we start our P^H scale from 14 (alkaline region). As the titration progress the P^H of NH_4OH begins to fall until the averagely P^H of 4(3-5) is reached where the right indicator undergoes a colour change.

Volume of titre = starting point − colour change point = 14-4 = $10cm^3$ (assumption is made here). But if the wrong indicator is used the colour change will occurs at average P^H of 9(8-10). Volume of titre = 14-9 = 5cm. Hence the wrong indicator gives a less titre value.

(ii) NaOH with CH_3COOH: The right indicator average P^H is 9 (8-10). NaOH is in the conical flask. Since NaOH is base with start our P^H scale from 14. As the titration progress the P^H of NH_4OH begins to fall until the average P^H of 9(8-10) is reached where the right indicator change colour.

Volume of titre = 14-9 = $5cm^3$.

But if the wrong indicator is used the colour change will occur at an average P^H of 4. Volume of titre = 14-4=$10cm^3$.

Hence the wrong indicator gives a greater value.

(iii)NH_4OH against HCl: The right indicator against P^H is 4(3-5). HCl is in the conical flask. Since HCl is an acid with start our P^H scale from 0. As the titration progress the P^H of HCl begins to rise until the average P^H of 4(3-5) is reached where the right indicator change colour.

Volume of titre = 4-0 = $4cm^3$

But if the wrong indicator is used the colour change will occur at an average P^H of 9(8-10).

Volume of titre = 9-0 = $9cm^3$

Hence the wrong indicator gives a greater value, so we have <, >, >

The correct option is C.

16. The general equation of the contribution of the alkanol is given as

$$C_nH_{2n+1}OH + \frac{3n}{2}O_2 \rightarrow nCO_2 + (n+1)H_2O$$

$$\Rightarrow x = \frac{3n}{2}, y = n \text{ and } z = n+1$$

$$\therefore x + y = \frac{3n}{2} + \frac{n}{1} = \frac{3n+2n}{2} = \frac{5n}{2}$$

$$y + z = n + n + 1 = 2n + 1$$

The correct option is C

17. The equation is an ionic equation because of the presence of ions. The equation is not a redox equation because none of the species undergoes change in oxidation state i.e. there is no oxidation and reduction half reactions.

The correct option is A

18. Properties of NH_4Cl

(i) It undergoes thermal dissociation

$NH_4Cl \rightleftharpoons NH_3 + HCl$ (Δ)

(ii) It liberate ammonia gas when heated with alkali

$NaOH + NH_4Cl \rightarrow NH_3 + NaCl + H_2O$

(iii)It aqueous solution is acidic. Hence it turn blue litm paper red.

(iv)It is extremely soluble in water

The correct option is A

19. $A_{(s)} + 3B_{(g)} \rightleftharpoons 3C_{(s)} + D_{(g)}\ \Delta H = +ve$

The rate of the forward reaction is increase by

(i) Increase in temperature

(ii) Increase in pressure

(iii)The use of a positive catalyst

(iv)The increase of the concentration of A and B or decreasing the concentration of C and D.

The correct option is C

20. R_f is inversely proportion to intermolecular force i.e. the greater the intermolecular force the lesser the R_f.

Ph.CH(OH)CH(OH)Ph<Ph.CH_2CH(OH)Ph < Ph.CO.CH_2.Ph < PhCH_2CH_2Ph

(Increasing R_f value)

The correct option is A

21. In the titration of Na_2CO_3 and HCl the require indicator is methyl orange. Methyl orange is normally use because the end point is acidic.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + \underset{\text{acid}}{H_2CO_3}$$

The use of phenolphthalein implies that the resultant solution or end point is an alkaline. Meaning that the Na_2CO_3 is in excess.

$Na_2CO_3 + HCl \rightarrow NaOH + NaCl + CO_2$ $\quad 25cm^3$ $0.12M, 15.40cm^3$

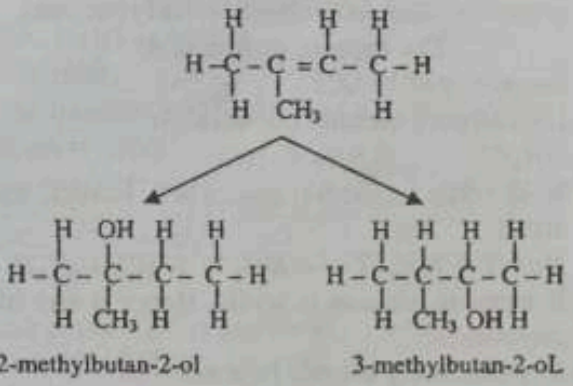
$$\cap_{HCl} = \left(\frac{15.40}{1000}\right)dm^3 \times 0.12 moldm^{-3}$$

$$= 0.001848 mole$$

$$\cap_{Na_2CO_3} = \left(\frac{1\ mole\ of\ Na_2CO_3}{1\ mole\ of\ HCl}\right) dm^3 \times 0.12 mol dm^{-3}$$
$$= 0.001848 mole$$
$$\cap_{Na_2CO_3} = \frac{V\ in\ cm^3}{1000} \times molar\ conc$$
$$molar\ conc = \frac{\cap_{Na_2CO_3} \times 1000}{V\ in\ cm^3}$$
$$= \frac{0.001848 \times 1000}{25}$$
$$= 0.07392M$$

The correct option is A

22. When an alkanol is dehydrate to form alkene the two carbon bearing the double bond indicate the position of the –OH group in the alkanol from which the alkene is form.



2-methylbutan-2-ol 3-methylbutan-2-oL

The correct option is C

23. The properties of iodine use in making the spots of colourless compounds visible on plates are:

i. It is colour
ii. It's readily sublime
iii. It has empty or vacant d-orbitals

The correct option is B

24. R.M.M of CH_3CH_2OH = 46g/mol

$$\cap_{CH_3CH_2OH} = \frac{0.46g}{46g/mol} = 0.01mol$$

Heat liberated by burning ethanol = Heat absorb by water.

$$Q = mc\Delta t$$
$$= 50g \times 4.2J/gk \times 14.3k$$
$$= 3003J$$
$$= 3.003kJ$$

0.01mol of CH_3CH_2OH liberate 3.003kJ of heat

1mol of CH_3CH_2OH liberate xkJ of heat

$$\frac{0.01}{1} = \frac{3.003}{x}$$
$$0.01x = 3.003$$
$$x = \frac{3.003}{0.01} = 300.3kJ$$

The heat or enthalpy of combustion of ethanol is -300.3kJ/mol

The correct option is A

25.

Ox State: +3 +1 +6 -1

Reaction: $CrO_2^- + ClO^- \longrightarrow CrO_4^{2-} + Cl^-$

$CrO_2^- \longrightarrow CrO_4^{2-}$ (oxidation half rxn)

$ClO^- \longrightarrow Cl^-$ (reduction hald rxn)

$4OH^- + CrO_2^- + 2H_2O \longrightarrow CrO_4^{2-} + 4H_2O + 3e^-$

$4OH^- + CrO_2^- \longrightarrow CrO_4^{2-} + 2H_2O + 3e^- \ldots \times 2$

$2e^- + ClO^- + 2H_2O \longrightarrow Cl^- + H_2O + 2OH^- \ldots \times 3$

Cancel similar species and add up the two half reactions

$8OH^- + 2CrO_2^- \longrightarrow 2CrO_4^{2-} + 4H_2O + 6e^-$

$6e^- + 3ClO^- + 6H_2O \longrightarrow 3Cl^- + 6OH^- + 3H_2O$

$2CrO_2^- + 3ClO^- + 2OH^- \longrightarrow 2CrO_4^{2-} + 3Cl^- + H_2O$

$\therefore y = 2, z = 3, x = 0, s = 1$

The correct option is A

26. $2AgNO_3 + Na_2CO_3 \longrightarrow Ag_2CO_3 + 2NaNO_3$

$60cm^3, 0.1M$ $50cm^3, 0.05M$

$$\cap_{AgNO_3} = \frac{60}{1000} \times 0.1 = 0.006mol$$
$$\cap_{Na_2CO_3} = \frac{50}{1000} \times 0.05 = 0.0025mol$$
$$\cap_{AgNO_3} : \cap_{Na_2CO_3}$$
$$\frac{0.006}{2} : \frac{0.0025}{1}$$
$$0.003 : 0.0025$$

The limiting reagent is Na_2CO_3

The excess reagent is $AgNO_3$

$$\cap_{AgNO_3} = \frac{1\ mole\ of\ Ag_2CO_3}{1\ mole\ of\ Na_2CO_3} \times 0.0025mol\ of\ Na_2CO_3$$
$$= 0.0025mol$$

R.M.M. of Ag_2CO_3

$=(2(108) + 12 + 3(16) = 276g/mol$

$$\cap_{AgNO_3} = \frac{mass\ of\ AgNO_3}{Molar\ mass\ of\ AgNO_3}$$
$$mass\ of\ AgNO_3 = 0.0025mol \times 276g/mol$$
$$= 0.69g$$

The correct option is C

27. $C_nH_{2n} + \frac{3n}{2}O_2 \longrightarrow nCO_2 + nH_2O$

$$C_nH_{2n+1}OH + \frac{3n}{2}O_2 \longrightarrow nCO_2 + (n+1)H_2O$$
$$\Rightarrow \frac{n}{n+1} = \frac{2}{3}$$
$$3n = 2(n+1)$$
$$3n = 2n + 2$$
$$3n - 2n = 2$$
$$n = 2$$
$$\Rightarrow C_nH_{2n} = C_2H_4$$
$$\Rightarrow C_nH_{2n+1}OH = C_2H_5OH$$

The correct option is A

28

S/N	Solution	P^H	Action on litmus paper
i.	NH_4Cl	< 7	Turns blue litmus red
ii.	Na_2SO_4	= 7	No action
iii.	NaHCOO	> 7	Turns red litmus blue
iv.	Na_2CO_3	> 7	Turns red litmus blue
v.	$FeCl_3$	< 7	Turns blue litmus red
vi.	KCl	= 7	No action

The correct option is A

29. Alkanals and alkanones react with HCN,$LiAlH_4$/dry ether,2,4-dintophenyl-hydrazine and I_2/NaOH, 70°C. But alkanals also reacts with Tollen's reagent and Fehling's solution.

The correct option is E

30. $E_{cell} = E_{oxidant} - E_{reductant}$
$= 1.50v - (-0.76v)$
$= 1.50v + 0.76v$
$= 2.26v$

The correct option is D

31. The anode of electrochemical cell
(i) is negatively change
(ii) is the site of oxidation reaction

The correct option is B

32. $NH_4Cl \underset{}{\overset{\Delta}{\rightleftharpoons}} NH_3 + HCl$
The above reaction is rightly called thermal dissociation.

The correct option is C

33. Atomic number of the element
= 2+8+8+1=19
Electronic configuration:
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$
From the information supply we can reduced the following
(i) The number of p-electrons = 12
(ii) The number of d-electrons = 0
(iii)The atomic number i.e. 19
(iv)The number of s-electrons = 7
Note that we cannot deduced the atomic mass and the number of neutrons because we need further information.

The correct option is A

34. Properties of alkalis
(i) Slippery to the touch
(ii) Yields alkaline gas with ammonium salts
(iii)Turns phenolphthalein pink
(iv)Turns methyl orange yellow
(v) Turns red litmus solution blue

The correct option is C

35. Double decomposition reaction is also known as **metathesis**. It has the following properties.
(i) The reactants are water soluble
(ii) One of the products is a precipitate (i.e. solids)
(iii)The others products are water soluble.

The correct option is A

36. $PbBr_{2(s)} \rightleftharpoons Pb^{2+} + 2Br^-$
$xm \qquad xm \qquad 2xm$
$K_{sp} = [Pb^{2+}][Br^-]^2$
$= x(4x^2)$
$K_{sp} = 4x^3$
$9.0 \times 10^{-6} = 4x^3$
$x^3 = \dfrac{9.0 \times 10^{-6}}{4} = 2.25 \times 10^{-6}$
$x = \sqrt[3]{2.25 \times 10^{-6}}$
$= 0.0131M = 1.31 \times 10^{-2}M$

The correct option is A

37. CH_3CH_2OH → (KOH, Reflux) → $CH_3CH_2OCOCH_2CH_3$
CH_3CH_2OH → (KOH, Reflux) → CH_3CH_2COOK
CH_3CH_2COOK → (H_2O/H^+, Reflux) → CH_3CH_2COOH + CH_3CH_2OH

$\Rightarrow G \rightarrow CH_3CH_2OH, H \rightarrow CH_3CH_2COOH$
$E \rightarrow CH_3CH_2OH \ \&\ F \rightarrow CH_3CH_2COOK$

Note that the assigning of the compound form to E, F, G & H is arbitrary. Hence option B or C is correct.

The correct option is B and C

38. The concentration of a stock solution is given by $C = \frac{10pd}{M}$
Where p = 98% d = 1.80g/cm^3 M = 98g/mol
$$C = \frac{10 \times 98 \times 1.8}{98} = 18M$$

The correct option is A

39. (i) Isotopes have the same atomic numbers e.g. $^{12}_{6}A$ & $^{14}_{6}C$
(ii) Isotones have the same neutron numbers e.g. $^{14}_{7}B$ & $^{15}_{8}E$
(iii) Isobars have the same mass numbers
e.g $^{14}_{7}B$ & $^{14}C_6$
(iv) $^{20}_{10}D$ is a noble gas

The correct option is B

40. According to faraday second law of electrolysis
$$\frac{M_1}{M_2} = \frac{C_2 \times M_1}{C_1 \times M_2}$$
$$\frac{M_{Al}}{3.2} = \frac{2 \times 27}{3 \times 64}$$
$$M_{Al} = \frac{2 \times 27 \times 3.2}{3 \times 64} = 0.90g$$

The correct option is A

41.

Species	Hybridization of central atoms
$BeCl_2$	Sp
BF_3	Sp^2
CH_4	Sp^3
CO_2	Sp
NH_3	Sp^3

H_2O	Sp'

The correct option is C

42. Starch, ethanoyl chloride and chloroethane undergo hydrolysis under appropriate conditions. Their hydrolysis are shown below:

(i) $(C_6H_{10}O_5)_n + nH_2O \xrightarrow{H^+} n\,C_6H_{12}O_6$
starch

(ii) $CH_3COCl + H_2O \longrightarrow CH_3COOH + HCl$

(iii) $CH_3CH_2Cl + H_2O \xrightarrow[hydrolysis]{} CH_3CH_2OH + HCl$ rxn 1

$HCl + NaOH \xrightarrow[Neutralization]{} NaCl + H_2O$ rxn 2

Add up rxn 1 and rxn 2

$$CH_3CH_2Cl + NaOH \longrightarrow CH_3CH_2OH + NaCl$$

The correct option is B

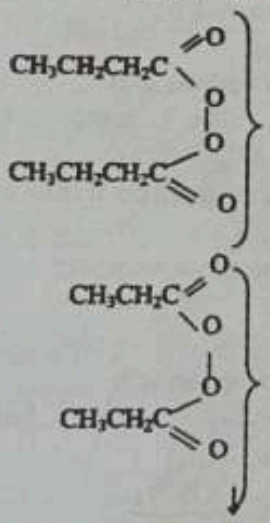
43. BF_3 molecules is
(i) Trigonal planar in shape
(ii) Lewis acid
(iii) Sp^2 hybridized
(iv) Electrophile

The correct option is C

44. The equilibrium position moves in opposite direction to the direction of the reaction according to Le-Chatelier principles. For the equilibrium position to move forward the reaction will move backward. The backward reaction is favour by:
(i) Decrease in the concentration of HI
(ii) Increase in the concentration of H_2& I_2
(iii) Addition of a positive catalyst
N.B: Pressure does not affect the system in this case.

The correct option is E

45.



CH₃CH₂CH₃ C CH₂CH₂CH₃ + (O)
heptan-4-one

CH₃CH₃ C CH₂CH₃ + (O)
Pentan-3-one

CH₃CH₂CH₃ C CH₂CH₃ + (O)
hexan-3-one

Please refer to ONE TIME SUCCESS volume 2 for detail explanation.

The correct option is A

46. $R = K[A]^m[B]^n$

If the concentration of A is double the rate law becomes

$$R_1 = K(2[A])^m[B]^n$$
$$= K(2^m[A]^m)[B]^n$$
$$= 2^m(K[A]^m[B]^n)$$
$$R_1 = 2^m R$$

But $R_1 = 2R$

$$2R = 2^m R$$
$$2 = 2^m$$
$$m = 1$$

If the concentration of B is double the rate law becomes

$$R_2 = K[A]^m(2[B])^n$$
$$= (2^n(K[A]^m)[B]^n)$$
$$= 2^n R$$
$$R_2 = 2^n R$$

But $R_2 = 2R$

$$2R = 2^n R$$
$$2 = 2^n$$
$$n = 1$$
$$\therefore m = 1 \;\&\; n = 1$$

The rate law is

$$R = K[A][B]$$

The correct option is D

2007/2008 CHEMISTRY 001 EXAMINATION

1. $25cm^3$ of a $0.05moldm^{-3}$ solution of Sodium trioxocarbonate (IV) titrated with a solution of hydrochloric acid, using phenolphthalein as indicator, reached equivalence point with $15.5cm^3$ of a solution of hydrochloric acid. The Concentration in $moldm^{-3}$ of the hydrochloric acid solution is (a) 0.12 (b) 0.06 (c) 0.2 (d) 0.08
2. A saturated solution of silver trioxocarbonate (iv) was found to have a concentration of $1.35 \times 10^{-5} mol/dm^{-3}$. The solubility product of the trioxocarbonate (IV) in correct units is (a) 8.79×10^{-5} (b) 1.69×10^{-10} (c) 1.82×10^{-10} (d) 9.84×10^{-15}
3. A mixture of 0.20 mol of argon, 0.20 mole of nitrogen and 0.3 mol of hydrogen exerts a total pressure of 2.1 atmospheres. The partial pressure of Nitrogen in the mixture is (a) 0.40atm (b) 0.90atm (c) 0.60atm (d) 0.50atm.
4. I. Atomic number II. Ionization potential III. Electron affinity IV. Atomic radius V. Metallic character. Which of the above properties decreases along the period but increases down the group? (a) I, II and III only (b) III, IV and V only (c) II and III only (d) IV and V only.
5. The possible values of m for an electron with $\ell = 2$ are: (a) -2, -1,0, +1, +2 (b) 0, 1, 2 (c) −1,0, +1 (d) −2, 0, +2

6. The detailed electronic configuration of copper (I) ion, Cu^+. Cu having atomic number 29, is: (a) $1s^22s^22p^53s^23p^73d^{10}4s^1$ (b) $1s^22s^22p^63s^23p^63d^94s$ (c) $1s^22s^22p^63s^23p^63d^{10}4s^1$ (d) $1s^22s^22p^63s^23p^53d^{10}4s^2$

7. $Fe3O4 + xHCl \rightarrow yFeCl3 + zFeCl2 + x/2H2O$. x, y, z in the given equation are respectively (a) 2, 1 and 1 (b) 4, 2 and 1 (c) 6,3 and 1 (d)8,2 and 1

8. Consider the following reaction that is already in equilibrium.
$A_{(s)} + 3B_{(g)} \rightleftharpoons 2C_{(g)} \rightarrow 2D_{(g)}$, ΔH=–ve
Also consider the following conditions. I. Increase in temperature II. Increase in pressure III. Addition of a positive catalyst. Which of the factors will increase the rate of backward reaction? (a) I and II only (b) II and III only (c) I and III only (d) III only

9. Give the respective combining powers of (Cl), (HCO_3) and (Na). (a) 1, 1, 1 (b) -1, +1, +1 (c) 0,-1, 0 (d) -1, -1, + 1

10. Which of the following pieces of evidence can be used to justify the particulate nature of matter. I. Diffusion of colored solution II. Dilution of colored crystal III. Sublimation IV. Brownian motion. (a) I and II only (b) I and II only (c) I, II and III only (d) III and IV only

11. $25cm^3$ of a gas X contains Z molecules at 288K and 750 mm of Hg. Calculate the number of molecules which $150cm^3$ of another gas Y will contain at 576K. (a) 4z (b)z (c)3z (d)2z

12. 1.0 g of calcium trioxocarbonate (iv) were added to $140cm^3$ of a $0.1mol/dm^3$ solution of hydrochloric acid. The maximum volume (in cm^3) at s.t.p of gas evolved is [Ca = 40; C = 12; O = 16; H = 1;Cl = 35.5] (a) 224.0 (b) 150.5 (c) 179.2 (d) 156.8

13. Which of the following statements is/are true of a proton? I. The mass of a proton is one-twelfth the molar mass of C-12 II. The mass of a proton is 1840 times the mass of an electron III. The mass of a proton is 1 .0008g (a) I, II and III only (b) II and III only (c) II only (d) II and III only

14. Use the given redox potential values (M_1 and M_2 are metals while X_1 and X_2 are non metals) to decide on which of the ions will be respectively discharged when solutions containing the ions are electrolysed.

Couple	E^0
M_1^{2+}/M	-2.71
M_2^{+}/M	+0.80
X_1/X_1^-	+0.54
X_2/X_2^-	+1.36

(a) M_1^+ and X_1^- (b) M_2^+ and X_1^- (c) M_2^+ and X_2^- (d) M_1^{2+} and X_2^-

15. If the pressure and absolute temperature of 3litres of a gas are doubled its volume would be (a) 2litres (b) 6litres (c) 3litres (d) 12litres

16. What will be the equilibrium constant for $A_{(g)} + B_{(g)} \rightleftharpoons AB_{(g)}$, if the constant for $AB_{(g)} \rightleftharpoons A_{(g)} + B_{(g)}$ is 0.1 (a) 10 (b) 0.1 (c) 1 (d) 1.2

17. The pH of a solution obtained by mixing $50cm^3$ of a 0.1M H_2SO_4 solution with $50cm^3$ of a 0.4M NaOH solution is (a) 1.5 (b) 12.5 (c) 10.0 (d) 7.0

18. Which of the following features are associated with H_2O molecules? (I) Linear (II) Bent (III) SP^3 hybridization (IV) Excitation of an electron from 2S to 2P- orbitals (V) Intermolecular hydrogen bonding. (a) I, II, III, IV, V (b) II, III, and V (c) I, III, and V (d) II, III, IV

19. Which of the following statements are true of the cathode of an electrochemical cell? I. Positively charged II. Negatively charged III. Oxidation occurs there IV. Reduction occurs there. (a) I and IV (b) II and IV (c) II and III (d) 1 and II

20. For a reaction $A_{2(g)} + B_{2(g)} \rightarrow 2AB_{(g)}$ formation of AB will be H=xkJ. According to this reaction, heat of formation of AB will be (a) x/2 kJ (b) -xkJ (c) xkJ (d) –xkJ.

21. Given that $E^0_{Zn^{2+}/Zn}$= -0.76v and $E^0_{Ag^+/Ag}$= +0.80v, calculate the standard cell potential of the cell $Zn_{(s)}/Zn^{2+}_{(aq)}//Ag^{(+)}_{(aq)}/Ag_{(s)}$
(a) -0.04V (b) +2.34V (c) +1.56V (d)1.56V

SECTION B (45MINS)

Answer All Questions

1(a) For $BeCl_2$

(i) Is the ground state electronic configuration of the central atom subjected to excitation before bonding? Yes or No.

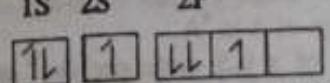
(ii) Give reason(s) for your answer to (i)

(iii)If the orbital used by the central atom are based on your answers to (i) draw these orbital (not in box form)

(iv)Give reason why the orbital drawn in (iii) are not actually used.

(v) Which orbitals are used: indicate their number.

(b) The following is the electronic configuration of an atom.



Some rules/principles are utilized in filling electrons into orbitals. State which of the rules/principles is/are violated in the above

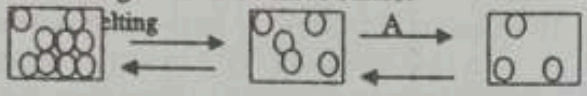
configurations. Indicate the reason for the violation in any of the rules.

(c) If 21.6g of silver is deposited at the cathode of an electrolytic cell containing silver trioxonitrateand using platinum electrodes, calculate the volume, (at s.t.p.) of gas librated at the anode of the cell.

(d) Complete and balance the following equation in alkaline medium

$CrO_2^- + ClO^- \rightarrow CrO_4^{2-} + Cl^-$

2(a) The state of matter are solid, liquid and gas. The diagram below shows how molecules are arranged in these three states.



State the names given to the change of state labeled A, B and C.

(b) A chemical reaction is first order with respect to reactant X and second order with respect to reactant Y

(i) Give an expression for the rate equation (ii) What is the overall order for the reaction(iii) By what factor will the rate increase if the concentration of X and Y are both doubled?

(c) Calculate the free energy change for a reaction at 47°C if ΔH and ΔS values for the reaction are 727 kJ/mol and 0.2 kJ/mol. respectively.

(d) When Ethanoic acid is titrated against Sodium hydroxide

(i) Which of the following indicators would you use? (a)P^Hchange 3-5 (b)P^Hchange 8-10

(ii) Why do you choose the particular indicator?

(iii)Will the titre be more or less than expected if a wrong indicator is used? Do not give any reason.

3(a) the reaction between chlorine and hot concentrated calcium hydroxide solution is represented by the following molecular equation.

$$6Cl_{2_g} + 6Ca(OH)_{2_{aq}} \rightarrow Ca(ClO_3)_{2_{aq}} + 5CaCl_{2_{aq}} + 6H_2O$$

Write the:

(i) ionic equation for the reaction (ii) net ionic equation for the reaction

(b) A solution of trioxonitrate (v) acid which is 70% pure and has density of 1.40g per cm^3 Determine the concentration, in $moldm^{-3}$ of the acid.

(c) An element A contains two isotopes ^4A and ^6A - if the average atomic weight is 4.5. What percentage of A is ^4A

(d) $200cm^3$ of a 0.5 mole per dm^3 solution of calcium hydrogen trioxocarbonate (iv) are warmed. Calculate the maximum weight of precipitate that is formed. [Ca =40; C=12: O =16; H = 1]

SOLUTIONS

The use of phenolphthalein equation indicate that the resultant solution is Alkaline

1. $Na_2CO_3 + HCl \rightarrow NaCl + NaOH + CO_2$

$$\cap_{Na_2CO_3} = \left(\frac{25}{1000}\right)dm^3 \times 0.05 moldm^{-3}$$

$$= 0.00125mol$$

$$\cap_{HCl} = \frac{1\ mole\ of\ HCl}{1\ mole\ of\ Na_2CO_3} \times 0.00125mol\ of\ Na_2CO_3$$

$$= 0.00125mol$$

$$\text{Conc.HCl} = \frac{0.00125mol}{15.5cm^3} = \frac{0.00125mol}{0.0155dm^3}$$

$$= 0.0806moldm^{-3}$$

$$\simeq 0.08moldm^{-3}$$

The correct option is D

2. $Ag_2CO_{3(aq)} \rightleftharpoons 2Ag^+_{(aq)} + CO_3^{2-}{}_{(aq)}$

xM 2xM xM

$K_{sp} = [Ag^+]^2[CO_3^{2-}]$

$(2x)^2(x) = 4x^3$

$K_{sp} = 4x^3$ But $x = 1.35 \times 10^{-5} moldm^{-3}$

$K_{sp} = 4(1.35 \times 10^{-5} moldm^{-3})^3 = 9.84 \times 10^{-15} mol^3dm^{-9}$

The correct option is D

3. Total no of moles ($\cap_T$) =

$= 0.20 + 0.20 + 0.30 = 0.70mol$

$$P_{N_2} = \frac{I\ N_2}{I_1} \times P_T = \frac{0.2}{0.70} \times 2.1atm = 0.600atm$$

The correct option is C.

4. Metallic character, atomic volume, atomic radius and ionic radius decrease across the period and increase down the group.

The correct option is D

5. If $l = 2$, then M = -2, -1, 0, 1, 2

The correct option is A

6. $Cu^+ \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^{10}$

Note that +1 means that one electron has been loss, hence the number of electron remaining is 28.Note that the transition element loss all of their *S*-orbital electrons before losing their d-orbital electrons

The correct option is E meaning none of the option is correct.

7. $Fe_3O_4 + 8HCl \rightarrow 2FeCl_3 + FeCl_2 + 4H_2O$

x = 8, y = 2 and z = 1

The correct option is D

8. Increase in temperature and addition of a positive catalyst will increase the rate of backward reaction

Note that a positive catalyst increases the rate of both the forward and backward reaction

The correct option is C.

9. The combining power of CT^-, HCO_3^- and Na^+ is 1. 1. &1.Note that the one of the major difference between oxidation number and combining power is that while oxidation number carry sign, combining power does not

The correct option is A

10. The evidence of the particulate nature of matter is justified by dilution of coloured solution, diffusion of coloured crystal, sublimation, Brownian motion and Tyndall effect .

The correct option is D.

11. $P_1V_1 = n_1RT_1$ .....(1)
$P_2V_2 = n_2RT_2$ .....(2)

$$\frac{P_1V_1}{P_2V_2} = \frac{n_1T_1}{n_2T_2}$$

$$\frac{V_1}{V_2} = \frac{n_1T_1}{n_2T_2}$$

$$\frac{25}{150} = \frac{z \times 288}{n_2 \times 576}$$

$25 \times n_2 \times 576 = 150 \times Z \times 288$

$$n_2 = \frac{150 \times Z \times 288}{25 \times 576} = 3Z$$

Note that since only one pressure is supplied, then,.it is assume constant

The correct option is C.

12. R.M.M. of $CaCO_3 = 100g/mol$

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

$$\cap_{CaCO_3} = \frac{\text{Reacting mass}}{\text{Molar mass}} = \frac{1.0g}{100g/mol}$$

$$= 0.01mol$$

$$\cap_{HCl} = \left(\frac{140}{1000}\right)dm^3 \times 0.1 moldm^{-3} = 0.014mol$$

$\cap CaCO_3$	:	$\cap_{HCl}$
$\frac{0.010}{1}$	:	$\frac{0.014}{2}$
0.010	:	0.007

Note that the 1 and 2 used for the division are the co-efficient of the reactant in the balance equation.

HCl is the limiting reagent

$\cap_{CaCO_3}$ is the excess reagent

$$\cap_{HCl} = \frac{1 \text{ mole of } Co_2}{2 \text{ mole of } HCl} \times 0.014mol \text{ of } HCl$$

$$= 0.007mol$$

$$\cap CO_2 = \frac{\text{vol at s.t.p}}{22.4dm^3}$$

$0.007mol \times 22400cm^3/mol = \text{vol at s.t.p}$

Vol of CO_2 at s.t.p = $156.80cm^3$

The correct option is D

13. The properties of the proton are:
- It has a relative charge of +1
- It has an absolute charge of $+6.02 \times 10^{-19}C$
- It has a relative mass of 1(in atomic mass unit)
- It has an absolute mass of $1.67 \times 10^{-27}kg$
- It mass is 1840 the mass of an electron

The correct option is C.

14. The more reducing a substance is, the greater the tendency of the substance to exist as an ion in solution while the more oxidizing a substance is, the greater the tendency to come out of solution. From the E^θ value supply, $M_2^+/M_2, X_1/X_1^-$ *and* X_2/X_2^- are oxidant with X_2/X_2^- the greatest but X_1/X_1^- the least. While M_1^{2+}/M_1, is a reductant. Between the metals M_2^+/M_2, will be discharge while between the non-metals X_2/X_2^- will be discharge (i.e. M_2^+ *and* X_2^-)

The correct option is C

15. $P_1 = P, T_1 = T, V_1 = 3L$
$P_2 = 2P, T_2 = 2T, V_2 = 2$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{P_1V_1T_2}{P_2T_1} = V_2$$

$$V_2 = \frac{P \times 3L \times 2T}{2P \times T} = 3L$$

The correct option is C.

16. $AB_{(g)} \rightleftharpoons A_{(g)} + B_{(g)}$ $K_1 = 0.1$
$A_{(g)} + B_{(g)} \rightleftharpoons AB_{(g)} K_2 = 1/k_1$
$K_2 = 1/k_1 = 1/0.1 = 10$

Note that when a chemical equation is reverse, the new equilibrium constant is the inverse of the first.

The correct option is A.

17. $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

$$\cap_{NaOH} = \left(\frac{50}{1000}\right)dm^3 \times 0.4 \text{ moldm}^3$$

$= 0.02mol$

$$\cap H_2SO_4 = \left(\frac{50}{1000}\right)dm^3 \times 0.1 moldm^3$$

$= 0.005mol$

$\cap NaOH$:		$\cap H_2SO_4$
$\frac{0.02}{2}$	:	$\frac{0.005}{1}$
0.01	:	0.005

The limiting reagent is H_2SO_4

The excess reagent is NaOH

Mole of NaOH used up =

$$\frac{2 \text{ mole of NaOH}}{1 \text{ mole of } H_2SO_4} \times 0.005mol = 0.01mol$$

$$\text{Moles of } NaOH = 0.02mol - 0.01mol$$

$$= 0.01mol.$$

Concentration of NaOH $= \frac{0.01mol}{100cm^3}$

$= \frac{0.01mol}{0.1dm^3} = 0.1M$

$NaOH \rightarrow Na^+ + OH^-$

0.1M 0.1M 0.1M

$P^{OH} = -\text{Log}_{10}[OH^-] = -\text{Log}_{10}{}^{0.1} = 1.0$

But $P^H + P^{OH} = 14$

$P^H = 14 - P^{OH}$

$P^H = 14 - 1.0 = 13$

The correct option is E meaning that none of the option is correct.

18. The of water molecules is bent, angular or V-shape, SP^3-hybridized and its intermolecular force is hydrogen bonding.

The correct option is B.

19. The cathode of an electrochemical cell is the positive terminal and the site where reduction half reaction occur.

The correct option is A.

20. $A_{2(g)} + B_{2(g)} \rightarrow 2AB_{(g)} \Delta H = xkJ$
2mole of AB is formed by xkJ. Therefore 1mole of AB will be formed by x/2kJ.

The correct option is A

21. E.m.f of cell= E^0 oxidant – E^0reductant
$= 0.80v - (-0.76v) = 0.80v + 0.760$
$= 1.56v$
Note that the Oxidant have E^0 = +ve while reductant have E^0 = –ve

The correct option is C.

SECTION B

1a. (i) Yes

(ii) $_4Be \rightarrow 1s^2\ 2s^2$

1s 2s

$_4Be \rightarrow$ [↿⇂] [↿⇂] Ground state

Since there is no vacant orbital to accommodate the incoming electron from the two chlorine atoms. An electron is promoted from the 2s-orbital to 2p-orbital in order to accommodate the two electrons

1s 2s 2p

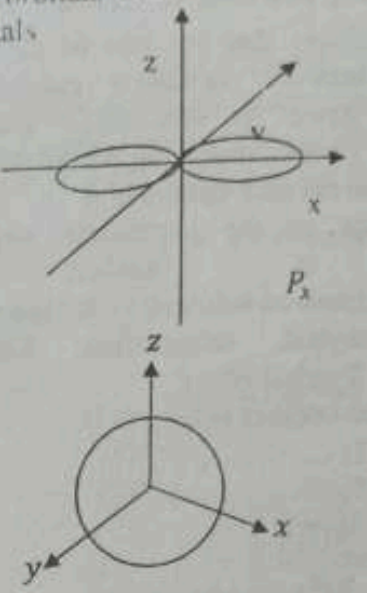
$_4Be \rightarrow$ [↿⇂] [↿] [↿] [ ] [ ] Excited state

The two electrons from the chlorine atoms are then accommodated by the two incomplete orbital (2s and $2p_x$)

[↿⇂] [↿x] [↿x] [ ] [ ]

Where X denote the two electron coming from chlorine atom

(v) The orbitals that are use are the s- and p_x-orbitals



S-orbital in x, y, z Cartesian co-ordinates

(v) The $2p_y$ and the $2p_z$ orbitals are not used.

This is because the valence of Be is 2,hence a single promotion of electron is carried out (i.e one electron is promoted from the 2s-orbital to the 2p-orbital).

(iii) The s- and –p orbitals(i.e 2s and $2p_x$).Two orbitals are used

1b.

1s 2s 2p

[↿⇂] [↿] [↿] [↿] [ ]

(i) **Aufbau principle** state that electrons must be filled into orbital with a lower energy (i.e 2S) before filling orbitals with a high energy(e.g.2p).

(ii) **Pauli's exclusion principle** states that no two electrons in an atom can have the same of all four quantum number. Therefore the spin of one electron must be up while the other down in an orbital. This principle limit the number of electrons an orbital can contain to 2

(iii) **Hund's rule of maximum multiplicity** state that for an orbital with more than one degeneracy, electron must be filled into each degenerate orbital singly before electron pairing occurs.

2p 2p

i.e. [↿] [↿] [↿] but not [↿⇂] [↿] [ ]

1c.

Ionization	Anode (+)	Cathode (-)
$AgNO_3 \rightarrow Ag^+ + NO_3^-$	NO_3^-	Ag^+
$H_2O \rightarrow H^+ + OH^-$	OH^-	H^+

At the anode OH^- is discharge to liberate Oxygen gas.

$$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$$

At the cathode Ag^+ is discharge to be deposited as silver metal at the cathode.

$$4e^- + 4Ag^+ \rightarrow 4Ag_{(s)}$$

$$4Ag^+ + 4OH^- \rightarrow 4Ag^+ + 2H_2O + O_2$$

R.M.M. of Ag = 108g/mol

No of mole of Ag^+ = $\frac{\text{Reacting mass}}{\text{Molar mass}} = \frac{21.6g}{108g/mol} = 0.2mol$

$$\cap_{O_2} = \frac{1mole\ of\ O2 \times 0.2mol\ of\ Ag^+}{4\ mole\ of\ Ag^+} = 0.05mol$$

$$\cap_{O_2} = \frac{\text{vol at s. t. p of } O_2}{22.4dm^3/mol}$$

Vol at s.t.p. of $O_2 = 0.05mol \times 22.4dm^3/mol$

$= 1.12dm^3$

d. $CrO_2^- + ClO^- \rightarrow CrO_4^{2-} + Cl^-$

$CrO_2^- \rightarrow CrO_4^{2-}$ (oxidation half reaction)

$ClO^- \rightarrow Cl^-$ (reduction half reaction)

Balance each half reaction

$$CrO_2^- + 4OH^- \rightarrow CrO_4^{2-} + 2H_2O + 3e^- \quad .....1$$

$$2e^- + ClO^- + H_2O \rightarrow Cl^- + 2OH^- \quad .....2$$

To balance the number of electron in the two half reaction multiply equation 1 by 2 and equation 2 by 3

$$CrO_2^- + 4OH^- \rightarrow CrO_4^{2-} + 2H_2O + 3e^- \quad .....\times 2$$

$$2e^- + 2ClO^- + 2H_2O \rightarrow 2Cl^- + 4OH^- \quad .....\times 3$$

$$2CrO_2^- + 8OH^- \rightarrow 2CrO_4^{2-} + 4H_2O + 6e^- \quad .....3$$

$$6e^- + 3ClO^- + 3H_2O \rightarrow 3Cl^- + 6OH^- \quad .....4$$

Add up equation 3and 4

$$2CrO_2^- + 8OH^- \rightarrow 2CrO_4^{2-} + 4H_2O + 6e^-$$

$$6e^- + 3ClO^- + 3H_2O \rightarrow 3Cl^- + 6OH^-$$

$$2OH^- + 2CrO_2^- + 3ClO^- \rightarrow 2CrO_4^{2-} + 3Cl^- + H_2O$$

2a. A → Evaporation

B → condensation

C → solidification or freezing

2b(i) $R = K[X][Y]^2$

The order of the reaction is the sum of the co-efficient to which the concentration terms are raise in the rate equation.

(ii)Overall order of reaction = 1 + 2 = 3

(iii)New conc. of X = 2[X]

New conc. of Y = 2[Y]

New rate = R_1

$R_1 = k(2[X])(2[Y])^2$

$= k(2[X])(4[Y]^2)$

$= 8k[X][Y]^2$

$= 8(k[X][Y]^2)$

$R_1 = 8R$

The rate of the reaction will increase by a factor of 8.

2c. $\Delta G = \Delta H - T\Delta S$

$T = 470C = 47 + 273 = 320k$

$\Delta G = 727kJ/mol - 0.2kJ/molk \times 320k$

$= 727kJ/mol - 64kJ/mol$

$= 663kJ/mol$

2d(i) B

(ii) An indicator with a P^H change of 8-10 is sensitive to base and show a shape end point in an alkaline or basic medium.

Since the acid is weak and the base is strong the salt form on hydrolysis will produced an alkaline medium.

$CH_3COOH + NaOH \rightarrow NaCH_3COO + H_2O$

$NaCH_3COO + H_2O \rightarrow CH_3COOH + NaOH$

(iii)The titre values will be more if a wrong indictor is used.

3a(i) Break or dissociate all aqueous species into their component ions and cancel out similar species

$$6Cl_{2(g)} + 12OH^- \rightarrow 2ClO_3^- + 10Cl^- + 6H_2O_{(L)}$$

b. **Method 1**

Density = $1.40g/cm^3$ meaning that

$1cm^3$ of the solution contain 1.40g of solute

$1cm^3$ of the solution contain 70% of 1.40g of HNO_3

$$= \frac{70}{100} \times 1.40g = 0.98g$$

$1cm^3$ of the solution contain 0.98g of HNO_3

$1000cm^3$ of the solution will contain 980g of HNO_3

Mass conc of $HNO_3 = 980g/dm^3$

$$molar\ conc = \frac{mass\ conc.}{molar\ mass} = \frac{980\,g/dm^3}{63\,g/mol}$$

$= 15.56moldm^{-3}$

Method 2

Molar conc of $HNO_3 = \frac{10pd}{M}$

where P = % by mass of HNO_3 in the stock solution

d = density or specified gravity of solution

M = R.M.M. of HNO_3

Molar conc. of HNO_3

$= \frac{10 \times 70 \times 1.40}{63}$

$= 15.56moldm^{-3}$

3c. R.M.M. of $A = \alpha_1 M_1 + \alpha_1 M_2$

where $\alpha_1 + \alpha_2 = 1 \Rightarrow \alpha_1 = 1 - \alpha_2$ (sum of fractions)

m_1 and m_2 are the mass number of the isotopes

$4.5 = 4\alpha_1 + 6\alpha_2$

$4.5 = 4 - 4\alpha_2 + 6\alpha_2$

$4.5 = 4 + 2\alpha_2$

$4.5-4 = 2\alpha_2$

$0.5 = 2\alpha_2$

$\alpha_2 = 0.5/2 = 0.25$

$\alpha_2 = 0.25$ or 25%

$\alpha_1 = 1-\alpha_2 = 1-0.25 = 0.75$

$\alpha_1 = 0.75$ or 75%

3d. $Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$

$$Ca(HCO_3)_2 = \frac{200}{1000}\,dm^3 \times 0.5 moldm^{-3}$$

$= 0.1$mol

$$\cap_{CaCO_3} = \frac{1 \text{ mole of } CaCO_3}{1 \text{ mole of } Ca(HCO_3)_2} \times 0.1\text{mol of } Ca(HCO_3)_2$$

$= 0.1$ mol

$$R.M.M\ of\ CaCO_3\ found = \cap_{CaCO_3}$$

$$= 0.1mol \times 100g/mol$$

$$= 10g$$

The maximum weight of $CaCO_3$ formed = 10.0g

2006/2007 CHEMISTRY 001 EXAMINATION

1.(a) In tabular form, list two differences between electrochemical cells and electrolytic cells.

(b) Write the expression for the equilibrium constant of the reaction,

$$CO_g + 2H_{2_g} \rightarrow CH_3OH_g$$

(c) A is a solution containing 3.65g of pure HCl acid in $100cm^3$ solution. Solution B was prepared by diluting $100cm^3$ of a saturated solution of Na_2CO_3 at 30°C to $1000cm^3$. If $25cm^3$ portion of B was neutralized by $21.10cm^3$ portion of A, calculate the solubility of the Na_2CO_3 at 30°C (in gdm^{-3}) [H = 1, C =12, O = 16, Na = 23, Cl = 35.5].

(d)(i) Work out the group, the period and the block of family of elements A with atomic number 10.

(ii) Calculate the mass of residual solid produced by strongly heating 0.01 mole of Calcium hydrogen trioxocarbonate (IV) to constant mass (equation essential) [Ca = 40; O = 16; C = 12; H = 1]

2.(a) Carbon burns with oxygen to give two oxides according to the following equations

$C_{(s)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{(g)} \Delta H = -111$kJ

$C_{(s)} + O_2(g) \rightarrow CO_{2(g)} \Delta H = -394$kJ

Calculate the enthalpy of the process, $CO_g + \frac{1}{2}O_{2_g} \rightarrow CO2(g)$.

(b) Calculate the final concentration of a solution obtained when $15ml$ of $0.20moldm^{-3}$ HCl was mixed thoroughly with $25ml$ of $0.08moldm^{-3}$ HCl.

(c) The Industrial preparation of ammonia by Haber process can be represented by the equation,

$N_{2_g} + 3H_{2_g} \rightleftharpoons 2NH_{3_g} \Delta H = -xkJ$.

Where x is a positive integer.

(i) State two changes that will increase the equilibrium constant of this reaction.

(ii) Draw a well annotated energy profile diagram for the reaction and show x.

(iii)On the same plot in (cii) show using dotted lines, what the effect of finely divided iron, the catalyst for the reaction will be on the energy profile diagram.

(d) State the observation from the following, giving reason for your answer:

(i) Litmus test-on the resulting solution from electrolysis of conc. NaCl through which a current of 10A has been passed for many hours.

(ii) Colour intensity - with progress of electrolysis of solution of copper(II) sulphate electrolysed, using copper electrodes, with the same current as in (e(1) above).

(e) Arrange $0.1moldm^{-3}$ solutions of the following salts in order of increasing pH; $NaHCO_3$, $AlCl_3$, $NaNO_3$, $NaOH$, Na_2CO_3 (no reasons is required).

3.(a) What fundamental definition of cathode is common to both electrolytic and electrochemical cells?

(b) A saturated solution of silver trioxocarbonate (IV) was found to have a concentration $1.3 \times 10^{-5}moldm^{-3}$ of the salt. Calculate the solubility product.

(c) For the molecule of CO_2, indicate

(i) The shape

(ii) The hybridization of the central atom

(iii)The overlapping orbital together with their orientation towards each other and type of bond formed

(d) Deduce a balanced equation for the reaction between MnO_4^- and $C_2O_4^{2-}$ in an alkaline medium.

(e) $25cm^3$ of calcium chloride solution were pipetted into a conical flask. $30cm^3$ of silver trioxonitrate (V) solution (an excess) were added to precipitate all the chloride ions and the precipitate weighed 3.507 g. Use these result to, determine the concentration in $moldm^{-3}$ of the calcium chloride solution.

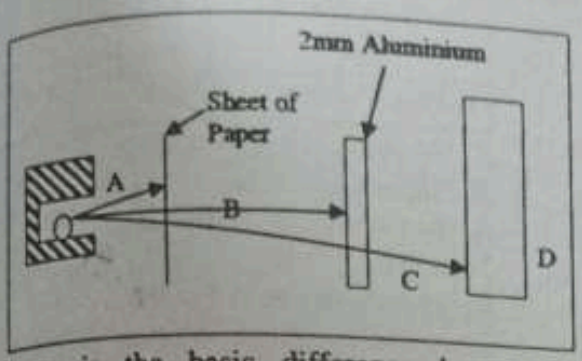
[Ag = 108; Cl = 35.5; O = 16]

(f) $25.0cm^3$ portion of a $0.05moldm^{-3}$ solution of sodium trioxocarbonate (IV) were titrated with 0.10moldm^{-3} solution of hydrochloric acid using certain indicator. The average titre value was found to be $12.50cm^3$. Use these

results to determine the stoichiometry of the reaction as well as the balanced equation.

3.(a) Combustion or burning is an oxidation reaction. Name two natural processes that can be classified as oxidation reaction.

(b)



(i) What is the basic difference between B and C?

(ii) Name A and D

(c) $MnO_4^- + H_2O_2 + H^+ \rightarrow Mn^{2+} + O_2 + H_2O$

In the reaction above, H_2O_2 breaks down to O_2 and H_2O write balanced half reaction equations for the oxidation and reduction processes and hence the full balanced ionic equation.

(d) Consider the reaction, $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$ if the concentration of HI increases from 0 to $0.001 moldm^{-3}$ in 50 seconds, what is the rate of the reaction?

(e) Four moles of acidified water were electrolysed completely by passage of 4.5 amperes according to the reaction $4H_2O \rightarrow 4H_2 + 2O_2$. Assuming platinum electrodes were used how many hours elapsed for the collection of the gas librated at the anode. [IF = 96500 C].

SOLUTIONS

Electrochemical cells	Electrolytic cell
It converts chemical energy to electrical energy.	It converts electrical energy to chemical energy.
The positive terminal is the cathode	The positive terminal is the anode
The negative terminal of the anode	The negative terminal is the cathode

1b. $K_c = \frac{[CH_3OH]}{[CO][H_2]^2}$

1c. R.M.M. of HCl = 36.5g/mol

R.M.M of Na_2CO_3 = 106g/mol

$\cap_{HCl} = \frac{\text{Reacting mass}}{\text{Molar mass}} = \frac{3.65g}{36.5g} = 0.1$ mol

Molar conc. of HCl = $\frac{\text{No of mole of HCl}}{\text{Vol. of sol.(in } dm^3)}$

$= \frac{0.1mol}{1000cm} = \frac{0.1mol}{1dm^3} = 0.1mol/dm^3$

$1000cm^3$ of solution contain 0.1mol of HCl

$21.10cm^3$ of solution will contain ymol of HCl

$\frac{1000}{21.10} = \frac{0.1}{y}$

$y = \frac{0.1 \times 21.10}{1000} = 0.00211 mol$

$2HCl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O$

$\cap Na_2CO_3 =$

$\frac{1 \text{ mole of } Na_2CO_3}{2 \text{ mole of HCl}} \times 0.00211 \text{mole of HCl}$

$= 0.001055 mol$

$25cm^3$ of Na_2CO_3 solution contain 0.001055mol of Na_2CO_3

$1000cm^3$ of Na_2CO_3 solution contain xmol of Na_2CO_3

$\frac{25}{1000} = \frac{0.001055}{x}$

$x = \frac{0.001055 \times 1000}{25} = 0.0422 mol$

Molar conc. of Na_2CO_3 = $\frac{0.0422mol}{1000cm^3} = \frac{0.0422mol}{1dm^3} = 0.0422M$

Molar conc. = $\frac{\text{mass conc } (g/dm^3)}{\text{Molar mass}}$

$0.0422 mol/dm^3 = \frac{\text{mass conc } (g/dm^3)}{106g/mol}$

$Mass\ conc.\ of\ Na_2CO_3 = 0.0422mol/dm^3 \times 106g/mol = 4.4732g/dm3$

1d.(i) $_{10}A \rightarrow 1s^2\ 2s^2\ 2p^6$

The highest principal quantum number is 2. Hence the element is in period 2.

The number of electron in the highest principal quantum number is 8 (i.e. 2 + 6). Hence the element is in group 8.

The outermost electron of the element is in a p-orbital, so the element is a p-block, representative or main group element

Element A is in group 8, period 2 and it is a p-block element

(ii) $Ca(HCO_3)_{2(g)} \rightarrow CaCO_{3(g)} + H_2O_{(g)} + CO_{2(g)}$

The residual solid form is $CaCO_3$.

$\cap_{CaCO_3} = \frac{1 \text{mole of } CaCO_3}{1 \text{ mole of } Ca(HCO_3)_2} \times 0.01 \text{mole of } Ca(HCO_3)_2 = 0.01 mole$

R.M.M of $CaCO_3$ = 100g/mol

Mass of $CaCO_3$ formed =

R.M.M of $CaCO_3$ x $\cap_{CaCO3}$

$= 100g/mol \times 0.01mol$

$= 1.0g$

2a. When a set of chemical equation is given with their enthalpy of reaction, to calculate the enthalpy of a particular reaction, Hess's law of constant heat summation is applied.

The rule is that combined the sets of equation given such that similar substance cancel out to form the require equation. Whenever any equation is reverse the sign of the enthalpy (ΔH) is also reverse.

Reversing equation 1 and combine it with equation 2 gives the require equation.

$CO_{(g)} \rightarrow C_{(s)} + \frac{1}{2}O_{2(g)} \Delta H = 111kJ$

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \Delta H = -394kJ$

$CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)} \Delta H = -283kJ$

The enthalpy of the reaction:

$CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$ is -283kJ

2b. $(\cap_{HCl})_1$ = vol(dm^3)x molar conc ($moldm^3$)

$= \left(\frac{15}{1000}\right) dm^3 x 0.20 mol/dm^3 =$

$0.003 mol$

$(\cap_{HCl})_2 = \left(\frac{25}{1000}\right) dm^3 \times \quad 0.08 mol/dm^3 \quad =$

$0.002 mol$

Total Number of mole in the mixture ($\cap_T$)

$= (\cap_{HCl})_1 + (\cap_{HCl})_2$

$= 0.003mol + 0.002mol$

$= 0.005mol$

Total vol.(V_T)=15ml+25ml=40ml= $0.04dm^3$

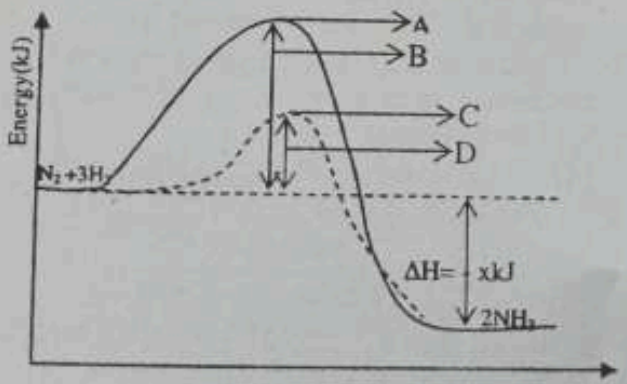
Final conc. of mixture $= \frac{n_T}{V_T} = \frac{0.005mol}{0.04dm^3}$

$= 0.125 mold/m^{-3}$

2c(i) The equilibrium constant of a reversible reaction is affect only by the following factors.

* Change in temperature (the major factor)
* Change in the Stoichiometry of the reaction i.e. in the number of moles of the reactants and product.

(ii)



Reaction path

A= Activation complex of the uncatalysed rxn

B= Activation energy of the uncatalysed rxn

C= Activation complex of the catalyzed reaction

D = Activation energy of the uncatalysed reaction

2d(i)

Ionization	Anode (+)	Cathode (-)
$NaCl \rightarrow Na^+ + Cl^-$	Cl^-	Na^+
$H_2O \rightarrow H^+ + OH^-$	OH^-	H^+

At the anode, Cl^- is discharge –

$2Cl^-_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$

At the cathode H^+ is discharge

$2e^- + 2H^+_{(aq)} \rightarrow H_{2(g)}$

Resultant solution is NaOH

Since the resultant solution is NaOH, it will turn red moist litmus paper blue.

(ii)

Ionization	Anode (+)	Cathode (-)
$CuSO_4 \rightarrow Cu^{2+} + SO_4^{2-}$	SO_4^{2-}	Cu^{2+}
$H_2O \rightarrow H^+ + OH^-$	OH^-	H^+

At the anode the Cu anode dissolve to form ions

$Cu_{(s)} \rightarrow Cu^{2+} + 2e^-$

At the cathode Cu^{2+} is discharge

$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(g)}$

At the anode $Cu_{(g)}$ goes into solution and at the cathode $Cu_{(g)}$ comes out of the solution. Therefore there is no change in the concentration of $CuSO_4$ and the colour of the electrolyte ($CuSO_4$) does not change (i.e. remain the same).

2e. $NaNO_3 < AlCl_3 < Na_2CO_3 < NaHCO_3 < NaOH$

3(a) It is the electrode at which reduction half reaction occur.

b. $Ag_2CO_{3(g)} \rightleftharpoons 2Ag^+ + CO_3^{2-}$

xM 2xM xM

$K_{sp} = [Ag^+][CO_3^{2-}]$

$= (2x)^2 (x)$

$K_{sp} = 4x^3$

But $x = 1.30 \times 10^{-5} moldm^3$

$K_{sp} = 4(1.30 \times 10^{-5} mold/m^{-3})^3$

$= 8.788 \times 10^{-15} mol^3 dm^{-7}$

Therefore the solubility products of silver trioxocarbonate IV (Ag_2CO_3) is 8.788×10^{-15} $mol^3 dm^{-9}$

c(i) Linear

(ii) Sp

(iii)

Overlapping orbitals	Orientation	Types of bond
s and P	Linear	Sigma
P and P	Lateral	Pie

3d. $MnO^-_4 + C_2O_4^{2-} \rightarrow Mn^{2+} + CO_2$

$MnO_4^- \rightarrow Mn^{2+}$ (reduction half reaction)

$C_2O_4^{2-} \rightarrow CO_2$ (oxidation half reaction)

$5e^- + MnO_4^- + 8H_2O \rightarrow Mn^{2+} + 4H_2O + 8OH^-$

$5e^- + MnO_4^- + 4H_2O \rightarrow Mn^{2+} + 8OH^-$ ...(1)

$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$ .....(2)

Multiply equation 1 by 2 and equation 2 by 5

$5e^- + MnO_4^- + 8H_2O \rightarrow Mn^{2+} + 4H_2O + 8OH^-$ ..... $\times 2$

$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$ ..... $\times 5$

$10e^- + 2MnO_4^- + 8H_2O \rightarrow 2Mn^{2+} + 16OH^-$

$5C_2O_4^{2-} \rightarrow 10CO_2 + 10e^-$

$2MnO_4 + 5C_2O_4 + 8H_2O \rightarrow 2Mn^{2+} + 10CO_2 + 16OH$

3e. R.M.M. of AgCl = 143.50g/mol

R.M.M of $CaCl_2$ = 111g/mol

$CaCl_2 + 2AgNO_3 \rightarrow 2AgCl + Ca(NO_3)_2$

$\cap_{HCl} = \frac{\text{Reacting mass}}{\text{Molar mass}} = \frac{3.507g}{143.50g/mol} = 0.0244$ mol

$\cap_{CaCl_2} = \frac{1 \text{ mole of } CaCl_2}{2 \text{ mole of AgCl}} \times 0.0244 \text{mol of AgCl}$

$= 0.0122mol$

$\text{Concentration of } CaCl_2 = \frac{\cap_{CaCl_2}}{\text{Vol.}}$

$= \frac{0.0122mol}{25cm^3} = \frac{0.0122mol}{0.025dm^3}$

$= 0.488mol/dm^3$

3f. $\cap Na_2CO_3 = \left(\frac{25}{1000}\right)dm^3 \times 0.05moldm^{-3}$

$= 0.00125$mol

$\cap_{HCl} = \left(\frac{12.50}{1000}\right)dm^3 \times 0.10moldm^{-3}$

$= 0.00125$mol

$\cap Na_2CO_3 : \cap_{HCl}$

$0.00125 : 0.00125$

$1 : 1$

Normally the stoichiometry of the reaction supposes to be 1:2.Since it is 1:1, it means that Na_2CO_3 is in excess. The excess Na_2CO_3 is hydrolyzed by the water form to $NaOH$. Hence the chemical equation is

$Na_2CO_3 + HCl \rightarrow NaOH + NaCl + CO_2$

4a(i) Photosynthesis & (ii) Rusting of iron

4b.B is a βeta- particle while C is a gamma-ray

(ii) A is an alpha particle

D is a lead block

c. $MnO_4^- \rightarrow Mn^{2+}$(reduction half react)

$H_2O_2 + H^+ \rightarrow O_2 + H_2O$ (oxidation half react)

The presence of H^+ mean the reaction is in acidic medium

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ ...(2)

$2H_2O_2 + H^+ \rightarrow O_2 + 2H_2O + H^+$

$2H_2O_2 \rightarrow O_2 + 2H_2O$ ..... (2)

Add equation 1 and 2

$MnO_4^- + 8H^+ + 2H_2O_2 + 5e^- \rightarrow O_2 + 6H_2O + Mn^{2+}$

d. Rate of reaction

$(R) = \frac{\Delta[HI]}{\Delta t} = \frac{0.001 - 0}{50 - 0}$

$= \frac{0.001}{50} = 0.00002M/S$

e. $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

1 mole of O_2 require 4mole of $e^- = 4F$

$\Rightarrow$ 2mole of O_2 require 8mole $e^- = 8F$

$Q = 8F = 8(96500C) = 772000C$

$Q = It$

$t = \frac{Q}{I} = \frac{772000c}{4.5A} = 171555.5556secs$

$t = 171555.5556sees \times \frac{1mm}{60secs} \times \frac{1hr}{60min}$

$= 47.65$hrs

$t = 47.65$hrs

2005/2006 CHEMISTRY 001 EXAMINATION

1a. Consider the above Table:

Compound	Melting point °C	Boiling point °C	Solubility in 100g of H_2O	Solubility in 100g of Benzene
WCl_a	900	1540	40.0g	0.17
ZCl_b	−34	87	0.18	60

What type of bond binds I. W to Cl II. Z to Cl. What types of forces of attraction bind the molecule of III. WCl_a IV. ZCl_b

(a) Copy and complete the following table showing the effect of the indicated parameters on the position of equilibrium:

Forward reaction left to right	Parameter	Effect on the position of Equilibrium
(i) $H_{2g} + I_{2g} \rightleftharpoons 2HI_g \Delta H$=-ve	Increase in temperature	
(ii) $2O_{3g} \rightleftharpoons 3O_2$	Decrease in total pressure	
(iii) $H_2O_l \rightleftharpoons H_2O_g$ ΔH= +ve	Decrease in temperature	
(iv) A+B $\rightleftharpoons$ C+D	Increase in Concentrations of C and D	

c(i) Given the following half-cell reactions:

$Fe^+_{2\,aq} + 2e \rightarrow Fe_s$ $E° = -0.44V$

$Cu^+_{2\,aq} + 2e \rightarrow Cu_s$ $E° = +0.34V$

(a) Calculate the e.m.f of the galvanic cell (b) Write down the standard shorthand notation for the galvanic cell (c) Determine whether the reaction is spontaneous or not by estimating

the change in standard free energy ΔG° that accompanied the reaction [$1F = 96500C/mol$].

C(ii) Draw a curve showing the variation of rate with temperature for an explosive reaction.

2a(i) Write an expression relating the free energy change ΔG to the enthalpy change ΔH, entropy change ΔS and temperature T.

(ii) The decomposition of calcium trioxocarbonate (IV) occur according to the following equation:

$$CaCO_3 \rightarrow CaO + CO_{2(g)} \Delta H = +62kJ$$

Using the expression in (ai) above give reason why the supply of heat is needed for this reaction to occur.

b(i) For each of the following processes state whether each leads to increase, decrease or no change in entropy

(i) $NaCl_s + H_2O_l \rightarrow NaCl_{aq}$

(ii) $3H_{2g} + N_{2g} \rightarrow 2NH_{3g}$;

(iii) $N_2O_{4g} \rightarrow 2NO_{2g}$

(iv) $H_2O_l \rightarrow H_2O_g$

b(ii) Using either oxidation state method or half electronic equation method balance the equation for the reaction leading to the formation of tin (iv) ion by action of acidified potassium heptaoxodichromate (vi), $K_2Cr_2O_7$ on tin (ii) ion.

c(i) State in not more than two lines, in each case, how the solubility of (a) ammonia gas, (b) solid potassium nitrate vary with decrease in temperature of the solvent.

c(ii) (a) Write down the chemical equation(s) for the hydrolysis of Na_2CO_3. (b) What Would be the effect of the process in c(i) above on a drop of litmus?

3a. What name is given to each of the following thermal transformations

(i) $\frac{1}{2}A_{2g} \rightarrow A_g$;

(ii) $B_s \rightarrow B_g$;

(iii) $C_l \rightarrow C_g$

b.(i) In a tabular form, state two major differences between the electrochemical and electrolytic cells. Give the formula of the following: (a) Caustic Soda, (b) Glauber's salt

(ii) Compute the volume of Oxygen evolved at $30^{\circ}C$ and $720mmHg$ when 4.0A is Passed through dilute tetraoxosulphate(VI) acid from 10.30 to 15.00 hour [IF = 96500C. molar volume of a gas ats.t.p is 22.4 dm^3]

(iii) How many hydrogen atoms/ions are furnished by $20cm^3$ of $0.01moldm^{-3}$ tetraoxosulphate (VI) acid? [N_A= $6.02 \times 10^{23}/mol$]

c.(i) Consider the reaction, $2A + B \rightarrow C$ (a) Write an expression to equate the rates of species A, B and C. (b) if the rate of disappearance of A is $6.4 \times 10^{-4} moldm^{-3} S^{-1}$, what is the rate of the appearance of C?

(ii) The atomic number of elements X, Y and Z are 8, 9 and 19 respectively. Write the formula of the compound formed between (a) Z and X (b) Y and X (c) Y and Z.

4.(a) I. Why is the charge-to-mass ratio of cathode rays are constant? II. An element X exists as a mixture of two isotopes ($^{16}X_8$ and $^{18}X_8$). If the average atomic mars of X is 16.2 what are the abundances of the isotopes? III. What is the implication of the following postulate of kinetic theory of gases the collisions between the molecules of a gas are perfectly elastic?

(b) I. What is the molarity of a standard solution prepared by dissolving 1.0g of Na_2CO_3 in $100cm^3$ volumetric flasks? II. The solubility product of lead(II) iodide is $1.4 \times 10^{-8} mol^3 dm^{-6}$ at $25^{\circ}C$. Calculate the solubility of the salt in pure water at $25^{\circ}C$. (c) (i) Consider the reactions: (i) $C(s) + O_2(g) \rightarrow CO_2(g)$; $\Delta H = -393$ KJ mol^{-1}

(ii) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$; $\Delta H = -285$KJ mol^{-1} calculate ΔH for the reaction: $C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g)$.

SOLUTIONS

1a.(i) Ionic bond because of the high melting and boiling points couple with the high solubility in polar solvent, water

(ii) Covalent bond because of the low melting and boiling points couple with the high solubility in non-polar solvent, Benzene

(ii) Electrostatic force of attraction

(iii)Van der waal's force

1b.

Forward reaction left to right	Parameter	Effect on the position of Equilibrium
(i)$H_{2(g)}+I_{2(g)} \rightleftharpoons 2HI(g)$ ΔH= -ve	Increase in temperature	Move forward
(ii)$2O_{3(g)} \rightleftharpoons 3O_{2(g)}$	Decrease in total pressure	Move backward
(iii)$H_2O_{(l)} \rightleftharpoons H_2O(g)$ ΔH=+ve	Decrease in temperature	Move forward
(iv)A+B $\rightleftharpoons$ C+D	Increase in Concentrations of C and D	Move forward

Note that according to Le-chatelier principle, the equilibrium position move in opposite direction to the side the reaction follows. That is, if the reaction moves forward the equilibrium position will move backward

1c.(i) e.m.f of all = $E^{\ominus}$ oxidant − $E^{\ominus}$ reductant

$= 0.34v - (-0.44v)$

$= 0.34v + 0.44v$

$= 0.78v$

$Fe_{(s)} / Fe^{2+}{}_{(aq)} // Cu^{2+}{}_{(aq)} / Cu_{(s)}$

$\Delta G = -nFE^{0}$

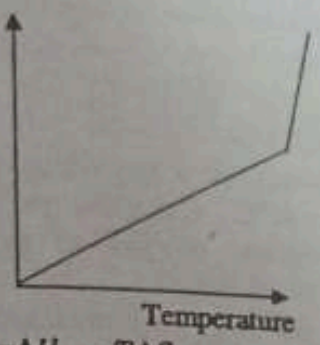
$= -2 \times 96500 \times 0.78$

$= -150540J$

$= -150.54kJ$

The reaction is spontaneous because $\Delta G = -ve$ and $E^{0} = +ve$

(ii) Rate



2a.(i) $\Delta G = \Delta H - T\Delta S$

(ii) Since ΔH is positive, for ΔG to be negative (i.e. for the reaction to be spontaneous) TΔS must be greater than ΔH. Therefore heat is supplied to the reaction to increase T and ΔS for the product (TΔS) to be greater than ΔH for $\Delta G < O$.

2b(i) (i) Increase (ii) Decrease (iii) Increase (iv) Increase

(ii) $Sn^{2+}_{aq} + Cr_2O_7^{2-} \rightarrow Cr^{3+}_{aq} + Sn^{4+}_{aq}$

$Sn^{2+}_{aq} \rightarrow Sn^{4+}_{aq}$ (oxidation half reaction)

$Cr_2O_7^{2-} \rightarrow Cr^{3+}_{aq}$ (reduction half reaction)

$Sn^{2+}_{aq} \rightarrow Sn^{4+}_{aq} + 2e^{-}$.....(2) x 3

$6e^{-} + Cr_2O_7^{2-}{}_{aq} + 14H \rightarrow 2Cr^{3+}_{aq} + 7H_2O$

$3Sn^{2+}_{aq} \rightarrow 3Sn^{4+}_{aq} + 6e^{-}$

$6e^{-} + Cr_2O_7^{2-}{}_{aq} + 14H \rightarrow 2Cr^{3+}_{aq} + 7H_2O$

$3Sn^{2+}_{aq} + Cr_2O_7^{2-}{}_{aq} + 14H^{+}_{aq} \rightarrow Sn^{4+}_{aq} + 2Cr^{3+}_{aq} + 7H_2O$

2c(i) Solubility of gases (e.g NH_3) increases with decreases in temperature.

Solubility of ionic substance (e.g KNO_3) decreases with decrease in temperature.

(ii) (a) $Na_2CO_3 + H_2O \rightarrow NaOH + H_2CO_3$

(b) It will turn red litmus paper blue

3a. (i) Atomization (ii) Sublimation (iii) Vapourizatio

3b(i).

Electrochemical cell	Electrolytic cell
It converts chemical energy to electrical energy	It converts electrical energy to chemical energy
The positive electrode is the cathode	The positive electrode is the anode
The negative electrode is the anode	The negative electrode is the cathode

Caustic soda → NaOH

Glauber's salt → $Na_2SO_4 .10H_2O$

(ii) Note that from 10.30 to 15 hrs is 4hrs 30mins

$Q = It = 4 \times (4.50 \times 3600s) = 64800c$

1 mole of O_2 =4mole of e⁻=4F= 4(96500C)

x mole of O_2 = 64800C.

$$\frac{1}{x} = \frac{4(96500)}{64800}$$

$$x = \frac{64800}{4(96500)} = 0.1679mol$$

$$\cap O_2 = \frac{volatst.p}{22.4dm^3/mol}$$

Vol.O_2 at s.t.p= 0.1679mol x 22.4dm³/mol

= 3.7604dm³

The volume obtain is at s.t.p. To obtain the volume at 30°C and 720mmHg, we applied general gas law.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$P_1 = 760mmHg, T_1 = 273k, V_1 = 3.7604dm^3$

$P_2 = 720mmHg, T_2 = 303k, V_2 = ?$

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{760 \times 3.7604 \times 303}{720 \times 273} = 4.4055dm^3$$

(iii) $\cap H_2SO_4$=Vol.(dm³)xmolarconc. $(moldm^{-3})$

$= \left(\frac{20}{100}\right)dm^3$ x 0.01 mol dm^{-3} = 0.0002mol

$H_2SO_4 \rightarrow 2H^{+} + SO_4^{2-}$

0.0002mol 0.0004mol 0.0002mol

$\cap_{H^+}$=0.0004mol = $\frac{\text{No of molecules of } H^+}{6.02 \times 10^{23}}$

No of molecules of H^+ = 2,408 x 10^{20}

c(i) $R = -\frac{1}{2}\frac{\Delta[A]}{\Delta t} = \frac{-\Delta[B]}{\Delta t} = \frac{\Delta[c]}{\Delta t}$

Take note that there is a negative sign in the front of the change in the concentration of the reactant. This is because the concentration of the reactant decreases with time. Since the rate of reaction is always a positive value, the negative sign is used to ensure the rate is positive

If $\frac{\Delta[A]}{\Delta t} = 6.4 \times 10^{-4}\ mol\ dm^{-3}s^{-1}$

$\Rightarrow \frac{1}{2}\frac{\Delta[A]}{\Delta t} = \frac{\Delta[C]}{\Delta t}$

$\frac{1}{2} \times 6.4 \times 10 - 4\ moldm - 3s - 1 = \frac{\Delta[C]}{\Delta t}$

$\frac{\Delta[C]}{\Delta t} = 3.2 \times 10^{-4} moldm^{-3}s^{-1}$

(ii) the valence of X, Y, and Z is 6, 7 and 1 which means that their oxidation state is -2, -1 and +1 respectively.

(a) $Z^+ + X^{2-} \rightarrow Z_2X$

(b) $Y^- + X^{2-} \rightarrow XY_2$

(c) $Y^- + Z^+ \rightarrow ZY$

In any compound the most electropositive element is written first.

4a.(i) It is because all cathode rays have the same mass and charge irrespective of their sources.

(ii) R.M.M of $X = \alpha_1 m_1 + \alpha_2 m_2$

Where $\alpha_1 + \alpha_2 = 1$ (sum of fractions)

m_2 and m_1 are the mass number of the isotopes

$\Rightarrow \alpha_1 = 1 - \alpha_2$

$16.2 = 16\alpha_1 + 18\alpha_2$

$16.2 = 16\alpha_1 + 18(1-\alpha_1)$

$16.2 = 16\alpha_1 + 18 - 18\alpha_1$

$16.2 - 18 = -2\alpha_1$

$-1.8 = -2\alpha_1$

$$\alpha_1 = \frac{-1.8}{-2} = 0.9$$

$\alpha_1 = 0.9$ or 90%

$\alpha_2 = 1 - \alpha_1 = 1 - 0.9 = 0.1$ or 10%

The relative abundance of the isotopes ${}^{16}_{8}X$ and ${}^{18}_{8}X$ is 90% and 10% respectively.

(iii) The random motion of gaseous molecules continues indefinitely.

4b.(i) R.M.M of $Na_2CO_3 = 106g/mol$

No of mole of Na_2CO_3 =

$$\frac{\text{Relating mass}}{\text{molar mass}} = \frac{1.0g}{106g/mol}$$

$= 0.0094mol$

Molarity of Na_2CO_3 =

$$\frac{\text{No of mole of } Na_2CO_3}{\text{Vol of solution on dm}^3} =$$

$$\frac{0.0094mol}{100cm^3} = \frac{0.0094mol}{0.1dm^3}$$

$= 0.094 moldm^{-3}$

(ii) $PbI_{2_s} \rightleftharpoons Pb^+_{2_{aq}} + 2I^-_{aq}$

xM $\quad$ xM $\quad$ $2x$M

$K_{sp} = [Pb^{2+}][I^-]^2 = x(2x)^2 = 4x^3$

$K_{sp} = 4x^3$

$$x = 3\sqrt{\frac{K_{sp}}{4}} = 3\sqrt{\frac{1.4\times10^{-8}}{4}}$$

$x = 0.00152M = 1.52 \times 10^{-3}M$

The solubility of PbI_2 in water is $1.52 \times 10^{-3}M$

c (i) $C_s + O_{2_g} \rightarrow CO_{2_g} \Delta H = -393kJ/mol$

$CO_g + \frac{1}{2}O_2 \rightarrow CO_{2_g} \Delta H = -285kJ/mol$

Applying Hess' law of constant heat summation; I have:

$C_s + O_{2_g} \rightarrow CO_{2_g} \Delta H = 393kJ/mol$

$CO_{2_g} \rightarrow CO_s + \frac{1}{2}O_{2_g} \Delta H = 285kJ/mol$

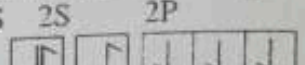
$C_s + \frac{1}{2}O_{2_g} \rightarrow CO_g \Delta H = -108kJ/mol$

Note that reversing a chemical equation; reverse the sign of its ΔH.

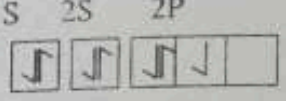
2004/2005 CHEMISTRY 001 EXAMINATION

1(a) Which principle is violated by each of the following electron configuration?

(i)



(ii)



(b) 0.563g sample of a gas occupies $500cm^3$ at 1atm. at 30°C. Calculate its molar mass [Molar volume of gas at s.t.p. occupies $22.4dm^3$] *3mks*

(c) Consider the following nuclides: I. ${}^{14}C_6$, II. ${}^{14}N_7$ III. ${}^{15}O_8$ IV. ${}^{12}C_6$, state which of them are (I) isotopes (II) isotones and (III) isobars. *3mks*

(d) Ionize and then work out the oxidation state(s) of nitrogen in NH_4NO_3.

(e) (i) Write an equation for the thermal decomposition of potassium trioxochlorate (v) (ii) What catalyst is used for this decomposition? (iii) $CaCO_3 \rightarrow CaO + CO_2$. Calculate the number of molecules of CO_2 produced from the decomposition of 10g of $CaCO_3$ [Ca =40; C=12; O= 16].

(f) Discuss the electrolysis of aqueous copper (II) tetraoxosulphate (VI) based strictly on the following: I. Equation for the reaction at the anode. II. Equation for the reaction at the cathode III. Effect of electrolysis on the electrolyte.

(g) Given the following standard redox potentials $E^0_{X^+/X} = -0.58v$; $E^0_{Y^{2+}/Y} = -0.42v$;

Deduce:

(i) The half-cell reaction

(ii) The overall reaction,

(iii) The standard cell potential of the cell $X/X^+// Y^{2+}/Y$

2(a) The solubility product of Lead (II) bromide has the numerical value of 9.0×10^{-6}. Calculate its solubility, in water.

(b) $2CrO_4 + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$. A student inspected the equation above and concluded that it represented a redox reaction. Is his conclusion true or false? Give reasons.

(c) A commercial solution HNO_3, relative molar mass 63; is 70% pure and has a density of $1.40g$ per cm^3. Calculate its concentration in mole per dm^3.

(d) The central atom in CH_4, NH_3 and H_2O are sp^3 hybridized. Bond angles are however respectively 109.5, 107 and 105. Explain the differences.

(e) Given the relationship: $\Delta G = \Delta H - T\Delta S$. Decide on the fate of the reactions with the following sets of conditions: I. ΔH= -ve and greater than $T\Delta S$ II. ΔH =+ve and less than $T\Delta S$.

Hint: Fix a particular positive or negative value, as the case may be, for ΔH and compute the corresponding value for ΔG

(f) Draw an energy profile diagram to illustrate a catalyzed and non-catalyzed exothermic reaction. Label parts of the diagram and indicate the enthalpy change.

(g) $Na + \frac{1}{2} Cl_2 \rightarrow NaCl$

The above equation represents a reaction between one atom of sodium and one atom of chlorine, what charge (s) is /are carried by each of the reacting species? ***2mks***

3(a) (i) Why is cathode ray not a true ray? (ii) Where, in Periodic Table do you find the most electronegative element? (iii) (I) ionization energy (II) metallic character (III) atomic radius (IV) atomic number (V) electron affinity.

Which of I to V increases along the period but decreases down the group?

(b) (i)The name water for H_2O is trivial. Give all the possible systematic names for water. (ii) A compound is name trioxocarbonate (IV) Give the implication of (I) trioxo and (II) carbonate (IV)

(c) Use kinetic theory to explain how increases in temperature increase the rate of a chemical reaction.

(d) Consider the following reaction that is already in equilibrium:

$2A_{(s)} + 2B_{(g)} \rightleftharpoons C_{(s)} + D_{(g)}$; ΔH=-ve. Also consider the following conditions:

I. Increase in temperature; II. increase in pressure; III. addition of positive catalyst. Which of conditions I, II and III

(I) Will increase the rate of backward reaction, (II) have effect on the equilibrium.

(e) $50cm^3$ each of sodium hydroxide and tetraoxosulphate (VI) acid each containing 0.0001mole of the respective chemicals are mixed.

(i) Write ionic equation for the reaction taking place II. which component in equation I. is excess and by how many mole III. Determine the pH of the mixture.

(f) Using the following standard redox potentials

$\frac{1}{2} Cr_2O_7^{2-}/Cr_3 + \quad E^0 = +1.33V$

$\frac{1}{2} C_{12}/Cl^- \; E^0 = +1.36V$

Decide whether the, following reaction will go or not $Cr_2O_7^{2-} + 6Cl^- + 14H^+ \rightarrow 2Cr_3 + 3C_{12} + 7H_2O$.

(g) 0.05M solution of sodium trioxocarbonate (IV) is titrated with 0.05 solution of tetraoxosulphate (VI) acid using phenolphthalein as indicator. Write an equation for the reaction taking place *2mks*

SOLUTIONS

1a.

(i)Aufbau principle and

(ii)Hund's rule of maximum multiplicity

1b.

$P_1 = 1atm = 760mmHg, V_1 = 500cm^3,$

$T_1 = 30^0C = 303k,$

at s.t.p

$P_2 = 760mmHg$

$T_2 = 273k, V_2 = ?$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow V_2 = \frac{P_1V_1T_2}{P_2T_1}$$

$$V_2 = \frac{760 \times 500 \times 273}{760 \times 303} = 450.4950cm^3$$

No of mole of gas =

$$\frac{\text{Reacting mass}}{\text{Molar mass}} = \frac{\text{vol at s.t.p}}{22.4dm^3/mol}$$

$$\Rightarrow \frac{0.563g}{\text{Molar mass}} = \frac{450.4950cm^3}{22400cm^3/mol}$$

$$\text{Molar mass} = \frac{0.563g \times 22400cm^3/mol}{450.4950cm^3}$$

$= 27.9941g/mol \approx 28g/mol$

1c.(i) Isotopes are atoms of an element with the same atomic number i.e. $^{12}_{6}C$ & $^{14}_{6}C$

(ii) Isotones are atoms of elements with the same number of neutrons i.e. $^{14}_{7}N$ & $^{15}_{8}O$

(iii)Isobars are atoms of elements with the same mass number i.e. $^{14}_{6}C$ and $^{14}_{7}N$

1d. $NH_4NO_3 \rightarrow NH_4^+ + NO_3^-$

Let the oxidation number of N in NH_4^+ be x

$x + 4(+1) = +1 \Rightarrow x + 4 = 1 \therefore X = -3$

Let the oxidation number of N in NO_3^- be y

$y + 3(-2) = -1 \Rightarrow y - 6 = -1$

$y = -1 + 6 \Rightarrow y = +5$

The oxidation number of N in NH_4HCl is -3 and $+5$

1e.(i) $2KClO_{3(s)} \rightarrow 2KCl_{(g)} + 3O_{2(g)}$

(ii) The catalyst used is magnesium IV oxides (MnO_2)

(iii)$CaCO_{3(g)} \rightarrow CaO_{(g)} + CO_{2(g)}$

$$\cap CaCO_3 = \frac{10g}{100g/mol} = 0.1mol$$

$$\cap CO_2 = \frac{1\,\text{mole of } CO_2}{1\,\text{mole of } CaCO_3} \times 0.1\,\text{mol of } CaCO_3$$

$$= 0.1\ \text{mole}$$

$$\cap CO_2 = \frac{\text{No of molecules of } CO_2}{6.02 \times 10^{23}}$$

$$No\ of\ molecules\ of\ CO_2 = \cap_{CO_2} \times 6.02 \times 10^{23}$$

$$= 0.1mol \times 6.02 \times 10^{23}$$

$$= 6.02 \times 10^{22} molecules$$

The number of CO_2 molecules produces is 6.02×10^{22}

1f. Since the electrodes use are not mention, we considered it as inert electrode i.e. it does not participate in the electrolysis

Equations	Anode(+)	Cathode (-)
$CuSO_4 \rightarrow Cu^{2+} + SO_4^{2-}$	SO_4^{2-}	Cu^{2+}
$H_2O \rightarrow H^+ + OH^-$	OH^-	H^+

At the anode OH^- is discharge to produce oxygen gas and water.

$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

At the cathode Cu^{2+} is discharge to produce metallic copper.

$2Cu^{2+} + 4e^- \rightarrow Cu_s$

At the anode OH^- is removed from the electrolyte while at the cathode Cu_{aq}^{2+} is removed from the electrolyte. The remaining ions in the electrolyte are SO_4^{2-} & H^+ (i.e. H_2SO_4). Hence the resultant solution is acidic.

Note that if the passage of the electric current continues, the electrolysis of the dilute acid (H_2SO_4) will begin to occur

1g.(i) $2X_s \rightarrow 2X^+ + 2e^- \; E^0 = 0.58V$

$Y_{aq}^{2+} + 2e^- \rightarrow Y_{(s)} \; E^0 = -0.42V$

(ii) $2X_s \rightarrow 2X^+ + 2e^- \; E^0 = 0.58V$

$Y_{aq}^{2+} + 2e^- \rightarrow Y_{(s)} \; E^0 = -0.42V$

$2X + Y^{2+} \rightarrow 2X^+ + Y \; E^0 = 0.16V$

Reversing an equation changes the sign of it electrode potential.

(iii)The standard cell electrode potential of the cell is 0.16V.

2a. $PbBr_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Br^-_{(aq)}$

xM xM 2xM

$K_{sp} = [Pb^{2+}][Br^-]^2$

$= (x)(2x)^2 = x(4x^2) = 4x^3$

$K_{sp} = 4x^3$

$9.0 \times 10^{-6} = 4x^3$

$x^3 = 2.25 \times 10^{-6}$

$x = \sqrt[3]{2.25 \times 10^{-6}} = 0.0131M$

The solubility of $PbBr_2$ in water is 0.0131M.

2b. It is false. The reason is that a redox reaction is a reaction in which oxidation and reduction occur simultaneously. In the reaction $2CrO_4^- + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$ All the elements do not change their oxidation state, so no elements is reduced or oxidized.

2c. In a stock solution (i.e. a commercially produced solution), the concentration is given by $C = \frac{10Pd}{M}$

Where P = percentage by mass of solute in the solution. If the solution is pure (p) = 100

d = density in g/cm^3 or specific gravity

M = Relative molecular mass of the solute

$$C = \frac{10 \times 70 \times 1.40}{63} = 15.56M$$

2d. The reasons is that molecules or ions assumed the shape that best minimized the repulsion between lone pair – lone pair (Lp-Lp), lone pair-bond pair (Lp-bp) or bond pair-bond pair (bp-bp) electrons. Note that, the order of repulsion is Lp-Lp > Lp-bp> bp –bp.

Therefore the greater the number of lone pair electrons, the greater the repulsion between electrons and the lower the bond angle.

Molecules	Number of lone pair	bond angle
CH_4	-	109.5
NH_3	1	107.
H_2O	2	105

2e. $\Delta G = \Delta H - T\Delta S$

(i) if ΔH = -ve (say ΔH = -2) and greater than $T\Delta S$ (say $T\Delta S$ = -10). Note that -2 is greater than -10 then

$\Delta G = \Delta H - T\Delta S = -2 - (-10) = +8$

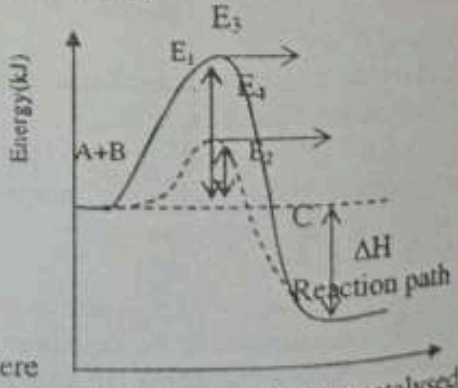
ΔG = +ve

Since ΔG is positive the reaction is non spontaneous.

(ii) If ΔH = +ve (say ΔH = 10) and less than $T\Delta S$ (say $T\Delta S$ = 15) then

$\Delta G = 10 - 15 = -5$ i.e. ΔG = -ve

Since ΔG is negative the reaction is spontaneous



Where

E_1= Activation energy of the uncatalysed reaction

E_2= Activation energy of the catalyzed reaction

E_3=Activation complex of the uncatalysed reaction

E_a= Activation complex of the catalyzed reaction
ΔH= Enthalpy of reaction

2g. The charge or the oxidation state of Na & Cl_2 in the reaction is zero.

3a.(i) It is because they has mass and charge. All true rays do not possess mass and charge.

(ii) At the upper most part of group VII

(iii)Ionization energy and electron affinity increases across the period and decreases down the group.

3b.(i) Hydrogen oxide & oxygen hydride

(ii) Trioxo-means the compound contains 3-oxygen atom. Carbonate IV-means the parent or central atom of the compound is carbon and +4 is its oxidation state.

3c. According to kinetic theory of matter, the molecules of matter are in continual random motion colliding with one another and with the wall of their container. It also states that the average kinetic energy of the molecules is proportional to the temperature of the colliding particles so when the temperature of the reactants is increase, the particles of the reactant gain more kinetic energy and collide more frequently, so that the rate of collision increases. According to the collision theory molecules or particles of the reactant must collide before a reaction can occur and the greater the rate of effective collision the greater the rate of reaction.

In essences, increase in temperatures, increases the rate of collision of the reactant particle which consequently increases the rate of reaction.

3d. (i)Increase in temperature and addition of a positive catalyst favour backward reactions

(ii)increase in pressure and addition of a positive catalyst favour forward reactions.

(ii)Both increase in temperature and pressure will affect the equilibrium position of the reaction.

Note that catalyst will not affect the equilibrium position of a reversible reaction but allow equilibrium to be achieved easily.

3e.(i) $OH^- + H^+ \rightarrow H_2O$

(ii) $\cap NaOH$ $\cap H_2SO_4$

$\frac{0.0001}{2}$ $\frac{0.0001}{1}$

0.00005 0.0001

NaOH is the limiting reagent

H_2SO_4 is the excess reagent

From the reaction

0.0001mol of NaOH required 0.00005mol of H_2SO_4 excess mole of H_2SO_4 = $(0.0001 - 0.00005)\,mole = 0.00005moles$

Concentration of excess H_2SO_4

$$= \frac{\text{No of mole of excess } H_2SO_4}{\text{Volume of the mixture}}$$

$$= \frac{0.00005mol}{100cm^3}$$

$$= \frac{0.00005ml}{0.10dm^3}$$

$= 0.0005moldm^{-3}$

$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

0.0005M 0.001M 0.0005M

$p^H = -log_{10}^{[H+]} = -log_{10}^{0.001}$

$= 3$

The p^H of the solution is 3.

3f.

$6e^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr_3^+ + 7H_2O \quad E^0 = 1.33V$

$6Cl^- \rightarrow 3Cl_2 + 6e^- \quad E^0 = -1.36V$

$6Cl^- + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 3Cl_2 + 7H_2O \quad E^0 = -0.03V$

The reaction is not feasible (i.e. it will not occur) because for a reaction to be feasible E^0 must be positive (E^0 = +ve).

3g. The use of phenolphthalein indicate that the resultant solution is basic (i.e. the end point of the titration is basic).

$2Na_2CO_3 + H_2SO_4 \rightarrow 2NaOH + Na_2SO_4 + CO_2$

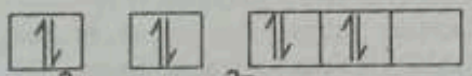
2003/2004 CHEMISTRY 001 EXAMINATION

SECTION A

1. Which of the following properties generally decrease across the period in the Periodic Table? (I) First ionization Energy (II) Electron affinity (III) Electronegativity (IV) Ionic radius (V) Atomic radius. (a) II and V (b) II, IV and V (c) III only (d) All of the above.
2. The following represents the equation for the synthesis of ammonia by Haber process $N_{2g} + 3H_{2g} \rightleftharpoons 2NH_{3g}$ ΔH = -ve which of the following will favour the production of NH_3? (I) increase in pressure (II) increase in temperature (III) Addition of catalyst (IV) decrease in temperature (V) decrease in pressure. (a) I and II (b)I, III and (IV) (c) All of the above (d) IV and V.
3. Which of the following are common reducing agents? (I) Iron (II) Salts (II) SO_2 (III) Acidified H_2O_2 (IV) Acidified $KMnO_4$ (V) NO_2 gas (a) I and II (b) III and V (c) I, IV and III (d) II and IV.
4. Which of the following molecules is /are linear? (I) C_2H_4 (II) H_2 (III) CS_2 (IV) NH_3 (V) H_2O (a) II and III (b) III and V (c) III only (d) II only
5. The force of attraction between hydrogen fluoride molecules which is responsible for the

unexpectedly high boiling point is the (a) Electrovalent bond (b) Covalent bond (c) Van der Waals' force (d) Hydrogen bond.

6. Given the following nuclear reaction: $^{214}_{82}Pb \rightarrow ^{214}_{83}Bi + ^{0}_{-1}e$. Which of the following statements is/are true of this nuclear reaction? (I) the daughter nucleus is $^{0}_{-1}e$ (II) The reaction shows a beta-decay (III)^{214}Bi is an isotope of ^{214}Pb (IV)The parent nucleus is $^{214}Pb_{82}$ (a) I only (b) I and II (c) I and IV (d) none of the above.
7. 0.07g of a hydride of carbon occupies $56.0cm^3$ at STP when vapourized and contain 14.29% by mass of hydrogen. The formula of the hydrocarbon is: (a) C_2H_2 (b) C_2H_6 (c) C_2H_4 (d) CH_2
8. What is the concentration of a solution which contains 2.0g of Sodium hydroxide per $250cm^3$? [Na=23, O=16, H =1] (a) $0.02mol/dm^3$ (b) $0.05mol/dm^3$ (c) $2.00\ mol/dm^3$ (d) $0.20\ mol/dm^3$.
9. The number of Hydrogen ions in 2.8g of tetraoxosulphate (VI) acid is (a) 1.72×10^{22} (b) 3.01×10^{23} (c) 3.01×10^{22} (d) 6.02×10^{22}.
10. Which of the following salts is a mixture? (a) $Fe(NH_4)_2(SO_4)_2$ (b) $K_4Fe(CN)_6$ (c) $Cu(NH_3)_4C_{12}$ (d) $CuSO_4$
11. A student wrote the electronic configuration of oxygen as



Which of the following was (were) violated by the student? (a) Pauli Exclusion Principle only (b) Hund's Rule only (c) Aufbau Principle and Pauli Exclusion Principle (d) Aufbau Principle only.

12. The mass defect usually observed in nuclear reactions is accounted for by (a) Schrödinger equation. (b) De Broglie equation (c) Einstein equation (d) Planck's equation
13. The bond angle of methane, ammonia and water are 109^0, 107^0 and 105^0 respectively even though the central element in each molecule is sp^3 hybridized. This observation is due to the progressive. (a) Increase in the electronegativity of carbon through nitrogen to oxygen. (b) Increase in the number of lone pairs from carbon through nitrogen to oxygen. (c) Decrease in the electronegativity of carbon through nitrogen to oxygen. (d) Decrease in the number of lone pairs from carbon through nitrogen to oxygen.
14. (I)Nature of the three states of matter (II) Brownian motion (III) Diffusion (IV) Evaporation. Which of the above illustrate(s) the kinetic theory of matter? (a). I only (b). II, III and IV (c). I, II, III and IV (d). I, III and IV.
15. Which of the following sets of conditions will ensure sp ontaneity at all temperatures? (a) ΔH negative and ΔS positive. (b)ΔH negative and ΔS negative (c) ΔH positive and ΔS negative (d) ΔH positive and ΔS positive
16. $Cu^{2+} + 4NH_3 \rightleftharpoons Cu(NH_3)_4^{2+}$. In the reaction above, copper (11) ion acts as (a) Conjugate acid. (b) Arrhenius acid (c) Lewis acid (d) Bronsted-Lowry acid.
17. $15.00cm^3$ of a solution of H_2SO_4 completely neutralized $25.0cm^3$ of $0.125\ moldm^{-3}$ NaOH solution. What is the molar concentration of the acid solution? (a) $0.023moldm^{-3}$ (b) $0.925moldm^{-3}$ (c) $0.104\ moldm^{-3}$ (d) $0.156moldm^{-3}$
18. $0.563g$ sample of a gas occupies a volume of $500cm^3$ at 1.00 atm. and 30°C. What is the molar mass of the gas? [Molar volume of a gas at s.t.p = $22.4dm^3$; R= $0.0821\ dm^3\ atm.K^{-1}mol^{-1}$]. (a) $58.0gmol^{-1}$ (b) $32.0gmol^{-1}$ (c) $44.0gmol^{-1}$(d) $28.0\ gmol^{-1}$
19. For the reaction: 2A + B → C the rate of disappearance of A is given as $\frac{-d[A]}{dt} = k[A][B]^2$ If concentration of A is doubled and that of B tripled, what happens to the rate of appearance of C? (a) Increases 18-fold (b) Decreases 18-fold (c) Increases 4-fold (d) Decreases 4-fold
20. The solubility product of Magnesium hydroxide is $4.2 \times 10^{-12}mol^3dm^{-9}$ at 25°C. What is its solubility at this temperature (a) $1.016 \times 10^{-5}moldm^{-3}$ (b) $1.016 \times 10^{-3}moldm^{-3}$ C. $1.016 \times 10^{-4}moldm^{-3}$ (d) $1.016 \times 10^{2}moldm^{-3}$
21. Give $E^0_{Zn^{2+}/Zn}$ = -0.76V and $E^0_{Ag^+/Ag}$= +0.80V. Calculate the standard cell potential of the cell, $Zn_{(s)}/Zn^{2+}_{(aq)}\ //Ag^+/Ag_{(s)}$ A -2.34V (b) 56V (c) +2.34V (d) +0.78V
22. If an element X of atomic number Z and mass number Y is irradiated by an intense concentration of neutrons, the" relevant nuclear equation is (a) $^{Y}X_z + {}^{1}n_0 \rightarrow {}^{Y-1}X_{z+1}$ (b) $_zX^y + {}^{1}n_0 \rightarrow {}^{Y+1}X_z$ (c) $^{Y}X_z + {}^{1}n_0 \rightarrow {}^{Y}X_{z+1}$ (d) $^{Y}X_z + {}^{1}n_0 \rightarrow {}^{Y+1}X_{z-1}$
23. $2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$

The above equation can best be described as (a) ionic (b) reduction (c) displacement (d) oxidation

24. Which of the following solutions will have a pH greater than 7 I. Na_2CO_3 II. $NaHCO_3$ III.

$NaCl$ IV. Na_2SO_4 (a) III and IV only (b) I and II (c) III only (d) I only

25. In general, an increase in temperature increases the solubility of an ionic solute in water because: (a) most solutes dissolve with absorption of heat (b) most solutes dissolve with evolution of heat (c) more solute molecules dissociate at higher temperatures (d) more solute molecules collide with each other.

26. $NaCl(s) + H_2SO_4(l) \rightarrow HCl(g) + NaHSO_4(s)$

In the reaction above, H_2SO_4 behaves as (a) a dehydrating agent (b) a non volatile acid (c) an oxidizing agent (d) strong acid

27. For iodine crystals to sublime on heating, the molecules must acquire energy that is: (a) Greater than the forces of attraction in both the solid and the liquid phases (b) Equal to the forces of attraction in the solid (c) Necessary to melt the solid (d) Less than the forces of attraction in the solid.

28. In what way is equilibrium constant for the forward reaction related to that of the reverse reaction? (a) The product of the two is always greater than one. (b) The product of the two is expected to be one (c) The two equilibrium constants are identical (d) The addition of the two is expected to be one.

29. A small quantity of solid ammonium chloride (NH_4Cl) was heated gently in a test tube. The solid gradually disappeared to produce a mixture of two gases. Later a white cloudy deposit was observed on the cooler part of the test tube. The ammonium chloride is said to have undergone. (a) evaporation (b) thermal dissociation (c) distillation (d) sublimation.

30. Which of the following statements is/are correct I. The average kinetic energy of a gas is directly proportional to its temperature II. At constant temperature, the volume of a gas increases as the pressure increases. III. The pressure of a gas is inversely proportional to its volume IV. If pressure is constant, increasing the temperature of a gas will make the volume to increase. (a) II, III and IV only (b) I, II and III only (c) I, II and IV only (d) I, II, III and IV.

31. A basic assumption in the kinetic theory of gases that molecules of a gas move in straight lines between collisions implies that (a) Gases can be compressed (b) Forces of repulsion and attraction are in equilibrium. (c) Molecules will continue their motions indefinitely (d) Collisions are perfectly elastic.

32. Two plugs of glass wool were soaked one into conc. Ammonia and the other into conc. hydrochloric acid at a distance of $150cm^3$ apart. The distance, from NH_3 end, at which a white smoke is first noticed is: (a) 34.4cm (b) 89.2cm (c) 75.2cm (d) 120.2cm [H = 1; N=64; Cl = 35.5].

33.

Initial concentration of NO in moles	Initial Rate (moles/Sec.)
0.001	3.0×10^{-5}
0.002	1.2×10^{-4}

The data in the table above shows the rate of reaction of nitrogen (II) oxide with chlorine at 25°C. It can be concluded that doubling the initial concentration of NO increases the rate of reaction by a factor of (a) five (b) three (c) four (d) two

34. $30cm^3$ of a 0.05M solution is mixed with $10cm^3$ of distilled water the molarity of the resulting solution is(a) 0.36 (b) 0.35 (c) 0.34 (d) 0.38

SECTION B

Answer all the questions in the answer booklet

1(a) Predict the sign of Δs (positive, negative or zero) in each of the following changes.

(i) $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$ (ii) $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ (iii) $H_{2(g)} \rightarrow 2H_{(g)}$

(b) Deduce the formula of the compound which contains:

(i) 6.02×10^{23} atoms of sodium (ii) 35.5g of chlorine and (iii) 3 moles of oxygen atoms in one mole of the compound.

(c) Calculate the number of molecules of CO_2 produced when $10g$ of $CaCO_3$ is treated with $200cm^3$ of $0.1\,moldm^{-3}$ solution of HCl. [Ca=40; C=12; O=16; H=1; Cl=35.5]

2(a) Identify the orbitals described by the following quantum numbers (i) n=2; ℓ=0; (ii) n=5; ℓ=1

(b) Indicate any three differences between the orbitals in (i) and (ii)

(c) From the following standard redox potentials;

Cu^{2+}/Cu ——— +0.34V

Fe^{2+}/Fe ——— $-0.44V$

Calculate the e.m.f. of the galvanic cell formed by using two couples.

(d) What weight of silver is deposited during the electrolysis of silver trioxonitrate (v) at the same time as 2.40g of copper is deposited during the electrolysis of copper(II) tetraoxosulphate(VI)? [$Cu = 64$; $Ag = 108$; $O = 16$; $N = 14$; $H = 1$]

3(a)(i) In an investigation of the stoichiometry of the reaction between sodium trioxocarbonate (iv) and tetraoxosulphate (vi) acid, $25.0cm^3$ portion of $0.050moldm^{-3}$ trioxocar

bonate (iv) solution required an average of $25.0cm^3$ of $0.025mol dm^{-3}$ solution of tetraoxosulphate(vi) acid. Determine the stoichiometry of the reaction. Write a balanced equation for the reaction.

(b) What indicator is suitable for the titration?

(c) Na_2CO_3, is used in acid/base titration

(i) Is this compound an acid, a base or what is it? (ii) Comment on its use in the said titration

(e) $25.0cm^3$ of Calcium chloride solution is mixed with an excess of Silver trioxonitrate (v) solution. The weight of the dry precipitate obtained is 3.507g. Calculate the concentration in $moldm^{-3}$ of the chloride solution [Ca=40; N=14; O=16; Ag=108; Cl=35.5]

SOLUTIONS

1. Metallic character, atomic volume, atomic radius & ionic radius decreases across the period and increase down the group. While electronegativity, electron affinity and ionization energy increases across the period and decrease down the group. Note that atomic number and mass number increases across the period and increases down the group.

None of the option is correct

2. For the reaction:

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \Delta H$ = -ve

Increase in pressure, decrease in temperature, increase in the concentration of N_2 & H_2 and addition of catalyst will favour the formation of NH_3.

The correct option is B

3. SO_2, Iron II salts, H_2SO_3, & H_2S are reducing agent. Reducing agents are also known as REDUCTANT. Note that H_2O_2act as a reducing agent in the presence of a powerful oxidizing agent, (also known as oxidant)

The Correction option is A.

4. H_2, CO_2, CS_2 and $BeCl_2$ are linear.

The correct option is A.

5. Hydrogen bonding is a bond which comes into play whenever hydrogen is directly bonded to oxygen, Nitrogen or fluorine. Hydrogen bond is responsible for the low volatility and unusual boiling point of molecules such as H_2O, HF, NH_3 e.t.c

The correct option is D.

6. In the nuclear reaction:

$^{214}_{82}Pb \rightarrow {}^{214}_{83}Bi + {}^{0}_{-1}e$

The following is true.

(i) The reaction show beta $\left({}^{0}_{-1}e \text{ or } {}^{0}_{-1}\beta\right)$decay

(ii) The parent nucleus is $^{214}_{82}Pb$

(iii) The daughter nucleus is $^{214}_{83}Bi$

(iv) $^{214}_{82}Pb$ and $^{214}_{83}Bi$ are isobar

The correction option is D

7. No of mole of hydride

$$= \frac{\text{vol at s.t.p}}{22.4\text{dm}^3/\text{mol}}$$

$$= \frac{56.0\text{cm}^3}{22400\text{cm}^3/\text{mol}} = 0.0025\text{mol}$$

$$\text{Relative molecules mass of hydride} = \frac{\text{mass of hydride}}{\text{No of mass of hydride}}$$

$= 0.07/0.0025 = 28\,{}^{g}/_{mol}$

$\Rightarrow$ R.M.M of hydride = 28g/mol

% of hydrogen in hydride =14.29%

% of carbon in hydride = 85.71%

Since the measurement is done in percentage, we have to consider 100g of the analyze.

Mass of carbon in 100g of hydride

$$= \frac{85.71}{100} \times 100g = 85.71\text{g}$$

Mass of hydrogen in 100g of hydride =

$$\frac{14.29}{100} \times 100g = 14.2\text{g}$$

C	:	H
$\frac{85.71}{12}$		$\frac{14.2}{1}$
7.1425		14.2
1	:	2

Empirical formula = CH_2

Let $(CH_2)n = 28$

$(12 + 2)n = 28$

$14n = 28$

$n = 2$

$(CH_2)n = (CH_2)2 = C_2H_4$

The molecular formula of the hydride is C_2H_4

The correct option is C.

8. $\text{Molar concentration} = \frac{\text{Amt of solution mol}}{\text{Volume of Sol in dm}^3}$

R.M.M. of NaOH = 40g/mol

No of moles of NaOH = $\frac{\text{Reacting mass}}{\text{Molar mass}}$

$$= \frac{2.0g}{40\text{g/mol}} = 0.05\text{mol}$$

$$\text{Molar concentration} = \frac{\text{No of moles of NaOH}}{\text{Volume of Sol in dm}^3}$$

$$= \frac{0.05\text{mol}}{250\text{cm}^3}$$

$$= \frac{0.05\text{mol}}{0.25\text{cm}^3} = 0.2\text{mol/dm}^3$$

Molar conc. = 0.2mol/dm^3

The correct option is D

9. R.M.M. of H_2SO_4 = 98g/mol

No of moles of H_2SO_4

$= \frac{2.8g}{98g/mol} = 0.0286mol$

$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

0.0286mol 0.0571mol 0.0286mol

$\cap_{H^+} = 0.0571mol = \frac{\text{No of hydrogen ion}}{6.02 \times 10^{23}}$

No of hydrogen ion

$= 0.0571mol \times 6.02 \times 10^{23}$

$= 3.44 \times 10^{22}$

None of the option is correct

10. A double salt is a compound of two salts formed by crystallization from a solution containing both of them i.e. it is a mixture. A double salt has the general formulae $M^{3+}M^{+}(SO_4)_2.12H_2O$ or $M^{2+}(M^{+})_2(SO_4)_2.12H_2O$ e.g $Fe^{2+}(NH_4^{+})_2(SO_4)_2.12H_2O$

The correct option is A

11. Hund's Rule only

The correct option is B

12. Mass detect also known as packing fraction is accounted for by Einstein equation ($E=mc^2$).

The correct option is C.

13. The observation is due to the increase in the number of lone pairs of electron from carbon through nitrogen to oxygen.

The correct option is B.

14. The nature of the three states of matter, Brownian motion, diffusion and evaporation show that matter consist of particles which are in random motion.

The correct option is C.

15. Spontaneity of a reaction implies that;

(i) $\Delta G < 0$ i.e. ΔG = -ve

(ii) $\Delta H < T\Delta S$

(iii) $K > 1$ (K=equilibrium constant)

(iv) $E^0 > 0$ i.e. E^0 = +ve.

The correct option is A.

16. A Lewis acid a substance which accept unshared pair of electron in bonding. Since Cu^{2+} accept unshared pair of electron from NH_3. It is a Lewis acid and NH_3 is Lewis base.

The correct option is C.

17. R.M.M of H_2SO_4 = 98g/mol

R.M.M of NaOH = 40g/mol

$2NaOH + H_2SO_4 \rightarrow NaSO_4 + 2H_2O$

No of mole of NaOH ($\cap_{NaOH}$) =

Vol. (dm^3) × molar conc.

$= \left(\frac{25}{1000}\right)dm^3 \times 0.125 moldm^{-3}$

$= 0.003125mol$

$\cap_{H_2SO_4} = \frac{1\text{ mol of } H_2SO_4}{2\text{ mol of NaOH}} \times 0.003125mol \text{ of NaOH}$

$= 0.0016mol$

Molar concentration of H_2SO_4

$= \frac{0.0016mol}{15cm^3}$

$= \frac{0.0016mol}{0.015dm^3}$

$= 0.1042 mol/dm^3$

The correct option is C

18. PV = nRT

P = 1.00atm

$V = 500cm^3 = 0.5dm^3$

$T = 30^0C = 303k$

$n = \frac{PV}{RT} = \frac{1 \times 0.5}{0.0821 \times 303} = 0.0201mol$

n = 0.0201mol

$No\ of\ mole\ of\ gas\ (\cap gas) = \frac{\text{Reacting mass}}{\text{Molar mass}}$

Molar mass of gas = Reacting mass / No of mole of gas

$= \frac{0.563g}{0.0201mol}$ 28.0107g/mol

The correct option is D

19. $R = \frac{-d[A]}{dt} = k[A][B]^2$

If the conc. of A is double and conc. of B triple then new conc. of A = 2[A]

New conc. of B = 3[B]

$R_2 = k(2[A])(3[B])^2$

$= k(2[A])(9[B])$

$= 18k[A][B]^2$

$R_2 = 18R$

Therefore the rate of reaction is increase by 18 fold.

The correct option is A.

20. $Mg(OH)_2(s) \quad Mg^{2+}(aq) + 2OH^-(aq)$

xM xM 2xM

$K_{sp} = [Mg^{2+}][OH^-]^2$

$= (x)(2x)^2 = x(4x^2) = 4x^3$

$K_{sp} = 4x^3$ but $K_{sp} = 4.2 \times 10^{-12} mol^3dm^{-9}$

$4.2 \times 10^{-12} = 4x^3$

$x = 1.016 \times 10^{-4}M$

The correct option is C

21. E.m.f of cell = $E^0_{oxidant} - E^0_{reductant}$

$= 0.80v - (-0.76v)$

$= 1.56V$

The correct option is B.

.22. The nuclear reaction is:

$^{y}_{z}X + {}^{1}_{0}n \rightarrow {}^{y+1}_{z}X$

The correct option is B

23. The equation $2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$ is an ionic equation because of the presence of ions. It is not a redox equation because none of the element undergoes change in their oxidation number.

The correct option is A

24. A $p^H > 7$ show basicity. But

(i) Na_2CO_3 solution is basic
(ii) $NaHCO_3$ solution is basic
(iii) NaCl solution is neutral
(iv) Na_2SO_4 solution is acidic

Note that $NaHCO_3$ is bicarbonate. it aqueous solution is strongly alkaline due to hydrolysis, although it is an acidic salt

$NaHCO_3 + H_2O \rightarrow NaOH + H_2CO_3$

The correct option is B

25. Increase in temperature increases the solubility of ionic salt or solute because more solute molecules dissociate to form ions.

The correct option is C.

26. In the reaction H_2SO_4 acid as a strong acid to displace a volatile acid from their salts.

The correct option is D.

27. For iodine crystals to sublime on heating, the molecules must acquire energy that is greater than the forces of attraction in both the solid and the liquid phases or states.

The correct option A.

28. $K_f K_b = 1$

Where k_f = equilibrium constant for the forward reaction

k_b =equilibrium constant for the backward reaction

The correct option is B

29. $NH_4Cl(g) \rightleftharpoons NH_3(g) + HCl(g)$

For a substance to sublime it must change from the solid state direct to the gaseous state without passing through the liquid state and the substance must not decompose along the line. Therefore NH_4Cl does not sublime because it decomposes along the process. Since the reaction is reversible, it is rightly called thermal dissociation.

The correct option is B

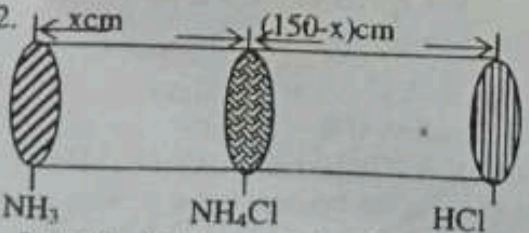
30. Only (i) is correct (iii) is wrong because there is no condition given.

None of the option is correct.

31. Since the molecules of gases move in straight lines between collisions their motion will continue indefinitely on a straight line because their collision is perfectly elastic.

The correct option is D

32.



R.M.M of $NH_3 = 17 g/mol$,

R.M.M. of $HCl = 36.5 g/mol$

Rate of diffusion of $NH_3 = (x/t) cm/s$

Rate of diffusion of $HCl = (100 - x/t) cm/s$

According to Graham's law

$$\frac{RNH_3}{RHcl} = \sqrt{\frac{MHCl}{MNH_3}}$$

$$\frac{x/t}{\frac{150-x}{t}} = \sqrt{\frac{36.5}{17.}}$$

$$= \frac{x}{150-x} = 1.4653.$$

$$x = 1.4653\,(150 - x)$$

$$= 219.7927 - 1.4053x$$

$$x + 1.4653x = 291.7927$$

$$2.4653x = 219.7927$$

$$x = \frac{219.7927}{2.4653} = 89.154cm$$

Distance from NH_3 to the point at which smoke is first notice is $89.20cm^3$

The correct option is B

33. If the concentration changes from 0.01 to 0.02 the rate of reaction changes from 3.0×10^{-5} to 1.2×10^{-4} factors of increase of rate of reaction $= R_2/R_1 = \frac{1.2\times10^{-4}}{3.0\times10^{-5}} = 4$

The correct option is C

34. $C_1V_1 = C_2V_2$ Note that $V_2 = V_1 + V_{H_2O}$

$V_2 = 30 + 10 = 40cm^3$

$30 \times 0.05 = 40C_2$

$C_2 = \frac{30\times0.05}{40} = 0.0375M$

None of the option is correct.

Section B

1a.(i) zero (ii) positive (iii) positive

Note that for an entropy change to be zero, the reactants and products must be in the same state and the number of mole of the reactants and products must be the same. For reaction in which all species are in the same state, the side of the reaction with the highest number will have the greatest entropy

1b. 6.02×10^{23} atoms of sodium mean one mole of sodium. 35.5g of chlorine means 1mole of chlorine.

Therefore, the compound with one mole of sodium and chlorine and three mole of oxygen is $NaClO_3$

1c. $CaCO_{3(g)} \rightarrow CaO_{(s)} + CO_{2(g)}$

R.M.M of $CaCO_3 = 100g/mol$

$$\cap_{CaCO_3} = \frac{10g}{100g/mol} = 0.1mol$$

$\cap_{CO_2} = \frac{1 mole\ of\ CO_2}{1\ mole\ of\ CaCO_3} \times 0.1 mol\ of\ CaCO_3$

$= 0.1mol$

$\cap_{CO_2} = \frac{No\ of\ molecules\ of\ CO_2}{6.02\times10^{23}}$

No of molecules of $CO_2 = 0.1 \times 6.024 \times 10^{23}$
$= 6.02 \times 10^{22}$

2a.(i) n = 2, ℓ = 0 describe 2S – orbital
(ii) n = 5, ℓ = 1 describe 5P - orbital

2b.

2s-orbital	5p-orbital
It has a degeneracy of 1	It has a degeneracy of 3.
It has a lower energy	It has a higher energy
It is spherical in shape	It is dumb-bell in shape
It takes a maximum of two electron	It takes a maximum of six electrons

2c. E.m.f of cell = E^0oxidant – E^0reductant
= 0.34 – (-0.44)
= 0-34 + 0.44
= 0.78v.

Note that, if the standard electrode potential value of elements is positive, it indicates that the species is an Oxidant (or oxidizing agent). While if it is negative, it is a reductant (or reducing agent)

2d. According to Faraday's second law of electrolysis

$$\frac{MAg}{MCu} = \frac{Ccu \times MAg}{CAg \times Mcu}$$

Where C_{Cu} = charge on copper ion
C_{Ag} = charge on silver ion
M_{Ag} = R.M.M of silver
M_{Cu} = R.M.M. of copper

$$\frac{MAg}{2.40} = \frac{2 \times 108}{1 \times 64}$$

$$M_{Ag} = \frac{2 \times 108 \times 2.4}{64} = 8.10g$$

The mass of Silver deposited is 8.10g

3a.No of moles of Na_2CO_3 ($\cap NaCO_3$)

$$= \left(\frac{25}{1000}\right) dm^3 \times 0.05 mol/dm^3$$

= 0.00125mol

No of moles of H_2SO_4 ($\cap H_2SO_4$)

$$= \left(\frac{25}{1000}\right) dm^3 \times 0.025 mol/dm^3$$

= 0.000625mol

$\cap Na_2CO_3$	:	$\cap H_2SO_4$
0.00125		0.000625
2	:	1

Normally the stoichiometry of the reaction between Na_2CO_3 and H_2SO_4 is 1:1.Since the stoichiometry of the reaction is 2:1, it means that Na_2CO_3 is in excess. The water form will hydrolyze the excess Na_2CO_3 to $NaOH$. Hence the balance equation is:

$$2Na_2CO_3 + H_2SO_4 \rightarrow 2NaOH + Na_2SO_4 + 2CO_2$$

3b. A suitable indicator for the titration would be phenolphthalein because it is sensitive to Alkaline medium (base) since the resultant solution is basic.

3c.(i) Na_2CO_3 is a salt

(ii) It used in titration as base is due to its hydrolysis to produce NaOH.

$$Na_2CO_3 + H_2O \rightarrow NaOH + H_2CO_3$$

3d. $2AgNO_3 + CaCl_2 \rightarrow 2AgCl + Ca(NO_3)_2$

R.M.M. of AgCl = 143.5g/mol

$$\cap_{AgCl} = \frac{3.50ng}{143.5g/mol} = 0.0244mol$$

$$\cap_{CaCl_2} = \frac{1 \text{ mole of } CaCl_2}{2 \text{mole of AgCl}} \times 0.0244mol \text{ of AgCl} =$$

0.0122mol

Concentration of $CaCl_2$ =

$$\frac{n}{v} = \frac{0.0122 \text{ mol}}{25cm^3}$$

$$= \frac{0.0122 \text{ mol}}{0.025dm^3}$$

$$= 0.488 mol dm^{-3}$$

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