

AGOTIDEBE MODUPE VICTOR PA
CHM/2019/104

TYPE 4

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA
DEPARTMENT OF CHEMISTRY



CHM 201: BASIC INORGANIC CHEMISTRY
2021/2022 HARMATTAN SEMESTER EXAMINATION

Time Allowed: 2 Hrs

ATTEMPT ALL QUESTIONS

- Quantum numbers are obtained as of solving the Schrödinger Wave Equation of the hydrogen atom or other similar systems.
 - Derivatives
 - Probability
 - Eigenvalues
 - Integration constants
- Which of the following group of statement is true?
 - For $n > 1$, the wave function is zero in certain regions called nodes
 - Magnitude of the wave function is highest at the nucleus.
 - Inversion around the centre is a common feature of all types of orbitals
 - The sign of r changes from +ve to -ve as it passes through a node
 - I, II, III
 - I, II, IV
 - I, IV
 - All of the above
- Identify the correct statement among the following
 - The energy of an electron independent of any quantum number
 - Only the principal and azimuthal quantum numbers determine the energy of an electron
 - All the quantum numbers determine the energy of an electron
 - The energy of an electron is only dependent on the principal quantum number (n)
- Calculate the energy of the outermost electron of Beryllium.
 - 54.40 eV
 - 27.20 eV
 - 108.80 eV
 - 12.93 eV
- Which of the following diatomic ions will have the highest bond distance between its atoms?
 - O_2^+
 - O_2^-
 - O_2^{2+}
 - O_2^{2-}
- Which of the following statements is/are true?
 - Mendeleev's law state that the properties of elements are a periodic function of their atomic number
 - Mendeleev arranged elements in increasing order of their atomic weights to obtain a Mendeleev Periodic Table
 - Mendeleev placed hydrogen in Group 1A with alkali metals
 - I only
 - II & III only
 - III only
 - I & II only
 - The arrangement of elements in the periodic table by Bohr based on Mosely's suggestion addresses many defects of the Mendeleev Periodic Table, except
 - The anomalous position of hydrogen
 - Position of isotopes
 - Non-classification of metals and non-metals
 - Lanthanides and Actinides are not accommodated in the main body of the Periodic Table
 - I & II only
 - I & III only
 - I & IV only
 - II & III only
 - According to modern periodic law, the properties of elements repeat at regular intervals when the elements are arranged in order of:
 - Increasing atomic weights
 - Increasing atomic number
 - Decreasing atomic weights
 - Decreasing atomic number
 - What is the cause of periodicity in the properties of the elements in the periodic table?
 - The atomic number of elements
 - Reoccurrence of similar shell electronic configurations after regular intervals
 - Valence shell of elements
 - Electronic configurations
 - The period and the block of an element with configuration $[Ar]4s^13d^{10}$ in the periodic table are, respectively
 - 4 & s block
 - 3 & s block
 - 4 & d block
 - 3 & d block

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11. Which of the following pairing of quantum numbers and radial nodes is incorrect?
 a. 3p orbital; 1 radial node
 b. 5p orbital; 3 radial nodes
 c. 2d orbital; zero radial nodes
 d. 3s orbital; 1 radial nodes
12. Which of the orbitals between 5p and 4d has the higher radial nodes and by how much?
 a. 4d, 2
 b. 5p, 1
 c. 5p, 2
 d. 4d, 1
13. The number of radial nodes for an orbital is evaluated by
 a. Subtracting one from the difference between principal and azimuthal quantum numbers
 b. Adding one to the difference between magnetic and azimuthal quantum numbers
 c. Subtracting one from the difference between principal and magnetic quantum numbers
 d. Subtracting one from the difference between azimuthal and spin quantum numbers
14. Which scientist's experiments resulted in the nuclear model of the atom?
 a. Ernest Rutherford's gold foil experiments
 b. Johann Hittorf's experiments with objects in vacuum tubes
 c. Robert Millikan's oil drop experiments
 d. William Crookes' experiments passing a current through vacuum tubes
15. Which group of observations were highlighted by Bohr's theory
 I. The slowing down of electrons in an orbit after a while
 II. The attraction of electrons and neutrons
 III. Movement of electrons in defined orbits
 IV. Deceleration of electrons into the nucleus
 a. I, II, III
 b. I, II, IV
 c. I, III, IV
 d. All of the above
16. To which of the groupings can the Schrödinger wave equation be applied?
 I. He²⁺
 II. Be²⁺
 III. H⁺
 IV. Li²⁺
 a. I, II, III
 b. II, III, IV
 c. I, III, IV
 d. All of the above
17. Calculate the wavelength of an electron accelerated from rest through a potential difference of 40 kV.
 a. 4.36 pm
 b. 6.10 pm
 c. 3.54 pm
 d. 12.2 pm
18. What is the minimum uncertainty in the position of an electron accelerated to within 10 μm⁻¹?
 a. 5.80 m
 b. 6.12 m
 c. 3.80 m
 d. 2.12 m
19. Calculate the difference in shielding constants between the 2p electrons in oxygen and nitrogen respectively.
 a. 0.85
 b. 0.35
 c. 1.00
 d. 0.70
20. What is the effective nuclear charge or screening (Z_{eff}) involved for a 2p electron of oxygen?
 a. 3.45
 b. 0.35
 c. 4.55
 d. 8.00
21. Calculate the energy for an electron in the outermost shell of Sulphur.
 a. -45.05 eV
 b. -45.50 eV
 c. -40.55 eV
 d. -54.05 eV
22. The Slater's rule can be quantitatively used to evaluate which of the following group of concepts under the atomic theory.
 I. Orbital penetration
 II. Electron shielding
 III. Proton-neutron interactions
 IV. Effective nuclear charge
 a. I, II, III
 b. I, II, III, IV
 c. II, III, IV
 d. I, II, IV
23. Which between oxygen and nitrogen has the higher effective nuclear charge (Z_{eff}) involving the p-orbital electrons and by how much?
 a. Nitrogen, 0.35
 b. Oxygen, 0.85
 c. Nitrogen, 0.65
 d. Oxygen, 0.65
24. Which of the statements is untrue?
 a. The higher the bond order, the shorter the bond
 b. The lower the bond order, the stronger the bond
 c. The shorter the bond, the shorter the bond distance
 d. The shorter the bond distance, the stronger the bond

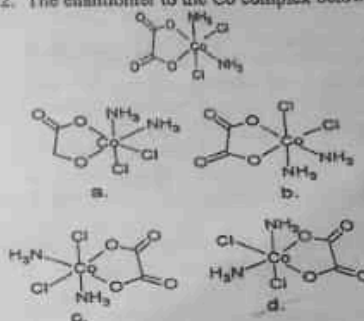
$$\lambda = \frac{h}{\sqrt{2mE}}$$

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25. Using the molecular orbital theory, how many $\pi(\pi)$ electrons are in oxygen molecule.
- 8
 - 4
 - 2
 - 6
26. Identify the correct statement among the following.
- Addition of more electrons to the bonding molecular orbital lowers the bond order and stabilizes the molecule
 - Addition of more electrons to the antibonding molecular orbital reduces the bond order and destabilizes the molecule
 - Addition of more electrons to the antibonding molecular orbital does not impact the bond order or the stability of the molecule
 - Addition of more electrons to the antibonding molecular orbital increases the bond order and stabilizes the molecule
27. How many sigma (σ) electrons are held by Nitrogen and Oxygen atoms respectively?
- 8, 10
 - 12, 14
 - 10, 10
 - 14, 16
28. Which of the following is not a criterion for a stable molecular orbital?
- The energies of the atomic orbitals must be comparable
 - The atomic orbitals must be positioned so that good overlap can occur
 - The orbitals must have uniform electron density
 - The atomic orbitals must have same or approximately the same symmetry with respect to the bond axis
29. Which of the following is the significance of the overlap integral of two combined orbitals A and B?
- measures polarity
 - determines hybridization
 - describes coordination
 - measures bond strength
30. The correct meaning of the term "ungerade" is
- inversion of the orbital through the centre causes a change in sign of the wave function
 - inversion of the orbital through the centre doubles the probability of locating an electron
 - inversion of the orbital through the centre does not result in a change of the sign of the wave function
 - inversion of the orbital through the centre reduces the probability of locating an electron
31. High spin configuration is a result of the
- presence of unpaired electrons
 - presence no forced pairing of the electrons

- presence of strong field ligands
- presence asymmetrically filled orbitals

32. The enantiomer to the Co complex below is



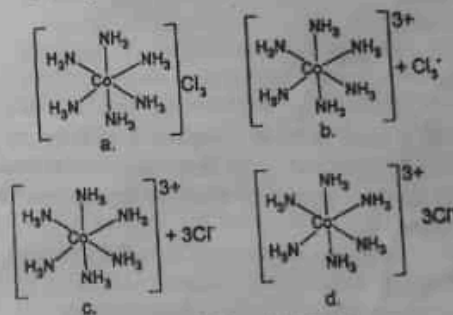
33. Which one of the following complexes would exhibit mer - /fac - isomerism

- $\text{Na}[\text{Fe}(\text{H}_2\text{O})_3(\text{CN})]$
- $\text{Na}_2[\text{Fe}(\text{H}_2\text{O})_2(\text{CN})_2]$
- $\text{Na}_3[\text{Fe}(\text{H}_2\text{O})_3(\text{CN})_3]$
- $\text{Na}_4[\text{Fe}(\text{H}_2\text{O})_2(\text{CN})_4]$

34. Which one of these statements best describes a coordination isomerism?

- Coordination isomerism involves an interchange of H_2O and another ligand within the coordination sphere and outside of it
- Coordination isomerism involves an interchange of ligand between 2 different metal centers in which the cation and anions are themselves complex ions
- Coordination isomerism involves an interchange of an anionic ligand that is inside the coordination sphere with another anionic ligand outside the coordination sphere
- Coordination isomerism arise when one or more ligands can coordinate to a metal ion in more than one way

35. Which one of the following is the correct representation of a complex dissolved in water?

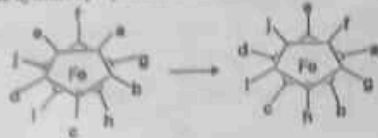


36. C_{60} belong to which point group

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- a. I_h
- b. R_2
- c. T_d
- d. S_6

37. The symmetry operation that ferrocene has undergone is



- a. C_{10}
- b. S_2
- c. S_{10}
- d. σ

38. H_2O and BF_3 both have mirror planes but

- a. BF_3 has both σ_v and σ_h ; H_2O σ_v only
- b. BF_3 has σ_v planes only
- c. H_2O has σ_h planes
- d. H_2O has both σ_v and σ_h ; BF_3 has σ_v only

39. One of the molecules below has no principal axis of rotation or a mirror plane but possesses a center of symmetry, which one is it?

- a. $CClHFBBr$
- b. CH_2FCI
- c. Staggered $C_2H_2F_2Cl_2$
- d. Eclipsed $C_2H_2F_2Cl_2$

40. SF_4 molecule has a seesaw shape instead of tetrahedral. This is because

- a. Sulphur has 6 valence electrons and fluorine has 7
- b. The electron-electron repulsion between the lone pair and bond pair distorts its shape
- c. Sulphur cannot attain complete octet
- d. The molecule has 1 lone pair and 4 bond pairs

41. Consider the following electronic configuration $[Ar]4s^13d^5$; which orbital is being filled?

- a. s-orbital
- b. d-orbital
- c. s and d orbital
- d. none

42. There is a need to have adequate knowledge of the properties of the atoms of the elements to understand the periodic trends in properties. Many of these properties of atoms depend on

- I. The way electrons are arranged around the nucleus.
 - II. Strength of the pull by the nucleus.
 - III. The number of core electrons of the elements.
- a. I, II & III

- b. I & II only
- c. I & III only
- d. II & III only

43. For a given n value, in which of the following orbitals will an electron occupying it have the lowest degree of penetration?

- a. s
- b. p
- c. d
- d. f

44. Which of the following statements about an effective nuclear charge is/are not true?

- I. Both the screening and penetrating effects do not influence it.
 - II. It regularly increases across Period 2.
 - III. A decrease in atomic radii results from its increase across the Period
- a. II & III
b. I only
c. I & III only
d. III only

45. Consider the order $Al^{3+} < Mg^{2+} < Na^+ < F^- < O^{2-}$, which of the following statements is/are true about the order of arrangements of the isoelectronic species? The species have been arranged in order of

- I. Decreasing nuclear charge
- II. Increasing ionic radius
- III. Decreasing atomic number

- a. I & III
- b. II & III only
- c. I, II & III
- d. I & II only

46. Which of the following statements is/are correct about the trends of ionic radius?

- I. If the charge of a cation increases, the ionic radius decreases
- II. If the charge of an anion increases, the ionic radius decreases
- III. If the charge of a cation increases, the ionic radius increases
- IV. If the charge of an anion increases, the ionic radius increases

- a. I & III
- b. I & IV only
- c. II & III only
- d. III & IV only

47. Incorrect order of ionic radius is

- a. $F^- < Cl^-$

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- b. $Fe^{3+} < Fe^{2+}$
 c. $S^{2-} < S^{-}$
 d. $O^{2-} < S^{2-}$
48. Which of the following atomic radii is/are in the correct order?
 I. $Ga > Al$
 II. $Sc < Y < La$
 III. $radius\ 3d < radius\ 4d$
 IV. $Tl = In$
 a. I, II & III only
 b. I, III & IV only
 c. II, III & IV only
 d. I, II & IV only
49. The correct order of Ionisation Energy in the following set is/are
 I. $B > Tl > Ga \geq Al > In$
 II. $Sc < Pb < Ge < Si < C$
 III. $B > In > Ga \geq Al > Tl$
 a. I & II only
 b. I & III only
 c. II & III only
 d. I, II & III
50. Which of the following have approximately the same indicated properties?
 a. In & Tl → ionisation energy
 b. Al & Ga → atomic radii
 c. O^{2-} & F^{-} → ionic radii
 d. F & O → electron affinity
51. Among the following configurations, the element which has the highest electron affinity is
 a. $[Ne]3s^23p^2$
 b. $[Ne]3s^23p^3$
 c. $[Ne]3s^23p^1$
 d. $[Ne]3s^23p^4$
52. Which of the following is/are true about electronegativity?
 I. It decreases as the s-character in hybrid orbital increases.
 II. It decreases when the radius increases.
 III. It increases when the oxidation state of an element increases.
 a. I & II only
 b. I & III only
 c. II only
 d. II & III only
53. The following statements are true about Polarising Power and Polarizability, except
 a. Polarising power is the ion's susceptibility to distortion
- b. A negative ion has greater polarizability than a positive ion
 c. If the degree of polarization is quite small, then the bond remains largely ionic
 d. Large negative ions have greater polarizability than small negative ion
54. According to Fajan's rule, the following factors favour polarisation and hence covalency, except
 a. Large charges on either ion or both ions
 b. A small positive ion
 c. A large positive ion
 d. If positive ions do not have a noble gas configuration
55. Choose the statements that are true about chemical bonding
 I. A bond will only be formed if it is more stable and has lower energy.
 II. Only electrons in the outermost shell of an atom are involved in bond formation.
 III. Chemical changes tend not to occur when the products of the change are not energetically favourable than the reactants
 a. I & II only
 b. II & III only
 c. I & III only
 d. I, II & III
56. Which of the following covalent compounds has a network of three-dimensional arrays of covalently bonded atoms?
 a. Trifluoroethane
 b. Water
 c. Silicon dioxide
 d. Carbon tetrachloride
57. Each of SiH_4 , PH_3 , and H_2S has a similar molecular weight. Arrange in increasing order of melting & boiling points.
 a. SiH_4 , PH_3 , H_2S
 b. H_2S , PH_3 , SiH_4
 c. H_2S , SiH_4 , PH_3
 d. SiH_4 , H_2S , PH_3
58. All the following are entirely true except
 a. Once formed, coordinate covalent bonds are identical to normal covalent bonds
 b. Unequal sharing of electrons occurs when atoms of two different elements are covalently bonded
 c. Differences in electronegativity cause bond polarity
 d. A polar covalent bond cannot occur between the same elements even if the rest of the molecule differs in electron-attracting ability
59. When the surface of a metal is dull rather than lustrous, it is usually because
 a. The free electrons cannot absorb and reemit light of a wavelength in the visible region.

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- b. The valence-free electrons are limited to a specific energy level
 c. The metal has few valence electrons
 d. A layer of metal oxide or sulphide may have formed on the surface
60. The following are true about metallic bonds, except
 a. Metals with many valence electrons will have high melting and boiling points
 b. High thermal conductivity is caused because electrons can move freely as the temperature rises
 c. Metals' malleability and ductility are due to the breaking of bonds when a mechanical force is applied
 d. The electrical conductivity of metal decreases with increase in temperature
61. Which of the following statements about electrochemical cells is true?
 a. Reduction occurs at the anode
 b. An element with a high love for electrons is likely to be easily oxidized
 c. Oxidation occurs at the anode
 d. Only oxidation half-reactions are useful
62. What is E° for the following balanced reaction, if $K = 4.38 \times 10^{10}$

$$\text{Zn}_{(s)} + \text{Fe}^{2+}_{(aq)} \rightarrow \text{Zn}^{2+}_{(aq)} + \text{Fe}_{(s)}$$

 a. +0.315 V
 b. -0.315 V
 c. +0.866 V
 d. -0.866 V

63. What occurs at the anode of a lead storage battery?
 a. Lead is reduced
 b. Lead gains electrons
 c. It is basic
 d. Lead is the reducing agent

64. The value of E° for the following reaction is 1.260 V. What is the value of E°_{cell} given the concentrations shown?

$$2\text{Al}_{(s)} + 3\text{Cd}^{2+}_{(aq)} \rightarrow 2\text{Al}^{3+}_{(aq)} + 3\text{Cd}_{(s)}$$

 0.1 M 0.6 M
 a. 1.235 V
 b. 1.285 V
 c. 1.151 V
 d. 1.372 V

65. The oxidation of methanol, as described by the equation below, has a ΔG° value of cell -937.9 kJ/mol. What is the standard cell potential for a methanol fuel cell?

$$2\text{CH}_3\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 4\text{H}_2\text{O}$$

 a. 0.405 V
 b. 0.810 V
 c. -2.43 V

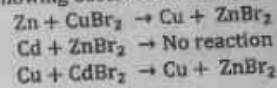
d. -9.72 V

66. What is ΔG° for the following balanced reaction, if $E^\circ = +2.431$ V?

$$\text{Al}_{(s)} + \text{Fe}^{2+}_{(aq)} \rightarrow \text{Al}^{3+}_{(aq)} + \text{Fe}_{(s)}$$

- a. -704 kJ/mol
 b. +704 kJ/mol
 c. -235 kJ/mol
 d. +235 kJ/mol

67. Which of the following correctly ranks the "activity" (strength as reducing agents) of the elements Cu, Cd, and Zn, given the following observed reactivity information?

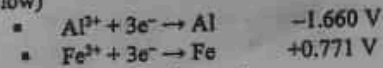


- a. Zn > Cu > Cd
 b. Zn > Cd > Cu
 c. Cu > Cd > Zn
 d. Cu > Zn > Cd

68. Based on the periodic table and general patterns of activity, which of the following would react with metallic calcium?
 $\Rightarrow \text{KBr, NaI, FeCl}_2, \text{NiBr}_2$

- a. Both KBr and NaI
 b. FeCl₂ only
 c. NiBr₂ only
 d. Both FeCl₂ and NiBr₂

69. What is the standard cell potential for a voltaic cell using the Al^{3+}/Al and Fe^{2+}/Fe half-reactions and which metal is the anode? (Use the Standard Reduction Potentials table shown below)



- a. -2.43 V, Al is the anode
 b. +2.43 V, Al is the anode
 c. -0.89 V, Fe is the anode
 d. +0.89 V, Fe is the anode

70. The special characteristic of most corrosion processes is that the oxidation and reduction steps occur at separate locations on the metal. What characteristic of metals enables this to occur?

- a. Colour
 b. Lustre
 c. Malleability
 d. Redox

$$E = 1.260 + \frac{0.0591 \times 0.6}{6} = 1.279$$

Handwritten notes:
 $E = 1.260 + \frac{0.0591 \times 0.6}{6} = 1.279$
 $E = 1.260 + \frac{0.0591 \times 0.6}{6} = 1.279$