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1. A metal rod is dipped in a solution of its ions. Its electrode potential is independent of
   A. temperature of the solution
   B. concentration of the solution
   C. area of the metal
   D. nature of the metal

2. A student made the following observations in the laboratory:
   i. Clean copper metal did not react with 1 M $Pb(NO_3)_2$ solution
   ii. Clean lead metal dissolves in 1 M $AgNO_3$ solution and crystals of Ag metal appeared
   iii. Clean silver metal did not react with 1M $Cu(NO_3)_2$ solution

   A. $Cu > Pb > Ag$ B. $Cu > Ag > Pb$ C. $Pb > Cu > Ag$ D. $Pb > Ag > Cu$

3. We have an oxidation-reduction system: $[Fe(CN)_6]^{3-} + e \rightleftarrows [Fe(CN)_6]^{4-}$; $E^o = +0.36\,V$. The ratio of concentrations of oxidized and reduced form at which the potential of the system becomes 0.24 V is (Given: RT/F = 0.059)

   A. 2:1 B. 1:2 C. 1:20 D. 1:100

4. For an electrochemical cell: $Zn|Zn^{2+}(C_1\,M) \parallel Cu^{2+}(C_2\,M)|Cu$, the decrease in free energy at a given temperature is a function of

   A. In C_1 B. In C_2 C. In $C_2.C_1$ D. In C_1/C_2

5. For the cell: $Ni|Ni^{2+} \parallel Cu^{2+}|Cu; E^o = 0.77\,V$. By which of the following activity, E^o_{cell} will increase?
   A. On decreasing $[Cu^{2+}]$
   B. On decreasing $[Ni^{2+}]$
   C. On increasing mass of Ni electrode
   D. On increasing mass of Cu electrode

6. For a cell reaction involving a two-electron change, the standard electro motive force of the cell is found to be +0.295 V at 25°C. The equilibrium constant of the reaction at 25°C will be

   A. 1×10^{10} B. 1×10^{-10} C. 29.5×10^{-2} D. 2×10^{10}

7. Which one of the following statements is incorrect regarding an electrochemical cell?
   A. The electrode on which oxidation takes place is called anode
   B. Anode is the negative electrode
   C. The direction of the current is the same as that of the direction of flow of electron
   D. The flow of current is partly due to flow of electrons and partly due to flow of ions

8. The correct cell notation for the reaction: $H_2(g) + 2AgCl(s) \rightarrow 2H^+(aq) + 2Cl^-(aq) + 2Ag(s)$ is
   A. $Ag|AgCl(s)|KCl(aq) \parallel AgNO_3(aq)|Ag$
   B. $Pt|H_2(g)|HCl(aq) \parallel AgNO_3(aq)|Ag$
   C. $Pt|H_2(g)|HCl(aq) \parallel AgCl(s)|Ag$
   D. $Pt|H_2(g)|KCl(aq) \parallel AgCl(s)|Ag$

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9. A current of 3.7 A is passed for 6 hours between nickel electrodes in 0.50 liter of 2 M solution of Ni $(NO_3)_2$. The molarity of Ni^{2+} at the end of electrolysis is

A. 1.172 M B. 0.172 M C. 0.586 M D. 2 M

10. The standard E^o_{cell} of a Daniel cell at 298 K is E_1. When the concentration of $ZnSO_4$ is 1.0 M and that of $CuSO_4$ is 0.01 M, the E_{cell} becomes E_2 at 298 K. The correct relationship between E_1 and E_2 is

A. $E_1 = E_2$ B. $E_2 = 0$ C. $E_1 > E_2$ D. $E_1 < E_2$

11. The equation below represent a radioactive decay giving rise to---------

$$^{22}_{11}Na \rightarrow {}^{0}_{1}e + {}^{22}_{10}Ne$$

A. Beta Particle
B. Positron production
C. Electron capture
D. Alpha particle

12. Which of the following statement is incorrect about β-particle
A. It changes thorium-234 nuclide to protactinium-234
B. The mass number of the radioactive nuclide remain unchanged after the decay.
C. The atomic number of the radioactive nuclide increases by one after the decay
D. The net effect is to change a proton into a neutron

13. Supply the missing particle and name the decay process in these equations

$$^{195}_{79}Au + ? \rightarrow {}^{195}_{78}Pt$$

A. $^{0}_{-1}e$ and Positron
B. $^{0}_{-1}e$ and β-particle
C. $^{0}_{-1}e$ and Electron capture
D. $^{0}_{-1}e$, β-particle/electron capture

14. Radioactivity is not applicable in the field of
A. Medicine
B. Food processes
C. Electricity
D. Carbon dating

15. In a solution prepared by dissolving 0.1 mol $NaNO_2$ in 1.0 L pure water, which species has the lowest concentration?
A. Na^+
B. NO_2^-
C. HNO_2
D. H_3O^+

16. Lead (II) iodide has a solubility product constant of 1.4×10^{-8}. What is the concentration of iodide ion in a saturated solution of PbI_2?
A. 1.2×10^{-4} M B. 2.4×10^{-4} M C. 1.5×10^{-3} M D. 3.0×10^{-3} M

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17. Carbon monoxide reacts with hydrogen in the presence of a catalyst to give methanol:
$CO(g) + 2\ H_2(g) \leftrightarrows CH_3OH(g)$
A metal container at 400 K is charged with 2.00 atm of an equimolar mixture of CO and H_2. A catalyst for the reaction is introduced and the pressure falls to 1.29 atm once equilibrium is achieved. What is K_p for this reaction at 400 K?
A. 1.32 B. 6.54 C. 8.44 D. 29.1

18. A 0.10 M solution of glycolic acid is 3.8% ionized. What is the percent ionization of a 0.50 M solution of glycolic acid? (Assume glycolic acid is a weak acid)
A. 1.7 % B. 3.8 % C. 8.5 % D. 19.0 %

19. The hydrogenation of carbon monoxide represented below is exothermic.
$CO(g) + 2\ H_2(g) \leftrightarrows CH_3OH(g)$ $\Delta H°_{rxn} < 0$
Which changes will increase the equilibrium yield of CH_3OH?
I. Increasing the temperature of the system
II. Removing some of the $CH_3OH(g)$
A. I only B. II only C. Both I and II D. Neither I nor II

20. What is the pH of a 0.10 M solution of nitrous acid (HNO_2, $K_a = 7.2 \times 10^{-4}$)?
A. 1.57 B. 2.07 C. 2.57 D. 11.43

21. The K_{sp} of $Sr(OH)_2$ is 2.0×10^{-3}. What is the pH of a saturated solution of $Sr(OH)_2$?
A. 11.30 B. 12.65 C. 12.90 D. 13.20

22. 100.0 mL 0.15 M aqueous HF ($K_a = 6.8 \times 10^{-4}$) is mixed with 125.0 mL 0.23 M NaF. What is the pH of the resulting solution?
A. 2.17 B. 3.17 C. 3.35 D. 3.45

23. Consider the reaction:
$H_2(g) + Br_2(g) \leftrightarrows 2\ HBr(g)$ $K_{eq} = ???$
Into a 1.00 L vessel, 1.00 mol $H_2(g)$ and 1.00 mol $Br_2(g)$ are placed at a high temperature. When the reaction mixture stops changing, it is found that 79.0% of the $H_2(g)$ has reacted. What is the equilibrium constant for this reaction at this temperature?
A. 14.2 B. 17.9 C. 35.8 D. 56.6

24. For the reaction $2HI(g) \leftrightarrows H_2(g) + I_2(g)$, what is the relationship between K_c and K_p at 25 °C?
A. $K_c = K_p$
B. $K_c > K_p$
C. $K_c < K_p$
D. The relationship varies depending on the pressure.

25. Calculate the $[H^+]$ in a 0.25 M solution of methylamine (weak base), CH_3NH_2 ($K_b = 4.4 \times 10^{-4}$).
A. 1.1×10^{-4}
B. 1.05×10^{-2}
C. 9.1×10^{-11}
D. 9.5×10^{-13}

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26. For the reaction $CaCO_3(s) \leftrightarrows CaO(s) + CO_2(g)$, the value of K_p is

A. P_{CO_2} B. $\frac{P_{CO_2}}{P_{CaCO_3}}$ C. $\frac{P_{CaO}P_{CO_2}}{P_{CaCO_3}}$ D. $\frac{P_{CaCO_3}}{P_{CaO}P_{CO_2}}$

27. Consider the formation of SO_3 according to the reaction $2SO_2(g) + O_2(g) \leftrightarrows 2SO_3(g)$; $\Delta H = -198kJ$. Which of the following may change the value of the equilibrium constant of the above reaction?
   A. Adding He gas to reaction vessel.
   B. Adding more of O_2 to the reaction vessel.
   C. Increasing the temperature.
   D. Doubling the volume of reaction vessel.

28. At chemical equilibrium, a reaction is
   A. spontaneous in forward direction.
   B. spontaneous in backward direction.
   C. spontaneous in both directions.
   D. spontaneous in neither direction

29. The equilibrium constants for some reactions are given below against each of the reaction
   i. $2N_2 + 5O_2 \leftrightarrows N_2O_5; K = 5 \times 10^{-27}$
   ii. $N_2 + O_2 \leftrightarrows NO; K = 2 \times 10^{-15}$
   iii. $N_2 + 2O_2 \leftrightarrows NO_2; K = 1.5 \times 10^{-29}$

   Which of the following statement is correct?
   A. The least stable oxide is NO_2.
   B. The most stable oxide is NO
   C. The stability order is $N_2O_5 > NO_2 > NO$.
   D. The stability order is $NO_2 > NO > N_2O_5$.

30. Consider the reaction between Fluorine and Chlorine dioxide represented by the following equation:

   $F_2(g) + 2ClO_2(g) \rightarrow 2FClO_2(g)$

   If 0.030 Mole of ClO_2 is consumed in 1.0 liter of solution per second. What is the rate of consumption of F_2?

   A. 0.030 M/s B. 0.015 M/s C. 0.060 M/s D. 0.150 M/s

31. $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$

   If the concentration of N_2O_5 in the equation above at time 600 s is 1.24×10^{-2} M and at 1200 s, the concentration is 0.93×10^{-2} M. Calculate the rate of formation of O_2 at the same period.

   A. 1.04×10^{-6} M/s B. 1.04×10^{-5} M/s C. 5.2×10^{-6} M/s D. 2.6×10^{-6} M/s

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32. For the reaction $BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$, if at a particular time, $\Delta[BrO_3^-]/\Delta t = 1.5 \times 10^{-2}$. What is $\Delta[Br^-]/\Delta t$ at the same time.
A. 13 M/s B. 1.5×10^{-2} M/s C. 0.0075 M/s D. 7.5×10^{-2} M/s

33. In the oxidation of Bromide ion in an acidic solution, the experimentally determined rate law is:
Rate = $k[Br^-][HBrO_3^-][H^+]^2$. What is the overall order of the reaction?
A. 1 B. 2 C. 3 D. 4.

34. The rate constant for the formation of hydrogen iodide from the elements:
$H_2(g) + I_2(g) \rightarrow 2HI(g)$ is 2.7×10^{-4} L/(M.s) at 600K and 3.5×10^{-3} L/(M.s) at 650K. Calculate the activation energy E_a for the reaction. ($R = 8.314$ $Jmol^{-1}K^{-1}$)
A. 1.66×10^5 J/mol. B. 3.32×10^5 J/mol. C. 8.3×10^4 J/mol. D. 1.66×10^3 J/mol. +5, +7

35. The reaction $A + 2B \rightarrow 2C$, the rate of disappearance of B is 2.53×10^{-5}M/s. What is the rate of formation of C?
A. 1.26×10^{-5}M/s. B. 2.53×10^{-5}M/s. C. 5.06×10^{-5}M/s. D. 2.53×10^{-4}M/s.

36. The rate of Zero-order chemical reaction A → B can be represented as follows:
A. Rate = k[A][B] B. Rate = k C. Rate = k[lnA] D. Rate = k[A].

37. The initial rate of a reaction represented by A + B → C was measured at different concentrations of A and B in the following experiments.

Experiments No	[A] (Mol./dm^3)	[B] (Mol./dm^3)	Initial Rate (M/s)
1	0.030	0.010	1.7×10^{-8}
2	0.060	0.010	6.8×10^{-8}
3	0.030	0.020	3.37×10^{-8}

What is the order of the reaction with respect to [A] ?
A. 4. B. 2. C. 3. D. 1.

38. Using the above table, calculate the value of the rate constant for the reaction.
A. $1.89 \times 10^{-3}(mol/dm^3)^{-2}.s^{-1}$ B. $5.67 \times 10^{-5}(mol/dm^3)^{-2}.s^{-1}$ C. $2.1 \times 10^3(mol/dm^3)^{-2}.s^{-1}$ D. $3.78 \times 10^{-3}(mol/dm^3)^{-2}.s^{-1}$

39. In a first-order reaction, A → Product, $k = 0.015\ min^{-1}$. If [A] is 0.400 M initially, what will [A] be after 2.00 hours?.
A. 0.388 B. 0.0661 M C. 0.056 M D. 1.92×10^{-3} M

40. The followings are true of the Periodic Table of Elements except?

(i) Elements Li, Na, K in the periodic table are called alkali metals.
(ii) Elements Be, Mg, Ca are described as metalloids.
(iii) The elements F, Cl, Br are called halogens.
(iv) Metals at the bottom of Group 1 are the most powerful oxidising agents.
(v) Elements in d-block and f-block are called transition and inner transition elements respectively.

A. i, ii and v only B. iv and v only C. i iii, iv D. ii and iv only

41. Which of the followings best describe the factors that determine the radius of an atom?
i. The attractive force between the nucleus and the outermost electrons;
ii. The shielding/screening of the outermost electrons by the inner electrons;
iii. The energy released when a gaseous atom accepts an electron
iv. The number of shells occupied by electrons.

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A. ii and iv only B. i and ii only C. ii, iii and iv only D. i, ii and iv only

42. Given that the abundance of the lighter bromine isotope is 50.54%, calculate the natural atomic weight of bromine, if the element has only two naturally occurring isotopes weighing 78.9184 and 80.9163 respectively. Express your answer to 3 significant figure.
A. 79.9 B. 97.9 C. 87.9 D. 68.

43. The ground state electronic configuration for Ni (Atomic no 28) in a shorthand form is

A. [Ar] $4s^1 3d^{10}$ B. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$ C. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
D. [Ar] $4s^2 3d^8$.

44. The table below shows the values of Subsidiary/Angular quantum numbers and shapes of the orbitals identify correctly letters X, Y and Z in the table respectively.

ℓ	0	1	Y	3
Orbital type	X	P	d	Z

A. s, 2 and f B. g, 2 and s C. f, 2 and s D. f, 4 and g

45. The molar enthalpy of solution of a salt that dissolves endothermically in water is measured in a coffee-cup calorimeter by weighing a known amount of distilled water into the cup and measuring its temperature, then adding a known mass of the salt to the water and measuring the temperature after the salt dissolves. If some water is initially present in the cup before the weighed amount of water is added, what is the effect on the experiment?
A. Calculated $\Delta H°soln >$ True $\Delta H°soln$
B. Calculated $\Delta H°soln =$ True $\Delta H°soln$
C. Calculated $\Delta H°soln <$ True $\Delta H°soln$
D. The reaction will be calculated to be exothermic even though it is actually endothermic.

46. When liquid water converts to solid ice at 0 °C and 1 atm pressure, which of the following changes takes place?

A. Heat flows out of the system.
B. The volume of the system decreases.
C. The vapor pressure of water increases.
D. The hydrogen bonds become weaker.

47. Which compound has the lowest normal boiling point?
A. HF B. HCl C. HBr D. HI

48. 37.5 g piece of gold at 83.0 °C is added to 100. g H_2O at 22.0 °C in a well-insulated cup. What is the temperature after the system comes to equilibrium? (The specific heat capacity of Au is 0.129 $J.g^{-1}.K^{-1}$, Specific heat capacity of water is 4.2 $J.g^{-1}.K^{-1}$)
A. 22.7 °C B. 23.0 °C C. 25.0 °C D. 52.5 °C

49. Processes are always spontaneous, regardless of temperature, when _____
A. $\Delta H > 0$ and $\Delta S < 0$ B. $\Delta H < 0$ and $\Delta S < 0$

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C. $\Delta H < 0$ and $\Delta S > 0$

D. None of these is true, as temperature must always be taken into account.

50. The overall reaction in a commercial heat pack can be represented as

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \quad \Delta H = -1652\ kJ \quad [Fe = 55.84; O = 16.0]$$

How much heat is released when 10 g Fe is reacted with 2.00 g O_2?

A. 74.0 kJ B. 34.4 kJ C. 7.4 kJ D. 51.6 kJ

51. Given the following data:

$C_2H_2(g) + \frac{5}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$ $\Delta H = -1300\ kJ$

$2C(s) + 2O_2(g) \rightarrow 2CO_2(g)$ $\Delta H = -394\ kJ$

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286\ kJ$

Calculate ΔH for the reaction: $2C(s) + H_2(g) \rightarrow C_2H_2(g)$

A. -620 kJ B. -798 kJ C. +226 kJ D. +620 kJ

52. Use bond energies to estimate the ΔH for the combustion of one mole of acetylene:

$$C_2H_2(g) + \frac{5}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(g)$$

Given: Average Bond Energies of C≡C, C-H, C=O, O-H, O=O are 839, 413, 799, 467 and 495 kJ/mol respectively.

A. -1227.5 kJ B. -370.5 kJ C. +370.5 kJ D. -1022 kJ

53. If the decomposition of 2 moles of gaseous HCl into 1 mole each of gaseous H_2 and gaseous Cl_2 at 25 °C absorbs 185 kJ of heat energy, then what is the standard heat of formation of HCl in kilojoules per mole?

A. +92.5 kJ/mol B. −185.0 kJ/mol C. +185.0 kJ/mol D. -92.5 kJ/mol

54. Which one of the following reactions result in a positive ΔS_{sys}.

A. $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

B. $H_2O(g) + CO_2(g) \rightarrow H_2CO_3(aq)$

C. $H_2O(g) \rightarrow H_2O(l)$

D. $C_2H_2O_2(g) \rightarrow 2CO(g) + H_2(g)$

55. The enthalpy of vaporization of methanol (CH_3OH) is 35.3 kJ/mol at the boiling point of 62.4 °C. Calculate the entropy change for methanol going from liquid to vapor.

A. 600 J/K.mol B. 551 J/K.mol C. 105 J/K.mol D. -105 J/K.mol

56. Calculate the standard entropy change for the following reaction:

$$Cu(s) + \frac{1}{2}O_2(g) \rightarrow CuO(s)$$

Given that $S^0[Cu(s)] = 33.15$ J/K.mol

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$S^\circ [O_2(g)] = 205.14$ J/K.mol

$S^\circ [CuO(s)] = 42.63$ J/K.mol

A. 195.66 J/K B. 93.09 J/K C. -93.09 J/K D. -45.28 J/K

57. Consider the reaction: $\frac{3}{2} O_2(g) \rightarrow O_3(g)$

Calculate ΔG° for this reaction given: T = 25 °C, $\Delta H^\circ_f [O_3(g)] = 142.2$ kJ mol, $S^\circ [O_2(g)] =$ 205.0 J/K.mol and $S^\circ [O_3(g)] = 237.7$ J/K.mol

A. 163 kJ B. -69.8 kJ C. -163 kJ D. 69.8 KJ

58. A carbonate, MCO_3, of an unknown metal, M, is treated with HCl to produce CO_2. Upon treating 1.00 g of MCO_3 with excess HCl, 0.522 g of CO_2 is produced. What is the percentage by mass of M in MCO_3? [C = 12.0; O = 16.0]

A. 84.3% B. 43.8% C. 28.8% D. 24.3%

59. A portable hydrogen generator utilizes the reaction: $CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$. How many g of hydrogen can be produced by a 70 g cartridge of CaH_2? [H = 1.0; O = 16; Ca = 40].

A. 6.7 g B. 9.7 g C. 12.7 g D. 15.7 g

60. How many mL of water must be added to 200 mL of 0.65 M HCl to give a solution of 0.20 M HCl solution?

A. 650 mL B. 550 mL C. 450 mL D. 200 mL

61. A 0.07 g sample of a given hydrocarbon, C_xH_y, occupies 56.0 cm^3 at s.t.p. when vaporized. What is the formula of the hydrocarbon given that it contains 14.29% H by mass? [H = 1; C = 12]; Molar Volume of gas at STP =22.4 liters)

A. C_3H_6 B. C_2H_4 C. C_3H_8 D. C_2H_6

62. Calculate the respective oxidation numbers of Cl in ClO_3^- and ClO_4^- [O = -2]

A. +7, +5 B. +5, +7 C. -5, -7, D. -7, -5