CHEMISTRY

SECTION- I

STRAIGHT OBJECTIVE TYPE

This section contains 6 multiple choice questions. Each question has 4 choice (A), (B), (C) and (D), out of which ONLY-ONE is correct

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47. 2.5 mL of $\frac{2}{5}$ M weak monoacidic base ($K_b = 1 \times 10^{-12}$ at 25°C) is titrated with $\frac{2}{15}$ M HCl in water at 25°C. The concentration of H^+ at equivalence point is ($K_w = 1 \times 10^{-14}$ at 25°C)

(A) 3.7×10^{-13} M (B) 3.2×10^{-7} M (C) 3.2×10^{-2} M (D) 2.7×10^{-2} M

Sol: Ans [C] At equivalence point, equivalents of acid = equivalents of base

$$\frac{2}{15} \times V = 2.5 \times \frac{2}{5}$$

$$V = 7.5 \text{ ml}$$

Total volume = 2.5 + 7.5 = 10 ml

$$\text{concentration of salt at equivalence point} = \frac{2.5 \times \frac{2}{5}}{10}$$

$$C = 0.1 \text{ M}$$

$BOH + HCl \longrightarrow BCl + H_2O$

Now BCl undergoes hydrolysis

$B^+ + H_2O \rightleftharpoons BOH + H^+$

$$[H^+] = Ch = C \times \sqrt{\frac{K_w}{K_b \times C}} = \sqrt{\frac{K_w}{K_b} \times C} = 3.33 \times 10^{-2} \text{ M}$$

48. Native silver metal forms a water soluble complex with a dilute aqueous solution of NaCN in the presence of

(A) nitrogen (B) oxygen (C) carbon dioxide (D) argon

Sol: Ans [B]

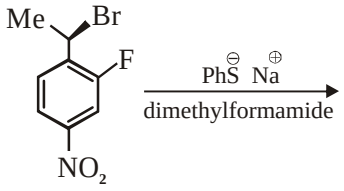
49. Under the same reaction conditions, initial concentration of 1.386 mol dm^{-3} of a substance becomes half in 40 seconds and 20 seconds through first order and zero order kinetics, respectively. Ratio $\left(\frac{k_1}{k_0}\right)$ of the rate constants for first order (k_1) and zero order (k_0) of the reactions is

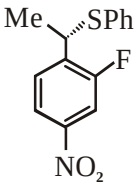
(A) 0.5 mol^{-1} dm^3 (B) 1.0 mol dm^{-3} (C) 1.5 mol dm^{-3} (D) 2.0 mol^{-1} dm^3

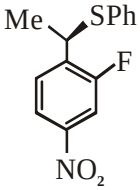
Sol: Ans [A] $K_1 = \frac{0.693}{40}$, $K_0 = \frac{1.386}{2\times 20}$

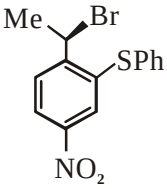
$$\frac{K_1}{K_0} = \frac{0.693}{40}\times\frac{40}{1.380} = 0.5 \text{ mol}^{-1}\text{dm}^3.$$

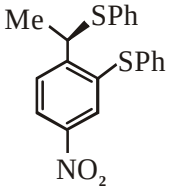
50. The major product of the following reaction is



(A) 

(B) 

(C) 

(D) 

Sol: Ans [A] It is S_N2 reaction as solvent is polar aprotic and S_N2 reaction leads to walden inversion.

51. Aqueous solution of $Na_2S_2O_3$ on reaction with Cl_2 gives

(A) $Na_2S_4O_6$ (B) $NaHSO_4$ (C) NaCl (D) NaOH

Sol: Ans [B] $Na_2S_2O_3$ when react with I_2 forms $Na_2S_4O_6$ but with other halogen molecules sulphur is oxidised to +6 oxidation state.

52. Hyperconjugation involves overlap of the following orbitals

(A) $\sigma - \sigma$ (B) $\sigma - p$ (C) $p - p$ (D) $\pi - \pi$

Sol: Ans [B] Hyperconjugation is overlap of σ – p orbital

SECTION- II

MULTIPLE CORRECT ANSWERS TYPE

This section contains 4 multiple correct answer(s) type questions. Each question has 4 choice (A), (B), (C) and (D), out of which ONE OR MORE is correct

53. A gas described by van der Waals equation

(A) behaves similar to an ideal gas in the limit of large molar volumes

(B) behaves similar to an ideal gas in the limit of large pressures

(C) is characterized by van der Waals coefficients that are dependent on the identity of the gas but are independent of the temperature

(D) has the pressure that is lower than the pressure exerted by the same gas behaving ideally

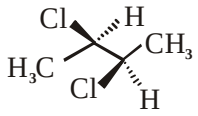
Sol: Ans [A,C,D]

54. A solution of colourless salt **H** on boiling with excess NaOH produces a non-flammable gas. The gas evolution ceases after sometime. Upon addition of Zn dust to the same solution, the gas evolution restarts. The colourless salt(s) **H** is (are)

(A) NH_4NO_3 (B) NH_4NO_2 (C) NH_4Cl (D) $(NH_4)_2SO_4$

Sol: Ans [A,B]

55. The correct statement(s) about the compound given below is (are)

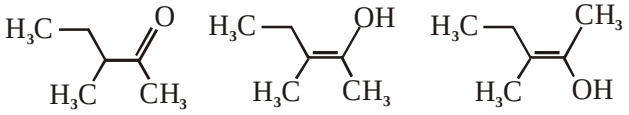


(A) The compound is optically active (B) The compound possesss centre of symmetry

(C) The compound possesses plane of symmetry (D) The compound possesses axis of symmetry

Sol: Ans [A] Configuration around both the carbon is R – R.

56. The correct statement(s) concerning the structures **E, F** and **G** is (are)



(**E**) (**F**) (**G**)

(A) **E, F** and **G** are resonance structures (B) **E, F** and **E, G** are tautomers

(C) **F** and **G** are geometrical isomers (D) **F** and **G** are diastereomers

Sol: Ans [B,C,D] **E, F, G** are tautomer but not resonating structures.

SECTION- III

REASONING TYPE

This section contains 4 reasoning type questions. Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct.

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57. STATEMENT-1: Pb^{4+} compounds are stronger oxidizing agents than Sn^{4+} compounds.

and

STATEMENT-2: The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to 'inert pair effect'.

(A) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is a correct explanation for STATEMENT-1

(B) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is **NOT** a correct explanation for STATEMENT-1

(C) STATEMENT-1 is True, STATEMENT-2 is False

(D) STATEMENT-1 is False, STATEMENT-2 is True

Sol: Ans [C] Lower oxidation state becomes more stable down the group due to inert pair effect.

58. STATEMENT-1: The plot of atomic number (*y*-axis) versus number of neutrons (*x*-axis) for stable nuclei shows a curvature towards *x*-axis from the line of 45° slope as the atomic number is increased.

and

STATEMENT-2: Proton-proton electrostatic repulsions begin to overcome attractive forces involving protons and neutrons in heavier nuclides.

(A) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is a correct explanation for STATEMENT-1

(B) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is **NOT** a correct explanation for STATEMENT-1

(C) STATEMENT-1 is True, STATEMENT-2 is False

(D) STATEMENT-1 is False, STATEMENT-2 is True

Sol: Ans [B]

59. STATEMENT-1: Bromobenzene upon reaction with Br_2/Fe gives 1, 4-dibromobenzene as the major product.

and

STATEMENT-2: In bromobenzene, the inductive effect of the bromo group is more dominant than the mesomeric effect in directing the incoming electrophile.

(A) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is a correct explanation for STATEMENT-1

(B) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is **NOT** a correct explanation for STATEMENT-1

(C) STATEMENT-1 is True, STATEMENT-2 is False

(D) STATEMENT-1 is False, STATEMENT-2 is True

Sol: Ans [C] Statement 2 is wrong as I-effect is not important in directing the incoming electrophile.

60. STATEMENT-1: For every chemical reaction at equilibrium, standard Gibbs energy of reaction is zero.

and

STATEMENT-2: At constant temperature and pressure, chemical reactions are spontaneous in the direction of decreasing Gibbs energy.

(A) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is a correct explanation for STATEMENT-1

(B) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 is **NOT** a correct explanation for STATEMENT-1

(C) STATEMENT-1 is True, STATEMENT-2 is False

(D) STATEMENT-1 is False, STATEMENT-2 is True

Sol: Ans [D] $\Delta G = 0$ at equilibrium but ΔG^0 is not zero.

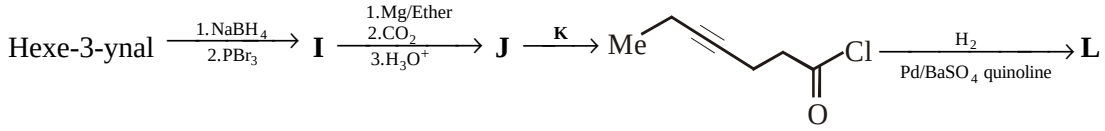
SECTION- IV

LINKED COMPREHENSION TYPE

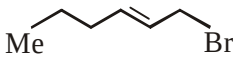
This section contains 3 Paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

Paragraph for Question Nos. 61 to 63

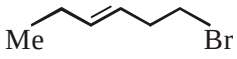
In the following reaction sequence, products **I**, **J** and **L** are formed. **K** represents a reagent.



61. The structure of the product **I** is

(A) 

(B) 

(C) 

(D) 

Sol: Ans [D] $CH_3–CH_2C \equiv CCH_3CHO \xrightarrow{NaBH_4} CH_3CH_2C \equiv CCH_2CH_2OH$

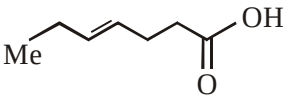
$\xrightarrow{P.Br_3} CH_3CH_2C \equiv CCH_2CH_2Br$

(I)

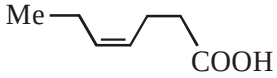
62. The structures of compounds **J** and **K**, respectively, are

(A) 

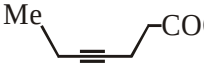
and $SOCl_2$

(B) 

and SO_2Cl_2

(C) 

and $SOCl_2$

(D) 

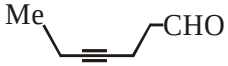
and CH_3SO_2Cl

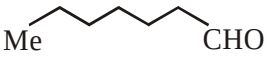
Sol: Ans [A] $CH_3CH_2C \equiv CCH_2CH_2Br \xrightarrow[3.H_3O^+]{1.Mg/Ether\ 2.CO_2} CH_3CH_2C \equiv CCH_2CH_2COOH$

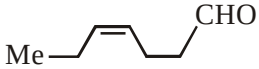
J

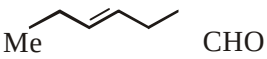
$\xrightarrow[K]{SOCl_2} CH_3CH_2C \equiv CCH_2CH_2COCl$

63. The structure of product **L** is

(A) 

(B) 

(C) 

(D) 

Sol: Ans [C] $CH_3CH_2C \equiv CCH_2CH_2COCl \xrightarrow[Pd/BaSO_4 \text{ quinoline}]{H_2} CH_3CH_2CH = CHCH_2CH_2CHO.$

L

Paragraph for Question Nos. 64 to 66

There are some deposits of nitrates and phosphates in earth's crust. Nitrates are more soluble in water. Nitrates are difficult to reduce under the laboratory conditions but microbes do it easily. Ammonia forms large number of complexes with transition metal ions. Hybridization easily explains the ease of sigma donation capability of NH_3 and PH_3. Phosphine is a flammable gas and is prepared from white phosphorous.

64. Among the following, the correct statement is

(A) Phosphates have no biological significance in humans

(B) Between nitrates and phosphates, phosphates are less abundant in earth's crust

(C) Between nitrates and phosphates, nitrates are less abundant in earth's crust

(D) Oxidation of nitrates is possible in soil

Sol: Ans [C] As nitrates are more soluble in water, phosphate are more abundant in earth crust.

65. Among the following, the correct statement is

(A) Between NH_3 and PH_3, NH_3 is a better electron donor because the lone pair of electrons occupies spherical 's' orbital and is less directional.

(B) Between NH_3 and PH_3, PH_3 is a better electron donor because the lone pair of electrons occupies sp^3 orbital and is more directional

(C) Between NH_3 and PH_3, NH_3 is a better electron donor because the lone pair of electrons occupies sp^3 orbital and is more directional

(D) Between NH_3 and PH_3, NH_3 is a better electron donor because the lone pair of electrons occupies spherical 's' orbital and is less directional

Sol: Ans [C] NH_3 is better electron donor, and the lone pair is present in sp^3 hybrid orbital.

66. White phosphorous on reaction with NaOH gives PH_3 as one of the products. This is a

(A) dimerization reaction (B) disproportionation reaction

(C) condensation reaction (D) precipitation reaction

Sol: Ans [B] $P_4 + NaOH \longrightarrow PH_3 + NaH_2PO_2$

It is dispropornation reaction.

Paragraph for Question Nos. 67 to 69

Properties such as boiling point, freezing point and vapour pressure of a pure solvent change when solute molecules are added to get homogeneous solution. These are called colligative properties. Applications of colligative properties are very useful in day-to-day life. One of its examples is the use of ethylene glycol and water mixture as anti-freezing liquid in the radiator of automobiles

A solution **M** is prepared by mixing ethanol and water. The mole fraction of ethanol in the mixture is 0.9

Given: Freezing point depression constant of water $\left(K_f^{water}\right)$ = 1.86 K kg mol^{-1}

Freezing point depression constant of ethanol $\left(K_f^{ethanol}\right)$ = 2.0 K kg mol^{-1}

Boiling point elevation constant of water $\left(K_b^{water}\right)$ = 0.52 K kg mol^{-1}

Boiling point elevation constant of ethanol $\left(K_b^{ethanol}\right)$ = 1.2 K kg mol^{-1}

Standard freezing point of water = 273 K

Standard freezing point of ethanol = 155.7 K

Standard boiling point of water =373 K

Standard boiling point of ethanol = 351.5 K

Vapour pressure of pure water = 32.8 mm Hg

Vapour pressure of pure ethanol = 40 mm Hg

Molecular weight of water = 18 g mol^{-1}

Molecular weight of ethanol = 46 g mol^{-1}

In answering the following questions, consider the solutions to be ideal dilute solutions and solutes to be non-volatile and non-dissociative.

67. The freezing point of the solution **M** is

(A) 268.7 K (B) 268.5 K (C) 234.2 K (D) 150.9 K

Sol: **Ans [D]** Ethanol is solvent and water is solute

$$\Delta T_f = K_f \times m = 2 \times \frac{1000 \times x_B}{M_A \times x_A}$$

$$= 2 \times 2.415 = 4.83.$$

$$T_f = T° - \Delta T_f = 155.7 - 4.86 = 150.9 \text{ K}$$

68. The vapour pressure of the solution **M** is

(A) 39.3 mm Hg (B) 36.0 mm Hg (C) 29.5 mm Hg (D) 28.8 mm Hg

Sol: **Ans [A]** $P_A = P°_A \cdot x_A = 40 \times 0.9$

$P_B = P°_B \cdot x_B = 32.8 \times 0.1$

$P = P_A + P_B = 39.3$ mm kg.

69. Water is added to the solution **M** such that the mole fraction of water in the solution becomes 0.9. The boiling point of this solution is

(A) 380.4 K (B) 376.2 K (C) 375.5 K (D) 354.7 K

Sol: **Ans [B]** Now mole fraction of water is 0.9 hence water is solvent.

$\Delta T_b = K_b \times m = 0.52 \times 6.173 = 3.209$

$T_b = T° + \Delta T_b = 376.2$ K.