

CHEMISTRY

SECTION-I

Straight Objective Type

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

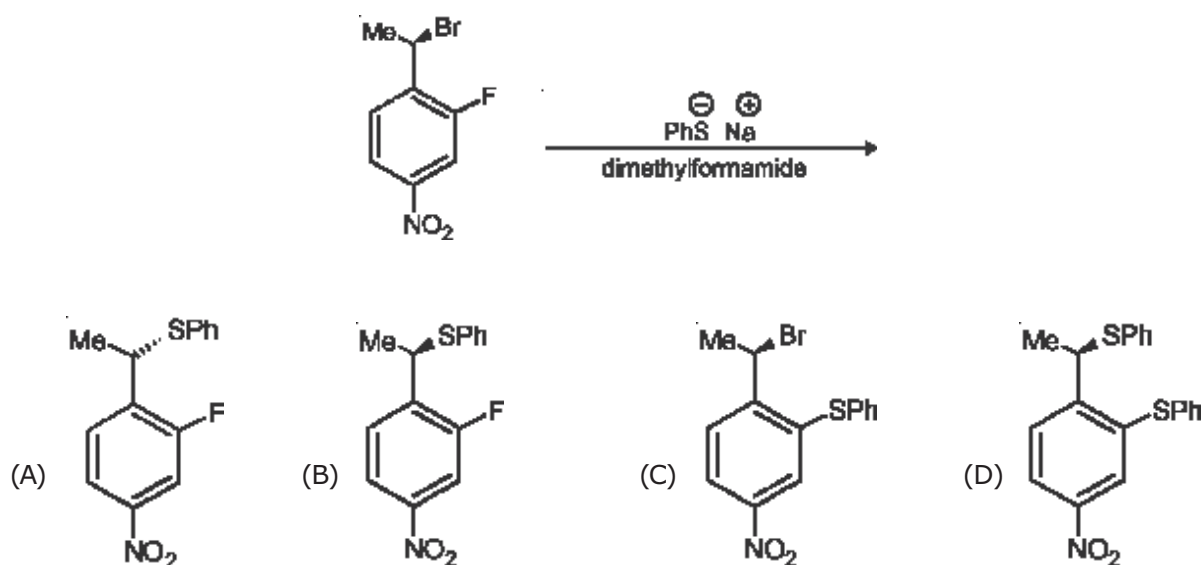
Q.47 Hyperconjugation involves overlap of the following orbitals

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

Sol. (B)

Hyper conjugation involves $\sigma - p$ conjugation.

Q.48 The major product of the following reaction is



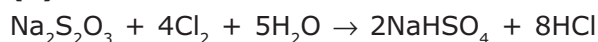
Sol. (A)

$\text{S}_{\text{N}}2$ mechanism occurs in polar aprotic solvent hence inversion of configuration takes place.

Q.49 Aqueous solution of $\text{Na}_2\text{S}_2\text{O}_3$ on reaction with Cl_2 gives-

- (A) $\text{Na}_2\text{S}_4\text{O}_6$ (B) NaHSO_4 (C) NaCl (D) NaOH

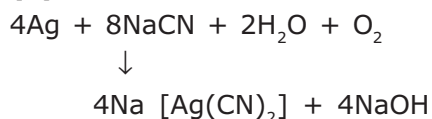
Sol. (B)



Q.50 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. (B)



Q.51 Under the same reaction conditions, initial concentration of $1.386 \text{ mol dm}^{-3}$ 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) $0.5 \text{ mol}^{-1} \text{ dm}^3$ (B) 1.0 mol dm^{-3} (C) 1.5 mol dm^{-3} (D) $2.0 \text{ mol}^{-1} \text{ dm}^3$

Sol. (A)

$$k_1 = \frac{0.693}{40} \text{ (first order kinetics)}$$

$$k_0 = \frac{1.386}{2 \times 20} \text{ (zero order kinetics)}$$

$$\frac{k_1}{k_0} = 0.5 \text{ mol}^{-1} \text{ dm}^3$$

SECTION-II

Multiple Correct Answers Type

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

Q.52 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) $3.7 \times 10^{-13} \text{ M}$ (B) $3.2 \times 10^{-7} \text{ M}$ (C) $3.2 \times 10^{-2} \text{ M}$ (D) $2.7 \times 10^{-2} \text{ M}$

Sol. (C)

At equivalence point

$$N_1 V_1 = N_2 V_2$$

(base) (acid)

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

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

$$\therefore \text{Milli equivalents of salt} = 1$$

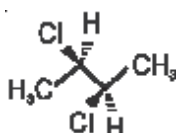
$$\text{pH} = 7 - \frac{1}{2} \text{p}K_b - \frac{1}{2} \log C$$

$$= 7 - 6 - \frac{1}{2} \log \frac{1}{10}$$

$$= 7 - 6 + 0.5 = 1.5$$

$$(\text{H}^+) = 10^{-1.5} = 3.2 \times 10^{-2} \text{ M}$$

Q.53 The correct statement(s) about the compound given below is (are)



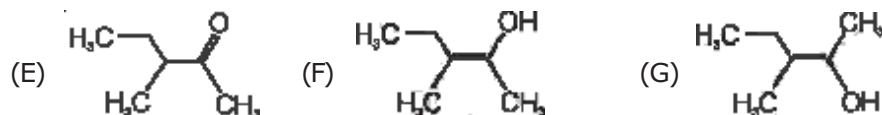
- (A) The compound is optically active
 (B) The compound possesses centre of symmetry
 (C) The compound possesses plane of symmetry
 (D) The compound possesses axis of symmetry

Sol. (A, D)

Since configuration is R, R

∴ Optically active and possesses axis of symmetry.

Q.54 The correct statement(s) concerning the structures E, F and G is (are)



- (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. (B, C, D)

Compound E, F and E, G are keto-enol tautomers.

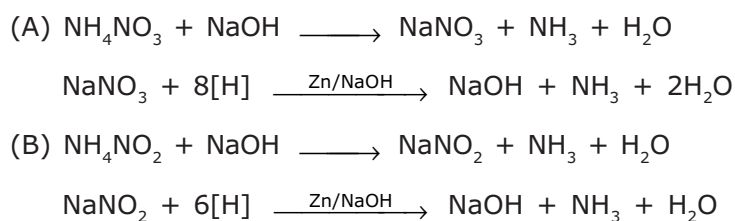
(F) & (G) show cis trans isomerism and these are also diastereomers.

Q.55 A solution of colourless salt **H** on bonding 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) $(\text{NH}_4)_2\text{SO}_4$

Sol. (A, B)

All ammonium salt evolves NH_3 with NaOH but only NO_3^- and NO_2^- ions restarts evolution of NH_3 again with zinc dust.



Q.56 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 characterised 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. (A, C, D)

Because V is very large, so in Van der Waal's equation $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, $\frac{a}{V^2}$ and b are neglected and equation becomes $PV = RT$. Coefficients depends on the identity of the gas but are independent of the temperature. Real gas exert lower pressure than the same gas behaving ideally due to intermolecular force of attraction.

SECTION-III

Assertion - Reason Type

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

Q.57 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 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. (C)

In bromobenzene, inductive effect is responsible for deactivating the benzene nucleus and has no effects on directive influence. Mesomeric effect governed directive influence.

Q.58 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 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. (C)

Statement (2) is false

As we go down the group stability of higher oxidation state decreases and stability of lower oxidation state increases due to inert pair effect hence Pb^{+2} is more stable than Pb^{+4} state.

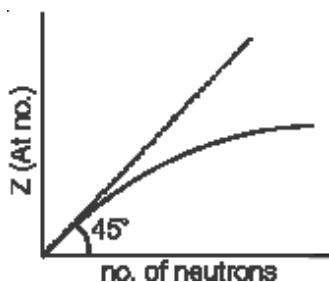
Q.59 STATEMENT - 1 : The plot of atomic number (y-axis versus number of neutrons (x-axis) for stable nuclei shows a curvature towards x-axis from the line of 45° slope as the atomic number is increased.

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 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. (B)



Elements with higher atomic number are more stable if they have slight excess of neutron as this increase the attractive force and also reduces repulsion between protons.

Q.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 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. (D)

$$\Delta G = \Delta G^\circ + RT \ln Q$$

at equilibrium

$$\Delta G = 0$$

$$Q = K_{eq}$$

$$\therefore \Delta G^\circ = -RT \ln K_{eq}$$

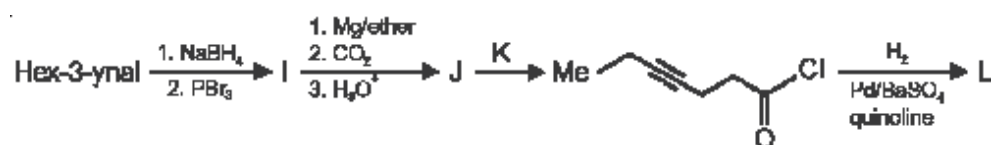
SECTION-IV

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 Numbers 61 to 63

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

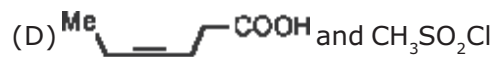
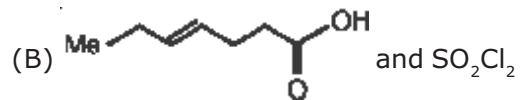
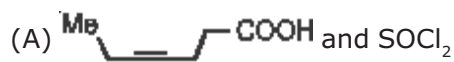


Q.61 The structure of the product I is-



Sol. (D)

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

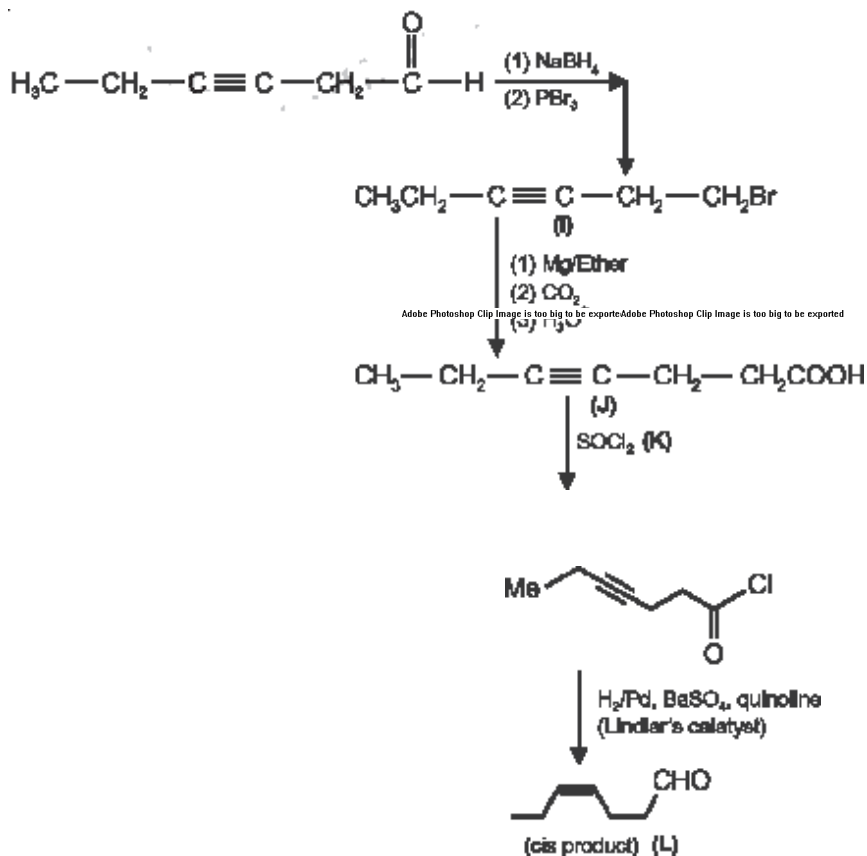


Sol. (A)

Q.63 The structure of product L is-



Sol. (C)



Freezing point depression constant of ethanol (K_f^{ethanol}) = 2.0 K kg mol⁻¹

Boiling point elevation constant of water (K_b^{water}) = 0.52 kg mol⁻¹

Boiling point elevation constant of ethanol (K_b^{ethanol}) = 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.

Q.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. (D)

$$\Delta T_f = k_f m = 2 \times \frac{0.1}{0.9} \times \frac{1000}{46} = 4.83$$

$$\Delta T_f = T_f^0 - T_f$$

$$T_f = 155.7 - 4.83 = 150.9$$

Q.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. (B)

Water is solute

$$\frac{p^0 - p_s}{p^0} = X_{\text{solute}}$$

$$\frac{40 - p_s}{40} = 0.1$$

$$p_s = 36 \text{ mm of Hg}$$

Here ethanol is considered as non-volatile solute as given in statement of paragraph.

Q.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) 345.7 K

Sol. (B)

Here, water is solvent and ethanol is solute.

$$\Delta T_b = k_b \times m$$

$$= 0.52 \times \frac{0.1 \times 1000}{0.9 \times 18}$$

$$= 3.2084$$

$$\text{Now, B.P. of solution} = 373 + 3.2084 = 376.2084$$