

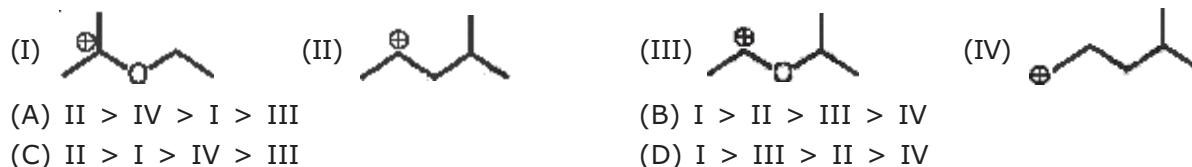
## CHEMISTRY

## SECTION-I

## Straight Objective Type

This section contains 9 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

**Q.45** The correct stability order for the following species is

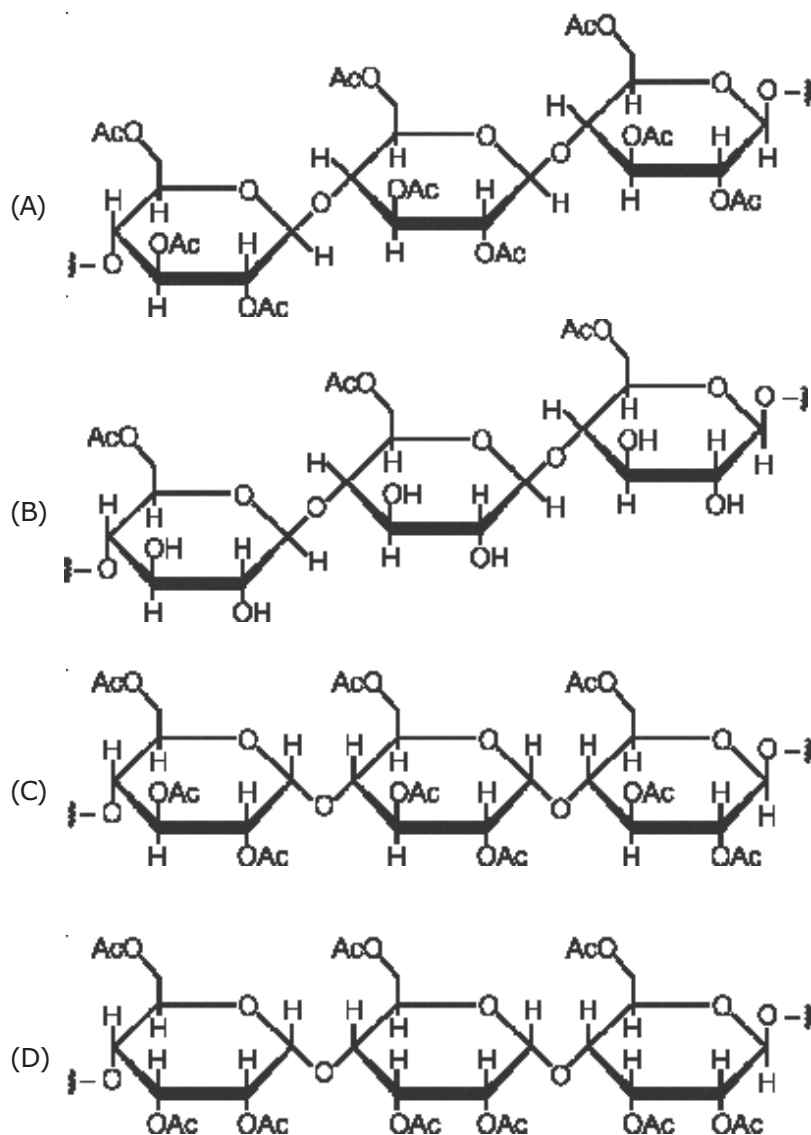


**Sol. (D)**

I & III are stabilized by resonance, hyperconjugation and + inductive effect.

∴ order I > III > II > IV

**Q.46** Cellulose upon acetylation with excess acetic anhydride/ $H_2SO_4$  (catalytic) gives cellulose triacetate whose structure is-





- Q.51** Electrolysis of dilute aqueous NaCl solution was carried out by passing 10 milli ampere current. The time required to liberate 0.01 mol of H<sub>2</sub> gas at the cathode is  
(1 Faraday = 96500 C mol<sup>-1</sup>)  
(A) 9.65 × 10<sup>4</sup> sec (B) 19.3 × 10<sup>4</sup> sec (C) 28.95 × 10<sup>4</sup> sec (D) 38.6 × 10<sup>4</sup> sec

**Sol. (B)**

$$\frac{W}{E} = \frac{it}{F}$$

$$\frac{W}{E} = 0.01 \times 2 = \frac{10 \times 10^{-3} \times t}{96500}$$

$$t = 19.3 \times 10^4 \text{ s}$$

- Q.52** Among the following, the surfactant that will form micelles in aqueous solution at the lowest molar concentration at ambient conditions is-

- (A) CH<sub>3</sub>(CH<sub>2</sub>)<sub>15</sub>N<sup>+</sup>(CH<sub>3</sub>)<sub>3</sub>Br<sup>-</sup> (B) CH<sub>3</sub>(CH<sub>2</sub>)<sub>11</sub>OSO<sub>3</sub><sup>-</sup> Na<sup>+</sup>  
(C) CH<sub>3</sub>(CH<sub>2</sub>)<sub>6</sub>COO<sup>-</sup>Na<sup>+</sup> (D) CH<sub>3</sub>(CH<sub>2</sub>)<sub>11</sub>N<sup>+</sup>(CH<sub>3</sub>)<sub>3</sub>Br<sup>-</sup>

**Sol. (B)**

Detergent will form micelles in aqueous solution at the lowest molar concentration at ambient condition.

- Q.53** Solubility product constants (K<sub>sp</sub>) of salts of types MX, MX<sub>2</sub> and M<sub>3</sub>X at temperature 'T' are 4.0 × 10<sup>-8</sup>, 3.2 × 10<sup>-14</sup> and 2.7 × 10<sup>-15</sup>, respectively. Solubilities (mol dm<sup>-3</sup>) of the salts at temperature 'T' are in the order-

- (A) MX > MX<sub>2</sub> > M<sub>3</sub>X (B) M<sub>3</sub>X > MX<sub>2</sub> > MX  
(C) MX<sub>2</sub> > M<sub>3</sub>X > MX (D) MX > M<sub>3</sub>X > MX<sub>2</sub>

**Sol. (D)**

$$\begin{aligned} \text{(MX)} \quad S^2 &= 4.0 \times 10^{-8} \\ S &= 2.0 \times 10^{-4} \end{aligned}$$

$$\begin{aligned} \text{(MX}_2\text{)} \quad 4S^3 &= 3.2 \times 10^{-14} \\ S^3 &= 0.8 \times 10^{-14} \\ S^3 &= 8 \times 10^{-15} \\ S &= 2 \times 10^{-5} \end{aligned}$$

$$\begin{aligned} \text{(M}_3\text{X)} \quad 27S^4 &= 2.7 \times 10^{-15} \\ S &= 1 \times 10^{-4} \end{aligned}$$

∴ Order is

$$MX > M_3X > MX_2$$

## SECTION-II

### 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.54 STATEMENT - 1** : Aniline on reaction with NaNO<sub>2</sub>/HCl at 0°C followed by coupling with β-naphthol gives a dark blue coloured precipitate.

and

**STATEMENT - 2** : The colour of the compound formed in the reaction of aniline with NaNO<sub>2</sub>/HCl at 0°C followed by coupling with β-naphthol is due to the extended conjugation.

- (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)**

Aniline on reaction with  $\text{NaNO}_2/\text{HCl}$  at  $0^\circ\text{C}$  followed by coupling with  $\beta$ -naphthol gives an orange red dye.

$\therefore$  Statement-1 is false but statement-2 is true.

**Q.55 STATEMENT - 1 :**  $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}] \text{SO}_4$  is paramagnetic.

**and**

**STATEMENT - 2 :** The Fe in  $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]\text{SO}_4$  has three unpaired electrons.

- (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. (A)**

$[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]\text{SO}_4$  is paramagnetic in nature. Magnetic moment of complex is 3.9 BM. Hence it has 3 unpaired electrons. In this complex, oxidation number of Fe is +1.

**Q.56 STATEMENT - 1 :** The geometrical isomers of the complex  $[\text{M}(\text{NH}_3)_4\text{Cl}_2]$  are optically inactive.

**and**

**STATEMENT - 2 :** Both geometrical isomers of the complex  $[\text{M}(\text{NH}_3)_4\text{Cl}_2]$  possess axis of symmetry.

- (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. (A)**

$[\text{M}(\text{NH}_3)_4\text{Cl}_2]$  show cis-trans geometrical isomers and are not optically active due to presence of axis of symmetry.

**Q.57 STATEMENT - 1 :** There is a natural asymmetry between converting work to heat and converting heat to work.

**and**

**STATEMENT - 2 :** No process is possible in which the sole result is the absorption of heat from a reservoir and its complete conversion into work.

- (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)**

According to second law of thermodynamics. It is impossible to convert energy into 100% work.

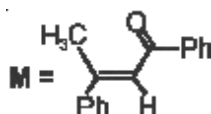
## SECTION-III

### Linked Comprehension Type

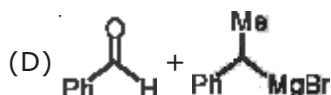
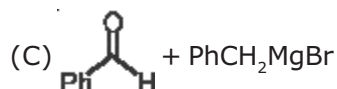
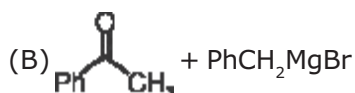
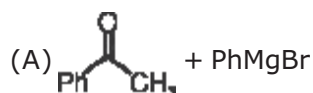
This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

## Paragraph for Question Numbers 58 to 60

A tertiary alcohol H upon acid catalysed dehydration gives a product I. Ozonolysis of I leads to compounds J and K. Compound J upon reaction with KOH gives benzyl alcohol and a compound L, whereas K on reaction with KOH gives only M.

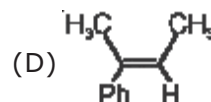
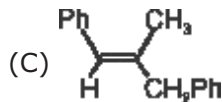
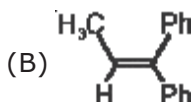
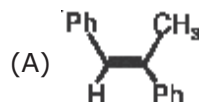


**Q.58** Compound H is formed by the reaction of



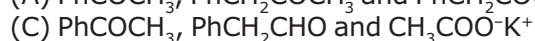
**Sol. (B)**

**Q.59** The structure of compound I is-



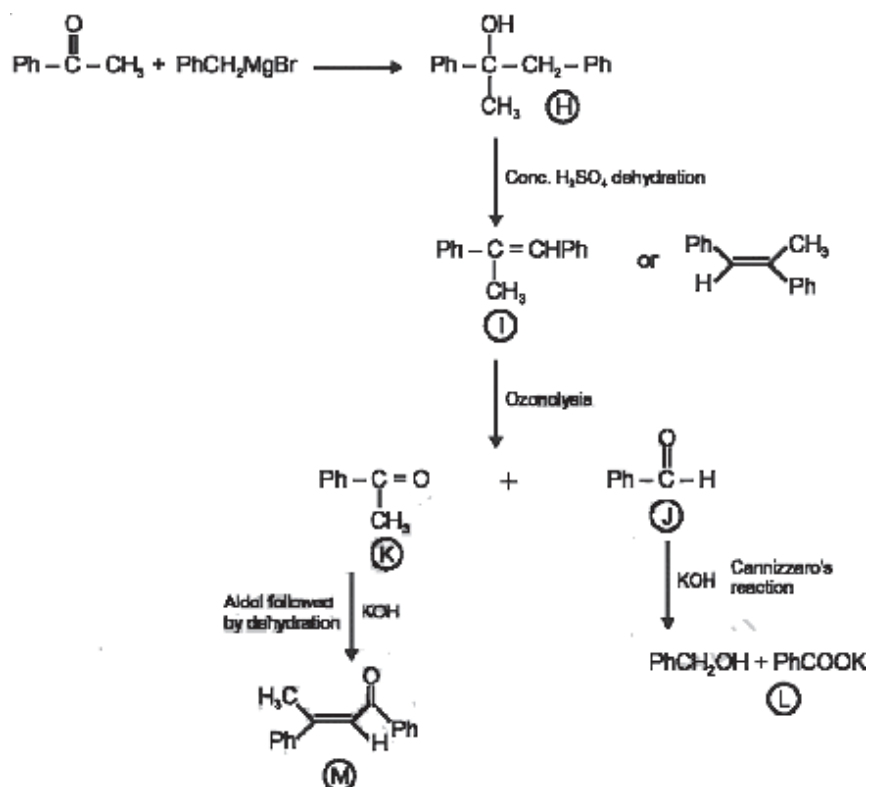
**Sol. (A)**

**Q.60** The structures of compounds J, K and L respectively, are-



**Sol. (D)**

## Solution of Q. 58 to 60



**Paragraph for Question Numbers 61 to 63**

In hexagonal systems of crystals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are regular hexagons and three atoms are sandwiched in between them. A space-filling model of this structure, called hexagonal close-packed (HCP), is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. Three spheres are then placed over the first layer so that they touch each other and represent the second layer. Each one of these three spheres touches three spheres of the bottom layer. Finally, the second layer is covered with a third layer that is identical to the bottom layer in relative position. Assume radius of every sphere to be 'r'

**Q.61** The number of atoms in this HCP unit cell is-

- (A) 4 (B) 6 (C) 12 (D) 17

**Sol. (B)**

The number of effective atom in a unit cell

$$= 12 \times \frac{1}{6} + 2 \times \frac{1}{2} + \left( \begin{array}{l} 3 \times 1 \\ \text{(No. of atoms in} \\ \text{hexagonal primitive} \\ \text{unit cell)} \end{array} \right) = 6$$

**Q.62** The volume of this HCP unit cell is-

- (A)  $24\sqrt{2} r^3$  (B)  $16\sqrt{2} r^3$  (C)  $12\sqrt{2} r^3$  (D)  $\frac{64}{3\sqrt{3}} r^3$

**Sol. (A)**

Volume of HCP unit cell

= Base area  $\times$  height

$$= \left( 6 \times \frac{\sqrt{3}}{4} a^2 \right) \times 4r \left( \sqrt{\frac{2}{3}} \right)$$

$$= \left| 6 \times \frac{\sqrt{3}}{4} (2r)^2 \right| \times \left( 4r \sqrt{\frac{2}{3}} \right)$$

$$= 24\sqrt{2} r^3$$

**Q.63** The empty space in this HCP unit cell is-

- (A) 74% (B) 47.6% (C) 32% (D) 26%

**Sol. (D)**

$$\text{Packing fraction} = \frac{6 \times \frac{4}{3} \pi r^3}{\text{Base area} \times \text{Height}}$$

$$= \frac{6 \times \frac{4}{3} \pi r^3}{\left( 6 \times \frac{\sqrt{3}}{4} a^2 \right) \times 4r \sqrt{\frac{2}{3}}} = 0.74$$

$$\% \text{ of empty space} = (1 - 0.74) \times 100 = 26\%.$$

**SECTION-IV****Matrix - Match Type**

This section contains 3 questions. Each question contains statements given in two columns which have to be matched. Statements in **Column I** are labelled as (A), (B), (C) and (D), whereas statements in **Column II** are labelled as (p, q, r and s). The answers to these questions have to be

appropriately bubbled as illustrated in the following example.

If the correct match are A-p, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled matrix will look like the following:

	p	q	r	s
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
C	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

**Q.64** Match the compounds in **Column I** with their characteristic test(s)/reaction(s) given in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS:

<b>Column I</b>	<b>Column II</b>
(A) $\text{H}_2\text{N}-\text{NH}_3^+\text{Cl}^-$	(p) Sodium fusion extract of the compound gives Prussian blue colour with $\text{FeSO}_4$
(B)	(q) Gives positive $\text{FeCl}_3$ test
(C)	(r) Gives white precipitate with $\text{AgNO}_3$
(D)	(s) Reacts with aldehydes to form the corresponding hydrazone derivative.

**Sol.** A(r, s); B(p, q); C(p, q, r), D(p)

**Q.65** Match the conversions in **Column I** with the type(s) of reaction(s) given in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS:

<b>Column I</b>	<b>Column II</b>
(A) $\text{PbS} \rightarrow \text{PbO}$	(p) Roasting
(B) $\text{CaCO}_3 \rightarrow \text{CaO}$	(q) Calcination
(C) $\text{ZnS} \rightarrow \text{Zn}$	(r) Carbon reduction
(D) $\text{Cu}_2\text{S} \rightarrow \text{Cu}$	(s) Self reduction

**Sol.** A(p), B(q), C(p, r), D(p, s)

**Q.66** Match the entries in **Column I** with the correctly related quantum number(s) in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS:

<b>Column I</b>	<b>Column II</b>
(A) Orbital angular momentum of the electron in a hydrogen-like atomic orbital.	(p) Principal quantum number.
(B) A hydrogen-like one electron wave function obeying Pauli principle.	(q) Azimuthal quantum number.
(C) Shape, size and orientation of hydrogen like atomic orbitals.	(r) Magnetic quantum number.
(D) Probability density of electron at the nucleus in hydrogen like atom.	(s) Electron spin quantum number.

**Sol.** A(q); B(s); C(p, q, r), D(p, q, r).