

**SECTION 1 (Maximum Marks: 12)**

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated **according to the following marking scheme:**  
*Full Marks* : +3 If **ONLY** the correct option is chosen;  
*Zero Marks* : 0 If none of the options is chosen (i.e. the question is unanswered);  
*Negative Marks* : -1 In all other cases.

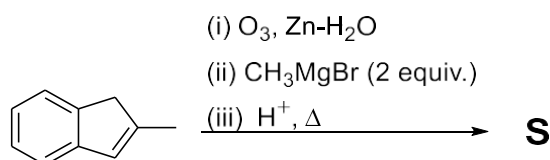
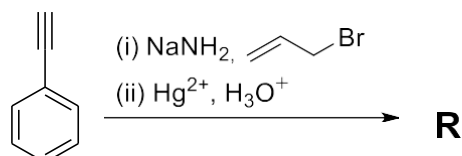
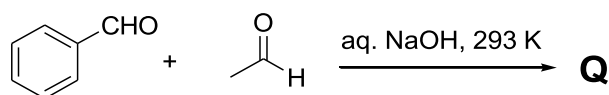
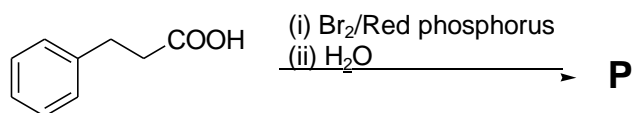
Q.1 During sodium nitroprusside test of sulphide ion in an aqueous solution, one of the ligands coordinated to the metal ion is converted to

|     |                |     |                |     |                |     |                |
|-----|----------------|-----|----------------|-----|----------------|-----|----------------|
| (A) | $\text{NOS}^-$ | (B) | $\text{SCN}^-$ | (C) | $\text{SNO}^-$ | (D) | $\text{NCS}^-$ |
|-----|----------------|-----|----------------|-----|----------------|-----|----------------|

Q.2 The complete hydrolysis of  $\text{ICl}$ ,  $\text{ClF}_3$  and  $\text{BrF}_5$ , respectively, gives

|     |   |
|-----|---|
| (A) | $\text{IO}^-$ , $\text{ClO}_2^-$ and $\text{BrO}_3^-$   |
| (B) | $\text{IO}_3^-$ , $\text{ClO}_2^-$ and $\text{BrO}_3^-$ |
| (C) | $\text{IO}^-$ , $\text{ClO}^-$ and $\text{BrO}_2^-$     |
| (D) | $\text{IO}_3^-$ , $\text{ClO}_4^-$ and $\text{BrO}_2^-$ |

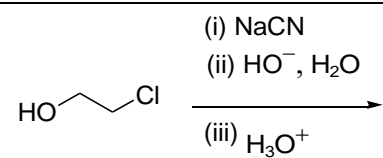
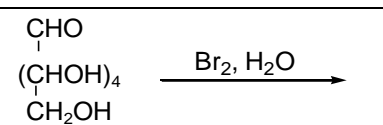
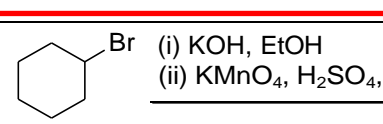
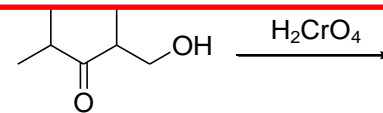
Q.3 Monocyclic compounds **P**, **Q**, **R** and **S** are the major products formed in the reaction sequences given below.



The product having the highest number of unsaturated carbon atom(s) is

|     |          |     |          |
|-----|----------|-----|----------|
| (A) | <b>P</b> | (B) | <b>Q</b> |
| (C) | <b>R</b> | (D) | <b>S</b> |

Q.4 The correct reaction/reaction sequence that would produce a dicarboxylic acid as the major product is

|     |  |
|-----|--|
| (A) |  <chem>OCCl</chem> $\xrightarrow[\text{(iii) H}_3\text{O}^+]{\text{(i) NaCN; (ii) HO}^-, \text{H}_2\text{O}}$                                 |
| (B) |  $\begin{array}{c} \text{CHO} \\   \\ (\text{CHOH})_4 \\   \\ \text{CH}_2\text{OH} \end{array} \xrightarrow{\text{Br}_2, \text{H}_2\text{O}}$ |
| (C) |  <chem>C1CCC(CC1)Br</chem> $\xrightarrow[\text{(ii) KMnO}_4, \text{H}_2\text{SO}_4, \Delta]{\text{(i) KOH, EtOH}}$                            |
| (D) |  <chem>CC(C)C(O)C(=O)C</chem> $\xrightarrow{\text{H}_2\text{CrO}_4}$  |

**SECTION 2 (Maximum Marks: 16)**

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated **according to the following marking scheme**:
 

*Full Marks* : +4 **ONLY** if (all) the correct option(s) is(are) chosen;

*Partial Marks* : +3 If all the four options are correct but **ONLY** three options are chosen;

*Partial Marks* : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct;

*Partial Marks* : +1 If two or more options are correct but **ONLY** one option is chosen and it is a correct option;

*Zero Marks* : 0 If none of the options is chosen (i.e. the question is unanswered);

*Negative Marks* : -2 In all other cases.
- For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to correct answers, then
  - choosing **ONLY** (A), (B) and (D) will get +4 marks;
  - choosing **ONLY** (A) and (B) will get +2 marks;
  - choosing **ONLY** (A) and (D) will get +2 marks;
  - choosing **ONLY** (B) and (D) will get +2 marks;
  - choosing **ONLY** (A) will get +1 mark;
  - choosing **ONLY** (B) will get +1 mark;
  - choosing **ONLY** (D) will get +1 mark;
  - choosing no option (i.e. the question is unanswered) will get 0 marks; and
  - choosing any other combination of options will get -2 marks.

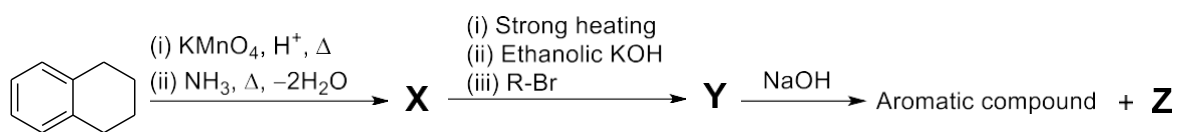
Q.5 The correct statement(s) about intermolecular forces is(are)

|     |   |
|-----|---|
| (A) | The potential energy between two point charges approaches zero more rapidly than the potential energy between a point dipole and a point charge as the distance between them approaches infinity. |
| (B) | The average potential energy of two rotating polar molecules that are separated by a distance $r$ has $1/r^3$ dependence.   |
| (C) | The dipole-induced dipole average interaction energy is independent of temperature.   |
| (D) | Nonpolar molecules attract one another even though neither has a permanent dipole moment.   |

Q.6 The compound(s) with P-H bond(s) is(are)

|     |                                  |
|-----|----------------------------------|
| (A) | $\text{H}_3\text{PO}_4$          |
| (B) | $\text{H}_3\text{PO}_3$          |
| (C) | $\text{H}_4\text{P}_2\text{O}_7$ |
| (D) | $\text{H}_3\text{PO}_2$          |

Q.7 For the reaction sequence given below, the correct statement(s) is(are)



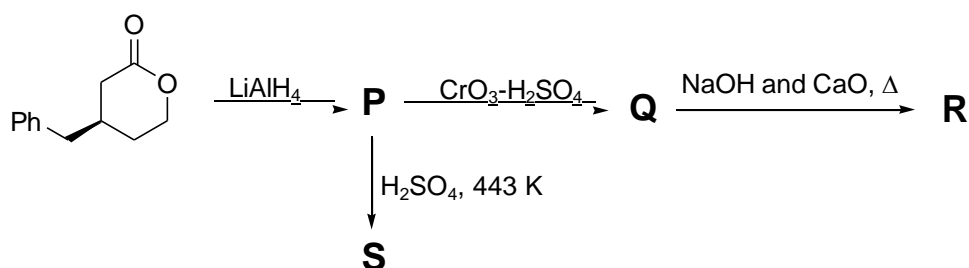
(A) Both **X** and **Y** are oxygen containing compounds.

(B) **Y** on heating with  $\text{CHCl}_3/\text{KOH}$  forms isocyanide.

(C) **Z** reacts with Hinsberg's reagent.

(D) **Z** is an aromatic primary amine.

Q.8 For the reaction sequence given below, the correct statement(s) is(are)



(A) **P** is optically active.

(B) **S** gives Bayer's test.

(C) **Q** gives effervescence with aq.  $\text{NaHCO}_3$ .

(D) **R** is an alkyne.

**SECTION 3 (Maximum Marks: 32)**

- This section contains **EIGHT (08)** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated **according to the following marking scheme:**  
*Full Marks* : +4 If ONLY the correct numerical value is entered in the designated place;  
*Zero Marks* : 0 In all other cases.

Q.9 The density (in  $\text{g cm}^{-3}$ ) of the metal which forms a cubic close packed (ccp) lattice with an axial distance (edge length) equal to 400 pm is 11

Use: Atomic mass of metal = 105.6 amu and Avogadro's constant =  $6 \times 10^{23} \text{ mol}^{-1}$

Q.10 The solubility of barium iodate in an aqueous solution prepared by mixing 200 mL of 0.010 M barium nitrate with 100 mL of 0.10 M sodium iodate is  $X \times 10^{-6} \text{ mol dm}^{-3}$ . The value of  $X$  is 3.95

Use: Solubility product constant ( $K_{\text{sp}}$ ) of barium iodate =  $1.58 \times 10^{-9}$

Q.11 Adsorption of phenol from its aqueous solution on to fly ash obeys Freundlich isotherm. At a given temperature, from 10  $\text{mg g}^{-1}$  and 16  $\text{mg g}^{-1}$  aqueous phenol solutions, the concentrations of adsorbed phenol are measured to be 4  $\text{mg g}^{-1}$  and 10  $\text{mg g}^{-1}$ , respectively. At this temperature, the concentration (in  $\text{mg g}^{-1}$ ) of adsorbed phenol from 20  $\text{mg g}^{-1}$  aqueous solution of phenol will be 16

Use:  $\log_{10} 2 = 0.3$

Q.12 Consider a reaction  $A + R \rightarrow \text{Product}$ . The rate of this reaction is measured to be  $k[A][R]$ . At the start of the reaction, the concentration of  $R$ ,  $[R]_0$ , is 10-times the concentration of  $A$ ,  $[A]_0$ . The reaction can be considered to be a pseudo first order reaction with assumption that  $k[R] = k'$  is constant. Due to this assumption, the relative error (in %) in the rate when this reaction is 40 % complete, is 4.17  
[ $k$  and  $k'$  represent corresponding rate constants]

- Q.13 At 300 K, an ideal dilute solution of a macromolecule exerts osmotic pressure that is expressed in terms of the height (h) of the solution (density =  $1.00 \text{ g cm}^{-3}$ ) where h is equal to 2.00 cm. If the concentration of the dilute solution of the macromolecule is  $2.00 \text{ g dm}^{-3}$ , the molar mass of the macromolecule is calculated to be  $X \times 10^4 \text{ g mol}^{-1}$ . The value of X is 2.49.

Use: Universal gas constant (R) =  $8.3 \text{ J K}^{-1} \text{ mol}^{-1}$  and acceleration due to gravity (g) =  $10 \text{ m s}^{-2}$

- Q.14 An electrochemical cell is fueled by the combustion of butane at 1 bar and 298 K. Its cell potential is  $\frac{X}{F} \times 10^3$  volts, where F is the Faraday constant. The value of X is 105.50.

Use: Standard Gibbs energies of formation at 298 K are:  $\Delta_f G^\circ_{\text{CO}_2} = -394 \text{ kJ mol}^{-1}$ ;  $\Delta_f G^\circ_{\text{Water}} = -237 \text{ kJ mol}^{-1}$ ;  $\Delta_f G^\circ_{\text{Butane}} = -18 \text{ kJ mol}^{-1}$

- Q.15 The sum of the spin only magnetic moment values (in B.M.) of  $[\text{Mn}(\text{Br})_6]^{3-}$  and  $[\text{Mn}(\text{CN})_6]^{3-}$  is 7.74.

- Q.16 A linear octasaccharide (molar mass =  $1024 \text{ g mol}^{-1}$ ) on complete hydrolysis produces three monosaccharides: ribose, 2-deoxyribose and glucose. The amount of 2-deoxyribose formed is 58.26 % (w/w) of the total amount of the monosaccharides produced in the hydrolyzed products. The number of ribose unit(s) present in one molecule of octasaccharide is 2.

Use: Molar mass (in  $\text{g mol}^{-1}$ ): ribose = 150, 2-deoxyribose = 134, glucose = 180;  
Atomic mass (in amu): H = 1, O = 16

**END OF THE QUESTION PAPER**