Chemistry

SECTION 1 (Maximum Marks: 12)

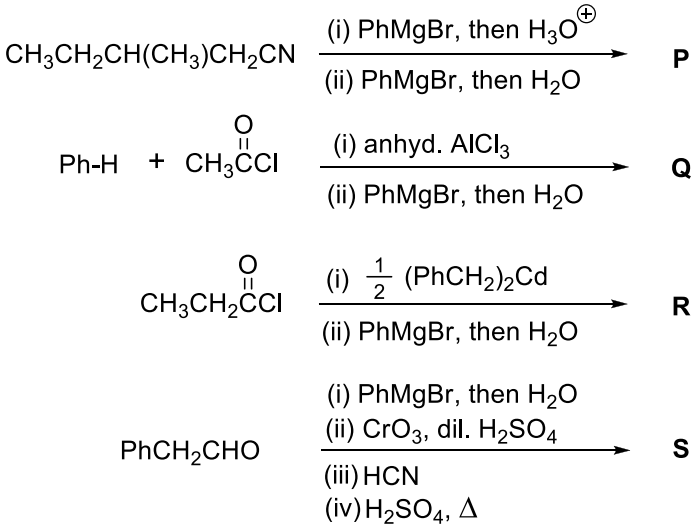
- This section contains **THREE (03)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will 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.1 The correct statement(s) related to processes involved in the extraction of metals is(are)

(A) Roasting of Malachite produces Cuprite.
(B) Calcination of Calamine produces Zincite.
(C) Copper pyrites is heated with silica in a reverberatory furnace to remove iron.
(D) Impure silver is treated with aqueous KCN in the presence of oxygen followed by reduction with zinc metal.

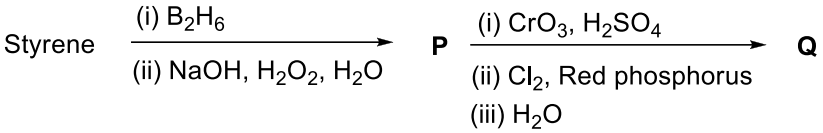
Q.2 In the following reactions, **P**, **Q**, **R**, and **S** are the major products.

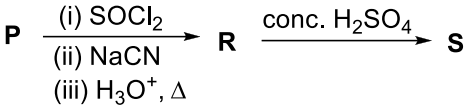


The correct statement(s) about **P**, **Q**, **R**, and **S** is(are)

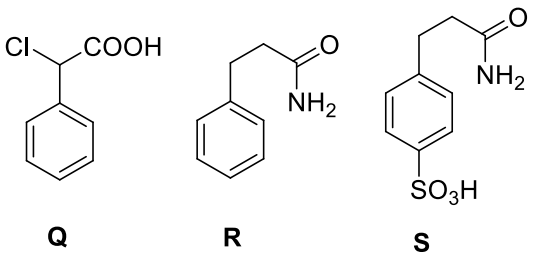
(A) Both **P** and **Q** have asymmetric carbon(s).
(B) Both **Q** and **R** have asymmetric carbon(s).
(C) Both **P** and **R** have asymmetric carbon(s).
(D) **P** has asymmetric carbon(s), **S** does **not** have any asymmetric carbon.

Q.3 Consider the following reaction scheme and choose the correct option(s) for the major products **Q**, **R** and **S**.

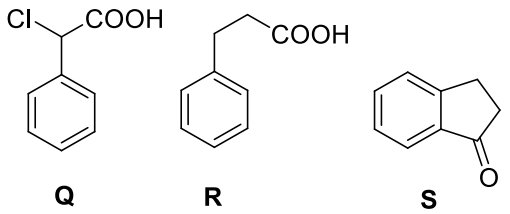




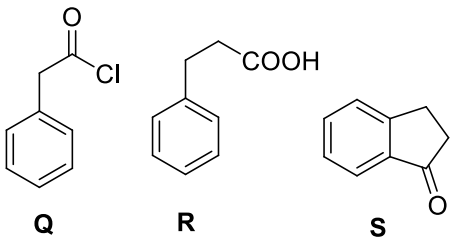
(A)



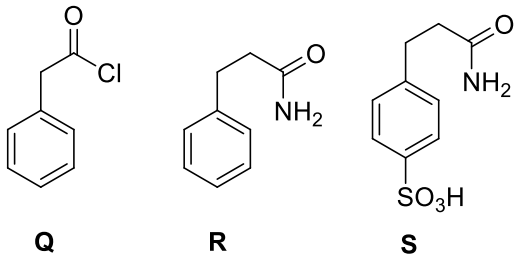
(B)



(C)



(D)

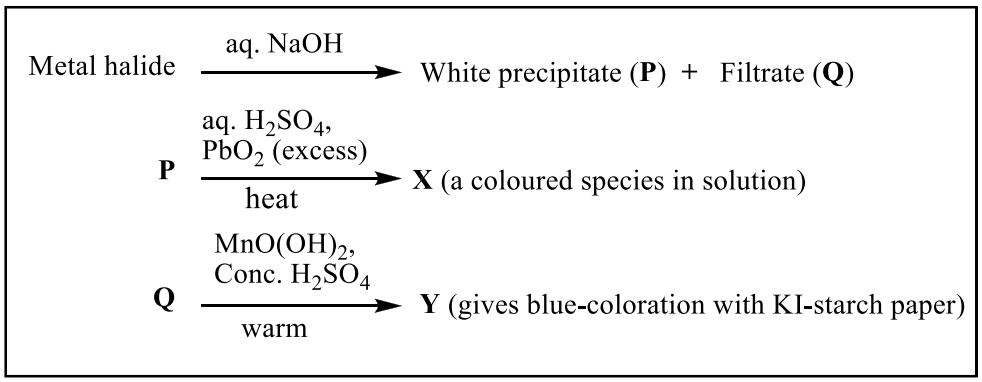


SECTION 2 (Maximum Marks: 12)

- 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.4 In the scheme given below, **X** and **Y**, respectively, are



(A) CrO_4^{2-} and Br_2
(B) MnO_4^{2-} and Cl_2
(C) MnO_4^{-} and Cl_2
(D) $MnSO_4$ and HOCl

Q.5 Plotting $1/\Lambda_m$ against $c\Lambda_m$ for aqueous solutions of a monobasic weak acid (HX) resulted in a straight line with y-axis intercept of P and slope of S. The ratio P/S is

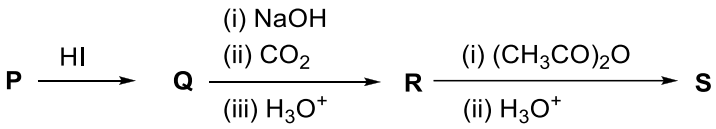
[Λ_m = molar conductivity
Λ_m^o = limiting molar conductivity
c = molar concentration
K_a = dissociation constant of HX]

(A) $K_a \Lambda_m^o$
(B) $K_a \Lambda_m^o/2$
(C) $2 K_a \Lambda_m^o$
(D) $1 / (K_a \Lambda_m^o)$

Q.6 On decreasing the pH from 7 to 2, the solubility of a sparingly soluble salt (MX) of a weak acid (HX) increased from 10^{-4} mol L^{-1} to 10^{-3} mol L^{-1}. The $p\mathrm{K_a}$ of HX is

(A) 3
(B) 4
(C) 5
(D) 2

Q.7 In the given reaction scheme, **P** is a phenyl alkyl ether, **Q** is an aromatic compound; **R** and **S** are the major products.



The correct statement about **S** is

(A) It primarily inhibits noradrenaline degrading enzymes.
(B) It inhibits the synthesis of prostaglandin.
(C) It is a narcotic drug.
(D) It is *ortho*-acetylbenzoic acid.

SECTION 3 (Maximum Marks: 24)

- This section contains **SIX (06)** questions.
- The answer to each question is a **NON-NEGATIVE INTEGER**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : $+4$ If **ONLY** the correct integer is entered;
  Zero Marks : 0 In all other cases.

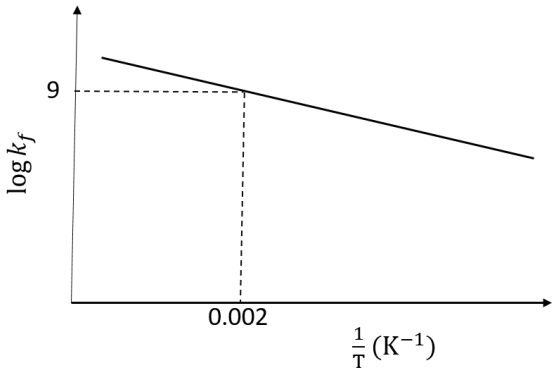
Q.8 The stoichiometric reaction of 516 g of dimethyldichlorosilane with water results in a tetrameric cyclic product **X** in 75% yield. The weight (in g) of **X** obtained is___.

[Use, molar mass (g mol^{-1}): H = 1, C = 12, O = 16, Si = 28, Cl = 35.5]

Q.9 A gas has a compressibility factor of 0.5 and a molar volume of 0.4 $dm^3\ mol^{-1}$ at a temperature of 800 K and pressure **x** atm. If it shows ideal gas behaviour at the same temperature and pressure, the molar volume will be **y** $dm^3\ mol^{-1}$. The value of $\mathbf{x/y}$ is ___.

[Use: Gas constant, R = 8×10^{-2} L atm $K^{-1}\ mol^{-1}$]

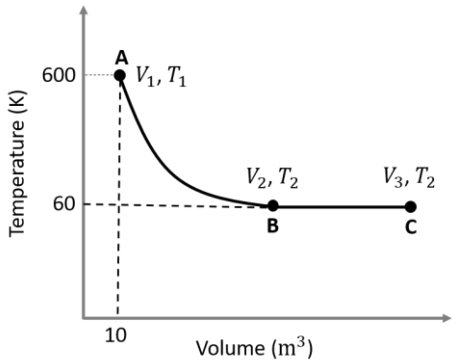
Q.10 The plot of $\log k_f$ versus $1/T$ for a reversible reaction A (g) ⇌ P (g) is shown.



Pre-exponential factors for the forward and backward reactions are $10^{15}\ s^{-1}$ and $10^{11}\ s^{-1}$, respectively. If the value of $\log K$ for the reaction at 500 K is 6, the value of $|\log k_b|$ at 250 K is ___.

[K = equilibrium constant of the reaction
k_f = rate constant of forward reaction
k_b = rate constant of backward reaction]

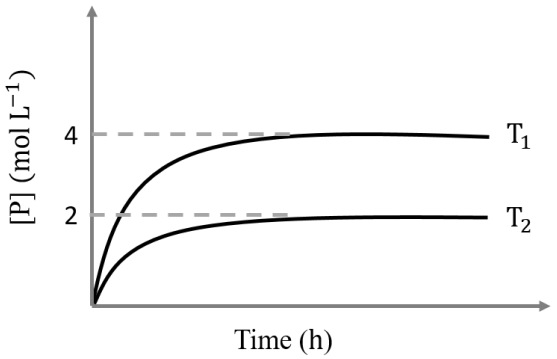
Q.11 One mole of an ideal monoatomic gas undergoes two reversible processes (A → B and B → C) as shown in the given figure:



A → B is an adiabatic process. If the total heat absorbed in the entire process (A → B and B → C) is $RT_2 \ln 10$, the value of $2\log V_3$ is ___.

[Use, molar heat capacity of the gas at constant pressure, $C_{p,m} = \frac{5}{2}R$]

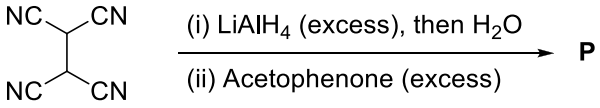
Q.12 In a one-litre flask, 6 moles of A undergoes the reaction A (g) ⇌ P (g). The progress of product formation at two temperatures (in Kelvin), T_1 and T_2, is shown in the figure:



If $T_1 = 2T_2$ and $\left(\Delta G_2^\Theta - \Delta G_1^\Theta\right) = RT_2 \ln x$, then the value of x is ___.

[ΔG_1^Θ and ΔG_2^Θ are standard Gibb's free energy change for the reaction at temperatures T_1 and T_2, respectively.]

Q.13 The total number of *sp*^{2} hybridised carbon atoms in the major product **P** (a non-heterocyclic compound) of the following reaction is ___.



SECTION 4 (Maximum Marks: 12)

- This section contains **FOUR (04)** Matching List Sets.
- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists: **List-I** and **List-II**.
- **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : $+3$ **ONLY** if the option corresponding to the correct combination 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.14 Match the reactions (in the given stoichiometry of the reactants) in List-I with one of their products given in List-II and choose the correct option.

List-I

(P) $P_2O_3 + 3H_2O \rightarrow$
(Q) $P_4 + 3NaOH + 3H_2O \rightarrow$
(R) $PCl_5 + CH_3COOH \rightarrow$
(S) $H_3PO_2 + 2H_2O + 4AgNO_3 \rightarrow$

List-II

(1) $P(O)(OCH_3)Cl_2$
(2) H_3PO_3
(3) PH_3
(4) $POCl_3$
(5) H_3PO_4

(A) P $\rightarrow$ 2; Q $\rightarrow$ 3; R $\rightarrow$ 1; S $\rightarrow$ 5
(B) P $\rightarrow$ 3; Q $\rightarrow$ 5; R $\rightarrow$ 4; S $\rightarrow$ 2
(C) P $\rightarrow$ 5; Q $\rightarrow$ 2; R $\rightarrow$ 1; S $\rightarrow$ 3
(D) P $\rightarrow$ 2; Q $\rightarrow$ 3; R $\rightarrow$ 4; S $\rightarrow$ 5

Q.15 Match the electronic configurations in List-I with appropriate metal complex ions in List-II and choose the correct option.
[Atomic Number: Fe = 26, Mn = 25, Co = 27]

List-I

(P) $t_{2g}^6 e_g^0$
(Q) $t_{2g}^3 e_g^2$
(R) $e^2 t_2^3$
(S) $t_{2g}^4 e_g^2$

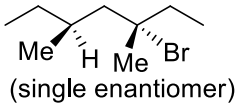
List-II

(1) $[Fe(H_2O)_6]^{2+}$
(2) $[Mn(H_2O)_6]^{2+}$
(3) $[Co(NH_3)_6]^{3+}$
(4) $[FeCl_4]^-$
(5) $[CoCl_4]^{2-}$

(A) P → 1; Q → 4; R → 2; S → 3
(B) P → 1; Q → 2; R → 4; S → 5
(C) P → 3; Q → 2; R → 5; S → 1
(D) P → 3; Q → 2; R → 4; S → 1

Q.16 Match the reactions in List-I with the features of their products in List-II and choose the correct option.

List-I

(P) (-)-1-Bromo-2-ethylpentane (single enantiomer) $\xrightarrow[S_N2 \text{ reaction}]{\text{aq. NaOH}}$
(Q) (-)-2-Bromopentane (single enantiomer) $\xrightarrow[S_N2 \text{ reaction}]{\text{aq. NaOH}}$
(R) (-)-3-Bromo-3-methylhexane (single enantiomer) $\xrightarrow[S_N1 \text{ reaction}]{\text{aq. NaOH}}$
(S)  $\xrightarrow[S_N1 \text{ reaction}]{\text{aq. NaOH}}$

(single enantiomer)

List-II

(1) Inversion of configuration
(2) Retention of configuration
(3) Mixture of enantiomers
(4) Mixture of structural isomers
(5) Mixture of diastereomers

(A) P → 1; Q → 2; R → 5; S → 3
(B) P → 2; Q → 1; R → 3; S → 5
(C) P → 1; Q → 2; R → 5; S → 4
(D) P → 2; Q → 4; R → 3; S → 5

Q.17 The major products obtained from the reactions in List-II are the reactants for the named reactions mentioned in List-I. Match List-I with List-II and choose the correct option.

List-I	**List-II**
(P) Etard reaction	(1) Acetophenone $\xrightarrow{\text{Zn-Hg, HCl}}$
(Q) Gattermann reaction	(2) Toluene $\xrightarrow[\text{(ii) } SOCl_2]{\text{(i) } KMnO_4, KOH, \Delta}$
(R) Gattermann-Koch reaction	(3) Benzene $\xrightarrow[\text{anhyd. } AlCl_3]{CH_3Cl}$
(S) Rosenmund reduction	(4) Aniline $\xrightarrow[273\text{-}278\ K]{NaNO_2/HCl}$
	(5) Phenol $\xrightarrow{Zn, \Delta}$

(A) P $\rightarrow$ 2; Q $\rightarrow$ 4; R $\rightarrow$ 1; S $\rightarrow$ 3
(B) P $\rightarrow$ 1; Q $\rightarrow$ 3; R $\rightarrow$ 5; S $\rightarrow$ 2
(C) P $\rightarrow$ 3; Q $\rightarrow$ 2; R $\rightarrow$ 1; S $\rightarrow$ 4
(D) P $\rightarrow$ 3; Q $\rightarrow$ 4; R $\rightarrow$ 5; S $\rightarrow$ 2

END OF THE QUESTION PAPER