FINAL JEE(Advanced) EXAMINATION – 2023

(Held On Sunday 04th June, 2023)

PAPER-1 | TEST PAPER WITH SOLUTION

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 marks;
choosing ONLY (B) will get +1 marks;
choosing ONLY (D) will get +1 marks;
choosing no option (i.e. the question is unanswered) will get 0 marks; and
choosing any other combination of options will get –2 marks.

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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.

Ans. (B,C,D)

Sol. $\Rightarrow$ Under roasting condition, the malachite will be converted into

$$CuCO_3.Cu(OH)_2 \rightarrow 2CuO + CO_2 + H_2O$$

$$\Rightarrow \underset{\text{(Calamine)}}{ZnCO_3} \rightarrow \underset{\text{(Zincite)}}{ZnO} + CO_2 \uparrow$$

$\Rightarrow$ Copper pyrites is heated in a reverberatory furnace after mixing with silica. In the furnace, iron oxide 'slag of' as iron silicate and copper is produced in the form of copper matte.

$$FeO + SiO_2 \rightarrow \underset{\text{(Slag)}}{FeSiO_3}$$

$$\Rightarrow Ag + KCN + O_2 + H_2O \longrightarrow [Ag(CN)_2]^- + KOH$$

$$[Ag(CN)_2]^- \xrightarrow{Zn} Ag\downarrow + [Zn(CN)_4]^{2-}$$

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

$$CH_3CH_2CH(CH_3)CH_2CN \xrightarrow[\text{(ii) PhMgBr, then } H_2O]{\text{(i) PhMgBr, then } H_3O^{\oplus}} \textbf{P}$$

$$Ph-H + CH_3\overset{\overset{\displaystyle O}{||}}{C}Cl \xrightarrow[\text{(ii) PhMgBr, then } H_2O]{\text{(i) anhyd. } AlCl_3} \textbf{Q}$$

$$CH_3CH_2\overset{\overset{\displaystyle O}{||}}{C}Cl \xrightarrow[\text{(ii) PhMgBr, then } H_2O]{\text{(i) } \frac{1}{2}(PhCH_2)_2Cd} \textbf{R}$$

$$PhCH_2CHO \xrightarrow[\substack{\text{(iii) HCN} \\ \text{(iv) } H_2SO_4, \Delta}]{\substack{\text{(i) PhMgBr, then } H_2O \\ \text{(ii) } CrO_3, \text{dil. } H_2SO_4}} \textbf{S}$$

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

(A) Both **P** and **Q** have asymmetric carbon(s).

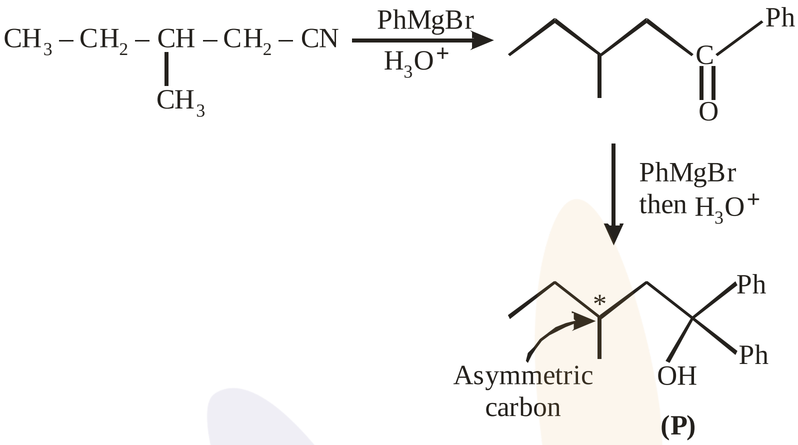
(B) Both **Q** and **R** have asymmetric carbon(s).

(C) Both **P** and **R** have asymmetric carbon(s).

(D) **P** has asymmetric carbon(s), **S** does **not** have any asymmetric carbon.

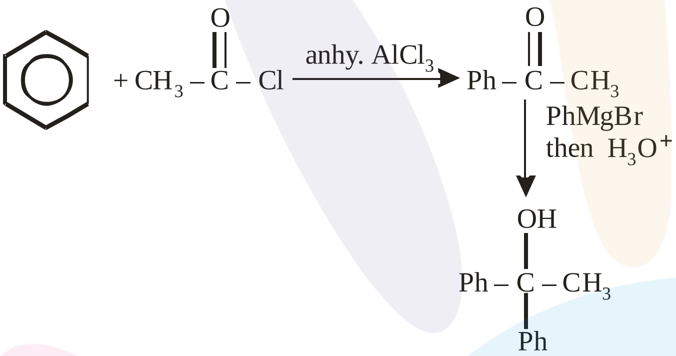
Ans. (C,D)

Sol. **Formation of P**



(P)

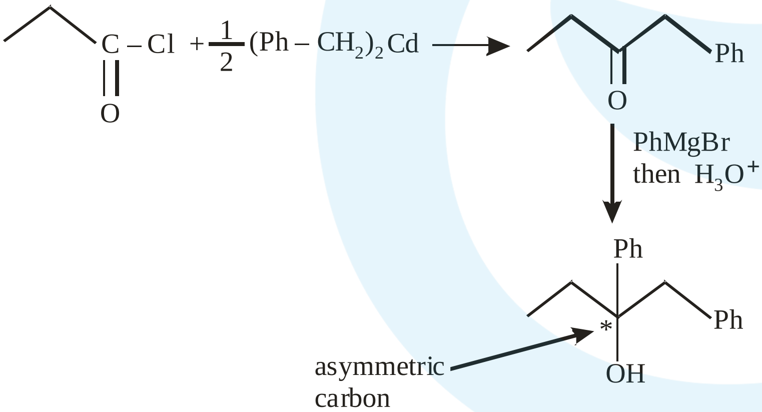
Formation of Q



(Q)

No asymmetric carbon

Formation of R



(R)

Formation of S

$$Ph-CH_2-\underset{\underset{O}{||}}{C}-H \xrightarrow[H_3O^+]{PhMgBr} Ph-CH_2-\underset{\underset{OH}{|}}{CH}-Ph$$

$$\downarrow CrO_3 \text{ with dil. } H_2SO_4$$

$$Ph-CH_2-\underset{\underset{O}{||}}{C}-Ph$$

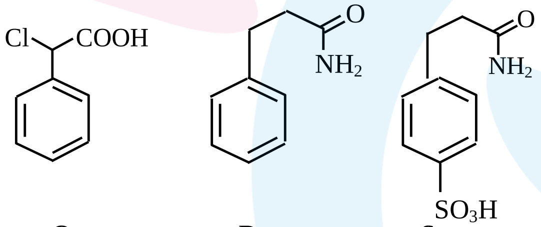
$$\downarrow HCN$$

$$\underset{\text{(S) No asymmetric carbon}}{Ph-CH=\underset{\underset{COOH}{|}}{C}-Ph} \xleftarrow[\Delta]{H_2SO_4} Ph-CH_2-\overset{\overset{OH}{|}}{\underset{\underset{CN}{|}}{C}}-Ph$$

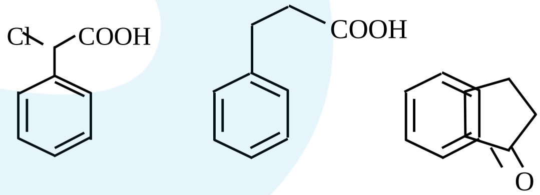
3. Consider the following reaction scheme and choose the correct option(s) for the major products **Q**, **R** and **S**.

$$\text{Styrene} \xrightarrow[\text{(ii) NaOH, } H_2O_2, H_2O]{\text{(i) } B_2H_6} \mathbf{P} \xrightarrow[\substack{\text{(ii) } Cl_2\text{, Red Phosphorus} \\ \text{(iii) } H_2O}]{\text{(i) } CrO_3, H_2SO_4} \mathbf{Q}$$

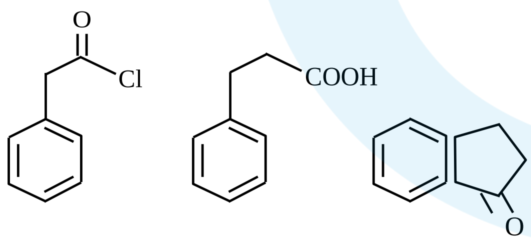
$$\mathbf{P} \xrightarrow[\substack{\text{(ii) NaCN} \\ \text{(iii) } H_3O^+, \Delta}]{\text{(i) } SOCl_2} \mathbf{R} \xrightarrow{\text{conc. } H_2SO_4} \mathbf{S}$$

(A) 

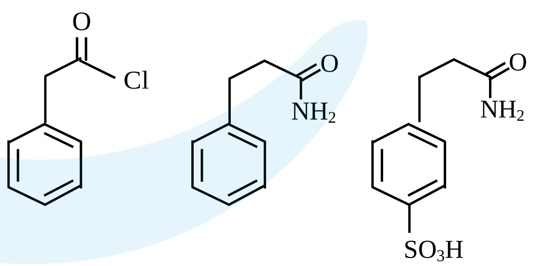
Q R S

(B) 

Q R S

(C) 

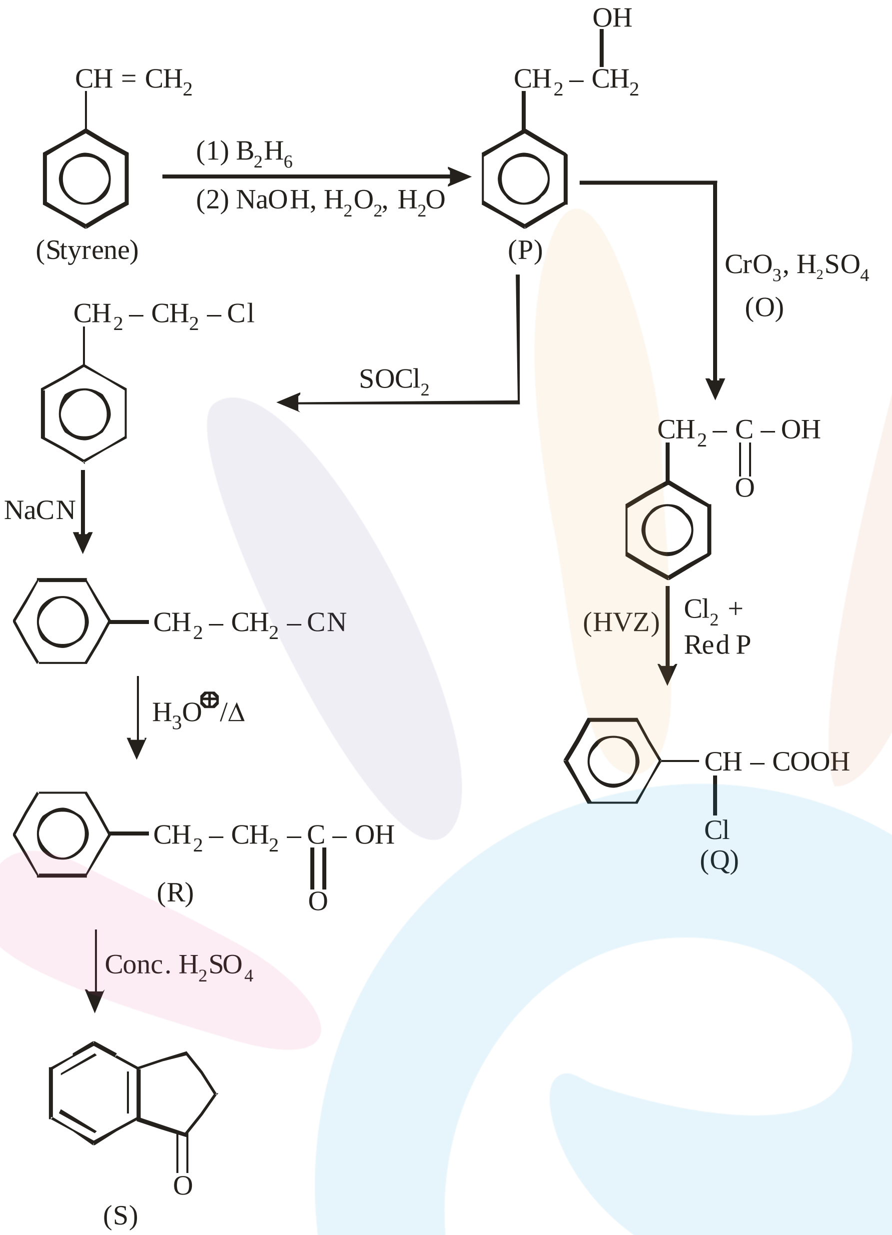
Q R S

(D) 

Q R S

Ans. (B)

Sol.


OH
CH = CH2
CH2 – CH2
(1) B2H6
(2) NaOH, H2O2, H2O
(Styrene)
(P)
CrO3, H2SO4
(O)
CH2 – CH2 – Cl
SOCl2
CH2 – C – OH
O
NaCN
CH2 – CH2 – CN
(HVZ)
Cl2 +
Red P
H3O⊕/Δ
CH – COOH
Cl
(Q)
CH2 – CH2 – C – OH
(R)
O
Conc. H2SO4
O
(S)

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.

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

$$\text{Metal halide} \xrightarrow{\text{aq. NaOH}} \text{White precipitate } \mathbf{(P)} + \text{Filtrate } \mathbf{(Q)}$$

$$\mathbf{P} \xrightarrow[\text{heat}]{\text{aq.}H_2SO_4,\ PbO_2(\text{excess})} \mathbf{X} \text{ (a coloured species in solution)}$$

$$\mathbf{Q} \xrightarrow[\text{warm}]{MnO(OH)_2,\ \text{Conc.}H_2SO_4} \mathbf{Y} \text{ (gives blue-coloration with KI-starch paper)}$$

(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

Ans. (C)

Sol. $$MnCl_2 + NaOH \rightarrow \underset{\substack{\mathbf{(P)} \\ \text{(white ppt.)}}}{Mn(OH)_2\downarrow} + \underset{\substack{\mathbf{(Q)} \\ \text{(Filterate)}}}{NaCl}$$

$$Mn(OH)_2 \xrightarrow[\text{heat}]{PbO_2 + H^+ (H_2SO_4)} \underset{\text{Purple}}{MnO_4^-} + Pb^{2+}$$

$$Cl^- \xrightarrow{MnO(OH)_2/\text{conc. } H_2SO_4/\square} Cl_2 \xrightarrow{2I^-} \underbrace{(\text{Starch} + I_2)}_{\text{blue coloration}} + 2Cl^-$$

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° = limiting molar conductivity

c = molar concentration

K_a = dissociation constant of HX]

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

Ans. (A)

Sol. For weak acid, $\alpha = \dfrac{\Lambda_m}{\Lambda_0}$

$$K_a = \frac{C\alpha^2}{1-\alpha} \Rightarrow K_a(1-\alpha) = C\alpha^2$$

$$\Rightarrow K_a\left(1-\frac{\Lambda_m}{\Lambda_0}\right) = C\left(\frac{\Lambda_m}{\Lambda_0}\right)^2$$

$$\Rightarrow K_a - \frac{\Lambda_m K_a}{\Lambda_0} = \frac{C\Lambda_m^2}{(\Lambda_0)^2}$$

Divide by $'\Lambda_m'$

$$\Rightarrow \frac{K_a}{\Lambda_m} = \frac{C\Lambda_m}{(\Lambda_0)^2} + \frac{K_a}{\Lambda_0}$$

$$\Rightarrow \frac{1}{\Lambda_m} = \frac{C\Lambda_m}{K_a(\Lambda_0)^2} + \frac{1}{\Lambda_0}$$

Plot $\dfrac{1}{\Lambda_m}$ vs $C\,\Lambda_m$ has

Slope $= \dfrac{1}{K_a(\Lambda_0)^2} = S$

y-intercept $= \dfrac{1}{\Lambda_0} = P$

Then, $$\frac{P}{S} = \frac{\frac{1}{\Lambda_0}}{\frac{1}{K_a(\Lambda_0)^2}} = K_a\Lambda_0$$

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 pK_a of HX is:

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

Ans. (B)

Sol. At pH = 7 $\Rightarrow$ pure water

solubility = $S_1 = \sqrt{K_{sp}}$

At pH = 2

$\Rightarrow$ $MX(s) + aq \xrightleftharpoons{K_{SP}} M^+(aq) + X^-(aq)$

$\qquad\qquad\qquad\qquad\qquad s \qquad s-x$

$X^-(aq) + H^+(aq) \xrightleftharpoons{1/K_a} HX(aq)$

$s-x \qquad 10^{-2} \qquad\qquad x \simeq s$

Approximation : $s - x \simeq 0$ [X^- is limiting reagent]

$\Rightarrow s \simeq x$

$\Rightarrow$ $s(s-x) = K_{sp}$ ...... (1)

$$\frac{s}{(s-x)(10^{-2})} = \frac{1}{K_a} \quad ...... (2)$$

Multiply (1) × (2) $\Rightarrow \dfrac{s^2}{10^{-2}} = \dfrac{K_{sp}}{K_a}$

$$\Rightarrow s = \frac{\sqrt{K_{sp}}}{10\sqrt{K_a}}$$

Now given : $\dfrac{s}{s_1} = \dfrac{10^{-3}}{10^{-4}}$

$$\Rightarrow \frac{\dfrac{\sqrt{K_{sp}}}{10\sqrt{K_a}}}{\sqrt{K_{sp}}} = 10 \qquad \Rightarrow \frac{1}{10\sqrt{K_a}} = 10$$

$$\Rightarrow \sqrt{K_a} = 10^{-2}$$

$\Rightarrow K_a = 10^{-4}$

$\Rightarrow pK_a = 4$

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

$$\mathbf{P} \xrightarrow{HI} \mathbf{Q} \xrightarrow[\text{(iii)}\, H_3O^+]{\text{(i) NaOH, (ii)}\, CO_2} \mathbf{R} \xrightarrow[\text{(ii)}\, H_3O^+]{\text{(i)}\, (CH_3CO)_2O} \mathbf{S}$$

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.

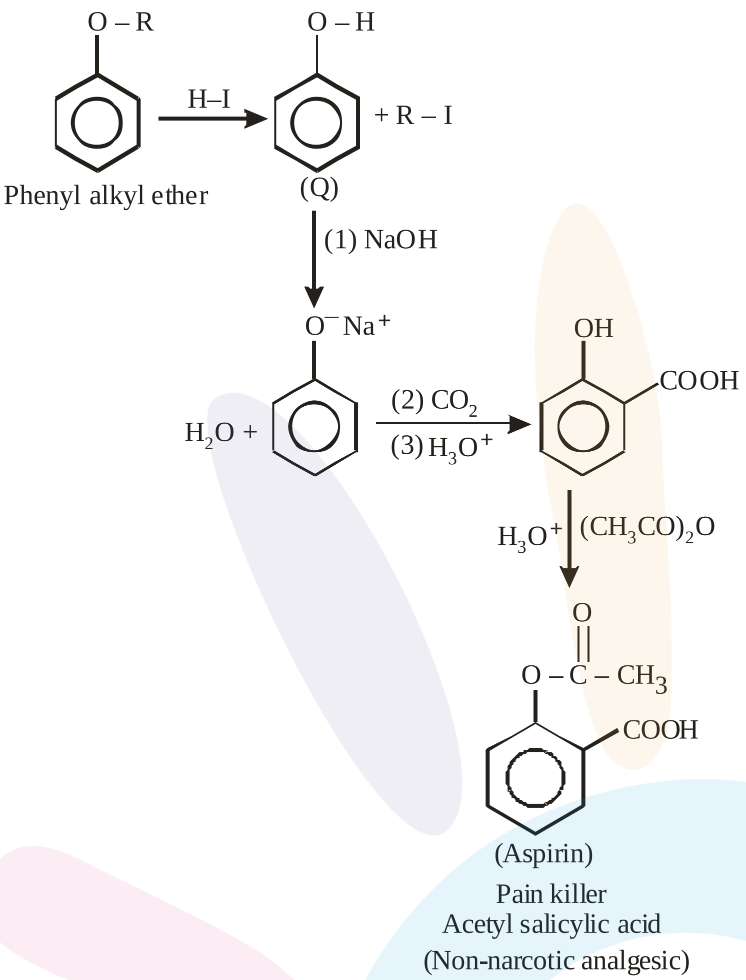
Ans. (B)

Sol. P is phenyl alkyl ether

Q is aromatic compound

R and S are the major product

i.e.



Correct ans is (B)

Aspirin inhibits the synthesis of chemicals known as prostaglandin's.

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 **ONLY** If the correct integer is entered;
  Zero Marks : 0 In all other cases.

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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]

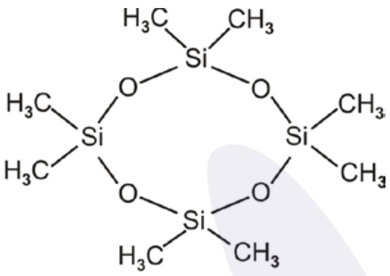
Ans. (222)

Sol. $4(CH_3)_2SiCl_2 + 4H_2O \xrightarrow{75\%} \underset{(X)}{(CH_3)_8Si_4O_4} + 8HCl$

$w = 516\,g$

$\underset{(moles)}{n} = \frac{516}{129}$

$= 4$



weight = 296 g

% yield = 75

The weight of X (in gram) $= 296 \times \frac{75}{100} = 222\,g$

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 **x/y** is ___.

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

Ans. (100)

Sol. For gas : $Z = 0.5$, $V_m = 0.4$ L/mol

$T = 800$ K, $P = X$ atm.

$\Rightarrow\ Z = \frac{PV_m}{RT}$

$\Rightarrow\ \frac{X(0.4)}{0.08 \times 800} = 0.5$

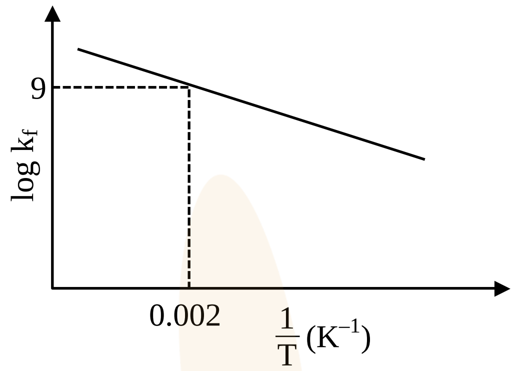
$\Rightarrow\ X = 80$

For ideal gas, $PV_m = RT$

$\Rightarrow\ V_m = \frac{RT}{P} = \frac{0.08 \times 800}{80} = 0.8\ L\ mol^{-1} = y$

Then, $\frac{x}{y} = \frac{80}{0.8} = 100.$

10. The plot of log k_f versus $\frac{1}{T}$ for a reversible reaction A (g) $\rightleftharpoons$ 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]

Ans. (5)

Sol. For reaction A(g) $\rightleftharpoons$ P(g)

$$\log k_f = \frac{-E_f}{2.303RT} + \log A_f \text{ [Arrhenius equation for forward reaction]}$$

From plot when, $\frac{1}{T} = 0.002$, log $k_f = 9$

$$\Rightarrow\ 9 = \frac{-E_f}{2.303R}(0.002) + \log(A_f)$$

Given : $A_f = 10^{15}\ s^{-1}$

$$\Rightarrow\ 9 = \frac{-E_f}{2.303R}(0.002) + 15$$

$$\Rightarrow\ \frac{E_f}{2.303R} = \frac{6}{0.002} = 3000$$

Now, $K = \frac{k_f}{k_b} = \frac{A_f}{A_b}e^{-(E_f - E_b)/RT}$

$$\log K = -\frac{1}{2.303}\frac{(E_f - E_b)}{RT} + \log\left(\frac{10^{15}}{10^{11}}\right)$$

At 500 K

$$\Rightarrow\ 6 = \frac{-(E_f - E_b)}{500R\ (2.303)} + 4$$

$\Rightarrow$ (1000 R) (2.303) = $E_b - E_f$

$\Rightarrow$ (1000 R) (2.303) = E_b – 3000 (2.303 R)

$\Rightarrow$ E_b = 4000 R (2.303) ……… (1)

Now $k_b = A_b e^{-E_b/RT}$

$\Rightarrow \log k_b = \dfrac{-E_b}{2.303RT} + \log A_b$

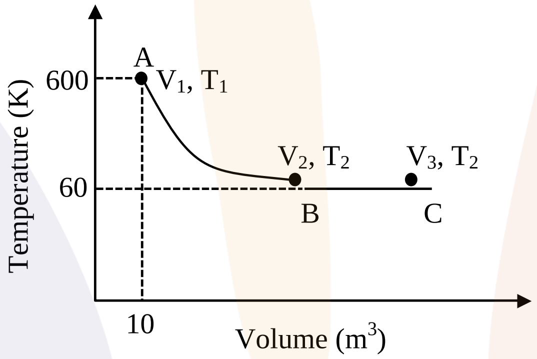
At 250 K

$\Rightarrow \log k_b = -\dfrac{4000}{250} + \log(10^{11})$ [From equation (1)]

$= -16 + 11 = -5$

$|\log k_b| = 5$

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



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

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

Ans. (7)

Sol. For $A \rightarrow B$ $\quad 600\,V_1^{\gamma-1} = 60V_2^{\gamma-1}$ $(\gamma = 5/3)$

(Reversible adiabatic)

$\Rightarrow 600\,(V_1)^{2/3} = 60\,(V_2)^{2/3}$

$\Rightarrow 10 = \left(\dfrac{V_2}{V_1}\right)^{2/3}$

$\Rightarrow 10 = \left(\dfrac{V_2}{10}\right)^{2/3}$

$\Rightarrow V_2 = 10(10)^{3/2} = 10^{5/2}$

Now, $q_{net} = RT_2\, ln\, 10 = 60\, R\, ln\, 10 = q_{AB} + q_{BC}$

$\because \; q_{AB} = 0$

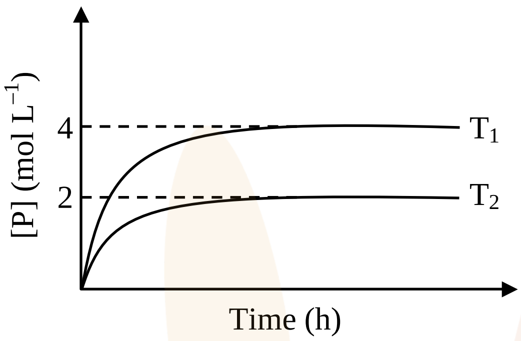
$\Rightarrow q_{BC} = 60\, R\, ln\, 10 = 60\, R\, ln\, \dfrac{V_3}{V_2}$ [$\because$ $B \rightarrow C$ is reversible isothermal]

$\Rightarrow 60\, R\, ln\, 10 = 60\, R\, ln \left(\dfrac{V_3}{10^{5/2}}\right)$

$\Rightarrow \log 10 = \log V_3 - \dfrac{5}{2}$

$\Rightarrow \log V_3 = \dfrac{7}{2} \Rightarrow 2 \log V_3 = 7$

12. In a one-litre flask, 6 moles of A undergoes the reaction A (g) $\rightleftharpoons$ 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 $(\Delta G_2^\ominus - \Delta G_1^\ominus) = RT_2 \ln x$, then the value of x is ______.

[$\Delta G_1^\ominus$ and $\Delta G_2^\ominus$ are standard Gibb's free energy change for the reaction at temperatures T_1 and T_2, respectively.]

Ans. (8)

Sol. At T_1 K : A(g) $\rightleftharpoons$ P(g)

t = 0   6

t = ∞   6 – x   x = 4 (from plot)

$\Rightarrow$ At T_1 K : $K_{P_1} = \dfrac{4}{2} = 2$

At T_2 K : A(g) $\rightleftharpoons$ P(g)

t = 0   6

t = ∞   6 – y   y = 2 (from plot)

$\Rightarrow$ At T_2 K : $K_{P_2} = \dfrac{2}{4} = \dfrac{1}{2}$

Now, $\Delta G_2^o = -RT_2\, ln\, K_{P_2} = -RT_2\, ln\, \dfrac{1}{2}$

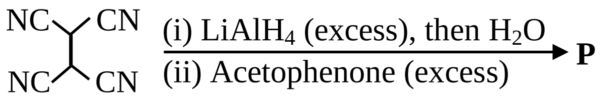
$\Rightarrow \Delta G_2^o = RT_2\, ln\, 2$

$\Delta G_1^o = -RT_1 \ln K_{P_1} = -RT_1\, ln\, 2 = -2RT_2\, ln\, 2$

Given : $\Delta G_2^o - \Delta G_1^o = RT_2\, ln\, 2 + 2RT_2\, ln\, 2 = 3RT_2\, ln\, 2 = RT_2\, ln\, x$

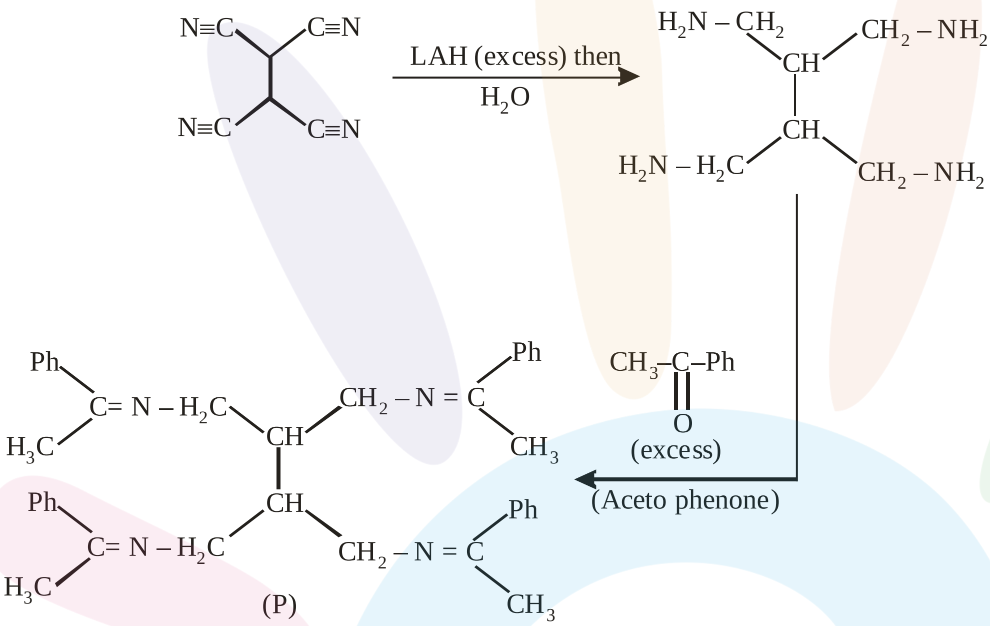
$\Rightarrow x = 2^3 = 8$

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



Ans. (28)

Sol.



Total number of sp^2 hybridised C-atom in P = 28

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.

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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		**List-II**	
(P)	$P_2O_3 + 3H_2O \rightarrow$	(1)	$P(O)(OCH_3)Cl_2$
(Q)	$P_4 + 3NaOH + 3H_2O \rightarrow$	(2)	H_3PO_3
(R)	$PCl_5 + CH_3COOH \rightarrow$	(3)	PH_3
(S)	$H_3PO_2 + 2H_2O + 4AgNO_3 \rightarrow$	(4)	$POCl_3$
		(5)	H_3PO_4

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

Ans. (D)

Sol. (P) $P_2O_3 + 3H_2O \rightarrow 2\underline{H_3PO_3}$

(Q) $P_4 + 3NaOH + 3H_2O \rightarrow 3NaH_2PO_2 + \underline{PH_3}$

(R) $PCl_5 + CH_3COOH \rightarrow CH_3COCl + \underline{POCl_3} + HCl$

(S) $H_3PO_2 + 2H_2O + 4AgNO_3 \rightarrow 4Ag + 4HNO_3 + \underline{H_3PO_4}$

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]

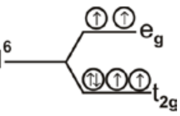
List-I		**List-II**	
(P)	$t_{2g}^{6}e_{g}^{0}$	(1)	$[Fe(H_2O)_6]^{2+}$
(Q)	$t_{2g}^{3}e_{g}^{2}$	(2)	$[Mn(H_2O)_6]^{2+}$
(R)	$e^{2}t_{2}^{3}$	(3)	$[Co(NH_3)_6]^{3+}$
(S)	$t_{2g}^{4}e_{g}^{2}$	(4)	$[FeCl_4]^{-}$
		(5)	$[CoCl_4]^{2-}$

(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

Ans. (D)

Sol. 1. $\overset{\text{II}}{[Fe(H_2O)_6]^{+2}}$
$\underset{\text{WFL}}{}$ WFL

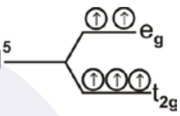
configuration $3d^6$



$t_{2g}^{\ 4}\,e_g^{\ 2}$ (S)

2. $\overset{\text{II}}{[Mn(H_2O)_6]^{+2}}$
WFL

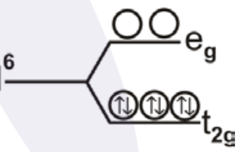
configuration $3d^5$



$t_{2g}^{\ 3}\,e_g^{\ 2}$ (Q)

3. $\overset{\text{III}}{[Co(NH_3)_6]^{+3}}$
SFL

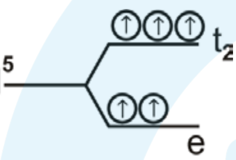
configuration $3d^6$



$t_{2g}^{\ 6}\,e_g^{\ 0}$ (P)

4. $\overset{\text{III}}{[Fe\,Cl_4]^{\ominus}}$
WFL

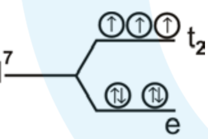
configuration $3d^5$



$e^2\,t_2^{\ 3}$ (R)

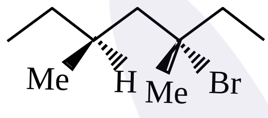
5. $\overset{\text{II}}{[Co\,Cl_4]^{-2}}$
WFL

configuration $3d^7$



$e^4\,t_2^{\ 3}$ (None)

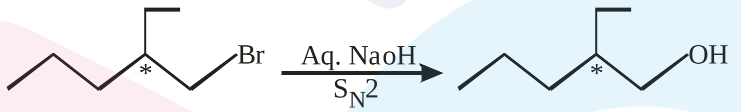
16. Match the reactions in List-I with the features of their products in List-II and choose the correct option.

List-I	List-II
(P) (-)-1-Bromo-2-ethylpentane (single enantiomer) $\xrightarrow[S_N2 \text{ reaction}]{\text{aq. NaOH}}$	(1) Inversion of configuration
(Q) (-)-2-Bromopentane (single enantiomer) $\xrightarrow[S_N2 \text{ reaction}]{\text{aq. NaOH}}$	(2) Retention of configuration
(R) (-)-3-Bromo-3-methylhexane (single enantiomer) $\xrightarrow[S_N1 \text{ reaction}]{\text{aq. NaOH}}$	(3) Mixture of enantiomers
(S)  (Single enantiomer) $\xrightarrow[S_N1 \text{ reaction}]{\text{aq. NaOH}}$	(4) Mixture of structural isomers
	(5) Mixture of diastereomers

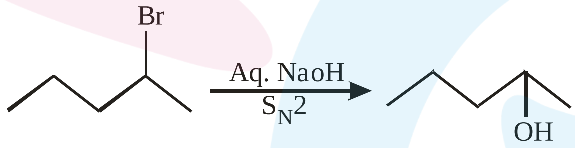
(A) P → 1; Q → 2; R → 5; S → 3
(B) P → 2; Q → 1; R → 3; S → 5
(C) P → 1; Q → 2; R → 5; S → 4
(D) P → 2; Q → 4; R → 3; S → 5

Ans. (B)

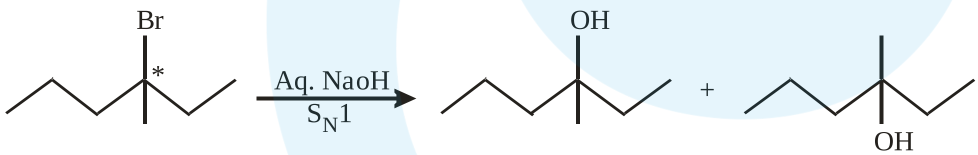
Sol. P → 2, Q → 1, R → 3, S → 5

(P) 

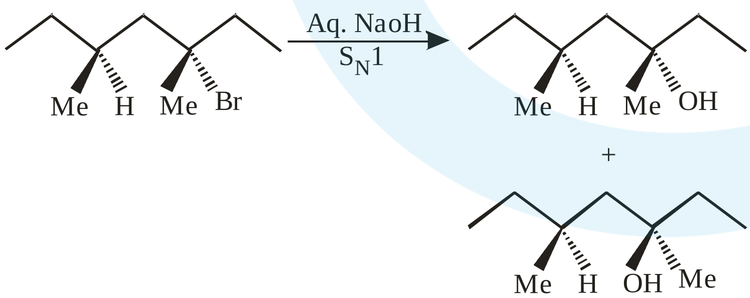
Retention of configuration

(Q) 

Inversion of configuration

(R) 

Mixture of enantiomers

(S) 

Diastereomeric mixture

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 $\xrightarrow[\text{(ii) SOCl}_2]{\text{(i) KMnO}_4\text{,KOH, }\Delta}$
(R)	Gattermann-Koch reaction	(3)	Benzene $\xrightarrow[\text{anhyd. AlCl}_3]{\text{CH}_3\text{Cl}}$
(S)	Rosenmund reduction	(4)	Aniline $\xrightarrow[\text{273–278 K}]{\text{NaNO}_2\text{/HCl}}$
		(5)	Phenol $\xrightarrow{\text{Zn, }\Delta}$

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

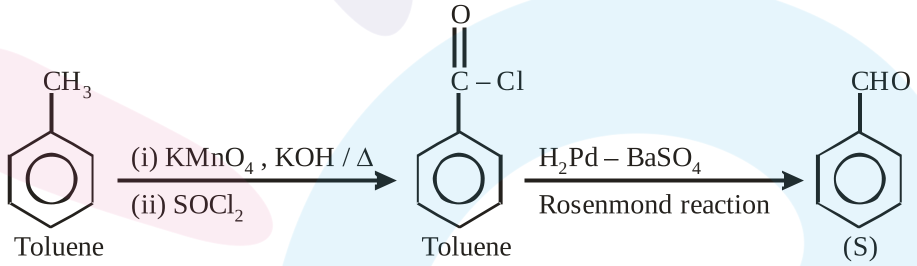
Ans. (D)

Sol. $\mathbf{P \to 3, Q \to 4, R \to 5, S \to 2}$

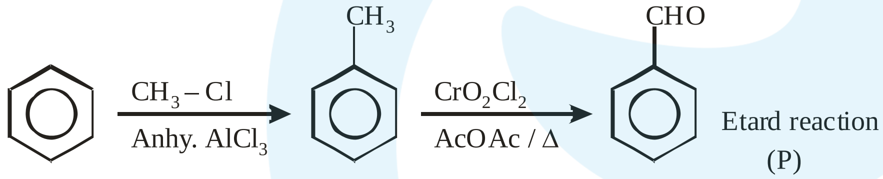
(i) $\text{Ph}-\overset{\overset{\text{O}}{\|}}{\text{C}}-\text{CH}_3 \xrightarrow{\text{Zn–Hg/HCl}} \text{Ph}-\text{CH}_2-\text{CH}_3$

Acetophenone

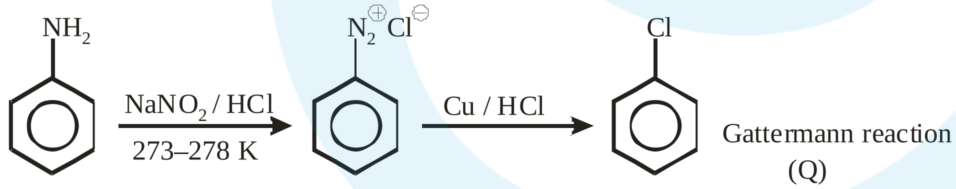
(ii)



(iii)



(iv)



(v)