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.

- 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. Formation of P

$$CH_3 - CH_2 - CH - CH_2 - CN \xrightarrow{PhMgBr} H_3O^+$$

$$PhMgBr \\ then H_3O^+$$

$$Asymmetric \\ carbon \\ (P)$$

Formation of Q

Formation of R

$$C-C1 + \frac{1}{2}(Ph-CH_2)_2Cd$$

$$PhMgBr$$

$$then H_3O^+$$

$$asymmetric$$

$$carbon$$

$$(R)$$

Formation of S

$$Ph - CH_{2} - C - H \xrightarrow{PhMgBr} Ph - CH_{2} - CH - Ph$$

$$\downarrow CrO_{3} \text{ with dil. } H_{2}SO_{4}$$

$$Ph - CH_{2} - C - Ph$$

$$\downarrow O$$

$$\downarrow HCN$$

$$Ph - CH = C - Ph \xrightarrow{H_{2}SO_{4}} Ph - CH_{2} - C - Ph$$

$$\downarrow COOH$$

(S) No asymmetric carbon

3. Consider the following reaction scheme and choose the correct option(s) for the major products \mathbf{Q} ,

R and S.

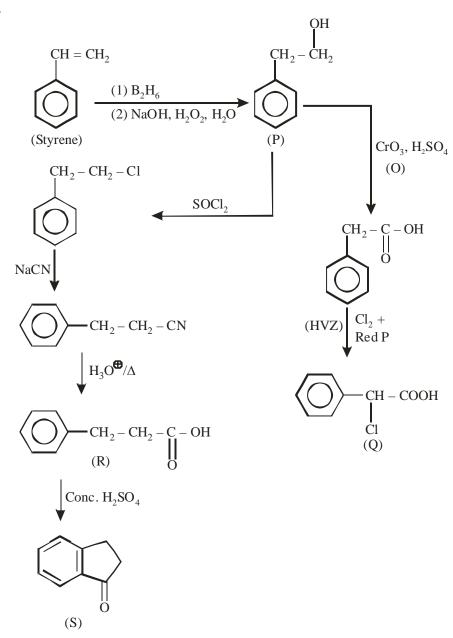
$$Styrene \xrightarrow{\text{(i) B}_2H_6 \\ \text{(ii) NaOH}, H_2O_2, H_2O} \\ \textbf{P} \xrightarrow{\text{(ii) Cl}_2, Re\ d\ Phosphorus} \\ \textbf{(iii) H}_2O$$

$$P \xrightarrow{\text{(i) SOCl}_2 \atop \text{(ii) NaCN}} R \xrightarrow{\text{conc. H}_2SO_4} S$$

(C)
$$Q$$
 R S Q R S

Ans. (B)

Sol.



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:

: +3 If **ONLY** the correct option is chosen; Full Marks

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

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

$$\mathbf{P} \xrightarrow{\text{aq. H}_2\text{SO}_4 \atop \text{PbO}_2(\text{excess})} \mathbf{X} \text{ (a coloured species in solution)}$$

$$\mathbf{Q} \xrightarrow{\text{Conc. H}_2\text{SO}_4 \atop \text{warm}} \mathbf{Y} \text{ (gives blue-coloration with KI-starch paper)}$$

(A) CrO_4^{2-} and Br_2

(B) MnO₄²⁻ and Cl₂

(C) MnO₄⁻ and Cl₂

(D) MnSO₄ and HOCl

Ans. (C)

Sol.
$$\operatorname{MnCl}_2 + \operatorname{NaOH} \rightarrow \operatorname{Mn(OH)}_2 \downarrow + \operatorname{NaCl}_{\begin{subarray}{c} (\mathbf{P}) \\ \text{(white ppt.)} \end{subarray}} + \operatorname{NaCl}_{\begin{subarray}{c} (\mathbf{Q}) \\ \text{(Filterate)} \end{subarray}}$$

$$\begin{array}{c} Mn(OH)_2 \xrightarrow{PbO_2 + H^+(H_2SO_4)} MnO_4^- + Pb^{2+} \\ Purple \\ Cl^- \xrightarrow{MnO(OH)_2/conc. \ H_2SO_4/\square} Cl_2 \\ & \downarrow 2l^- \\ & (Starch + l_2) + 2Cl^- \end{array}$$

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

 $[\Lambda_{\rm m} = {\rm molar\ conductivity}]$

 $\Lambda_{\rm m}^{\circ}$ = 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, $\alpha = \frac{\Lambda_m}{\Lambda_0}$

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

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

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

Divide by $\, {}^{\backprime} \! \Lambda_m \, {}^{\backprime}$

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

$$\Rightarrow \frac{1}{\Lambda_{\rm m}} = \frac{C\Lambda_{\rm m}}{K_{\rm a}(\Lambda_0)^2} + \frac{1}{\Lambda_0}$$

Plot
$$\frac{1}{\Lambda_m}$$
 vs $C\Lambda_m$ has

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

y-intercept =
$$\frac{1}{\Lambda_0}$$
 = 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

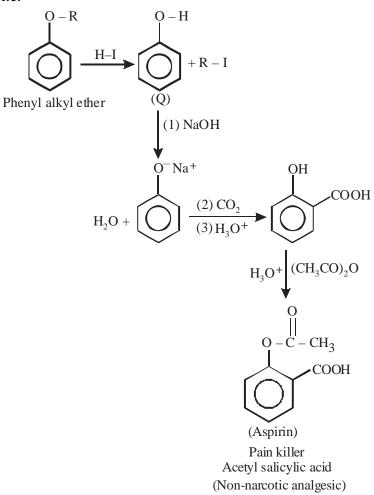
(B) 4

(C) 5

(D) 2

Ans. (**B**)

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 <u>according to the following marking scheme</u>:

Full Marks : +4 **ONLY** If the correct integer is entered;

Zero Marks : 0 In all other cases.

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)

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

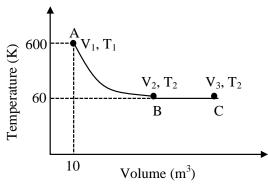
At 250 K

$$\Rightarrow \log k_b = -\frac{4000}{250} + \log (10^{11})$$
$$= -16 + 11 = -5$$

[From equation (1)]

$$|\log k_b| = 5$$

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



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

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

Ans. (7)

Sol. For
$$A \rightarrow B$$

$$600 V_1^{\gamma - 1} = 60 V_2^{\gamma - 1} \quad (\gamma = 5/3)$$

(Reversible adiabatic)

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

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

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

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

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

$$\therefore$$
 $q_{AB} = 0$

$$\Rightarrow$$
 q_{BC} = 60 R *l*n 10 = 60 R *l*n $\frac{V_3}{V_2}$

 $[:: B \to C \text{ is reversible isothermal}]$

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

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

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

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

NC
$$\leftarrow$$
 CN (i) LiAlH₄ (excess), then H₂O (ii) Acetophenone (excess) \rightarrow **P**

Ans. (28)

Sol.

$$\begin{array}{c} N \equiv C \\ C \equiv N \\ N \equiv C \\ C \equiv N \\$$

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.

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.

•	•		•
	10	4	•

- (P) $P_2O_3 + 3H_2O \rightarrow$
- (Q) $P_4 + 3NaOH + 3H_2O \rightarrow$
- (R) $PCl_5 + CH_3COOH \rightarrow$
- (S) $H_3PO_2 + 2H_2O + 4AgNO_3 \rightarrow$
- (A) $P \rightarrow 2$; $Q \rightarrow 3$; $R \rightarrow 1$; $S \rightarrow 5$
- (A) $P \rightarrow 2$, $Q \rightarrow 3$, $R \rightarrow 1$, $S \rightarrow 3$ (C) $P \rightarrow 5$; $Q \rightarrow 2$; $R \rightarrow 1$; $S \rightarrow 3$

List-II

- (1) $P(O)(OCH_3)Cl_2$
- (2) H_3PO_3
- (3) PH₃
- (4) POCl₃
- (5) H_3PO_4
- (B) $P \rightarrow 3$; $Q \rightarrow 5$; $R \rightarrow 4$; $S \rightarrow 2$
- (D) $P \rightarrow 2$; $Q \rightarrow 3$; $R \rightarrow 4$; $S \rightarrow 5$

Ans. (D)

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

- (Q) $P_4 + 3NaOH + 3H_2O \rightarrow 3NaH_2PO_2 + PH_3$
- (R) $PCl_5 + CH_3COOH \rightarrow CH_3COCl + POCl_3 + HCl$
- (S) $H_3PO_2 + 2H_2O + 4AgNO_3 \rightarrow 4Ag + 4HNO_3 + H_3PO_4$
- **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

- (P) $t_{2g}^{6}e_{g}^{0}$
- $(Q) \quad t_{2g}^3 e_g^2$
- (R) $e^2t_2^3$
- $(S) t_{2g}^4 e_g^2$
- _
- (A) $P \rightarrow 1$; $Q \rightarrow 4$; $R \rightarrow 2$; $S \rightarrow 3$
- (C) $P \rightarrow 3$; $Q \rightarrow 2$; $R \rightarrow 5$; $S \rightarrow 1$

- List-II
- (1) $[Fe(H_2O)_6]^{2+}$
- (2) $[Mn(H_2O)_6]^{2+}$
- (3) $\left[\text{Co}(\text{NH}_3)_6\right]^{3+}$
- $(4) [FeCl_4]^-$
- (5) $[CoCl_4]^{2-}$
- (B) $P \rightarrow 1$; $Q \rightarrow 2$; $R \rightarrow 4$; $S \rightarrow 5$
- (D) $P \rightarrow 3$; $Q \rightarrow 2$; $R \rightarrow 4$; $S \rightarrow 1$

Ans. (D)

$$\begin{array}{ccc} \textbf{Sol.} & 1. & [Fe(H_2O)_6]^{+2} \\ & \text{WFL} \end{array}$$

configuration
$$3d^{\frac{6}{2g}}e_{g}$$

$$t_{2g}^{\frac{4}{2g}}e_{g}^{\frac{2}{3}}(S)$$

2.
$$[Mn(H_2O)_6]^{+2}$$

WFL

configuration
$$3d^{\frac{5}{2g}}e_{g}$$

$$t_{2g}^{\frac{3}{2}}e_{g}^{\frac{2}{2}}(Q)$$

3.
$$[Co(NH_3)_6]^{+3}$$
SFL

configuration
$$3d^{\frac{6}{2g}}e_{g}$$

$$t_{2g}^{\frac{6}{2g}}e_{g}^{\frac{0}{2g}}(P)$$

4.
$$[\text{Fe Cl}_4]^{\Theta}$$

configuration
$$3d^{\frac{5}{2}}$$

$$e^{2}t_{2}^{3}(R)$$

configuration
$$3d^{7}$$

$$e^{4}t_{2}^{3} \text{ (None)}$$

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

- (P) Etard reaction
- List-II (1) Zn-Hg, HCl Acetophenone –
- Gattermann reaction
- (i) KMnO₄,KOH, Δ (2) Toluene -(ii) SOCl₂
- Gattermann-Koch reaction
- CH₃Cl Benzene anhyd. AlCl₃
- **(S)** Rosenmund reduction
- (4) Aniline -
- (5) Phenol-

(A)
$$P \rightarrow 2$$
; $Q \rightarrow 4$; $R \rightarrow 1$; $S \rightarrow 3$

(B)
$$P \rightarrow 1$$
; $Q \rightarrow 3$; $R \rightarrow 5$; $S \rightarrow 2$

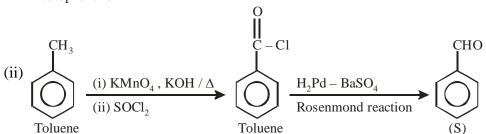
(C)
$$P \rightarrow 3$$
; $Q \rightarrow 2$; $R \rightarrow 1$; $S \rightarrow 4$

(D)
$$P \rightarrow 3$$
; $Q \rightarrow 4$; $R \rightarrow 5$; $S \rightarrow 2$

Ans. (D)

Sol.
$$P \rightarrow 3$$
, $Q \rightarrow 4$, $R \rightarrow 5$, $S \rightarrow 2$

(i) $Ph - C - CH_3 \xrightarrow{Zn - Hg/HCl} Ph - CH_2 - CH_3$
Acetophenone



(3)

