# JEE ADVANCED - 2013

## Paper - 2

## CHEMISTRY

### SECTION –1 (One or more options correct Type)

This section contains **8 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

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*21. The $K_{sp}$ of $Ag_2CrO_4$ is $1.1 \times 10^{-12}$ at 298K. The solubility (in mol/L) of $Ag_2CrO_4$ in a 0.1M $AgNO_3$ solution is

(A) $1.1 \times 10^{-11}$ (B) $1.1 \times 10^{-10}$

(C) $1.1 \times 10^{-12}$ (D) $1.1 \times 10^{-9}$

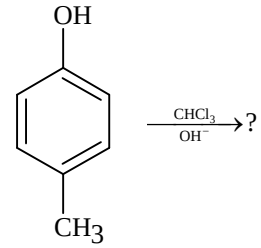
***Sol.*** **(B)**

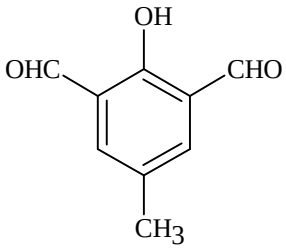
$$K_{sp} = 1.1\times10^{-12} = \left[Ag^{+}\right]^2 \left[CrO_4^{-2}\right]$$

$$1.1\times10^{-12} = \left[0.1\right]^2 \left[s\right]$$

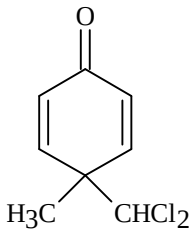
$$s = 1.1\times10^{-10}$$

22. In the following reaction, the product(s) formed is(are)

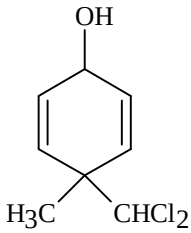


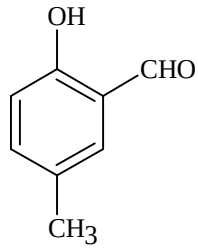

P




Q




R

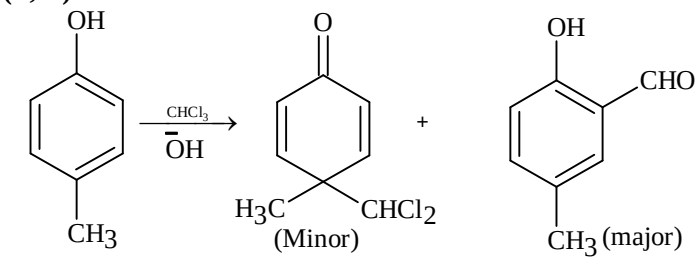



S

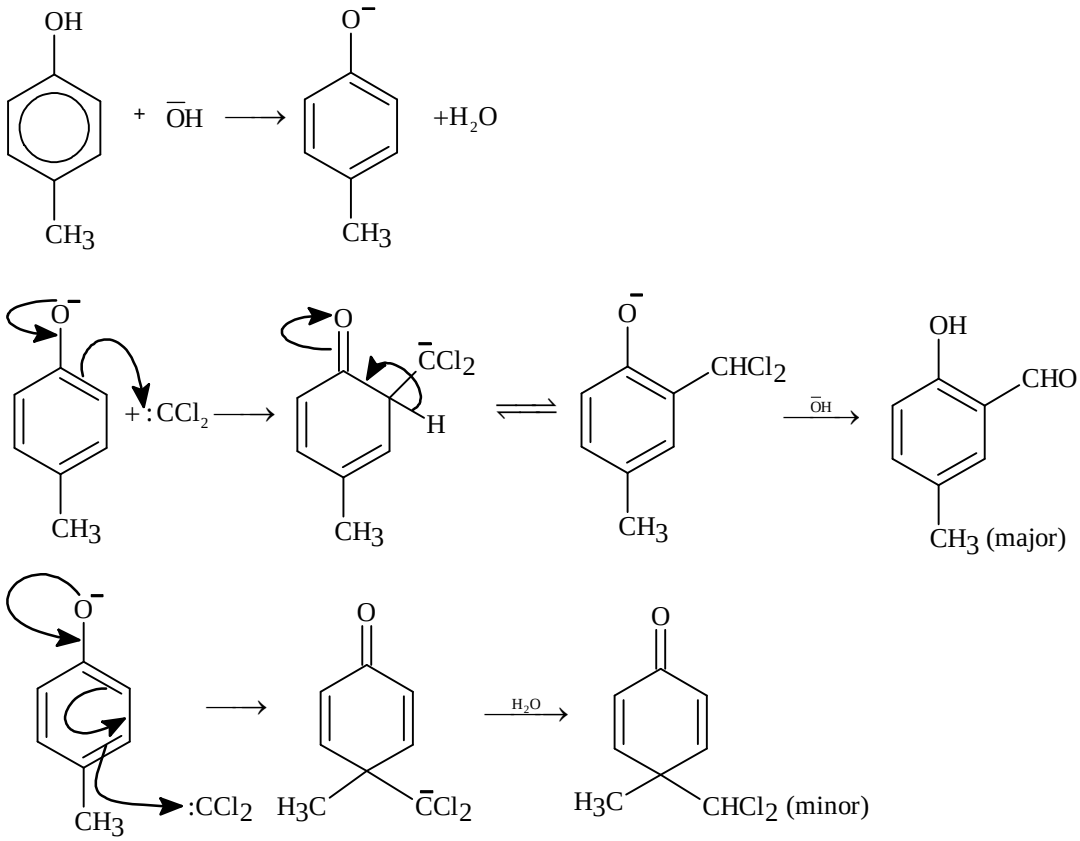
(A) P(major) (B) Q(minor)

(C) R(minor) (D) S(major)

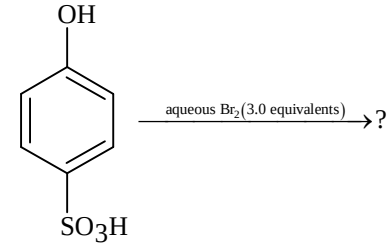
***Sol.*** **(B, D)**

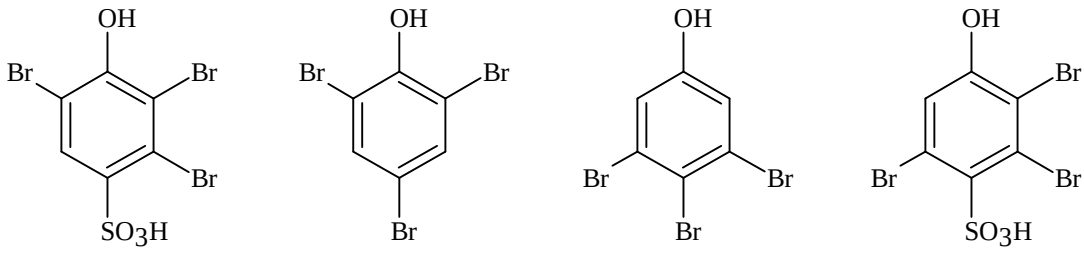



$$CHCl_3 + \overline{O}H \longrightarrow :CCl_2 + H_2O + Cl^{-}$$



23. The major product(s) of the following reaction is (are)

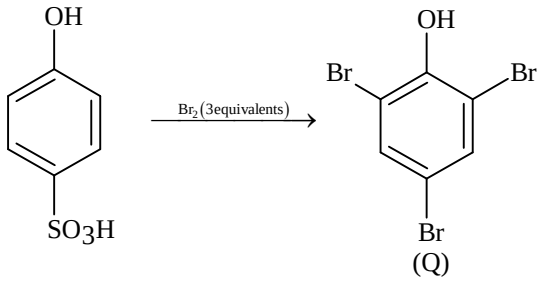




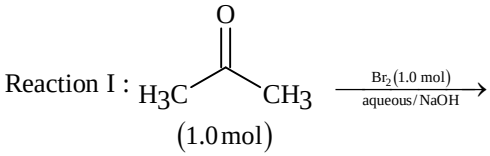
P Q R S

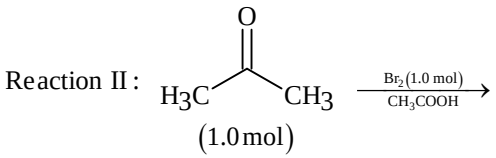
(A) P
(B) Q
(C) R
(D) S

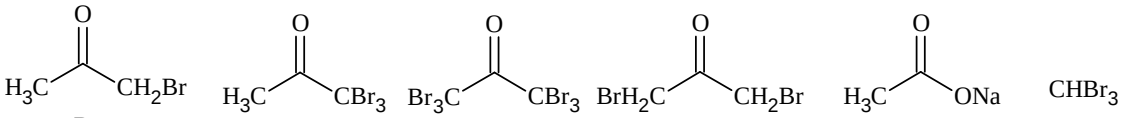
***Sol.*** **(B)**




24. After completion of the reactions (I and II), the organic compound(s) in the reaction mixtures is(are)



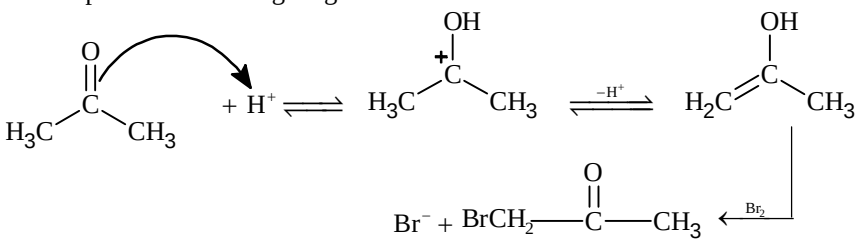




(A) Reaction I: P and Reaction II : P
(B) Reaction I: U, acetone and Reaction II:Q, acetone
(C) Reaction I : T, U, acetone and Reaction II : P
(D) Reaction I : R, acetone and Reaction II : S, acetone

***Sol.*** **(C)**

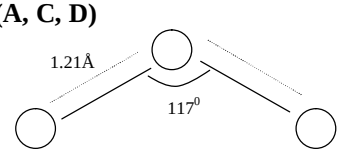
Solve as per law of limiting reagent.




25. The correct statement(s) about $O_3$ is(are)

(A) O–O bond lengths are equal.
(B) Thermal decomposition of $O_3$ is endothermic.
(C) $O_3$ is diamagnetic in nature.
(D) $O_3$ has a bent structure.

***Sol.*** **(A, C, D)**



*26. In the nuclear transmutation

$^{9}_{4}\text{Be} + \text{X} \longrightarrow {}^{8}_{4}\text{Be} + \text{Y}$

(X, Y) is (are)

(A) ($\gamma$, n) (B) (p, D)

(C) (n, D) (D) ($\gamma$, p)

***Sol.*** **(A, B)**

$^{9}_{4}\text{Be} + \gamma \longrightarrow {}^{8}_{4}\text{Be} + {}^{1}_{0}\text{n}$

$^{9}_{4}\text{Be} + {}^{1}_{1}\text{P} \longrightarrow {}^{8}_{4}\text{Be} + {}^{2}_{1}\text{H}$

Hence (A) and (B) are correct

27. The carbon–based reduction method is NOT used for the extraction of

(A) tin from $SnO_2$ (B) iron from $Fe_2O_3$

(C) aluminium from $Al_2O_3$ (D) magnesium from $MgCO_3.CaCO_3$

***Sol.*** **(C, D)**

$Fe_2O_3$ and $SnO_2$ undergoes C reduction. Hence (C) and (D) are correct.

*28. The thermal dissociation equilibrium of $CaCO_3$(s) is studied under different conditions.

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

For this equilibrium, the correct statement(s) is(are)

(A) $\Delta H$ is dependent on T

(B) K is independent of the initial amount of $CaCO_3$

(C) K is dependent on the pressure of $CO_2$ at a given T

(D) $\Delta H$ is independent of the catalyst, if any

***Sol.*** **(A, B, D)**

For the equilibrium $CaCO_3(s) \rightleftharpoons CaO(S) + CO_2(g)$. The equilibrium constant (K) is independent of initial amount of $CaCO_3$ where as at a given temperature is independent of pressure of $CO_2$. $\Delta H$ is independent of catalyst and it depends on temperature.

Hence (A), (B) and (D) are correct.

## SECTION-2 (Paragraph Type)

This section contains **4 paragraphs** each describing theory, experiment, data etc. **Eight questions** relate to four paragraphs with two questions on each paragraph. Each question of a paragraph has **only one correct answer** among the four choices (A), (B), (C) and (D).

### Paragraph for Question Nos. 29 and 30

An aqueous solution of a mixture of two inorganic salts, when treated with dilute HCl, gave a precipitate **(P)** and a filtrate **(Q).** The precipitate **P** was found to dissolve in hot water. The filtrate **(Q)** remained unchanged, when treated with $H_2S$ in a dilute mineral acid medium. However, it gave a precipitate **(R)** with $H_2S$ in an ammoniacal medium. The precipitate **R** gave a coloured solution **(S),** when treated with $H_2O_2$ in an aqueous NaOH medium.

29. The precipitate **P** contains

(A) $Pb^{2+}$ (B) $Hg_2^{2+}$

(C) $Ag^{+}$ (D) $Hg^{2+}$

***Sol.*** **(A)**

30. The coloured solution **S** contains

(A) $Fe_2(SO_4)_3$ (B) $CuSO_4$

(C) $ZnSO_4$ (D) $Na_2CrO_4$

***Sol.*** **(D)**

**Solution for the Q. No. 29 to 30.**

$$Pb^{+2} + 2HCl \longrightarrow PbCl_2 \xrightarrow[\text{Water}]{\text{Hot}} \text{soluble.}$$

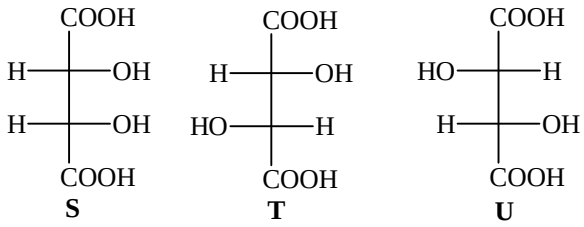
$$Cr^{+3} \xrightarrow[\text{ammoniacal}]{H_2S} Cr(OH)_3 \downarrow$$

$$Cr(OH)_3 \xrightarrow[H_2O_2]{NaOH} \underset{\text{Yellow solution}}{Na_2CrO_4}$$

## Paragraph for Question Nos. 31 to 32

**P** and **Q** are isomers of dicarboxylic acid $C_4H_4O_4$. Both decolorize $Br_2/H_2O$. On heating, **P** forms the cyclic anhydride.

Upon treatment with dilute alkaline $KMnO_4$, **P** as well as **Q** could produce one or more than one from **S, T** and **U.**




*31. Compounds formed from **P** and **Q** are, respectively

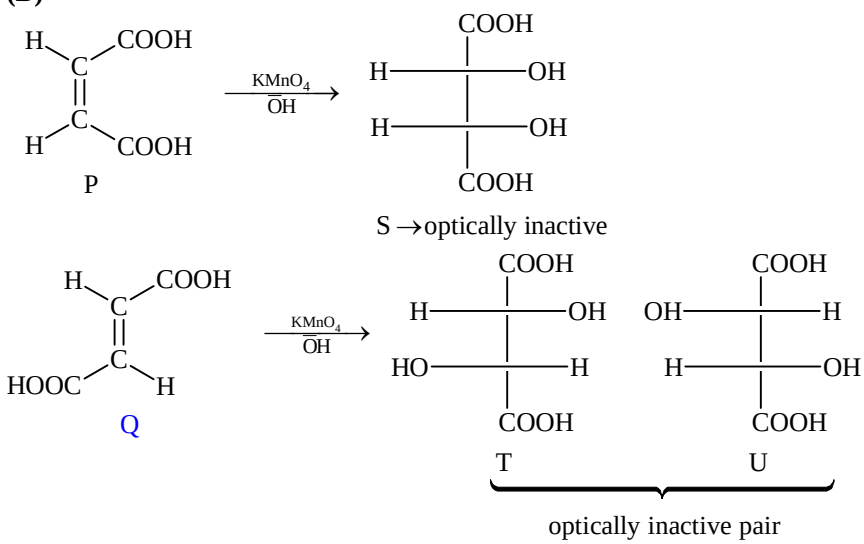
(A) Optically active **S** and optically active pair **(T, U)**

(B) Optically inactive **S** and optically inactive pair **(T, U)**

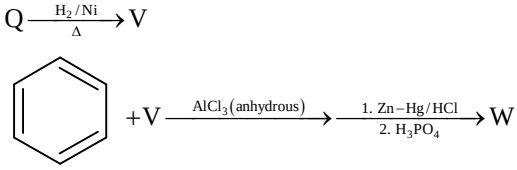
(C) Optically active pair **(T, U)** and optically active **S**

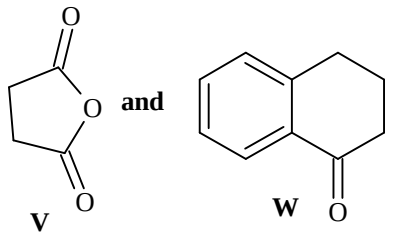
(D) Optically inactive pair **(T, U)** and optically inactive **S**

***Sol.*** **(B)**

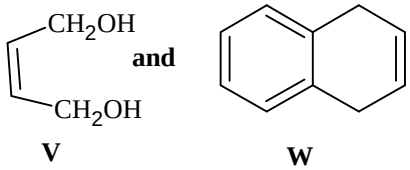


*32. In the following reaction sequences **V** and **W** are, respectively

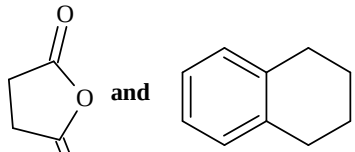



(A)  **and**

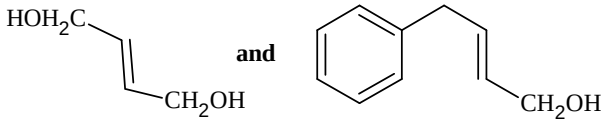
**V** **W**

(B)  **and**

**V** **W**

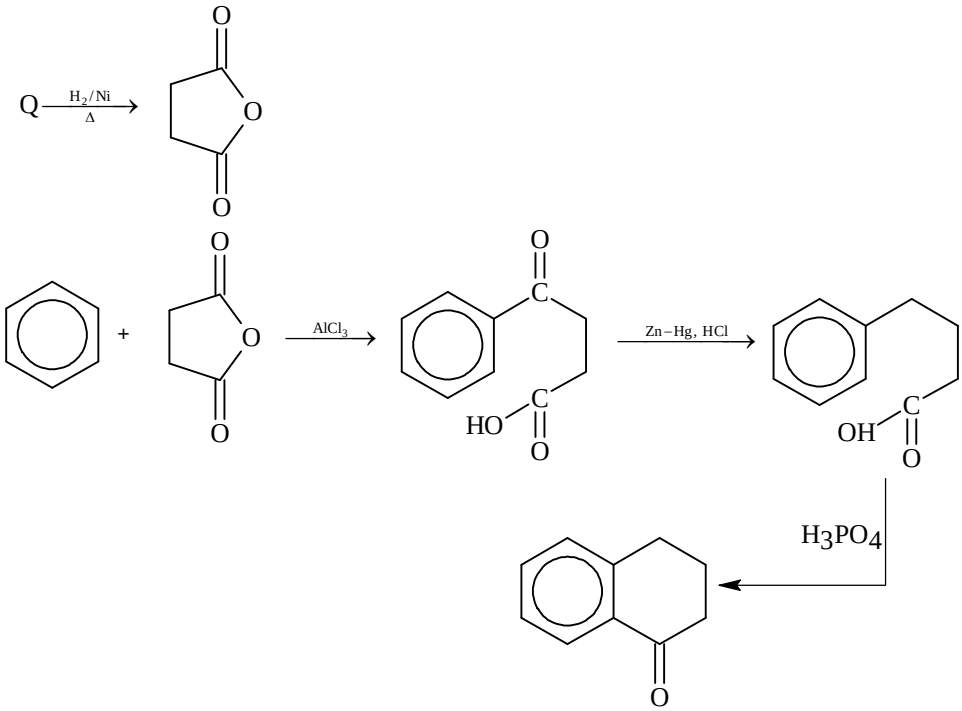
(C)  **and**

**V** **W**

(D)  **and**

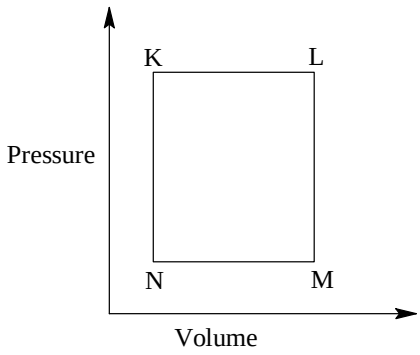
**V** **W**

***Sol.*** **(A)**




## Paragraph for Question Nos. 33 to 34

A fixed mass ‘m’ of a gas is subjected to transformation of states from K to L to M to N and back to K as shown in the figure




*33. The succeeding operations that enable this transformation of states are

(A) Heating, cooling, heating, cooling
(B) Cooling, heating, cooling, heating
(C) Heating, cooling, cooling, heating
(D) Cooling, heating, heating, cooling

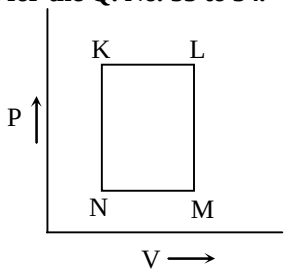
***Sol.*** **(C)**

*34. The pair of isochoric processes among the transformation of states is

(A) K to L and L to M
(B) L to M and N to K
(C) L to M and M to N
(D) M to N and N to K

***Sol.*** **(B)**

**Solution for the Q. No. 33 to 34.**




K – L heating, isobaric
L – M cooling, isochoric
M – N cooling, isobaric
N – K heating, isochoric

## Paragraph for Question Nos. 35 to 36

The reactions of $Cl_2$ gas with cold-dilute and hot-concentrated NaOH in water give sodium salts of two (different) oxoacids of chlorine, **P** and **Q,** respectively. The $Cl_2$ gas reacts with $SO_2$ gas, in presence of charcoal, to give a product **R.** **R** reacts with white phosphorus to give a compound **S.** On hydrolysis, **S** gives an oxoacid of phosphorus, **T**.

35. **P** and **Q,** respectively, are the sodium salts of

(A) hypochlorus and chloric acids
(B) hypochlorus and chlorus acids
(C) chloric and perchloric acids
(D) chloric and hypochlorus acids

***Sol.*** **(A)**

36. **R, S** and **T,** respectively, are

(A) $SO_2Cl_2$, $PCl_5$ and $H_3PO_4$
(B) $SO_2Cl_2$, $PCl_3$ and $H_3PO_3$
(C) $SOCl_2$, $PCl_3$ and $H_3PO_2$
(D) $SOCl_2$, $PCl_5$ and $H_3PO_4$

***Sol.*** **(A)**

**Solution for the Q. No. 35 to 36**

$$\underset{(\text{Cold + dil})}{2NaOH} + Cl_2 \longrightarrow NaCl + \underset{P}{NaClO} + H_2O$$

$$\underset{(\text{Hot + conc.})}{6NaOH} + 3Cl_2 \longrightarrow 5NaCl + \underset{Q}{NaClO_3} + 3H_2O$$

$$SO_2 + Cl_2 \xrightarrow{\text{Charcoal}} \underset{R}{SO_2Cl_2}$$

$$SO_2Cl_2 + P_4 \longrightarrow \underset{S}{PCl_5} + SO_2$$

$$PCl_5 + H_2O \longrightarrow \underset{T}{H_3PO_4} + HCl$$

## SECTION – 3: (Matching List Type)

This section contains **4 multiple choice questions. Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

37. The unbalanced chemical reactions given in List – I show missing reagent or condition (?) which are provided in List – II. Match List – I with List – II and select the correct answer using the code given below the lists:

| List – I | | List - II | |
|---|---|---|---|
| (P) | $PbO_2 + H_2SO_4 \xrightarrow{?} PbSO_4 + O_2 + \text{other product}$ | (1) | NO |
| (Q) | $Na_2S_2O_3 + H_2O \xrightarrow{?} NaHSO_4 + \text{other product}$ | (2) | $I_2$ |
| (R) | $N_2H_4 \xrightarrow{?} N_2 + \text{other product}$ | (3) | Warm |
| (S) | $XeF_2 \xrightarrow{?} Xe + \text{other product}$ | (4) | $Cl_2$ |

Codes:

| | P | Q | R | S |
|---|---|---|---|---|
| (A) | 4 | 2 | 3 | 1 |
| (B) | 3 | 2 | 1 | 4 |
| (C) | 1 | 4 | 2 | 3 |
| (D) | 3 | 4 | 2 | 1 |

***Sol.*** **(D)**

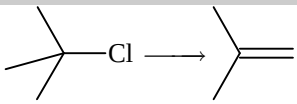
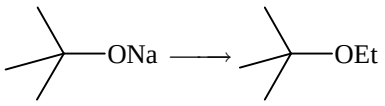
(P) $PbO_2 + H_2SO_4 \xrightarrow{\Delta} PbSO_4 + H_2O + \frac{1}{2}O_2$

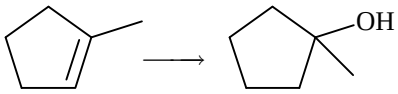
(Q) $2Na_2S_2O_3 + Cl_2 + 2H_2O \longrightarrow 2NaCl + 2NaHSO_4 + 2S$

(R) $N_2H_4 + 2I_2 \longrightarrow N_2 + 4HI$

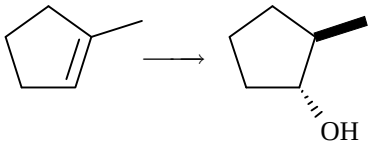
(S) $XeF_2 + 2NO \longrightarrow Xe + 2NOF$

*38. Match the chemical conversions in List – I with appropriate reagents in List – II and select the correct answer using the code given below the lists:

| List – I | | List - II | |
|---|---|---|---|
| (P) |  | (1) | (i) $Hg(OAc)_2$; (ii) $NaBH_4$ |
| (Q) |  | (2) | NaOEt |

(R) 

(3) Et-Br

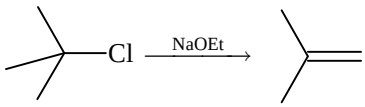
(S) 

(4) (i) $BH_3$; (ii) $H_2O_2$/NaOH

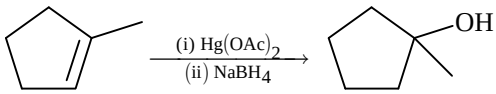
Codes:

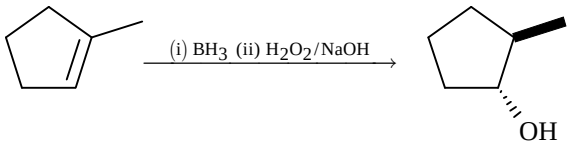
| | P | Q | R | S |
|---|---|---|---|---|
| (A) | 2 | 3 | 1 | 4 |
| (B) | 3 | 2 | 1 | 4 |
| (C) | 2 | 3 | 4 | 1 |
| (D) | 3 | 2 | 4 | 1 |

***Sol.*** **(A)**

(P) 

(Q) 

(R) 

(S) 

39. An aqueous solution of X is added slowly to an aqueous solution of Y as shown in List – I. The variation in conductivity of these reactions in List – II. Match List – I with List – II and select the correct answer using the code given below the lists:

| List – I | | List - II | |
|---|---|---|---|
| (P) | $\underset{X}{(C_2H_5)_3N} + \underset{Y}{CH_3COOH}$ | (1) | Conductivity decreases and then increases |
| (Q) | $\underset{X}{KI(0.1M)} + \underset{Y}{AgNO_3(0.01M)}$ | (2) | Conductivity decreases and then does not change much |
| (R) | $\underset{X}{CH_3COOH} + \underset{Y}{KOH}$ | (3) | Conductivity increases and then does not change much |
| (S) | $\underset{X}{NaOH} + \underset{Y}{HI}$ | (4) | Conductivity does not change much and then increases |

Codes:

| | P | Q | R | S |
|---|---|---|---|---|
| (A) | 3 | 4 | 2 | 1 |
| (B) | 4 | 3 | 2 | 1 |
| (C) | 2 | 3 | 4 | 1 |
| (D) | 1 | 4 | 3 | 2 |

***Sol.*** **(A)**

(P) $\underset{X}{(C_2H_5)_3}N + \underset{Y}{CH_3COOH} \longrightarrow (C_2H_5)_3NH^+CH_3COO^-$

Initially conductivity increases due to ion formation after that it becomes practically constant because X alone can not form ions. Hence (3) is the correct match.

(Q) $\underset{X}{KI(0.1\,M)} + \underset{Y}{AgNO_3(0.01M)} \longrightarrow AgI\downarrow + KNO_3$

Number of ions in the solution remains constant until all the $AgNO_3$ precipitated as AgI. Thereafter conductance increases due to increases in number of ions. Hence (4) is the correct match.

(R) Initially conductance decreases due to the decrease in the number of $\overline{O}H$ ions thereafter it slowly increases due to the increases in number of $H^+$ ions. Hence (2) is the correct match.

(S) Initially it decreases due to decrease in $H^+$ ions and then increases due to the increases in $\overline{O}H$ ions. Hence (1) is the correct match.

40. The standard reduction potential data at 25°C is given below:

$E^\circ\left(Fe^{3+}, Fe^{2+}\right) = +0.77V;$

$E^\circ\left(Fe^{2+}, Fe\right) = -0.44V$

$E^\circ\left(Cu^{2+}, Cu\right) = +0.34V;$

$E^\circ\left(Cu^{+}, Cu\right) = +0.52V$

$E^\circ\left[O_2(g) + 4H^+ + 4e^- \rightarrow 2H_2O\right] = +1.23V;$

$E^\circ\left[O_2(g) + 2H_2O + 4e^- \rightarrow 4OH^-\right] = +0.40V$

$E^\circ\left(Cr^{3+}, Cr\right) = -0.74V;$

$E^\circ\left(Cr^{2+}, Cr\right) = -0.91V$

Match $E^0$ of the redox pair in List – I with the values given in List – II and select the correct answer using the code given below the lists:

| | List – I | | List – II |
|---|---|---|---|
| (P) | $E^\circ\left(Fe^{3+}, Fe\right)$ | (1) | –0.18 V |
| (Q) | $E^\circ\left(4H_2O \rightleftharpoons 4H^+ + 4OH^-\right)$ | (2) | –0.4 V |
| (R) | $E^\circ\left(Cu^{2+} + Cu \longrightarrow 2Cu^+\right)$ | (3) | –0.04 V |
| (S) | $E^\circ\left(Cr^{3+}, Cr^{2+}\right)$ | (4) | –0.83 V |

Codes:

| | P | Q | R | S |
|---|---|---|---|---|
| (A) | 4 | 1 | 2 | 3 |
| (B) | 2 | 3 | 4 | 1 |
| (C) | 1 | 2 | 3 | 4 |
| (D) | 3 | 4 | 1 | 2 |

***Sol.*** **(D)**

(P) $\Delta G^o_{Fe^{3+}/Fe} = \Delta G^o_{Fe^{3+}/Fe^{2+}} + \Delta G^o_{Fe^{2+}/Fe}$

$\Rightarrow -3\times FE^o_{(Fe^{+3}/Fe)} = -1\times FE^o_{(Fe^{+3}/Fe^{+2})} + \left(-2\times FE^o_{Fe^{+2}/Fe}\right)$

$\Rightarrow E^o_{Fe^{+3}/Fe} = -0.04\ V$

(Q) $O_2(g) + 2H_2O + 4e^- \longrightarrow 4\bar{O}H \quad E^o = 0.40\ V$ ... (i)

$2H_2O \longrightarrow O_2(g) + 4H^+ + 4e^- \quad E^o = -1.23\ V$ .. (ii)

So $4H_2O \rightleftharpoons 4H^+ + 4\bar{O}H$ ... (iii)

$E^o$ for III$^{rd}$ reduction = 0.40 – 1.23 = - 0.83 V.

(R) $\Delta G^o_{(Cu^{+2}/Cu)} = \Delta G^o_{(Cu^{+2}/Cu^+)} + \Delta G^o_{(Cu^+/Cu)}$

$-2 \times FE^o_{Cu^{+2}/Cu} = -1 \times FE^o_{Cu^{+2}/Cu^+} + \left(-1 \times F \times E^o_{Cu^+/Cu}\right)$

$\Rightarrow E^o_{Cu^{+2}/Cu} = -0.18\ V$ .

(S) $\Delta G^o_{Cr^{+3}/Cr^{+2}} = \Delta G^o_{Cr^{+3}/Cr} + \Delta G^o_{Cr/Cr^{+2}}$

$-1 \times F \times E^o_{Cr^{+3}/Cr^{+2}} = -3 \times F \times E^o_{Cr^{+3}/Cr} + \left(-2 \times F \times E^o_{Cr/Cr^{+2}}\right)$

$\Rightarrow E^o_{Cr^{+3}/Cr^{+2}} = -0.4\,V$ .