PART - II: 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.

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

(A) 1.1×10^{-11} (B) 1.1×10^{-10}

(C) 1.1×10^{-12} (D) 1.1×10^{-9}

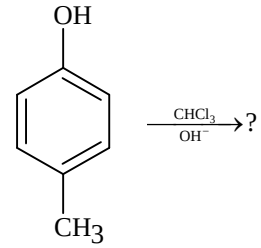
Sol. **(B)**

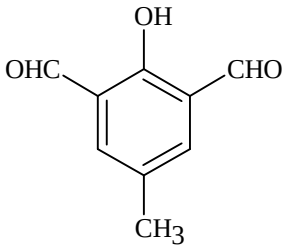
$$K_{sp} = 1.1\times10^{-12} = \left[Ag^{+}\right]^2 \left[CrO_4^{-2}\right]$$

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

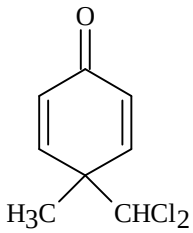
$$s = 1.1\times10^{-10}$$

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

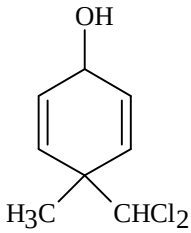




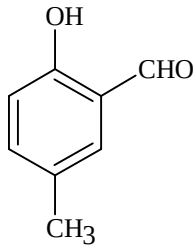
P



Q



R

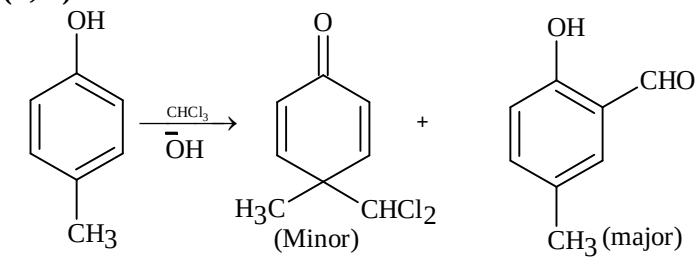


S

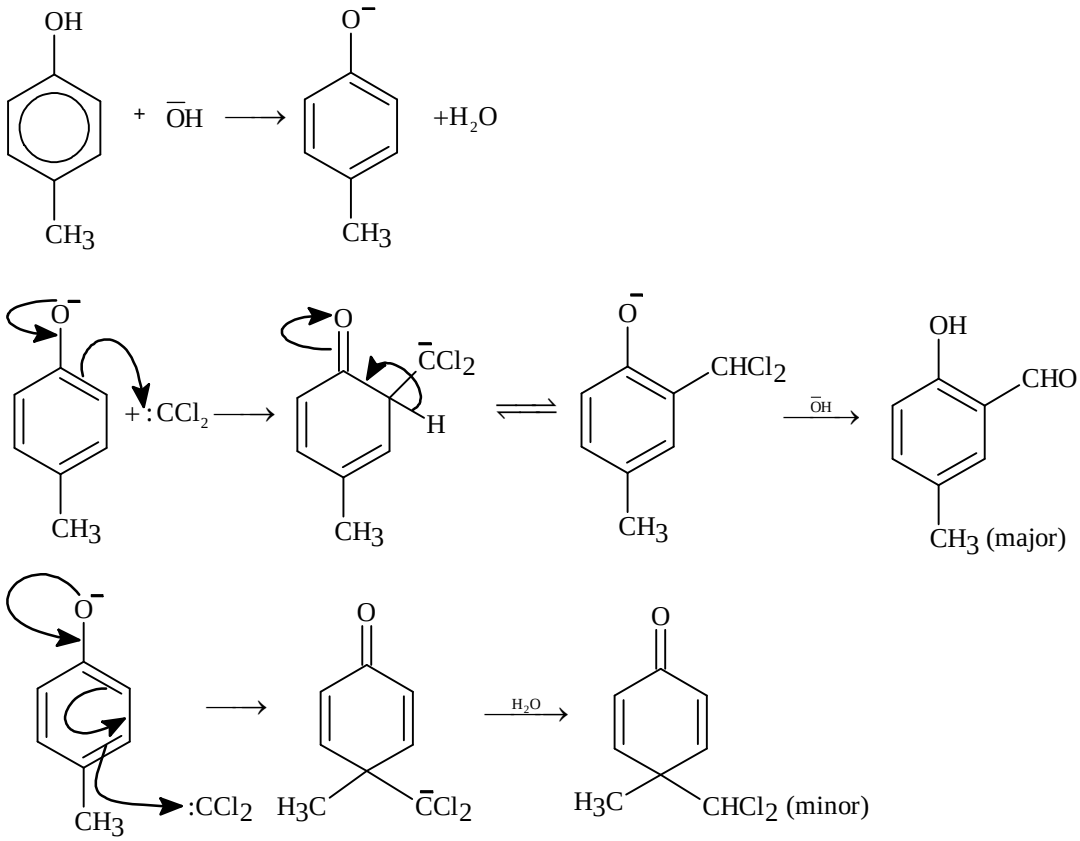
(A) P(major) (B) Q(minor)

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

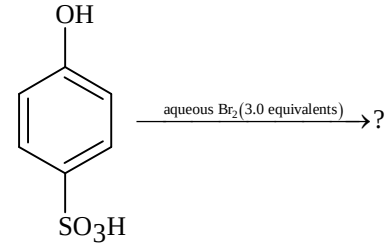
Sol. **(B, D)**

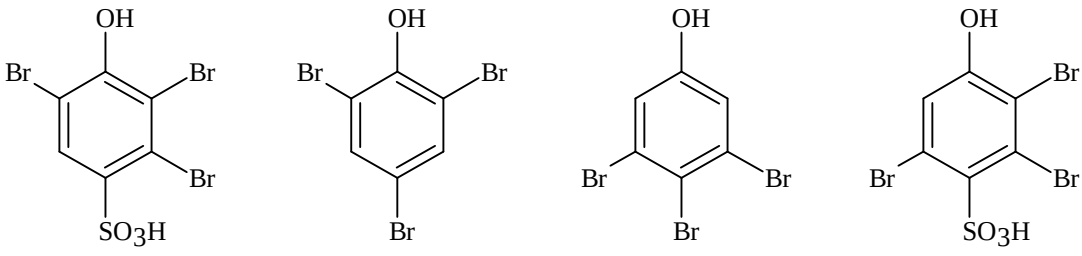


$$CHCl_3 + \overline{O}H \longrightarrow :CCl_2 + H_2O + Cl^{-}$$



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

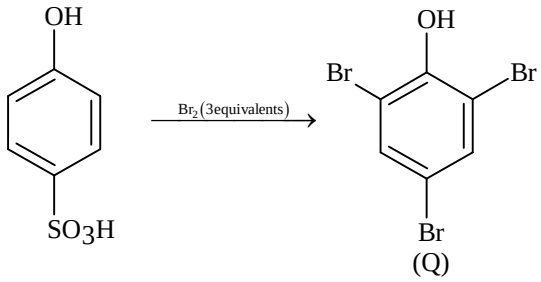




P Q R S

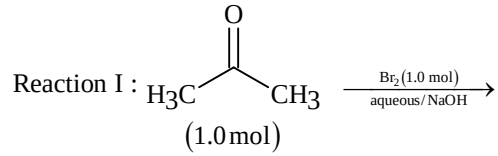
(A) P
(B) Q
(C) R
(D) S

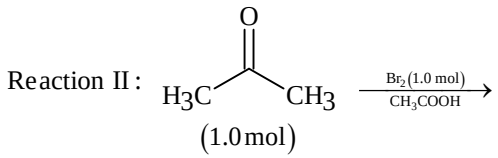
Sol. **(B)**

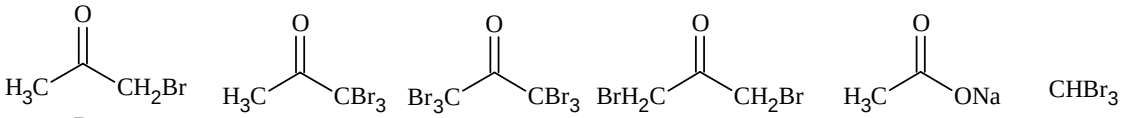


(Q)

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



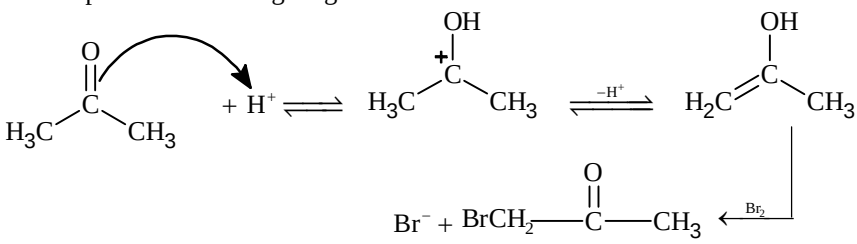




(A) Reaction I: P and Reaction II : P
(B) Reaction I: U, acetone and Reaction II:Q, acetone
(C) Reaction I : T, U, acetone and Reaction II : P
(D) Reaction I : R, acetone and Reaction II : S, acetone

Sol. **(C)**

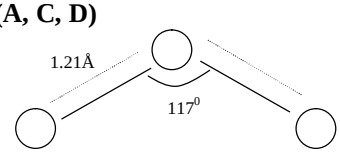
Solve as per law of limiting reagent.



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) (γ, n) (B) (p, D)

(C) (n, D) (D) (γ, 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.

$\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$

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

(A) ΔH 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) ΔH is independent of the catalyst, if any

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

For the equilibrium $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{S}) + \text{CO}_2(\text{g})$. 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. ΔH 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.

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

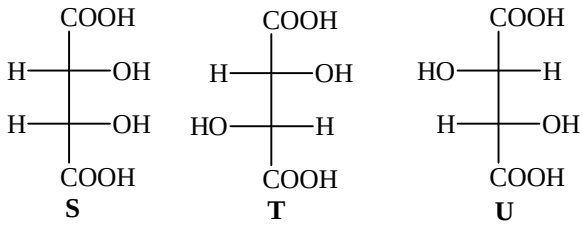
$$Cr^{+3} \xrightarrow[\text{ammoniacal}]{H_2S} Cr(OH)_3 \downarrow$$

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

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

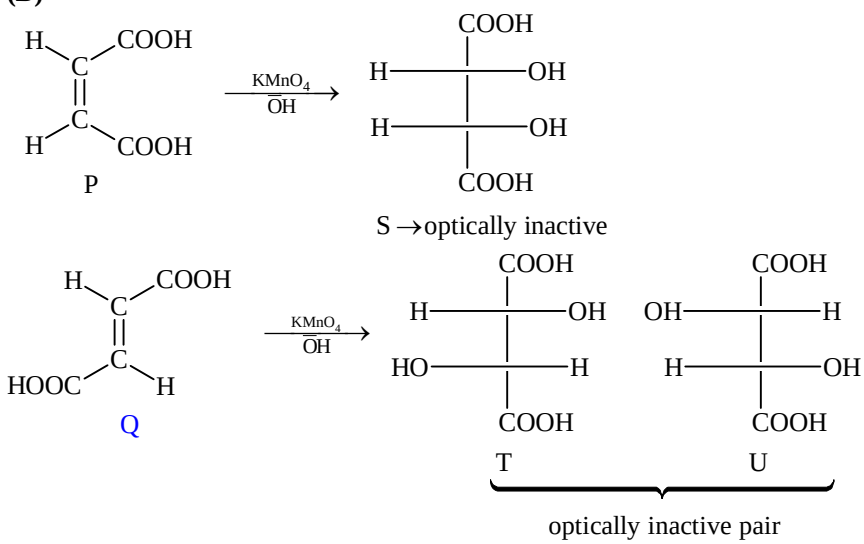
(A) Optically active **S** and optically active pair **(T, U)**

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

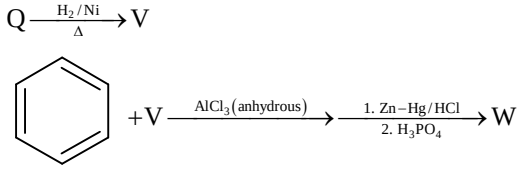
(C) Optically active pair **(T, U)** and optically active **S**

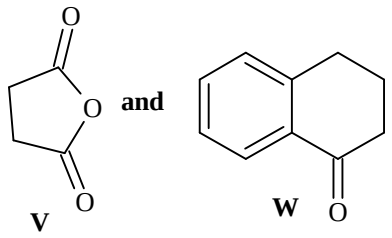
(D) Optically inactive pair **(T, U)** and optically inactive **S**

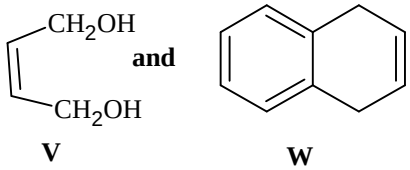
Sol. **(B)**

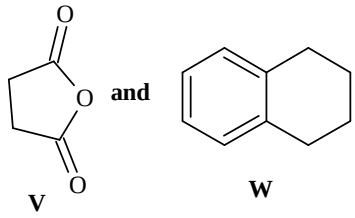


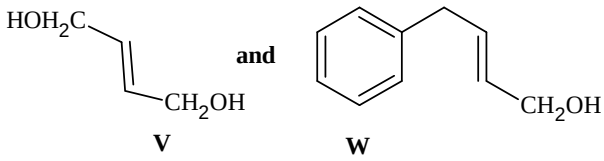
*32. In the following reaction sequences **V** and **W** are, respectively



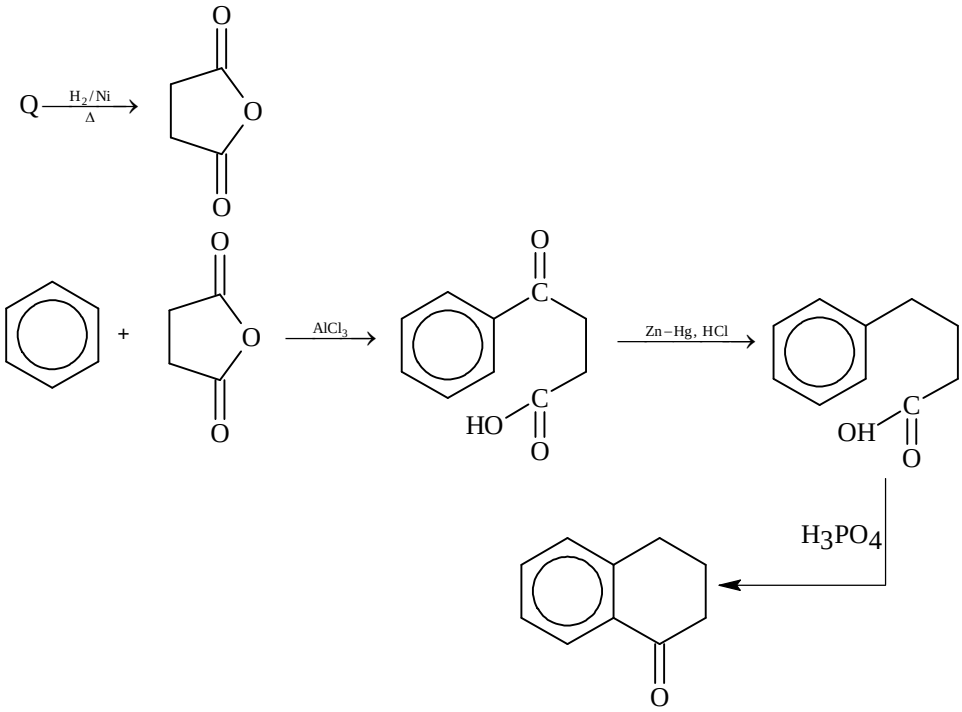
(A)  **V** **and** **W**

(B)  **V** **and** **W**

(C)  **V** **and** **W**

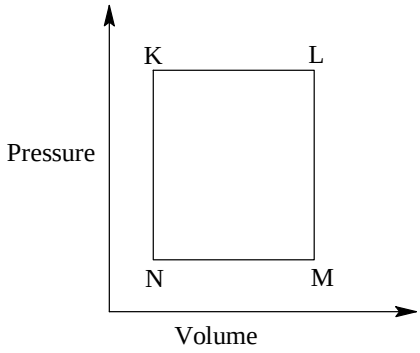
(D)  **V** **and** **W**

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

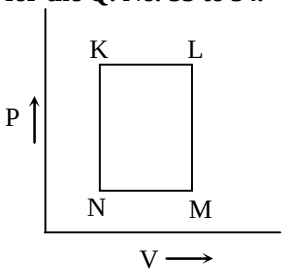
Sol. **(C)**

*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)**

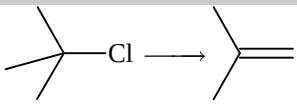
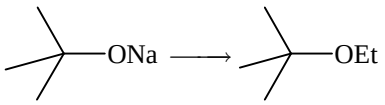
(P) $PbO_2 + H_2SO_4 \xrightarrow{\Delta} PbSO_4 + H_2O + \frac{1}{2}O_2$

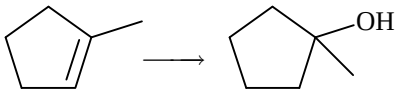
(Q) $2Na_2S_2O_3 + Cl_2 + 2H_2O \longrightarrow 2NaCl + 2NaHSO_4 + 2S$

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

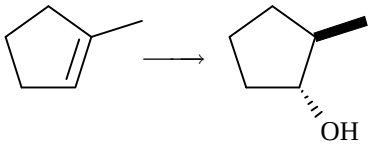
(S) $XeF_2 + 2NO \longrightarrow Xe + 2NOF$

*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

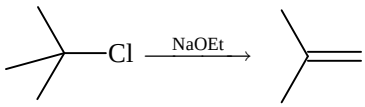
(S) 

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

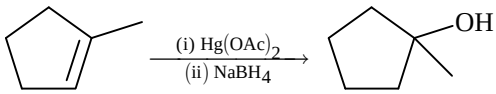
Codes:

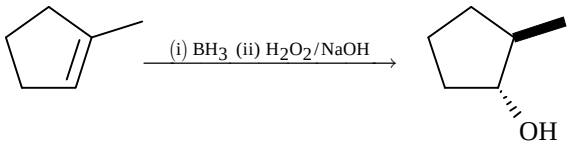
	P	Q	R	S
(A)	2	3	1	4
(B)	3	2	1	4
(C)	2	3	4	1
(D)	3	2	4	1

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

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

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