Reliable INSTITUTE
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JEE ADVANCED 2024

PAPER - 2

QUESTIONS & SOLUTIONS

26 MAY, 2024

02:30 PM to 05:30 PM

Duration : 3 Hours

SUBJECT - CHEMISTRY

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CHEMISTRY

SECTION 1 (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.

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1. According to Bohr's model, the highest kinetic energy is associated with the electron in the

(A) first orbit of H atom (B) first orbit of He^+
(C) second orbit of He^+ (D) second orbit of Li^{2+}

Ans. **(B)**

Sol. K.E. = –T.E.

$$\text{K.E.} = +13.6\frac{Z^2}{n^2}\ \text{eV/atom}$$

(A) $(\text{K.E.})_H = 13.6\frac{1}{1} = 13.6$ eV/atom

(B) $(\text{K.E.})_{He^+} = 13.6\times\frac{(2)^2}{1} = 54.4$ eV/atom

(C) $(\text{K.E.})_{He^+} = 13.6\times\frac{(2)^2}{(2)^2} = 13.6$ eV/atom

(D) $(\text{K.E.})_{Li^{2+}} = 13.6\times\frac{(3)^2}{(2)^2} = 30.6$ eV/atom

2. In a metal deficient oxide sample, $M_XY_2O_4$ (M and Y are metals), M is present in both +2 and +3 oxidation states and Y is in +3 oxidation state. If the fraction of M^{2+} ions present in M is 1/3, the value of X is _____.

(A) 0.25 (B) 0.33 (C) 0.67 (D) 0.75

Ans. **(D)**

Sol. Metal deficient oxide sample $M_XY_2O_4$

apply charge balancing

$$\left(2\times\frac{1}{3}+3\times\frac{2}{3}\right)X+6-8=0$$

$$\left(\frac{2}{3}+2\right)X=2$$

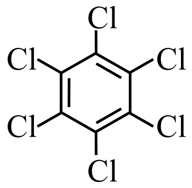
$$\left(X=\frac{3}{4}\right)$$

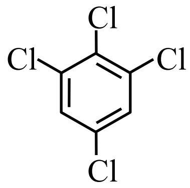
Ans. 0.75

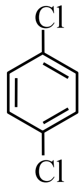
Correct answer (D)

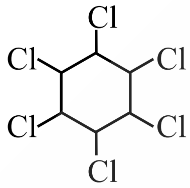
3. In the following reaction sequence, the major product **Q** is

$$\text{L}-\text{Glucose}\xrightarrow[\text{ii)}Cr_2O_3,775K,10-20atm]{\text{i)}HI,\Delta}P\xrightarrow[UV]{Cl_2(\text{excess})}Q$$

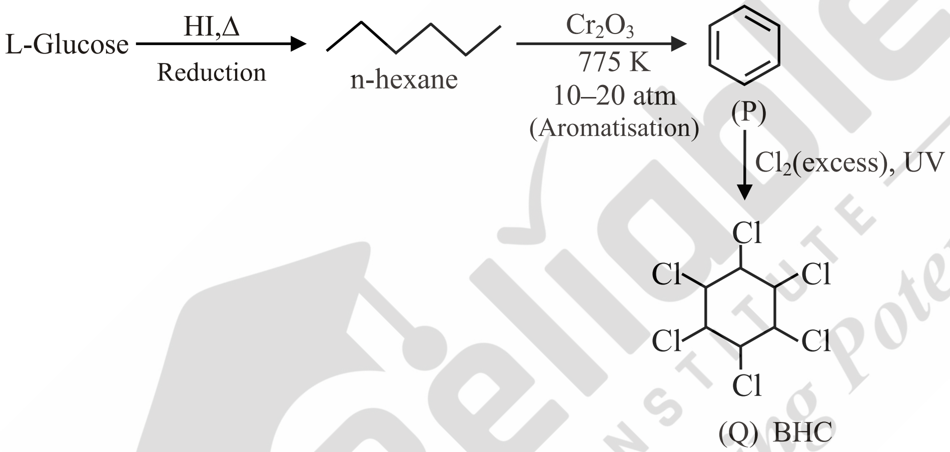
(A) 

(B) 

(C) 

(D) 

Ans. **(D)**

Sol. 

4. T he species formed on fluorination of phosphorus pentachloride in a polar organic solvent are

(A) $[PF_4]^+[PF_6]^-$ and $[PCl_4]^+[PF_6]^-$ (B) $[PCl_4]^+[PCl_4F_2]^-$ and $[PCl_4]^+[PF_6]^-$

(C) PF_3 and PCl_3 (D) PF_5 and PCl_3

Ans. **(B)**

Sol. $PCl_5 \xrightarrow[\text{organic solvent}]{\text{Fluorination in polar}} [PCl_4]^+\ [PCl_4F_2]^-$ and $[PCl_4]^+\ [PF_6]^-$

colourless crystal White crystal

SECTION 2 (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 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 +2marks;
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(s) (i.e. the question is unanswered) will get 0 marks and
choosing any other option(s) will get −2 marks.

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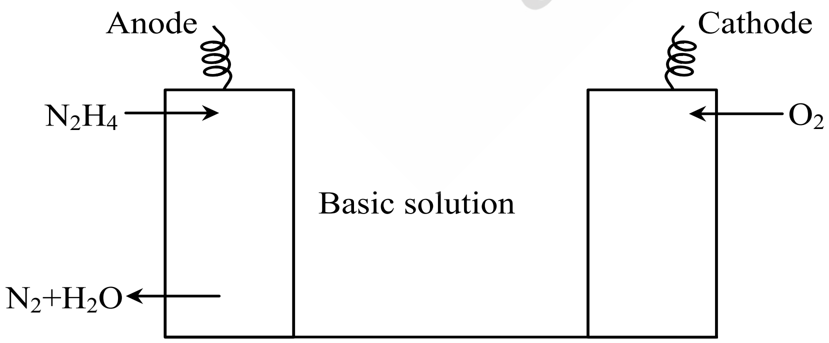
5. A n aqueous solution of hydrazine (N_2H_4) is electrochemically oxidized by O_2, there by releasing chemical energy in the form of electrical energy. One of the products generated from the electrochemical reaction is $N_2(g)$.
Choose the correct statement(s) about the above process
(A) OH^- ions react with N_2H_4 at the anode to form $N_2(g)$ and water, releasing 4 electrons to the anode.
(B) At the cathode, N_2H_4 breaks to $N_2(g)$ and nascent hydrogen released at the electrode reacts with oxygen to form water.
(C) At the cathode, molecular oxygen gets converted to OH^-.
(D) Oxides of nitrogen are major by-products of the electrochemical process.

Ans. **(AC)**

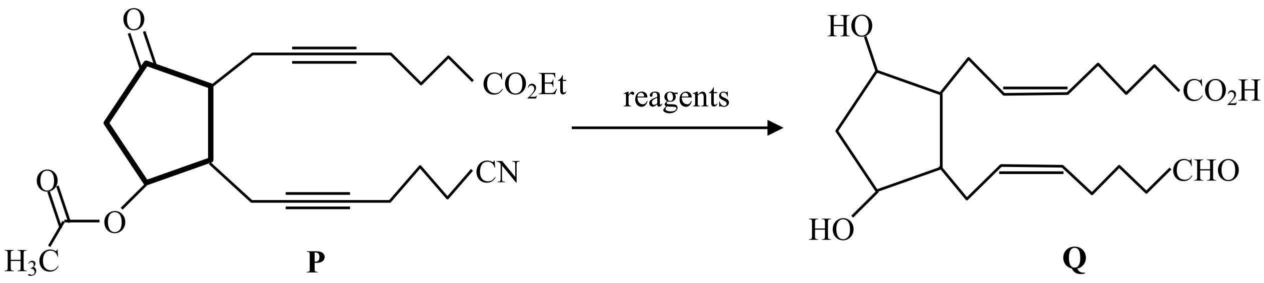
Sol.



Anode: $N_2H_4 + 4OH^- \longrightarrow N_2 + 4H_2O + 4e^-$
Cathode: $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$ $E° = 1.23$
$N_2H_4 + O_2 \rightleftharpoons N_2 + 2H_2O$

There is no contact between N_2H_4 and O_2. During cell operation therefore product of oxides are very less.

6. The option(s) with correct sequence of reagents for the conversion of P to Q is (are)



(A) i) Lindlar's catalyst, H_2 ; ii) $SnCl_2/HCl$; iii) $NaBH_4$; iv) H_3O^+

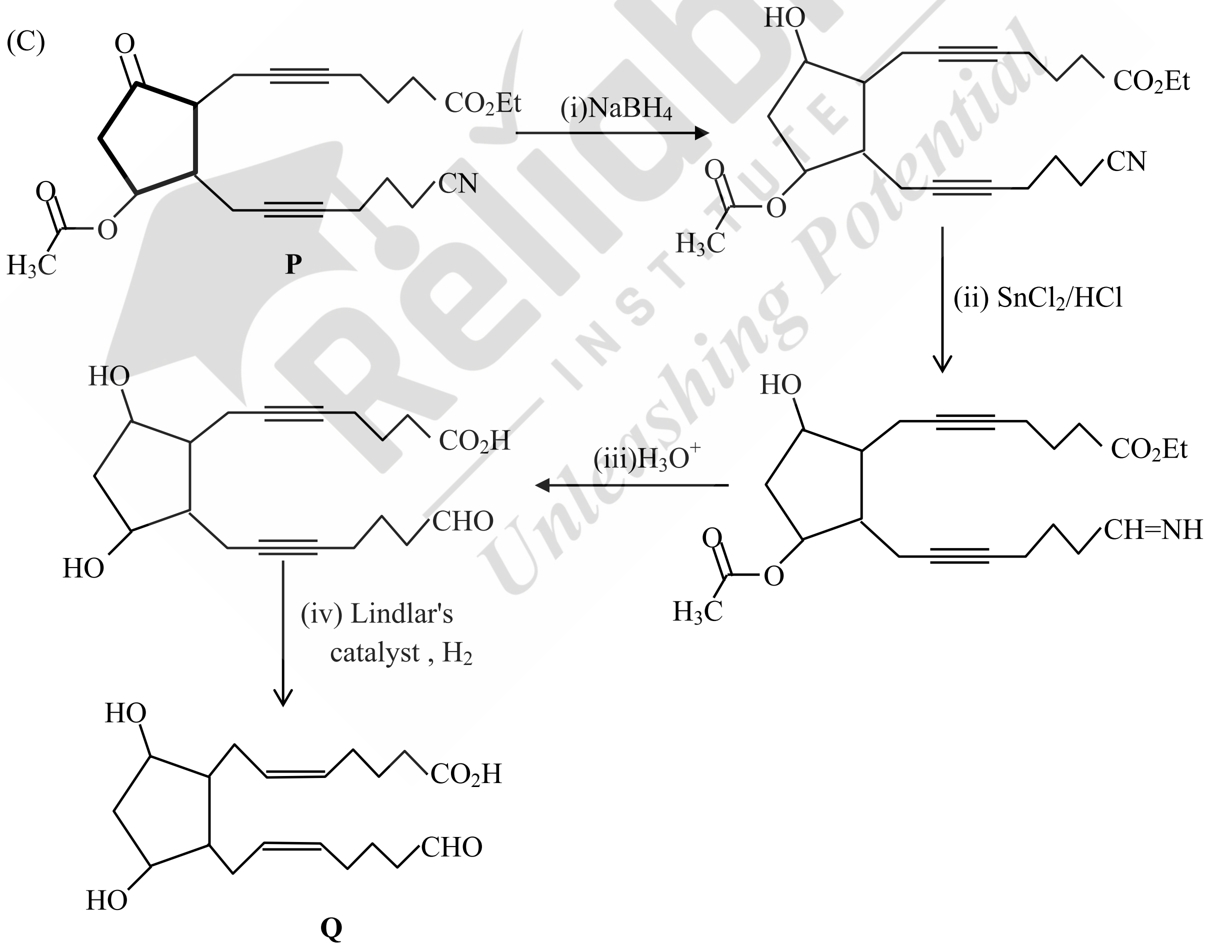
(B) i) Lindlar's catalyst, H_2 ; ii) H_3O^+; iii) $SnCl_2/HCl$; iv) $NaBH_4$

(C) i) $NaBH_4$; ii) $SnCl_2/HCl$; iii) H_3O^+;iv) Lindlar's catalyst, H_2

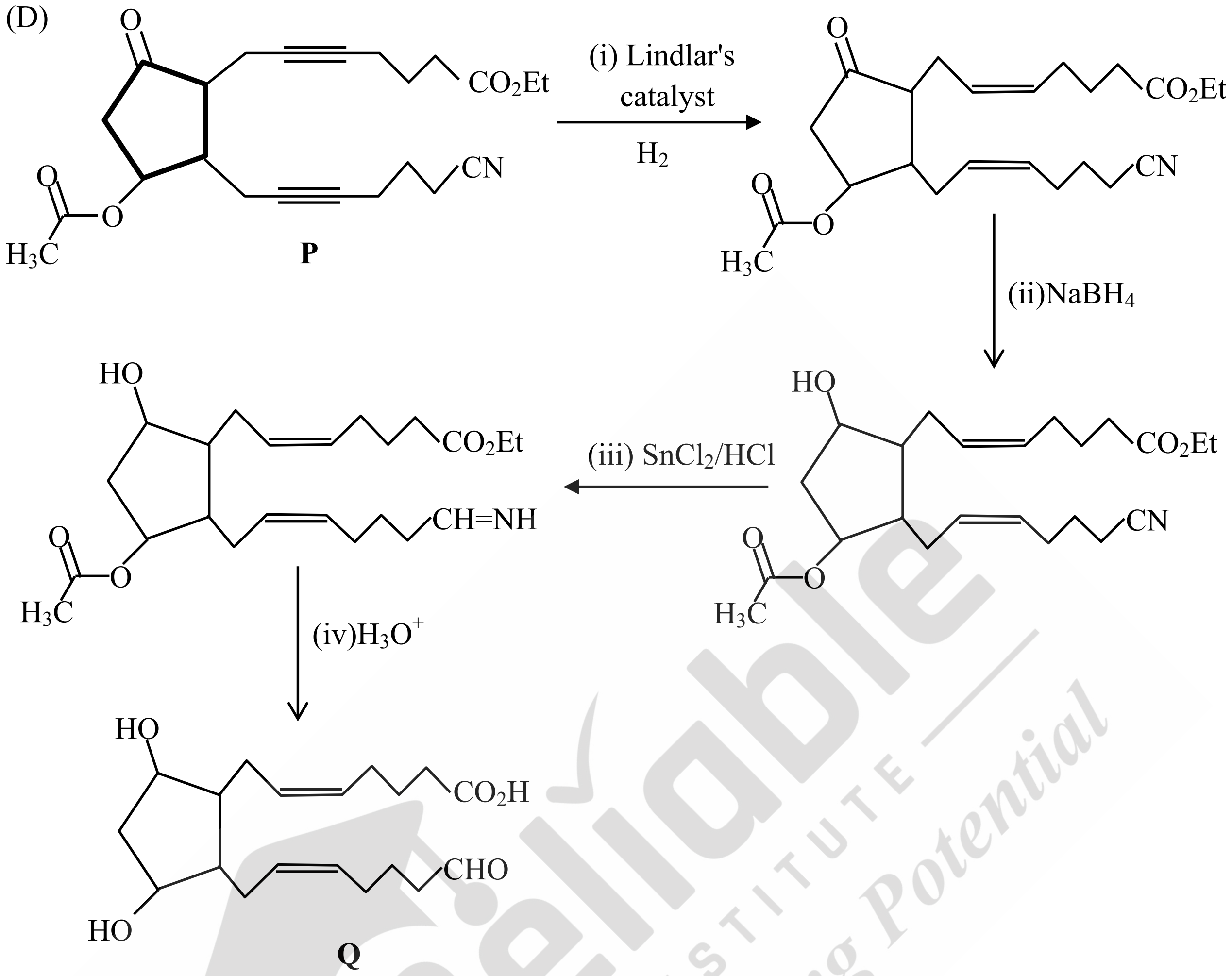
(D) i) Lindlar's catalyst, H_2 ii) $NaBH_4$; iii) $SnCl_2/HCl$; iv) H_3O^+;

Ans. **(CD)**

Sol. (C)



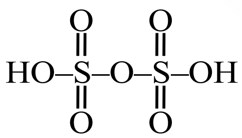
(D)

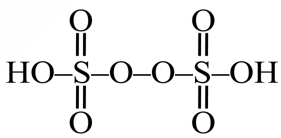


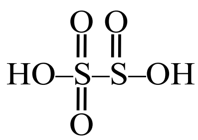
7. The compound(s) having peroxide linkage is(are)

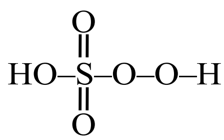
(A) $H_2S_2O_7$ (B) $H_2S_2O_8$ (C) $H_2S_2O_5$ (D) H_2SO_5

Ans. (BD)

Sol. (A) 

(B) 

(C) 

(D) 

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 onscreen 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.

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8. To form a complete monolayer of acetic acid on 1g of charcoal, 100 mL of 0.5 M acetic acid was used. Some of the acetic acid remained unadsorbed. To neutralize the unadsorbed acetic acid, 40 mL of 1 M NaOH solution was required. If each molecule of acetic acid occupies $P \times 10^{-23}$ m^2 surface area on charcoal, the value of P is _____.

[Use given data: Surface area of charcoal = 1.5×10^2 m^2g^{-1};

Avogadro's number (NA) = 6.0×10^{23} mol^{-1}]

Ans. **2500**

Sol. Total milimoles of CH_3COOH = 50

CH_3COOH + NaOH $\longrightarrow$ $CH_3COONa + H_2O$

Unadsorbed 40 m moles

m moles of CH_3COOH adsorbed = 10

Total molecules of CH_3COOH adsorbed

$= 6 \times 10^{23} \times 10 \times 10^{-3}$

$= 6 \times 10^{21}$

6×10^{21} molecules occupies 1.5×10^2 m^2

1 molecule occupies $= \frac{1.5\times10^2}{6\times10^{21}}$

$= \frac{15}{60}\times10^{-19} = 0.25 \times 10^{-19}$

$= 25 \times 10^{-21}$

$= 2500 \times 10^{-23}$

$= 2500$

9. Vessel-1 contains $\mathbf{w_2\ g}$ of a non – volatile solute **X** dissolved in $\mathbf{w_1\ g}$ of water. vessel-2 contains $\mathbf{w_2\ g}$ of another non – volatile solute **Y** dissolved in $\mathbf{w_1\ g}$ of water. Both the vessel are at the same temperature and pressure. The molar mass of **X** is 80% of that of **Y**. The van't Hoff factor for X is 1.2 times of that of **Y** for their respective concentrations.

The elevation of boiling point for solution in Vessel -1 is ______ % of the solution in Vessel-2

Ans. **150**

Sol.

Vessel-1	Vessel-2
Non-volatile solute (X) = W_2	Non-volatile solute (Y) = W_2 g
Weight of water = W_1	Weight of water = W_1

$M_X = 0.8M_Y$

$i_X = 1.2\ i_Y$

$$\frac{(\Delta T_b)_{Vessel-1}}{(\Delta T_b)_{Vessel-2}} = \frac{i_X K_b \times \frac{W_2}{M_X} \times \frac{1000}{W_1}}{i_Y K_b \times \frac{W_2}{M_Y} \times \frac{1000}{W_1}}$$

$$= \frac{1.2 i_Y}{i_Y} \times \frac{M_Y}{0.8 M_Y} = \frac{1.2}{0.8} = \frac{3}{2} = 1.5$$

Ans. = 1.5 × 100 = 150

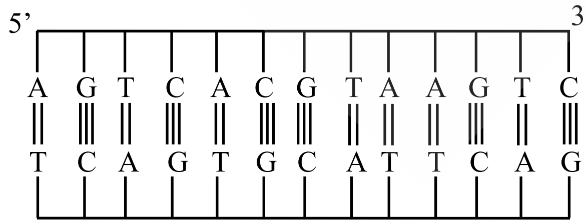
10. For a double strand DNA, one strand is given below:

The amount of energy required to split the double strand DNA into two single strands is _____ $kcalmol^{-1}$.

[Given: Average energy per H-bond for A-T base pair = 1.0 kcal mol^{-1}, G-C base pair = 1.5 kcal mol^{-1}, and A-U base pair = 1.25 kcal mol^{-1}. Ignore electrostatic repulsion between the phosphate groups.]

Ans. **41**

Sol. In DNA number of H-bonds between Adenine & Thymine = 2, Guanine & Cytosine = 3



No. of (A=T) H-bonds broken to split the double strand DNA into two single strands. = 7

No. of (G ≡ C) H-bonds broken to split the double strand DNA into two single strands. = 6

Total amount of energy required = 7 × 2 × 1 + 6 × 3 × 1.5

= 14 + 27 = 41 K.Cal/mol

11. A sample initially contains only U-238 isotope of uranium. With time, some of the U-238 radioactively decays into Pb-206 while the rest of it remains undisintegrated.
When the age of the sample is P $\times 10^8$ years, the ratio of mass of Pb-206 to that of U-238 in the sample is found to be 7. The value of P is _____.
[Given: Half-life of U-238 is 4.5 $\times 10^9$ years; $\log_e 2 = 0.693$]

Ans. 143.5 (Range 142 –144)

Sol. $U^{238} \longrightarrow Pb^{206}$

According to question

$$\frac{W_{Pb}}{W_{Uranium}} = 7$$

$$(n_{Uranium})_{Sample} = \frac{x}{238}$$

$$(n_{Pb})_{Sample} = \frac{7x}{206}$$

$$\text{Initial moles of } U^{238} = \frac{x}{238} + \frac{7x}{206}$$

$$t = \frac{1}{\lambda} \ln \frac{n_0}{n}$$

$$t = \frac{4.5 \times 10^9}{\ln 2} \ln \frac{\frac{x}{238} + \frac{7x}{206}}{\frac{x}{238}}$$

$$t = \frac{4.5 \times 10^9}{\ln 2} \times \ln 9$$

$$t = \frac{4.5 \times 10^9}{0.3010} \times 2 \times 0.48$$

$= 14.35 \times 10^9 = 143.5 \times 10^8$

Ans. 143.5 (Range 142 –144)

12. Among $[Co(CN)_4]^{4-}$, $[Co(CO)_3(NO)]$, XeF_4, $[PCl_4]^+$, $[PdCl_4]^{2-}$, $[ICl_4]^-$, $[Cu(CN)_4]^{3-}$ and P_4 the total number of species with tetrahedral geometry is _____.

Ans. (5)

Sol.

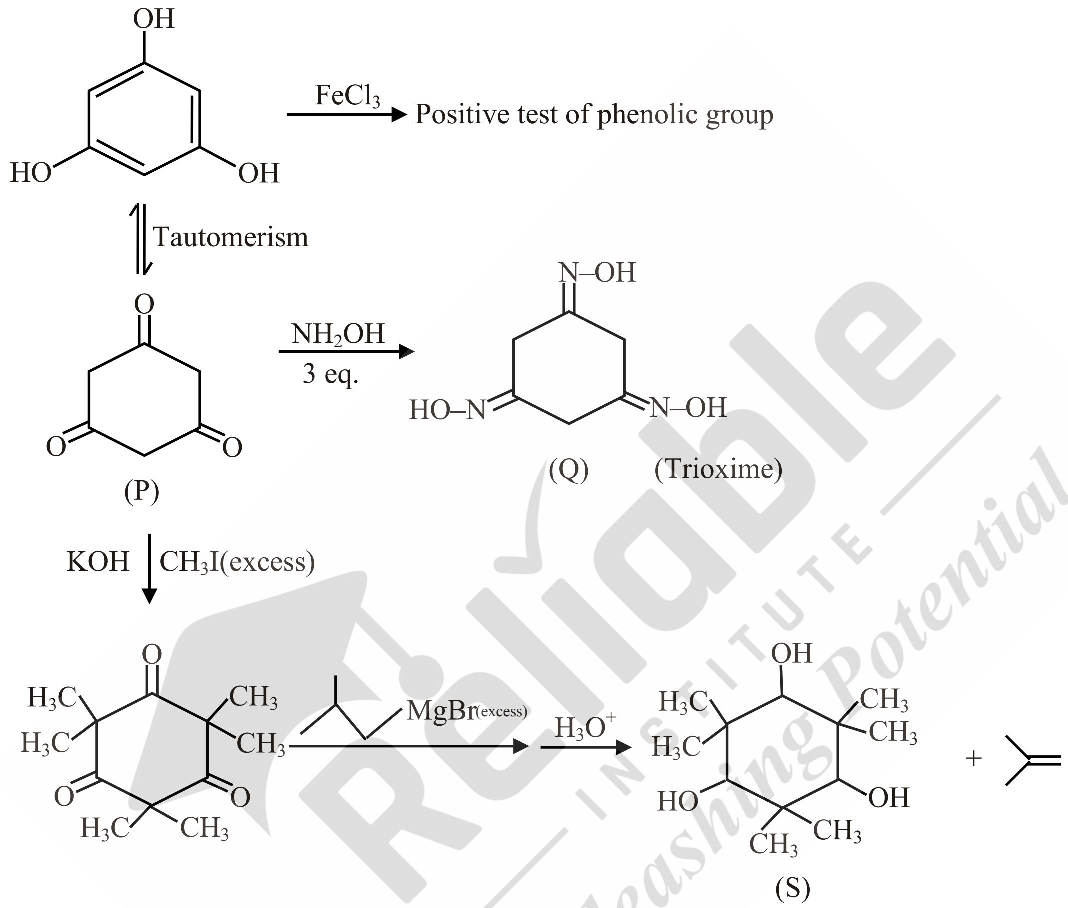
$[Co(CN)_4]^{4-}$ $\longrightarrow$ Tetrahedral
$[Co(CO)_3(NO)]$ $\longrightarrow$ Tetrahedral
XeF_4 $\longrightarrow$ Square planar
PCl_4^{+1} $\longrightarrow$ Tetrahedral
$[PdCl_4]^{2-}$ $\longrightarrow$ Square planar
ICl_4^- $\longrightarrow$ Square planar
$[Cu(CN)_4]^{3-}$ $\longrightarrow$ Tetrahedral
P_4 $\longrightarrow$ Tetrahedral

13. An organic compound **P** having molecular formula $C_6H_6O_3$ gives ferric chloride test and does not have intramolecular hydrogen bond . The compound P reacts with 3 equivalents of NH_2OH to produce oxime **Q**. Treatment of **P** with excess methyl iodide in the presence of KOH produces compound **R** as the major product. Reaction of **R** with excess iso-butylmagnesium bromide followed by treatment with H_3O^+ gives compound **S** as the major product.

The total number of methyl (–CH_3) group(s) in compound **S** is _____.

Ans. **6**

Sol.



SECTION 4 (Maximum Marks: 12)

- This section contains **TWO (02)** paragraphs.
- Based on each paragraph, there are TWO (02) questions.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 — If **ONLY** the correct numerical value is entered in the designated place;

Zero Marks : 0 — In all other cases.

"PARAGRAPH I"

An organic compound **P** with molecular formula $C_9H_{18}O_2$ decolorizes bromine water and also shows positive iodoform test. **P** on ozonolysis followed by treatment with H_2O_2 gives **Q** and **R**. While compound **Q** shows positive iodoform test, compound **R** does not give positive iodoform test. **Q** and **R** on oxidation with pyridinium chlorochromate (PCC) followed by heating give **S** and **T**, respectively. Both **S** and **T** show positive iodoform test.

Complete copolymerization of 500 moles of **Q** and 500 moles of **R** gives one mole of a single acyclic copolymer **U**.

[Given, atomic mass: H =1, C = 12, O =16]

14. Sum of number of oxygen atoms in S and T is ____.

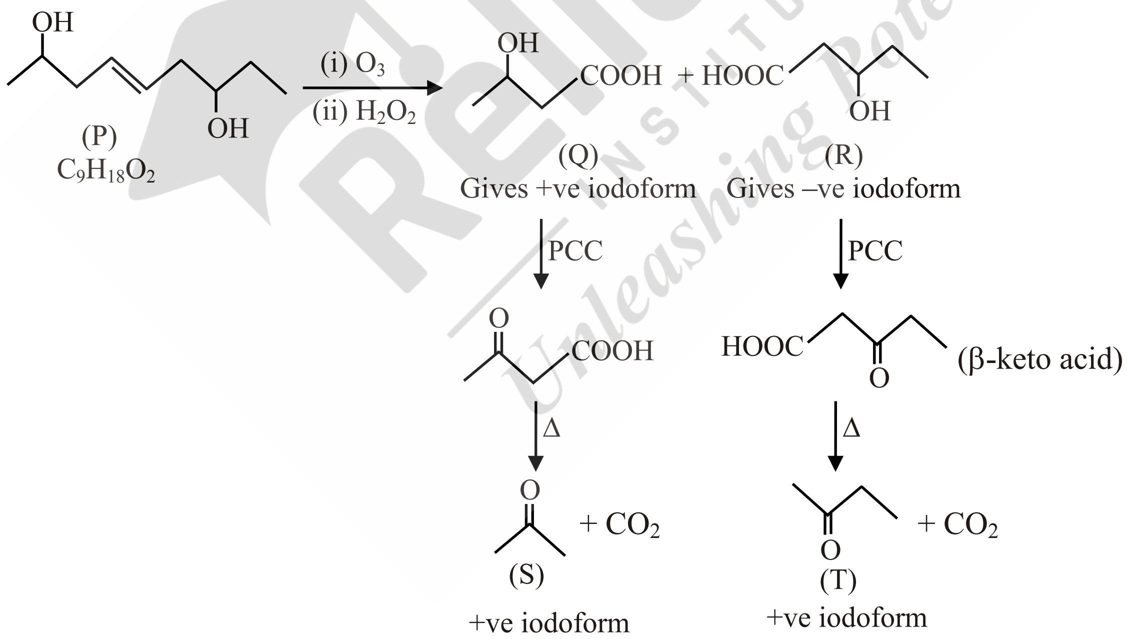
Ans. 2

Sol. Compound $P(C_9H_{18}O_2)$ has one C=C and two OH groups.

$P \xrightarrow{O_3} \xrightarrow{H_2O_2} Q + R$ (Q shows iodoform test but R does not)

$Q \xrightarrow{PCC} \xrightarrow{\Delta} S$

$R \xrightarrow{PCC} \xrightarrow{\Delta} T$ (Both S & T show iodoform test)

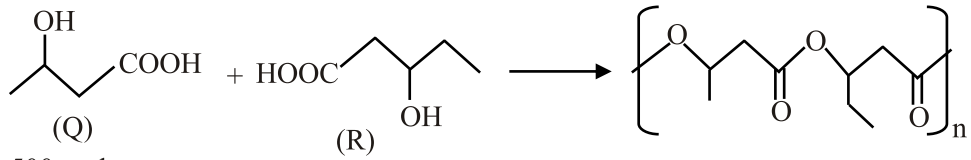


Sum of number of O-atoms in S and T = 1 + 1 = 2

15. The molecular weight of U is _____.

Ans. **93018**

Sol.



(Q) 500 moles, molar mass =104 + (R) 500 moles, molar mass =118 ⟶ (PHBV) $(C_9H_{14}O_4)_n$, molar mass =186

Number of moles of monomer units of Q and R in one mole of polymer U = 500 moles each

Mass of the polymer U = mass of 500 moles of (monomer Q + monomer R) – mass of 999 moles of H_2O = (104 × 500 + 118 × 500) – 999 × 18 = 93018 g

"PARAGRAPH II"

When potassium iodide is added to an aqueous solution of potassium ferricyanide, a reversible reaction is observed in which a complex **P** is formed. In a strong acidic medium, the equilibrium shifts completely towards **P**. Addition of zinc chloride to **P** in a slightly acidic medium results in a sparingly soluble complex **Q**.

16. The number of moles of potassium iodide required to produce two moles of **P** is _____.

Ans. **(2)**

Sol. $2K_3[Fe(CN)_6] + 2KI \longrightarrow \underset{(P)}{2K_4[Fe(CN)_6]} + I_2$

Number of moles of potassium iodide required to produce two moles of P is 2.

17. The number of zinc ions present in the molecular formula of Q is _____.

Ans. **(3)**

Sol. $3Zn^{2+} + \underset{(Excess)}{2K_4[Fe(CN)_6]} \longrightarrow K_2Zn_3[Fe(CN)_6]_2 + 6K^+$