JEE ADVANCED PAPER 2024 WITH SOLUTIONS

Chemistry

PAPER 1

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.

1. A closed vessel contains 10 g of an ideal gas **X** at 300 K, which exerts 2 atm pressure. At the same temperature, 80 g of another ideal gas **Y** is added to it and the pressure becomes 6 atm. The ratio of root mean square velocities of **X** and **Y** at 300 K is

(A) $2\sqrt{2} : \sqrt{3}$ **(B)** $2\sqrt{2} : 1$

(C) $1 : 2$ **(D)** $2 : 1$

2. At room temperature, disproportionation of an aqueous solution of *in situ* generated nitrous acid (HNO_2) gives the species

(A) H_3O^+, NO_3^- and NO

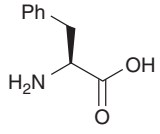
(B) H_3O^+, NO_3^- and NO_2

(C) H_3O^+, NO^- and NO_2

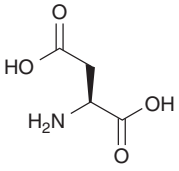
(D) H_3O^+, NO_3^- and N_2O

3. Aspartame, an artificial sweetener, is a dipeptide aspartyl phenylalanine methyl ester. The structure of aspartame is

Structures of phenylalanine and aspartic acid are given below.

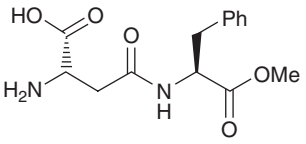


Phenylalanine

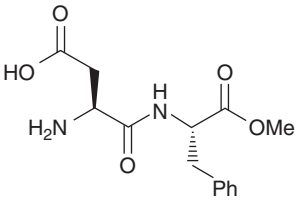


Aspartic acid

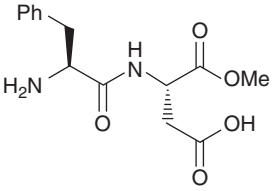
(A)



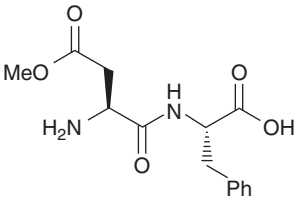
(B)



(C)



(D)



4. Among the following options, select the option in which each complex in **Set-I** shows geometrical isomerism and the two complexes in **Set-II** are ionization isomers of each other.
[en = $H_2NCH_2CH_2NH_2$]

(A) **Set-I**: $[Ni(CO)_4]$ and $[PdCl_2(PPh_3)_2]$

Set-II: $[Co(NH_3)_5Cl]SO_4$ and $[Co(NH_3)_5(SO_4)]Cl$

(B) **Set-I**: $[Co(en)(NH_3)_2Cl_2]$ and $[PdCl_2(PPh_3)_2]$

Set-II: $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$

(C) **Set-I**: $[Co(NH_3)_3(NO_2)_3]$ and $[Co(en)_2Cl_2]$

Set-II: $[Co(NH_3)_5Cl]SO_4$ and $[Co(NH_3)_5(SO_4)]Cl$

(D) **Set-I**: $[Cr(NH_3)_5Cl]Cl_2$ and $[Co(en)(NH_3)_2Cl_2]$

Set-II: $[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

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).

5. Among the following the correct statement(s) for electrons in an atom is(are)

(A) Uncertainty principle rules out the existence of definite paths for electrons.

(B) The energy of an electron in 2*s* orbital of an atom is lower than the energy of an electron that is infinitely far away from the nucleus.

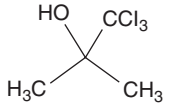
(C) According to Bohr's model, the most negative energy value for an electron is given by n = 1, which corresponds to the most stable orbit.

(D) According to Bohr's model, the magnitude of velocity of electrons increases with increase in values of n.

6. Reaction of *iso*-propylbenzene with O_2 followed by the treatment with H_3O^+ forms phenol and a by-product **P**. Reaction of **P** with 3 equivalents of Cl_2 gives compound **Q**. Treatment of **Q** with $Ca(OH)_2$ produces compound **R** and calcium salt **S**.

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

(A) Reaction of **P** with **R** in the presence of KOH followed by acidification gives



(B) Reaction of **R** with O_2 in the presence of light gives phosgene gas

(C) **Q** reacts with aqueous NaOH to produce Cl_3CCH_2OH and $Cl_3CCOONa$

(D) **S** on heating gives **P**

7. The option(s) in which at least three molecules follow Octet Rule is(are)

(A) CO_2, C_2H_4, NO and HCl

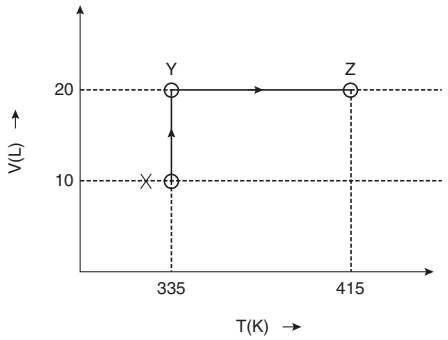
(B) NO_2, O_3, HCl and H_2SO_4

(C) BCl_3, NO, NO_2 and H_2SO_4

(D) CO_2, BCl_3, O_3 and C_2H_4

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.

8. Consider the following volume–temperature (V–T) diagram for the expansion of 5 moles of an ideal monoatomic gas.



Considering only P-V work is involved, the total change in enthalpy (in Joule) for the transformation of state in the sequence X → Y → Z is _____.

[Use the given data: Molar heat capacity of the gas for the given temperature range, $C_{V,m}$ = 12 J K^{-1} mol^{-1} and gas constant, R = 8.3 J K^{-1} mol^{-1}]

9. Consider the following reaction,

$2H_2(g) + 2NO(g) \rightarrow N_2(g) + 2H_2O(g)$

which follows the mechanism given below:

$2NO(g) \underset{k_{-1}}{\overset{k_2}{\rightleftharpoons}} N_2O_2(g)$ (fast equilibrium)

$N_2O_2(g) + H_2(g) \xrightarrow{k_2} N_2O(g) + H_2O(g)$ (slow reaction)

$N_2O(g) + H_2(g) \xrightarrow{k_3} N_2(g) + H_2O(g)$ (fast reaction)

The order of the reaction is _____?

10. Complete reaction of acetaldehyde with excess formaldehyde, upon heating with conc. NaOH

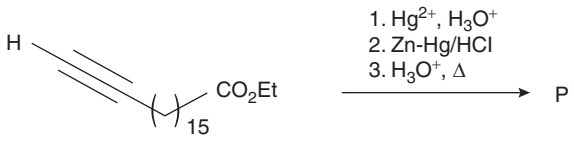
solution, gives **P** and **Q**. Compound **P** does not give Tollens' test, whereas **Q** on acidification gives positive Tollens' test. Treatment of P with excess cyclohexanone in the presence of catalytic amount of p-toluenesulfonic acid (PTSA) gives product **R**.

Sum of the number of methylene groups (–CH2–) and oxygen atoms in **R** is _____.

11. Among $V(CO)_6$, $Cr(CO)_5$, $Cu(CO)_3$, $Mn(CO)_5$, $Fe(CO)_5$, $[Co(CO)_3]^{3-}$, $[Cr(CO)_4]^{4-}$, and $Ir(CO)_3$, the total number of species isoelectronic with $Ni(CO)_4$ is _____.

[Given atomic number: V = 23, Cr, = 24, Mn = 25, Fe = 26, Co = 27, Ni = 28, Cu = 29, Ir = 77]

12. In the following reaction sequence, the major product **P** is formed.



Glycerol reacts completely with excess **P** in the presence of an acid catalyst to form **Q**. Reaction of **Q** with excess NaOH followed by the treatment with $CaCl_2$ yields Ca-soap **R**, quantitatively. Starting with one mole of **Q**, the amount of **R** produced in gram is _____.

[Given, atomic weight: H = 1, C = 12, N = 14, O = 16, Na = 23, Cl = 35, Ca = 40]

13. Among the following complexes, the total number of diamagnetic species is _____.

$[Mn(NH_3)_6]^{3+}$, $[MnCl_6]^{3-}$, $[FeF_6]^{3-}$, $[CoF_6]^{3-}$, $[Fe(NH_3)_6]^{3+}$ and $[Co(en)_3]^{3+}$

[Given, atomic number: Mn = 25, Fe = 26, Co = 27; en = $H_2NCH_2CH_2NH_2$]

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.

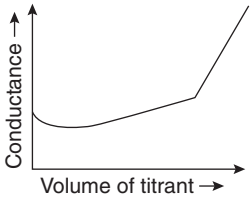
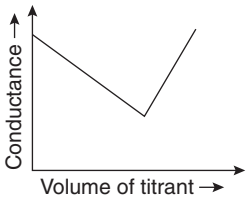
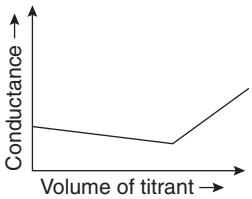
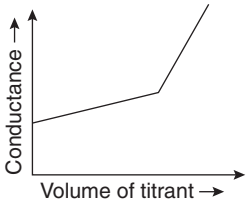
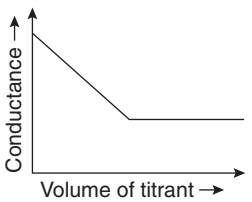
14. In a conductometric titration, small volume of titrant of higher concentration is added stepwise to a larger volume of titrate of much lower concentration, and the conductance is measured after each addition.

The limiting ionic conductivity (Λ_0) values (in mS m^2 mol^{-1}) for different ions in aqueous solutions are given below:

Ions	Ag^+	K^+	Na^+	H^+	NO_3^-	Cl^-	SO_3^{2-}	OH^-	CH_3COO^-
Λ_0	6.2	7.4	5.0	35.0	7.2	7.6	16.0	19.9	4.1

For different combinations of titrates and titrants given in **List-I**, the graphs of 'conductance' versus 'volume of titrant' are given in **List-II**.

Match each entry in **List-I** with the appropriate entry in **List-II** and choose the correct option.

List-I		List-II
(P)	Titrate: KCl Titrant: $AgNO_3$	(1) 
(Q)	Titrate: $AgNO_3$ Titrant: KCl	(2) 
(R)	Titrate: NaOH Titrant: HCl	(3) 
(S)	Titrate: NaOH Titrant: CH_3COOH	(4) 
		(5) 

(A) P-4, Q-3, R-2, S-5

(B) P-2, Q-4, R-3, S-1

(C) P-3, Q-4, R-2, S-5

(D) P-4, Q-3, R-2, S-1

15. Based on VSEPR model, match the xenon compounds given in **List-I** with the corresponding geometries and the number of lone pairs on xenon given in **List-II** and choose the correct option.

	List-I		List-II
(P)	XeF_2	(1)	Trigonal bipyramidal and two lone pair of electrons
(Q)	XeF_4	(2)	Tetrahedral and one lone pair of electrons
(R)	XeO_3	(3)	Octahedral and two lone pair of electrons
(S)	XeO_3F_2	(4)	Trigonal bipyramidal and no lone pair of electrons
		(5)	Trigonal bipyramidal and three lone pair of electrons

(A) P-5, Q-2, R-3, S-1

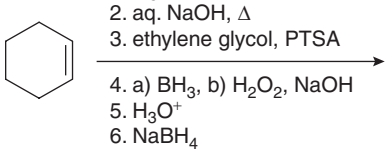
(B) P-5, Q-3, R-2, S-4

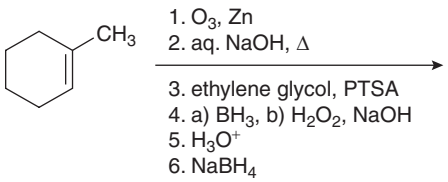
(C) P-4, Q-3, R-2, S-1

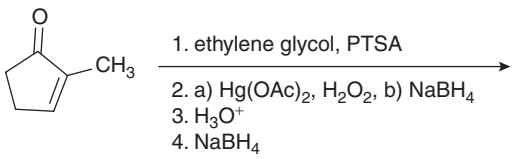
(D) P-4, Q-2, R-5, S-3

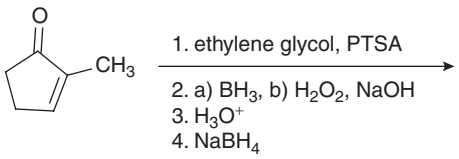
16. **List-I** contains various reaction sequences and **List-II** contains the possible products. Match each entry in **List-I** with the appropriate entry in **List-II** and choose the correct option.

List-I

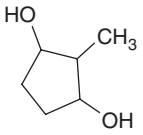
(P) 

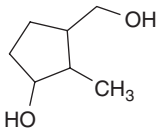
(Q) 

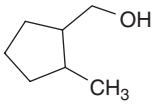
(R) 

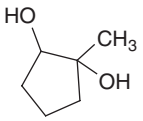
(S) 

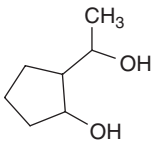
List-II

(1) 

(2) 

(3) 

(4) 

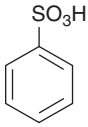
(5) 

(A) P-3, Q-5, R-4, S-1 **(B)** P-3, Q-2, R-4, S-1

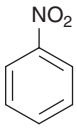
(C) P-3, Q-5, R-1, S-4 **(D)** P-5, Q-2, R-4, S-1

17. **List-I** contains various reaction sequences and **List-II** contains different phenolic compounds. Match each entry in **List-I** with the appropriate entry in **List-II** and choose the correct option.

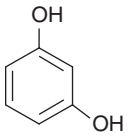
List-I

(P) 

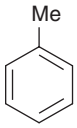
1. molten NaOH, H_3O^+
2. Conc. HNO_3

(Q) 

1. Conc. HNO_3/ Conc. H_2SO_4
2. Sn/HCl
3. $NaNO_2$/HCl, 0-5°C,
4. H_2O
5. Conc. HNO_3/ Conc. H_2SO_4

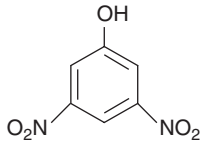
(R) 

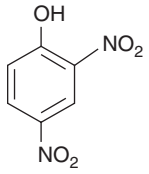
1. Conc. H_2SO_4
2. Conc. HNO_3
3. H_3O^+, Δ

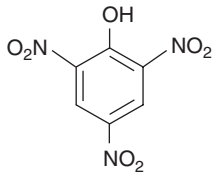
(S) 

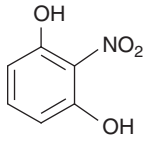
1. (a) $KMnO_4$/KOH, Δ; (b) H_3O^+
2. Conc. HNO_3/ Conc. H_2SO_4, Δ
3. (a) $SOCl_2$, (b) NH_3
4. Br_2, NaOH
5. $NaNO_2$/HCl, 0-5°C,
6. H_2O

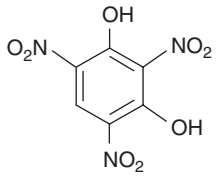
List-II

(1) 

(2) 

(3) 

(4) 

(5) 

(A) P-2, Q-3, R-4, S-5 **(B)** P-2, Q-3, R-5, S-1

(C) P-3, Q-5, R-4, S-1 **(D)** P-3, Q-2, R-5, S-4

PAPER 2

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.

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+}

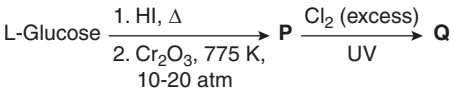
2. In a metal deficient oxide sample, $\mathbf{M_XY_2O_4}$ (**M** and **Y** are metals), **M** is present in both +2 and +3 oxidation states and **Y** is in +3 oxidation

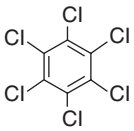
state. If the fraction of M^{2+} ions present in **M** is $\frac{1}{3}$, the value of **X** is _____.

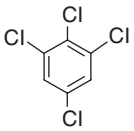
(A) 0.25 **(B)** 0.33

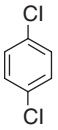
(C) 0.67 **(D)** 0.75

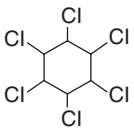
3. In the following reaction sequence, the major product **Q** is



(A) 

(B) 

(C) 

(D) 

4. The 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

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).

5. An aqueous solution of hydrazine (N_2H_4) is electrochemically oxidized by O_2, thereby 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

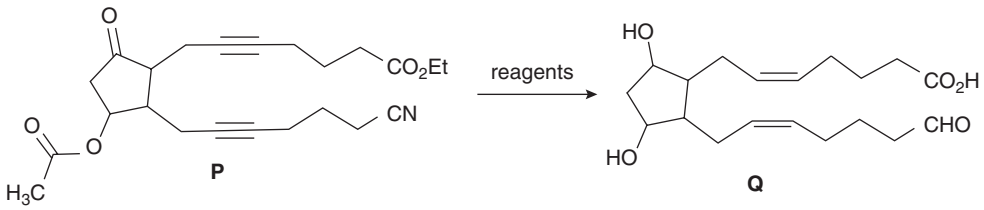
(A) OH^- ions react with N_2H_4 at the anode to form $N_2(g)$ and water, releasing 4 electrons to the anode.

(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.

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^+

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

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.

8. To form a complete monolayer of acetic acid on 1 g 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}]

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 vessels 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.

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 _____ kcal mol^{-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.]

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 $\mathbf{P} \times 10^8$ 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 4.5×10^9 years; $\log_e 2 = 0.693$]

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 _____.

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 _____.

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.

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 _____.

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]

15. The molecular weight of **U** is _____.

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

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**.

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

ANSWER KEY

Paper 1

1. (D) **2.** (A) **3.** (B) **4.** (C) **5.** (A, B, C) **6.** (A, B, D) **7.** (A, D) **8.** (8120)

9. (3) **10.** (18) **11.** (1) **12.** (909) **13.** (1) **14.** (C) **15.** (B) **16.** (A)

17. (C)

Paper 2

1. (B) **2.** (D) **3.** (D) **4.** (B) **5.** (A, C) **6.** (A, C, D) **7.** (B, D) **8.** (2500)

9. (150) **10.** (41) **11.** (143) **12.** (3) **13.** (12) **14.** (2) **15.** (102018) **16.** (2)

17. (3)

ANSWERS WITH EXPLANATION

PAPER 1

1. Given,

$W_X = 10$ g

$P_X = 2$ atm

$W_Y = 80$ g

$P_Y = P_{total} - P_X$

$\Rightarrow \quad 6 - 2 = 4$ atm

As $\quad V_{rms} = \sqrt{\dfrac{3RT}{M}}$,

$$\frac{(V_{rms})_X}{(V_{rms})_Y} = \sqrt{\frac{M_Y}{M_X}}$$

As we know,

$PV = nRT$

Volume and temperature remains same.

$$P_X V = \frac{W_X}{M_X} RT$$

$$P_Y V = \frac{W_Y}{M_Y} RT$$

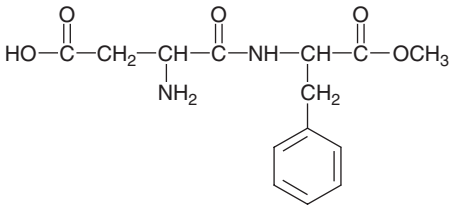
$$M_X \propto \frac{W_X}{P_X}$$

$$M_Y \propto \frac{W_Y}{P_Y}$$

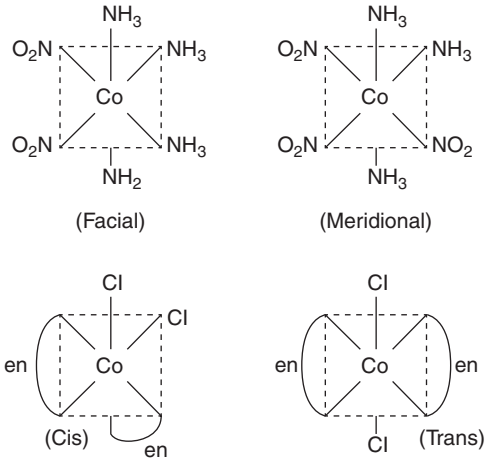
$$\frac{(V_{rms})_X}{(V_{rms})_Y} = \sqrt{\frac{W_Y}{P_Y} \cdot \frac{P_Y}{W_X}} = \sqrt{\frac{80}{4} \times \frac{2}{10}} = \sqrt{4} = \frac{2}{1} = 2:1$$

2. $3HNO_2\ (aq) \rightleftharpoons H_3O^+ + NO_3^- + 2NO$

3. The structure of ASPARTAME (an artificial structure) is:



4. **Set-I:**



Set-II: $[Co(NH_3)_5Cl]SO_4$ and $[Co(NH_3)_5(SO_4)]Cl$ are ionisation isomers.

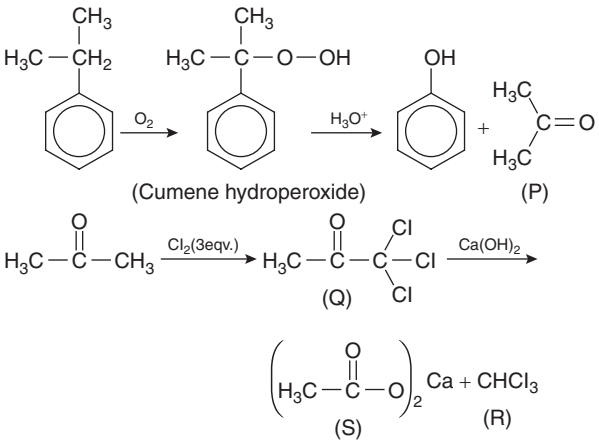
5. **(A)** Uncertainty principle talks about probability of finding electrons in different regions around the nucleus rather than definite paths.

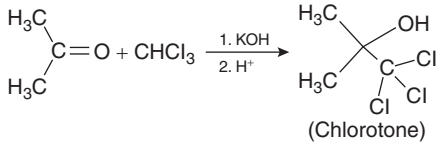
(B) With increase in distance of electron from the nucleus, its energy increases.

(C) Energy of electron $E_n = -13.6 \times \dfrac{Z^2}{n^2}$ eV/atom.

(D) Velocity of electron $V_n = 2.19 \times 10^6 \times \dfrac{Z}{n}$ m/sec.

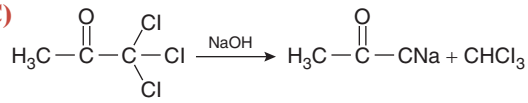
6.



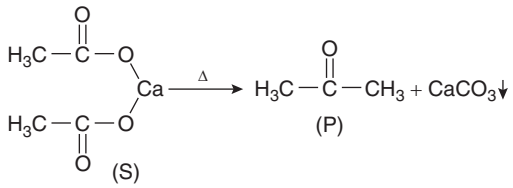
(A) 

(Chlorotone)

(B) $CHCl_3 + \frac{1}{2}O_2$ (air) $\longrightarrow$ $COCl_2 + HCl$
(phosgene)

(C) 

So, (C) is wrong.

(D) 

7. **(A)** CO_2, C_2H_4 and HCl follow octet rule.

(B) O_3 and HCl and follow octet rule.

(C) None of them follow octet rule.

(D) CO_2, O_3 and C_2H_4 follow octet rule.

Correct answer is (A) and (D).

8. For ideal gas

$\Delta H = nC_P\Delta T$

$C_P = C_V + R = 12 + 8.3 = 20.3$ J/K-mole

$\Delta H = 5 \times 20.3 \times (415 - 335)$

$\Delta H = 8120$ J

9. Net reaction:

$$2H_2(g) + 2NO(g) \longrightarrow N_2(g) + 2H_2O(g)$$

(i) $2NO(g) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} N_2O_2(g)$ (fast)

$$\frac{k_1}{k_{-1}} = \frac{[N_2O_2]}{[NO]^2} \quad ...(1)$$

(ii)

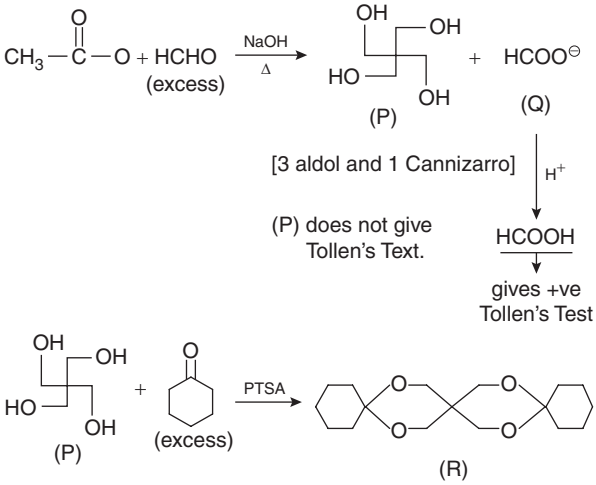
$N_2O_2(g) + H_2(g) \xrightarrow{k_2} N_2O(g) + H_2O(g)$ (slow reaction)

$r = k_2[N_2O_2][H_2]$

$= k_2 \times \frac{k_1}{k_{-1}}(NO)^2 \times (H_2)$

$r = \frac{k_2k_1}{k_{-1}}(NO)^2(H_2)$

So, order of reaction = 3.

10. 

Number of CH_2 groups in R = 14

Number of O-atoms = 4

Required Answer = 14 + 4 = 18

11. In case of complexes, isoelectronic species should be those having same effective atomic number (EAN)

$Ni(CO)_4 \Rightarrow 28 + 4 \times 2 = 36$

$V(CO)_6 \Rightarrow 23 + 2 \times 6 = 35$

$Cr(CO)_5 \Rightarrow 24 + 2 \times 5 = 34$

$Cu(CO)_3 \Rightarrow 29 + 2 \times 3 = 35$

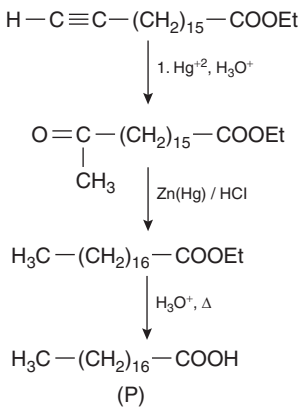
$Mn(CO)_5 \Rightarrow 25 + 2 \times 5 = 35$

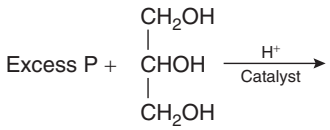
$Fe(CO)_5 \Rightarrow 26 + 2 \times 5 = 36$

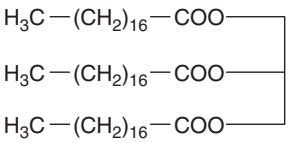
$[Co(CO)_3]^{3-} \Rightarrow 27 + 3 + 2 \times 3 = 36$

$[Cr(CO)_4]^{4-} \Rightarrow 24 + 4 + 2 \times 4 = 36$

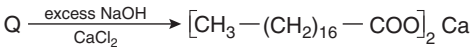
$Ir(CO)^3 \Rightarrow 77 + 2 \times 3 = 83$

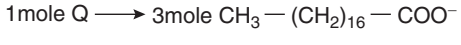
12. 

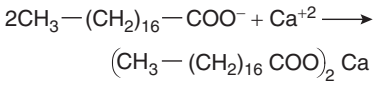




(Q)







(R)

Mole of R = 1.5

Wt. of R = 1.5 × 606

Wt. of R = 909

13. $[Mn(NH_3)_6]^{3+}$: Paramagnetic

$[MnCl_6]^{3-}$: Paramagnetic

$[FeF_6]^{3-}$: Paramagnetic

$[CoF_6]^{3-}$: Paramagnetic

$[Fe(NH_3)_6]^{3+}$: Paramagnetic

$[Co(en)_3]^{3+}$: Diamagnetic

Only 1 complex is diamagnetic.

14. **Option (P):**

On adding $AgNO^3$ solution to KCl solution precipitation of AgCl will occur due to which Cl^- already present will be replaced by NO^{3-} ions. So, conductance of solution will decrease till equivalence point. After complete precipitation of AgCl, further added $AgNO_3$ will increase the number of ions in resulting solution, so conductance will increase.

Option (Q):

On adding KCl solution to $AgNO_3$ solution, precipitation of AgCl will occur due to which already present Ag^+ ions will be replaced by K^+ ions in solution. So, conductance of solution will increase. After complete precipitation of AgCl further added KCl will increase the number of ions in resulting solution, so conductance will increase further.

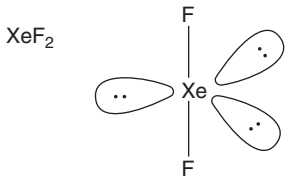
Option (R):

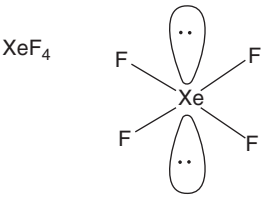
On adding HCl solution to NaOH solution, OH^- will be replaced by Cl^- ions, so conductance of solution decreases. After complete neutralisation further added HCl will increase number of ions in the solution. So, conductance will increase further.

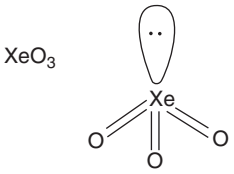
Option (S):

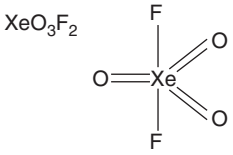
On adding CH_3COOH solution to NaOH solution OH^- will be replaced by CH_3COO^- ions, so conductance of solution decreases. After complete neutralisation further added CH_3COOH will remain undissociated because it is a weak acid and there is also common ion effect on acetate ions. So, number of ions in solution will remain almost constant, therefore conductance of solution will remain constant.

15.

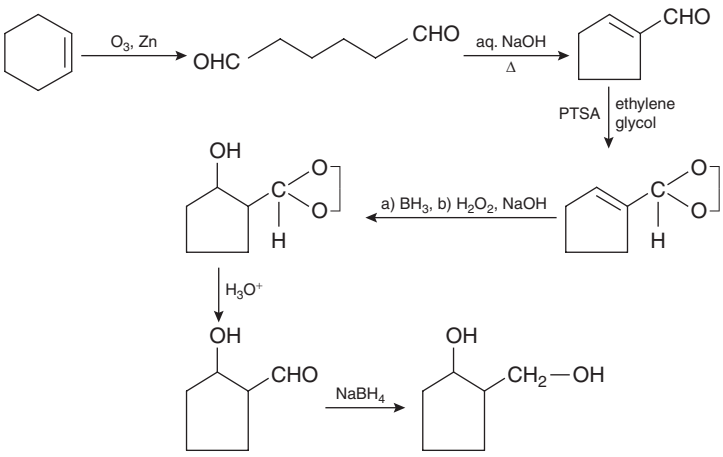






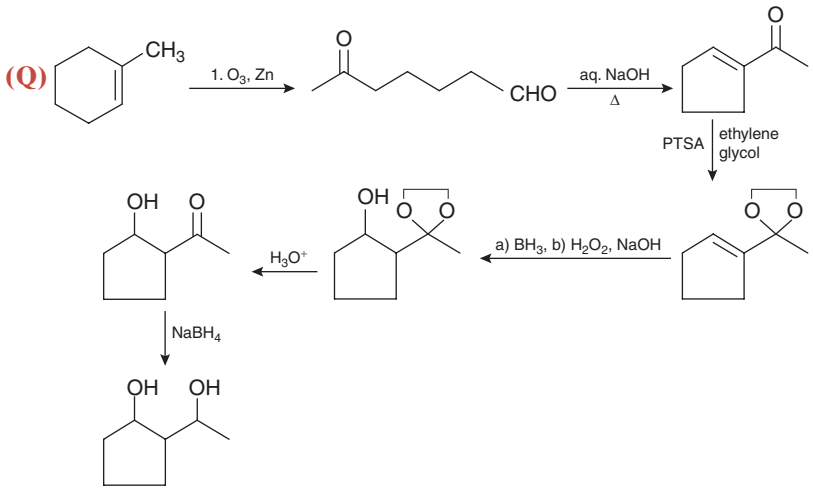


16. (P)



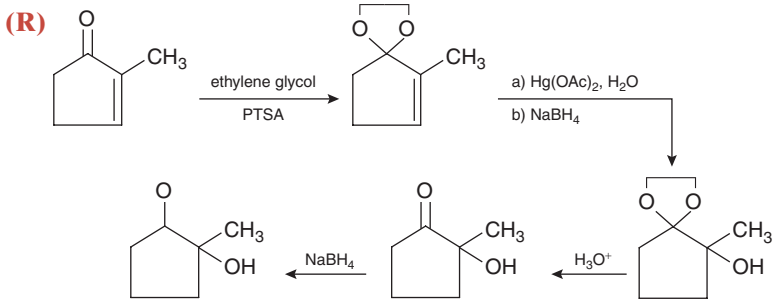
P-3

(Q)



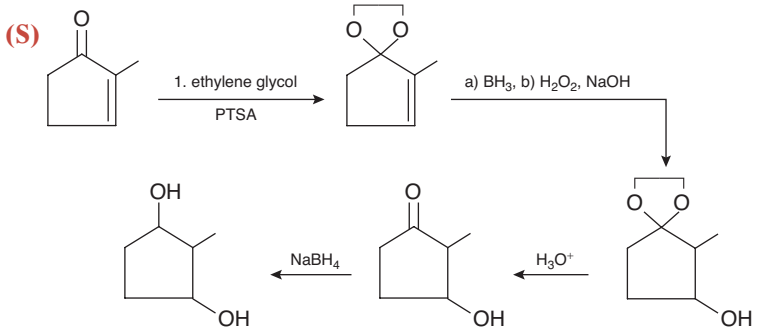
Q-5

(R)



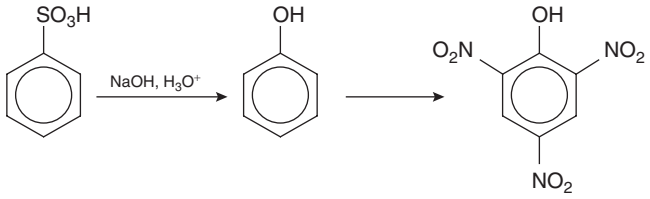
R-4

(S)

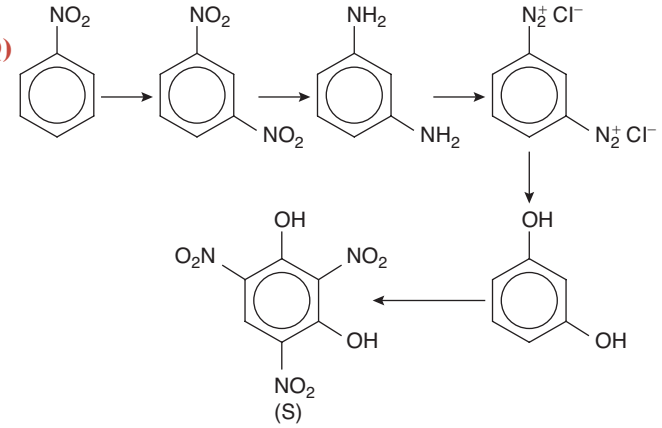


S-1

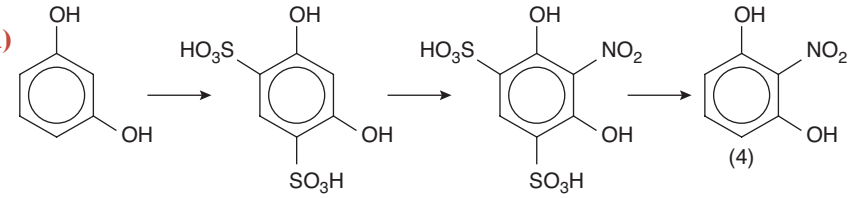
17. (P)



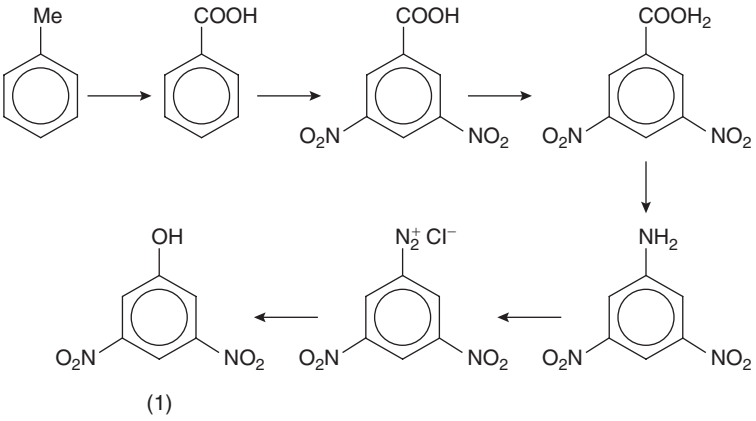
(Q)



(R)



(S)



PAPER 2

1. K.E. of election in n^{th} Bohr's orbit,

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

$n = 1$ (H-atom) $\rightarrow$ K.E. $\propto \frac{1^2}{1^2} = 1$

$n = 1$ (He^+ ion) $\rightarrow$ K.E. $\propto \frac{2^2}{1^2} = 4$

$n = 2$ (He^+ ion) $\rightarrow$ K.E. $\propto \frac{2^2}{2^2} = 1$

$n = 2$ (Li^{2+} ion) $\rightarrow$ K.E. $\propto \frac{3^2}{2^2} = \frac{9}{4}$

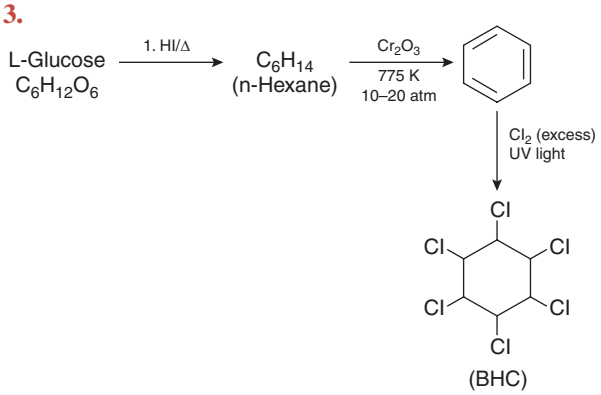
Highest for $\rightarrow$ n = 1 of He^+ ion.

2. $M_XY_2O_4$

$$+2\times\frac{x}{3}+3\times\frac{2x}{3}=+2$$

$$x=0.75$$

3.



(BHC)

4. PCl_5 when fluorinated in a polar organic solvent, ionic isomers are formed.

$[PCl_4^+][PCl_4F_2]^-$ (colorless crystals)

$[PCl_4^+][PF_6]^-$ (white crystals)

5. Anode: $N_2H_4(aq) + 4OH^-(aq) \rightarrow N_2(g) + 4H_2O(l) + 4e^-$

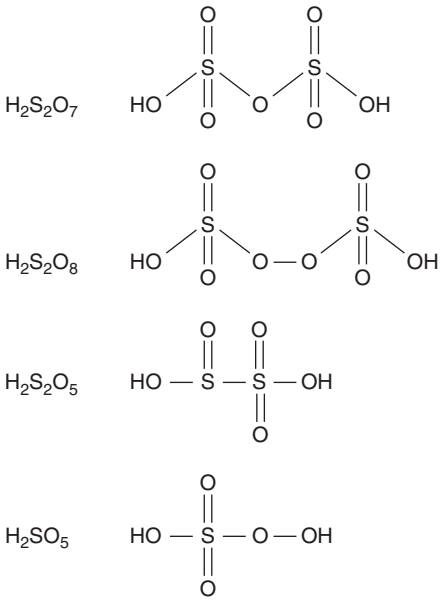
Cathode: $2H_2O(l) + O_2(g) + 4e^- \rightarrow 4OH^-(aq)$

6. Reagent

(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_+

7.



8. Number of moles of NaOH = $40 \times 1 \times 10^{-3} = 4 \times 10^{-2}$

Number of moles of Acetic acid = $100 \times 0.5 \times 10^{-3} = 5 \times 10^{-2}$

Therefore, the number of moles of acetic acid adsorbed on charcoal = $5 \times 10^{-2} - 4 \times 10^{-2} = 1 \times 10^{-2}$

Therefore, the number of molecules of acetic acid adsorbed = $1 \times 10^{-2}\ N_A = 6 \times 10^{-21}$

Total surface area adsorbed by one molecule of acetic acid = $\frac{1.5\times10^{2}}{6\times10^{21}} = 2500\times10^{-23}$

Therefore, P = 2500

9. **Vessel – I:**

$$(\Delta T_b)_1 = i_1 \times K_b \times \frac{w_2/GMM_x}{w_1/1000}$$

Vessel – II:

$$(\Delta T_b)_2 = i_2 \times K_b \times \frac{\frac{w_2}{GMM_y}}{\frac{w_1}{1000}}$$

$$\frac{(\Delta T_b)_1}{(\Delta T_b)_2} = \frac{i_1}{i_2} \times \frac{GMM_y}{GMM_x} = \frac{1.2}{0.8} = \frac{3}{2}$$

$$\left[\frac{(\Delta T_b)_1}{(\Delta T_b)_2}\right] \times 100 = \frac{3}{2} \times 100 = 150\%$$

10.

A	G	T	C	A	C	G	T	A	A	G	T	C
T	C	A	G	T	G	C	A	T	T	C	A	G
(1)	(i)	(2)	(ii)	(3)	(iii)	(iv)	(4)	(5)	(6)	(v)	(7)	(vi)

Total energy = [BE H-bond A – T × No. of A = T pair × 2] + [BE H-bond G – C × No. of G ≡ C pair × 3]

$= [1 \times 7 \times 2] + [1.5 \times 6 \times 3]$

$= 14 + 27$

$= 41$ kcal

11. Mass = Number of moles × Molar mass

$$\frac{(\text{Mass})P_b}{(\text{Mass})U} = \frac{n_{Pb} \times 206}{n_U \times 238} = \frac{7}{1}$$

$$\frac{n_{Pb}}{n_U} = \frac{238 \times 7}{206}$$

$$\ell n\left(1+\frac{n_{Pb}}{n_U}\right) = \lambda t$$

$$\ell n\left(1+\frac{238\times 7}{206}\right)=\frac{\ell n2}{t_{1/2}}\times t$$

$$\ell n\left(\frac{206+1666}{206}\right)=\frac{\ell n2}{t_{1/2}}\times t$$

$$\ell n(9)=\frac{\ell n2}{t_{1/2}}\times t$$

$$t=\frac{\ell n9}{\ell n2}\times t_{1/2}$$

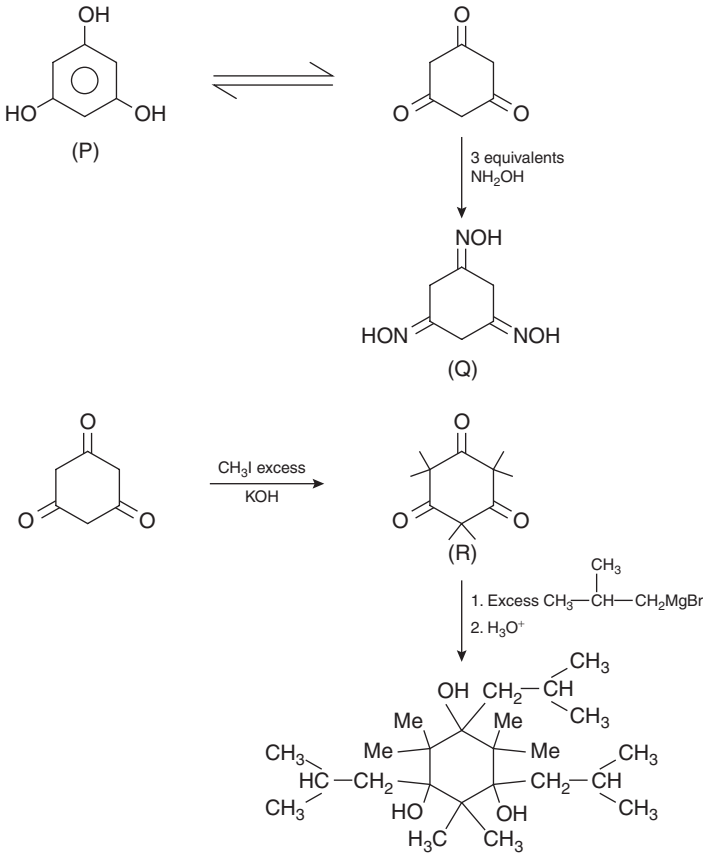
$$t=\frac{2\times 0.4771}{0.3010}\times 4.5\times 10^{9}$$

$t = 14.265 \times 10^9 = 142.65 \times 10^8$ years

$P = 142.65$

12. $[Co(CN)_4]^{4-}$, $[Co(CO)_3(NO)]$, $[PCl_4]^+$, $[Cu(CN)_4]^{3-}$ and P_4 are with tetrahedral geometry.

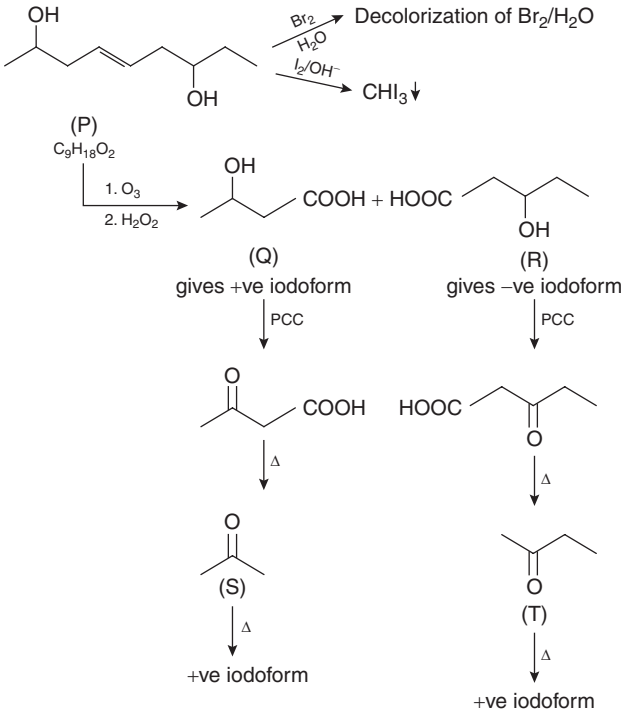
13.



Number of CH_3 groups = 12

PARAGRAPH I

14.



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

15. QR → Polymer (U)

Since moles of U = 1.

$$\text{Moles} = \frac{\text{Weight}}{\text{Molar Mass}}$$

Weight of "U" = Weight of (Q + R) – Weight of water

Weight of "Q" = $500 \times 104 = 52{,}000$ g

Weight of "R" = $500 \times 118 = 59{,}000$ g

Weight of "H_2O" = $999 \times 18 = 17982$ g

Weight of polymer = 52000 + 59000 – 17982

= 93018 g/mol

PARAGRAPH II

16. $KI + K_3[Fe(CN)_6] \rightleftharpoons K_4[Fe(CN)_6] + \frac{1}{2}I_2$

Moles of KI required = 2

17. $Zn^{2+} + K_4[Fe(CN)_6] \rightarrow K_2Zn_3[Fe(CN)_6]_2$

OR

$Zn^{2+} + K_4[Fe(CN)_6] \rightarrow Zn_2[Fe(CN)_6]$