FINAL JEE(Advanced) EXAMINATION - 2022

(Held On Sunday 28th AUGUST, 2022)

PAPER-2 | **TEST PAPER WITH SOLUTION**

CHEMISTRY

SECTION-1 : (Maximum Marks : 24)

- This section contains **EIGHT (08)** questions.
- The answer to each question is a **SINGLE DIGIT INTEGER ranging from 0 TO 9, BOTH INCLUSIVE.**
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	: +3	If **ONLY** the correct integer is entered;
Zero Marks	: 0	If the question is unanswered;
Negative Marks	: −1	In all other cases.

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1. Concentration of H_2SO_4 and Na_2SO_4 in a solution is 1 M and 1.8×10^{-2} M, respectively. Molar solubility of $PbSO_4$ in the same solution is $X \times 10^{-Y}$ M (expressed in scientific notation). The value of Y is _________.
[Given: Solubility product of $PbSO_4$ (K_{sp}) = 1.6×10^{-8}. For H_2SO_4, K_{a1} is very large and $K_{a2} = 1.2 \times 10^{-2}$]

Ans. (6)

Sol. $H_2SO_4 \rightleftharpoons HSO_4^- + H^+$

1M	-	-
-	1M	1M

$Na_2SO_4 \longrightarrow 2Na^+ + SO_4^{2-}$

1.8×10^{-2} M	-	-
	3.6×10^{-2} M	1.8×10^{-2} M

$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$; $K_{a_2} = 1.2 \times 10^{-2}$ M

1M	1M	1.8×10^{-2} M
		Since $Q_C > K_C$ it will move in backward direction.
$1 + x$	$1 - x$	$1.8 \times 10^{-2} - x$

$$K_{a_2} = 1.2 \times 10^{-2} = \frac{(1-x)(1.8\times10^{-2}-x)}{(1+x)}$$

Since x is very small $(1 + x) \simeq$ **1 and (1 – x)** $\simeq 1$

$$x = \left(1.8\times10^{-2} - 1.2\times10^{-2}\right)M$$

$$\left[SO_4^{2-}\right] = \left(1.8\times10^{-2} - 0.6\times10^{-2}\right)M$$

$= 1.2 \times 10^{-2}$ M

$PbSO_4$	$\longrightarrow$	Pb^{2+}	+	SO_4^{2-}
s		-		1.2×10^{-2} M
-		s		$(s + 1.2 \times 10^{-2})$

$K_{sp} = s\,(s + 1.2 \times 10^{-2}) = 1.6 \times 10^{-8}$
$(PbSO_4)$

Here, $(s + 1.2 \times 10^{-2}) \simeq 1.2 \times 10^{-2}$ (since 's' is very small)

$s(1.2\times10^{-2}) = 1.6 \times 10^{-8}$

$$\Rightarrow s = \frac{1.6}{1.2}\times10^{-6}M = X\times10^{-Y}M$$

$\Rightarrow Y = 6$

2. An aqueous solution is prepared by dissolving 0.1 mol of an ionic salt in 1.8 kg of water at 35 ºC. The salt remains 90% dissociated in the solution. The vapour pressure of the solution is 59.724 mm of Hg. Vapor pressure of water at 35 ºC is 60.000 mm of Hg. The number of ions present per formula unit of the ionic salt is _______.

Ans. (5)

Sol. 0.1 mole ionic salt in 1.8 kg water at 35° C

Vapour pressure of solution = 59.724 mm of Hg

Vapour pressure of pure H_2O = 60.000 mm of Hg

Let the number of ions present per formula unit of the ionic salt be 'x'

A_x	$\longrightarrow$	xA
(Salt)		(Ions)
0.1		-
0.1 (1 – 0.9)		(0.1×0.9) x

Total moles of non-volatile particles = 0.01 + 0.09 x
in 1.8 kg water

$$\text{Moles of water} = \frac{1.8\times10^{3}}{18} = 100 \text{ moles}$$

$$\text{Relative lowering of vapour pressure } \frac{P^\circ - P_s}{P^\circ} = \text{Mole fraction of non – volatile particles}$$

$$\frac{P^\circ - P_s}{P_s} = \frac{\text{moles of non-volatile particles}}{\text{moles of water}}$$

$$\frac{60.000 - 59.724}{59.724} = \frac{0.01 + 0.09x}{100}$$

$(0.276) \times 100 = 0.59274 + (0.59274 \times 9)x$

$27.6 - 0.59274 = (0.59274 \times 9)x$

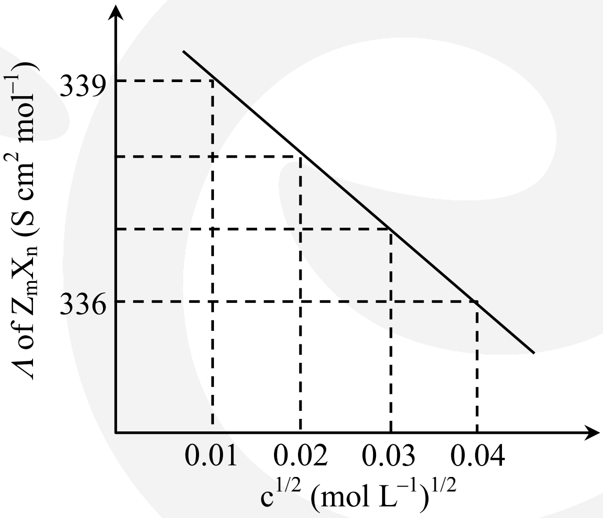
$$\Rightarrow x \simeq \frac{27}{0.6 \times 9} = 5$$

3. Consider the strong electrolytes Z_mX_n, U_mY_p and V_mX_n . Limiting molar conductivity (Λ^0) of U_mY_p and V_mX_n are 250 and 440 S cm^2 mol^{-1}, respectively. The value of (m + n + p) is ________.
Given:

Ion	Z^{n+}	U^{p+}	V^{n+}	X^{m-}	Y^{m-}
λ^0(S cm^2 mol^{-1})	50.0	25.0	100.0	80.0	100.0

λ^0 is the limiting molar conductivity of ions

The plot of molar conductivity (Λ) of Z_mX_n *vs* $c^{1/2}$ is given below.



Ans. (7)

Sol. $\Lambda^\circ(U_mY_p) = m \times \lambda^\circ_{U^{p+}} + p \times \lambda^\circ_{Y^{m-}} = 250$

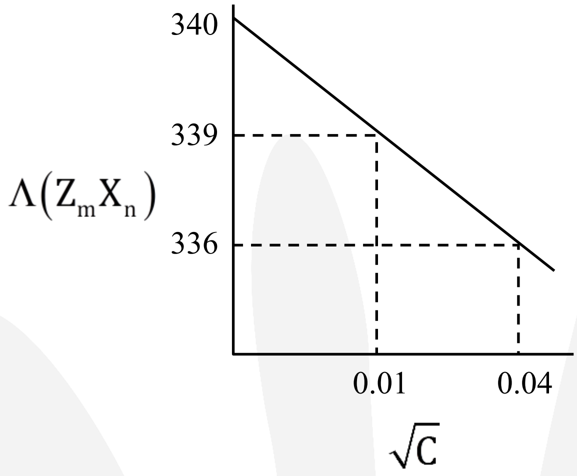
$25m + 100p = 250$

$m + 4p = 10$ ......(1)

$\Lambda^\circ(V_mX_n) = m \times \lambda_{V^{n+}} + n \times \lambda^\circ_{X^{m-}} = 440$

$100m + 80n = 440$

$5m + 4n = 22$ ......(2)



From the extrapolation of curve

$$\Lambda^\circ(Z_mX_n) = 340$$

$$m \times \lambda^\circ_{Z^{n+}} + n\lambda^\circ_{X^{m-}} = 340$$

$$50m + 80n = 340$$

$$5m + 8n = 34 \quad ....(3)$$

(3) — (2) $\Rightarrow$ $4n = 12 \Rightarrow n = 3$

Putting in (2) we get m = 2

Putting in (1) we get p = 2

$m + n + p = 2 + 3 + 2 = 7$

4. The reaction of Xe and O_2F_2 gives a Xe compound **P**. The number of moles of HF produced by the complete hydrolysis of 1 mol of **P** is _______.

Ans. (4)

Sol. $Xe + 2O_2F_2 \rightarrow XeF_4 + 2O_2$

$$3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + \frac{3}{2}O_2 + 12HF$$

$\therefore$ One mole of XeF_4 gives 4 moles of HF on hydrolysis.

5. Thermal decomposition of $AgNO_3$ produces two paramagnetic gases. The total number of electrons present in the antibonding molecular orbitals of the gas that has the higher number of unpaired electrons is _______.

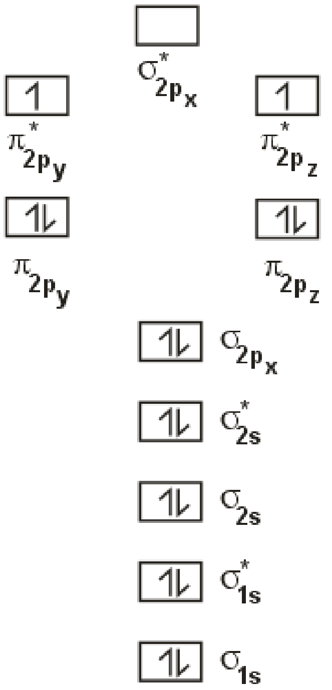
Ans. (6)

Sol. $AgNO_3 \rightarrow 2Ag + 2NO_2 + \frac{1}{2}O_2$

– Both NO_2 & O_2 are paramagnetic

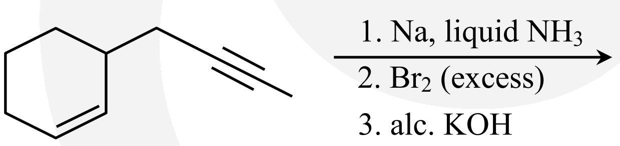
– NO_2 is odd electron molecule with one unpaired electron

–O_2 has two unpaired electrons



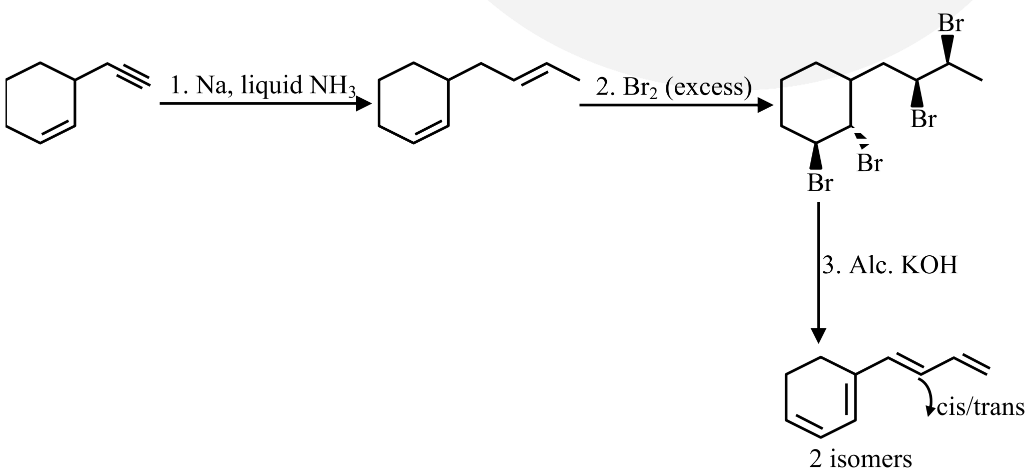
Total number of antibonding electrons = 6

6. The number of isomeric tetraenes (**NOT** containing *sp*-hybridized carbon atoms) that can be formed from the following reaction sequence is ________.

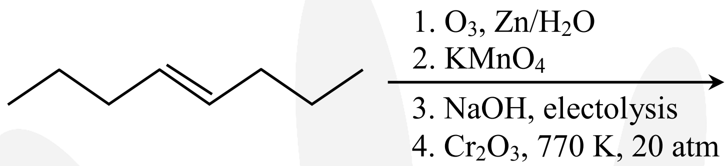


Ans. (2)

Sol.

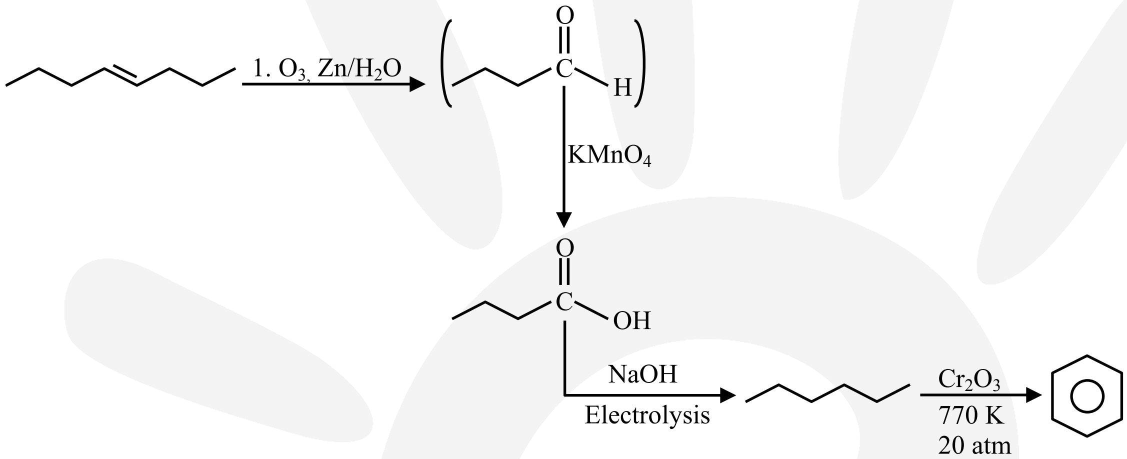


7. The number of -CH_2- (methylene) groups in the product formed from the following reaction sequence is ________.

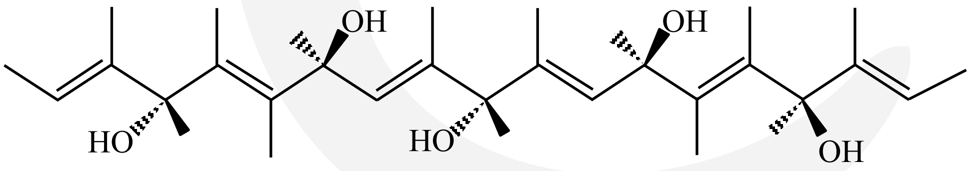


Ans. (0)

Sol.



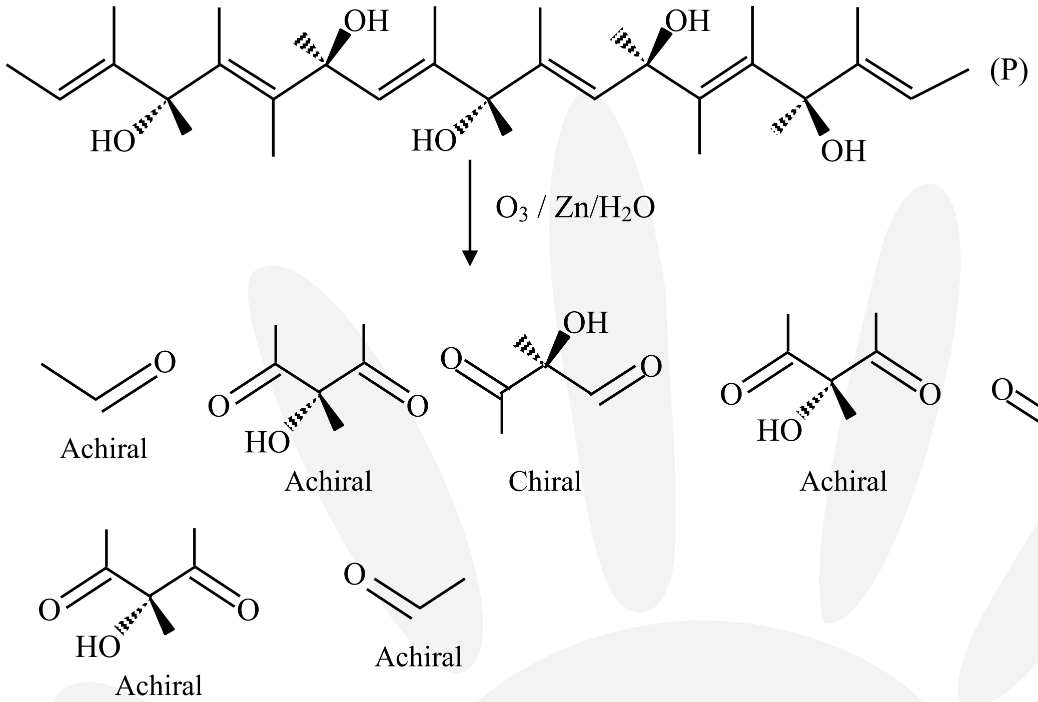
8. The total number of chiral molecules formed from one molecule of **P** on complete ozonolysis (O_3, Zn/H_2O) is ________.



P

Ans. (2)

Sol.



SECTION-2 : (Maximum Marks : 24)

- This section contains **SIX (06)** 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.

9. To check the principle of multiple proportions, a series of pure binary compounds (P_mQ_n) were analyzed and their composition is tabulated below. The correct option(s) is(are)

Compound	Weight % of P	Weight % of Q
1	50	50
2	44.4	55.6
3	40	60

(A) If empirical formula of compound **3** is P_3Q_4, then the empirical formula of compound **2** is P_3Q_5.

(B) If empirical formula of compound **3** is P_3Q_2 and atomic weight of element P is 20, then the atomic weight of Q is 45.

(C) If empirical formula of compound **2** is PQ, then the empirical formula of the compound **1** is P_5Q_4.

(D) If atomic weight of P and Q are 70 and 35, respectively, then the empirical formula of compound **1** is P_2Q.

Ans. **(B,C)**

Sol.

Compound	Weight % of P	Weight % of Q
1	50	50
2	44.4	55.6
3	40	60

For option (A)

Let atomic mass of P be M_P and atomic mass of Q be M_Q

Molar ratio of atoms P : Q in compound 3 is

$$\frac{40}{M_P}:\frac{60}{M_Q}=3:4$$

$$\frac{2M_Q}{3M_p}=\frac{3}{4}\Rightarrow 9M_P=8M_Q$$

Molar ratio of atoms P : Q in compound 2 is

$$\frac{44.4}{M_P}:\frac{55.6}{M_Q}$$

$= 44.4\ M_Q : 55.6\ M_P$

$= 44.4\ M_Q : 55.6 \times \frac{8M_Q}{9}$

$= 44.4 : 55.6 \times \frac{8}{9}$

$= 9 : 10$

$\Rightarrow$ Empirical formula of compound 2 is therefore P_9Q_{10}

Option (A) in incorrect

For option (B)

Molar Ratio of atoms P : Q in compound 3 is $\frac{40}{M_P}:\frac{60}{M_Q}=3:2$

$$\frac{2M_Q}{3M_P}=\frac{3}{2}\Rightarrow 9M_P=4M_Q$$

If $M_P = 20$ $\Rightarrow M_Q=\frac{9\times 20}{4}=45$

Option (B) is correct

For option (C)

Molar ratio of atoms P : Q in compound 2 is

$$\frac{44.4}{M_P}:\frac{55.6}{M_Q}=44.4M_Q:55.6\,M_P=1:1$$

$$\Rightarrow \frac{M_P}{M_Q}=\frac{44.4}{55.6}$$

Molar ratio of atoms P : Q in compound 1 is

$$\frac{50}{M_P}:\frac{50}{M_Q}=M_Q:M_P$$

$= 55.6 : 44.4$

$\simeq 5 : 4$

Hence, empirical formula of compound 1 is P_5Q_4

Hence, option (C) is correct

For option (D)

Molar ratio of atoms P : Q in compound 1 is

$$\frac{50}{M_P}:\frac{50}{M_Q}=M_Q:M_P$$

$= 35 : 70 = 1 : 2$

Hence, empirical formula of compound 1 is PQ_2

Hence, option (D) is incorrect

10. The correct option(s) about entropy (S) is(are)

[R = gas constant, F = Faraday constant, T = Temperature]

(A) For the reaction, $M(s) + 2H^+(aq) \rightarrow H_2(g) + M^{2+}(aq)$, if $\frac{dE_{cell}}{dT}=\frac{R}{F}$, then the entropy change of the reaction is R (assume that entropy and internal energy changes are temperature independent).

(B) The cell reaction, $Pt(s) \mid H_2(g, 1bar) \mid H^+(aq, 0.01M) \parallel H^+(aq, 0.1M) \mid H_2(g, 1bar) \mid Pt(s)$, is an entropy driven process.

(C) For racemization of an optically active compound, $\Delta S > 0$.

(D) $\Delta S > 0$, for $[Ni(H_2O)_6]^{2+} + 3\text{ en} \rightarrow [Ni(en)_3]^{2+} + 6H_2O$ (where en = ethylenediamine).

Ans. (B,C,D)

Sol. $\Delta G = \Delta H - T\Delta S$

$$\Delta G = \Delta H + T\left(\frac{d\Delta G}{dT}\right)_p$$

$$-nF\left(\frac{dE_{cell}}{dT}\right) = -\Delta S$$

$$\frac{dE_{cell}}{dT} = \frac{\Delta S}{nF} = \frac{R}{F}(\text{given})$$

$\Rightarrow \Delta S = nR$

For the reaction, $M(g) + 2H^{\oplus}(aq) \longrightarrow H_2(g) + M^{2\oplus}(aq)$

$n = 2$

$\Rightarrow$ $\Delta S = 2R$

Hence, option (A) is incorrect

For the reaction, $Pt_{(s)}\,|H_{2(g)}, 1\text{ bar}|\,H^{\oplus}_{aq}(0.01M)||\,H^{\oplus}(aq, 0.1M)\,|\,H_2(g, 1\text{ bar})|\,Pt_{(s)}$

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{1}\log\frac{0.01}{0.1} = 0.0591V$$

E_{cell} is positive $\Rightarrow \Delta G < 0$ and $\Delta S > 0$ ($\Delta H = 0$ for concentration cells)

Hence, option (B) is correct

Racemization of an optically active compound is a spontaneous process.

Here, $\Delta H = 0$ (similar type of bonds are present in enantiomers)

$\Rightarrow \Delta S > 0$

Hence, option (C) is correct.

$\left[Ni(H_2O)_6\right]^{2+} + 3\text{ en} \rightarrow \left[Ni(en)_3\right]^{2+} + 6H_2O$ is a spontaneous process

more stable complex is formed

$\Rightarrow \Delta S > 0$

Hence, option (D) is correct.

11. The compound(s) which react(s) with NH_3 to give boron nitride (BN) is(are)

(A) B (B) B_2H_6 (C) B_2O_3 (D) HBF_4

Ans. **(B,C)**

Sol. **(A)** $2B + 2NH_3 \rightarrow 2BN + 3H_2$

Boron produced BN with ammonia but **Boron is element not compound.** So that this option not involve in answer.

(B) $3B_2H_6 + 6NH_3 \rightarrow 3[BH_2(NH_3)_2]^+[BH_4^-] \xrightarrow{T = 200°C} 2B_3N_3H_6 + 12H_2$

$B_3N_3H_6 \xrightarrow{T > 200°C} (BN)_x$

(C) $B_2O_3(\ell) + 2NH_3 \xrightarrow{1200°C} 2BN_{(s)} + 3H_2O_{(g)}$

(D) $HBF_4 + NH_3 \rightarrow NH_4[BF_4]$

12. The correct option(s) related to the extraction of iron from its ore in the blast furnace operating in the temperature range 900 – 1500 K is(are)

(A) Limestone is used to remove silicate impurity.

(B) Pig iron obtained from blast furnace contains about 4% carbon.

(C) Coke (C) converts CO_2 to CO.

(D) Exhaust gases consist of NO_2 and CO.

Ans. (A,B,C)

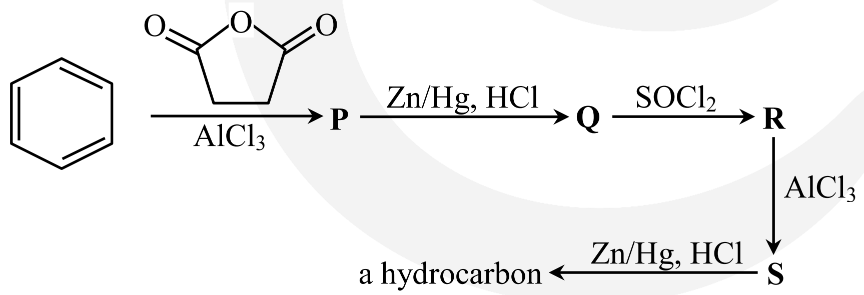
Sol. (A) $CaO + SiO_2 \rightarrow CaSiO_3$ (in the temperature range 900 – 1500 K)

(B) In fusion zone molten iron becomes heavy by absorbing elemental impurities and produces Pig iron. (in the temperature range 900 – 1500 K)

(C) $C + CO_2 \rightarrow 2CO$ (in the temperature range 900 – 1500 K)

(D) Exhaust gases does not contain NO_2.

13. Considering the following reaction sequence, the correct statement(s) is(are)



(A) Compounds **P** and **Q** are carboxylic acids.

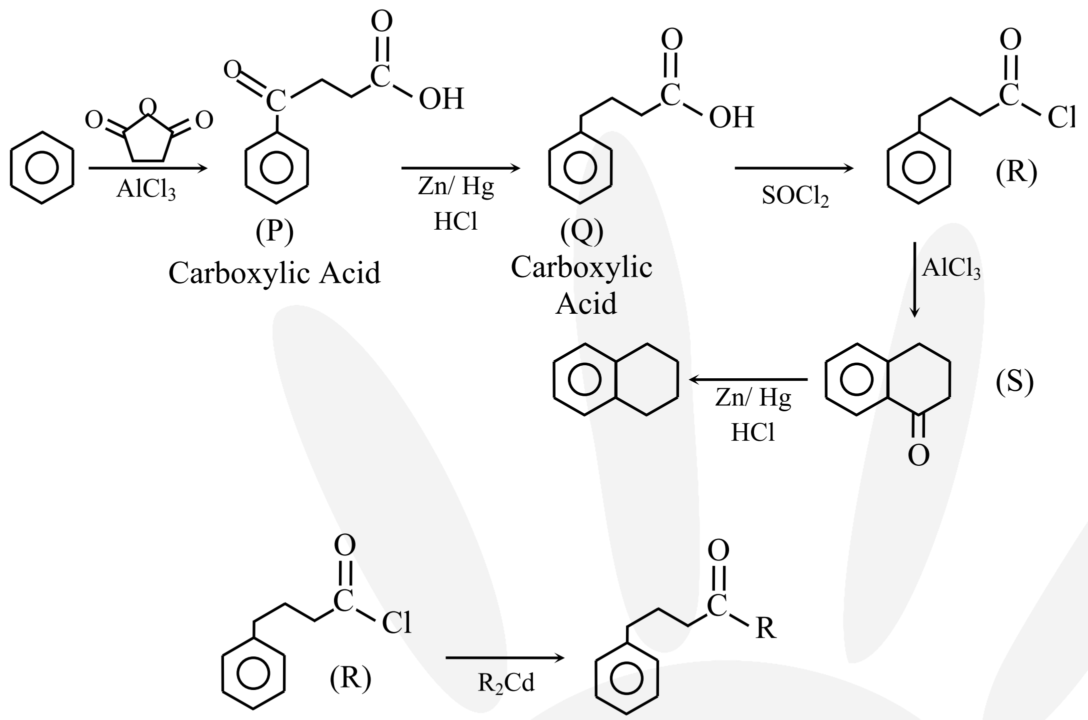
(B) Compound **S** decolorizes bromine water.

(C) Compounds **P** and **S** react with hydroxylamine to give the corresponding oximes.

(D) Compound **R** reacts with dialkylcadmium to give the corresponding tertiary alcohol.

Ans. (A,C)

Sol.



14. Among the following, the correct statement(s) about polymers is(are)

(A) The polymerization of chloroprene gives natural rubber.

(B) Teflon is prepared from tetrafluoroethene by heating it with persulphate catalyst at high pressures.

(C) PVC are thermoplastic polymers.

(D) Ethene at 350-570 K temperature and 1000-2000 atm pressure in the presence of a peroxide initiator yields high density polythene.

Ans. **(B,C)**

Sol. (a) The polymerisation of neoprene gives natural rubber.

(b) is correct statement

(c) is correct statement

(d) Ethene at 350-570 K temperature and 1000-2000 atm pressure in the pressure of a peroxide initiator yields low density polythene.

SECTION-3 : (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.

15. Atom X occupies the fcc lattice sites as well as alternate tetrahedral voids of the same lattice. The packing efficiency (in %) of the resultant solid is closest to

(A) 25 (B) 35 (C) 55 (D) 75

Ans. (B)

Atom 'X' occupies FCC lattice points as well as alternate tetrahedral voids of the same lattice

$\Rightarrow \frac{1}{4}$th distance of body diagonal

$$= \frac{\sqrt{3}a}{4} = 2r_X$$

$$\Rightarrow a = \frac{8r_X}{\sqrt{3}}$$

Number of atoms of X per unit cell

= 4 + 4 = 8

(FCC lattice points) (Alternate tetrahedral voids)

$$\%\text{ packing efficiency} = \frac{\text{Volume occupied by X}}{\text{Volume of cubic unit cell}} \times 100$$

$$= \frac{8 \times \frac{4}{3}\pi(r_X)^3}{a^3} \times 100$$

$$= \frac{8 \times \frac{4}{3}\pi(r_X)^3}{\left(\frac{8r_X}{\sqrt{3}}\right)^3} \times 100$$

$$= \left(8 \times \frac{4}{3} \times \pi \times \frac{1}{8^3} \times 3\sqrt{3}\right) \times 100$$

$$= \frac{\sqrt{3}\pi}{16} \times 100$$

$$= 34\%$$

Hence, option (B) is the most appropriate option

16. The reaction of $HClO_3$ with HCl gives a paramagnetic gas, which upon reaction with O_3 produces

(A) Cl_2O (B) ClO_2 (C) Cl_2O_6 (D) Cl_2O_7

Ans. (C)

Sol. $HClO_3 + HCl \rightarrow \underset{\text{(Paramagnetic)}}{ClO_2} + \frac{1}{2}Cl_2 + H_2O$

$2ClO_2 + 2O_3 \rightarrow Cl_2O_6 + 2O_2$

17. The reaction $Pb(NO_3)_2$ and NaCl in water produces a precipitate that dissolves upon the addition of HCl of appropriate concentration. The dissolution of the precipitate is due to the formation of

(A) $PbCl_2$ (B) $PbCl_4$ (C) $[PbCl_4]^{2-}$ (D) $[PbCl_6]^{2-}$

Ans. (C)

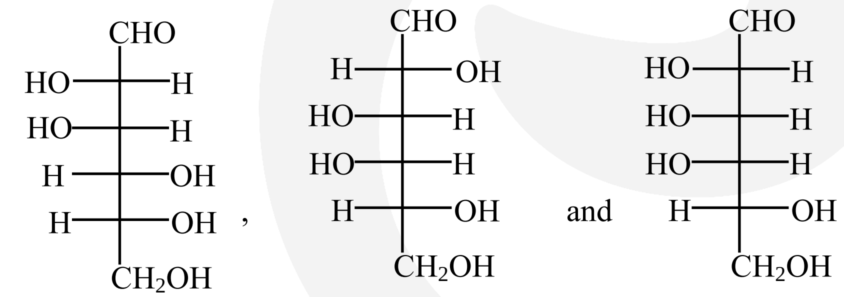
Sol.

$$Pb(NO_3)_2 + 2NaCl \longrightarrow PbCl_2 + 2NaNO_3$$

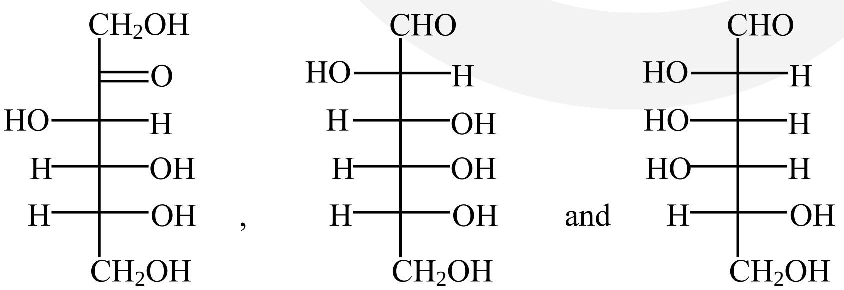
$$PbCl_2 \xrightarrow{\text{excess HCl}} [PbCl_4]^{2-}$$

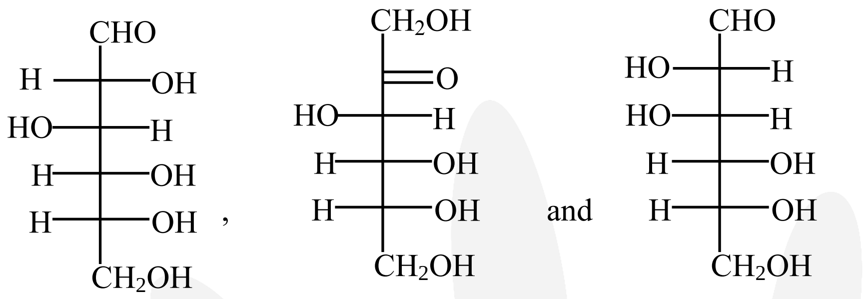
18. Treatment of D- glucose with aqueous NaOH results in a mixture of monosaccharides, which are

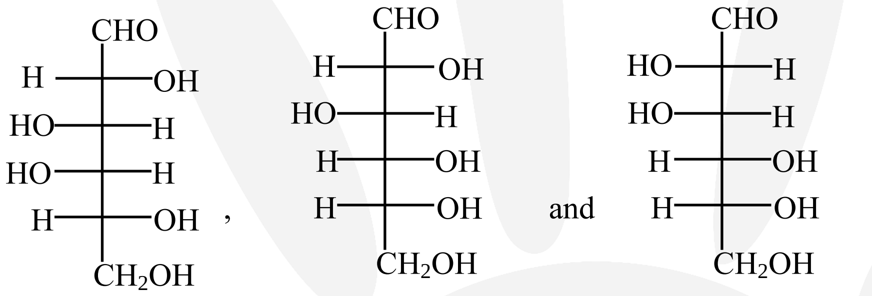
(A)



(B)



(C) 

(D) 

Ans. (C)

Sol. Basic catalyse tautomerism through enediol intermediate