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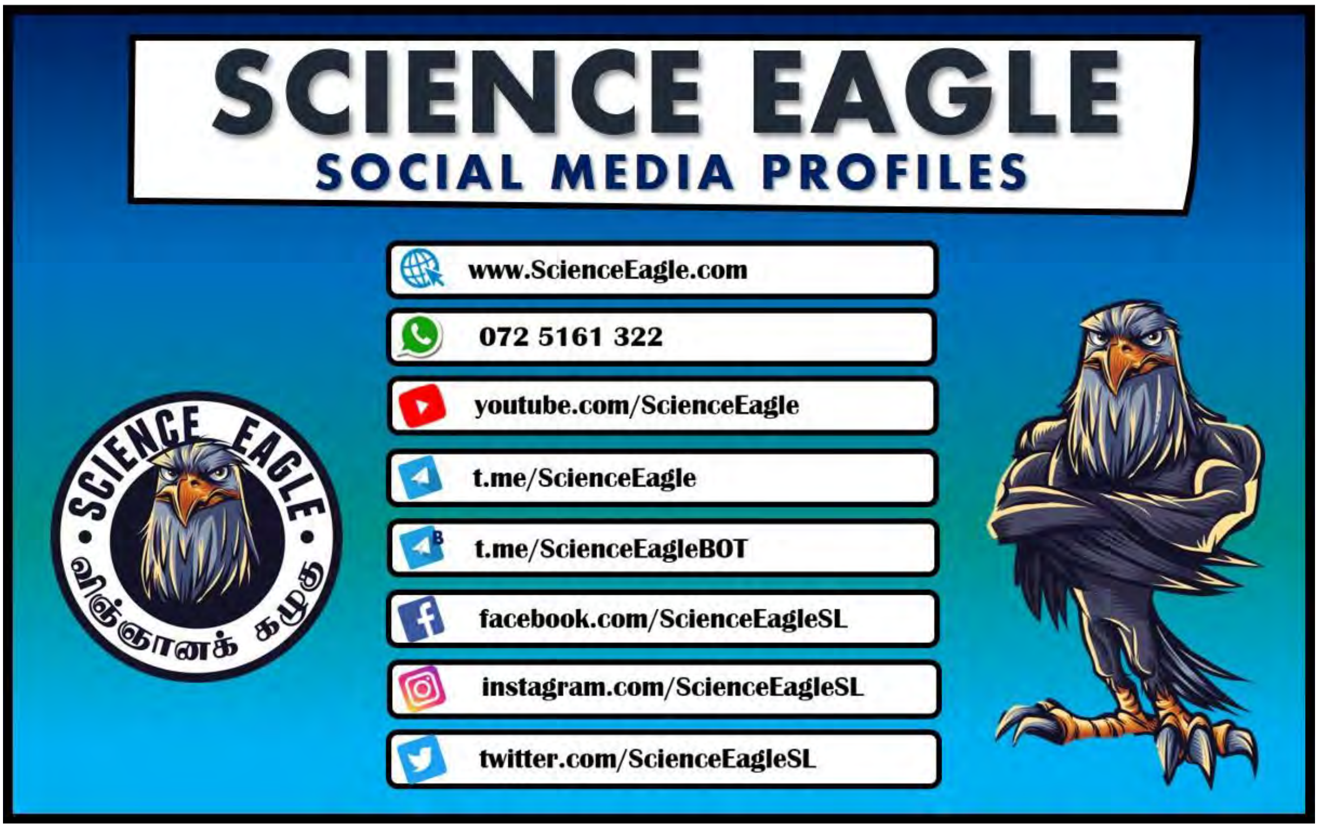
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தரம் :- 13 (2022)	இரசாயனவியல்	புள்ளித்திட்டம்

Part I

(1) 3	(11) 3	(21) 4	(31) 3	(41) 4
(2) 2	(12) 4	(22) 2	(32) 5	(42) 2
(3) 1	(13) 3	(23) 2	(33) 1	(43) 1
(4) 2	(14) 2	(24) 2	(34) 5	(44) 1
(5) 2	(15) 5	(25) 5	(35) 3	(45) 3
(6) 2	(16) 3	(26) 3	(36) 3	(46) 4
(7) ~~3~~ 5	(17) 4	(27) 4	(37) 5	(47) 4
(8) 4	(18) 3	(28) 5	(38) 3	(48) 5
(9) 3	(19) 2	(29) 5	(39) 2	(49) 5
(10) 2	(20) 3	(30) 2/5	(40) 4	(50) 2

Final marks

Part I — 50 × 01 = 50%

Part II - Structure 4 × 100 = 400
Essay 4 × 150 = 600

1000 ÷ 20 = 50%

Part II A
Structured Essay

1 (a) (i) $Na_2O < MgO < SiO_2 < Al_2O_3$ (ii) $CO < CO_2 < SO_4^{2-} < CO_3^{2-}$

28

(iii) $KF < KCl < NaCl < Na_2S$ (iv) $F_2 < Cl_2 < O_2 < N_2$

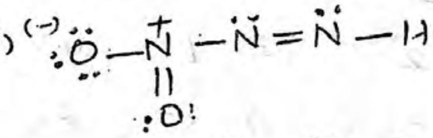
(v) $NH_3 < NH_4^+ < NO_3^- < NO_2^+$

(vi) $Na < Li < O < S$ (vii) $HCO_3^- < OH^- < CH_3O^- < NH_2^-$

$(7 \times 04 = 28 \text{ marks})$

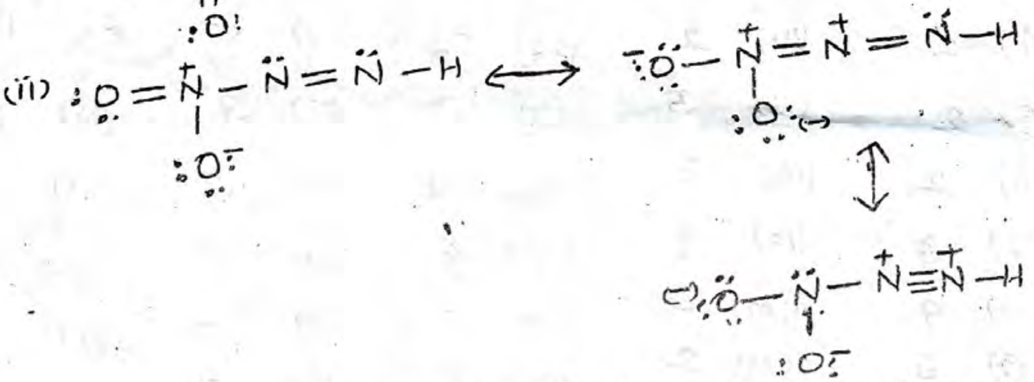
(b) (i)

47



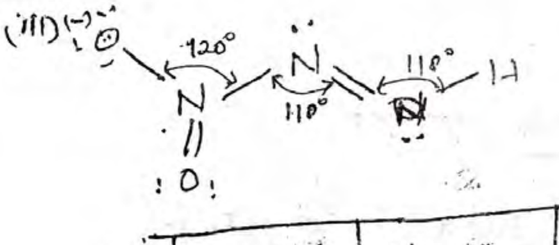
------- (04) marks.

(ii)



--- $3 \times 02 = (06)$ marks)

(iii)



------ structure (04)
bond angle (03.)

	C_1	N_2	C_3	S_4
VSEPR pairs	3	3	2	4
Electron pair geometry	trigonal planar	trigonal planar	linear	tetrahedral
shape	trigonal planar	angular / v shaped	linear	tetrahedral
Hybridization	sp^2	sp^2	sp	sp^3

----- $(16 \times 01 = (16)$ marks)

(V) (1) Cl -- sp^3/3p C^1 -- sp^2 (VI) 1) N_1 -- 2p C^3 -- 2

(2) C^1 -- sp^2 N^2 -- sp^2 (2) C^3 -- 2p S^4 --

(3) N^2 -- sp^2 C_3 -- sp

(4) C_3 -- sp S_4 -- sp^3 2x 01 = (02) marks

(5) S^4 -- sp^2 O_5^+ -- sp^2/2p

(6) S^4 -- sp^3 H -- 1s

--- 12x 01 = (12) marks

(C) (I) true (II) false (III) false (IV) true

(V) true

15

--- 5x 03 = (15) marks

10 (d) $E = \frac{1}{2}mv^2$, $\lambda = \frac{h}{mv}$

If E is increased four times, v becomes doubled

∴ New wave length = $\lambda/2$ (10)

(2) (a) (i) X = Cl , Y = K ---- 2x04 = (08)

40 (ii) Z = KCl , B = KOH , C = NH_3 , D = HOCl

4x 03 = (12)

(iii) HOCl , $HClO_2$, $HClO_3$, $HClO_4$ --- 4x 01 = (04)

அமில இயல்பு HOCl < $HClO_2$ < $HClO_3$ < $HClO_4$

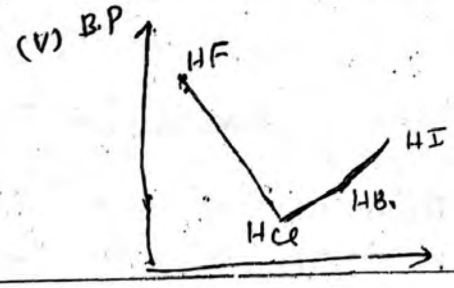
---- (04)

(iv) $2Fe_{(s)} + 3Cl_{2(g)} \longrightarrow 2FeCl_{3(s)}$

$2NH_{3(g)} + 3Cl_{2(g)} \longrightarrow N_{2(g)} + 6HCl_{(g)}$ 3x02 = (06)

$3Cl_2 + \underset{\text{(hot, conc.)}}{6KOH} \longrightarrow 5KCl + KClO_3 + 3H_2O$

(v)



------ (06)

(VI) Gas $\longrightarrow$ Liquid. - - - 02 marks

(VII) For water, melting point decreases with increasing pressure. whereas in the case of CO_2, m.p increases when the pressure is increased. (due to anomalous expansion of H_2O) - - - 04 marks

(b) (I) (ii) Anode – $Zn_{(s)} | Zn^{2+}_{(aq)}$ electrode - - 02 marks

(iii) Anode : $Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2e$

Cathode : $AgCl_{(s)} + e \longrightarrow Ag_{(s)} + Cl^-_{(aq)}$

$2 \times 02 = 04$ marks

(iv) $Zn_{(s)} + 2AgCl_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)} + 2Cl^-_{(aq)}$ - - - - 02 marks

(iv) emf $= E^\ominus_{cathode} - E^\ominus_{anode}$ - - - 01 mark

$= +0.22V - (-0.76V) = 0.98\ V$ - 01 mark

(V) $Zn_{(s)} | Zn^{2+}_{(aq)} \vdots Cl^-_{(aq)} | AgCl_{(s)}, Ag_{(s)}$ - - - - 02 marks

(II) (i) Cathode : $Al^{3+}_{(aq)} + 3e \longrightarrow Al_{(l)}$

Anode : $2O^{2-}_{(l)} \longrightarrow O_{2(g)} + 4e$

$2 \times 03 = 06$ marks

(ii) Overall re^n : $4Al^{3+}_{(l)} + 6O^{2-}_{(l)} \longrightarrow 4Al_{(l)} + 3O_{2(g)}$ - - - 02 marks

(or $2Al_2O_{3(l)} \longrightarrow 4Al_{(l)} + 3O_{2(g)}$)

$n_{O_2} = \frac{V}{V_m} = \frac{112\ cm^3}{22,400\ cm^3 mol^{-1}} = 0.005\ mol$ - - - - 02 marks

$n_{Al} = \frac{4}{3} \times 0.005\ mol = \frac{20}{3} \times 10^{-3}\ mol$ - - 01 mark

$\therefore$ mass of Al deposited $= \frac{20}{3} \times 10^{-3} \times 27\,g$

$= 0.18\,g$ --- 01

(ii) $\frac{m_M}{m_{Al}} = \frac{E_M}{E_{Al}}$ --- 02

$\frac{1.373\,g}{0.18\,g} = \frac{137.3/x}{27/3} = \frac{137.3}{9x}$ --- 02

$\Rightarrow x = 2$ --- 02

[or Balancing the charge, $3 \times Al\ mol = x \times M\ mol$

$\therefore 3 \times \frac{20}{3} \times 10^{-3} = x \times 0.01$]

total $\boxed{06}$

(iii) For depositing 1 mol of Al $\rightarrow$ 3 mol e^- --- 02

$\therefore$ For 0.18 g of Al $\rightarrow \frac{3}{27} \times 0.18$ mol e^-

$= 0.02$ mol of e^- --- 02

Let N_A be the Avogadro constant

$q = 1.602 \times 10^{-19}\,C \times N_A \times 0.02\,mol = It$

$= 3.21\,A \times 10 \times 60\,s$ --- 02

$\Rightarrow N_A = \frac{3.21 \times 10 \times 60\,C}{1.602 \times 0.02 \times 10^{-19}\,C\,mol}$ --- 02

$= \underline{6 \times 10^{23}\,mol^{-1}}$ --- 02

total $\boxed{10}$

(c) (i) $N_2O_{(g)} \longrightarrow N_{2(g)} + O_{(g)}$ - slow step

$N_2O_{(g)} + O_{(g)} \longrightarrow N_{2(g)} + O_{2(g)}$ fast step

$2 \times (02+02) = 08$

2 steps — 2x

slow, fast — 2x

(ii) $O_{(g)}$ is the intermediate --- 02

(iii) $\Delta H = -164\,kJ\,mol^{-1}$, $E_a = 80\,kJ\,mol^{-1}$

$2 \times 02 = 04$

(iv) TS_1 — First transition state / first activated complex

TS_2 — Second transition state / first activated complex

$2 \times 02 = 04$

(v) Rate $\propto [N_2O_{(g)}]$ --- 02

(vi) $2N_{2(g)} + O_{2(g)} \longrightarrow 2N_2O_{(g)}$

$\Delta S_{rec} = \Sigma S_{Product} - \Sigma S_{Reactant}$

$= [2\times220 - (2\times192 + 205)]\ J\,mol^{-1}K^{-1}$ --- 02

$= -149\ J\,mol^{-1}K^{-1}$ --- 02

total 10

$\Delta H = +164\ kJ\,mol^{-1}$

Using

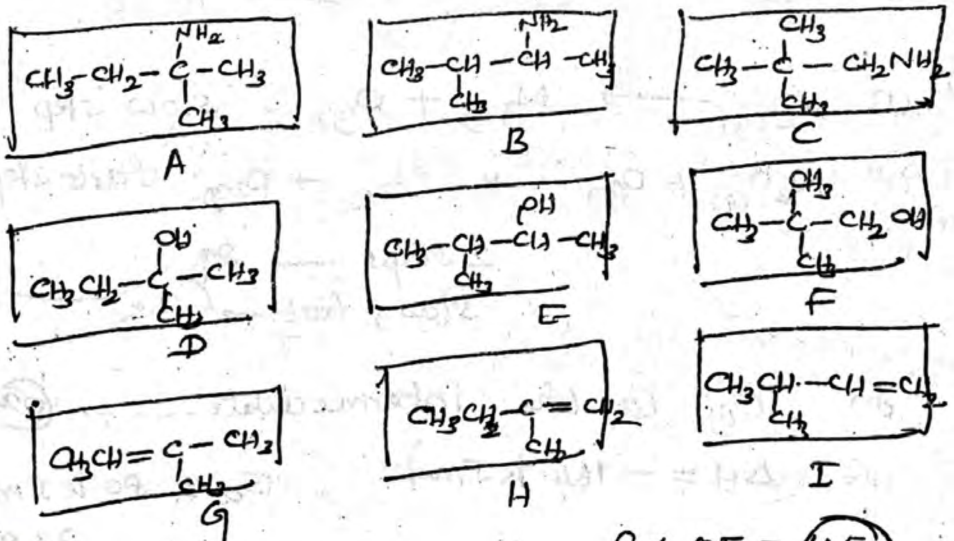
$\Delta G = \Delta H - T\Delta S$ --- 02

$\Delta G = +164\ kJ\,mol^{-1} - 500K \times (-149\times10^{-3}\ kJ\,mol^{-1}K^{-1})$ --- 02

Since $\Delta G > 0$

$\therefore$ the re^n is non-spontaneous. --- 02

4 (a) 45

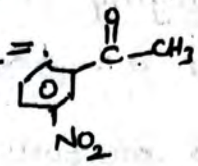
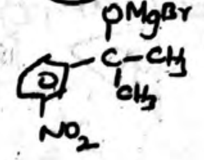


$9 \times 05 = 45$

(b) (i) $P =$ PCC , $J = CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2CHO$, $K = CH_3-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_2CHO$.

40

$3 \times 04 = 12$

$Q = CH_3COCl$ / anhyd. $AlCl_3$, $L =$  , $M =$ 

$3 \times 04 = 12$

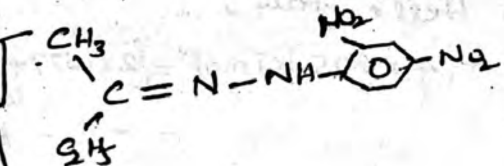
$R, N = CH_3CH_2OH$ / (04)

(ii) (I) Reaction (2) – Nucleophilic addition
Reaction (3) – Nucleophilic substitution
Reaction (4) – Electrophilic substitution
Reaction (5) – Nucleophilic addition

$4 \times 03 = 12$

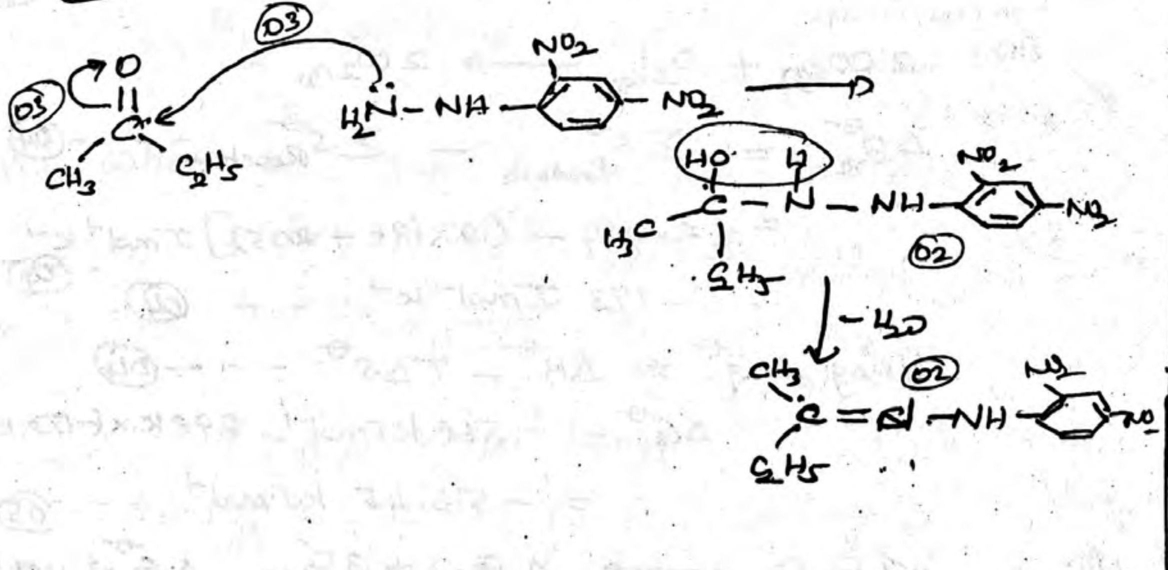
(c)

15



– – – – (05)

Mechanism – – – (10)



Essay Questions

Part II B

(5) (a) (I) Applying $PV = nRT$,

90 15

for gas P : $1 \times 10^5 \, Nm^{-2} \times V = \frac{20}{M_P} \times R \times 300K$ —— ① (04)

for gas mixture : $1.5 \times 10^5 \, Nm^{-2} V = \left(\frac{20}{M_P} + \frac{9}{M_Q}\right) R \times 300K$ —— ② (04)

$\frac{①}{②} \Rightarrow \frac{1}{1.5} = \frac{20/M_P}{(20/M_Q + 9/M_Q)}$ ---- (02)

$\frac{M_P}{M_Q} = \frac{10}{9}$ -------- (05)

(II) (i) 15

$$2CO_{(g)} + O_{2(g)} \xrightarrow{\Delta H_R^\ominus} 2CO_{2(g)}$$

$2CO_{(g)} \xrightarrow{2\times1077 \, kJmol^{-1}} 2C_{(g)}$, $O_{2(g)} \xrightarrow{498 \, kJmol^{-1}} 2O_{(g)}$, $2CO_{2(g)} \xrightarrow{4\times805 \, kJmol^{-1}} 2C_{(g)} + 4O_{(g)}$

$$2C_{(g)} + 4O_{(g)}$$

Cycle → (10)

Values → 3 × 02 = (06)

According to Hess's law,

$\Delta H_R^\ominus + 4 \times 805 \, kJmol^{-1} = [2\times1077 + 498] \, kJmol^{-1}$ --- (04)

$\Rightarrow \Delta H_R^\ominus = -568 \, kJmol^{-1}$ --- (05)

(ii) $2CO_{(g)} + O_{2(g)} \longrightarrow 2CO_{2(g)}$

$\Delta S_{rxn}^\ominus = \sum S^\ominus_{Products} - \sum S^\ominus_{Reactants}$ --- (04)

$= [2\times214 - (2\times198 + 205)] \, Jmol^{-1}K^{-1}$ (04)

$= -173 \, Jmol^{-1}K^{-1}$ --- (04)

Using $\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$ ---- (04)

$\Delta G^\ominus = -568 \, kJmol^{-1} - 298K \times (-173 \times 10^{-3} \, kJmol^{-1}K^{-1})$ --- (04)

$= -516.45 \, kJmol^{-1}$ --- (05)

(iii) $2Fe_2O_{3(s)} \longrightarrow 4Fe_{(s)} + 3O_{2(g)}$ —— Eqn ① $\Delta G^\ominus = +1480 \, kJmol^{-1}$

$2CO_{(g)} + O_{2(g)} \longrightarrow 2CO_{2(g)}$ —— Eqn ② $\Delta G^\ominus = -516.45 \, kJmol^{-1}$

$① + ② \times 3 \Rightarrow 2Fe_2O_{3(s)} + 6CO_{(g)} \longrightarrow 4Fe_{(s)} + 6CO_{2(g)}$

$\Delta G^\ominus = (1480 - 516.45 \times 3)\ kJmol^{-1}$

$= -69.35\ kJmol^{-1}$ --- (10)

$\therefore Fe_2O_{3(s)} + 3CO_{(g)} \longrightarrow 2Fe_{(s)} + 3CO_{2(g)},$

$\Delta G^\ominus = -34.675\ kJmol^{-1}$ (05)

Since $\Delta G^\ominus < 0$, the reⁿ is spontaneous. --- (10)

(b) (i) $2XY_{2(s)} \rightleftharpoons X_{2(g)} + 2Y_{2(g)}$ (60)

$P \qquad 2P$ (Since V, R and T are const. $P \propto n$)

$3P = 6 \times 10^5\ Pa$

$\therefore P = 2 \times 10^5\ Pa$ ---- (04)

$K_{P_1} = P_{X_{2(g)}} \times P^2_{Y_{2(g)}}$ ---

$= P \times (2P)^2 = 4P^3 = 32 \times 10^{15}\ Pa^3$ --- (04)

(ii) $2ZY_{2(s)} \rightleftharpoons Z_{2(g)} + 2Y_{2(g)}$

$P' \qquad 2P'$

$3P' = 9 \times 10^5\ Pa$

$\therefore P' = 3 \times 10^5\ Pa$ --- (04)

$K_{P_2} = 4(P')^3 = 4(3 \times 10^5\ Pa)^3$

$= 108 \times 10^{15}\ Pa^3$ --- (04)

(iii) when the two bulbs are connected,

$2XY_{2(s)} \rightleftharpoons X_{2(g)} + 2Y_{2(g)}$

$P_1 \qquad 2P_1 + 2P_2$

$2ZY_{2(s)} \rightleftharpoons Z_{2(g)} + 2Y_{2(g)}$

$P_2 \qquad 2P_1 + 2P_2$

K_P is unchanged as T is const

$\therefore K_{P_1} = 32 \times 10^5\ Pa^3 = P_1(2P_1 + 2P_2)^2$ --- (03)

$8 \times 10^5\ Pa^3 = P_1(P_1 + P_2)^2$

$P_1 = \dfrac{8 \times 10^5\ Pa}{(P_1 + P_2)^2}$ —— ① --- (03)

$K_{P_2} = P_2(2P_1+2P_2)^2$ ---- (03)

$108 \times 10^{15}\ Pa^3 = P_2(2P_1+2P_2)^2$

$P_2 = \dfrac{27\times10^{15}}{(P_1+P_2)^2} Pa$ ——— ② ---- (03)

① + ② ⟹ $P_1 + P_2 = \dfrac{35\times10^{15}\ Pa^3}{(P_1+P_2)^2}$

$(P_1+P_2)^3 = 35\times10^{15}\ Pa^3$ --- (03)

$P_1 + P_2 = 3.27\times10^5\ Pa$ ---- (03)

Substituting $P_1+P_2 = 3.27\times10^5$ in eqn ①,

$P_1 = \dfrac{8\times10^{15}\ Pa^3}{(3.27\times10^5)^2} = \dfrac{8}{10.7}\times10^{5}\ Pa$

$= 0.747\times10^5\ Pa$ --- (04)

$P_2 = \dfrac{27\times10^{5}\ Pa^3}{(3.27\times10^5 Pa)^2} = 2.52\times10^5\ Pa$ --- (04)

$P_{X_2} = P_1 = 0.747\times10^5\ Pa$
$P_{Y_2} = 2(P_1+P_2) = 6.54\times10^5\ Pa$
$P_{Z_2} = P_2 = 2.52\times10^5\ Pa$
$3\times03 = (09)$

Total pressure of the system

$P_T = P_{X_2} + P_{Y_2} + P_{Z_2}$

$= 9.807\times10^5\ Pa$ --- (05)

Assumption : Gases behave ideally -- (04)

(6) (a) (i) $[B]_{t=0} = \dfrac{0.14\ mol\ dm^{-3}\times 200\ cm^3}{1000\ cm^3} = 0.028\ mol\ dm^{-3}$ --- (05)

(80)

$[B]_{t=8s} = 0.0205\ mol\ dm^{-3}$ (given)

∴ For first 8s time interval

$\Delta[B] = -7.5\times10^{-3}\ mol\ dm^{-3}$ --- (05)

$\therefore$ Rate of consumption of $B = \frac{-\Delta[B]}{\Delta t}$

$= \frac{7.5 \times 10^{-3} mol\,dm^{-3}}{8\,s}$ --- (05)

$= 9.37 \times 10^{-4}\ mol\,dm^{-3}s^{-1}$

--- (05)

Rate of consumption of A, $\frac{\Delta[A]}{\Delta t} = 2 \times \frac{\Delta[B]}{\Delta t}$

$= 1.874 \times 10^{-3} mol\,dm^{-3}s^{-1}$

--- (05)

(ii) For a zeroth order re^n, $t_{1/2}$ is directly proportional to C_0

and for a 1st order re^n, $t_{1/2}$ is independent of initial concent^n.

$2 \times 03 =$ (06)

Zeroth order $\Rightarrow t_{1/2} = \frac{[A]_0}{2k}$

1st order $\Rightarrow t_{1/2} = \frac{0.693}{k}$ $\Big\}$ $2 \times 02 =$ (04)

(where k is the rate const)

(iii) Under conditions of expt (2),

$[A]_0 \quad 0.2M \xrightarrow[t_{1/2} = 119s]{} 0.1M$

$[A]_0 \quad 0.1M \xrightarrow[t_{1/2} = \frac{119}{2} \approx 60s]{} 0.05M$, $0.05M \xrightarrow[t_{1/2} = \frac{60}{2} = 30s]{} 0.025$

Since $t_{1/2} \propto [A]_0$, order w.r.t A is 0.

---- (05)

Given that the unit of rate const $= s^{-1}$

$\therefore$ Overall order should be one.

---- (05)

$\Rightarrow$ order w.r.t B is one

--- (05)

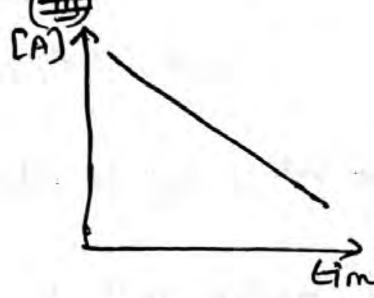
(iv) Under the cond^{ns} of expt (I)

(I) $t_{1/2} = \frac{0.693}{k} = \frac{0.693}{2.1 \times 10^{-3} s^{-1}}$ --- 05

$= 330 s$ --- 05

(II) $100 \times \left(\frac{1}{2}\right)^3 = 12.5\%$ --- 05

(v) (I)



(II) $R = k[B]$ --- 03

(∵ order w.r.t A is zero)

$= 2.1 \times 10^{-3} s^{-1} \times 0.4 \, mol \, dm^{-3}$

$= 8.4 \times 10^{-4} \, mol \, dm^{-3} s^{-1}$

--- 02

(III) As [B] is kept const., when the re^n is completed, [A] must be zero.

--- 05

$-\frac{1}{4} \frac{[0 - 0.2] \, mol \, dm^{-3}}{\Delta t} = 8.4 \times 10^{-4} \, mol \, dm^{-3} s^{-1}$

$\Rightarrow \Delta t = 600 s$. --- 05

(b) 70

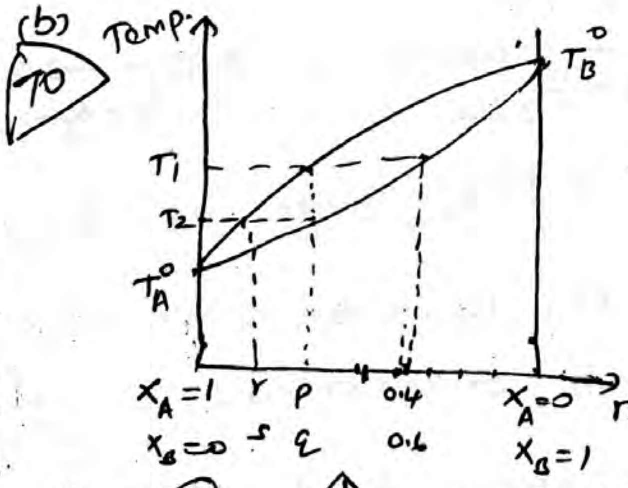


Diagram 04

marking T_A^o, T_B^o, p, q, r and s → $5 \times 03 = 15$

T_A^o, T_B^o → 10

In liquid phase,

$X_A = 2/5 = 0.4$

$X_B = 3/5 = 0.6$ --- 02

$P_A = X_A P_A^o = 0.4 \times 6 \times 10^5 Pa$

$= 2.4 \times 10^5 Pa$ --- 02

$P_B = X_B P_B^o$

$= 2.4 \times 10^5 Pa$ 02

Total pressure, $P_{Tot} = P_A + P_B = 4.8 \times 10^5 Pa$ - - - 05

For gaseous phase, $P_A = p \times P_{Tot}$

$\Rightarrow p = \frac{P_A}{P_{Tot}} = \frac{2.4 \times 10^5 Pa}{4.8 \times 10^5 Pa}$

$= 0.5 = q$

III ly from calculation, $r = 0.6$ and

$s = 0.4$ } $2 \times 03 = 06$

(iv) Fractional distillation - - - 05

(v) • Petroleum extraction (from crude oil)

• Extraction of N_2 gas from liquified air.

$2 \times 05 = 10$

7 (a) (i) Cell which has the highest emf consists of
$D^+_{(aq)}|D_{(s)}$ and $B^{2+}_{(aq)}|B_{(s)}$ - - - 05

IUPAC notation $D_{(s)}|D^+_{(aq)}||B^{2+}_{(aq)}|B_{(s)}$ 05

$emf = E^\ominus_{cathode} - E^\ominus_{anode} = 0.80V - (-1.34V)$

$= 2.14V$ - - - 05

(ii) Cell which has the lowest emf consists of
$A^{2+}_{(aq)}|A_{(s)}$ and $C^{3+}_{(aq)}|C_{(s)}$ - 05 -

Cathodic re^n: $A^{2+}_{(aq)} + 2e \longrightarrow A_{(s)}$

Anodic re^n: $C_{(s)} \longrightarrow C^{3+}_{(aq)} + 3e$

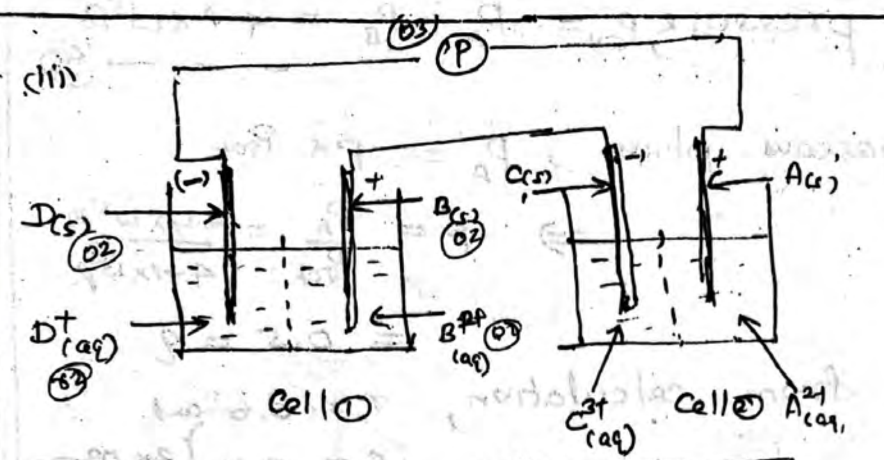
Cell re^n: $3A^{2+}_{(aq)} + 2C_{(s)} \longrightarrow 3A_{(s)} + 2C^{3+}_{(aq)}$

-- $3 \times 05 = 15$

$emf = E^\ominus_{cathode} - E^\ominus_{anode} = -0.45V - (-0.77V)$

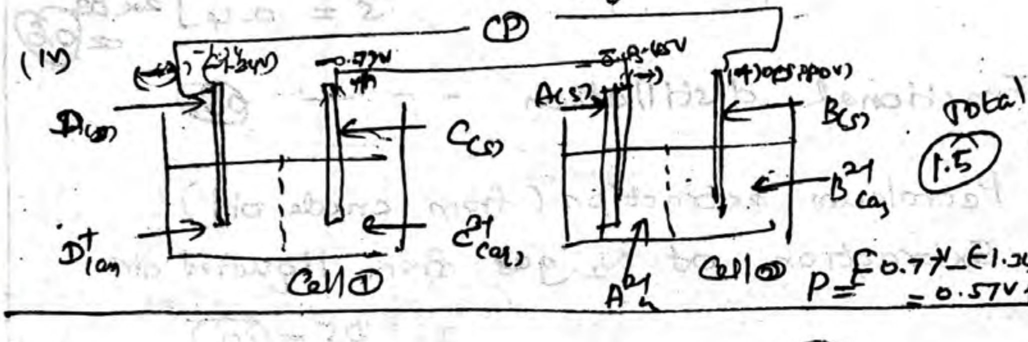
$= 0.32V$ 10

(iii)



Total (15) marks

(iv)



Total (1.5) marks

$P = [0.77V - (-1.34V)] + [0.8V - \ldots$
$= 0.57V + 1.25V$ (−0.45)

(b) (i) $M \Rightarrow$ Co / Cobalt ------ (05)

15 (ii) Oxidation state of M in P = +2 --- (05)

(iii) $n = 2$ --- (05)

(iv) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$ ------ (05)

(v) $P \Rightarrow [Co(H_2O)_6]^{2+}_{(aq)}$, $Q \Rightarrow Co(OH)_{2(s)}$, $R \Rightarrow [Co(NH_3)_6]^{2+}_{(aq)}$

$S \Rightarrow [Co(NH_3)_6]^{3+}_{(aq)}$, $T \Rightarrow [CoCl_4]^{2-}_{(aq)}$, $U = NaOH_{(aq)}$

$V \Rightarrow [Co(OH)_4]^{2-}_{(aq)}$ --- $7 \times 05 = 35$

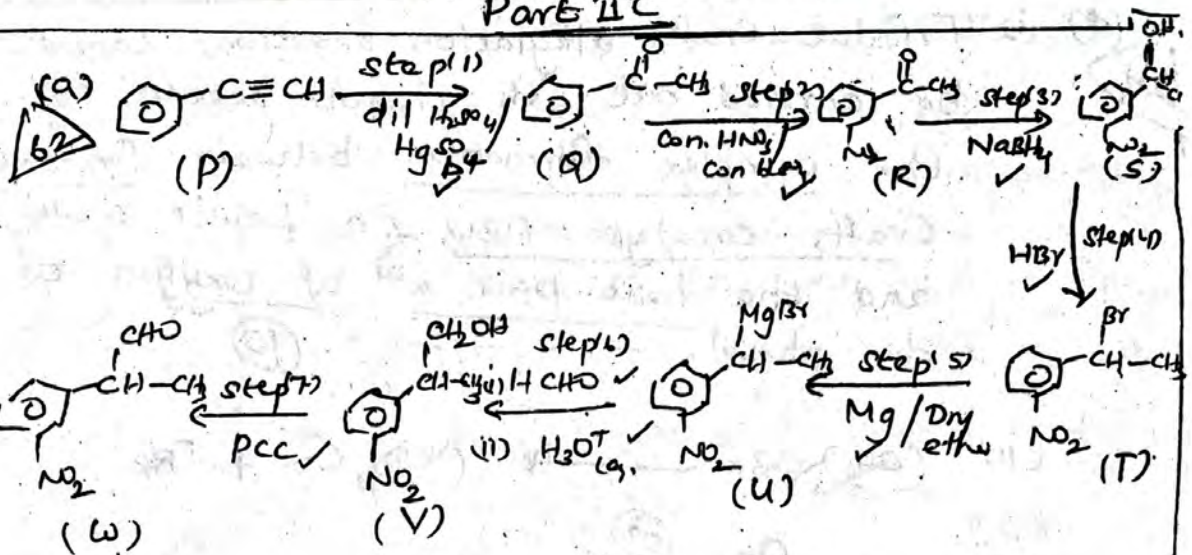
(vi) P – hexaaquacobalt(II) ion
R – hexaamminecobalt(II) ion
T – tetrachloridocobaltate (II) ion
V = tetrahydroxidocobaltate(II) ion

$4 \times 05 = 20$

Part II C

(8) (a)

62



Structures Q ⟶ V ⟹ $6 \times 05 = 30$

Reagents 8 ⟹ $8 \times 04 = 32$

62

(b)

48

$CH_3CH_2OH \xrightarrow{H^+/MnO_4^-} CH_3COOH \xrightarrow{PCl_5} CH_3COCl$ ⟶ Required product

$CH_3CH_2OH \xrightarrow{PCC} CH_3CHO \xrightarrow{dil\,NaOH} CH_3CH(OH)-CH_2CHO \xrightarrow{PCl_5} CH_3CH(Cl)-CH_2CHO \xrightarrow{Con.\,NH_3} CH_3-CH(NH_2)-CH_2CHO$

Reagents → $6 \times 04 = 24$

Products → $5 \times 04 = 20$

$44 + 04$ ← Adding the two product

(c) C_2H_5Br and H_2O —— $2 \times 02 = 04$

16

$C_2H_5-\ddot{O}-H + H-Br \longrightarrow C_2H_5-\overset{+}{O}H_2 + :\bar{Br}$ (02, 02, 02)

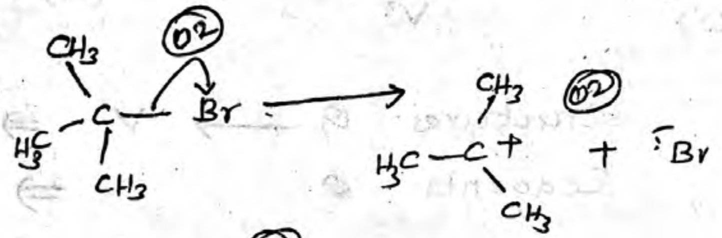
$CH_3-CH_2-\overset{+}{O}H_2 \;\; :Br \longrightarrow CH_3CH_2Br + H_2O$ (02, 02, 02)

Mechanism 12

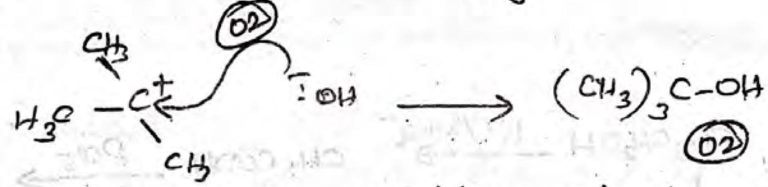
24 (d) (i) Friedal - Crafts alkylation reactions cannot be carried out with phenols because of the complex formation between Friedal-Crafts catalyst $AlCl_3$ (a Lewis acid) and the lone pair e^{-s} of Oxygen of the phenol. — — — — (10)

(ii) $(CH_3)_3CBr \longrightarrow (CH_3)_3C^+ + {}^-Br$

step 1 :



step (2)



When considering the stability of the carbo-cation formed, the tertiary alkyl halides which are able to form more stable tertiary carbo-cations, tend to undergo nucleophilic substitution in two steps. — — — (03)

As the primary carbocation is less stable, primary halides undergo the same re^n in one step in which both bond breaking and bond formation take place simultaneously — — — (03)

9 (a) (i) Sn^{2+}, Cr^{3+}, Zn^{2+}, SO_3^{2-} --- $4 \times 05 = 20$

60

(ii) (1) ⇒ No gp I cations --- 03

Colourless gas may be $CO_2/SO_2/H_2S$ 03

(2) ⇒ as moistened flower petals were bleached, the gas must be SO_2. --- 03

∴ The anion is SO_3^{2-} --- 03

(3) ⇒ brown ppt. with H_2S may be SnS. --- 03

∴ Sn^{2+} is present --- 03

Total 34

(4) ⇒ formation of blue-green ppt is due to Cr^{3+} --- 03

(5),(6) ⇒ an amphoteric metal cation ($Al^{3+}/Zn^{2+}/Sn^{2+/4+}/Pb^{2+}$) may be present

* Absence of Gp IV cations (Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+})

but Al^{3+} or $Sn^{2+/4+}$ / Pb^{2+} are not in the solⁿ --- 03

∴ Zn^{2+} is present --- 03

(7) Presence of Cr^{3+} is confirmed. Yellow coloured solⁿ must be CrO_4^{2-} --- 03

(iii) $Cr(OH)_{3(s)} + 3HCl_{(aq)} \longrightarrow CrCl_{3(aq)} + H_2O_{(l)}$

$2Cr^{3+}_{(aq)} + 10OH^-_{(aq)} + 3H_2O_{2(aq)} \longrightarrow 2CrO_{4(aq)}^{2-} + 8H_2O$

$2 \times 03 = 06$

(b) (i)

90

$$\left.\begin{array}{l}
2Fe^{2+} + 2H^+ + H_2O_2 \longrightarrow 2Fe^{3+} + 2H_2O \\
SO_3^{2-} + H_2O_2 \longrightarrow SO_4^{2-} + H_2O \\
2Fe^{2+} + 2I^- \longrightarrow 2Fe^{2+} + I_2 \\
2H^+ + H_2O_2 + 2I^- \longrightarrow I_2 + 2H_2O \\
I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-} \\
Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4\downarrow
\end{array}\right\} 6 \times 05 = 30$$

(ii) $n_{BaSO_4} = \frac{0.5825\,g}{233\,g\,mol^{-1}} = 2.5 \times 10^{-3}\,mol$ ---- 05

$x+y = 2 \times 2.5 \times 10^{-3}\,mol$

$x+y = 5 \times 10^{-3}\,mol$ ——— ① ---- 05

(iii) Initial amt. of $H_2O_2 = 0.2\,mol\,dm^{-3} \times 50 \times 10^{-3}\,dm^3$

$= 0.01\,mol$ ---- 05

Amt. of H_2O_2 reacted with Fe^{2+}

$= \frac{x+y}{2}$ ---- 05

Amt. of H_2O_2 reacted with SO_3^{2-}

$= x$

Remaining no. of moles of H_2O_2 in $100\,cm^3$ of T

$= \left\{0.01 - \left(\frac{x+y}{2} + x\right)\right\} mol$

$= \left\{0.01 - \left(\frac{3x+y}{2}\right)\right\} mol$ ---- 05

(iv) For $50\,cm^3$ solⁿ, ---- 05

Reacted $n_{S_2O_3^{2-}} = 2$ (amt. of I_2 formed by Fe^{3+} + amt of I_2 produced by remaining H_2O_2)

05

$\therefore 0.04 \times 200 \times 10^{-3}\,mol = 2\left\{\left(\frac{x+y}{2}\right) \times \frac{1}{2} + \frac{0.01}{2} - \frac{3x+y}{4}\right\}$ ---- 05

$8 \times 10^{-3} = 0.01 - x$

$\Rightarrow x = 2 \times 10^{-3}\,mol$ } $2 \times 05 = 10$

From eq ①, $y = 3 \times 10^{-3}\,mol$

$\therefore$ Concentration of $FeSO_4 = \frac{2 \times 10^{-3}}{50} \times 1000\,mol\,dm^{-3}$

$= \underline{0.04\,mol\,dm^{-3}}$ 05

Concentration of $FeSO_3 = \frac{3 \times 10^{-3}}{50} \times 1000\,mol\,dm^{-3}$

$= \underline{0.06\,mol\,dm^{-3}}$ ---- 05

(10) (a)(I) (i) A ⇒ anode – Titanium / Ti

75 B ⇒ cathode – Nickel / Ni

$2\times(03+03) = 12$

(ii) At A / anode : $2Cl^-_{(aq)} \rightarrow Cl_{2(g)} + 2e$

At B / cathode : $2H_2O_{(l)} + 2e \rightarrow 2OH^-_{(aq)} + H_{2(g)}$

$2\times 04 = 08$

(iii) C ⇒ $Cl_{2(g)}$ / chlorine

D ⇒ $H_{2(g)}$ / hydroge

$2\times 04 = 08$

(iii) P ⇒ concentrated NaCl / (brine) solution

Q ⇒ used (salt) solution

R ⇒ water

S ⇒ NaOH solution

$4\times 03 = 12$

(iv) Overall reaction $2NaCl_{(aq)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + Cl_{2(g)} + H_{2(g)}$ ---- 04

(v) E – selective membrane ---- 04

Permeable only to + ions and ∴ allows migration of Na^+ ---- 04

(vi) sea water ---- 03

(vii) Mg^{2+}, Ca^{2+} and SO_4^{2-} --- $3\times 01 = 03$

(viii) Uses : use of NaOH . Production of soap

. as a strong base

. production of paper

--- any one --

$3\times 01 = 03$

Use of by-product

H_2 – manufacture of HCl

production of margarine

of NH_3

any one –

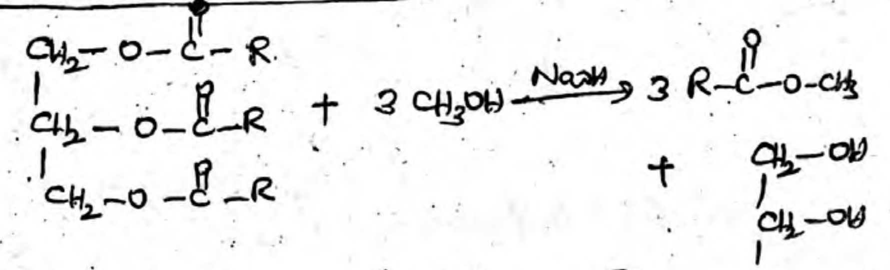
use of Cl_2 – . purifying drinking water

~~HCl production~~

21

(b) Production of bio-diesel

75



03

Temp. 50°c – 60°c --- 01

Catalyst NaOH --- 01

TiO_2

$TiO_{2(s)} + C_{(s)} + 2Cl_{2(g)} \longrightarrow TiCl_{4(l)} + CO_{2(g)}$ --- 02

$T = 950°C$ --- 01

NH_3 :

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ --- 03

$3 \times 02 = 06$ $\begin{cases} T = 450 - 500°C \\ P = 250 \text{ atm} \\ \text{Catalyst - Fe, Promoter } Al_2O_3. \end{cases}$

(b) (i) SO_2 - combustion of coal.

75

. impurities (like FeS) present in coal get oxidized

- O_3, PAN } - photochemical smog.
- CO, CO_2 } exhaust fumes from vehicles burning of ~~pe~~ fossil fuels
- CF_2Cl_2 - use of refirgerators / coolant gas in airconditioning aerosol spray. In perfumes

$4 \times 06 = 24$

(ii) · global warming
· depletion of ozone layer
· photochemical smog
· ~~de~~ acid rain

$4 \times 05 = 20$

(iii) Ozone layer which prevents the entry of harmful uv rays to the earth's surface does not remain constant but decreases due to natural factors and human activities. This is known as depletion of ozone layer - - - - 07

(iv) chemically inert / non-reactive
non-poisonous
can be easily liquefied (by compression)
more volatility

$4 \times 04 = 16$

(v) Advantage - does not contribute to ozone layer depletion as C-Cl bond is not present

Disadvantage - causes global warming

$2 \times 04 = 08$