Part I

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

Part II A - Structured Essay

Q1. (a) (i) $NH_3 < HF < H_2O < H_2O_2$

(ii) $HCO_3^- < OH^- < CH_3O^- < NH_2^-$

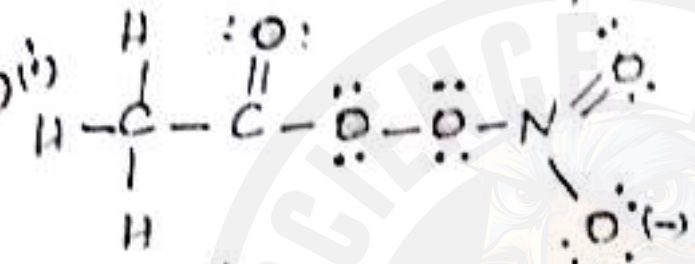
(iii) $(NH_4)_2CO_3 < BeCO_3 < BaCO_3 < Na_2CO_3$

(iv) $NH_2^- < NH_3 < NH_2^+ < NO_3^-$

(v) $CO < CO_2 < S_2O_4^{2-} < CO_3^{2-}$

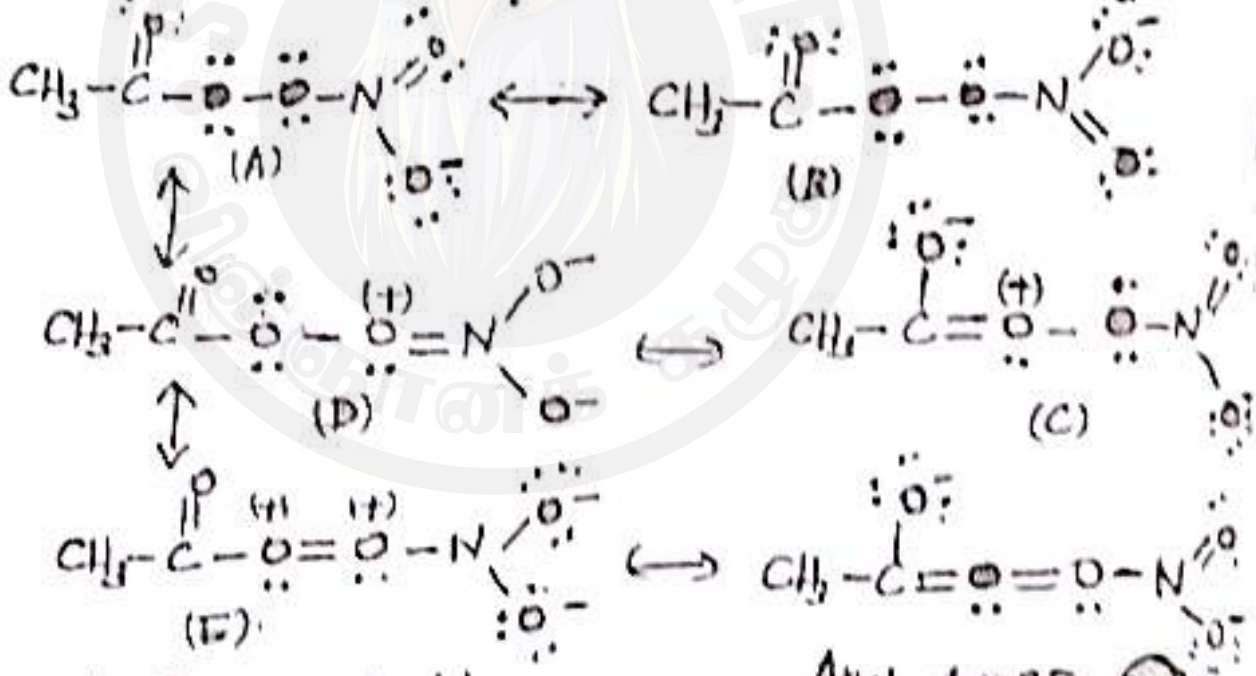
5 × 04 = 20

(b) (i)



10

(ii)



Any 4 × 05 = 20

A, B – stable

C, D – unstable – more electronegative atom O carries a (+) charg adjacent atoms having similar charge charge separation high

E – unstable

3 × 02 = 06

(iii)

$C_{(1)}$	sp^2	Trigonal planar	Trigonal planar
$C_{(2)}$	sp^3	Tetrahedral	angular/V-shaped
$N_{(2)}$	sp^2	Trigonal planar	Trigonal planar

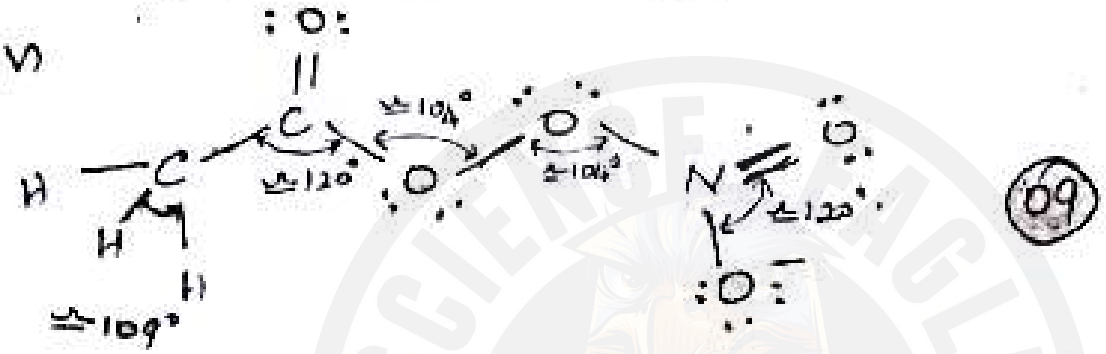
$9 \times 01 = (09)$

(iv) (I) $\underline{sp^2}$ of $C_{(1)}$ and $\underline{sp^3}$ of O

(II) $\underline{sp^2}$ of $C_{(1)}$ and $\underline{sp^3}$ of C $\quad 6 \times 01 = (06)$

(III) $\underline{sp^3}$ of $C_{(2)}$ and $\underline{sp^2}$ of $N_{(1)}$

(v)



(09)

(c) (20)

(I) True --- (02)

(03) Reactivity of alkalimetals depends on the tendency to lose their outermost electrons. Since size increases down the gp., I_1 decreases and hence reactivity ↑.

Reactivity of halogens * is determined by the ability to accept $e^{\ominus}$, which decreases down the gp.

(II) False --- (02)

(03) Correct order of covalent character

$BaF_2 < BaCl_2 < CaCl_2 < MgBr_2$

Explanation based on polarizing ability and polarizability

(III) True --- (02)

Carbon has the $e^{\ominus}$ configuration ns^2np^2 and nitrogen has ns^2np^3

ns^2np^3 is the half-filled state of p-sub-energy level which is relatively stable.

∴ Addition of $e^{\ominus}$ disturbs the stability

(03) ∴ Energy must be supplied for the addition of electron

(iv) False --- (02)

Co – $4s^2 3d^7$, Zn – $4s^2 3d^{10}$

Zn has completely filled d-sub energy level

(03) ∴ Less delocalization for metallic bond formation

∴ Metallic bond strength of Zn is low and hence m.p of Zn < m.p of Co. (01) [30]

Q(2) (a) (i) Q = C, R = N, T = O ---- 3 × 05 = (15)

(50) (ii) $2NO_{2(g)} + H_2O_{(l)} \longrightarrow HNO_{2(aq)} + HNO_{3(aq)}$ --- (05)

(iii) $N_2O_5 + 2NaOH_{(aq)} \longrightarrow 2NaNO_3 + H_2O_{(l)}$ --- (05)

(iv) HN_3, hydrazoic acid (05) + (01)

(v) A = CaC_2, B = CO --- 2 × 03 = (06)

Re^n cond^{ns} : Electric arc furnace 2000°C.] (01)

(vi) C ⇒ $Ca(OH)_2$, D ⇒ C_2H_2, E ⇒ $HC \equiv C-Ag$ 3 × 02 = (06)

(50) (b) (i) A = $Pb(N_3)_2$, B = $Na_2S_2O_3$, C = KI, D = NaOH

E = $CuCl_2$ 5 × 06 = (30)

(ii) Any test for N_3^-

eg: brown ring test (10)

(iii) $Na_2S_2O_{3(aq)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + S_{(s)} + SO_{2(g)} + H_2O$

--- (10)

Q(2) [100]

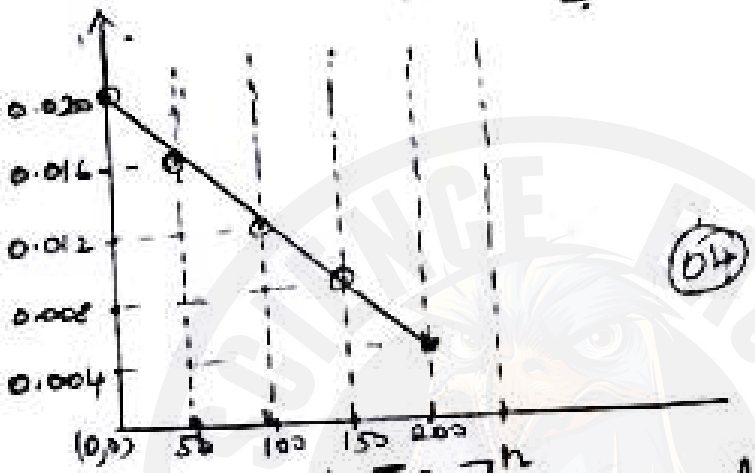
Q(3) (a) i)

Time/s	$[P_{(g)}]$/mol dm^{-3}
0.0	0.020
50.0	0.016
100.0	0.012
150.0	0.008
200.0	0.004
250.0	0.00

50

6 x 02 = (12)

(Ti)



(04)

(ii) Rate $= k[P_{(g)}]^n$ (04) or $-\frac{d[P]}{dt} = k[P_{(g)}]^n$

(iii) Gradient of the graph is a constant

Gradient represents rate.

∴ Rate = const or Rate is independant of conc

(06)

Hence, n must be zero.

(iv) Rate const. k = Rate

$k = \frac{(0.020 - 0.012)\ \text{mol dm}^{-3}}{100\text{s}}$ or any two pts.

$k = 8 \times 10^{-5}\ \text{mol dm}^{-3}\text{s}^{-1}$ (04)

(vi) $P_{(g)} \longrightarrow 2Q_{(g)}$

Initial: 0.02

After 75% completion: 0.005 0.03 (Concentr. in mol dm^{-3})

Amt. of gas after 75% has decomposed

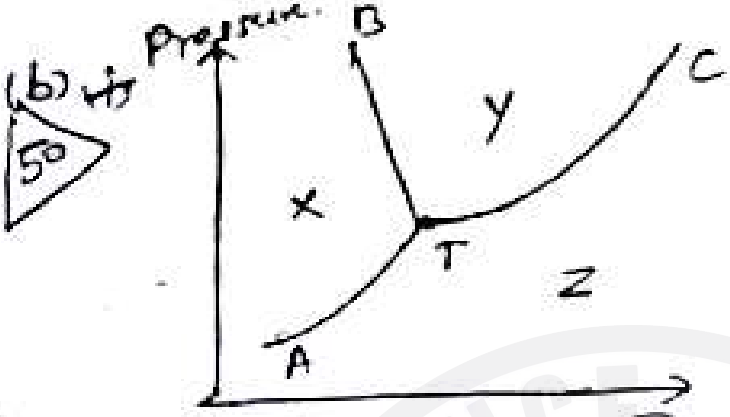
$= 0.005 + 0.03 = 0.035$ mol (10)

Assuming ideal gas behaviour apply

Pressure = $0.035 \text{ mol} \times 8.31 \text{ J K}^{-1} \text{ mol}^{-1} \times 273 \text{ K}$ / 10^{-3} m^3

$= 1.163 \times 10^4 \text{ N m}^{-2}$ (10)

(b) (i) 50



(i) Marking the regions
x - solid, y - liq, z - gas
3 x 05 = (15)

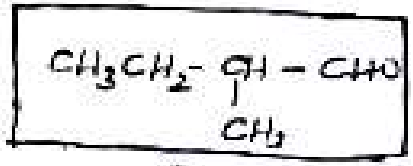
(ii) Minimum temperature above which gas cannot be liquified by pressure no matter how high the pressure would be (10)

(iii) Triple point (05)
- Ice, water and vapour co-exist together in equilibrium at this point. (05)

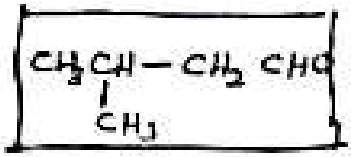
(iv) Temp. 273.16 K
Pressure : 0.006 atm } 2 x 05 = (10)

(v) Solid becomes vapour (sublimes) (05)

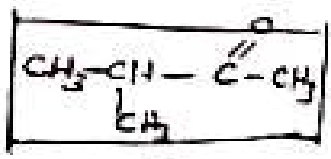
Q (4) (i) (a) 60



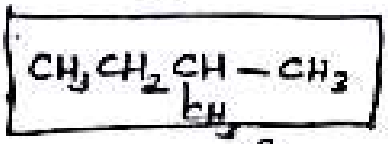
D



E

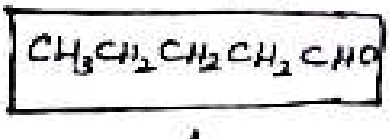


F

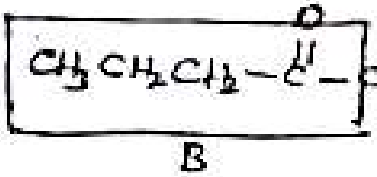


G

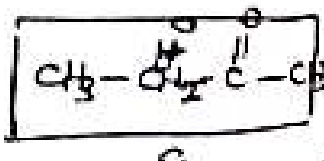
(ii)



A

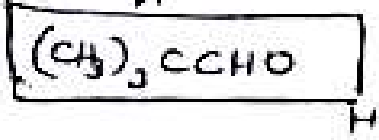


B



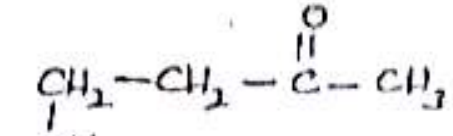
C

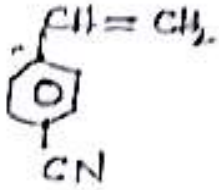
(iii)

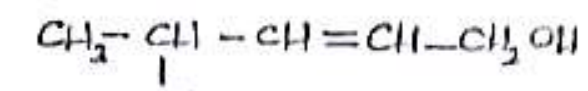


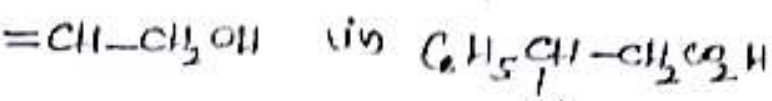
H

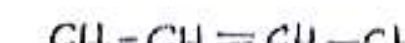
8 x 7.5 = (60)

(b) (i) 

(ii) 

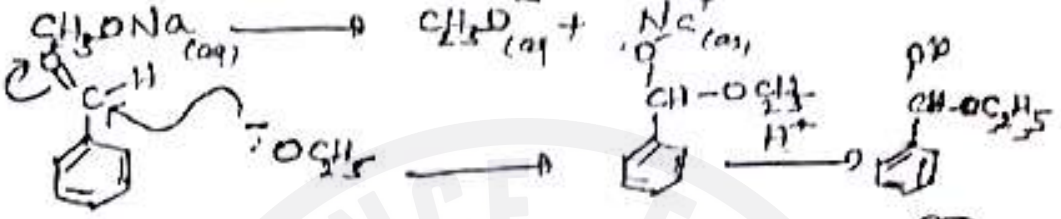
(iii) 

(iv) 

(v) 

5 × 05

(c) (i) Nucleophilic addition (05)

(ii) 

(10)

Part II B Essay

Q5 (a) (i) $HA + NaOH \longrightarrow NaA + H_2O$

$n_{HA} : n_{NaOH} = 1:1$

$\frac{c \times 25}{1000} = \frac{0.1 \times 50}{1000}$

$\Rightarrow c = 0.02 \text{ mol dm}^{-3}$ (05)

(ii) At 50% neutralization, $[HA_{(aq)}] = [NaA_{(aq)}]$

The resulting solⁿ is a buffer

$pH = pK_a + \log_{10} \frac{[\text{salt}]}{[\text{Acid}]}$

$pH = pK_a$ (05)

Since $pH = 5$, $K_a = 1 \times 10^{-5} \text{ mol dm}^{-3}$

(iii) pH at pt A $= -\log \sqrt{ck_a} = -\log(0.02 \times 1 \times 10^{-4})^{\frac{1}{2}} = 4 - \log 20 = 3.699$ (05)

(iv) At the equivalence point, pH is determined by the hydrolysis of salt formed. (NaA)

$A^-_{(aq)} + H_2O_{(l)} \rightleftharpoons HA_{(aq)} + OH^-_{(aq)}$

(05)

$$K_b = \frac{[HA_{(aq)}][OH^-_{(aq)}]}{[A^-_{(aq)}]}$$

$$[A^-_{(aq)}] = \frac{5 \times 10^{-3}\ mol}{75 \times 10^{-3}\ dm^3} = \frac{2}{30}\ mol\ dm^{-3}$$ (05)

$$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}\ mol^2\ dm^{-6}}{1 \times 10^{-5}\ mol\ dm^{-3}} = 1 \times 10^{-9}\ mol\ dm^{-3}$$ (05)

Since $[HA] = [OH^-]$,

$$[OH^-_{(aq)}]^2 = K_b [A^-_{(aq)}]$$

$$[OH^-] = \sqrt{1 \times 10^{-9}\ mol\ dm^{-3} \times \frac{2}{30}\ mol\ dm^{-3}}$$

$$= \sqrt{\frac{2}{3} \times 10^{-10}}$$ (10)

$$pOH = -\frac{1}{2}\log_{10} 2 + \frac{1}{2}\log_{10} 3 + 5$$

$$\Rightarrow pH = 14 + \frac{1}{2} \times 0.3010 - \frac{1}{2} \times 0.4771 - 5$$

$$= 8.911$$ (10)

(IV) Indicator y is suitable. Since its colour change pH interval completely lies within the sudden pH change at the end point. (05)

(b) (55)

(I) $Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + CrO^{2-}_{4(aq)}$

$$K_{sp} = [Ag^+_{(aq)}]^2 [CrO^{2-}_{4(aq)}]$$

Concentration of CrO_4^{2-} when Ag^+ ions start precipitating $= \frac{K_{sp(Ag_2CrO_4)}}{[Ag^+_{(aq)}]^2}$ (03)

$$= \frac{1.1 \times 10^{-12}\ mol^2\ dm^{-6}}{(0.01\ mol\ dm^{-3})^2}$$

$$= 1.1 \times 10^{-8}\ mol\ dm^{-3}$$ (02)

$$K_1 \times K_2 = \frac{[H^+_{(aq)}]^2 [S^{2-}_{(aq)}]}{[H_2S]} \quad \text{--- (05)} \qquad (5)$$

$$[H^+_{(aq)}] = \left\{ \frac{K_1 K_2 [H_2S]}{[S^{2-}]} \right\}^{1/2} = \left\{ \frac{10^{-7} \times 1.3 \times 10^{-13} \times 0.1}{1.2 \times 10^{-19}} \right\}^{\frac{1}{2}} \text{mol dm}^{-3}$$

$$= 0.104 \text{ mol dm}^{-3} \quad (05)$$

∴ The minimum pH at which MS will precipitate is: $pH = -\log(0.104)$

$$= 0.98 \quad (10)$$

(c) Initial mole fraction of $SO_2 = \frac{2}{3}$

(40)

Initial partial pressure of $SO_2 = x_{SO_2} \times P_{total}$

$$= \frac{2}{3} \times 3 \times 10^5 \text{ Nm}^{-2}$$

$$= 2 \times 10^5 \text{ Pa} \quad (05)$$

Initial partial pressure of $O_2 = x_{O_2} \times P_T$.

$$= \frac{1}{3} \times 3 \times 10^5 \text{ Pa}$$

$$= 1 \times 10^5 \text{ Pa} \quad (05)$$

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(s)}$$

At eqm: $(2 \times 10^5 - 1.8 \times 10^5)$ Pa $\quad (1 \times 10^5 - \frac{1.8}{2} \times 10^5)$ Pa $\quad 1.8 \times 10^5$ Pa.

$= 2 \times 10^4$ Pa $\quad 1 \times 10^4$ Pa $\quad 1.8 \times 10^5$ Pa

--- $3 \times 05 = (15)$

Total pressure at equilibrium

$$= (1.8 + 0.2 + 0.1) \times 10^5 \text{ Pa}$$

$$= 2.1 \times 10^5 \text{ Pa} \text{ ---} \quad (05)$$

Conversion of SO_2 into $SO_3 = \frac{1.8 \times 10^5}{2 \times 10^5} \times 100\%$

$$= 90\% \text{ ---} \quad (05)$$

$$K_p = \frac{P^2_{SO_3}}{P_{SO_2} \times P_{O_2}} = \frac{(1.8 \times 10^5 \text{ Pa})^2}{(2 \times 10^4 \text{ Pa})(1 \times 10^4 \text{ Pa})}$$

(02)

$$= 8.1 \times 10^{-9} \text{ Pa}^{-1}. \quad (03)$$

Q (5) 150

$$BaCrO_{4(s)} \rightleftharpoons Ba^{2+}_{(aq)} + CrO_{4(aq)}^{2-}$$

$$K_{sp} = [Ba^{2+}_{(aq)}][CrO_{4(aq)}^{2-}] \quad (03)$$

Concentration of CrO_4^{2-} when Ba^{2+} starts precipitating $= \frac{K_{sp(BaCrO_4)}}{[Ba^{2+}_{(aq)}]}$

$$= \frac{2.2 \times 10^{-10}\ mol^2 dm^{-6}}{0.01\ mol\ dm^{-3}}$$

$$= 2.2 \times 10^{-8}\ mol\ dm^{-3} \quad (02)$$

Since in soln 1.1×10^{-4} M is reached first, it is Ag^+ ions which start precipitate first. ---- (05)

(ii) When the second ion starts precipitating, $[Ag^+_{(aq)}]$ remaining in the soln.

$$= \left\{ \frac{K_{sp(Ag_2CrO_4)}}{[CrO_{4(aq)}^{2-}]} \right\}^{1/2}$$

$$= \left(\frac{1.1 \times 10^{-12}\ mol^3 dm^{-9}}{2.2 \times 10^{-8}\ mol dm^{-3}} \right)^{1/2}$$

$$= 7.07 \times 10^{-3}\ mol\ dm^{-3} \quad (05)$$

(iii) Percentage of Ag^+ ions remaining in the soln

$$= \frac{7.07 \times 10^{-3}}{0.01} \times 100\% = 70.7\% \quad (05)$$

Since only 29.3% of Ag^+ is precipitated out, the addition of CrO_4^{2-} is not a practical method to separate Ag^+ from Ba^{2+}. (05)

II The concentration of S^{2-} ion needed to precipitate MS is,

$$[S^{2-}] = \frac{K_{sp(MS)}}{[M^{2+}_{(aq)}]} = \frac{6 \times 10^{-21}\ mol^2 dm^{-6}}{0.05\ mol\ dm^{-3}}$$

$$= 1.2 \times 10^{-19}\ mol\ dm^{-3}. \quad (05)$$

$$H_2S \rightleftharpoons H^+_{(aq)} + HS^-_{(aq)} \qquad K_1 = 10^{-7}\ mol\ dm^{-3}$$

$$HS^- \rightleftharpoons H^+_{(aq)} + S^{2-}_{(aq)} \qquad K_2 = 1.3 \times 10^{-13}$$

(6) (a) (i) Definitions for initial rate and average rate
60 $2 \times 05 = 10$

(ii) concentration, temperature, catalyst, physical nature $4 \times 03 = 12$

(iii) Suitable expt. — (05)

(iii) Expts (1) and (2):
When [A] is doubled keeping [B] = const
rate is doubled (05)
∴ Order w.r.t A = 1

Expts. (2) and (3)
When [B] is doubled keeping [A] const
rate does not change
∴ Order wrt B = 0 (05)

$\text{rate} \propto [A][B]^0$

(I) Overall order = 1. (05)

(II) $R = 12 \times 10^{-5}\ \text{mol dm}^{-3}\text{s}^{-1}$ (05)

(III) $\text{rate} = k[A]$

$k = \frac{3 \times 10^{-5}\ \text{mol dm}^{-3}\text{s}^{-1}}{1 \times 10^{-3}\ \text{mol dm}^{-3}} = 3 \times 10^{-2}\ \text{s}^{-1}$ (10)

(b) (i) Definition of buffer soln. — (10)

50 (ii) Derivation of Henderson's eqn. — (15)

Let c_1 be the concentration of HA and c_2 be the concentration of NaOH. Initial vol. of HA = V

$HA + NaOH \longrightarrow NaA + H_2O$

$pH = pK_a + \log \frac{[Salt]}{[Acid]}$

When 10 cm³ NaOH is added,

$5.8 = pK_a + \log \frac{c_2 \times 10}{(c_1 V - c_2 \times 10)}$ — (1) (30)

When 20 cm³ NaOH is added

$6.402 = pK_a + \log \frac{c_2 \times 20}{(c_1 V - 20 c_2)}$ — (2)

(2) − (1) ⇒ $0.602 = \log \frac{20 c_2}{(c_1 V - 20 c_2)} \times \frac{(c_1 V - 10 c_2)}{10 c_2} = \log \frac{2(c_1 V - 10 c_2)}{c_1 V - 20 c_2}$

⇒ $pK_a = 6.1$

(c) (i) Raoult's law - - (10)

(ii) Derivation of $P_A = x_A P_A^\circ$ --- (10)

(iii) When $x_A = 0.2$ and $x_B = 0.8$,

$$P_{Tot} = x_A P_A^\circ + x_B P_B^\circ$$

$$P = 0.2 P_A^\circ + 0.8 P_B^\circ \quad \text{---} (1) \quad (05)$$

When $x_A = 0.6$ and $x_B = 0.4$

$$Q = 0.6 P_A^\circ + 0.4 P_B^\circ \quad \text{---} (2) \quad (05)$$

From (1), (2) $\Rightarrow$ $3P - Q = 2 P_B^\circ$

$$P_B^\circ = \frac{3P - Q}{2} \quad (02)$$

$$2Q - P = P_A^\circ \quad (02)$$

Since $\frac{P_A^\circ}{P_B^\circ} = 6$, $\frac{(2Q - P) \times 2}{(3P - Q)} = 6$

$$2Q - P = 9P - 3Q$$

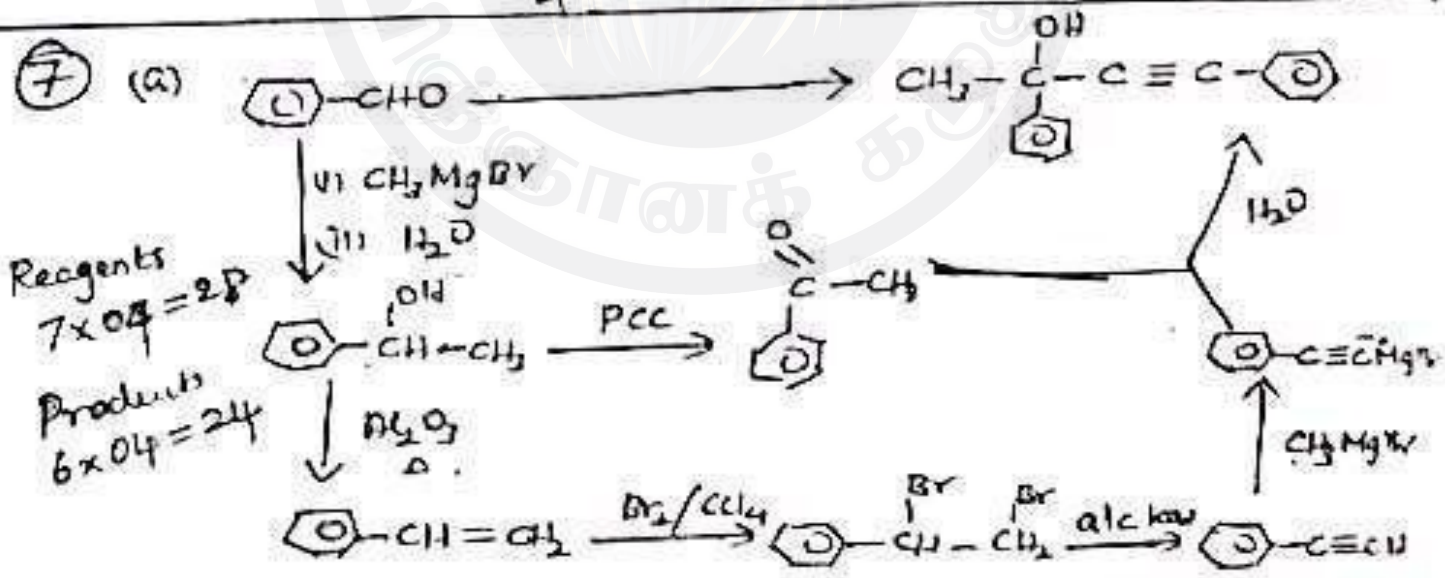
$$10P = 5Q$$

$$\frac{P}{Q} = \frac{1}{2} \quad (06)$$

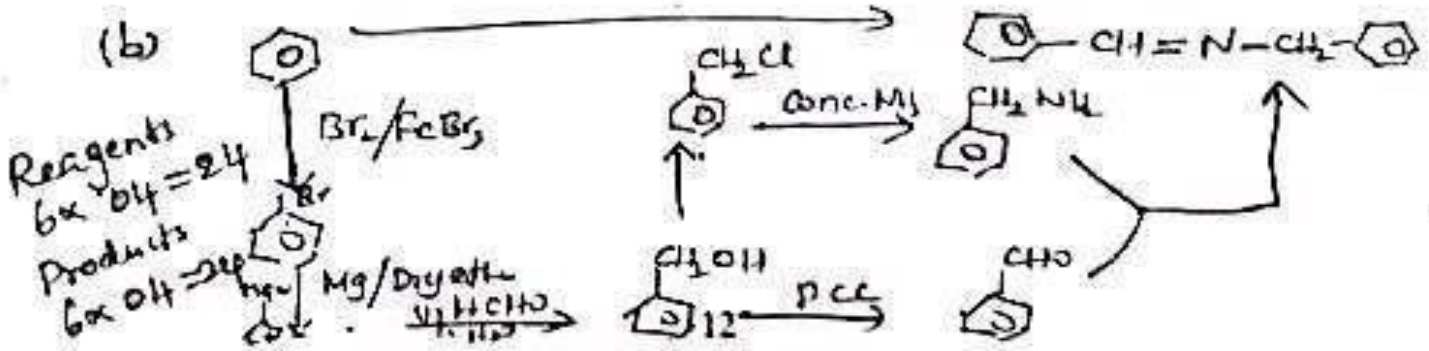
Q (6) $\Rightarrow$ **150**

---

(7) (a)



(b)



(v) blue violet colour changes into yellow (02)

$$2Cr^{3+}_{(aq)} + 10OH^-_{(aq)} + 3H_2O_{2(aq)} \longrightarrow 2CrO_4^{2-}{}_{(aq)} + 8H_2O_{(l)}$$ (02)

(c) (34)

$$Fe_3O_4 + 2I^- + 8H^+ \longrightarrow 3Fe^{2+} + 4H_2O + I_2$$
$$Fe_2O_3 + 2I^- + 6H^+ \longrightarrow 2Fe^{2+} + 3H_2O + I_2$$ } 3 eqns (06)

$$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$$

From the above eqns, 2 mol $S_2O_3^{2-} \equiv$ 1 mol I_2

$$n_{Na_2S_2O_3} = \frac{1 \times 7.2}{1000} = 7.2 \times 10^{-3} \text{ mol}$$ (02)

$$n_{I_2} = \frac{1}{2} \times 7.2 \times 10^{-3} \text{ mol} = 3.6 \times 10^{-3} \text{ mol}$$ (02)

$$n_{I_2} \text{ in } 50\,cm^3 = 5 \times 3.6 \times 10^{-3} \text{ mol}$$
$$= 18 \times 10^{-3} \text{ mol}$$ (02)

Let n_1 and n_2 be the amt. of Fe_3O_4 and Fe_2O_3 present in the given 5g sample.

$$n_1 + n_2 = 18 \times 10^{-3} \longrightarrow (1)$$ (03)

$$MnO_4^- + 5Fe^{2+} + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$ (02)

1 mol $MnO_4^- \equiv$ 5 mol Fe^{2+}

$$n_{MnO_4^-} = \frac{1 \times 4.2}{1000} = 4.2 \times 10^{-3} \text{ mol}$$ (02)

$$n_{Fe^{2+}} = 5 \times 4.2 \times 10^{-3} \text{ mol} = 21 \times 10^{-3} \text{ mol}$$ (02)

Hence, $n_{Fe^{2+}}$ in 50 cm^3 = $2 \times 21 \times 10^{-3}$ mol

$$= 42 \times 10^{-3} \text{ mol}$$ (02)

$$\Rightarrow 3n_1 + 2n_2 = 42 \times 10^{-3} \longrightarrow (2)$$ (03)

From (1), (2) $\Rightarrow$ $n_1 = 6 \times 10^{-3}$ mol
$n_2 = 12 \times 10^{-3}$ mol } 2 × 02 = (04)

Mass of Fe_3O_4 in 5g sample = 6×10^{-3} mol × 232 g mol^{-1}
$= 1.392$ g

Mass of Fe_2O_3 in 5g sample = 12×10^{-3} mol × 232 g mol^{-1}
$= 1.92$ g

Mass % of Fe_3O_4 = 27.84/13 (04)

(9) (a) (i) N_2 has triple bond $N \equiv N$ which is short and the bond energy is very high
Therefore it is difficult to break and hence is stable molecule. (15)

(ii) NO, NO_2, N_2O any two $2 \times 05 = 10$

(iii) acid rain, global warming, photochemical smog, depletion of ozone layer (10)

(iv) lightning, burning fossil fuels / Internal combustion in motor vehicle engines (10)

(v) acid rain

$$N_{2(g)} + O_{2(g)} \xrightarrow{\text{lightning}} 2NO_{(g)}$$

$$2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$$ (15)

$$4NO_{2(g)} + 2H_2O_{(l)} + O_{2(g)} \longrightarrow 4HNO_3$$

$$HNO_{3(aq)} \longrightarrow H^+_{(aq)} + NO_3^-$$

Photochemical smog:

Photolysis of NO_2 by absorbing sunlight

$$NO_2 \xrightarrow{h\nu} NO + O$$ (10)

(a) Atomic oxygen combines with O_2 molecule to form ozone

$$O + O_2 + M \longrightarrow O_3 + M$$

(M is a third body) which absorbs energy

(b) Atomic oxygen reacts with water vapour to form an free radical.

$$O + H_2O \longrightarrow 2\dot{O}H$$

'OH can initiate the rxn to produce different cpds like PAN, PBN .. etc.

(10)

9. cont...

(a) I) (i) CO_2 dissolves more in $NH_3(aq)$ and concentn of HCO_3^- will increase. Hence, $NaHCO_3$ will get deposited

(ii) The red at cathode being $2H_2O_{(l)} + 2e \rightarrow 2OH^-$ water is used up and to replenish it.

(iii) In the purification stage, any $NaOH$ solution remaining in the solution is neutralized by adding weak acid like citric acid

(iv) Prevent the reaction of Na produced at the cathode with Cl_2 liberated at anode

A×05 = (20)

(15) II) (i) iron ore, coke and limestone 3×02 = (06)

(ii) coke - as a reducing agent
limestone - as slag forming substance
- decomposes to CaO and CO_2 gas
CaO reacts with silicate impurities and forms slag which floats on molten iron and protects from being oxidized.

2×02 = (04)

(05) (iii) At 400°C : $3Fe_2O_{3(s)} + CO_{(g)} \rightarrow 2Fe_3O_{4(s)} + CO_{2(g)}$

At 500 - 600°C : $Fe_3O_{4(s)} + 2CO \rightarrow 3FeO_{(s)} + 2CO_{2(g)}$

At 900°C : $2CO_{(g)} \rightarrow C_{(s)} + CO_{2(g)}$

$CaCO_{3(s)} \xrightarrow{\text{at } 1000^\circ C} CaO + CO_2$ / $CaO + SiO_2 \rightarrow$ any

(III) i) Thermoplastic

Teflon, Polystyrene, Nylon, Rubber
Polyvinylchloride any four - 4×01 = (1)

Thermosetting

Bakelite / Phenol formaldehyde polymer --- (03)

(ii) $\left[\begin{matrix} F \\ | \\ C \\ | \\ F \end{matrix} - \begin{matrix} F \\ | \\ C \\ | \\ F \end{matrix} \right]_n$ (05)

(iii) Polystyrene (05)

(iv) $\left[CH_2 - C(CH_3) = CH - CH_2 \right]_n$ (05)

(v) Addition of 1-3 sulphur (03)

Valcanizing (03)

10. a) (i) NH_3, H_2O --- $2 \times 05 = 10$

(in AgCl) (05)

(ii) Since coordination spheres of P, Q, R are octahedral, central metal ion must have coordination number 6. --- (05)

According to the atomic comparison the coordination sphere the formulae of P, Q and R are

$[Co(NH_3)_3Cl_3]$, $[Co(NH_3)_4Cl_2]$ and $[Co(NH_3)_5Cl]$ $3 \times 04 = 12$

Oxidation state of Co must be $+3$ --- (05)

Since Q does not give ppt. with $AgNO_3(aq)$ there is no non-cordinated Cl^- ion in it (20)

$\Rightarrow$ Q is $[Co(NH_3)_3Cl_3]$ ---- (05)

100 cm^3 0.01 M P contain 0.01 mol of P

$n_{AgCl} = \frac{2.870\,g}{143.5\,g\,mol^{-1}} = 0.02$ mol --- (05)

Hence 1 mol P contains 2 moles of Cl^-

$\Rightarrow$ P is $[Co(NH_3)_5Cl]Cl_2$ --- (05)

Therefore, R must be $[Co(NH_3)_4Cl_2]Cl$

Relevant IUPAC names of P, Q and R $3 \times 05 = 15$

(10)

(b) (i) Faraday's laws of electrolysis:

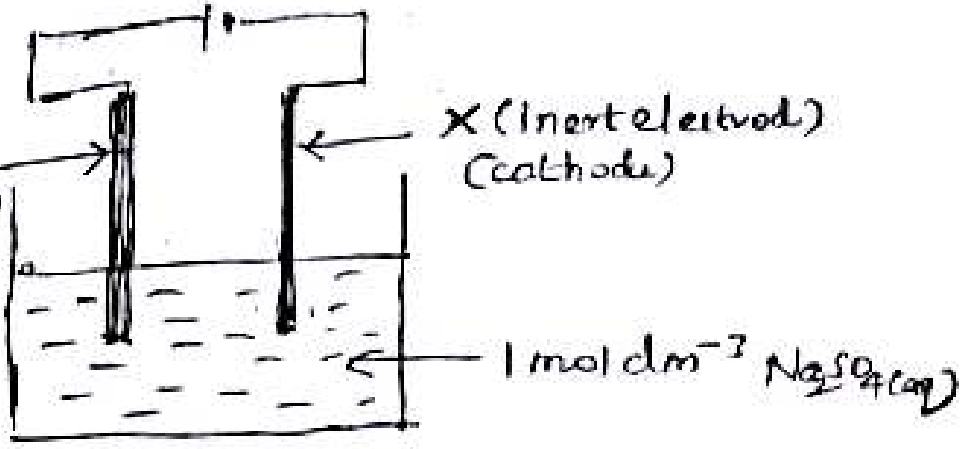
(90)

(I) The mass of a chemical substance deposited / liberated at an electrode during electrolysis is directly proportional to the quantity of electricity (expressed in coulombs) passed through the cell.

$2 \times 10 = 20$

(II) The masses of different substances produced by a given quantity of electricity are proportional to the equivalent mass of them.

(b) (i)



Complete labelled diagram (1.5)

(ii) Cathode : $2H_2O_{(l)} + 2e \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$

Anode : $Mg_{(s)} \longrightarrow Mg^{2+}_{(aq)} + 2e$ (0.5)

(iii) $Mg(OH)_{2(s)} \rightleftharpoons Mg^{2+}_{(aq)} + 2OH^-_{(aq)}$

By the rxn of electrolysis Mg^{2+} and OH^- are formed with the molar ratio 1:2

Just after forming turbidity, solⁿ becomes saturated with $Mg(OH)_2$.

Let x (mol dm^{-3}) be the concentration of Mg^{2+} at this pt.

$K_{sp} = [Mg^{2+}_{(a)}][OH^-_{(a)}]^2$ ... (0.5)

4×10^{-12} mol^3 dm^{-9} $= x(2x)^2 = 4x^3$

$x = 1 \times 10^{-4}$ mol dm^{-3} ... (0.5)

$n_{Mg^{2+}} = 1 \times 10^{-4}$ mol dm^{-3} $\times$ 0.5 dm^3 $= 5 \times 10^{-5}$ mol

$Q = It = 50 \times 10^{-3}$ A $\times$ t

$Q = 2 \times 5 \times 10^{-5}$ mol $\times$ 96,500 C mol^{-1} $\times$ 2

$\Rightarrow$ ~~$50 \times 10^{-3} t$~~ $= \dfrac{5 \times 10^{-5} \times 96{,}500 \times 2}{50 \times 10^{-3}}$ s

$= 1935$. ... (1.0)

(iv) Since I is a constant, $t \propto n_e$

$1935 \propto 10 \times 10^{-5}$ mol ——①

$7.72 \times 60 s \propto n_e$ ——②

$\frac{(1)}{(2)} \Rightarrow \frac{193}{7.72 \times 60} = \frac{1 \times 10^{-4}}{n_e}$

$$n_e = \frac{7.72 \times 60 \times 10^{-4}}{193} \text{ mol}$$

$$= 2.4 \times 10^{-4} \text{ mol} \quad (10)$$

$$n_{Mg(OH)_2} = \frac{1}{2} \times 2.4 \times 10^{-4} \text{ mol}$$

$$= 1.2 \times 10^{-4} \text{ mol} \quad (05)$$

$$Mg(OH)_2 \longrightarrow MgO + H_2O$$

$$n_{MgO} = 0.6 \times 10^{-4} \text{ mol} \quad (05)$$

Mass of MgO = 0.6×10^{-4} mol $\times$ 40 g mol^{-1}

= 2.4 mg (10)

Part II

Str. $4 \times 100 = 400$

Ess. $4 \times 150 = 600$

$20 \overline{)1000}$

50

Part I $\Rightarrow$ 50