வடமாகாணக் கல்வித் திணைக்களத்துடன் இணைந்து
தொண்டைமானாறு வெளிக்கள நிலையம் நடாத்தும்
தவணைப் பரீட்சை, மார்ச் - 2020

FWC

Conducted by Field Work Centre, Thondaimanaru
In Collaboration with Provincial Department of Education
Northern Province Term Examination, March - 2020

தரம் :- 13 (2020)	இரசாயனவியல்	புள்ளித்திட்டம்

பகுதி **I**

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

[1] (A) (i) $CO_2 > HCN > HCHO > CH_3Br$

(ii) $RbNO_3 > KNO_3 > NaNO_3 > LiNO_3$

(iii) $F > P > S > Be$

(iv) $(3, 1, 0, +\frac{1}{2}) > (3, 0, 0, +\frac{1}{2}) > (2, 1, 0, \frac{1}{2}) > (2, 0, 0, +\frac{1}{2})$

(v) $SO_3 > SO_2 > SO_4^{2-} > SO_3^{2-}$

(vi) $Cl > P > Na > Al$

6 × 05 = 30

(B) (i)

	N^1	C^3	C^4	O^8
	2	4	3	4
	Linear	Tetrahedral	Trigonal Planar	Tetrahedral
	Linear or —	Tetrahedral	Trigonal Planar	angular

16 × 01 = 16

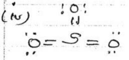
(ii) N^1 SP(h.o) C^2 SP(h.o)
C^3 SP^2(h.o) O^7 SP^2(h.o)
C^4 SP^2(h.o) O^8 SP^3(h.o)
C^5 SP^3(h.o) C^6 SP^3(h.o)

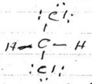
8 × 01 = 8

(iii) N^1 2P(a.o) C^2 2P(a.o)
C^4 2P(a.o) O^7 2P(a.o)

4 × 01 = 4

(iv)





7 × 02 = 14

VSEPR Pair	3	VSEPR Pair 4
σ Pair	3	σ Pair 4
Lone Pair	0	Lone Pair 0
shape	Trigonal planar	shape: Tetrahedral

(C) (i) ~~Basic~~ Linear overlaping (ii) σ bond.
(iii) Latteral overlaping (iv) π bond.

$4 \times 03 = 12$

(D) (i) Dipole Iduced dipole / Londanforce
(ii) H bond / Dipole-Dipole interaction / London force
(iii) Ion-dipole interaction / H bond / londanforce

$8 \times 02 = 16$

100

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2 (A) (i) $NCl_3 + 3H_2O \longrightarrow NH_3 + HOCl$
$PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl$
$AsCl_3 + 3H_2O \longrightarrow H_3AsO_3 + 3HCl$
$SbCl_3 + H_2O \rightleftharpoons SbOCl + 2HCl$
$BiCl_3 + H_2O \rightleftharpoons BiOCl + 2HCl$
$PCl_5 + H_2O \longrightarrow POCl_3 + 2HCl$

$6 \times 01 = 06$
$6 \times 03 = 18$

(ii) Bond angle $NCl_3 > PCl_3$,
Valance P orbital of N (2P) in NCl_3 molecule is closer to nucleous compared to that of P in PCl_3 (3P). Therefore it is more subjected to the nuclear attraction than in PCl_3 molecule and hence the Bond pair — Bond pair replusion is greater in NCl_3 compare to that in PCl_3.

10

		H_2O	NH_3	Cl^-
(B) I	Cr^{3+}	$[Cr(H_2O)_6]^{3+}$	—	—
		Violet	—	—
II	Mn^{2+}	$[Mn(H_2O)_6]^{2+}$	—	$MnCl_4^{2-}$
		Pale Pink	—	Greenish Yellow

Date: ..../........../..........

III Ni^{2+} $[Ni(H_2O)_6]^{2+}$ $[Ni(NH_3)_6]^{2+}$ $[NiCl_4]^{2-}$

Green Blue yellow

IV Zn^{2+} $[Zn(H_2O)_6]^{2+}$ $[Zn(NH_3)_4]^{2+}$ $[ZnCl_4^{2-}]$

colourless colourless colourless

complex ion and dash $12 \times 02 = 24$

colour / dash $12 \times 01 = 12$.

(C) SO_2 Oxidizing agent / reducing agent Possible answers

H_2S oxidizing agent / reducing agent Possible answers

NH_3 Oxidizing agent / reducing agent Possible answers

$6 \times 5 = 30$

100

③ (a) (i) $HA_{(aq)} + NaOH_{(aq)} \longrightarrow NaA_{(aq)} + H_2O_{(l)}$

$n_{NaOH} = 0.1\, mol\, dm^{-3} \times 50 \times 10^{-3} dm^3$

$= 5 \times 10^{-3}\, mol$ -------- (03)

Since HA : NaOH = 1 : 1 , $n_{HA} = 5 \times 10^{-3}\, mol$

$\therefore [HA] = \frac{5 \times 10^{-3}\, mol}{25 \times 10^{-3} dm^3} = 0.2\, mol\, dm^{-3}$ ----- (02)

(ii) Point P represents 50% neutralization.

$[HA] = [NaA]$ ------- (03)

Resulting soln. is a buffer.

$pH = pK_a + \log \frac{[Salt]}{[Acid]}$ ---- (02)

$pH = pK_a = 5$

$K_a = 1 \times 10^{-5} mol\, dm^{-3}$ ---- (05)

(iii) pH at point A $= -\log_{10} \sqrt{cK_a} = -\log_{10} \sqrt{0.2 \times 1 \times 10^{-5}}$

----- (03)

$= 3 - \log_{10} 2$

$= 2.6990\ (\simeq 2.7)$ --- (02)

(iv) pH at equivalence point is determined by the hydrolysis of salt formed.

$A^-_{(aq)} + H_2O_{(l)} \rightleftharpoons HA_{(aq)} + OH^-_{(aq)}$ ----- (03)

Initial $[A^-_{(aq)}] = \frac{5 \times 10^{-3} mol}{75 \times 10^{-3} dm^3} = \frac{2}{30} mol\, dm^{-3}$ ----- (03)

$K_{b(A^-)} = \frac{K_w}{K_{a(HA)}} = \frac{1 \times 10^{-14} mol^2 dm^{-6}}{1 \times 10^{-5} mol\, dm^{-3}}$ --- (02)

$= 1 \times 10^{-9}\, mol\, dm^{-3}$

$K_b = \frac{[HA_{(aq)}][OH^-_{(aq)}]}{[A^-_{(aq)}]} = \frac{[OH^-_{(aq)}]^2}{[A^-]}$ ---- (02)

$\therefore [OH^-_{(aq)}] = \sqrt{1 \times 10^{-9} mol\, dm^{-3} \times \frac{2}{30} mol\, dm^{-3}}$

$= \sqrt{\frac{2}{3} \times 10^{-10}}\ mol\, dm^{-3}$ --- (02)

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

$\therefore pH = 8.911$ -------- (03)

(v) Equivalence point: Volume of the titrant required to react in the stoichiometrically equivalent amount with the analyte --- (04)

End point: The point at which we stop adding the titrant which is indicated by the change in the colour of a substance (an indicator) ---- (04)

The end point is little in excess compared to the equivalence point, the difference being the titration error. (02)

(vi) Y ---- (02) Because the colour change pH interval of Y entirely lies within the abrupt pH near the equivalence point ----- (03)

(a) ⇒ 50

(b) (i) $n_{MgCO_3} = \frac{2.1\,g}{84\,g\,mol^{-1}} = 0.025\,mol$ ---- (02)

$n_{HCl} = 4\,mol\,dm^{-3} \times 25 \times 10^{-3}\,dm^3 = 0.1\,mol$ --- (02)

Therefore, limiting reagent is $MgCO_3$. ---- (02)

Heat energy liberated for 1 mol of $MgCO_3$ = 40 kJ

∴ For 0.025 mol $MgCO_3$ = 1 kJ ---- (04)

(ii) $Q = ms\Delta t$ ----- (02)

$1000\,J = 25\,cm^3 \times 1.19\,g\,cm^{-3} \times 4.2\,J\,g^{-1}K^{-1} \times \Delta t$ (04) subs. + (01) unit

$\Rightarrow \Delta t = 8\,^\circ C$ ---- (03)

(iii)


For cycle → (05)

By using Hess's law,

$\Delta H_{f(MgCO_3)} - 40\ kJmol^{-1} = -470\ kJmol^{-1} - 393\ kJmol^{-1} - 286\ kJmol^{-1}$ ---- (02)

$\therefore \Rightarrow \Delta H_{f(MgCO_3)} = -1109\ kJmol^{-1}$ ---- (03)

(iv) $2HCl_{(aq)} + Mg_{(s)} + ZnCl_{2(aq)} \xrightarrow{\Delta H_R} MgCl_{2(aq)} + Zn_{(s)} + 2HCl_{(aq)}$

$-470\ kJmol^{-1}$ ↘ ↙ $-270\ kJmol^{-1}$

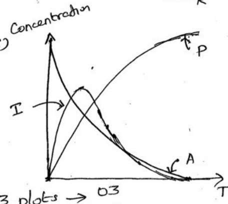
$ZnCl_{2(aq)} + MgCl_{2(aq)} + H_{2(g)}$ For cycle → (05)

Hess's law,

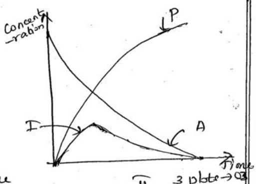
$-470\ kJmol^{-1} = \Delta H_R - 270\ kJmol^{-1}$ ---- (02)

$\Delta H_R = -200\ kJmol^{-1}$ ---- (03)

(C)



3 plots → 03
labelling → 02
I



II 3 plots → 03
labelling 02

(B) ⇒ 50

(4) (30)

(a) (i)

P: $HC \equiv C - \underset{|}{CH}(OH) - CH = C(CH_2OH)(H)$

Q: $CH_3 - CH_2 - CH(OH) - CH_2 - CH_2 - CH_2OH$

(+)

R: $CH_3CH_2-\overset{O}{\overset{\|}{C}}-CH_2CH_2COOH$

S: $CH_3CH_2CH_2CH_2CH_2COOH$

T: $CH_3CH_2-\overset{O}{\overset{\|}{C}}-CH_2CH_2COCl$

U: $CH_3CH_2-C(OH)(CH_3)-CH_2CH_2-C(OH)(CH_3)-CH_3$

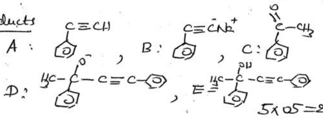
$6 \times 05 = 30$

(b) (ii) Reagents

Reagents	Type of mechanism
a ⇒ alc. KOH	elimination
b ⇒ $NaNH_2$	——
c ⇒ dil H_2SO_4, $Hg^{2+}_{(aq)}$, Δ	——
f ⇒ PBr_3 / HBr	nucleophilic addition nucleophilic subst.

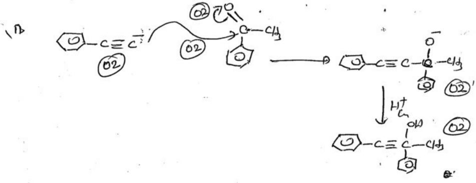
$4 \times 05 = 20$; $3 \times 05 = 15$

Products



$5 \times 05 = 25$

(iii)



Part II B

(5) (A) (i) [10]

$$Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + CrO^{2-}_{4(aq)} \text{ ------ (02)}$$

According to equilibrium law, ---- (02)

$$K = \frac{[Ag^+_{(aq)}]^2[CrO^{2-}_{4(aq)}]}{[Ag_2CrO_{4(s)}]} \text{ ---- (02)}$$

since Ag_2CrO_4 is a sparingly soluble solid

$[Ag_2CrO_{4(s)}]$ = constant --- (02)

$\therefore [Ag^+_{(aq)}]^2[CrO_4^{2-}] = K[Ag_2CrO_{4(s)}]$ = Const = K_{sp} --- (02)

(ii) [10]

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

equilibrium concentration: 2×10^{-4} mol dm^{-3} ; 1×10^{-4} mol dm^{-3} --- (02)

$K_{sp} = [Ag^+_{(aq)}]^2[CrO^{2-}_{4(aq)}]$ --- (03)

$= (2 \times 10^{-4} \text{ mol dm}^{-3})^2(1 \times 10^{-4} \text{ mol dm}^{-3})$ --- (02)

$= 4 \times 10^{-12}$ mol^3 dm^{-9} --- (03)

(iii) [10] maximum mass of Ag_2CrO_4 that can dissolve in 100 cm^3 of water

$= 1 \times 10^{-4} \text{ mol dm}^{-3} \times 0.1 \text{ dm}^3 \times 332 \text{ g mol}^{-1}$ ---- (05)

$= 332 \times 10^{-5}$ g $= 3.32$ mg --- (05)

(iv) [15]

$$[CrO^{2-}_{4(aq)}] = \frac{2 \text{ mol dm}^{-3} \times 250 \text{ cm}^3}{500 \text{ cm}^3} = 1 \text{ mol dm}^{-3} \text{ ---- (05)}$$

$$[Ag^+_{(aq)}] = \left\{\frac{K_{sp}}{[CrO_4^{2-}]}\right\}^{1/2}$$

$$= \left(\frac{4 \times 10^{-12} \text{ mol}^3\text{dm}^{-9}}{1 \text{ mol dm}^{-3}}\right)^{1/2} = 2 \times 10^{-6} \text{ mol dm}^{-3} \text{ ---- (05)}$$

Moles of Ag_2CrO_4 precipitated

$$= (2 \times 10^{-4} - 2 \times 10^{-6})\frac{500}{1000} \text{ mol}$$

$\simeq 1 \times 10^{-4}$ mol ------ (05)

(V) (15) In a saturated solⁿ of Ag_2CrO_4, the following equilibrium exists,

$$Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + CrO^{2-}_{4(aq)} \quad \text{--- ①} \quad (05)$$

when $NH_{3(aq)}$ is added, another equilibrium

$$Ag^+_{(aq)} + 2NH_{3(aq)} \rightleftharpoons [Ag(NH_3)_2]^+$$ reaches --- ② (05)

$Ag^+_{(aq)}$ ion concentration decreases and therefore according to Le-Chatelier's principle, reaction ① gets shifted towards right causing $[CrO_4^{2-}]$ to increase. --- (05)

(A) ⇒ /60

(B) (i) (15)

$$P_A = 1.2\times10^5\ Pa \times \frac{3}{4} = 9\times10^4\ Pa \text{ ---- } (05)$$

$$P_B = 1.2\times10^5\ Pa \times \frac{1}{4} = 3\times10^4\ Pa \text{ ---- } (05)$$

For gaseous phase, $PV = nRT$

$$n = \frac{PV}{RT} = \frac{1.2\times10^5\ Pa \times 8.314\times10^{-3}\ m^3}{8.314\ J\,mol^{-1}K^{-1} \times 300\,K}$$

$$= 0.4\ mol \text{ ---- } (05)$$

(ii) (10) gaseous phase,

$$n_A^v = \frac{P_A}{P_{Tot}} \times n_{Tot}$$

$$= \frac{3}{4} \times 0.4\ mol = 0.3\ mol \text{ --- } (03)$$

$$n_B^v = \frac{P_B}{P_{Tot}} \times n_{Tot} = 0.1\ mol \text{ ---- } (03)$$

liquid phase,

$$n_A^l = (1-0.3)\ mol = 0.7\ mol \text{ --- } (02)$$

$$n_B^l = (1-0.1)\ mol = 0.9\ mol \text{ --- } (02)$$

(iii) (15) According to Raoult's law, ---- (05)

$$P_A = X_A P_A^\circ$$

$$P_A^\circ = \frac{P_A}{X_A} = \frac{9\times10^4\ Pa}{0.7/1.6} = 20.57\times10^4\ Pa \text{ ---- } (05)$$

$$P_B^\circ = \frac{P_B}{X_B} = \frac{3\times10^4\ Pa}{0.9/1.6} = 5.33\times10^4\ Pa \text{ --- } (05)$$

(B) /40

(c) When $H_2S_{(g)}$ is passed through the solution, the following equilibria exist

$$H_2S_{(g)} \rightleftharpoons H_2S_{(aq)}$$

$$H_2S_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + HS^-_{(aq)} \; ; K_{a_1} = \frac{[H_3O^+_{(aq)}][HS^-]}{[H_2S_{(aq)}]}$$ --- (03)

$$HS^-_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + S^{2-}_{(aq)} \; ; K_{a_2} = \frac{[H_3O^+_{(aq)}][S^{2-}_{(aq)}]}{[HS^-_{(aq)}]}$$ --- (03)

$$\therefore K_{a_1} \times K_{a_2} = \frac{[H_3O^+_{(aq)}]^2[S^{2-}_{(aq)}]}{[H_2S_{(aq)}]} = (9.1 \times 10^{-8})(1 \times 10^{-19})$$

$$\Rightarrow [H_3O^+_{(aq)}]^2[S^{2-}_{(aq)}] = 9.1 \times 10^{-28}\ mol^3 dm^{-9}$$ --- (04)

Minimum $[S^{2-}_{(aq)}]$ required for precipitating ZnS

$$[S^{2-}_{(aq)}] = \frac{K_{sp}(ZnS)}{[Zn^{2+}_{(aq)}]} = \frac{1.6 \times 10^{-24}\ mol^2 dm^{-6}}{0.1\ mol dm^{-3}}$$ --- (02)

$$= 1.6 \times 10^{-23}\ mol dm^{-3}$$ (03)

Corresponding to this minimum concentration of S^{2-}, maximum concentration of H_3O^+ may be calculated using

$$[H_3O^+_{(aq)}]^2[S^{2-}_{(aq)}] = 9.1 \times 10^{-28}\ mol^3 dm^{-9}$$

$$[H_3O^+_{(aq)}]^2 = \frac{9.1 \times 10^{-28}}{1.6 \times 10^{-23}} \doteq 5.7 \times 10^{-5}\ mol^2 dm^{-6}$$ --- (05)

$$\therefore [H_3O^+_{(aq)}] = 7.6 \times 10^{-3}\ mol dm^{-3}$$ (02)

$$pH = -\log[H_3O^+_{(aq)}] = 3 - \log 7.6$$

$$= 2.1$$ --- (03)

Similarly, minimum $[S^{2-}_{(aq)}]$ required for precipitating FeS

$$[S^{2-}_{(aq)}] = \frac{K_{sp}(FeS)}{[Fe^{2+}_{(aq)}]} = \frac{6.3 \times 10^{-18}\ mol^2 dm^{-6}}{0.1\ mol dm^{-3}}$$

$$= 6.3 \times 10^{-17}\ mol dm^{-3}$$ --- (02)

maximum concentration of H_3O^+ may be calculated using (03)

$$[H_3O^+_{(aq)}][S^{2-}_{(aq)}] = 9.1 \times 10^{-28}\ mol^3 dm^{-9}$$ ---

$$[H_3O^+]^2 = \frac{9.1 \times 10^{-28}}{6.3 \times 10^{-17}}\ mol^2 dm^{-6}$$

$[H_3O^+_{(aq)}] = 3.7 \times 10^{-6}\ mol\ dm^{-3}$ --- (05)

$pH = -\log[H_3O^+_{a}] = 6 - \log 3.7$

$= 5.4$ ---- (05)

∴ The pH of the solution to separate the two ions should be between 2.1 and 5.4. ------ (10)

(c) ⇒ 50

---

(6) (a) (i) $[B]_0 = \frac{0.4 \times 200}{1000}\ mol\ dm^{-3}$ (80) (25)

$= 0.08\ mol\ dm^{-3}$ ------ (05)

$[B]_{t=12} = 0.032\ mol\ dm^{-3}$

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

$= \frac{(0.08 - 0.032)\ mol\ dm^{-3}}{12\ s}$ ---- (05)

$= 4 \times 10^{-3}\ mol\ dm^{-3} s^{-1}$ --- (05)

Rate of consumption of A

$= 8 \times 10^{-3}\ mol\ dm^{-3} s^{-1}$ --- (05)

Rate of formation of D

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

(ii) Considering the change in concentration of (20)

[A] $0.4\,M \longrightarrow 0.2\,M$ ($t_{\frac{1}{2}} = 120s$), $0.2\,M \longrightarrow 0.1\,M$ ($t_{\frac{1}{2}} = 60s$),

$0.1\,M \longrightarrow 0.05\,M$ ($t_{\frac{1}{2}} = 30s$)

It follows that

$t_{\frac{1}{2}} \propto [A]_0$ --- (05)

∴ order w.r.t A is zero. (05)

Since the unit of rate constant is s^{-1}, overall order should be one. --- (05)

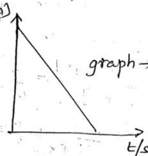
$\therefore$ Order w.r.t B must be one --- (05)

(12) (iii) (I) $t_{\frac{1}{2}} = \frac{0.693}{k} = \frac{0.693}{3.3 \times 10^{-3} s^{-1}}$ ---- (05)

$= 210\ s$ ----- (05)

(II) $100 \times \left(\frac{1}{2}\right)^3 = 12.5\%$ ---- (02)

(23) (iv) (I)



graph → (03)

(II) Initial rate,

$R = k[B]$

$= 3.3 \times 10^{-3} s^{-1} \times 0.4\ mol\ dm^{-3}$ ---- (05)

$= 1.32 \times 10^{-3}\ mol\ dm^{-3} s^{-1}$ (02)

Rate must be constant throughout the expt. (03)

(III) As [B] is constant, at the end of the reaction [A] must be zero.

$-\frac{1}{2}\frac{\Delta[A]}{\Delta t} = R$ ---- (02)

$-\frac{1}{2}\frac{[0 - 0.4]\ mol\ dm^{-3}}{\Delta t} = 1.32 \times 10^{-3}\ mol\ dm^{-3} s^{-1}$ ---- (05)

$\Rightarrow \Delta t = 151.5\ s$ --- (03) (A) ⇒ 70

(30) (b) (i) (05) Definition of buffer solⁿ ----- (05)

(15) (ii) $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH^+_{4(aq)} + OH^-_{(aq)}$ ---- (02)

$K_b = \frac{[NH^+_{4(aq)}][OH^-_{(aq)}]}{[NH_{3(aq)}]} = 1.8 \times 10^{-5}\ mol\ dm^{-3}$ --- (02)

Since pH = 9, $[OH^-_{(aq)}] = 1 \times 10^{-5}\ mol\ dm^{-3}$ --- (02)

$[NH^+_{4(aq)}] = \frac{1.8 \times 10^{-5}\ mol\ dm^{-3} \times 0.1\ mol\ dm^{-3}}{1 \times 10^{-5}\ mol\ dm^{-3}}$

$= 0.18\ mol\ dm^{-3}$ (02)

Number of moles of NH_4^+ = $0.1 \, mol\,dm^{-3} \times 1\,dm^3$

$= 0.18 \, mol$ --- (02)

Mass of NH_4Cl = $0.18 \, mol \times 53.5 \, g\,mol^{-1}$ --- (03)

$= 9.63 \, g$ --- (02)

(iii) $NH_4Cl_{(aq)} \longrightarrow NH_4^+{}_{(aq)} + Cl^-_{(aq)}$

(10) $NH_4^+{}_{(aq)} + H_2O_{(l)} \rightleftharpoons NH_{3(aq)} + H_3O^+_{(aq)}$ ------ (02)

	NH_4^+		NH_3	H_3O^+	
Initial concent:	0.5		−	−	$mol\,dm^{-3}$
Change in con:	$-x$		$+x$	$+x$	$mol\,dm^{-3}$
Eq^m. concen:	$0.5-x$		x	x	

$K_a = \frac{[NH_{3(aq)}][H_3O^+_{(aq)}]}{[NH_4^+]} = \frac{x^2}{0.5-x}$ ---- (03)

$K_{a(NH_4^+)} = \frac{K_w}{K_{b(NH_3)}} = \frac{1 \times 10^{-14} mol^2 dm^{-6}}{1.8 \times 10^{-5} mol\,dm^{-3}}$

$= 5.6 \times 10^{-10} \, mol\,dm^{-3}$ ------ (02)

$\Rightarrow 5.6 \times 10^{-10} \, mol\,dm^{-3} = \frac{x^2}{0.5 \, mol\,dm^{-3}}$

$x = [H_3O^+_{(aq)}] = 1.673 \times 10^{-5} \, mol\,dm^{-3}$

$pH = 5 - \log 1.673$ ---- (03)

(b) ⇒ 30

(c)

(i) $K_c = \frac{[Y_{(g)}][Z_{(g)}]}{[X]_{(g)}}$ ---- (05)

$= \frac{(0.4 \, mol\,dm^{-3})^2}{0.2 \, mol\,dm^{-3}}$ --- (05) $= 0.8 \, mol\,dm^{-3}$ --- (05)

(ii) Since P is halfed, concentrations also become half.

At the moment, $Q_c = \frac{0.2 \times 0.2}{0.1} mol\,dm^{-3}$

$= 0.4 \, mol\,dm^{-3}$

---- (05)

Since $Q_c < K_c$, the reaction proceed in the forward direction. --- (05)

(ii) $X_{(g)} \rightleftharpoons Y_{(g)} + Z_{(g)}$

new initial concent.: 0.1 0.2 0.2 .. $mol\,dm^{-3}$

concent^n at new eq^m: $(0.1-x)$ $(0.2+x)$ $(0.2+x)$ --- (05)

$$K_c = \frac{[Y][Z]}{[X]} = \frac{(0.2+x)^2}{0.1-x} \text{ --- (05)}$$

$\Rightarrow x = 0.034$ mol --- (05)

$\therefore [X] = (0.1 - 0.034)\ mol\,dm^{-3} = 0.066\ mol\,dm^{-3}$

$[Y] = 0.234\ mol\,dm^{-3}$ 2x05 = (10)

(C) ⇒ 40

7 (a) (i) $HCl_{(aq)}$ ----- (10) (05)

(100)

(ii) cathode : $Pt_{(s)} / Cl_{2(g)} / Cl^-_{(aq)}$ --- (10) or Cl_2 electrode

anode : $Ag_{(s)} / AgCl_{(s)} / Cl^-_{(aq)}$ or silver-silverchloride electrode --- (10)

(iii) $Ag_{(s)} / AgCl_{(s)} / Cl^-_{(aq)} \,\vdots\, Cl^-_{(aq)} / Cl_{2(g)} / Pt_{(s)}$ --- (10)

(iv) cathode: $Cl_{2(g)} + 2e \longrightarrow 2Cl^-_{(aq)}$

anode: $Ag_{(s)} + Cl^-_{(aq)} \longrightarrow AgCl_{(s)} + e$ } 2x05 = (10)

(v) $2Ag_{(s)} + Cl_{2(g)} \longrightarrow 2AgCl_{(s)}$ --- (10)

(vi) $E^\ominus_{cell} = E^\ominus_{cathode} - E^\ominus_{anode}$ --- (05)

$= 1.36\ V - 0.26\ V$ --- (05)

$= 1.10\ V$ --- (05)

(vii) $\Delta G^\ominus = -nFE^\ominus$

$= -2\ mol \times 96,500\ C\,mol^{-1} \times 1.10\ V$ --- (10)

$= -212.3\ kJ\,mol^{-1}$ --- (05)

(viii) E_{cell} remains unchanged --- (10)

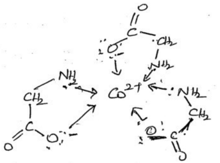
(b) (i) Since the aqueous sol^n of the compound does not give a precipitate with $BaCl_{2(aq)}$, SO_4^{2-} cannot be the anion. ---- (10)

50

As it gives ppt. with $AgNO_3$, Cl^- must be the anion. ---- (10)

∴ The structural formula is

$[Co(NH_3)_4SO_4]Cl$ ---- (15)

(ii) 

------ (15)

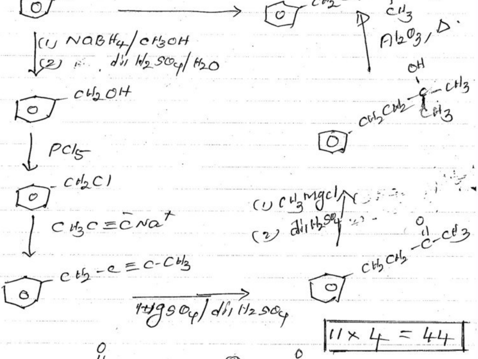
Part C

(8) (A)

R_1 Hg^{2+} / dil H_2SO_4	P_1 CH_3CHO
R_2 dil NaOH (aq)	P_2 $CH_3CH(OH)CH_2CHO$
R_3 I_2 / Δ	P_3 $CH_3CH=CHCHO$
R_4 H_2 / Ni, Δ	P_4 $CH_3CH_2CH_2CHO$
R_5 H_2 / Pd / $BaSO_4$, quinoline	P_5 $CH_2=CH_2$
R_6 HCl (g)	P_6 CH_3CH_2Cl
R_7 conc NH_3	P_7 $CH_3CH_2NH_2$

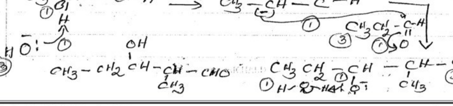
14 × 5 = 70

(B)



11 × 4 = 44

(C)



18

(ii) self condenzation Reaction. [4]

(iii) Basic Property $CH_3CH_2\overset{O}{\overset{||}{C}}-NH_2$ < $CH_3CH_2CH_2NH_2$

$CH_3-CH_2-\overset{O}{\overset{||}{C}}-\ddot{N}H_2 \longleftrightarrow CH_3CH_2-\overset{O^-}{C}=\overset{+}{N}H_2$ (8)

due to this resonance ability of donation of lone pair electron of Nitrogen is reduced. (6)

150

[14]

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(9)(A)(a) $n_{BaSO_4} = \frac{4.670\ g}{233\ g\ mol^{-1}}$ (4) $= 0.02\ mol$ (4)

$n_{SO_4^{2-}} = 0.02\ mol$ (4)

$C_{SO_4^{2-}} = \frac{0.02\ mol}{50 \times 10^{-3}\ dm^3}$ (4) $= 0.4\ mol\ dm^{-3}$ // (4)

[20]

(b) $5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$ (7)

$5CuS + 6MnO_4^- + 28H^+ \longrightarrow 6Mn^{2+} + 5Cu^{2+} + 5SO_2 + 14H_2O$ (7)

$n_{Fe^{2+}} = 0.2\ mol\ dm^{-3} \times 11.00 \times 10^{-3}\ dm^3$. 2+1

$= 2.2 \times 10^{-3}\ mol$ // 2+1

$n_{remaining\ MnO_4^-} = \frac{1}{5} \times 2.2 \times 10^{-3}\ mol$ 2+1

$= 0.44 \times 10^{-3}\ mol$ // 2+1

$n_{initial\ MnO_4^-} = 0.56\ mol\ dm^{-3} \times 30 \times 10^{-3}\ dm^3$ 2+1

$= 16.8 \times 10^{-3}\ mol$ // 2+1

Moles of MnO_4^- reacted with CuS $= (16.8 \times 10^{-3} - 0.44 \times 10^{-3})\ mol$

$= 16.36 \times 10^{-3}\ mol$ 2+1

$n_{CuS} = \frac{5}{6} \times 16.36 \times 10^{-3}$ mol $= 13.63 \times 10^{-3}$ mol 2+1 2+1

$n_{Cu^{2+}} = 13.63 \times 10^{-3}$ mol 2+1

$C_{Cu^{2+}} = \frac{13.63 \times 10^{-3} \text{ mol}}{50 \times 10^{-3} \text{ dm}^3} = 0.273$ mol dm^{-3}
2+1 2+1

50

(C) $IO_3^- + 5I^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$ (3)

$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$ × 3 (3)

$IO_3^- + 6S_2O_3^{2-} + 6H^+ \longrightarrow I^- + 3S_4O_6^{2-} + 3H_2O$ (4)

$n_{S_2O_3^{2-}} = 0.6$ mol $dm^{-3} \times 40 \times 10^{-3}$ dm^3 3+1
$= 24 \times 10^{-3}$ mol 3+1

n_{H^+} in $50 cm^3 = 24 \times 10^{-3}$ mol 3+1

$C_{H^+} = \frac{24 \times 10^{-3} \text{ mol}}{50 \times 10^{-3} \text{ dm}^3} = 0.48$ mol dm^{-3}
3+1 3+1

30

100

(B) (i) X = H_2S, Z = SO_2 10 × 2 = 20

(ii) Y = S 10

(iii) $2KMnO_4 + 3H_2SO_4 + 5H_2S \longrightarrow K_2SO_4(aq) + 5S\downarrow + 2MnSO_4 + 8H_2O$

ionic equation also acceptable.

H_2S + conc $H_2SO_4 \longrightarrow S + SO_2 + 2H_2O$

$H_2S + SO_2 \longrightarrow 3S\downarrow + 2H_2O$ 5 × 3 = 15 iv Crown shape (5)

[50]

[150]

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10 (A) i) Y - CuS , Z - $CuCl_4^{2-}$, P - MnS
Q - $MnCl_4^{2-}$, R - $SrCO_3$

[$5 \times 07 = 35$]

(ii) Cu^{2+}, Mn^{2+}, Sr^{2+} [$8 \times 3 = 24$]

(iii) $Mn(OH)_2 \downarrow$ (6) white or cream colour (5)

[70]

(B) A - $[Cr(H_2O)_6]^{3+}$ P - $Cr(OH)_3$.

B - $[Fe(H_2O)_6]^{3+}$ Q - $Fe(OH)_3$.

C - $[Co(H_2O)_6]^{2+}$ R - $[Co(NH_3)_6]^{3+}$

D - $[Mn(H_2O)_6]^{2+}$ S - $Mn(OH)_2$

[$8 \times 05 = 40$]

C (i) Potassium pentaamminecyanidomanganese(II)
hexaamminenickel(II) chloride

$5 \times 2 = 10$

(ii)

MnO	+2	base
Mn_2O_3	+3	weak base
MnO_2	+4	amphoteric
MnO_3	+6	weak acid
Mn_2O_7	+7	acid

[$15 \times 02 = 30$]

[150]