G.C.E. (A/L) Examination
Chemistry - 2006

M.C.Q. Answers

(1)	3	(16)	4	(31)	1	(46)	5
(2)	2	(17)	5	(32)	5	(47)	1
(3)	5	(18)	4	(33)	2	(48)	4
(4)	3	(19)	2	(34)	3	(49)	5
(5)	3	(20)	1	(35)	2	(50)	5
(6)	1	(21)	3	(36)	4	(51)	4
(7)	5	(22)	1	(37)	5	(52)	5
(8)	1	(23)	5	(38)	4	(53)	1
(9)	5	(24)	(2/4)	(39)	5	(54)	3
(10)	5	(25)	5	(40)	3	(55)	5
(11)	4	(26)	(1/5)	(41)	3	(56)	5
(12)	4	(27)	3	(42)	1	(57)	5
(13)	4	(28)	3	(43)	5	(58)	3
(14)	3	(29)	3	(44)	1	(59)	3
(15)	2	(30)	4	(45)	4	(60)	3

PART A - STRUCTURED ESSAY

Answer all four questions. Each question carries **10 marks**

(01) (a) (i) Mg
(ii) K
(iii) Na_2CO_3
(iv) $Ba(OH)_2$
(v) Cl and Mn (5 x 6 = 30)

(b) Zinc or Zn (10)

(i) $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$ (5)

(ii) $Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$ (5)

Galvanizing / cathodic protection/ batteries/ alloys (5)

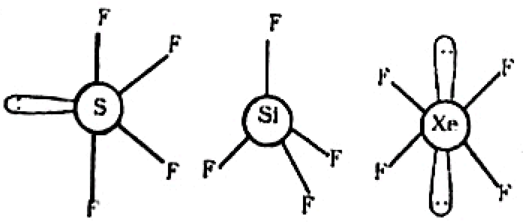
(c) (i) $\overset{\ominus}{N} = \overset{\oplus}{N} = \overset{\ominus}{N} \leftrightarrow N \equiv \overset{\oplus}{N} - \overset{2-}{N} \leftrightarrow \overset{2-}{N} - \overset{\oplus}{N} \equiv N$

(7 x 3)

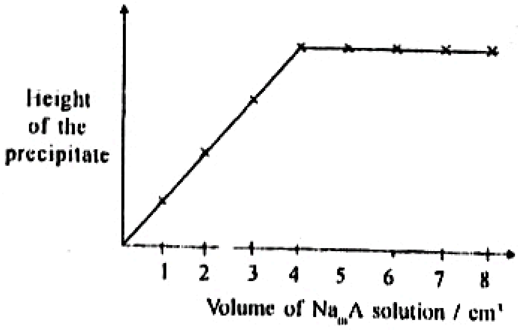
$\overset{\ominus}{N} = N \Rightarrow N$ and $N \equiv N \rightarrow \overset{\ominus}{N}$ also acceptable

Air bags/ detonators/ source of N_2/ toremove O_2 from analytical reagents/ synthesis of drugs/ pesticides (3)

(ii)



(8 x 3 = 24)



02 (a) (i) Moles of MCl_x used = $\frac{0.2}{1000} \times 9$ (5)

Maximum height reached when volume of Na_xA = 4.0 cm³ (5)

maximum number of moles of Na_xA used = $\frac{0.3}{1000} \times 4$ (5)

Moles of MCl_x : moles of Na_xA = $\frac{0.2}{1000} \times 9 : \frac{0.3}{1000} \times 4$

= 3 : 2

(05)

(ii) 1. $Al(OH)_3$ gelatinous or precipitate does not settle (05)

2. Difficult to prepare a standard solution of NH_4OH (10)

(a) (50) marks

(b) (i) increases, contact

(ii) slowly, activation energy, catalysts

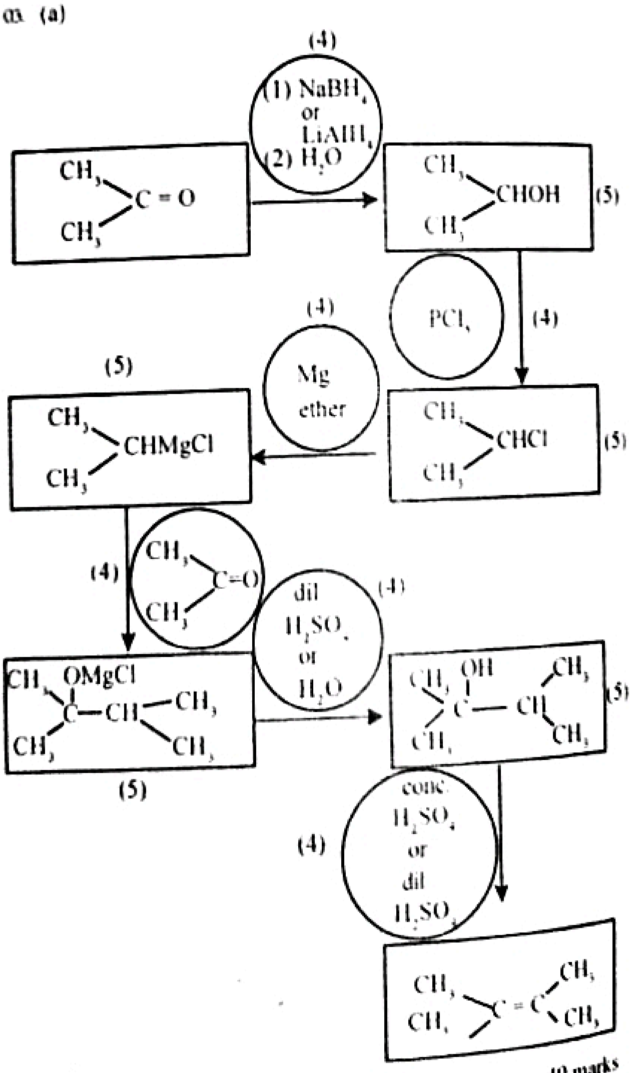
(iii) equilibrium, equilibrium, equlibrium, sodium salt, right, yield

(iv) Contact, rate

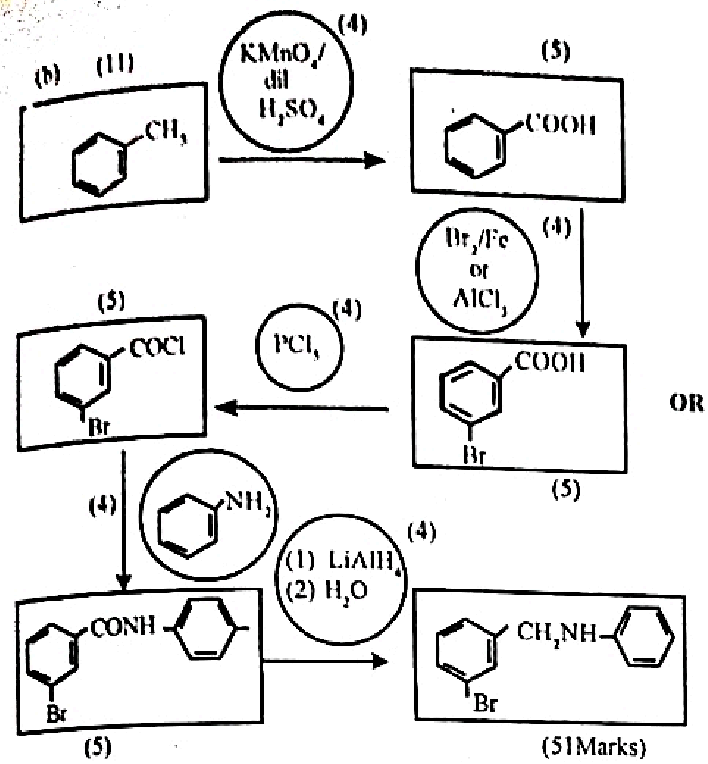
(v) Concentration, Sodium Salt density

(3 x 16 = (48) +2)
(50 Marks)

03. (a)

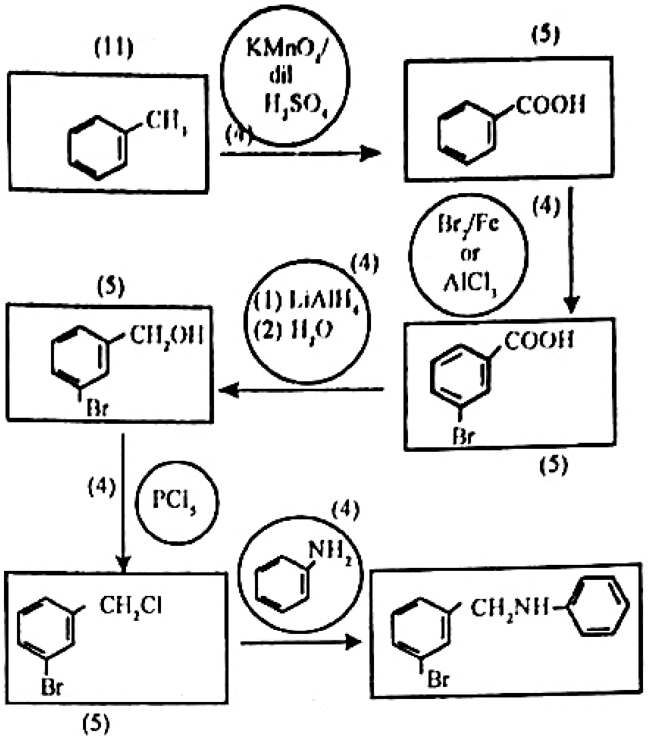


(a) = 49 marks



(51Marks)

OR



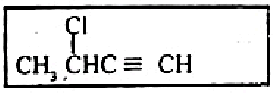
04. (a) (i)

$CH_3\ C \equiv C\ CH_3$

A (7)

$CH_3\ CH_2\ C \equiv CH$

B (7)



$CH_3\overset{Cl}{C}HC \equiv CH$

C (7)

$CH_3\ CH_2\overset{O}{\overset{\|}{C}}\ CH_3$

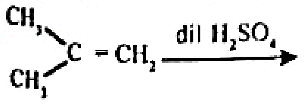
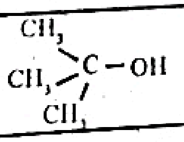
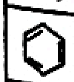
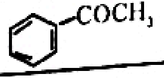
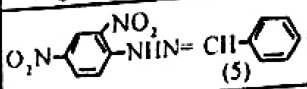
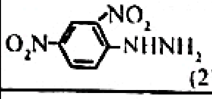
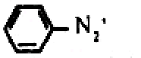
D (7)

(ii) Y = $HgSO_4$ OR Hg^{2+} OR (5)
mercuric sulphate

(iii) For B. Cuprous chloride or Cu_2Cl_2 solution → Brick - red ppt OR

Ammonical $AgNO_3$ → white ppt or Light yellow ppt (2)

For A. No precipitate (2)

P Reaction	Q Major Organic Product	R Mechanism type	S Electrophile	T Nucleophile	U
$CH_3CH_2CH_2I \xrightarrow{aq\ NaOH}$	$CH_3CH_2CH_2OH$ (5)	SN (2)	–	OH^- (2)	colourless (1)
 dil H_2SO_4	 (5)	A_E (2)	H^+ OR H_3O^+ (2)	–	colourless (1)
$CH_3CH_2\overset{CH_3}{C}HI \xrightarrow[KOH]{alcoholic}$	$CH_3CH = CHCH_3$ (5)	E (2)	–	–	colourless (1)
 $\xrightarrow[AlCl_3]{CH_3COCl}$	 (5)	S_E (2)	$CH_3C^+ = O$ (2)	–	colourless (1)
	 (5)	AN OR AN + E (2)	–	 (2)	yellow/ orange (2)
	 (5)	S_E (2)	 (2)	–	red/ orange yellow (2)

05. (a) (i) $C_2H_5OH(\ell) \rightarrow C_2H_5OH_{(aq)}$ (03) $\Delta H = 0$ (02)

(ii) $C_6H_{12}O_6(s) \rightarrow C_6H_{12}O_{6(aq)}$ (03) $\Delta H = 0$ (02)

(iii) $C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(\ell)$ (03)
$\Delta H^0 = -2808$ KJ mol^{-1} (02)

(iv) $C_2H_5OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$ (03)
$\Delta H^0 = -1368$ KJ mol^{-1} (02)

(iii) -2 x IV + 2 x 1 - II gives;
$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$
$\Delta H^0 = -2808 - 2(-1368)$ kJmol^{-1} : (04)
$= -72$ KJmol^{-1} (2 + 2)

Heat released by 2.5 mol = 2.5 mol x 72 kJmol^{-1}
= 180 kJ (2 + 2)

Alternative Calculation

$$\begin{tikzcd}
C_6H_{12}O_6(s) + 6O_2(g) \arrow[r, "\overset{(02)}{\Delta H=O}", "IV"'] \arrow[d, "I"', "\begin{matrix}-2808\ kJmol^{-1}\\(02)\end{matrix}"] & C_6H_{12}O_6(aq) + 6O_2(g) \arrow[d, "III"', "\Delta H"] \\
6CO_2(g) + 6H_2O(1) & 2C_2H_5OH_{(aq)} + 2CO_2(g) + 6O_2(g) \arrow[l, "II"', "\begin{matrix}2x(-1368)\ KJmol^{-1}\\(2)\end{matrix}"]
\end{tikzcd}$$

Writing Equations I, II, III and IV (4 x 3 = 12)
ΔH = O for enthalpy of dissolution of $C_2H_5OH(\ell)$ (02)
ΔH = -2808 - 2 (-1368) KJmol^{-1} (04)
= -72KJmol^{-1} (2 + 2)
Heat released by 2.5 mol = 2.5 mol x 72kJmol^{-1}
= 180kJ (2+2)

05. (a) (ii) Ratio = 72 KJmol^{-1}/2808 KJmol^{-1} = 0.0256
(4) (04)

Part (a) = 40 Marks

(b) (i) P = 10^5Pa, h = 3.0 m, A = 8.314 x 10^{-2}m^2, T = 300 K
pV = nRT
n = pV/RT (04)

$$= \frac{(10^5 Pa \times 3.0\ m \times 8.314 \times 10^{-2} m^2)/}{(8.314 J\ mol^{-1}K^{-1} \times 300\ K)}$$ (2 + 2)

= 10 mol (04)

(ii) $2x(g) \rightleftharpoons Y(g) + Z(g)$

	$2x(g)$	$Y(g)$	$Z(g)$	
initially	10.0	-	-	mol
At equilibrium	10.0 - 6.0	3.0	3.0	mol (04)

(A) Total number of moles is not changed ; p is constant

$V_1/T_1 = V_2/T_2 \Leftrightarrow Ah_1/T_1 = Ah_2/T_2 \Leftrightarrow h_1/T_1 = h_2/T_2$ (04)

$h_2 = 3.0$ m x 400 K/300 K = 4.0 m (2 + 2)

Alternative approach for part A

$pV = nRT$ $n = 10$ mol (04)
$10^5 \text{Pa} \times h \times 8.314 \times 10^{-2} \text{m}^2$
$= 10 \text{ mol} \times 8.314 \text{ J mol}^{-1}\text{K}^{-1} \times 400 \text{ K}$ (2 + 2)
$h = 4.0$ m (2 + 2)

(B) $P_x = (4.0/10.0) \times 10^5$ Pa
$= 4 \times 10^4$ Pa (2 + 2)

$Py = (3.0 / 10.0) \times 10^5$ Pa
$= 3.0 \times 10^4$ Pa (2 + 2)

$Pz = (3.0/10.0) \times 10^5$ Pa
$= 3.0 \times 10^4$ Pa (2 + 2)

(C) $Kp = Py.Pz/(Px)^2$ (04)
$= 3.0 \times 10^4 \text{Pa} \times 3.0 \times 10^4 \text{Pa}/(4.0 \times 10^4 \text{ Pa})^2$ (2 + 2)
$= 9.0 / 16.0$
$= 0.56$ (2 + 2)

(iii) Addition of the inert gas does not shift the above equilibrium (4)
Partial pressures do not change (2)
the values of Px, Py and Pz are the same as in 5 (b) section (B) (12)

OR

$Px = 4.0 \times 10^4$ Pa (2 + 2)
$Py = 3.0 \times 10^4$ Pa (2 + 2)
$Pz = 3.0 \times 10^4$ Pa (2 + 2)
$Ps = 1.0 \times 10^5$ Pa (2 + 2)
New total pressure $= 2.0 \times 10^5$ Pa (1 + 1)

(iv) $P_1V_1 = P_2V_2 \Rightarrow P_1h_1A = P_2h_2A \Rightarrow h_2 = P_1h_1/p_2$ (4)
$h_2 = 2 \times 10^5 \text{ Pa} \times 4.0 \text{ m} / 1 \times 10^5 \text{Pa} = 8.0$ m (2 + 2)

T is constant. ∴ K_p does not change. (2 + 2)
Number of moles at equilibrium does not change (4)

$Px = (4.0/20.0) \times 1 \times 10^5$ Pa
$= 2 \times 10^4$ Pa (2 + 2)

$Py = (3.0/20.0) \times 1 \times 10^5$ Pa
$= 1.5 \times 10^4$ Pa (2 + 2)

$Pz = (3.0 / 20.0) \times 1 \times 10^5$ Pa
$= 1.5 \times 10^4$ Pa (2 + 2)

$Ps = (10.0/20.0) \times 1 \times 10^5$ Pa
$= 5.0 \times 10^4$ Pa (2 + 2)

Alternative approach

Parameters of this system are similar to those in case (iii), except pressure. (4)
Pressure is halved Volume is doubled. (2)
Partial pressure is halved. (2)
$Px = 2.0 \times 10^4$ Pa (2 + 2)
$Py = 1.5 \times 10^4$ Pa (2 + 2)
$Pz = 1.5 \times 10^4$ Pa (2 + 2)
$Ps = 5 \times 10^4$ Pa (2 + 2)

(V) Assumption = Ideal gas behavior (2)

Total Marks for Part (b) = 110

06 (a) (i) Amount of I_2 in 15.00 cm^3 $CHCl_3$ solution
= 0.050 mol dm^{-3} x (15.00/1000) dm^3
= 0.00075 mol (4)

Amount of $S_2O_3^{2-}$ for titration
= 0.020 mol dm^{-3} x (24.00/1000) dm^3
0.00048 mol (4)

$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$ (4)

Amount of I_2 in 5.00 cm^3 of
$CHCl_3$ layer = 0.00024 mol (4)

Concentration of I_2 in
$CHCl_3$ layer $= \dfrac{0.00024 \text{ mol}}{0.005 \text{ dm}^3}$
= 0.048 mol dm^{-3} (2+2)

Amount of I_2 in 15.00 cm^3 of
$CHCl_3$ layer = 0.00072 mol (4)

Amount of I_2 in 100.00 cm^3 water = 0.00075 - 0.00072 mol
= 0.00003 mol (4)

Concentration of I_2 in
aqueous layer $= \dfrac{0.00003 \text{ mol}}{0.100 \text{ dm}^3}$
= 0.0003 mol dm^{-3}
(2 + 2)

(ii) partition coefficient $= \dfrac{[I_2]_{CHCl_3}}{[I_2]_{H_2O}}$ (4)

$= \dfrac{0.048 \text{ mol dm}^{-3}}{0.0003 \text{ mol dm}^{-3}}$

= 160 (2 + 2)

Total Marks for part (a) = ㊵

(b) (i) Amount of $S_2O_3^{2-}$ for titration
= 0.020 mol dm^{-3} x (8.00 / 1000) dm^3
= 0.00016 mol (5)

Amount of I_2 in 5.00 cm^3 of
$CHCl_3$ layer = 0.00016/2 mol
= 0.00008 mol (5)

Concentration of I_2 in
$CHCl_3$ layer $= \dfrac{0.00008 \text{ mol}}{0.005 \text{ dm}^3}$ (5)
= 0.016 mol dm^{-3}
(3 + 2)

Concentration of I_2 in
aqueous layer $= \dfrac{0.016 \text{ mol dm}^{-3}}{160}$ (5)
= 0.0001 mol dm^{-3}
(3 + 2)

(ii) Amount of I_2 in aqueous layer
= 0.0001 mol dm^{-3} x 0.100 dm^3
= 0.00001 mol (5)

Amount of I_2 in 15.00 cm^3
of $CHCl_3$ layer = 0.00008 mol x 15.00 cm^3/5.00 cm^3 (5)

= 0.00024 mol (5)

Amount of I_2 reacted with I^- to give I_3^- =
= initial mol I_2 in $CHCl_3$ - mol I_2 in $CHCl_3$ at eqm - mol I_2 in aqueous at eqm (10)

OR

= 0.00075 mol [from part (a)] - 0.00024 mol - 0.00001 mol
= 0.0005 mol (5)

OR

No. of moles of I_2 reacted with I^- to give I_3^- = 0.0005

(iii) Amount of I^- = initial amount of I^- - amount of I_2 reacted with I^- to give I_3^-

= $0.05\ mol\ dm^{-3} \times \frac{100}{1000}\ dm^3 - 0.0005\ mol$ (5)

= 0.0045 mol (5)

Concentration of I^- = 0.0045 mol / 0.100 dm^3
= 0.045 mol dm^{-3} (3+2)

Concentration of I_3^- = 0.0005 mol/0.100 dm^{-3}
= 0.0050 mol dm^{-3} (3+2)

(iv) $K_{eq} = [I_3^-]_{(aq)} / [I_2]_{(aq)} [I^-]_{(aq)}$ (5)

No marks, if 'aq' is not given

= [0.0050 mol dm^{-3} / [0.0001 mol dm^{-3}] [0.045 mol dm^{-3}] (3+2)

= 1111 mol^{-1} dm^3 (3+2)

Total marks for Part b = 100

(c) Higher solubility of I_2 (or more I_2) in aqueous KI solution than in water (5)

Less lost as vaper (5)

Total marks for Part C = ⑩

07. (a) Mass of Cu deposited = I x tx molar mass of Cu / 2 x F (4)

Mass of Cu deposited = (300 x 10^{-3} A) x (9.65 x 60 s) x 63.5 $gmol^{-1}$ /(96500 C mol^{-1} x 2)

substitution (0.5 + 0.5) x 4 (4)

= 0.057 g (2 + 2)

(A) Mass of the cathode = 10.0 g + 0.057 g (2)
= 10.057 g (2 + 2)

(B) Mass of the Anode = 10.0 g - 0.057 g (2)
= 9.943 g (2 + 2)

(C) Concentration of Cu^{2+} = 0.1 mol dm^{-3} (2 + 2)

(ii) Same amount of electricity is passed (4)

Change in the masses of electrodes is the same (2)

(A) Mass of the cathode = 10.057g + 0.057 g (2)
= 10.114 g (2)

(B) Mass of the Anode = 9.943 g - 0.057 g (2)
= 9.886 g (2)

(C) Concentration of Cu^{2+} = 0.05 mol dm^{-3} (2)

(iii) Discharge of only Pb^{2+} is not possible (4)

Reason :- Cu is discharged before Pb or contamination of Pb (4)

Total Marks for Part (a) = (50)

(b) (i) $K_{sp}(BaSO_4) = [Ba^{2+}_{(aq)}][SO_4^{2-}{}_{(aq)}]$ (5)

Note : No marks if 'aq' is not mentioned.

$[Ba^{2+}]_{aq} \times 1.1 \times 10^{-7}$ mol dm^{-3} = 1.1×10^{-10} mol^2dm^{-6} (3+2) 08.

$[Ba^{2+}]_{aq} = 1.0 \times 10^{-3}$ mol dm^{-3} (3+2)

(ii) Amount of Ba^{2+} in solution
= 1.0×10^{-3} mol dm^{-3} x 0.300 dm^3
= 3.0×10^{-4} mol (5)

Initial Amount of Ba^{2+}
= 5.0×10^{-3} mol dm^{-3} x 0.200 dm^3
= 1.0×10^{-3} mol (5)

No mol of Ba^{2+} precipitated
= $1.0 \times 10^{-3} - 3.0 \times 10^{-4}$ (5)
= 7.0×10^{-4} (5)

(iii) Let a = mol $BaSO_4$ in the precipitate

$3Ba(OH)_2(aq) + 2Na_3PO_4(aq) \rightarrow Ba_3(PO_4)_2(s) + 6NaOH$ (5)

$Ba(OH)_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaOH(aq)$ (5)

Molar mass of $BaSO_4$ = 137 + 32 + 4 x 16
= 233 g mol^{-1} (2)

Molar mass of $Ba_3(PO_4)_2$ = 3 x 137 + 2 [31 + 4 x 16]
= 601 g mol^{-1} (3)

No. of moles of $Ba_3(PO_4)_2$ in the precipitate
= $(1/3)(7.0 \times 10^{-4} - a)$ (5)
$233a + 1/3(7 \times 10^{-4} - a)601 = 0.1435$ (5)
$233a + 0.1402 - 200a = 0.1435$
$33a = 3.3 \times 10^{-3}$ (5)
$a = 1.0 \times 10^{-4}$ (5)

No. of moles of $BaSO_4$ in the precipitate = 1.0×10^{-4}
No. of moles of $Ba_3(PO_4)_2$ in the precipitate
= $(7.0 \times 10^{-4} - 1 \times 10^{-4})/3$
= 2.0×10^{-4} (5)

(iv) Amount of SO_4^{2-} in the initial solution = 1.0×10^{-4} mol (5)

Concentration of SO_4^{2-} in the initial solution
$= \frac{1.0 \times 10^{-4}\ mol}{0.100\ dm^3}$ (3+2)
= 1×10^{-3} mol dm^{-3} (3+2)

Amount of PO_4^{3-} in the initial solution

$= 2.0 \times 10^{-4} \times 2$ mol

4.0×10^{-4} mol

Concentration of PO_4^{3-} in the initial solution (5)

$$= \frac{4.0 \times 10^{-4}\ \text{mol}}{0.100\text{dm}^3}$$

$= 4 \times 10^{-3}$ mol dm^{-3}

Assumption (3+2)

All SO_4^{2-} and PO_4^{3-} in the solution have been precipitated

OR

Amounts of SO_4^{2-} and PO_4^{3-} remaining in the solution are negligible.

Part (b) = (100) Marks

08. (a) (i) 1 mol of the oxyanion of L reacts with 5 moles of M^{2+}. M^{2+} is converted to M^{3+}. This is a one electron change

(OR $M^{2+} \rightarrow M^{3+} + e$) (5)

L^{2+} is formed from the oxyanion of L.
This therefore involves a 5 electron change
Therefore the oxidation state of L in the oxyanin is + 7 (5)

(10)

(ii) L is (Mn) / Manganese, M is Fe/ Iron (10 + 10)

(iii) MnO_4^- , (no marks for LO_4^-) (10)

(iv) C, CO or C only (10)
(CO only) (5)
High temperature (600 to 1600 °C) (5)

(v) Reaction of $Mn(OH)_2$ with O_2 OR

$4Mn(OH)_2 + O_2 \rightarrow 2Mn_2O_3 + 4H_2O$

OR

$2Mn(OH)_2 + O_2 \rightarrow 2MnO_2 + 2H_2O$

OR

$4\ Mn(OH)_2 + O_2 + 2H_2O \rightarrow 4Mn(OH)_3$ (10)

Total for 8 (a) = 75 marks

(b) (i) A - Cl_2 gas (Chlorine) B - H_2 gas (Hydrogen)
C - Anode D - Cathode
E - Diaphragm
(4 x 5 = 20)

(ii) F - Brine/ Conc. NaCl Soln Na^+Cl^- (5)

G - NaOH + NaCl Soln OR $Na^+\ Cl^-\ OH^-$ (5)

(iii) Anode : Carbon (graphite) or Ti (Titanium) (5)
Cathode : Steel or Iron (Fe) (5)

(iv) Anode material : should not react with Cl_2 (5)
Cathode material : should not react with NaOH (5)

(v) Role of diaphragm :
To prevent reaction between NaOH and Cl_2 (5)
To prevent reaction between H_2 and Cl_2
OR To prevent reaction between Fe (cathode) and Cl_2 (5)

(vi) Solution level difference . To prevent NaOH (or solution G) from cathode compartment diffusing into the anode compartment. (5)

(vii) Reasons for using brine
(1) Higher concentration of NaCl (or Cl^-) makes the discharge of Cl^- ions C to produce Cl_2) easier.

(2) Prevents the discharge of OH^- ions producing O_2
(3) Reduces the resistance of the electrolyte.

Any two points (5 x 2)
Total for 8 (b) - ⑦⑤ marks

(09) (a) (i)

Test	Inference/s	
A	1. Absence of transition metal ions (Cu^{2+}, Ni^{2+}, etc)	(5)
	2. Absence of HCO_3^-, CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-} $S_2O_3^{2-}$	(1 x 5)
	3. Absence of Gp I cations	(5)
B	Presence of Sb^{3+} (antimony)	(5)
C.	Presence of Sb^{3+} (or Bi^{3+})	(5)
D.	Absence of NH_4^+	(5)
E.	Prensence of NO_3^- (or NO_2^-)	(5)

(ii)

(ii) Salt X is Antimony nitrate [$Sb(NO_3)_3$] (10)

(iii) Brown ring test (addition of $FeSO_4$ and Conc. H_2SO_4)

Heating X with Conc. H_2SO_4 gives reddish brown fums of NO_2.

Heating X with Conc. H_2SO_4 and Cu turnings gives reddish brown fums of NO_2

Any test (5)
Total for 9 (a) - ㊿marks

A|

b (i) When solution B is titrated with $KMNO_4$, SO_3^{2-} is converted to SO_4^{2-}, and $C_2O_4^{2-}$ converted to CO_2

$MnO_4^- + 8H^+ + 5e \rightarrow Mn^{2+} + 4H_2O$ (5)

$SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e$ (5)

$C_2O_4^{2-} \rightarrow 2CO_2 + 2e$ (5)

$SO_4^{2-} + Ba^{2+} \rightarrow BaSO_4$

Mass of $BaSO_4$ precipitate = 0.466 g

Amount of $BaSO_4$ in 25.0 cm^3 of solution B $= \frac{0.466}{233}$

= 0.002 mol

Amount of SO_4^{2-} in 25.0 cm^3 of solution B = 0.002 mol (5)

Concentration of SO_3^{2-} in Solution B $= 0.002 \times \frac{1000}{25}$ mol dm^{-3}

= 0.08 $moldm^{-3}$ (5)

A

Amount of MnO_4^- in 40.0 cm^3 of solution = $0.05 \times \frac{40}{1000}$ mol

= 0.002 mol (5)

Amount of SO_4^{2-} in 25.0 cm^3 of solution B = 0.002 mol

Amount of SO_3^{2-} of Solution B = 0.002 mol

Amount of MnO_4 reacted with SO_3^{2-} in 25.0cm^3 of solution B = $0.002 \times \frac{2}{5}$ mol

= 0.0008 mol (5)

Amount of MnO_4^- reacted with $C_2O_4^{2-}$ in 25.0cm^3 of solution B = 0.002 - 0.0008 mol

= 0.0012 mol (5)

Amount of $C_2O_4^{2-}$ in 25.0cm^3 of solution B = $0.0012 \times \frac{5}{2}$ mol

= 0.003 mol (5)

The Concentration of $C_2O_4^{2-}$ of Solution B $= 0.003 \times \frac{1000}{25}$ moldm^{-3}

$= \underline{0.12 \text{ mol dm}^{-3}}$ (05)

Total for 9 (b) (i) - 50 marks

(ii) React a known amount of the mixture with dil. H_2So_4 (5)
Fe, Zn and Al dissolve, and the residue is Cu (5)
From this, the percentage of Cu can be calculated (5)
React a known amount of the mixture with dil. NaOH (5)
Zn and Al dissolve, and the residue is Fe and Cu. (5)
From these result the percentage of Fe can be calculated. (5)

Acidify the above NaOH solution with dil H_2So_4 (5)
and add excess of NH_4OH (5)
Zn will be in solution, and Al will be precipitated as $Al(OH)_3$ (5)
From this, the percentage of Al can be calculated.
Percentage of Zn can be calculated from the difference. (5)

Total for 9 (b) (ii) -㊿ marks

Alternative method 9 (b) (ii)

React a known amount of the mixture with dil. NaOH (5)
Zn and Al dissolve, and the residue is Fe and Cu. (5)
Dissolve the residue in dil H_2SO_4 (5)
Fe dissolves, and the residue is Cu (5)
From these results the percentages of Fe and Cu can be calculated. (10)

Acidify the above NaOH solution with dil H_2So_4 (5)
and add excess of NH_4OH (5)
Zn will be in solution, and Al will be precipitated as $Al(OH)_3$ (5)
From this, the percentage of Al can be calculated.
Percentage of Zn can be calculated from the difference. (5)

Total for 9 (b) (ii) - 50 marks

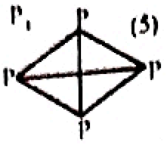
Alternative method 9 (b) (ii)

React a known amount of the mixture with dil. H_2SO_4 (5)
Fe, Zn and Al dissolve, and the residue is Cu. (5)
From this, the percentage of Cu can be calculated. (5)

Add excess dil NaOH to the above acidic solution (5)
Fe precipitates as $Fe(OH)_2$ (5)
Heat the precipitate to a constant mass to get Fe_2O_3 (5)
From this result, the percentage of Fe can be calculated. (5)
Acidify the above NaOH solution with dil H_2SO_4 (5)
and add excess of NH_4OH (5)
Zn will be in solution, and Al will be precipitated as $Al(OH)_3$ (5)
From this, the percentage of Al can be calculated.
Percentage of Zn can be calculated from the difference. (5)

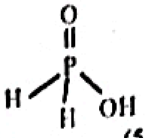
Total for 9 (b) (ii) - 50 marks

(10) (a) (i) P_4



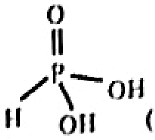
(5)

Phosphoric (I) acid (5)
(Hypophosphorous acid; phosphinic acid)
Oxidation state = +1 (5)



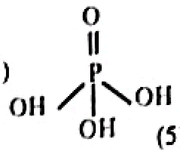
(5)

Phosphoric (III) acid (5)
(phosphorous acid; phosphinic acid)
Oxidation state = +3 (5)



(5)

Phosphoric (V) acid (5)
(phosphoric acid; orthophosphoric acid)
Oxidation state = +5 (5)



(5)

$2P_4 + 3Ba(OH)_2 + 6H_2O \rightarrow 3Ba(H_2PO_2)_2 + 2PH_3$ (20)

Oxidation states : $0 \longrightarrow +1$ -3 (1+2+2)
Disproportionation reaction (5)

(iii) Bond energy of one N ≡ N > Bond energy of three N-N bonds
(964 KJ mol^{-1} > 3 x 160 KJ mol^{-1}) (10)

Bond energy of three P-P bonds > Bond energy of one P ≡ P bonds
(3 x 200 KJ mol^{-1} > 490 kJ mol^{-1}) (10)

10 (a) - ⓞ100 Marks

(b) Mass of the mixture $CaCO_3$, $MgCO_3$, and SiO_2 = 2:00 g
Mass after heating = 1.12 g
Let the mass of $CaCO_3$ be x and mass of SiO_2 be y

$$x + \frac{84x}{100} + y = 2.00\text{ g (for the mixture before heating)}$$ (10)

$1.84x + y = 2.00$ g .... (1)

$$\frac{56x}{100} + (84x/100) + (40/84) + y = 1.12\text{ g (after heating)}$$ (10)

$0.96x + y = 1.12$ g .... (2)

(1) - (2) gives $0.88x = 0.88$ g

Mass of $CaCO_3$, x = 1.00 g (5)

Mass percentage of $CaCO_3$ $\frac{1.00}{2.00}$ x 100 = 50% (5)

Since the molar ratio of $CaCO_3$: $MgCO_3$ = 1:1

Mass of $MgCO_3$ = 1 x 84/100g = 0.84 g (5)

Mass percentage of $MgCO_3$ = $\frac{0.84}{2.00}$ x 100 = 42% (5)

Mass of SiO_2 = 2.00 - 1.84 = 0.16 g (5)

Mass percentage of SiO_2 = $\frac{0.16}{2.00}$ x 100 = 8% (5)

Total for 10 (b) - 50 Marks

Alternative calculation for 10 (b)

No. of moles of $CaCO_3$ = x

Mass of SiO_2 = y

For the mixture before heating :

$100x + 84x + y = 2.00$ g .... (1) (5)

For the mixture after heating :

$56.x + 40.x + y = 1.12$ g .... (2) (5)

(1) - (2)

$88x = 0.88$ g

$x = 0.01$ mol (5)

No. of moles of $CaCO_3$ = 0.01 (5)

No. of moles of $MgCO_3$ = 0.01 (5)

Mass of $CaCO_3$ = 100×0.01

= 1.00 g (5)

Mass of $MgCO_3$ = 84×0.01

= 0.84 g (5)

Mass percentage of $CaCO_3$ = $\left(\frac{1.00}{2.00}\right) \times 100 = 50\%$ (5)

Mass percentage of $MgCO_3$ = $\left(\frac{0.84}{2.00}\right) \times 100 = 42\%$ (5)

Mass percentage of SiO_2 = $\left(\frac{0.16}{2.00}\right) \times 100 = 8\%$ (5)

Total for 10 (b) - 50 Marks

Alternative calculation for 10 (b)

Mass of CO_2 avolved = 2.00 - 1.12 g (5)

= 0.88 g

No. of moles of CO_2 avolved = 0.88/44 = 0.02 (5)

Since the ratio of $CaCO_3 : MgCO_3$ = 1 : 1 (5)

No. of moles of $CaCO_3$ = 0.01 (5)

No. of moles of $MgCO_3$ = 0.01 (5)

Mass of $CaCO_3$ = 100×0.01

= 1.00 g (5)

Mass of $MgCO_3$ = 84×0.01

= 0.84 g (5)

Mass percentage of $CaCO_3$ = $\left(\frac{1.00}{2.00}\right) \times 100 = 50\%$ (5)

Mass percentage of $MgCO_3$ = $\left(\frac{0.84}{2.00}\right) \times 100 = 42\%$ (5)

Mass percentage of SiO_2 = $\left(\frac{0.16}{2.00}\right) \times 100 = 8\%$ (5)

Total for 10 (b) - 50 Marks