G.C.E. (A/L) Examination Chemistry - 2009

M.C.Q. Answers

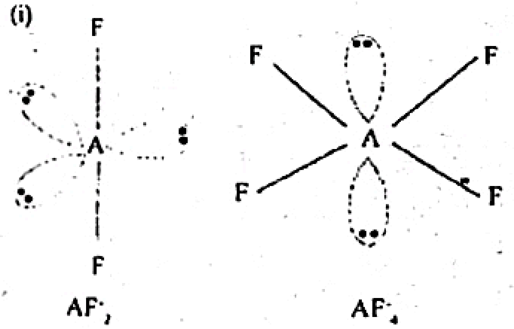
(1) - 4
(2) - 3
(3) - 3
(4) - 2
(5) - 4
(6) - 2
(7) - 1
(8) - 1
(9) - 3
(10) - 3
(11) - 5
(12) - 5
(13) - 1
(14) - 4
(15) - 2
(16) - 5
(17) - 1
(18) - 5
(19) - 3
(20) - 5
(21) - 4
(22) - 2
(23) - 2
(24) - 3
(25) - 1
(26) - 5
(27) - 4
(28) - all
(29) - 2
(30) - 4
(31) - 2
(32) - 4
(33) - 4
(34) - 5
(35)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

PART A - STRUCTURED ESSAY

Answer all four questions on this paper it self (Each question carries 10 marks)

1. (a) $\frac{1}{12}$th the mass of on atom of ^{12}C (isotope) (10)

(b) (i)



AF_2^- AF_4^-

(15) + (15)

(ii) VII A (or 17 or halogen group or group VII) (10)

(c) (i) ${}^4_2X + {}^9_4Be \rightarrow {}^{12}_6C + {}^1_0Y$

(ii) X - α particle or He

Y - n or neutron (5 x 5)

(d)

Atomic number	Z	Z+1	Z+2	Z+3	Z+4
Ionization Energy/ KJ mol⁻¹	1402	1313	1681	2081	495

(5 x 5)
100 marks

02. (a) (i)

Element	C	H	N	O
Mass %	$\frac{19.4}{120}$	$\frac{6.4}{1.0}$	$\frac{22.6}{140}$	$\frac{51.6}{160}$
	1.62	6.4	1.6	3.2
	1	4	1	2

12 x (02)

CH_4NO_2 (06)

(ii) $C_2H_8N_2O_4$ (10)

(iii) Ammonium oxalate (10)

2 (a) = 50 marks

(b) (i) The enthalpy change when one mole of CO_2 (g) is formed from C (granite) and O_2 (g) at a specified temperature and at 1 atm pressure. (10)

(ii) I. A.

	C	CO	CO_2	
Mass %	6 :	28 :	66	
No. of moles	$\frac{6}{12.0}$	$\frac{28}{28.0}$	$\frac{66}{44.0}$	(3x2=6)
Mole ratio	= 0.5	= 1.0	= 1.5	(3)
	1 :	2 .	3	(3)

B. $\frac{72.0g}{12.0\,g\,mol^{-1}} \times \frac{2}{6}$ (2)

= 2 mol (2)

C. $\frac{72.0g}{12.0\,g\,mol^{-1}} \times \frac{3}{6}$ (2)

= 3 mol (2)

D. $\frac{2}{6}$mol x 111 kJ mol⁻¹ + $\frac{3}{6}$mol x 394 kJ mol⁻¹ 2(1+1)

= 234 kJ (2+2)

II. $CO(g) + 1/2\ O_2(g) \longrightarrow CO_2(g)$

Enthalpy change when 1 mol of CO_2 is formed

= -394kJ - (-111kJ) (2+2)
= -283 kJ (1+1)

Reaction is exothermic (6)

2 (b) = 50 marks

03. (a) (i) $2C_xH_yO_z + \frac{1}{2}(4x+y-2z)\,O_2 \longrightarrow 2xCO_2 + yH_2O$
(2+2) (2+2) (2+2)

(ii) $C_xH_yO_z \xrightarrow{O_2} xCO_2 + \frac{y}{2}H_2O$

$C_xH_yO_z$	xCO_2	$\frac{y}{2}H_2O$
62 mmol	88 mmol	54mmol
62	44	18
1 mmol	2 mmol	3 mmol

(4)

$C_2H_6O_z$ ∴ x = 2 ∴ y = 6
(4) (4)

My = 12 x 2 + 1x 6 + 16 z = 62

∴ z = 2 (4)

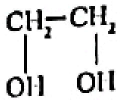
(iii) $\frac{62}{62}$ m mol of x gives $\frac{2}{2}$ m mol of H_2

That is, 1 m mol of x gives 1 m mol of H_2 (4)

Na reacts with 1 mol of OH gp, give 1/2 mol of H_2 (4)

∴ x has 2 OH gps (4)

∴ x is



$\underset{OH}{CH_2}-\underset{OH}{CH_2}$ (4)

3 (a) = 44 marks

(b) (i) In ethanol : hydrogen bonding / dipole - dipole attractive forces (4)

In methanoic acid : hydrogen bonding / dipole - dipole attractive forces (4)

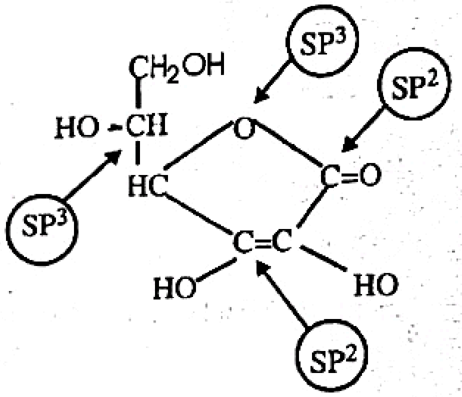
In propane : Vanderwaals attraction / London forces/ Dispersion forces/ attractive forces between non-polar molecules (4)

(ii) propane < ethanol < methanoic acid (4)

(iii) Hydrogen bonding is stronger than Vanderwaals forces. (4)
Between 2 molecules, ethanol has 1 hydrogen bond and methanoic acid has 2 hydrogen bonds (4)

3 (b) = 24 marks

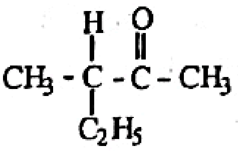
(c)



(4 x 4)

3 (c) = 16 marks

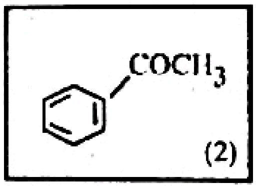
(d)



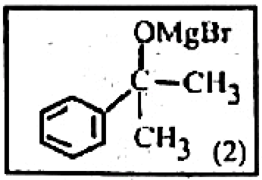
$CH_3-\overset{H}{\underset{C_2H_5}{C}}-\overset{O}{\overset{\|}{C}}-CH_3$ (16)

3 (d) = 16 marks

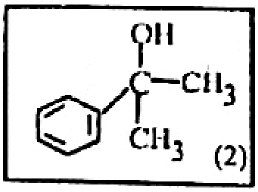
04. (a) (i)



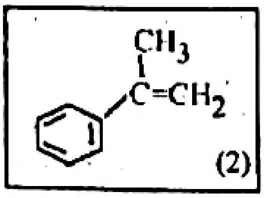
A



B



C



D

(ii)

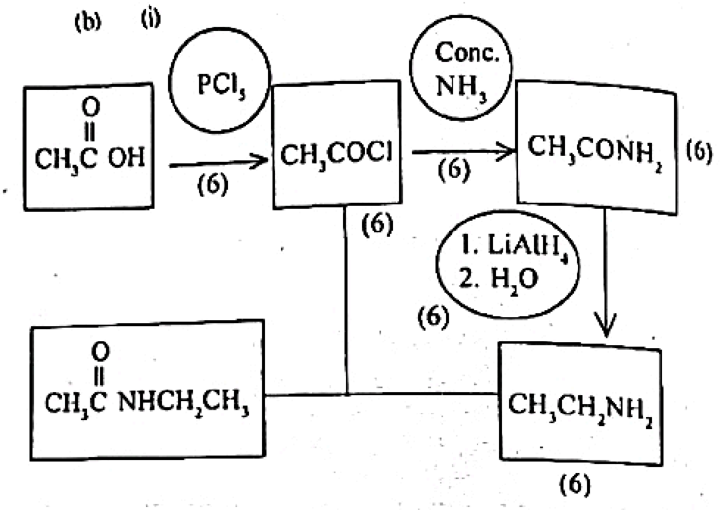
Reaction	1	2	3	4
Reaction type	S (2)	Ad (2)	S (2)	E (2)

(iii)

Reaction	Active Species	Electrophile/ Nucleophile
1	$CH_3C^+= O$ (2)	Electrophile (2)
2	CH^-_3 (2)	Nucleophile (2)

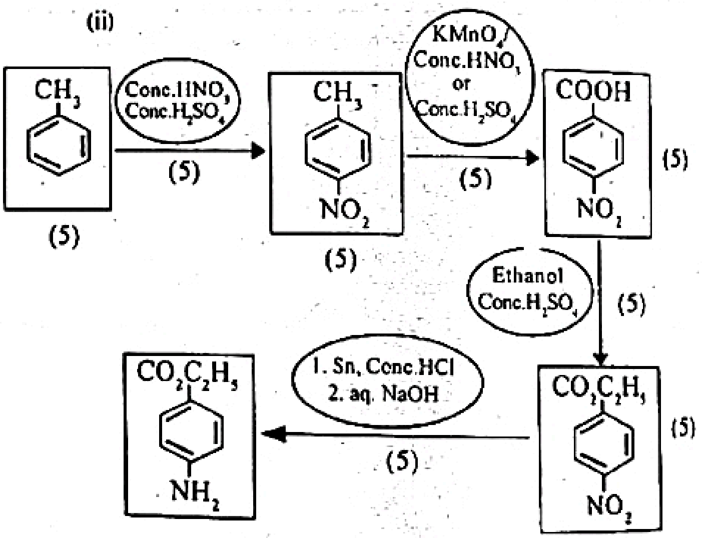
4 (a) = 24 marks

(b) (i)



(6 x 6 =36)

(ii)



5 x 8 =40

4 (b) = 76 marks

5. a) i) $X_{(g)} \rightleftharpoons 2Y_{(g)}$

Initially 2.0 .... mol

At eqm. 2.0 (1-25/100) $2 \times 2.0 \times (25/100)$ mol

2 x (2+1)

= 1.5 1.0 mol (2+1)

I. Total amount of X(g) and Y(g) at equilibrium

= 1.5 + 1.0 mol

= 2.5 mol (2+1)

Mole fraction of X(g) = 1.5 mol / 2.5 mol (3)

= 3/5 (or 0.6)

Mole fraction of Y(g) = 1.0 mol / 2.5 mol (3)

= 2/5 (or 0.4)

II. $Kp = \frac{(P_y)^2}{P_x}$

$= \frac{(2/5P)^2}{3/5\,P}$ (P = total pressure or $6.0 \times 10^5\ Nm^{-2}$) (3)

$= 4/15\ P$

Substituting for P,

$K_p = 4/15 \times 6.0 \times 10^5\ Nm^{-2}$ (2+1)

$= 1.6 \times 10^5\ Nm^{-2}$ (2+1)

a (i) = 30 marks

ii) I(A) $X_{(g)} \rightleftharpoons 2Y_{(g)} \rightleftharpoons Z_{(g)}$

Initially 2.0 — .... mol

At eqm. 1.0 0.5 mol OR

Amount of X dissociated = 1.0 mol (2+1)

Amount of Y initially formed = 2.0 mol (2+1)

Amount of Y then dissociated to yield 0.5 mol of Z = 1.0 mol (2+1)

Amount of y remained at equilibrium = 2.0 - 1.0 mol (2+1)

= 1.0 mol (2+1)

(B) $X_{(g)} \rightleftharpoons 2Y_{(g)} \rightleftharpoons Z_{(g)}$

At eqm. 1.0 1.0 0.5 mol

Total amount of X(g), Y(g) and Z(g) at equilibrium

= 1.0 + 1.0 + 0.5 mol

= 2.5 mol (2+1)

Mole fraction of X(g) = 1.0 mol / 2.5 mol

= 2/5 (or 0.4) (3)

Mole fraction of Y(g) = 1.0 mol / 2.5 mol

= 2/5 (or 0.4) (3)

Mole fraction of Z(g) = 0.5 mol / 2.5 mol

= 1/5 (or 0.2) (3)

(C) Apply pV = nRT at the two temperatures (3)

Total number of moles and the volume have not changed

$\frac{6.0 \times 10^5\ Nm^{-2}}{P} = \frac{450k}{600k}$ (2+1)

$P = 8.0 \times 10^5\ Nm^{-2}$ (2+1)

D) $Kp = \frac{(P_y)^2}{P_x}$

$= \frac{(2/5P)^2}{2/5\,P}$ (P = total pressure or $8.0 \times 10^5\ Nm^{-2}$) (3)

$= 2/5\ P$. (3)

Substituting for P, $Kp = 2/5 \times 8.0 \times 10^5\ Nm^{-2}$ (2+1)

$= 3.2 \times 10^5\ Nm^{-2}$ (2+1)

II (A) Assumption : 1. Ideal behavior (3)

2. The container does not expand OR volume does not change. (3)

(B) Kp has increased when the temperature is increased from 450 K to 600 K (3)

Therefore, the reaction is endothermic (3)

Total for part (a) (ii) = 60 marks

b) i) $K_D = \frac{[E]_{CHCl_3}}{[E]_{H_2O}}$ (3)

Let C = Concentration of E, in mol dm^{-3} . in the aqueous phase before partitioninge.

Amount of E initially present

$= C\ mol\ dm^{-3} \times 0.075\ dm^3$ (2+1)

After partition equilibrium,

Amount of E remaining in the equeous phase

$= C\ mol\ dm^{-3} \times 0.075\ dm^3 \times (1-75/100)$ (2+1)

$[E]_{H_2O} = \frac{C\ mol\ dm^{-3} \times 0.075\ dm^3 \times (1-75/100)}{0.075\ dm^3}$ (2+1)

$= C \times 25/100\ mol\ dm^{-3}$ (2+1)

Amount of E transferred to the organic phase

$= C\ mol\ dm^{-3}\ 0.075\ dm^3 \times (75/100)$ (2+1)

$[E]_{CHCl_3} = \frac{C\ mol\ dm^{-3}\ 0.075\ dm^3 \times (75/100)}{0.050\ dm^3}$ (2+1)

$= C \times 3/2 \times 75/100\ mol\ dm^{-3}$ (2+1)

$k_D = \frac{C \times 3/2 \times 75/100\ mol\ dm^{-3}}{C \times 25/100\ mol\ dm^{-3}}$ (2+1)

= 9/2 (or 4.5) (3)

Note : $K_D = 2/9$ if $K_D = \frac{[E]_{H_2O}}{[E]_{CHCl_3}}$ is used

Total for part (b) (i) = 30 marks

ii) Mole fraction of Y = 0.75 (5)

Mole fraction of X = 0.25 (5)

Mole ratio of X :Y = 0.25 : 0.75 or 1:3 (5)

II. Distill the mixture and collect the distillate (3)

According to the diagram, it will have more Y compared to the initial mixture (3)

Distill it again (3)

The distillate will have even more Y compared to that of the first distillate (3)

Continue this process until the distillate contains only Y. (3)

Total for part (b) (ii) = 30 marks

Total for part (b) = 60 marks

6. a) i) Point A

Concentration of H^+ from excess acid

$= \frac{(0.300 mol\ dm^{-3} \times 25.00 cm^3 - 0.300\ mol\ dm^{-3} \times 12.5 cm}{37.50\ cm^3}$ (3+2)

$= \frac{0.300\ mol\ dm^{-3} \times 12.50\ cm^3}{37.50\ cm^3}$ (3+2)

$= 0.100\ mol\ dm^{-3}$ (3+2)

Point B

Concentration of H^+ from excess acid.

$= \frac{0.300\ mol\ dm^{-3} \times 25.00 cm^3 - 0.300\ mol\ dm^{-3} \times 25.00 cm}{50.00\ cm^3}$

0 (3+2

OR.

The titration is between a strong acid and a strong base. (5)
H+ ions are only due to the ionization of water.

pH = 7.00 (5)

Point C

Concentration of OH^- from excess base

$$= \frac{(0.300\ mol\ dm^{-3} \times 50.00\ cm^3 - 0.300\ mol\ dm^{-3} \times 25.00 cm^3}{75.00\ cm^3} \quad (3+2)$$

$= 0.100\ mol\ dm^{-3}$. (3+2)

$pOH = -\log(0.100) = 1.00$

$pH = 14.00 - 1.00 = 13.00$ (5)

Total for part (a) (i) = 40 marks

ii)

Titration	Volume of NaOH added, cm^3		
	12.50	25.00	50.00
II	increased	unchanged	decreased
III	increased	increased	unchanged
IV	increased	increased	decreased

9 answers x 4 marks = 36 marks
Total for part (a) (ii) = 36 marks

ii) Point A

CH_3COOH is a weak acid OR Ionization of CH_3COOH is incomplete. (2)

$[H^+]$ in titration III < $[H^+]$ in titration I at the same point (2)
pH in titration III > pH in titration I (or pH is increased)

Point B

CH_3COOH has been completely converted to CH_3COONa (2)

CH_3COONa solutions are basic (2)

pH > 7 (or pH in titration III >pH in titration I)

Point C

This point characterized by the excess NaOH (2)

Volume and the concentrations of the acids in titrations I and III are the same (2)

Concentration of the base is the same (2)

pH is unchanged

part (a) (iii) = 14 marks
Total for part (a) = 90 marks

b) i) Let m = order of the reaction with respect to ClO_2 and
n = order of the reaction with respect to OH^-

rate $[ClO_2]^m\ [OH^-]^n$ or

rate $= k\,[ClO_2]^m\ [OH^-]^n$ (10)

Trial 1 : $[OH^-] = 1.0 \times 10^{-2} mol\ dm^{-3}$ (3+2)

$0.022\ mol\ dm^{-3} s^{-1} \propto [0.060\ mol\ dm^{-3}]^m\ [1.0 \times 10^{-2}\ mol\ dm^{-3}]^n$ ① (4+1)

Trial 2 :

$0.0025 mol\ dm^{-3} s^{-1} \propto [0.0201 mol\ dm^{-3}]^m [1.0 \times 10^{-2}\ mol\ dm^{-3}]^n$ ② (4+1)

Trial 3 : $[OH^-] = 1.0 \times 10^{-1}\ mol\ dm^{-3}$

$0.024\ mol\ dm^{-3} s^{-1} \propto [0.020\ mol\ dm^{-3}]^m\ [1.0 \times 10^{-1}\ mol\ dm^{-3}]^n$ 3 (④+1)

$$\frac{①}{②} \quad \frac{0.022}{0.0025} = \left(\frac{0.060}{0.020}\right)^m \quad (5)$$

$8.8 = 3^m$

$m \approx 2$ (5)

$$\frac{③}{②} \quad \frac{0.024}{0.0025} = \left(\frac{1.0 \times 10^{-1}}{1.0 \times 10^{-2}}\right)^n \quad (5)$$

$9.6 = 10^n$

$n \approx 1$ (5)

Total for part (b) (i) = 50 marks

ii) (I) Rate is increased when the temperation is increased (5)
(II) Mechanism is not changed when the temperature is increased.
Order with respect to each reactant is not changed. (5)

part (b) (ii) = 10 marks
Total for part (b) = 60 marks

7. (a) (i) $AgNO_3 (aq) + NaBr (aq) \rightleftharpoons AgBr(s) + NaNO_3(aq)$
or $Ag^+(aq) + Br^-(aq) \rightleftharpoons AgBr(s)$ (4)

I. $[Ag^+]_{aq} = 4.00 \times 10^{-3} mol\ dm^{-3} \times 25.00\ dm^3 / 100.00\ cm^3$
$= 1.00 \times 10^{-3} mol\ dm^{-3}$ (3+1)

$[Br^-]_{aq} = 8.00 \times 10^{-3}\ mol\ dm^{-3} \times 75.00 cm^3 / 100.00 cm^3$
$= 6.00 \times 10^{-3} mol\ dm^{-3}$ (3+1)

$[Ag^+]_{aq}[Br^-]_{aq} = (1.00 \times 10^{-3} mol\ dm^{-3}) \times (6.00 \times 10^{-3} mol\ dm^{-3})$
$= 6.00 \times 10^{-6} mol^2\ dm^{-6}$ (3+1)
$> K_{sp}$ of AgBr (4)

precipitation occurs (4)

II. Limiting reagent is $AgNO_3(aq)$ or $Ag^+(aq)$
or NaBr is in excess or Br^- is in excess (4)

Mass of precipitate
$= 4.00 \times 10^{-3} mol\ dm^{-3} \times 0.0250\ dm^{-3} \times 188.0 g\ mol^{-1}$
Or $= 1.00 \times 10^{-3} mol\ dm^{-3} \times 0.100 dm^3 \times 188.0 g\ mol^{-1}$ (6+2)
$= 0.0188$ g (3+1)

Total for part (a) (i) =40 marks

ii. Mass of Ag_2CrO_4 dissolved in $50.0\ cm^3$
$= 8.4 \times 10^{-5} mol\ dm^{-3} \times 332.0\ g\ dm^{-1} \times 0.050\ dm^3$ (3+1)
$= 0.00139$ g (4)
This is less than the mass of Ag_2CrO_4 used
Initially a reddish brown precipitate of Ag_2CrO_4 obseved (4)

Concentration of Cl^- in the final solution (of $100.0\ cm^3$)
$= 2.00 \times 10^{-5}\ mol\ dm^{-3} \times (50.0\ cm^3 / 100.0 cm^3)$ (3+1)
$= 1.00 \times 10^{-5}\ mol\ dm^{-3}$

Concentration of Ag^+ needed to precipitate AgCl (3+1)
$= Ksp\ [AgCl_s] / [Cl^-_{aq}]$
$= 1.8 \times 10^{-10} mol^2 dm^{-6} / 1.00 \times 10^{-5}\ mol\ dm^{-3}$ (3+1)
$= 1.8 \times 10^{-5} mol\ dm^{-3}$

Concentration of Ag^+ in a saturated solution of Ag_2CrO_4
$= 2x\ (8.4 \times 10^{-5})\ mol\ dm^{-3}$ (3+1)
$= 1.7 \times 10^{-4}\ mol\ dm^{-3}$ (3+1)
This is greater than the required concentration (4)
Therefore, AgCl precipitates as a white solid (4)

Alternative answer I

Concentration of Ag^+ in a saturated solution of Ag_2CrO_4
$= 2x\ (8.4 \times 10^{-5})\ mol\ dm^{-3}$
$= 1.7 \times 10^{-4}\ mol\ dm^{-3}$ (6+2)
$[Ag^+]_{aq}[Cl^-]_{aq} = (1.7 \times 10^{-4}\ mol\ dm^{-3}) \times (1{:}00 \times 10^{-5}\ mol\ dm^{-3})$
$= 1.7 \times 10^{-9}\ mol^2\ dm^{-6}$ (6+2)
$> K_{sp}\ (AgCl)$ (4)
Therefore, AgCl precipites as a white solid. (4)

Alternative answer II

Concentration of Ag^+ needed to precipitate AgCl
$= K_{sp}\ [AgCl]_s\ /\ [Cl^-]_{aq}$ (3+1)
$= 1.8 \times 10^{-10}\ mol^2\ dm^{-6}\ /\ 1.00 \times 10^{-5}\ mol\ dm^{-3}$
$= 1.8 \times 10^{-5}\ mol\ dm^{-3}$ (3+1)

Mass of Ag_2CrO_4 that would produce the above concentration
$= 1.8 \times 10^{-5}\ mol\ dm^{-3} \times (1/2) \times 0.100\ dm^3 \times 332 g\ mol^{-1}$ (3+1)
$= 0.00030\ g$ (3+1)
Mass of Ag_2CrO_4 (0.166g) is higher (4)
Therefore. AgCl precipitates as a white solid (4)
Molar solubility of AgCl $= (1.8 \times 10^{-10})\ mol\ dm^{-3}$
OR
$= 1.3 \times 10^{-5}\ mol\ dm^{-3}$ (3+1)
Molar solubility of AgCl < Molar solubility of Ag_2CrO_4 (4)
More Ag_2CrO_4 will come into solution as Ag+ is precipitated as AgCl (8)
yellow coloured supernatant solution is observed

part (a) (ii) = 60 marks
Total for part (a) = 100 marks

b) i) B (5)
ii) A (5)
iii) $Fe\ (s) \longrightarrow Fe^{2+}\ (aq) + 2e$ (5)
iv) $2H_2O(l) + O_2\ (g) + 4e \longrightarrow 4OH^-(aq)$ (5)
v) $2Fe(s) + 2H_2O(l) + O_2(g) \longrightarrow 2Fe^{2+}\ (aq) + 4OH^-(aq)$ (5)
vi) To show the formation of Fe^{2+} :
Add a solution of $K_3Fe(CN)_6$ (5)
Appearence of blue colour (5)

To show the formation of OH^- :
Add a few drops of phenolphthalein (5)
Red or pink colour (5)
vii) Corrosion or rust formation (5)
Total for part (b) = 50 marks

8 (a) (i) Balanced chemical equations

$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 10\ CO_2 + 2Mn^{2+} + 8H_2O$
OR
$\left.\begin{array}{l}2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \longrightarrow 10\ CO_2 + 2MnSO_4\\ \qquad\qquad + 8H_2O + K_2SO_4\end{array}\right\}$ (10)
OR
$MnO_4^- + 8H^+ + 5e \longrightarrow Mn^{2+} + 4H_2O$ (5)
$C_2O_4^{2-} \longrightarrow 2CO_2 + 2e$ (5)

$\left.\begin{array}{l}H^+ + OH^- \longrightarrow H_2O\\ \qquad OR\\ H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O\end{array}\right\}$ (5)

II. (A) Amount of MnO_4^- in 24.0 cm^3
$= \frac{0.05 \times 24.0}{1000}\ mol = 1.2 \times 10^{-3}\ mol$ (5)
Amount of $C_2O_4^{2-}$
$= \frac{0.05 \times 24.0 \times 5}{1000 \times 2}\ mol = 3.0 \times 10^{-3}\ mol$ (5)

Concenration of oxalicacid
$= 3.0 \times 10^{-3} \times \frac{1000}{25.0}\ mol\ dm^{-3}$ (5)
$= 0.12\ mol\ dm^{-3}$ (3+2)

(B)

$\begin{bmatrix}\text{Amount of } H^+\\ \text{ions from } H_2SO_4\end{bmatrix} = \begin{bmatrix}\text{Amount of } H^+\\ \text{ions remaining}\\ \text{after step (i)}\end{bmatrix} + \begin{bmatrix}\text{Amount of}\\ H^+ \text{ ions used}\\ \text{in step (i)}\end{bmatrix} - \begin{bmatrix}\text{Amount of}\\ H^+ \text{ ions from}\\ \text{oxalic acid}\end{bmatrix}$ (10)

Amount of H^+ remaining after step (i)
$= \frac{0.04 \times 15.0}{1000}\ mol = 6.0 \times 10^{-4}\ mol$ (5)
Amount of H^+ ions used in step (i) $= 8 \times 1.2 \times 10^{-3}\ mol$ (5)
Amount of H^+ from oxalic acid $= 2 \times 3.0 \times 10^{-3}\ mol$
$= 6.0 \times 10^{-3}\ mol$ (5)
Amount of H^+ from H_2SO_4
$= 6 \times 10^{-4}\ mol + 8 \times (1.2 \times 10^{-3}\ mol) - 2 \times (3.0 \times 10^{-3}\ mol)$
$= 4.2 \times 10^{-3}\ mol$ (5)
NO. of moles of H_2SO_4 in 25cm^3 of Y $= \frac{4.2}{2} \times 10^{-3}\ mol$ (5)
Concentration of H_2SO_4 $= 2.1 \times 10^{-3} \times \frac{1000}{25}\ mol\ dm^{-3}$ (5)
$= 0.084\ mol\ dm^{-3}$ (3+2)
Total for part (a) = 80 marks

(b) i) (I) Bleaching powder
$CaCO_3 \longrightarrow CaO + CO_2$ (5)
$CaO + H_2O \longrightarrow Ca(OH)_2$ (5)
$\left.\begin{array}{l}2Ca(OH)_2 + Cl_2 \longrightarrow Ca(OCl)_2 + CaCl_2 + H_2O\ \ OR\\ 3Ca(OH)_2 + 2Cl_2 \longrightarrow Ca(OCl)_2.CaCl_2.Ca(OH)_2 + 2H_2O\end{array}\right\}$ (10)

(II) $CaCO_3 \longrightarrow CaO + CO_2$
$3CaO + P_2O_5 \longrightarrow Ca_3(PO_4)_2$ OR
$3CaO + 2H_3PO_4 \longrightarrow Ca_3(PO_4)_2 + 3H_2O$ (10)
Balanced equations with $CaCO_3 + H_3PO_4$ are also accepted.

(III) $CaCO_3 \longrightarrow CaO + CO_2$
$CaO + 3C$ (coke) $\longrightarrow CaC_2 + CO$ (5)
$CaC_2 + 2H_2O \longrightarrow C_2H_2 + Ca(OH)_2$ (10)

(ii) Harmful to fauna (animals, fish) Harmful to flora (plants) Harmful to corals
Lowering of pH, Evolution of heat,
Evolution of CO_2, Evolution of Cl_2 (and other halogens)
any five - 5 x 05 = (25)
part (b) = 70 marks

9. (a) i) KI, $Fe_2(SO_4)_3$, $BaCl_2$, $K_4[Fe(CN)_6]$ (solutions are dilute identification by colour not accepted)
The two solutions that give a white ppt when mixed are $Fe_2(SO_4)_3$ and $BaCl_2$. (5) Take one of these solutions (we don't know which is which) and to the other two. (5) If the added solution does not produce any observale change (5), then the solution added is $BaCl_2$ (5). The other solution is $Fe_2(SO_4)_3$ (5)

Add this $Fe_2(SO_4)_3$ solution to the two remaining solutions (KI, $K_4[Fe(CN)_6]$) (5). That which produces ablue coloration / ppt is $K_4[Fe(CN)_6]$, the other is KI. (5) OR that which produces a brown colour (due to I_2) is KI, the other is $K_4[Fe(CN)_6]$

ii) React the two meta powders separately with the two solutions. (5)
The soloution that dissolves the metal powders is NaOH (5)
The other is NH_4Cl (5)
Now add NH_4Cl solution, to the two solutions of the metal powders in NaOH. (5)
The solution that produces a white ppt. (5) contains Al. (5)
The other contains Zn (No ppt is formed here) (5)

part (b) = 70 marks

b) i) A = $(NH_4)_2Cr_2O_7$ (15)
B = Cr_2O_3 (10)
C = N_2 (10)
D = Mg_3N_2 (10)
E = NH_3 (10)

$(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3 + N_2 + 4H_2o$

$3Mg + N_2 \rightarrow Mg_3N_2$

$Mg_3N_2 + 6H_2O \rightarrow 2NH_3 + 3Mg(OH)_2$

$(NH_4)_2Cr_2O_7 + 2Na_2CO_3 \rightarrow 2NH_3 + 2Na_2CrO_4 + H_2O + 2CO_2$

$$\left[\begin{array}{l} Cr_2O_3 + 4NaOH + 3H_2O_2 \rightarrow 2Na_2CrO_4 + 5H_2O \\ \text{OR} \\ Cr_2O_3 + 4OH^- + 3H_2O_2 \rightarrow 2CrO_4^{2-} + 5H_2O \end{array}\right]$$

5 x 5= 25
Total for part (b) = 80 marks

10. a) i) Reactions

$2Mn^{2+} + 4\,OH^- + O_2 \rightarrow 2MnO_2(s) + 2H_2O$
OR
$MnSO_4 + 2OH^- \rightarrow Mn(OH)_2 + SO_4^{2-}$

$2Mn(OH)_2(s) + O_2(aq) \rightarrow 2MnO(OH)_2(s)$
OR
$2Mn(OH)_2(s) + O_2(aq) \rightarrow 2MnO_2(s) + 2H_2O$
$MnO_2 + 4H^+ + 2I^- \rightarrow Mn^{2+} + 2H_2O + I_2$
$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$

(4 x 5= 20)

1mol $O_2 \equiv$ 2mol MnO_2 $\equiv$ 2mol I_2 $\equiv$ 4 mol $S_2O_3^{2-}$

The sample of water (250 cm^3) required 10.0cm^3 of 0.02 mol dm^{-3} $Na_2S_2O_3$

No. of moles of $S_2O_3^{2}$ required for titration

$= \frac{0.02 \times 10}{1000} = 2 \times 10^{-4}$ (5)

Amount of dissolved O_2 = $(2 \times 10^{-4}) / 4$ mol (5)
= 5.0×10^{-5} mol

Concentration of dissolved O_2

$= \frac{5.0 \times 10^{-5} \times 1000}{250}$ mol dm^{-3} (5)

$= 2 \times 10^{-4} \times 32$ g dm^{-3} = 0.0064 g dm^{-3} (5)
= 6.4 mg dm^{-3} (3+2)

iii) I) $H_2O_2 + 2H^+ + 2e \rightarrow 2H_2O$ (5)

$H_2O_2 \rightarrow O_2 + 2H^+ + 2e$ (5)

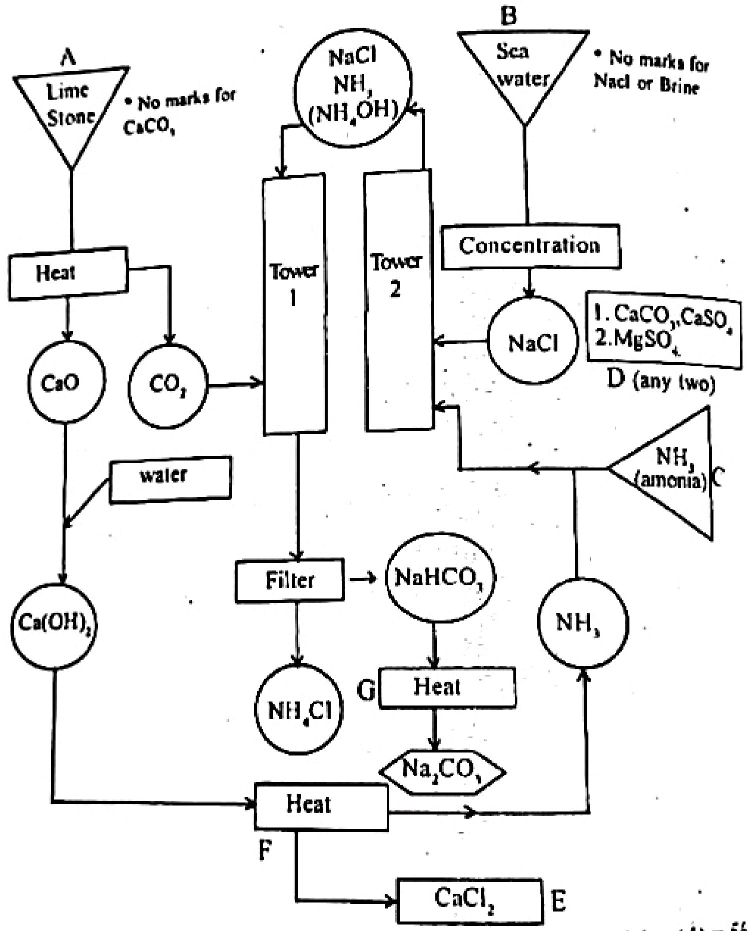
II) React a known volume (5) of H_2O_2 with excess (5) of KI solution (5) titrate the liberated I_2 with standard S_2O_3 (5)

OR

Titrate a known volume (5) of H_2O_2 with standard (5) acidified (5) $KMNO_4$ solution (5)

part (b) = 70 marks

10. (b)



14 x (4) = 56

(v) at F $2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + CaCl_2 + 2H_2O$ (5)

(vi) at G $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$ (5)

(vii) In tower 1

$$\left[\begin{array}{l} NH_3(g) + H_2O \rightleftharpoons NH_4^+ + OH^- \\ CO_2(g) + H_2O \rightleftharpoons HCO_3^- + H^+ \end{array}\right.$$

$$NH_4^+ + Na^+ + Cl^- + HCO_3^- \rightarrow NaHCO_3(s) + NH_4Cl$$

OR

$$NH_3 + NaCl + CO_2 + H_2O \rightarrow NaHCO_3(s) + NH_4Cl$$

OR

$$NH_3 + CO_2 + H_2O \rightarrow NH_4HCO_3$$

$$NH_4HCO_3 + NaCl \rightarrow NaHCO_3 + NH_4Cl$$

(9)

part (b) = 75 marks