G.C.E. (A/L) Examination
Chemistry - 2010

M.C.Q. Answers

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

PART A - STRUCTURED ESSAY

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

01.(a) (i) Na (Sodium) and F (Fluorine) (3+3)

(ii) N (Nitrogen) (3)

(iii) He (Helium) (3)

(iv) Any two out of B (Boron), Be (Beryllium), Al (Aluminium) (3+3)

(v) C (Carbon) (3)

(Vi) H (Hydrogen) (3)

(vii) First Na (Sodium) Seventh Cl (Chlorine) (3+ 3)

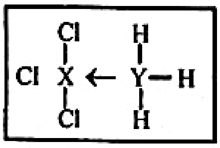
(Viii) Mg (Magnesium) (3)

(33 marks)

(b) (i) X = B Y = N (5+5)

(ii) XCl_3 : Trigonal planar YCl_3 : Pyramidal (5+5)

(iii)



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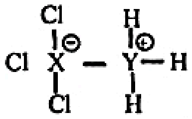


(5)

(iv) X : Tetrahedral Y : Tetrahedral (5 + 5)

35 marks

(c)

	Substance	Type of bond (ionic, polar covalent, nonpolar covalent	Type of intermolecular force (dipole - dipole, hydrogen bonding, london forces)
(i)	Iodine (solid)	nonpolar covalent (3)	London forces (3)
(ii)	Carbon tetra Chloride (liquide)	polar covalent (3)	London forces (3)
(iii)	Argon(liquide)	—	London forces (3)
(iv)	Sodium hydride (solid)	Ionic (3)	— (3)
(v)	Sulphur dioxide (gas)	polar covalent (3)	dipole - dipole and London forces (3+2)

(32 marks)
(Total 100)

02.(a) Let the weight of Mg in the alloy be x g (2)

∴ weight of Al in the alloy is (0.396 - x) g (2)

$2\,Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$ (3)

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$ (3)

moles of HCl required to react with xg of Mg = $\frac{X \times 2}{24}$ (5)

moles of HCl required to react with (0.396-X)g of Al (5)

$$= \frac{(0.396 - X) \times 3}{27}$$

number of moles of HCl in 10.0 cm^3 of 3.60 mol dm^{-3} HCl (5)

$$= \frac{3.60 \times 10}{1000}$$

(5)

$$\therefore \frac{X \times 2}{24} + \frac{(0.396 - X) \times 3}{27} = \frac{3.60 \times 10}{1000}$$

$$\frac{X}{12} + \frac{(0.396 - X)}{9} = \frac{3.60 \times 10}{1000}$$

$$\frac{X}{12} - \frac{X}{9} = \frac{36.0}{1000} - \frac{0.396}{9} = \frac{36.0}{1000} - 0.044$$

$$\frac{3X - 4X}{36} = \frac{36.0}{1000} - \frac{44}{1000}$$

$$\frac{X}{36} = \frac{8}{1000}$$ (3)

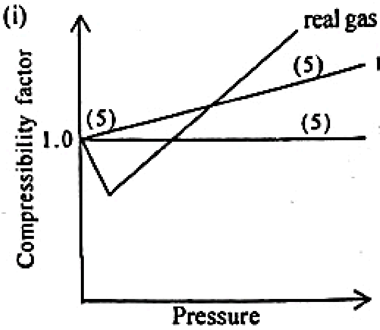
$$X = 0.288 \text{ g}$$ (2)

$$\therefore \%\ Mg = \frac{0.288 \times 100}{0.396}$$ (5)

$$= 72.7\ \%$$

(40 marks)

(b) (i)



(15

Note : Any one line / curve for a real gas is accepted.
Lines / curve should start at 1.0

(ii) (1) Presence of inter molecular attractions among real gaseous molecules

(2) Real gas molecules : have volumes / are not point masses / take space

(ii) I P_A = partial pressure of A after mixing

P_B = partial pressure of B after mixing

$2.0\ m^3 \times (3.0 \times 10^5\ Nm^{-2}) = 5.0\ m^3 \times P_A$ (1+1)

$P_A = 1.2 \times 10^5\ Nm^{-2}$ (2+1)

$3.0\ m^3 \times (5.0 \times 10^5\ Nm^{-2}) = 5.0\ m^3 \times P_B$ (1+1)

$P_B = 3.0 \times 10^5\ Nm^{-2}$ (2+1)

$P_{tot} = 1.2 \times 10^5\ Nm^{-2} + 3.0 \times 10^5\ Nm^{-2}$ (1+1)

$= 4.2 \times 10^5\ Nm^{-2}$ (2+1)

II.

Mole fraction of B $= \frac{n_B}{n_A + n_B}$ (3)

$= \frac{P_B}{P_A + P_B}$ (3)

$= \frac{3.0 \times 10^5\ Nm^{-2}}{4.2 \times 10^5\ Nm^{-2}}$ (1) + (1)

$= \frac{5}{7}$ or 0.71 (2)

(III) $\frac{P_B^{T_2}}{P_B^{T_1}} = \frac{T_2}{T_1}$ (3)

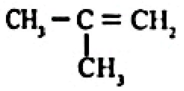
$P_B^{T_2} = \frac{350\ K \times 3.0 \times 10^5\ Nm^{-2}}{300K}$ (3 + 1)

$= 3.5 \times 10^5\ Nm^{-2}$ (2 + 1)

Note : Nm^{-2} or Pa is acceptable

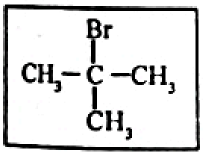
(60 marks)

3.(a)(i)



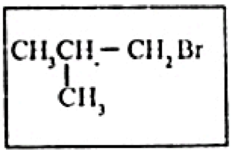
$CH_3-\underset{CH_3}{C}=CH_2$ (5)

(iii)



$CH_3-\overset{Br}{\underset{CH_3}{C}}-CH_3$ (3)

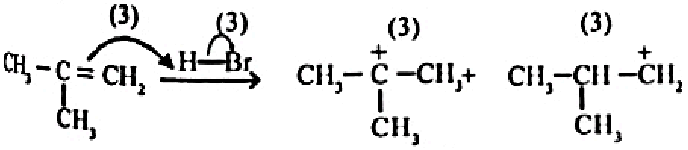
P : Major product



$CH_3\underset{CH_3}{CH}-CH_2Br$ (3)

Q : Minor product

(iii)

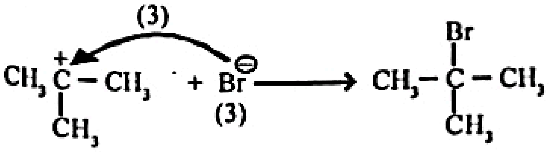


$\overset{(3)}{}\ CH_3-\underset{CH_3}{C}=CH_2 \xrightarrow{H-Br\ (3)} \overset{(3)}{CH_3-\overset{+}{\underset{CH_3}{C}}-CH_3} + \overset{(3)}{CH_3-\underset{CH_3}{CH}-\overset{+}{C}H_2}$

More stable carbocation (3)

a reason for the stability of the carbocation (3)

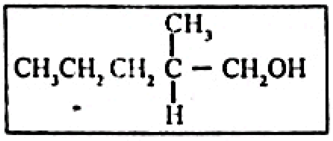
The reaction proceed via the more stable carbocation



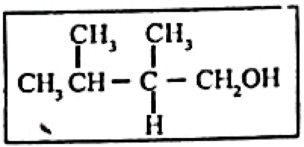
$CH_3\overset{+}{\underset{CH_3}{C}}-CH_3 + \underset{(3)}{Br^{\ominus}} \xrightarrow{} CH_3-\overset{Br}{\underset{CH_3}{C}}-CH_3$ (3)

(35 marks)

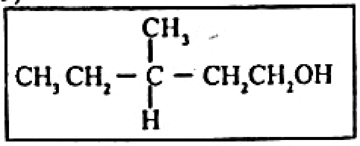
(b) (i)



$CH_3CH_2CH_2\overset{CH_3}{\underset{H}{C}}-CH_2OH$ (5)

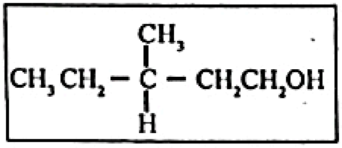


$CH_3\overset{CH_3}{CH}-\overset{CH_3}{\underset{H}{C}}-CH_2OH$ (5)



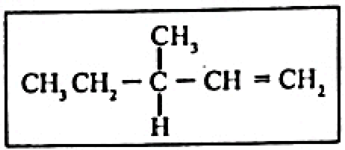
$CH_3CH_2-\overset{CH_3}{\underset{H}{C}}-CH_2CH_2OH$ (5)

(ii)



$CH_3CH_2-\overset{CH_3}{\underset{H}{C}}-CH_2CH_2OH$

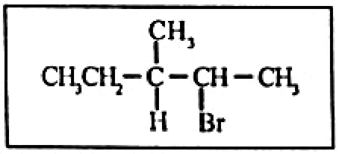
A (5)



$CH_3CH_2-\overset{CH_3}{\underset{H}{C}}-CH=CH_2$

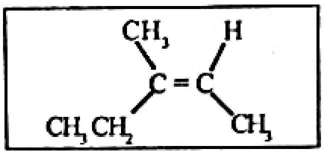
B (5)

(iii)

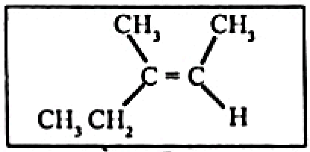


$CH_3CH_2-\overset{CH_3}{\underset{H}{C}}-\underset{Br}{CH}-CH_3$

C (10)



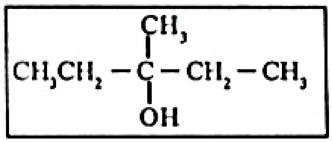
D (10)



E (10)

For one structure without stereochemistry for D/E (10)

(iv)



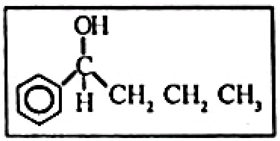
$CH_3CH_2-\overset{CH_3}{\underset{OH}{C}}-CH_2-CH_3$ (10)

F

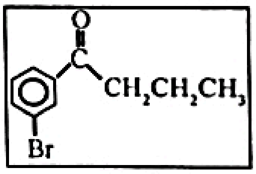
04. (a) (i)

$CH_3C\equiv\bar{C}\overset{+}{Na}$

P (3)



Q (3)



R (3)

(ii) H_2/Ni (Pd or Pt)

X (3)

$K_2Cr_2O_7/H^+$ or $KMnO_4/H^+$ or pyridinium chlorachromate

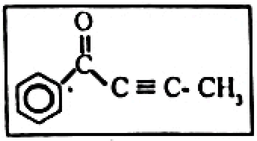
Y(3)

Alternative acceptable answer :

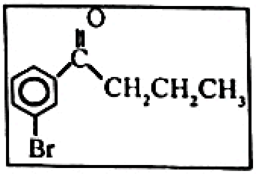
04. (a) (i)

$CH_3C\equiv\bar{C}\overset{+}{Na}$

P



Q



R

(ii) $K_2Cr_2O_7/H^+$

X

H_2/Ni (Pd or Pt)

Y

Note : $KMnO_4$ cannot be used in this alternative answer

(iii) Reaction 1 AB

(3)

Reaction 2 S_E

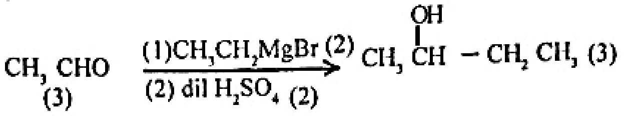
(3)

(iv) $CH_3C\equiv C\ CH_3$ (4)

(b) Preparation of Grinard Reagent : `18 marks

$$\underset{(3)}{CH_3CHO} \xrightarrow[(2)]{NaBH_4} \underset{(3)}{CH_3CH_2OH} \xrightarrow[(2)]{PBr_3} \underset{(3)}{CH_3CH_2Br} \xrightarrow[dry\ Et_2O]{Mg} (2) \downarrow \underset{(3)}{CH_3CH_2MgBr}$$

Preparation of alcohol : 10 marks

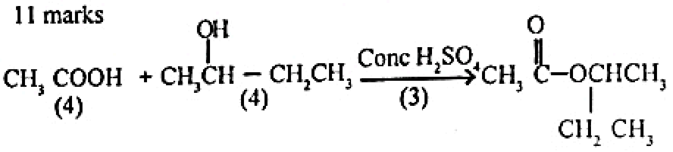


$$\underset{(3)}{CH_3\,CHO} \xrightarrow[(2)\ dil\ H_2SO_4\ (2)]{(1)CH_3CH_2MgBr\ (2)} CH_3\overset{\overset{OH}{|}}{C}H - CH_2\,CH_3\ (3)$$

Preparation of the acid : 08 marks

$$\underset{(3)}{CH_3\,CHO} \xrightarrow[dil\ H_2SO_4]{K_2Cr_2O_7\ (2)} CH_3COOH\ \ (3)$$

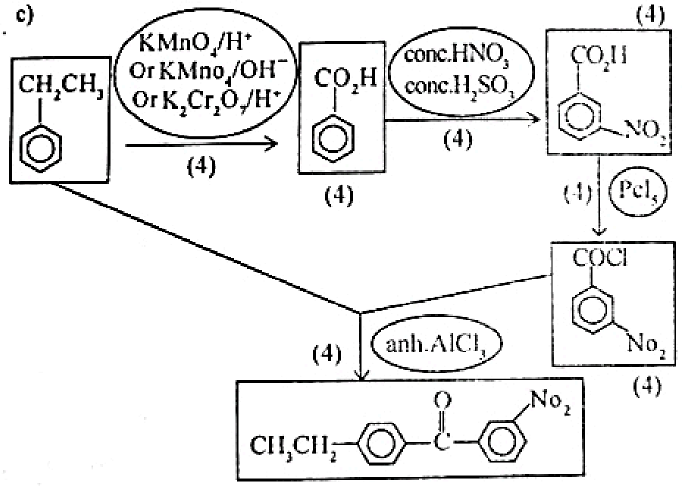
Using correct acid and alcohol to prepare the desired product : 11 marks



$$\underset{(4)}{CH_3\,COOH} + \underset{(4)}{CH_3\overset{\overset{OH}{|}}{C}H - CH_2CH_3} \xrightarrow[(3)]{Conc\ H_2SO_4} CH_3\overset{\overset{O}{\|}}{C}-\underset{\underset{CH_2\,CH_3}{|}}{O}CHCH_3$$

(47 marks)

c)



(28 marks)

5. (a)

$O_2(g) \longrightarrow 2O\,(g)$ $\Delta H_1 = 498$ kJ mol^{-1} (1) (4 +1)

$O(g) + e \longrightarrow O^-(g)$ $\Delta H_2 = -149$ kJ mol^{-1} (2) (4 +1)

$O^-(g) + e \longrightarrow O^{2-}(g)$ $\Delta H_3 = 798$ kJ mol^{-1} (3) (4 +1)

$Mg(s) \longrightarrow Mg(g)$ $\Delta H_4 = 148$ kJ mol^{-1} (4) (4 +1)

$Mg(g) \longrightarrow Mg^+(g) + e$ $\Delta H_5 = 738$ kJ mol^{-1} (5) (4 +1)

$Mg^+(g) \longrightarrow Mg^{2+}(g) + e$ $\Delta H_6 = 1451$ kJ mol^{-1} (6) (4 +1)

$Mg^{2+} + O^{2-}(g) \longrightarrow MgO(s)$ $\Delta H_7 = -3791$ kJ mol^{-1} (7) (4 +1)

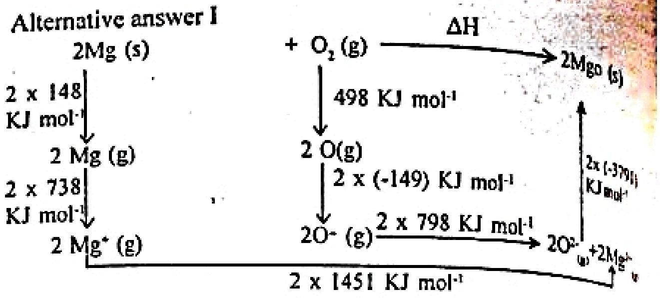
$$\overbrace{(1) + [2 \times (2)] + [2 + (3)]}^{(05)} \overset{(+)}{} + \overbrace{[2x(4)] + [2 \times (5)] + [2x(6)]}^{(05)} \overset{(+)}{} + \overbrace{[2 \times (7)]}^{(03)}$$

$2\,Mg(s) + O_2(g) \rightarrow 2MgO(s)$

$\Delta H = 498 + 2\,(-149) + 2\,(798) + 2(148) + 2\,(738) + 2\,(1451) +$
$2\,(-3791)$ KJ mol^{-1} (5 +2)
$= -1112$ KJ mol^{-1} (3 +2)

Total for 5 (a) = 60 marks

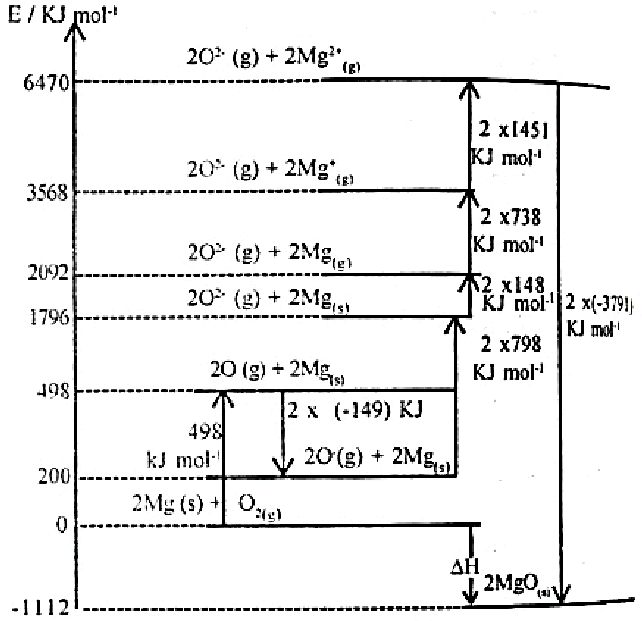
Alternative answer I



7 steps x (04) + 7 values & units x (01) = (35)
correct stoichiometry : Oxygen involving reactions (5) + Mg involving reactions (5) + Combination of $[Mg^{2+}(g) + O^{2-}(g)]$ (3) = (13)

$\Delta H = 498 + 2\,(-149) + 2\,(798) + 2\,(148) + 2(738) + 2\,(1451)$
$+ 2\,(-3791)$ KJ mol^{-1} (5 + 2)
$= -1112$ KJ mol^{-1} (3 + 2)

Alternative answer II



7 steps x (04) + 7 values & units (on the energy axis or on arrows) x (01) = (35)

Correct stoichiometry : Oxygen involving reactions (05) + Mg involving reactions (05) + Combination of $[Mg^{2+}(g) + O^{2-}(g)]$ (03) = (13)

$\Delta H = 498 + 2\,(-149) + 2\,(798) + 2\,(148) + 2\,(738) + 2\,(1451)$ (5+2)
$+ 2\,(-3791)$ kJ mol^{-1} (3+2)
$= -1112$ kJ mol^{-1}

b) $A\,(g) \rightleftharpoons 2B\,(g)$

(i) I PV = nRT or n = PV / RT (03)

$$n = \frac{(9.00 \times 10^5\ Nm^{-2}) \times (4.157 \times 10^{-3}\ m^3)}{(8.314\ J\ mol^{-1}\ K^{-1}) \times 600\ K}$$ 4 terms x (2 + 1) = 12

0.750 ml (2 +1)

(5b (i) I = 18 marks

II. $A\,(g) \rightleftharpoons 2B\,(g)$ (2+1)

	A (g)	2B (g)	
Initially	0. 45	.... mol	(2+1)
At eqm..,	0.45 - X	2X mol	(3)

0. 45 - X + 2X = 0.750 (3)
X = 0.750 - 0.45 = 0.30 (3)
number of mol of A at equilibrium = 0 45 - 0.30 = 0.15 (3)
number of mol of B at equilibrium = 2 x 0.30 = 0 6 (3)

5b (i) II = 18 marks

(3)

(iii) $K_P = \dfrac{P_B^2}{P_A}$

$= \dfrac{(X_B P)^2}{X_A P}$ (3)

Where X is the mole fraction and P is the total pressure.

$= \dfrac{X_B^2 P}{X_A}$

$X_A = \dfrac{0.15}{0.75} = \dfrac{1}{5}$; $X_B = \dfrac{0.60}{0.75} = \dfrac{4}{5}$

$P = 9.00 \times 10^5\ Nm^{-2}$ 2 x (3) = (6)

$\therefore K_P = \dfrac{\left(\frac{4}{5}\right)^2 \times (9.00 \times 10^5\ Nm^{-2})}{(1/5)}$ (3)

$= 2.88 \times 10^6\ Nm^{-2}$ (2 + 1)

To calculate K_C,

$K_P = K_C (RT)^{\Delta n}$ or $K_P = K_C RT$ or $K_C = \dfrac{K_P}{RT}$ (3)

$\therefore K_C = \dfrac{2.88 \times 10^6\ Nm^{-2}}{(8.314\ J\ mol^{-1}\ K^{-1}) \times 600K}$ 3terms x (2 + 1) = (9)

$= 577\ mol\ m^{-3}$ or $0.577\ mol\ dm^{-3}$ (2 + 1)

Alternative answer for part III

$K_C = \dfrac{C_B^2}{C_A}$ (3)

$= \dfrac{(n_B/v)^2}{(n_A/v)}$ (3)

where n is the number of moles and v is the volume

$= {n_B^2}/{n_A}v$ (3)

$K_c = \dfrac{(0.60\ mol)^2}{(0.15\ mol) \times (4.157 dm^3)}$ 3terms x (2 + 1) = (9)

$0.577\ dm^3$ or $577\ m^3$ (2+1)

To calculate K_C,

$K_p = K_c (RT)^{\Delta n}$ or $K_p = K_C RT$ (3)

$K_p = (577\ m^3)(8.314\ J\ mol^{-1}\ k^{-1})(600\ k)$ 3terms x (2 +1) = (9)

$= 2.88 \times 10^6\ Nm^{-2}$ (2+1)

5 b (i) III = 36 marks

5 b (i) = 72 marks

(ii)

	A (g)	$\rightleftharpoons$	2 B (g)	
Initial eqm.,	0.15		0.60 mol	
Added			0.30 mol	
New condition	0.15		0.90 mol	
At eqm.,	0.15 + X		0.90- 2X mol	(2 + 1)

$P_A = \dfrac{n_A RT}{V}$

$= \dfrac{(0.15 + X)\ mol \times (8.314\ J\ mol^{-1}\ k^{-1}) \times 600\ K}{4.157 \times 10^{-3}\ m^3}$ 4 terms x (2+1)= (12)

$= 1.2 \times 10^6 \times (0.15 + X)\ Nm^{-2}$ (02 + 01)

Alternative answer

Total number of mol of A and B = $(0.15+X) + (0.90 - 2X) = 1.05 - X$ (03)

Mole fraction of A $= \dfrac{0.15+X}{1.05 - X}$ (02)

Partial pressure of A (P_A) = mole fraction x total pressure (P)

$P = \dfrac{nRT}{V}$

$\therefore P = \dfrac{[(1.05 - X)\ mol]\ (8.314\ J\ mol^{-1}\ K^{-1})(600\ K)}{4.157 \times 10^{-3}\ m^3}$ (4+4) , OR

$P \propto (1.05 - x)\ mol$ } (2+2)

$9 \times 10^5\ Nm^{-2} \propto 0.75\ mol$

$P = \dfrac{[(1.05 - X)\ (9.00 \times 10^5)\ Nm^{-2}]}{0.75}$ (2+2)

OR

$P_A = \dfrac{0.15 + X}{1.05 - X} \times \dfrac{[(1.05 - X)\ mol]\ (8.314 J\ mol^{-1} K^{-1})\ (600\ K)}{4.157 \times 10^{-3}\ m^3}$

OR

$P_A = \dfrac{0.15 + X}{1.05 - X} \times \dfrac{[(1.05 - X)\ (9.00 \times 10^5) Nm^{-2}]}{0.75}$ (02)

$\therefore P_A = 1.2 \times 10^6 \times (0.15 + X)\ Nm^{-2}$ (02 +01)

5 b (ii) = 18 marks

Total for 5b = 90 marks

6 (a) (i) Rate $\propto [X]^{\alpha}[Y]^{\beta}$ or Rate $= K\ [X]^{\alpha}[Y]^{\beta}$ (06)

α = order of reaction with respect to X

β = order of reaction with respect to Y

Note : Any other symbols can be used to represent order with respect to each reactant.

6a (i) = 6 marks

(ii) Substitute the data given in Experiments 1,2 and 3 in the above rate expresion.

Expt. 1 : $0.0020 mol\ dm^{-3}s^{-1} \propto [1.0\ mol\ dm^{-3}]^{\alpha}\ [0.5\ mol\ dm^{-3}]^{\beta}$ — (01) (2 +1)

Expt. 2: $0.0010 mol\ dm^{-3}s^{-1} \propto [0.5\ mol\ dm^{-3}]^{\alpha}\ [0.5\ mol\ dm^{-3}]^{\beta}$ — (02) (2 +1)

Expt. 3 : $0.0040 mol\ dm^{-3}s^{-1} \propto [0.50\ mol\ dm^{-3}]^{\alpha}\ [1.0\ mol\ dm^{-3}]^{\beta}$ — (03) (2 +1)

(1) / (2), $2 = 2^{\alpha}$

$\alpha = 1$ OR order of reaction with respect to X = 1 (3)

(3) / (2), $4 = 2^{\beta}$

$\beta = 2$ OR order of reaction with respect to Y = 2 (3)

OR valid qualitative arguments to show

that $\alpha = 1$ (05) and $\beta = 2$ (05)

Example : Compare Experiment 1 and Experiment 2

The concentration of X is decreased by a factor of two, while keeping the concetration of Y constant, the rate of the reaction decreases by a factor of 2 (2)

$\therefore$ Order of reaction with respect to X = 1 (3)

6a (ii) = 15 marks

(iii) rate (r) $\propto [0.5\ mol\ dm^{-3}]^{\alpha}\ [2.0\ mol\ dm^{-3}]^{\beta}$ .... (04) (2+1)

(04) / (03) $\dfrac{r}{0.0040\ mol\ dm^{-3}s^{-1}} = 2^{\beta}$ (3)

$r = 2^2 \times 0.0040\ mol\ dm^{-3}S^{-1}$

$= 0.016\ mol\ dm^{-3}S^{-1}$ (2+1)

6a (iii) = 09 marks

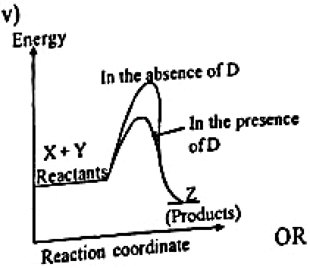
Note : Equation (4) can be divided by any of the three equations (1), (2) or (3)

(iv) It acts as a catalyst.

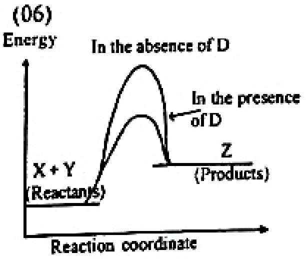
6a (iv) = 06 marks

(06)

(v)



OR



Curve with D (2)
Labelling reactants (2)
Labelling X-axis (2)

Curve with no D (2)
Labelling products (2)
Labelling Y-axis (2)

6 a (v) = 12 marks

(vi) Rate in increased (3) when the temperature is increased from 30°C to 50°C (3)

When the temperature is increased,

Kinetic energy (or speed or velocity) of reactants increases (3)

Fraction of reactant molecules having the energy greater than activation energy increases

Number of collisions per unit time increases (3)

∴ Rate increases.

6 a (vi) = 12 marks

Total for 6a = 60 marks

b (i) Solution P

$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$ (3)

Initially 0.056 ....moldm^{-3}

At eqm., 0.056 - X   X   X moldm^{-3}

(2+1)

$$Ka = \frac{[CH_3COO^- aq][H_3O^+ aq]}{[CH_3COOH(aq)]} \quad (3)$$

$$= \frac{X^2}{0.056 - X} \quad (3)$$

$$\therefore \frac{X^2}{0.056 - X} = 1.8 \times 10^{-5}$$

0.056 - X Ω0.056

$X^2 = 0.056 \times 1.8 \times 10^{-5}$ or $X^2 = 1.0 \times 10^{-6}$ (3)

$X = 1.0 \times 10^{-3}$ (3)

$pH = -\log(1.0 \times 10^{-3}) = 3.00$ (3)

Solution Q

$$[H_3O^+] = \frac{50.0\ cm^3 \times 0.200\ mol\ dm^{-3}}{(50.0 + 50.0)\ cm^3} \quad (5+1)$$

$= 0.100\ mol\ dm^{-3}$

pH = -log (0.100)

= 1.000 (3)

Solution R

$$[OH^-] = \frac{50.0cm^3 \times 0.022mol\ dm^{-3} - 50.0cm^3 \times 0.020mol\ dm^{-3}}{(50.0 + 50.0)\ cm^3} \quad (2)$$

$= 0.0010\ mol\ dm^{-3}$ (3 + 1)

POH = - log (0.0010) (03)

= 3.0

PH = 14. 0 - 3.0 = 11. 00

Alternative answer

$[H_3O^+] = 1.0 \times 10^{-11}\ mol\ dm^{-3}$ (03)

$PH = -\log(1.0 \times 10^{-11})$

= 11.00 (03)

6b(i) I = 42 marks

Assumptions

Solution P

- Amount of CH_3COOH ionized is negligible compared to the initial concentration (3)

  OR fraction of CH_3COOH ionized is very small
- Contribution from the ionization of H_2O to the overall H_3O+ concentration is negligible. (no marks)

Solution Q

- Contribution from hte ionization of CH_3COOH to the overall H_3O^+ concentration is negligible. (3)
- Contribution from the ionization of H_2O to the overall H_3O^+ concentration is neglible (no marks)

Solution R

- Contritibution from the ionization of H_2O to the overall H_3O+ concentration is neglibible (3)

6b(i) II = 09 marks

III Use solutions P and S (3)

Mix a larger volume of P and a smaller volume of S

After mixing, the solution has a mixture of CH_3COOH and CH_3COONa and the solution acts as a buffer (3) (3)

6 b (i) III = 9 marks

6 b (i) = 60 marks

(ii) I

- Take a small volume of the indicator into a test tube. Add the HCl acid solution dropwise until a colour change of the solution occurs. (4)
- Measure the pH of the solution at this point (4)
- Place another portion of the indicator in a test tube. Add the NaOH solution dropwise until a colour change of the solution occurs (04)
- Measure the pH of the solution at this point (4)
- The two pH values obtained represent the colour changing pH range of the indicator. (4)

6b(ii) I = 20 marks

(ii) Figure 1 : M or N (5)

Figure 2 : L (5)

6b (ii) II = 10 marks

6b (ii) = 30 marks

Total for 6b = 90 marks

(7) (a) (i) $E_{Cell} = 0.34V - (-2.37V)$ (2)

$= 2.71\ V$ (3)

(ii) No Change (5)

Only the cations are involved in the electrode reactions (5)

Although the anion is replaced, the concenration of the cation is not changed. (5)

(iii) To maintain electrical neutrality throughout the cell (5)

(OR to facilitate migration of ions-award only 2 marks)

KCl, KNO_3, NH_4Cl OR NH_4NO_3 (5)

(iv) Cu electrode (5)

(v) I Cathode reaction : $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$ (5)

II Anode reaction : $Mg(s) \rightarrow Mg^{2+}\cancel{(s)} + 2e$ [illegible] (5)

III Overall reaction : $Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$ (5)

(vi) F (5)

(vii) I E : $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e$ (5)

II F : $2H^+(aq) + 2e \rightarrow H_2(g)$ (5)

(viii) I No Change (5)

II No Change (5)

Total for 7a = 75 marks

b (i) $Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$

$K_{sp}(AgBr) = [Ag^+aq)][Br^-(aq)]$ (5)

$$[Ag^+(aq)] = \frac{K_{sp}(AgBr)}{[Br^-(aq)]}$$

$$= \frac{5.0 \times 10^{-13}\ mol^2\ dm^{-6}}{0.0010\ mol\ dm^{-3}} \quad (3+2)$$

$= 5.0 \times 10^{-10}\ mol\ dm^{-3}$ (3+2)

7b (i) = 15 marks

(ii) For AgCl precipitation,

$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$ (5)

$K_{sp}(AgCl) = [Ag^+(aq)]\,[Cl^-(aq)]$

Concentration of Ag^+ required for AgCl precipitation,

$[Ag^+ aq] = \dfrac{K_{sp}(AgCl)}{[Cl^- \; aq]}$

$= \dfrac{1.7 \times 10^{-10}\ mol^2\ dm^{-6}}{0.0020\ mol\ dm^{-3}}$ (3+2)

$= 8.5 \times 10^{-8}\ mol\ dm^{-3}$ (3 + 2)

Maximum concentration of Br- remaining in solution when AgCl precipitation occurs,

$[Br^-(aq)] = \dfrac{Ksp(AgBr)}{[Ag^+(aq)]}$ (5)

$= \dfrac{5.0 \times 10^{-13}\ mol^2\ dm^{-6}}{8.5 \times 10^{-8}\ moldm^{-3}}$ (3 + 2)

$= 5.9 \times 10^{-6}\ mol\ dm^{-3}$ (3 + 2)

7b (ii) = 30 marks

(iii) 1. Addition of the $AgNO_3$ solution does not change the volume of the solution. (5)

2. Temperature of the solution is not changed during the addition of the $AgNO_3$ solution. (5)

7b (ii) = 10 marks

(iv) $Ag^+(aq) + Cl^-(aq) \overset{\rightleftharpoons \text{ or }}{\longrightarrow} AgCl(s)$ (5)

$AgCl(s) + 2NH_3(aq) \rightleftharpoons Ag(NH_3)_2^+(aq) + Cl^-_{(aq)}$ (5)

Equilibrium constant (Formation constant) of the latter reaction is very high due to the stability of the silver - ammine ($Ag\text{-}NH_3$) complex. (5)

∴ AgCl precipitate readily dissolves in aqueous ammonia (5)

7b (iv) = 20 marks

Total for 7b = 75 marks

PART C

(08) (a) (i)

Formula	Oxidation State	Common name	acidic/ basic/ neutral character
1. N_2O	+ 1	nitrous Oxide	neutral
2. NO	+ 2	nitric Oxide	neutral
3. N_2O_3	+ 3	dinitrogen trioxide/ nitrogen trioxide/ nitrogen sesquioxide	acidic
4. N_2O_4 / NO_2	+ 4	dinitrogen tetraoxide/ nitrogen dioxide/	acidic
5. N_2O_5	+5	dinitrogen pentoxide/ nitrogen pentoxide	acidic

(01 x 20)

(ii) • N_2O

gentle heating of NH_4NO_3

$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$ / $NH_4NO_3 \xrightarrow{\Delta} N_2O$

• NO

reacting Cu with dil HNO_3 /

$3\,Cu + \text{dil } 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$/

$Cu + \text{dil } HNO_3 \longrightarrow NO$

• N_2O_3

$NO + NO_2 \xrightarrow[\text{low temp}]{-20°C \text{ or}} N_2O_3$

• NO_2

reacting Cu with conc. HNO_3

$Cu + \text{conc. } 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$ /

$Cu + \text{conc. } HNO_3 \longrightarrow NO_2$/

$Pb(NO_3)_2 \xrightarrow{\Delta} NO_2$

$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

• N_2O_4

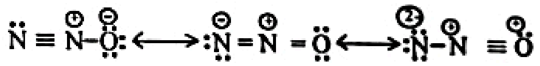
$NO_2 \xrightarrow[\text{temp}]{\text{low}} N_2O_4$ (NO_2 preparation must be given)

• N_2O_5

$\text{conc. } HNO_3 \xrightarrow{P_4O_{10}} N_2O_5$

Any three (4 x 3)

(iii)



(4 x3)

(iv) NO, NO_2

$NO \xrightarrow{\text{Cooled}} N_2O_2$ (4)

$NO_2 \xrightarrow{\text{Cooled}} N_2O_4$ (4)

$NO + NO_2 \xrightarrow{\text{Cooled}} N_2O_3$ / N_2O_4 / N_2O_2 (4)

(b) (i) M = Cu (Copper) X = C (Carbon) (5 + 5)

(ii) $1S^2\ 2S^2\ 2p^6\ 3S^2\ 3p^6\ 3d^{10}\ 4S^1$

(iii) + 1, +2 (3 + 3)

(iv) C - $[CuCl_4]^{2-}$

D - $[Cu(H_2O)_6]^{2+}$ and any one of

$[CuCl_4]^{2-}$, $[CuCl(H_2O)_5]^+$, $CuCl_2(H_2O)_4$ (5)

E - $[Cu(H_2O)_6]^{2+}$

G - $[Cu(NH_3)_4]^{2+}$, ($[Cu(NH_3)_4(H_2O)_2]^{2+}$ is also acceptable)

(2 x 5)

* $[CuCl_4]^{2-}$ - Tetrachlorocuprate (II) ion

* $[Cu(H_2O)_6]^{2+}$ - Tetraaquacopper (II) ion

$[CuCl(H_2O)_5]^+$ - Pentaaquachlorocopper (II) ion

$[CuCl_2(H_2O)_4]$ - Tetraaquadichlorocopper (II)

* $[Cu(NH_3)_4]^{2+}$ - Tetrammine copper (II) ion
$[Cu(NH_3)_4(H_2O)_2]^{2+}$ - Tetraamminediaquacopper (II) ion (2 x 3)

IUPAC names are expected of the compounds marked with an *

(v) B - CO_2, F - $Cu(OH)_2$ (4 +4)

(vi) $2Cu^{2+} + 4I^- \rightarrow 2CuI\downarrow + I_2$ (3)

(vii) Weight a known amount of A (Wg) (1)
Dissolve in dil. HCl (minimum quantity)
Dilute with H_2O (1)
Add excess KI (1)
Titrate the liberated I_2 with $Na_2S_2O_3$ of known concentration ($C\ mol\ dm^{-3}$) (2)

$2Cu^{2+} + 4I^- \rightarrow 2CuI + I_2$
$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ (1)

$2I^- + 2Cu^{2+} + 2S_2O_3^{2-} \rightarrow 2CuI + S_4O_6^{2-}$ (2)

$2\,Cu^{2+} \equiv 2\,S_2O_3^{2-}$
$Cu^{2+} \equiv S_2O_3^{2}$ (2)

Let the volume of $Na_2S_2O_3$ = $V cm^3$ (1)
∴ moles of $Na_2S_2O_3$ = (V / 1000) x C (2)
Hence moles of Cu^{2+} = (V / 1000) x C (2)
(Since $Cu^{2+} \equiv S_2O_3^{-}$)
∴ Weight of Cu = (V / 1000) x C x M_g (2)
(relative atomic mass at Cu = M)

∴ % Cu in A $= \left[\{(C/100) \times V \times M\}/W\right] \times 100$ (3)
= CVM / 10 W

(Viii) $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$ (4)
$C + 2H_2SO_4 \rightarrow CO_2 + 2SO_2 + 2H_2O$ (4)

(ix) $2Cu^{2+} + 2OH^- + 2e \rightarrow Cu_2O + H_2O$ (5)
This reaction is used to test the presence of reducing agents such as glucose in urine in the diagnosis of diabetes (3)

(x) electrical conductors / to make alloys (2+2)

(90 marks)

(09) (a)
(i) Al^{3+}, Ag^+, Zn^{2+} (5 + 5+ 5)

(ii) (1) $Al(OH)_3$ (5)
(2) AgCl (5)
(3) $Zn(OH)_2$ (5)

(iii) (1) blue mass (5)
(3) green mass (5)

(ii) $Al(OH)_3 + NaOH \rightarrow NaAlO_2 + 2H_2O$ (5)
$Al(OH)_3 + NaOH \rightarrow Na[Al(OH)_4]$ (also acceptable)

N.B. However, in place of Al^{3+} - Pb^{2+}, Sn^{2+}, Sn^{4+}, Be^{2+} are also acceptable
in place of Zn^{2+} - Cd^{2+} is also acceptable.

(45 marks)

b) (i) SO_3^{2-}, Cl^- (5 + 5)
(ii) (04) $BaSO_3$ (5)
(06) $BaSO_4$ (5)
(iii) $PbCl_2$ (5)
(iv) $5(SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e)$
$2(MnO_4^- + 8H^+ + 5e \rightarrow Mn^{2+} + 4H_2O)$
$5SO_3^{2-} + 2MnO_4^- + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$ (10)

(35 marks)

c) (i) $Fe_2O_3 + 6H^+ + 2I^- \rightarrow 2Fe^{2+} + I_2 + 3H_2O$ (7)
$Fe_3O_4 + 8H^+ + 2I^- \rightarrow 3Fe^{2+} + I_2 + 4H_2O$ (7)
$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$ (3)

Let there be X moles of Fe_2O_3 and Y moles of Fe_3O_4 in the ore
Moles of $Na_2S_2O_3$ required to titrate the I_2 in 25.0cm³ of the diluted solution = 1/1000 x 24 (4)
∴ moles of I_2 = (1/2) x (1/ 1000) x 24 (4)

∴ Therefore moles I_2 in 100.0cm³ solution = 0.012 x 4
= 0.048 x 4 (4)

Hene X + Y = 0.048 → (1) (10)
$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow 5Fe^{3+} + 4H_2O + Mn^{2+}$ (5)
Moles of $KMnO_4$ = (1 / 1000) x 5.2 (4)
Assuming I^- interference negligible (since end point has been reached) (2)
Moles of Fe^{2+} = 5 x (1 / 1000) x 5.2 x 4 (2)
= 0.104 (2)
Hene 2X + 3Y = 0.104 → (2) (05)
solving for x using eqations (1) and (2)
X = 0.004 (2)
∴ Weight of Fe_2O_3 = 0.004 x 160 = 6.4 g (2)
% Fe_2O_3 $= \left(\frac{6.4}{8.0}\right) \times 100$
= 80% (3)

(70 marks)

(10) (a)
(i) CO, CO_2, NO, NO_2, SO_2, C_XH_Y (unburnt hydrocarbons), Carbon particles (4 x 6)

(ii) NO_2, SO_2 (4 + 4)

(iii) N_2 (air) + $O_2 \rightarrow 2NO$, $2NO + O_2 \rightarrow 2NO_2$ (4x 3)
Sulpher (in fuel) + $O_2 \rightarrow SO_2$
(Can be given in words)

(iv) CO_2, NO_2, SO_2 (any two) (4 + 4)

(v) These gases absorb heat from the sun that is reflected from the earth surface and prevent heat from being readiated back to space (4)

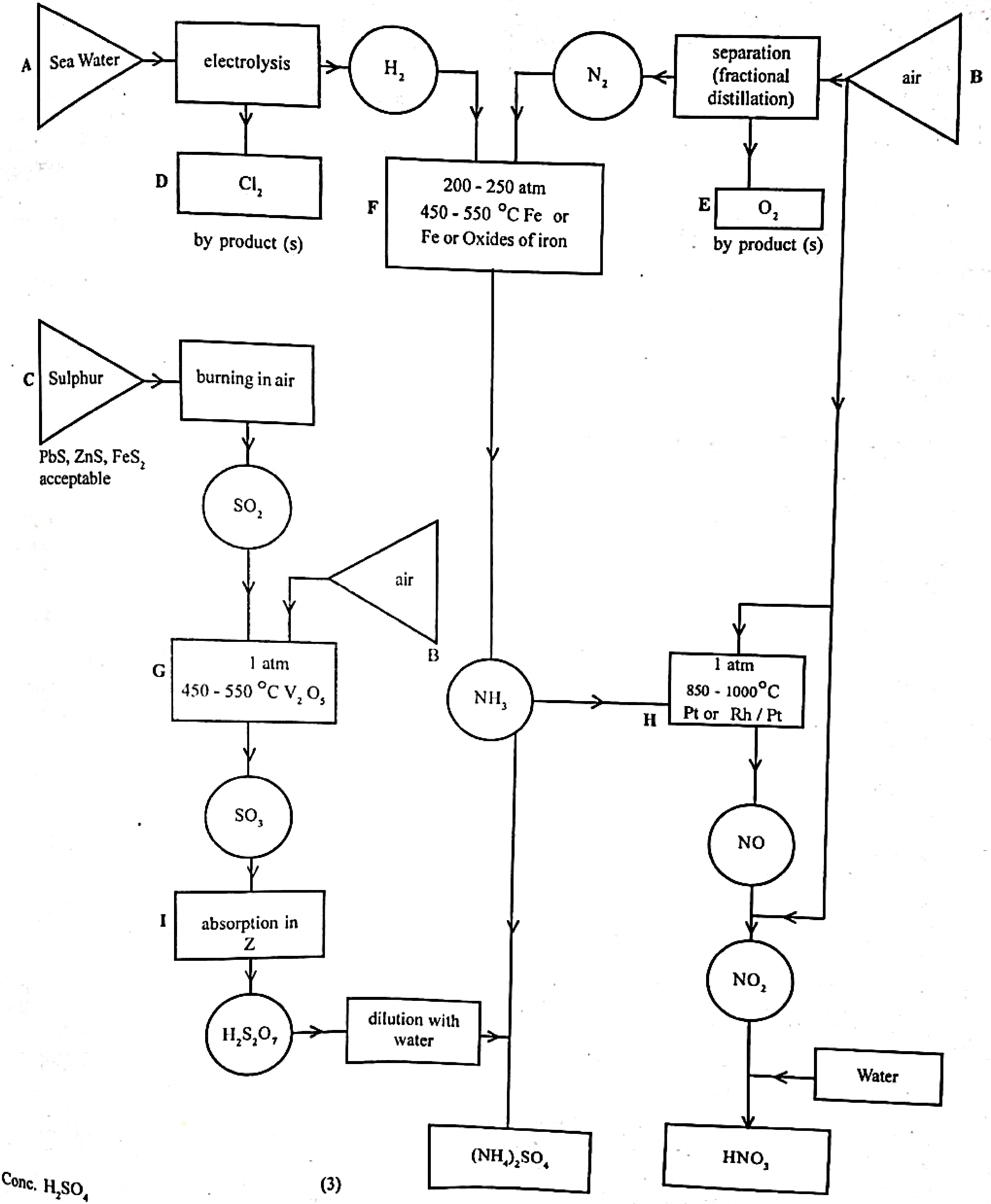
(vi) Green house effect leads to temperature increase in the atmosphere (3)
- Ice melts and water levels in ocean will increase which will threaten low lying lands
- Fresh water system can evoporate to from desserts (4+4)

(vii) • Use of catalytic convertors
- Controlling the quantity of air mixed with fuel (engine tuning)
- Use of Oxygenated fuels (4+4)

(any two, accept other suitable answers)

(75 marks)

10.(b). (Question Number 10 is not compulsory)



(i) Conc. H_2SO_4 (3)

(ii) F : $N_2 + 3H_2 \rightarrow 2NH_3$ (5)

G : $2SO_2 + O_2 \rightarrow 2SO_3$ (5)

H : $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ (5)

Marks :

Circles = 3 x 8 = 24

Triangles = 3 x 3 = 9

Rectangular boxes (small) D and E = 3 x 2 = 6

Rectangular boxes (G, F,H) = 6 x 3 = 18