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G.C.E. (A/L) Examination Chemistry - 2002

M.C.Q. Answers

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

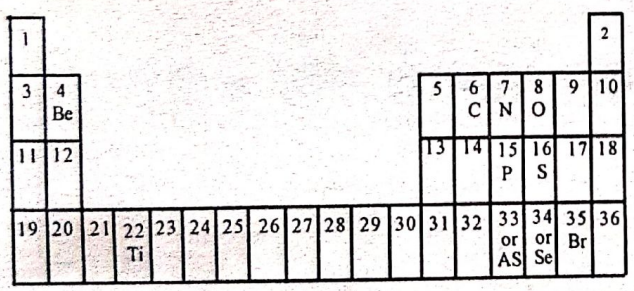
PART A - STRUCTURED ESSAY

Answer all four questions. Each question carries 10 marks.

(01) (a) (i) Bromine or Br (08)
(ii) Berylium or Be (08)
(iii) Carbon or C (08)
(iv) Titanium or Ti (08)

(b) A = N or Nitrogen (08)
(i) $N_2O_5 + H_2O \rightarrow 2HNO_3$ (10)
(ii) $NCl_3 + 3H_2O \rightarrow = NH_3 + 3HOCl$ (10)

(c) E = P/As or phosphours / Arsenic
G = S/Se or Sulphur / Selenium
J = O or Oxygen 3 x 8 (24)



(8 x 2 = 16)

(02) (a) $2Mg + O_2 \rightarrow 2MgO$
$3Mg + N_2 \rightarrow Mg_3N_2$
$Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$
$Mg(OH)_2 \rightarrow MgO + H_2O$

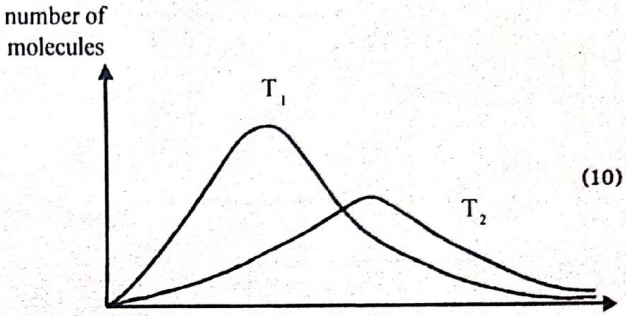
(4 x 3 = 12)

$Mg_3N_2 \rightarrow 3MgO$ (05)
$\therefore$ 100 g $Mg_3N_2 \rightarrow 3 \times 40 = 120$ g MgO
x g $Mg_3N_2 \rightarrow \frac{120x}{100}$ MgO
$\therefore (1.8 - x) + \frac{6x}{5} = 2$ (05)
$\therefore 9.0 - 5x + 6x = 10$
$X = 1.0$ g. (05)

Number of Mg_3N_2 moles $= \frac{1}{100}$
Number of MgO moles $= \frac{0.8}{40} = \frac{2}{100}$ (2+1)
$\therefore$ MgO : Mg_3N_2 = 2: 1 ..... (05)

(b) What is the value of n = 1 (05)
$M_2O_5^{2-} + 10H^+ + 6e \rightarrow 2M^+ + 5H_2O$ (10)

(c) (i) molecules should collide (i) in the faverable orientation
(2) colliding moleculer must have the activation energy of reaction (03)



(10)

ii) (A) * Activation energy of the reaction is high.
* Very few moleculer have the activation energy to undergo reaction at room temperature.
* pt is a catalyst for the reaction.
* pt lowers the activation energy of the reaction.
* In the presence of pt, more molecules will have the necessary activation energy for reaction.

(5 x 2 = 10)

(B) Either this is a chain reaction.
OR rate of the reaction quickly goes out of control.
OR large amount of energy is released due to fast reaction.
OR rate of release of energy is high.

(04)

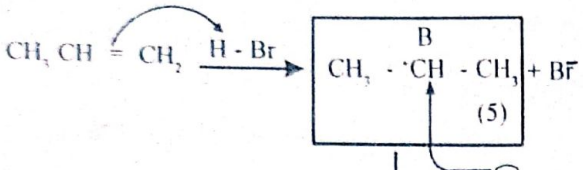
(d) (i) $S_2O_3^{2-} + 2H^+ \rightarrow H_2O + S\downarrow + SO_2$
OR
$S_2O^{2-}{}_3 + 2HCl \rightarrow H_2O + S\downarrow + SO_2 + 2Cl^-$
OR
$Na_2S_2O_3 + 2H^+ \rightarrow H_2O + S\downarrow SO_2 + 2Na^+$

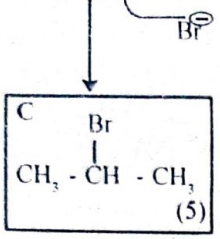
(05)

(ii) (A) Reactants are mixed in a beaker.
(B) Beaker is placed (on a white piece of paper) on which a 'X' is marked.
(C) Time taken for the 'X' to disappear is measured.

(3 x 5 = 15)

03. (a) (i)



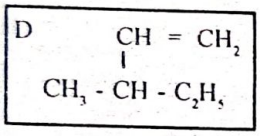


(5)

(ii) (1) ✓ (6) X
(2) X (7) ✓
(3) ✓ (8) X
(4) X (9) X
(5) ✓

(9 x 5 = 45)

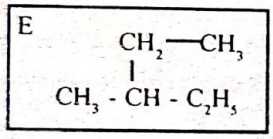
(b) (i)



(15)

(ii) No (05)

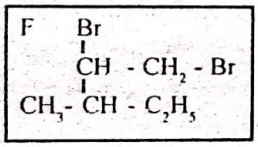
(iii)



(05)

(iv) No, because it does not contain an asymmetric C atom. (05)

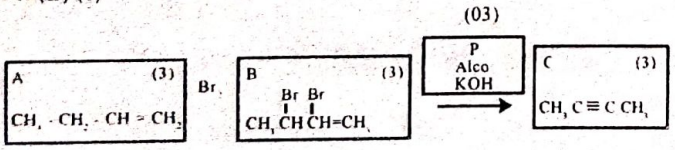
(V)



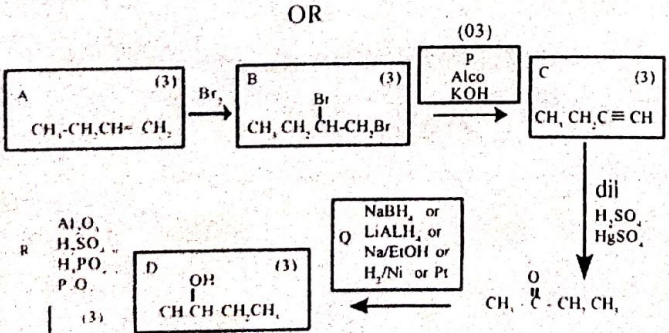
(05)

(vi) Two (05)

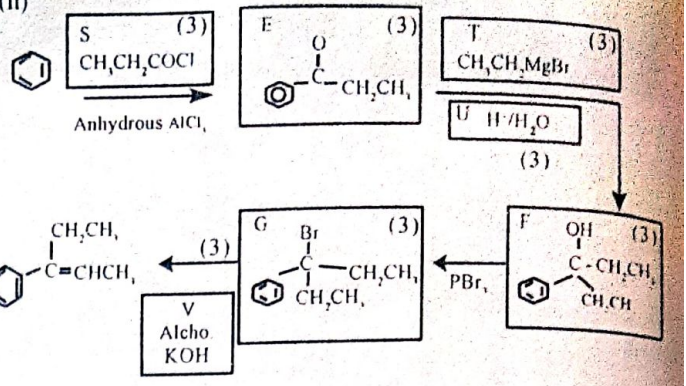
04. (a) (i)



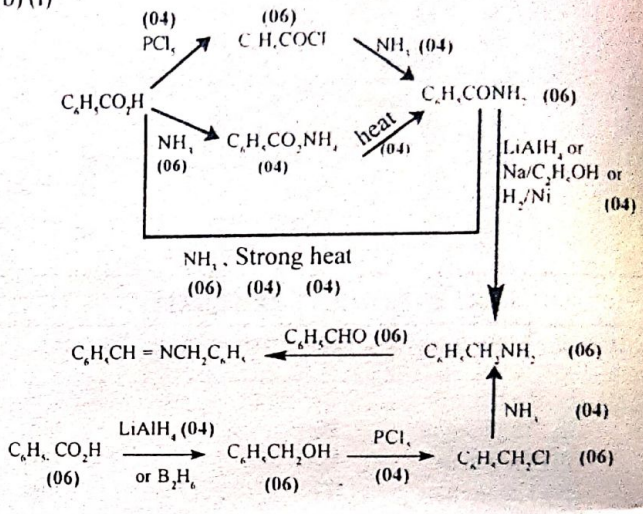
OR



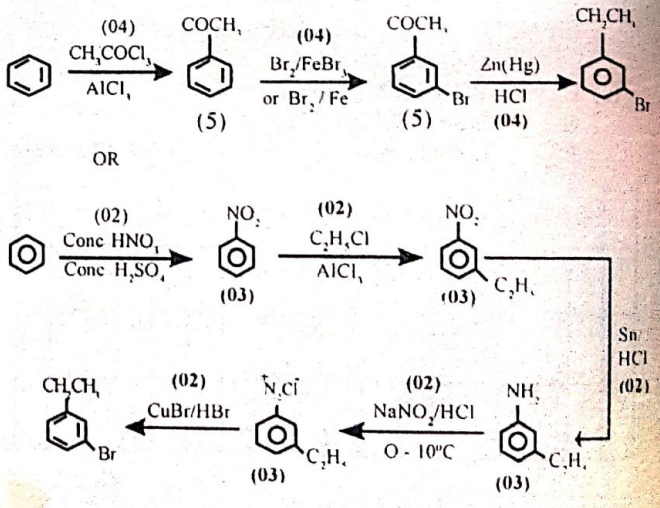
(ii)



(b) (i)



(c)



PART B - ESSAY

Answer two questions only. Each question carries 15 marks

5. (a) (i) $P = \frac{axd^2}{3G}$ (15)

(ii) $ZR = \frac{axd^2}{3yT}$ OR $\frac{Wd^2}{3T}$ (15)

(b) (i) Zero (15)

ii) Either

The nature of similar bonds in the reactants and products are not all exactly identical

OR

C = O bond in CH_3CO_2H is different to C = O bond in $CH_3CO_2C_2H_5$

OR

O-H bond in C_2H_5OH (Or CH_3CO_2H) is different to the O-H bond in H_2O.

OR

C-O bond in CH_3CO_2H is different to the C-O bond in $CH_3CO_2C_2H_5$

OR

Bond enthalpies obtained in the gaseous phase need not be strictly valid in the solution phase. (15)

(c) (i) Volume N_2 gas = 4.157 dm^3 (08)

No. of moles of N_2 = $\frac{PV}{RT} = \frac{10^3(4.157 \times 10^{-3})}{8.314 \times 400}$ (02)

= 0.125 (04)

(ii) (A) Total number of moles = $\frac{(13.2 \times 10^5) \times (4.157 \times 10^{-3})}{8.314 \times 800}$ (02)

= 0.825 (04)

(B) Total number of steam + H_2 + CO = 0.7 (04)

If x moles of steam react to give x moles each of CO & H_2

$(0.5 - X) + X + X = 0.7$ (04)

$\therefore X = 0.2$ (04)

. Equlibrium Mixture at 527 °C contains

0.3 of steam (04)

0.2 of H_2 (04)

0.2 of CO (04)

(C) $P_{N_2} = \frac{0.125}{0.825} \times 13.2 \times 10^5$

$= 2 \times 10^5$ Pa (4)

$P_{H_2} = P_{CO} = \frac{0.2}{0.825} \times 13.2 \times 10^5$

$= 3.2 \times 10^5$ Pa (4)

$P_{H_2O(g)} = \frac{0.3}{0.825} \times 13.2 \times 10^5$

$= 4.8 \times 10^5$ Pa (4)

(iii) $K_p = \frac{P_{CO} \times P_{H_2}}{P_{H_2O}}$ Or

$= \frac{(3.2 \times 10^5) \times (3.2 \times 10^5)}{(4.8 \times 10^5)}$ (04)

$= 2.13 \times 10^5$ Pa (4+4)

(iv) In the absence of N_2 (g), partiol pressures are not after

OR

(A) $P_{(steam)}$ = 4.8×10^5 pa (02)

(B) P_{CO} = 3.2×10^5 Pa (02)

(C) P_{H_2} = 3.2×10^5 Pa (02)

(D) Total pressure = 11.2×10^5 Pa (04)

(v) Fuel

As a source of H_2 gas (eg :- Haber process)

For gasoline Synthesis (4)

For methanol Synthesis

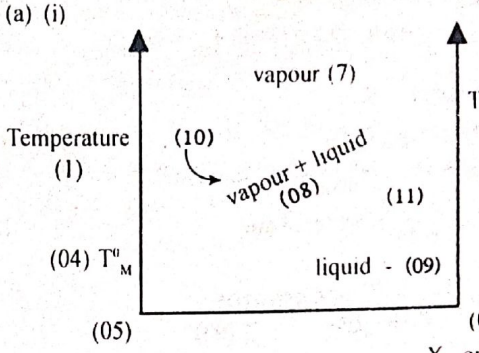
Assumption

(i) Ideal gas assumption for gaseous mixture OR

(ii) N_2 behaves as an unreacting / inert gas (4)

Total for 5 (c) 90

6. (a) (i)

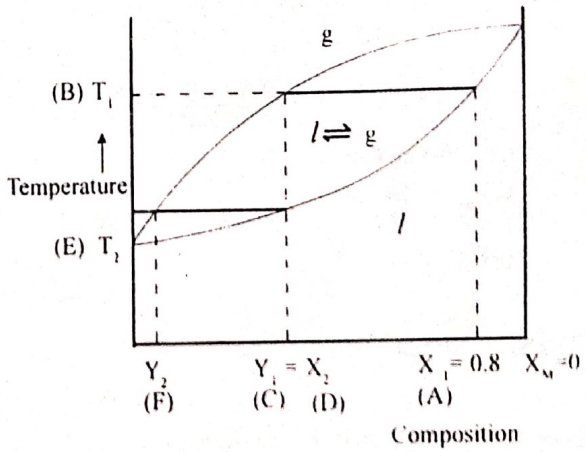


Z_M or X_M = 1 Composition Z_L/Z_M X_M or Z_M = 0

or or

Z_L or X_L = 0 X_L or Z_L = 1

11 points x 2 =22



The six symbols should be marked on the relevant axis

6 x 3 = 18

iii (A) 100% of M or pure M (5)

(B) Oil refinery or manufacture of industrial gases OR fractionation of air (5)

(C) Fractional Distillotion (5)

(D) Fractionating Column / Tower (5)

Total part a = 60

(b) (i)

$K_c = \frac{[CO_{2(aq)}]}{[CO_{2(g)}]}$ OR $Kc = \frac{Cco_{2(aq)}}{CcO_{2(g)}}$ (05)

$K_c = \frac{[HC\bar{O}_{3(aq)}][H^+_{(aq)}]}{[CO_{2(aq)}]}$

OR

$K_c = \frac{\left[C_{HC\bar{O}_{3(aq)}}\right]\left[C_{H^+(aq)}\right]}{Cco_{2(aq)}}$ (05)

ii (A) For a gas, concentration $= \frac{P}{RT}$ (05)

$\therefore C_{CO_{2(g)}} = \frac{498840\ Pa}{8.314J\ mol^{-1}K^{-1} \times 300k}$ (5+5)

$= 0.2\ moldm^{-3}$ (5)

(B) The concentration of $CO_{2(aq)}$ in mol dm^{-3}

$\therefore C_{CO_{2\ (aq)}} = K_C C_{CO_{2(g)}}$

$= 0.9 \times 0.2 = 0.18\ (\backsim 0.2)$ (05)

(C) The value of K'_C

$PH = -\log_{10} C_{H^+}$ (05)

$PH = 4,\ \therefore C_{H^+(aq)} = 10^{-4}$ mol dm^{-3} (05)

$\therefore C_{HCO^-_3(aq)} = 10^{-4}$ mol dm^{-3} (05)

$K'_C = \frac{10^{-4} \times 10^{-4}}{0.18} = 5.556 \times 10^{-8}$ (05) (05)

iii Opened bottle of Soda Water

C_{CO_2} (g) in air $= \frac{30\ Pa}{8.314 \times 300}$ (05)

$\therefore C_{CO_2}$ (aq) $= \frac{0.9 \times 30}{8.314 \times 300}$ molm^{-3} (3 + 2)

$[C_{H^+(aq)}]^2 = K'_c C_{CO_{2\ (aq)}}$

$= (5.556 \times 10^{-8}\ mol\ dm^{-3}) \left(\frac{0.9 \times 10^{-4}\ moldm^{-3}}{8.314}\right)$ (05)

$= 6.01 \times 10^{-13}\ mol^2\ dm^{-6}$

$C_{H^+(aq)} = 7.75 \times 10^{-7}$ (05)

pH = 6.11 (05)

Total (b) (90)

07. (a) (i) $K_a = \frac{[H^+_{aq}]\ [\bar{A}_{aq}]}{[HA_{aq}]}$ (10)

(ii) $\log K_a = \log [H^+_{aq}] + \log [\bar{A}_{aq}] - \log [HA_{aq}]$ (05)

$-\log K_a = -\log [H_{aq}] - \log [A^-_{aq}] + \log [HA_{aq}]$ (05)

$pH = -\log [H^+_{aq}]$ (05)

(iii) 25.00cm^3 of 0.04 mol dm^{-3} NaOH solution

contain $25 \times \frac{0.04}{1000}$ mol of (05)

$\frac{OH^-}{NaOH}$

Amount of acid HA initially present $= 2 \times 10^{-3}$ mol

This corresponds to half equuivalance point or equivalent statement (05)

$[A^-_{(aq)}] = [HA_{(aq)}]$ (10)

$pK_a = 6$ (05)

$K_a = 10^{-6}$ mol dm^{-3} (05 + 05)

(60)

7. (b) (i) $K_{sp} = [Bi^{3+}_{(aq)}]^2\ [S^{2-}_{aq}]^3$ (10)

(ii) For NiS precipitation not to occur

$[Ni_{(aq)}]\ [S^{2-}_{(aq)}] \leq K_{sp}$ Nis (10)

ie $[S^{2-}] \leq \frac{1 \times 10^{-19}}{0.10}$ (10)

But $[H^+_{(aq)}]^2\ [S^{-2}_{(aq)}] = 10^{-24}$

ie $[H^+_{(aq)}]^2 \geq \frac{10^{-24}}{10^{-18}}$ (10)

ie $[H^+_{(aq)}] \geq 10^{-3}$ mol dm^{-3} (05+ 05)

(50)

(c) (i) $2Fe\ (s) + 2H_2O + O_2\ (g) \longrightarrow 2Fe^{2+}\ (aq) + 4OH^-\ (aq)$

OR

$2Fe(OH)_2$ (15)

(ii) $E^\circ_{Cell} = E_{Cethode} - E_{Anode}$ OR (05)

$= E_{RHS} - E_{LHS}$

$= 0.4 - (-0.44)$ (05)

$= 0.84\ V$ (05)

(ii) The metal that is suitable for cathodic protection should have a more nagative standard electrode potential than that of Fe (05)

(05)

$\therefore$ Q is suitable

(40)

PART C - ESSAY

8 (a) (i) (A) $2SO_2 + O_2 \rightleftharpoons 2SO_3$ (05)

(B) Above reaction is exothermic / ΔH negative (05)

(C) Since reaction is exothermic, low temperatures (05)

(D) Forward reaction is also accompanied by a decrease in the number of moles / pressure (05)

(E) Therefore, forward reaction is favoured by high pressure (05)

(25)

(ii) (A) In an Industrial manufacture, economy has to be considered (05)

(B) Rate of this reaction is not fast enough at temperatures less than 450°C (05)

(C) producing high pressures is expensive (05)

(D) fabrication of industrical equipment to with stand high pressure is expensive (05)

(20)

(iii) (A) V_2O_5 acts as a catalyst

(B) V_2O_5, is cheape than pt

(C) V_2O_5 reduces the activation energy of the reaction

(D) Therefore V_2O_5 increases the rate of the reaction and is generally used in the given process

(E) V_2O_5 is not easily poisoned.

any 3 x 5 marks = 15

8 (b) (i) Since the total volume of mixtures A & B are identcal and the amount of salicylic acid present is the same in both mixtures. (05)

The amount of Fe^{3+} in mixtures A & B is the same (05)

Amount of Fe^{3+} in mixtures B = $0.002 \times 1.5 \times 10^{-3}$ mol (05)

∴ Concentration of Fe^{3+} in tube well water = $\frac{0.002 \times 1.5 \times 10^{-3} \times 10^3 \text{ moldm}^{-3}}{5}$ (3+2)

= $0.0006 \times 55 \times 1000$ (05)

= 33.0 (05)

(30)

(ii) purple colour (05)

(iii) 1 : 1 (05)

(iv) Add Calcium hydroxide (lime) and aerate (10)

(50)

(c)

(i)	(ii)
Cinnamon	Eygenol OR Cinnamaldehyde
Citronella	Geraniol OR Citronellol OR Citronellal
Clove	Eugenol
Nutmeg	Myristene OR Sabinene
Pepper	β Caryophylene OR α - pinene
Cardamon	1,8 Cineole OR terpenylacetate
Pinus	α - pinene β OR - pinene

any 3 x 3 = 9 Corresponding 3 x 5 = 15 = (24)

(ii) (A) Through steam distillation, essential oils, which could decompose at high temperature, can be distilled at temperatures less than 100°C

(B) essential oil can be easily separated since it is not miscible with water (2 x 8 = 16)

09) (a) (i) CO, NO_2, SO_2, CO_2 hydrocarbon (5 x 3 = 15)

(ii) C, Pb (2 x 3 = 06)

(iii) CO, NO (2 x 3 = 06)

(iv) SO_2, NO_2 (2 x 3 = 06)

(v) CO_2, SO_2, NO_x (OR NO_2 OR NO) CO, hydrocarbon (2 x 3 = 06)

(vi) Either Using a catalytic convertor

Or Using oxygenated fules

Or Controlling the quantity of air mixed withthe fuel (tuning engine)

Or Burning fuels at a higher working temperature. (3)

45

(b) Step A

Dissolve in HCl (02)

Filtter SiO_2 (03)

Filterate (F) obtained (02)

F contains $MgCl_2$ (2) and $CaCl_2$ (2)

(11 marks)

Step B

Heat dolomite to decompose it (2)

Dolomite decompposes and yields CaO (2)

MgO (2) and Silica (1)

Treat above mixture with water (2)

to form $Ca(OH)_2$ (2) and MgO (s) (2)

& $Mg(OH)_2$ (s) (2) filter to obtain $Ca(OH)_2$ (4)

(19 marks)

Step C

Treat filterate F (from step A) (2) with aq $Ca(OH)_2$ (from Step B) (2) to precipitate $Mg(OH)_2$ (3) Filter, (2) and wash (2) precipitated $Mg(OH)_2$ Dry (2) and calcine (2) to convert $Mg(OH)_2$ to MgO.

(15 marks)

Total (45)

Alternate Method (employing electrolysis)

Heat dolomite (2) to decompose it (2)

Dolomite decomposes and yields CaO (2),

MgO (2) and Silica (1)

Treat above mixture with water (2) repeatedly (3) and discard $Ca(OH)_2$ (2) by filtration (2) to obtain MgO (s) (2) and $Mg(OH)_2$ (2) and Silica (2)

Add HCl (3) to get $MgCl_2$ (3) Dry (3), fuse (3) and electrolyse (3) $MgCl_2$. Electrolysis yields pure Mg (3)

Burn Mg in air (3) to give MgO.

09) (c) (i)

(A) $N_2 + 3H_2 \underset{250 \text{ atm (2)}}{\overset{450\ C^\circ\ (2)}{\rightleftharpoons}} 2NH_3$ (03)

Catalyst : Fe or Mo or oxides of Fe (03)

(B) $4NH_3 + 5O_2 \xrightarrow{900 - 1000^\circ C\ (02)} 4NO + 6H_2O$ (03)

1 : 9 = NH_3 : O_2 (02)

Catalyst Pt or Pt - Rh (03)

(C) $2NO + O_2 \rightleftharpoons 2NO_2$ (03)

(D) Either $3NO_2 + H_2O \longrightarrow 3NO_2 + N_2O$

Or $2NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$

Or $3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$

Or $4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$ (03)

(E) $NH_3 + HNO_3 \longrightarrow NH_4NO_3$

(ii) $NH_3 + CO_2 + NaCl + H_2O \rightarrow NaHCO_3 + NH_4Cl$ (03)

low temp. or 30 - 40C° (03)

$2NaHCO_3 \xrightarrow[(03)]{\Delta} Na_2CO_3 + CO_2 + H_2O$ (03)

Sources of starting materials

N_2 from air

H_2 from fossil fuels / natural gas

CO_2 from Limestone / Corals

NaCl from salt water / deposits

(4 x 2 = 08)

Regeneration of raw materials (solvay)

$NH_3(g)$

NH_4Cl from Solvay process

CaO from Limestone (Corals)

Reaction of NH_4Cl with $Ca(OH)_2$

$CO_2(g)$ - Burning of $NaHCO_3(g)$

(4 x 2 = 08)

(10) (a)

(i) Cr

(ii) $1S^2\ 2S^2\ 2p^6\ 3S^2\ 3P^6\ 4S^1 3d^5$ OR

..... $3d^5\ 4S^1$ (08)

(iii) $2Cr^{3+} + 4OH^- + 3O_2^{2-} \rightarrow 2CrO_4^{2-} + 2H_2O$

OR $2Cr^{3+} + 10\ OH^- + 3H_2O_2 \rightarrow 2CrO_4^{2-} + 8H_2O$ (12)

(iv) yellow

(v) any $Cr_2O_7^{2-}$ and CrO_3^{2-} & CrO_2Cl_2 (2x5 = 10)

(vi) alloy steels / electroplating / leather industry (06)

Total = (52)

(b) (i) $2NaNO_3 \rightarrow 2NaNO_2 + O_2$ (06)

(ii) $2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$ (06)

(iii) $2AgNO_3 \rightarrow 2Ag + 2NO_2 + O_2$ (06)

(iv) $NH_4NO_3 \rightarrow N_2O + 2H_2O$ (06)

(v) $SO_2 + 2H_2S \rightarrow 2H_2O + 3S$ (06)

(vi) $SO_2 + 2H_2O + 2Fe^{3+} \rightarrow 2Fe^{2+} + H_2SO_4 + 2H^+$

OR

$5SO_2 + 2H_2O + 2KMnO_4 \rightarrow 2MnSO_4 + 2H_2SO_4 + K_2SO_4$

OR

$3SO_2 + Cr_2O^{2-}_7 + 2H^+ \rightarrow 2Cr^{3+} + 3SO_4^{2-} + H_2O$

OR

$SO_2 + 2H_2O + Cl_2 \rightarrow 2Cl^- + SO_4^{2-} + 4H^+$

OR

$SO_2 + HNO_3 \rightarrow H_2SO_4 + HNO_3$ (06)

(vii) $2Na + H_2S \rightarrow Na_2S + H_2$ (06)

(viii) $Cl_2 + H_2S \rightarrow 2HCl + S$

OR

$SO_2 + 2H_2S \rightarrow 2H_2O + 3S$

OR

$2Fe^{3+} + H_2S \rightarrow 2Fe^{2+} + 2H^+ + S$

OR

$Cr_2O^{2-}_7 + 8H^+ + 3H_2S \rightarrow 2Cr^{3+} + 7H_2O + 3S$

OR

$2MnO_4^- + 6H^+ + 5H_2S \rightarrow 2Mn^{2+} + 8H_2O + 5S$

(06)

(48)

(c) purple colour in experiments (iii) and (iv) due to I_2 (05)

It is produced by the oxidation of I^- (05)

Amongst the 4 compounds, I is present only in KI (05)

Since C + D and B + D both give the purple colour.

D is KI (05)

B and C must be able to oxidise D (KI) (05)

∴ B/C must be H_2O_2 / $FeCl_3$ (05)

∴ A is $K_3[Fe(CN)_6]$ (05)

Addition of A to (B + D) mixture gives a blue precipitate. (05)

Addition of $K_3[Fe(CN_6)]$ to a Fe^{2+} solution gives a blue precipitate. (05)

∴ B must be $FeCl_3$ (05)

Hence, C must be H_2O_2 (05)

(50)