GCE (A/L) Examination
Chemistry - 2001

M.C.Q. Answers

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

PART A - STRUCTURED ESSAY

Answer all four questions. Each question carries 10 marks

1. (a) (i) Q = Oxygen / O R = Sulphur / S (9+9)

(ii) Q

0	+2	-05	-1	-2
-	OF_2	KO_2	H_2O_2 Na_2O_2 BaO_2	H_2O K_2O MgO

R

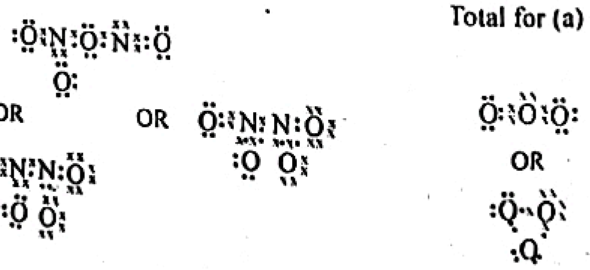
0	+6	+5	+4	+2	+1	-1	-2
$Na_2S_2O_3$ $Na_2S_4O_6$ –	SO_3 Na_2SO_4 $CuSO_4$ $K_2S_2O_8$ SF_6	$Na_2S_2O_6$ $Na_2S_4O_6$	SO_2 K_2SO_3 $KHSO_3$ $Na_2S_2O_3$ SF_4	SCl_2 SF_2	S_2Cl_2 S_2Br_2 S_2F_2	Na_2S_2 Mgs Bi_2S_3	Na_2S

For each correct state 1 x (Q- 5 + R - 8) = 13 marks

For each correct formula relevant to state = 1 x (Q - 5 + R -8)
= 13 marks

Total for (a) = 40

(b) (i)



(2 x 15) = 30

(C) A ☑ ☑ ☒ B ☒ ☑ ☒ C ☑ ☒ ☒ ☑

(3 x 10) = 30

2. (i) No. of moles of Cr_2O_3 . 0.01 (3)
No. of moles of H_2O . 0.04 (3)
No. of moles of N_2 . 0.01 (3)

$\therefore Cr_2O_3 : H_2O : N_2$ = 1:4:1: (3)

Emperiacal Formula = $Cr_2O_7H_8N_2$ (6)

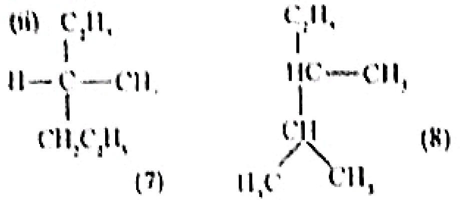
(ii) The $\dot{C}H_3$ has a higher probability of meeting Cl_2 molecule rather than another $\dot{C}H_3$

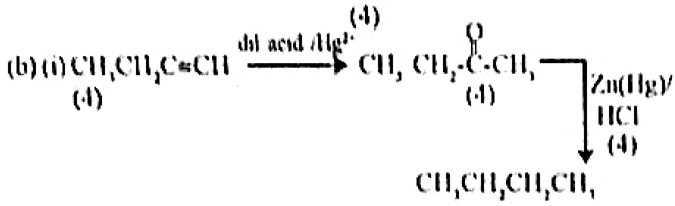
OR

The concentration of $\dot{C}H_3$ is very low when compared to the concentration of Cl_2 (10)

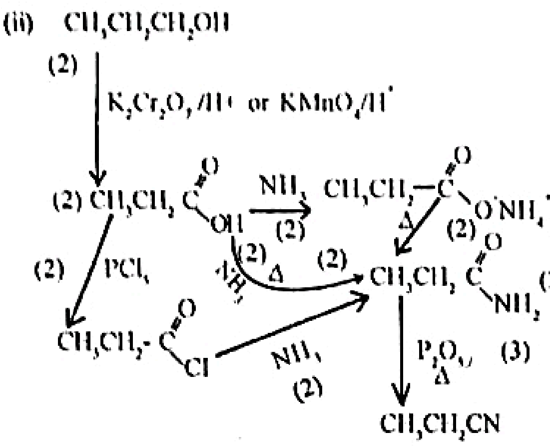
4 (a) (i) n = 7   m = 16   (5+5=10)

(ii)





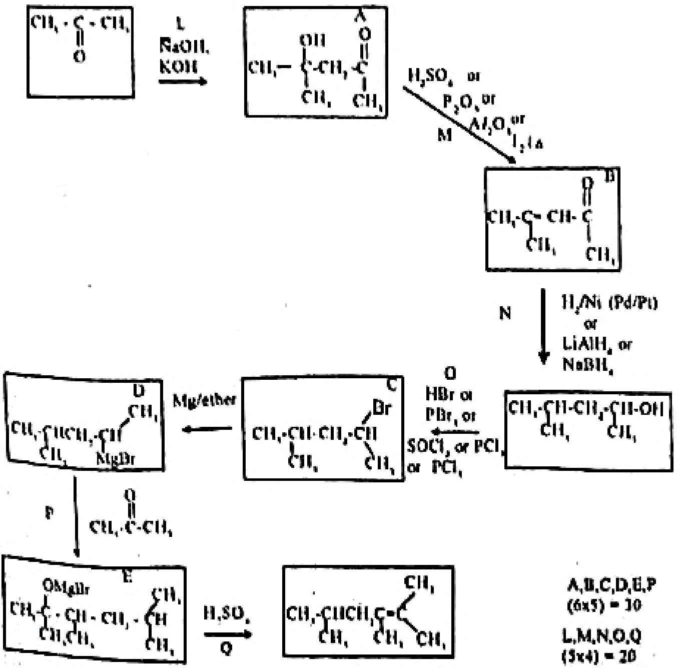
12 Marks



(12)

(13)

(C)



A,B,C,D,E,P
(6x5) = 30

L,M,N,O,Q
(5x4) = 20

PART B - ESSAY

5 (a) (i)

1. A neutralisation reaction between acid and NaOH can be represented by $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$
2. HCl, HNO_3, and NaOH are fully dissociated in aqueous solution
3. C_2H_5COOH is weakly / portially dissociated in aqueus solution.
4. C_2H_5COOH dissociation in aqueus solution is endothermic. (4 x 3 = 12)

(A) In the case of HCl/ HNO_3 netralisation, the standard enthalphy of neutralisation is identical to each other (- 57 KJmol^{-1}) (4)
and to the standard enthalphy of the neutralisation reaction $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$ (4)

(B) In the case of C_2H_5COOH a part of the standard enthalpy of neutralisation (-57KJmol^{-1}) is used up in dissociating C_2H_5COOH into its constituent ions (5)
The standard enthalphy of neutralisation obtained for C_2H_5COOH is only - 51 KJmol^{-1}

(ii) I. standard molar enthalphy of dissociation of water represented by
$H_2O_{(l)} \longrightarrow H^+_{aq} + OH^-_{(aq)}$ (5)
is + 57KJ mol^{-1} (5)

II. Standard molar enthalphy of dissociation of propanoic acid is 6 KJmol^{-1} (5)

(b) (i) $C_3H_{8(g)} + 5O_{2(g)} \rightarrow 4H_2O_{(l)} + 3CO_{2(g)}$ (5)

$C_8H_{18(l)} + \frac{25}{2}O_{2(g)} \rightarrow 9H_2O_{(l)} + 8CO_{2(g)}$ (5)

(I) 1Kg of propane yields (2200/0.044)kJ = 50,000kJ (5)
1Kg of octane yields (5130/0.114)kJ = 45,000kJ (5)

(II) 1Kg of propane yields. $\frac{3 \times 44 \times 1000}{44 \times 1000}$ = 3 kg of CO_2 (5)

1Kg of propane yields. $\frac{8 \times 44 \times 1000}{114 \times 1000}$ = 3.1 kg of CO_2 (5)

(b) (ii) more energy is produced 1 kg of propane (50,000 KJ) than 1 kg of Octane (45,000 KJ) (5)
CO_2 is environmentally less friendly (3)
because it causes globale warming/ green house effect (2)
Less CO_2 is produced from 1 kg of Propane (3 kg) than 1 kg of Octane (3.1 kg) (5)
Therefore Propane is economically more advantageous (3) and environmentally more (5) friendly. (2)

(c) (i) $K = \frac{[X]\ \text{chloroform}}{[X]\ \text{water}}$ (5)

(ii) From procedure (P), $[X]_{chloroform}$ = 0.144 mol dm^{-3}

$\therefore [X]_{water}$ = 0.18 - 0.144 = 0.036 (5)

$\therefore K = \frac{0.144}{0.036}$ = 4 at 25°C (05)

(iii) x = amount of "X" extracted into $CHCl_3$ layer.

for (q) $[X]_{CHCl_3} = \frac{X \times 1000}{500} = 2x$ mol dm^{-3}

$[X]_{water} = n - x$, where, n = initial number of moles before extraction

$4 = (2x)/(n - x)$

$6x = 4n$

∴ for first 500 Cm^3, $x_1 = \frac{4 \times 0.18}{6} = 0.12$mol (5)

∴ for second 500 Cm^3 $x_2 = \frac{4 \times 0.06}{6} = 0.04$mol (5)

∴ Total amount extractes = 0.12 + 0.04 = 0.16 mol (5)

(iv) q extracts more X per 1 dm^3 of Chloroform (5)
∴ q is the more efficient process. (5)

(v) ΔH for $A_{aq} \rightleftharpoons$ A(chloroform) is 1.0 $KJmol^{-1}$ (4)
process is Endothermic process. (3)
Increase in T drives equilibrium to right (4)
By raising T, extraction can be improved (4)
(60 Marks)

6. (a) (i) (1) $n_1 = \frac{P_1V_1}{RT_1} = \frac{1.995 \times 10^5 \times 5 \times 10^{-3}}{8.314 \times 300}$

$= 0.3999 \simeq 0.4$ (5)

(ii) $n_2 = \frac{P_2V_2}{RT_2} = \frac{4.656 \times 10^5 \times 10^{-3} \times 5}{8.314 \times 400}$

$= 0.7002 \simeq 0.7$ (5)

Assumption = Q and R behave : ideally (5)

(ii) $n - y$ mol $\rightleftharpoons$ y mol + y mol (3)

Total number of moles at eq^m = n + y (3)

$y = n_2 - n_1 = 0.7 - 0.4 = 0.3$ mol (3)

at eq^m P = 0.1 mol Q = R = 0.3 mol 3 x 1 (3)

$X_P = \frac{0.1}{0.7} = \frac{1}{7}$ $X_Q = X_R = \frac{3}{7}$ 3 x 2 (6)

$P_P = \frac{1 \times 4.656 \times 10^5 \text{ Pa}}{7}$

$P_Q = P_R = \frac{3 \times 4.656 \times 10^5 \text{ Pa}}{7}$ 3 x 2 (6)

$Kp = \frac{P_Q(g) \times P_R(g)}{P_P(g)} = \frac{4.656 \times 3/7 \times 3/7}{1/7} = 6.0 \times 10^5$pa

(4) (3) (6)

(iii) Introduction of inert gas does not change the partial pressure (5)

partial pressures of P, Q and R are the same (5)

But $X_P = \frac{P_P}{P_{Total}} = \frac{4.656}{7} \times \frac{1}{6.651} = 0.1$ (3+ 2)

$X_Q = X_R = 0.3$ (5)

$P_Z = (6.651 - 4.656) \times 10^5$ (3)

$X_Z = \frac{1.995}{6.651} = \frac{3}{10}$ (3)

or using , $X_Z = 1 - X_P - X_Q - X_R$

(a) total - 75 marks

(b) (i) Attractions between A-A, B-B and A-B are similar
Ability of A or B molecules to escape to vapour phase not affected by the other (4)
Partial vapour pressure α fraction of molecules at the surface (4)
Partial vapour pressure α mole fraction (2)
(2)

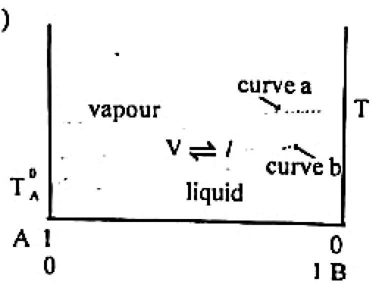
(ii) Mole fraction of A in vapour = 0.82
P_A = 1 atm x 0.82 = 0.82 x 10^5 P a (3)
P_B = 1 atm x 0.18 = 0.18 atm = 0.18 x 10^5Pa (3)
Assumption : Gaseous A and B behave ideally (3)
(3)

(iii) $P_A = 0.76 \times P^o_A$ (or $P_A = X_A P^o_A$ or

$\frac{P^o_A - P_A}{P^o_A} = X_B$ with X_A/X_B defined) (3)

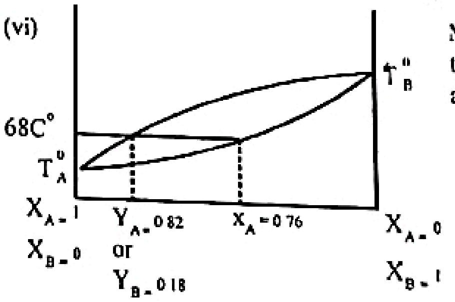
(iv) Surface contains both A and B molecules (3)
Since, A is more volatile than B, the vapour pressure of solution is higher than that of pure B at the same temperature. (3)
∴ P^o_B at 68°C ≯ < 1 atm (3)
std. Boiling point of B > 68°C (3)

(v)



Drawing diagram with two curves. (10)
vapour phase (1)
Liquid phase (1)
V ⇌ L (1)
Curve (a) (3)
Curve (b) (3)

(vi)



Marking 680C on the diagram appropriately. (3)
X_A or X_B (2)
Y_A or Y_B (2)

b (vii) If boiling is continued the vapour takes more A than B
Therefore (I) X_A decreases (3)
(II) Boiling point increases (3)

(b) Total - 75 Marks

7. (a) (i) $L_{(s)} + MSO_{4(aq)} \rightarrow LSO_{4(aq)} + M_{(s)}$
OR
$L_{(s)} + M^{2+}_{(aq)} + SO^{2-}_{4(aq)} \rightarrow L^{2+}_{(aq)} + SO^{2-}_{4(aq)} + M_{(s)}$

(ii) $L_{(s)} \rightarrow L^{2+}_{(aq)} + 2e$
$2e + M^{2+}_{(aq)} \rightarrow M_{(s)}$

(iii) $L_{(s)} / LSO_{4}(aq, 1mol\ dm^{-3}) // MSO_{4}(aq, 1mol\ dm^{-3}) / M_{(s)}$

(iv) $E_{Cell} = E_c - E_a$ OR $E_{RHS} - E_{LHS}$
$= -1.23\ V - (-2.12V)$
$= +0.89\ V$

(b) (i) Q (5)
Cathode (10)

(ii) Any soluble salt of copper such as $CuSO_4$ (5)

(iii) $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$ (5)

(c) (i) $K_{sp(AgX)} = [Ag^+_{(aq)}][X^-aq]$ (5)
$K_{sp} = 1 \times 10^{-10}\ mol^2dm^{-6}$
$[Ag^+][X^-] = 1 \times 10^{-10}\ mol\ dm^{-6}$
$[X^-] = 0.01 mol\ dm^{-3}$

Concentration of Ag^+ required to precipitate AgX

$$= \frac{1 \times 10^{-10} mol^2\ dm^{-6}}{0.01\ mol\ dm^{-3}} = 10^{-8}\ mol\ dm^{-3}$$ (5)

Concentration of Ag^+ required to precipitate AgY

$$= \frac{1 \times 10^{-18} mol^2\ dm^{-6}}{0.01\ mol\ dm^{-3}} = 10^{-16}\ mol\ dm^{-3}$$ (5)

∴ AgY will be precipitated first. (5)

(20)

(c) (ii) Concentration of Ag^+ in the solution, when AgX begin to precipitate.

$$[Ag^+] = \frac{K_{sp(AgX)}}{[X^-]}$$

$$= \frac{10^{-10}\ mol\ dm^{-6}}{0.01 mol\ dm^{-3}}$$

$= 0.10^{-8}\ mol\ dm^{-3}$ (5)

Concentration of y^- in the solution at this point

$$[Y^-] = \frac{K_{sp(AgY)}}{[Ag^+]}$$

$$= \frac{1 \times 10^{-18}\ mol^2\ dm^{-6}}{1.0 \times 10^{-8}\ mol\ dm^{-3}}$$ (5)

$= 10^{-10}\ mol\ dm^{-3}$ (5)

(iii) The volume of the mixture of halides does not change with the addition of $AgNO_3$ OR
Change in volume is negligible (10)

㊺

(d) (i) Starch combines with I_2 to give a blue colour which indicates the formation of I_2 during the reaction (7)

(ii) The time taken for a blue colour to appear is determined (5)

Rate of the reaction

$$= \frac{\text{Concentration of } I_2 \text{ produced up to the time a blue colour appears}}{\text{Time taken for a blue colour to appear}}$$

(iii)
- The concentration of I_2 required to produce a blue colour with starch is very small without $Na_2S_2O_3$, the time taken to produce this I_2 concentration is too short to measure accurately
- By removing a known amount of I_2 formed before it reaches a concentration sufficient to give a blue colour with starch the time taken for a blue colour to appear can be increased
- $S_2O_3^{2-}$ ions react with I_2 rapidly according to the reaction

$$2S_2O^{2-}_{3(aq)} + I_{2(aq)} \rightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-_{(aq)}$$

- A known small and constant amount of $S_2O_3^{-2}$ is used to remove a known small amount of I_2.
- Immediately after all the $S_2O_3^{-2}$ has reacted, I_2 reaches a concentration sufficient to produce a blue colour.
- ∴ $S_2O_3^{-2}$ is used in the experiment to increase the time taken for a blue colour to appear. So that it can be measured accurately.

6 points x 5 = 30

PART C - ESSAY

8. (a) (i) $1s^2\ 2s^2\ 2p^6\ 3S^2\ 3P^6\ 3d^5\ 4S^2$ .... (10)
$3d^5$ & $4S^2$ can be interchanged
(ii) Mn or Manganese (10)
(iii) + 2 or Mn^{2+} (6)
(iv) H^+ and a reducing agent
Fe^{2+} or $C_2O_4^{2-}$
or H_2O_2 or SO_2 (6)
(v) Alloying element (alloy) or to prevent corrosion iron (4)
(36)

(b) (i) C_2H_2 and $Ca(OH)_2$ (3+3)
(ii) NH_3 and $Mg(OH)_2$ (3+3)
(iii) BiOCl and HCl (3+3)
(iv) H_2 and $Al(OH)_3$ (3+3)
(24)

(c) Add NH_4Cl and NH_4OH white precipitate - Al^{3+} (10)
To the filterate, and excess NaOH white precipitate - Mg^{2+} (10)
Acidify the filterate slowly with dil HCl - white precipitate Zn^{2+} (10)
Alternative Method
Add excess of NaOH white precipitate - Mg^{+2} (10)
Acidify the filtrate with HCl and add excess NH_4OH White precipitate - Al^{3+} (10)
Acidify the filtrate slowly with dil HCl white precipitate - Zn^{2+} (10)
(30)

(d) $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ (3)
$MgCO_{3(s)} \rightarrow MgO_{(s)} + CO_{2(g)}$ (3)

Let x_g be the mass of $CaCO_3(s)$
Mass of $MgCO_3$ in the mixture $= (0.92 - x)g$ (4)
Mass of CaO formed $= \frac{56 \times X}{100} g$ (5)
Mass of MgO formed $= \frac{40 \times (0.92 - x)}{84} g$ (5)

$$\frac{56X}{100} + \frac{40 \times (0.92 - x)}{84} g = 0.48 g$$

X = 0.50 g (5)

Mass percentage of $CaCO_3 = \frac{0.50 \times 100}{0.92} = 54.3\%$ (5)
(30)

(c) (i) PCl_4^+

P - 5 valence electrons

1 electron from each Cl (positive charge)

Total = 5 + 4 - 1 = 8 (3)

No. of repulsion units 8/2 = 4 (3)

∴ Tetrahedral (4)

(ii) PCl_5

P-5 valence electrons

1 electron from each Cl

Total = 5 + 5 = 10 (3)

No. of repulsion units 10/2 = 5 (3)

∴ Trigonal Bipyramidal (4)

(iii) PCl_6^-

P-5 valence electrons

1 electron from each Cl (negative charge)

Total = 5 + 6 + 1 = 12 (3)

No. of repulsion units 12/2 = 6 (3)

∴ Octahedral (4)

(9) (a) (i) Oxygen or dioxygen O_2 and O_3 (5)

and

Ozone or trioxygen (5)

(ii) $4K_{(s)} + O_{2(g)} \rightarrow 2K_2O_{(s)}$ (5)

$2K_{(s)} + O_{2(g)} \rightarrow K_2O_{2(s)}$ (5)

or $2K_2O_{(s)} + O_{2(g)} \rightarrow 2K_2O_{2(s)}$

$K_{(s)} + O_{2(g)} \rightarrow KO_{2(s)}$ (5)

(or $K_2O_{2(s)} + O_{2(g)} \rightarrow 2KO_{2(s)}$)

(ii) $2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$ (5)

$3Mg_{(s)} + N_{2(g)} \rightarrow Mg_3N_{2(s)}$ (5)

or $5Mg_{(s)} + N_{2(g)} + O_{2(g)} \rightarrow Mg_3N_{2(s)} + 2MgO_{(s)}$

(iii) $2Al(s) + N_2(g) \rightarrow 2AlN_{(s)}$ (5)

or $6Al_{(s)} + 3O_{2(g)} + N_{2(g)} \rightarrow 2Al_2O_{3(s)} + 2AlN_{(s)}$

$4Al(s) + 3O_{2(g)} \rightarrow 2Al_2O_{3(s)}$ (5)

(iii) P_2O_5 - acidic (2)

SO_2 - acidic (2)

NO_2 - acidic (2)

CaO - basic (2)

BaO - basic (2)

Bi_2O_3 - basic (2)

(57)

(9)(b) (i) Dissolved Oxygen content $= 2 \times 10^{-4} \times 32 \times 1000\ mgdm^{-3}$

$= 6.4\ mgdm^{-3}$ (10)

(ii) Any one of the following reasons

- Reacting with dissolved organic matter
- Reacting with inorganic reducing agents such as Fe^{2+}, NO_2^-
- Use of oxygen by micro - organisms
- Use of oxygen by aquatic fauna (or flora) (10)

(iii) Ozone (O_3) or Chlorine dioxide (ClO_2) (10)

(30)

(c) (i) $Mn^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mn(OH)_{2(s)}$

$O_{2(aq)} + 2H_2O_{(l)} + 4e \rightarrow 4OH^-_{(aq)}$ — ①

$2MnO_2(s) + 4H_2O_{(l)} + 4e \rightarrow 2Mn(OH)_2(s) + 4OH^-_{(aq)}$ — ②

①-② $O_{2(aq)} + 2Mn(OH)_{2(s)} \rightarrow 2MnO_{2(s)} + 2H_2O_{(l)}$

$2MnO_{2(s)} + 8H^+_{(aq)} + 4e \rightarrow 2Mn^{2+}_{(aq)} + 4H_2O_{(l)}$ — ③

$2I_2(aq) + 4e \rightarrow 4I^-(aq)$ — ④

③-④ $2MnO_{2(s)} + 8H^+_{(aq)} + 4I^-_{(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 4H_2O_{(l)} + 2I$

$2I_{2(aq)} + 4e \rightarrow 4I^-_{(aq)}$ ⑤

$2S_4O_6^{2-}{}_{(aq)} + 4e \rightarrow 4S_2O_3^{2-}{}_{(aq)}$ ⑥

⑤-⑥ $2I_{2(aq)} + 4S_2O_3^{2-}{}_{(aq)} \rightarrow 4I^-_{(aq)} + 2S_4O^-_{6(aq)}$

(ii) $O_2 \equiv 2MnO_2 \equiv 2I_2 \equiv 4S_2O_3^{2-}$

Amount of $Na_2S_2O_3$ consumed $= \frac{20 \times 0.01}{1000}$ mol

Amount of O_2 in 200cm³ of in water sample $=$

$\frac{20 \times 0.01 \times 1}{1000 \times 4}$ mol

Dissolved Oxygen content =

$= \frac{20 \times 0.01 \times 1}{1000 \times 4} \times \frac{1000}{200} \times 32 \times 1000 mgdm$

$= 8.0\ (mg\ dm^{-3})$

(iii) Filling up of the bottle completely

Dipping the tips of the pipettes into the sample

10 (a) (i) Step I

$NH_{3(g)}$ is oxidised to $NO_{(g)}$

Air containing NH_3 with NH_3 : air = 1 : 9

is passed through / over pt catalyst/ pt - Rh catalyst

at 850 - 1000°C

$4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$

Step II

Cool the system

$NO_{(g)}$ is then converted to $NO_{2(g)}$

$2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$

Step III

Reaction of $NO_{2(g)}$ with water to produce HNO_3 and N

$3NO_{2(g)} + H_2O_{(l)} \rightarrow 2HNO_{3(aq)} + NO_{(g)}$

OR

$NO_2(g) + H_2O_{(l)} \xrightarrow[\text{of } O_2]{\text{in the presence}} HNO_{3(aq)}$

$4NO_{2(g)} + 2H_2O_{(l)} + O_{2(g)} \rightarrow 4HNO_{3(aq)}$

OR

Reaction of $NO_{2(g)}$ with water to produce $HNO_{3(aq)}$ an $HNO_{2(aq)}$ which then decomposes to HNO_3 and NO

$2NO_{2(g)} + H_2O_{(l)} \rightarrow HNO_{3(aq)} + HNO_{2(aq)}$

$3HNO_{2(aq)} \rightarrow HNO_{3(aq)} + 2NO_{(g)} + H_2O$

(ii) NO Ozone depletion
Smog / formation of PAN (Peroxyacety/ nitrate)
green house effect (2 x 5) = 10
NO_2 : acid rain
green house effect (2 x 5) = 10

(iii) H^+ : in water - affects aquatic fauna and flora
Soil - degration.

$$\begin{tikzcd}
N\bar{O}_3 \arrow[r, "\text{bacteria}"] & N\bar{O}_2 \arrow[r, "\text{Hb - (Fe)}"] \arrow[d, "R_2NH \text{ (blood) (secondary amine)}"] & \text{Hb - (Fe) - NO}_2 \text{ affects } O_2 \text{ transport.} \\
& R_2N{-}N = O
\end{tikzcd}$$

(nitrosoamine) 3x5=(15)

(b) (i) $NH_4NO_{3(aq)} + NaOH_{(aq)} \rightarrow NH_{3(g)} + NaNO_{3(aq)} + H_2O_{(l)}$ (5)

$H_2NCONH_{2(aq)} + 2NaOH_{(aq)} \rightarrow 2NH_{3(g)} + Na_2CO_{3(aq)}$ (5)

$NH_{3(g)} + HCl_{(aq)} \rightarrow NH_4Cl_{(aq)}$ (2)

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow Nacl_{(aq)} + H_2O_{(l)}$ (2)

$3NO^-_{3(aq)} + 8Al_{(s)} + 5OH^-_{(aq)} + 18H_2O_{(l)} \rightarrow 3NH_{3(g)} + 8[Al(OH)_4]^-_{(aq)}$

OR

$3NaNO_{3(aq)} + 8Al_{(s)} + 5NaOH_{(aq)} + 2H_2O_{(l)} \rightarrow 3NH_{3(aq)} + 8\,NaAlO_{2(aq)}$ (6)

(b) (ii) From the second titration :

Amount of NaOH in 40.0 cm^3 0.1 $moldm^{-3}$ NaOH $= \frac{0.1 \times 40.0}{10^3}$
$= 4 \times 10^{-3}$mol (3)

No. of moles of HCl reacted with NaOH $= 4 \times 10^{-3}$mol

No. of moles of HCl in 50.0 cm^3 0.1 $moldm^{-3}$ HCl $= \frac{0.1 \times 50.0}{10^3}$
$= 5 \times 10^{-3}$mol (2)

No. of moles of HCl that reacted with NH_3 liberated $= 5 \times 10^{-3} - 4 \times 10^{-3}$
$= 1 \times 10^{-3}$ (5)

i.e., the No. of moles of NH_3 liberated when heated with Al.
i.e. from $N\bar{O}_3$ (5)

No. of moles of $N\bar{O}_3$ $= 1 \times 10^{-3}$

Mass of NH_4NO_3 in the sample $= 1 \times 10^{-3} \times 80$ g $= 0.080$ g (5)

Mass % of NH_4NO_3 $= \frac{0.080 \times 100}{0.16}$
$= 50\%$ (5)

Similarly for the 1st titration,

No. of moles of HCl used for NH_4^+ and urea
$= 0.1 \times 10^{-3} (50 - 25) = 2.5 \times 10^{-3}$ (5)
i.e. No. of moles NH_3 from urea and NH_4^+ salt $= 2.5 \times 10^{-3}$
No. of moles of NH_3 from urea $= 2.5 \times 10^{-3} - 1.0 \times 10^{-3}$
$= 1.5 \times 10^{-3}$ (5)

No. of moles of urea $= 1/2 \times 1.5 \times 10^{-3}$
$= 0.75 \times 10^{-3}$ (5)

Mass of urea $= 0.75 \times 10^{-3} \times 60$ g $= 0.045$g (5)

Mass % of urea $= \frac{0.045 \text{ g} \times 100}{0.16} = 28\%$ (5)

(70)