

Second Team Test - Grade 13 - 2020
Chemistry Answer Script - Part A

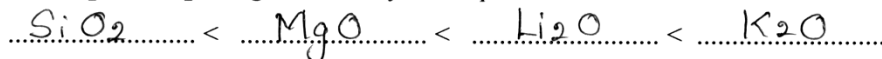
Part I

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

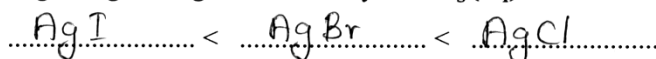
Part A - Structured Essay

(01) (a) Arrange the following element / compound in the increasing order of the property indicated in parenthesis.

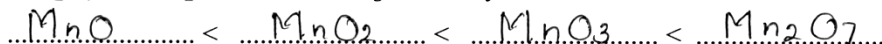
(i) $\text{LiO}, \text{K}_2\text{O}, \text{SiO}_2, \text{MgO}$ (Basicity of the product obtained when react with water)



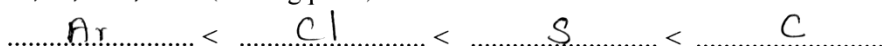
(ii) $\text{AgCl}, \text{AgBr}, \text{AgI}$ (Solubility in $\text{NH}_3(\text{aq})$)



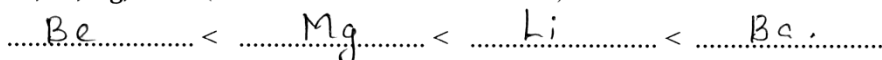
(iii) $\text{Mn}_2\text{O}_7, \text{MnO}_2, \text{MnO}, \text{MnO}_3$ (acidity)



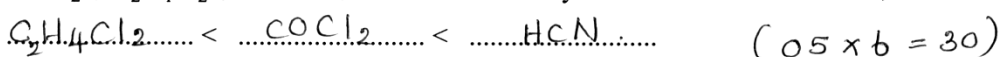
(iv) $\text{S}, \text{Cl}, \text{Ar}, \text{C}$ (Boiling point)



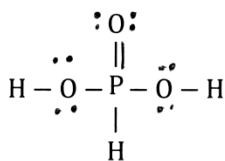
(v) $\text{Li}, \text{Be}, \text{Mg}, \text{Ba}$ (Rate of the reaction with water)



(vi) $\text{COCl}_2, \text{C}_2\text{H}_4\text{Cl}_2, \text{HCN}$ (S character of the hybridization of central atom.)



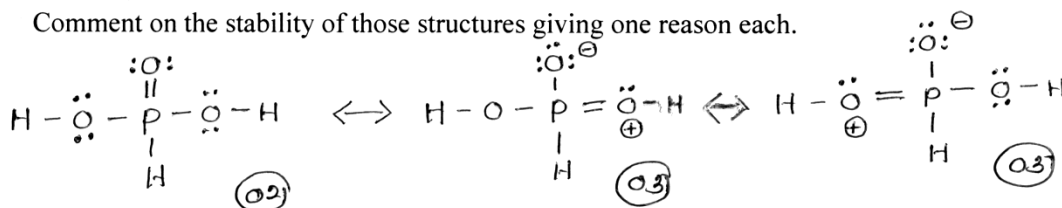
(b) i. Draw the Lewis structure for the H_3PO_3 which is an oxi acid of Phosphorous.



(06)

ii. Draw all the Lewis dot - dash structures (resonance structures) could be drawn for above molecule.

Comment on the stability of those structures giving one reason each.



stable ✓
• less charge distribution ✓

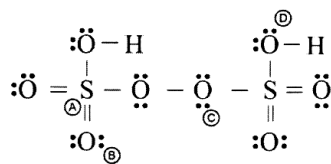
Unstable ✓
• +ve charge on 2 more electronegative
• More charge distribution

Unstable ✓
• +ve on more electronegative oxygen
• more charge distribution

(01 x 06 = 06)

(c) Based on the Lewis dot - dash structure given below state the following regarding the C, N and O atoms given in the table.

- VSEPR pairs around the atom.
- Electron pair geometry around the atom.
- shape around the atom.
- Hybridization of the atom.
- Oxidation number of the atom.

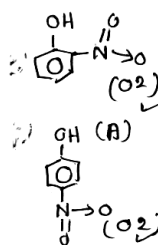


Atom	S _A	O _B	O _C	O _D
VSEPR pairs around the atom	4	3	4	4
Electron pair geometry around the atom.	Tetrahedral	Trigonal planar	Tetrahedral	Tetrahedral
shape around the atom.	Angular	Trigonal planar	Angular	Tetrahedral
Hybridization of the atom.	sp ³	sp ²	sp ³	sp ³
Oxidation number of the atom.	-1	-1	+2	+6

(01x20 = 20)

(B) (d) Mention whether the following statements are true or false. Write reasons briefly.

- (i) Boiling point of otho-nitrophenol is lower than the boiling point of Para - nitrophenol.



True (02)
 There are intermolecular H bonds exist among A molecules while there are intra molecular H bonds among B molecules. Thus ability to form intermolecular H bonds is low in B. Since molecules are strongly attracted by intermolecular H bonds, boiling point of A is higher than B. (02x3+03 = 15)

- (ii) Zn and Sc are transition metals of d block.

False (03) Zn - [Ar]3d¹⁰4s² Zn²⁺ - 3d¹⁰ Sc - [Ar]3d¹4s²
 Since there are no half filled electrons in d sub shell in Zn and Zn²⁺ not considered as transition element. But in Sc, there is d sub shell it is considered as transition element.

(01x7 + 08 = 15)

(02) (a) X is an element belong to the p block where atomic number is less than 20. There is an unpaired electron in X. X is used to bleach cloths and paper.

- (i) Identify X

Cl₂ (Chlorine) (05)

- (ii) Write condensed electron configuration of X

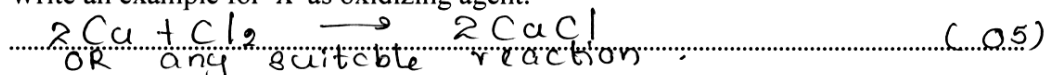
[Ne] 3s²3p⁵ (04)

- (iii) Write formula of compounds formed by X with elements of third period. Mention acidic / basic or amphoteric nature of them.

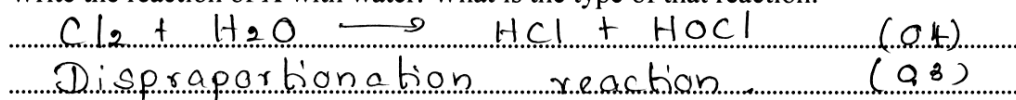
Element	Na	Mg	Al	Si	P
Compound	NaCl	MgCl ₂	AlCl ₃	SiCl ₄	PCl ₃ / PCl ₅
Nature	Neutral	Very weak acidic	Acidic	Acidic	Acidic.

(0.2 × 10 = 20)

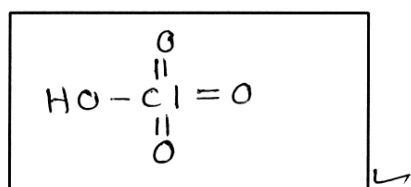
- (iv) Write an example for X as oxidizing agent.



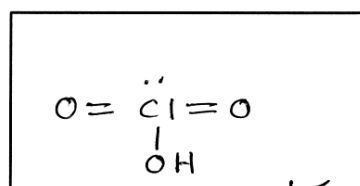
- (v) Write the reaction of X with water. What is the type of that reaction.



- (vi) Draw structures of two oxo acids formed by X and write IUPAC name.



perchloric acid ✓



OR
suitable answer.
chloric acid ✓ (0.4 × 4 = 16)

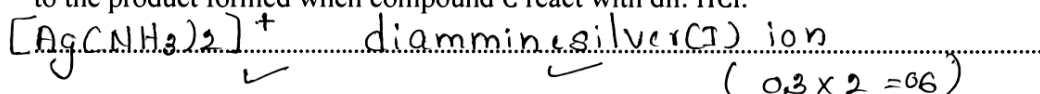
- (b) Test tubes labelled A to E contain solid compounds of CaCO₃, BaCl₂, AgNO₃, ZnSO₄ and NaOH (not in order). Observations obtained when they are subjected to some experiments are given below.

	Experiment	Observation
(a)	Dissolve each compound separately in water.	All compounds dissolve except compound D.
(b)	Dil HCl added to part of aqueous solutions each from A, B, C and E.	Only C gave a white precipitate.
(c)	Dil. H ₂ SO ₄ added gradually in to A, B and E separately as above.	Only E gave a white precipitate while it does not dissolve in excess dil. H ₂ SO ₄ .
(d)	Aqueous NH ₃ added separately to aqueous solutions of A and B.	Only B gave a white gelatinous precipitate.

- (i) Identify A, B, C, D, and E.

A NaOH
B ZnSO₄
C AgNO₃
D CaCO₃
E BaCl₂
(0.5 × 5 = 25)

- (ii) Write the chemical formula and IUPAC name of the product obtained when excess dil. NH₃ added to the product formed when compound C react with dil. HCl.



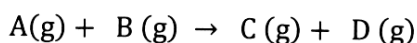
- (iii) If flame test carried out for above compounds. Select the compound which give characteristic colour to the flame and write the colour.

Compound	Colour of the flame
CaCO_3 ✓	Orange-red ✓
BaCl_2 ✓	Yellowish green ✓
NaOH ✓	Yellow ✓

(02 x 6 = 12)

- (03) (a) It was observed the reaction between A and B do not start till heat to 400K temperature.

At 400K, the reaction is



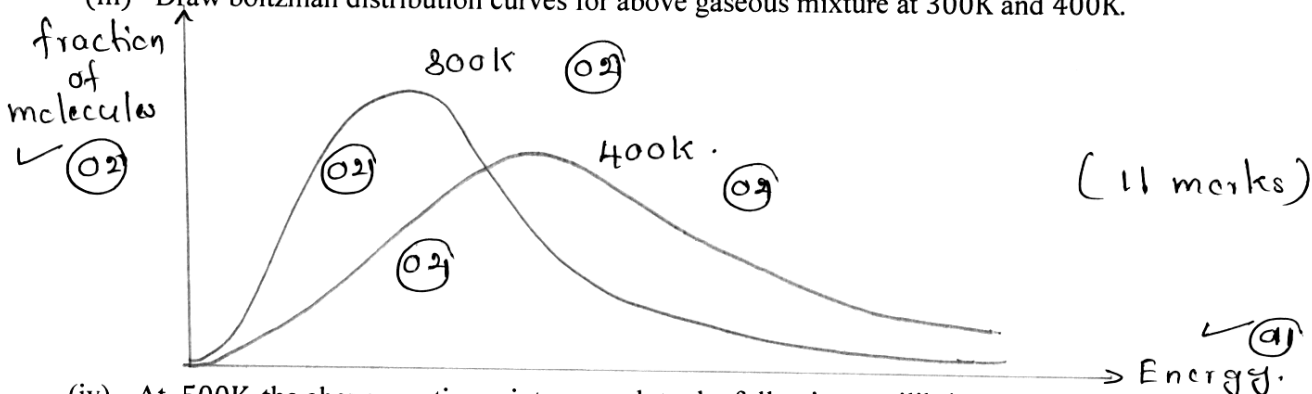
- (i) Explain briefly the reason that the reaction do not start till heat to 400K.

Activation energy of this reaction is a higher value. Number of molecules surmount higher activation energy is very low. When temperature increases no. of molecules surmounting activation energy is high. Thus no. of effective collisions increases. reaction start. (10 marks)

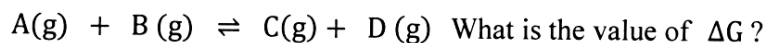
- (ii) Reaction takes place rapidly when the reaction mixture kept in the room temperature and small amount of d block element was added. Explain the reason briefly.

d block element act as catalyst. So reaction takes place through a path of low activation energy, and no. of molecules overcome the activation energy at room temperature. Reaction starts. OR Boltzmann distribution curve. (10 marks)

- (iii) Draw boltzman distribution curves for above gaseous mixture at 300K and 400K.



- (iv) At 500K the above reaction mixture reach to the following equilibrium.



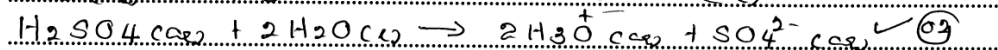
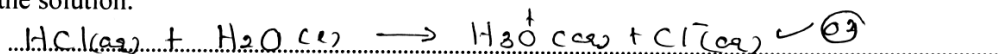
What is the value of ΔG ?

.....
 $\Delta G = 0$ (03)

- (b) (i) Define pH value.

$$pH = -\log_{10} \frac{[H_3O^+(aq)]}{(1 \text{ mol dm}^{-3})} \quad (06)$$

- (ii) At TK temperature 10cm³ of 0.1 mol dm⁻³ HCl solution and 10cm³ of 0.01 mol dm⁻³ H₂SO₄ solution were mixed. If there is no volume change what is the pH of the solution.



$$n_{H_3O^+} = \left(\frac{0.1 \times 10}{1000} + \frac{0.01 \times 10 \times 2}{1000} \right) \text{ mol} \quad (03)$$

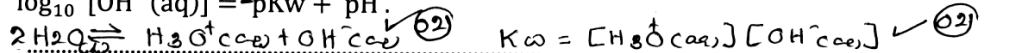
$$= (1 \times 10^{-3} + 0.2 \times 10^{-3}) \text{ mol} = 1.2 \times 10^{-3} \text{ mol} \quad (04)$$

$$[H_3O^+] = \frac{1.2 \times 10^{-3} \times 1000}{10} = 6 \times 10^{-2} \text{ mol dm}^{-3} \quad (03)$$

$$pH = -\log_{10} \left(\frac{6 \times 10^{-2} \text{ mol dm}^{-3}}{1 \text{ mol dm}^{-3}} \right) = 2 - 0.7782 \quad (03)$$

$$= 1.22 \quad (05) \quad (35 \text{ marks})$$

- (iii) If the ionic product of water is Kw, show OH⁻ concentration of above solution is, log₁₀ [OH⁻(aq)] = -pKw + pH.



$$-\log_{10} K_w = -\log_{10} [H_3O^+(aq)] - \log_{10} [OH^-(aq)] \quad (04)$$

$$\log_{10} [OH^-(aq)] = -\log_{10} [H_3O^+(aq)] + \log_{10} K_w \quad \log_{10} [OH^-(aq)] = pH - pK_w \quad (02)$$

- (iv) Calculate [OH⁻(aq)] of above solution using above or any other method. (10 marks)

At that temperature Kw = 1.2 x 10⁻¹⁰ mol² dm⁻⁶.

$$K_w = [OH^-(aq)][H_3O^+(aq)] \quad (04)$$

$$1.2 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6} = [OH^-(aq)] \times 6 \times 10^{-2} \text{ mol dm}^{-3} \quad (05) + (01)$$

$$[OH^-] = \frac{1.2 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}}{6 \times 10^{-2} \text{ mol dm}^{-3}}$$

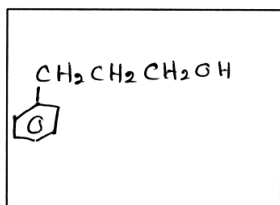
$$= 2 \times 10^{-9} \text{ mol dm}^{-3} \quad (04) + (01)$$

(15 marks)

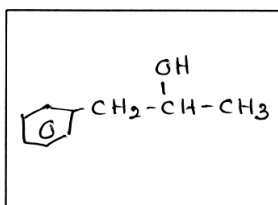
- (04) (a) A, B, C, D and E are five mono substituted aromatic alcohols with the molecular formula C₉H₁₂O. They show following properties.

Only A and D do not show enantiomerism while B, C and E show enantiomerism. Compound A oxidized by PCC to form P, while D do not undergo oxidation by PCC. B, C and E compounds are oxidized are PCC producing Q, R and S respectively. S gives silver mirror with NH₃/AgNO₃ and Q, R is not. There is a chiral carbon in the product when Q react with CH₃CH₂MgBr and hydrolysed.

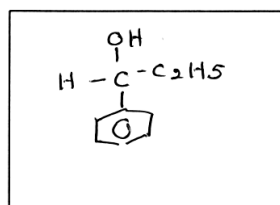
i. Draw the structures of alcohol molecules A, B, C, D and E in the boxes given below.



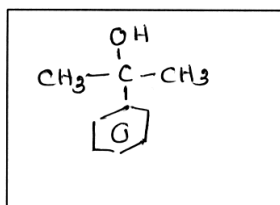
A



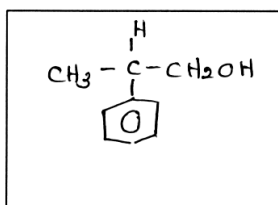
B



C



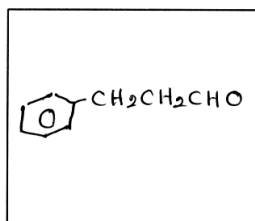
D



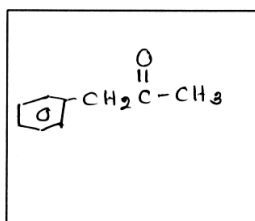
E

(04 x 5 = 20)

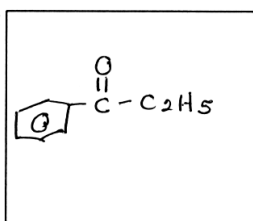
ii. Draw structures of the compounds P, Q, R and S.



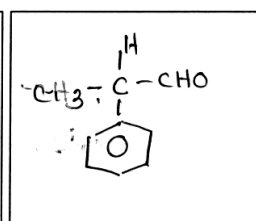
P



Q



R



(04 x 04 = 16)

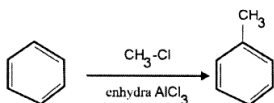
iii. Write an experiment to identify A and D with observations.

Lucas reagent :- Instant turbidity given by D
 ✓ OR ✓
 suitable answer
 (04 x 2 = 08)

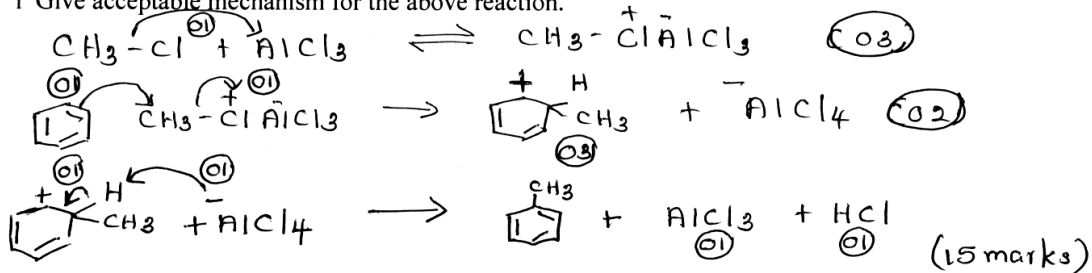
Write experiment to identify P and Q with observation.

Tollens reagent - Only P gives silver mirror
 ✓ OR ✓
 suitable answer. (04 x 2 = 08)

(b) Consider the following reaction.



i. Give acceptable mechanism for the above reaction.



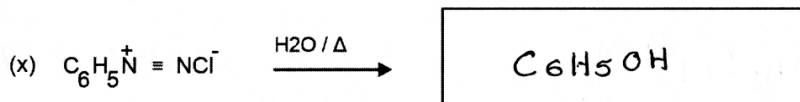
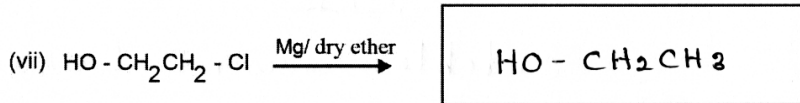
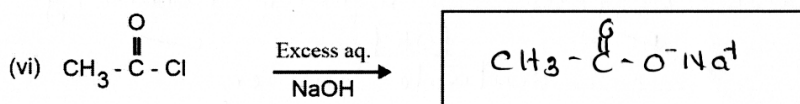
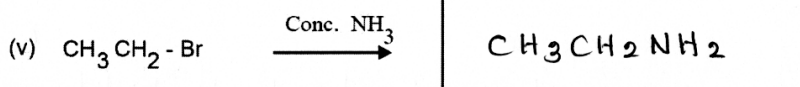
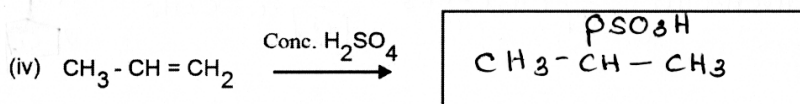
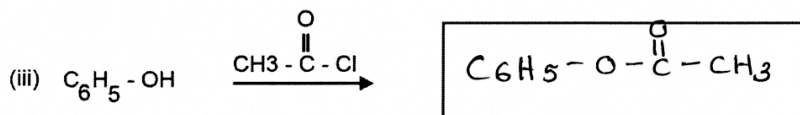
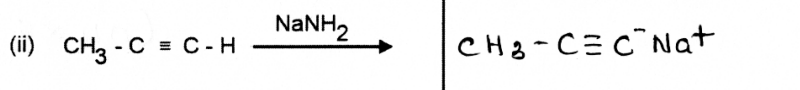
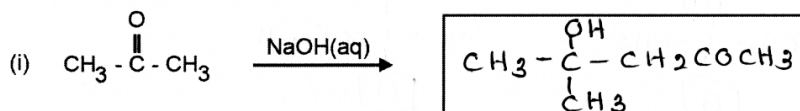
ii Write two importance of Anhydride AlCl_3 .

Act as Lewis acid and catalyst (2)

iii What is the anion act as Lewis base in the above reaction.

AlCl_4^- (1)

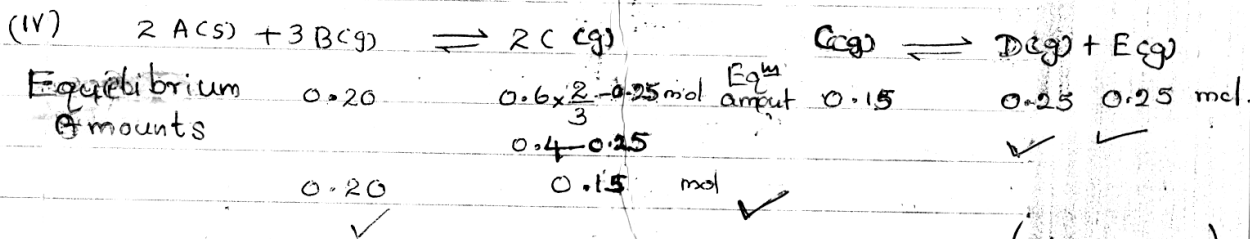
(b) Write the major organic product of each of the following reaction.



(3 x 10 = 30 marks)

Amount of B reacted -

$$= (0.80 - 0.20) \text{ mol} = 0.60 \text{ mol}$$



$$(0.1 \times 4 = 0.4)$$

Total equilibrium moles = $n_{\text{B(g)}} + n_{\text{C(g)}} + n_{\text{D(g)}} + n_{\text{E(g)}}$
 $= (0.20 + 0.15 + 0.25 + 0.25) \text{ mol}$
 $= 0.85 \text{ mol}$ ✓ $(0.2 \times 2 = 0.4)$

Applying $PV = nRT$ for system.

$$P = \frac{nRT}{V} = \frac{0.85 \text{ mol} \times 8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 700 \text{ K}}{4.157 \times 10^{-3} \text{ m}^3}$$

$$= 11.9 \times 10^5 \text{ Pa}$$

$$X_{\text{B(g)}} = \frac{0.20 \text{ mol}}{0.85 \text{ mol}} = \frac{4}{17}$$

$$X_{\text{C(g)}} = \frac{0.15 \text{ mol}}{0.85 \text{ mol}} = \frac{3}{17}$$

$$X_{\text{D(g)}} = X_{\text{E(g)}} = \frac{0.25 \text{ mol}}{0.85 \text{ mol}} = \frac{5}{17}$$

$$P_{\text{B(g)}} = \frac{4}{17} \times 11.9 \times 10^5 \text{ Pa} = 2.8 \times 10^5 \text{ Pa}$$

$$P_{\text{C(g)}} = \frac{3}{17} \times 11.9 \times 10^5 \text{ Pa} = 2.1 \times 10^5 \text{ Pa}$$

$$P_{\text{D(g)}} = P_{\text{E(g)}} = \frac{5}{17} \times 11.9 \times 10^5 \text{ Pa} = 3.5 \times 10^5 \text{ Pa}$$

$$(0.2 \times 13 = 2.6)$$

(V) v (1) For equilibrium:

$$K_p = \frac{P_{\text{C(g)}}^2}{P_{\text{B(g)}}^3} = \frac{(2.1 \times 10^5 \text{ Pa})^2}{(2.8 \times 10^5 \text{ Pa})^3} = 2.01 \times 10^{-6} \text{ Pa}^{-1}$$

(2) For equilibrium:

$$K_p = \frac{P_{\text{D(g)}} \times P_{\text{E(g)}}}{P_{\text{C(g)}}} = \frac{3.5 \times 10^5 \text{ Pa} \times 3.5 \times 10^5 \text{ Pa}}{2.1 \times 10^5 \text{ Pa}}$$

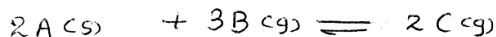
$$= 5.83 \times 10^5 \text{ Pa}$$

$$(0.2 \times 5 = 1.0)$$

K_p at $127^\circ\text{C} < K_p$ at 427°C .

(vi) ∴ When increasing temperature, equilibrium of (i) is shifted towards the forward reaction. ∴ forward reaction is endothermic. ✓ (05)

(vii)



New Amounts	$0.50 + 0.20$	$0.20 + 0.10$ mol	✓
	0.70	0.30 mol	✓
New Concentrations	$\frac{0.70}{4.157}$	$\frac{0.30}{4.157}$ mol/dm ³	✓

$$Q_c = \frac{[C(g)]^2}{[A(g)]^2 [B(g)]^3} = \frac{\left(\frac{0.30}{4.157} \text{ mol dm}^{-3}\right)^2}{\left(\frac{0.70}{4.157} \text{ mol dm}^{-3}\right)^3}$$

$$= \frac{0.30 \times 0.30 \times 4.157}{0.70 \times 0.70 \times 0.70}$$

$$= 1.09 \text{ mol}^{-1} \text{ dm}^3$$

$$= 1.09 \times 10^{-3} \text{ mol}^{-1} \text{ m}^3$$

∴ $Q_c < K_c$

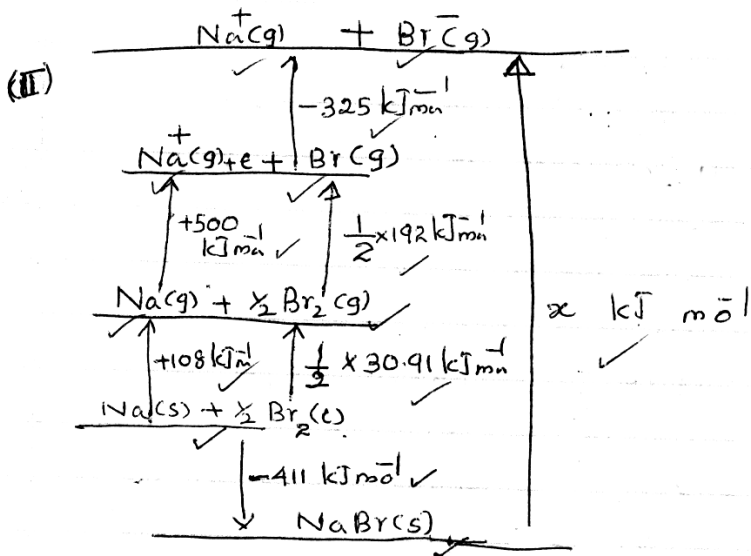
∴ $Q_c < K_c$ ✓

∴ forward reaction is favoured. ✓ (01 × 8 = 08)

(b) I

- (i) $\text{Na}(s) \longrightarrow \text{Na}(g)$; $\Delta H_s^\ominus = +108 \text{ kJ mol}^{-1}$ ✓
- (ii) $\text{Na}(g) \longrightarrow \text{Na}^+(g) + e^-$; $\Delta H_{IE}^\ominus = +500 \text{ kJ mol}^{-1}$ ✓
- (iii) $\text{Na}(s) + \frac{1}{2}\text{Br}_2(l) \longrightarrow \text{NaBr}(s)$; $\Delta H_f^\ominus = -411 \text{ kJ mol}^{-1}$ ✓
- (iv) $\text{Br}_2(l) \longrightarrow \text{Br}_2(g)$; $\Delta H_{\text{vap}}^\ominus = +30.91 \text{ kJ mol}^{-1}$ ✓
- (v) $\text{Br}_2(g) \longrightarrow 2\text{Br}(g)$; $\Delta H_B^\ominus = +192 \text{ kJ mol}^{-1}$ ✓
- (vi) $\text{Br}(g) + e^- \longrightarrow \text{Br}^-(g)$; $\Delta H_{EA}^\ominus = -325 \text{ kJ mol}^{-1}$ ✓
- (vii) $\text{NaBr}(s) \longrightarrow \text{Na}^+(g) + \text{Br}^-(g)$; $\Delta H_L^\ominus = x \text{ kJ mol}^{-1}$ ✓

(02 × 7 = 14)



and so on:

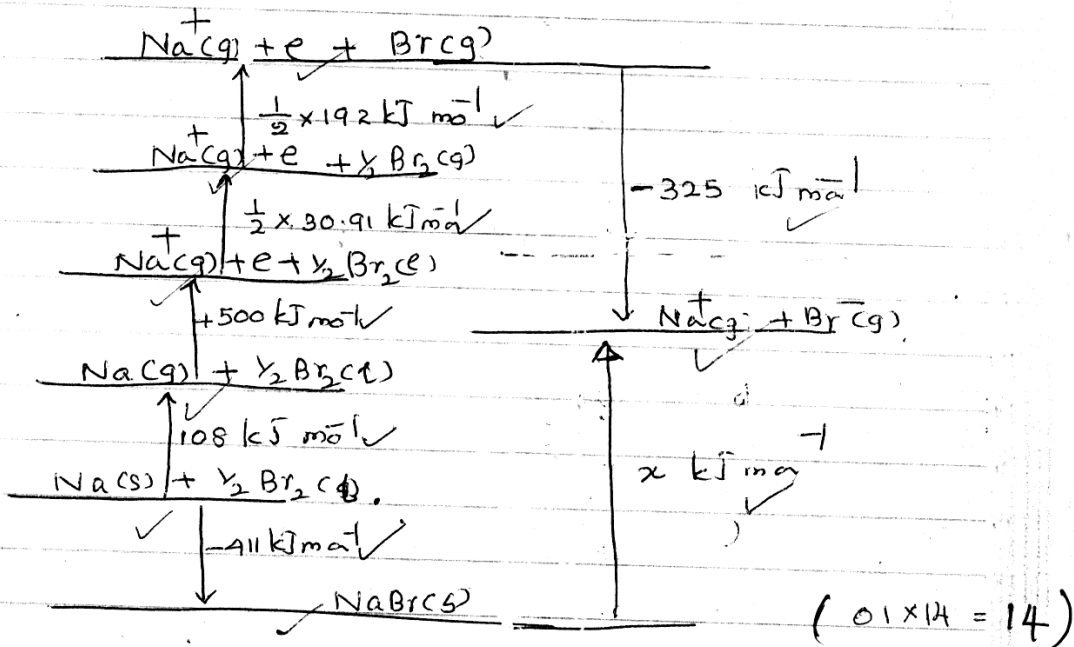
$$-411 \text{ kJ mol}^{-1} + x \text{ kJ mol}^{-1} = 108 \text{ kJ mol}^{-1} + 500 \text{ kJ mol}^{-1} + \frac{1}{2} \times 30.90 + \frac{1}{2} \times 192 \text{ kJ mol}^{-1} + (-325 \text{ kJ mol}^{-1})$$

$$x = 805.455$$

(03)

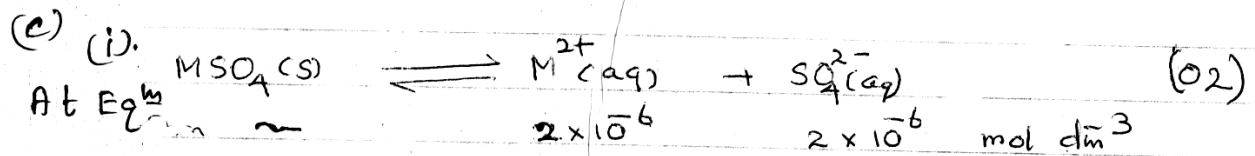
(02)

OR



04
(02)

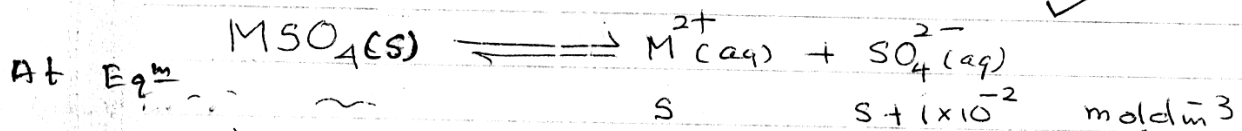
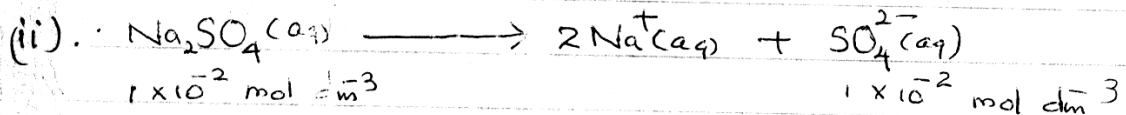
(34)



$$K_{sp} = [\text{M}^{2+}(\text{aq})][\text{SO}_4^{2-}(\text{aq})]$$

$$= 2 \times 10^{-6} \text{ mol dm}^{-3} \times 2 \times 10^{-6} \text{ mol dm}^{-3}$$

$$= 4 \times 10^{-12} \text{ mol}^2 \text{ dm}^{-6}$$



K_{sp} constant, since T is constant.

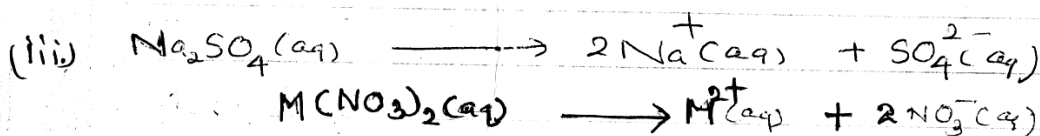
$$4 \times 10^{-12} \text{ mol}^2 \text{ dm}^{-6} = s \text{ mol dm}^{-3} (s + 1 \times 10^{-2}) \text{ mol dm}^{-3}$$

Since $K_{sp} \ll s$, $s \ll 1 \times 10^{-2} + s \approx 1 \times 10^{-2}$

$$4 \times 10^{-12} = s \times 1 \times 10^{-2}$$

$$s = 4 \times 10^{-10}$$

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



$$[\text{SO}_4^{2-}(\text{aq})] = 1 \times 10^{-5} \text{ mol dm}^{-3} \times \frac{50 \times 10^3 \text{ dm}^3}{100 \times 10^3 \text{ dm}^3}$$

$$= 5 \times 10^{-6} \text{ mol dm}^{-3}$$

$$[\text{M}^{2+}(\text{aq})] = 2 \times 10^{-5} \text{ mol dm}^{-3} \times \frac{50 \times 10^3 \text{ dm}^3}{100 \times 10^3 \text{ dm}^3}$$

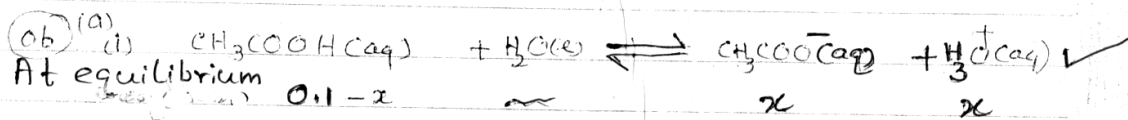
$$= 1 \times 10^{-5} \text{ mol dm}^{-3}$$

Ionic product of solution

$$= [\text{M}^{2+}(\text{aq})][\text{SO}_4^{2-}(\text{aq})]$$

$$= 1 \times 10^{-5} \text{ mol dm}^{-3} \times 5 \times 10^{-6} \text{ mol dm}^{-3} = 5 \times 10^{-11} \text{ mol}^2 \text{ dm}^{-6}$$

$$\boxed{0.1 \times 10^{-9} = 10^{-10}}$$



$$K_a = \frac{[\text{CH}_3\text{COO}^-(\text{aq})][\text{H}_3\text{O}^+(\text{aq})]}{[\text{CH}_3\text{COOH}(\text{aq})]}$$

$$1.8 \times 10^{-5} \text{ mol dm}^{-3} = \frac{x \text{ mol dm}^{-3} \times x \text{ mol dm}^{-3}}{(0.1 - x) \text{ mol dm}^{-3}}$$

Acid is a weak acid $x \ll 0.1$ ∴ $0.1 - x \approx 0.1$

$$1.8 \times 10^{-5} = \frac{x^2}{0.1}$$

$$(1.8 \times 10^{-5})^{1/2} = x$$

$$x = 1.342 \times 10^{-3}$$

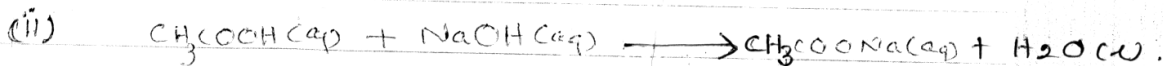
$$[\text{H}_3\text{O}^+(\text{aq})] = 1.34 \times 10^{-3} \text{ mol dm}^{-3}$$

$$\text{pH} = -\log_{10} \frac{[\text{H}_3\text{O}^+(\text{aq})]}{1 \text{ mol dm}^{-3}}$$

$$= -\log_{10} 1.34 \times 10^{-3}$$

$$= 3 - 0.1271$$

$$= 2.8729 = 2.87. \quad (0.3 \times 9 = 27)$$



Remaining $[\text{CH}_3\text{COOH}(\text{aq})] = \frac{0.1 \text{ mol dm}^{-3} \times 25 \times 10^{-3} \text{ dm}^3 - 0.2 \text{ mol dm}^{-3} \times 10 \times 10^{-3} \text{ dm}^3}{35 \times 10^{-3} \text{ dm}^3}$

$$= 1.43 \times 10^{-2} \text{ mol dm}^{-3}$$

formed: $[\text{CH}_3\text{COONa}(\text{aq})] = 5.71 \times 10^{-2} \text{ mol dm}^{-3}$



$$\text{pH} = \text{p}K_a + \log_{10} \frac{[\text{CH}_3\text{COO}^-(\text{aq})]}{[\text{CH}_3\text{COOH}(\text{aq})]}$$

$$= -\log_{10} 1.8 \times 10^{-5} + \log_{10} \frac{5.71 \times 10^{-2}}{1.43 \times 10^{-2}}$$

$$= 5 - 0.2553 + \log_{10} 3.99$$

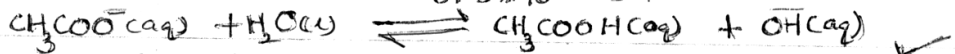
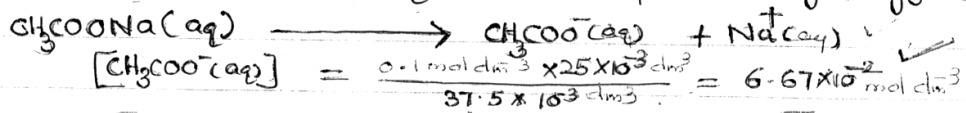
$$= 5 - 0.2553 + 0.6010 = 5.3457$$

$$= 5.35 \quad \checkmark$$

(ii) Cannot. Because weak acid and its conjugate base in the solution. $(0.3 \times 7 = 2.1)$
 (05)

(iv) Required volume. = $\frac{0.1 \text{ mol dm}^{-3} \times 25.0 \times 10^{-3} \text{ dm}^3}{0.2 \text{ mol dm}^{-3}} = 12.5 \times 10^{-3} \text{ dm}^3$
 (03)
 $= 12.5 \text{ cm}^3$
 (02)

(v) CH_3COONa formed at the equivalence point hydrolyzed.



At eq^m $6.67 \times 10^{-2} = x$ x x mol dm^{-3}

$$K_b = \frac{[\text{CH}_3\text{COOH}(\text{aq})][\text{OH}^-(\text{aq})]}{[\text{CH}_3\text{COO}^-(\text{aq})]}$$

$$K_a \times K_b = K_w \quad \checkmark$$

$$\frac{1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{1.8 \times 10^{-5} \text{ mol dm}^{-3}} = \frac{x^2}{6.67 \times 10^{-2} - x}$$

$$x \ll 6.67 \times 10^{-2} \quad \therefore 6.67 \times 10^{-2} - x = 6.67 \times 10^{-2}$$

$$0.5556 \times 10^{-9} = \frac{x^2}{6.67 \times 10^{-2}} \quad \checkmark$$

$$x^2 = 3.71 \times 10^{-11} = 37.1 \times 10^{-12}$$

$$x = 6.09 \times 10^{-6}$$

$$[\text{OH}^-(\text{aq})] = 6.09 \times 10^{-6} \text{ mol dm}^{-3} \quad \checkmark$$

$$\text{pOH} = 6 - 0.7846$$

$$\text{pH} = 14 - (6 - 0.7846)$$

$$= 8.7846 \quad \checkmark \quad (0.2 \times 10 = 2.0)$$

(vi) Remaining base is strong and pH of the solution depend on that.

$$\text{Remaining } [\text{NaOH}(\text{aq})] = \frac{0.2 \text{ mol dm}^{-3} \times 20 \times 10^{-3} \text{ dm}^3 - 0.2 \text{ mol dm}^{-3} \times 12.5 \times 10^{-3} \text{ dm}^3}{45 \times 10^{-3} \text{ dm}^3}$$

$$= 2.22 \times 10^{-2} \text{ mol dm}^{-3} \quad \checkmark$$

(4)

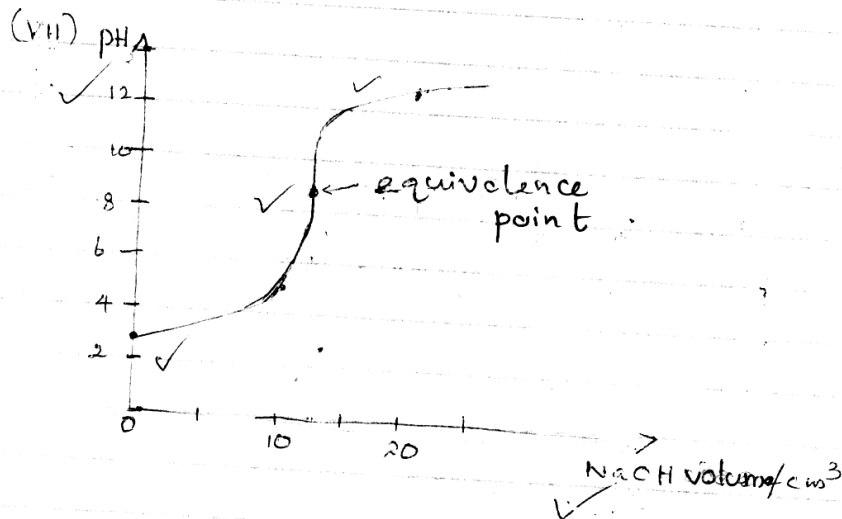
$$[\text{OH}^-]_{\text{eq}} = 3.33 \times 10^{-2} \text{ mol dm}^{-3}$$

$$\text{pOH} = 2 - 0.5224 = 1.4776$$

$$\text{pH} = 14 - 1.4776 = 12.5224 = 12.52$$

This solution can't act as buffer solution. Weak acid not contained here.

(0.2 x 4 = 0.8)



(VIII) Most suitable indicator is C ✓ (0.4)

100

(b). I Heat required to convert ice at 20°C to ice at 0°C } = m s Δt

$$= 90 \times 10^3 \text{ g} \times 2.09 \text{ J g}^{-1} \text{ } ^\circ\text{C}^{-1} \times 20^\circ\text{C}$$

$$= 3.762 \times 10^3 \text{ J}$$

$$= 3.762 \times 10^3 \text{ kJ}$$

Heat required to convert ice at 0°C to water at 0°C } = 6.0 kJ mol⁻¹ × $\frac{90 \times 10^3 \text{ g}}{18 \text{ g mol}^{-1}}$

Total amount of heat required

$$= 30 \times 10^3 \text{ kJ}$$

$$= 3.762 \times 10^3 \text{ kJ} + 30 \times 10^3 \text{ kJ}$$

$$= 33.762 \times 10^3 \text{ kJ}$$

(0.2 x 7 = 1.4)

$$(1) X_A = \frac{2 \text{ mol}}{2 \text{ mol} + 3 \text{ mol}} = \frac{2}{5}$$

$$X_B = \frac{3 \text{ mol}}{2 \text{ mol} + 3 \text{ mol}} = \frac{3}{5}$$

$$P_A = P_A^0 X_A = 5.0 \times 10^4 \text{ Pa} \times \frac{2}{5} = 2.0 \times 10^4 \text{ Pa}$$

$$P_A + P_B = P_T = 6.4 \times 10^4 \text{ Pa}$$

$$P_B = 6.4 \times 10^4 \text{ Pa} - 2.0 \times 10^4 \text{ Pa} = 4.4 \times 10^4 \text{ Pa}$$

$$P_B = P_B^0 X_B$$

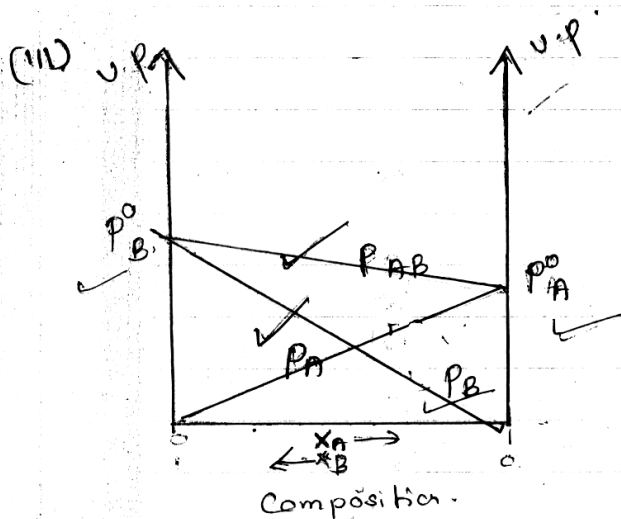
$$P_B^0 = \frac{4.4 \times 10^4 \text{ Pa}}{\frac{3}{5}} = 7.33 \times 10^4 \text{ Pa}$$

(II) Mole fractions of A and B in vapour phase is Y_A and Y_B respectively.

$$Y_A = \frac{P_A}{P_T} = \frac{2.0 \times 10^4 \text{ Pa}}{6.4 \times 10^4 \text{ Pa}} = 0.3125$$

$$Y_B = \frac{P_B}{P_T} = \frac{4.4 \times 10^4 \text{ Pa}}{6.4 \times 10^4 \text{ Pa}} = 0.6875$$

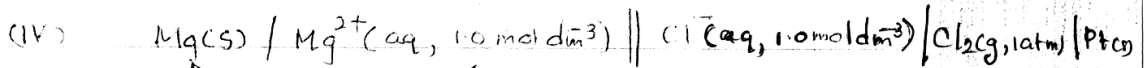
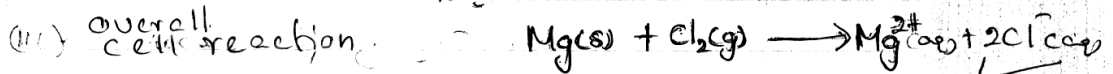
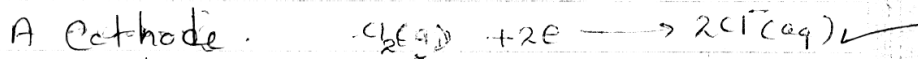
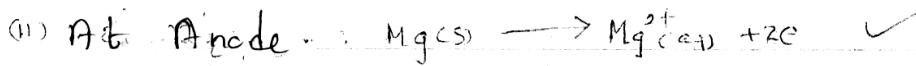
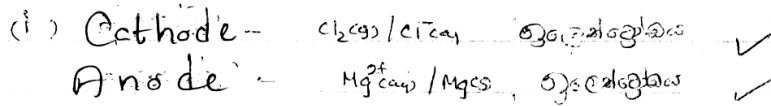
(0.2 x 15 = 30)



(0.1 x 6 = 0.6)

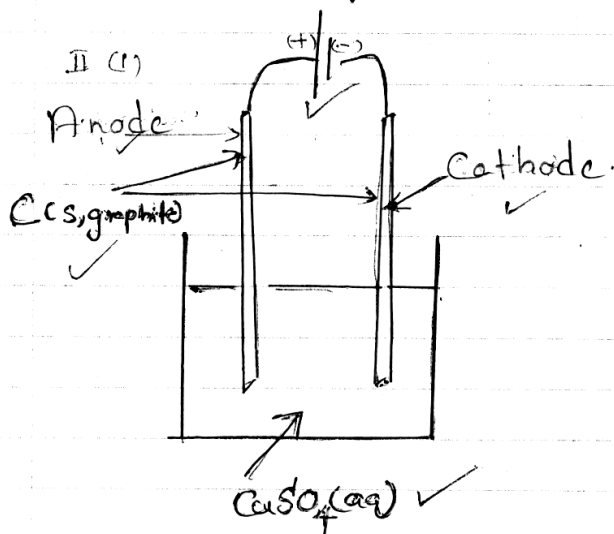
36

7) (a) I

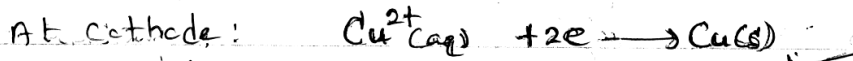


(v) $E_{\text{cell}}^{\ominus} = E_{\text{cathode}}^{\ominus} - E_{\text{anode}}^{\ominus}$ ✓ (06)
 $= +1.36 \text{ V} - (-2.37 \text{ V})$ ✓
 $= +3.73 \text{ V}$ ✓

03x8+06



(02x5=10)



(ii) Mass of cathode increases.

$Q = It = 2.0 \text{ A} \times 3600 \text{ s} = 7200 \text{ C}$ ✓

No of moles of e^- flow = $\frac{7200 \text{ C}}{96500 \text{ C mol}^{-1}} = 0.07461 \text{ mol}$ ✓

Moles of Cu deposited on Cathode = $\frac{1 \text{ mol}}{2 \text{ mol}} \times 0.07461 \text{ mol}$
 mass of Cu = $0.07461 \text{ mol} \times 63.5 \text{ g mol}^{-1}$
 $= 2.37 \text{ g}$

(iv) Amount of Cu consumed = $0.07461 \text{ mol} = 0.0373 \text{ mol}$

New concentration = $\frac{0.5 \text{ mol dm}^{-3} \times 250 \times 10^{-3} \text{ dm}^3 - 0.0373 \text{ mol}}{250 \times 10^{-3} \text{ dm}^3}$
 $= \frac{0.0877 \text{ mol}}{0.25 \text{ dm}^3}$
 $= 0.3508 \text{ mol dm}^{-3}$

(v) Volume of solution does not change. (of NH_4^+)

(b) I (i) Co ✓
 (ii) +2 ✓

54

(iii) $1s^2 3s^2 3p^6 3d^7$ ✓

(iv) $n=+2$ ✓ $n=6$ ✓

(v) $3d^7$ ✓

(vi) $P \equiv \text{Co(OH)}_2$ ✓ $R \equiv [\text{Co(NH}_3)_6]^{2+}$ ✓ $T \equiv [\text{CoCl}_4]^{2-}$ ✓
 $Q \equiv [\text{CoCO}_3]^{2-}$ ✓ $S \equiv [\text{Co(NH}_3)_6]^{3+}$ ✓

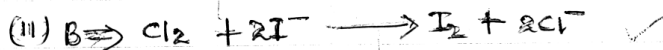
(vii) $Y \equiv [\text{CoCH}_3\text{O}_6]^{2+}$ hexaaquacobalt(II) ion ✓
 $Q \equiv [\text{Co(OH)}_4]^{2-}$ tetrahydroxidocobaltate(II) ion ✓
 $T \equiv [\text{CoCl}_4]^{2-}$ tetrachloridocobaltate(II) ion ✓
 $R \equiv [\text{Co(NH}_3)_6]^{2+}$ hexaamminecobalt(II) ion ✓
 $S \equiv [\text{Co(NH}_3)_6]^{3+}$ hexaamminecobalt(III) ion ✓
 (03 x 6 = 48)

II (i) $A \equiv [\text{Co(NH}_3)_4\text{Cl}_2] \text{Cl}$ ✓

$B \equiv [\text{Co(NH}_3)_4\text{Cl}_2] \text{I}$ ✓

$C \equiv [\text{Co(NH}_3)_4\text{Cl(NO}_2)] \text{Br}$ ✓

(10 x 3 = 30)



(iii) When $\text{Pb(CH}_3\text{COO)}_2$ added to aq solution of anion. $\text{Cl}^- \Rightarrow$ white ppt, dissolves when heating while reprecipitate (as needles)

$\text{I}^- \Rightarrow$ Golden yellow ↓ dissolves when heating while can see as a golden dust when cooling

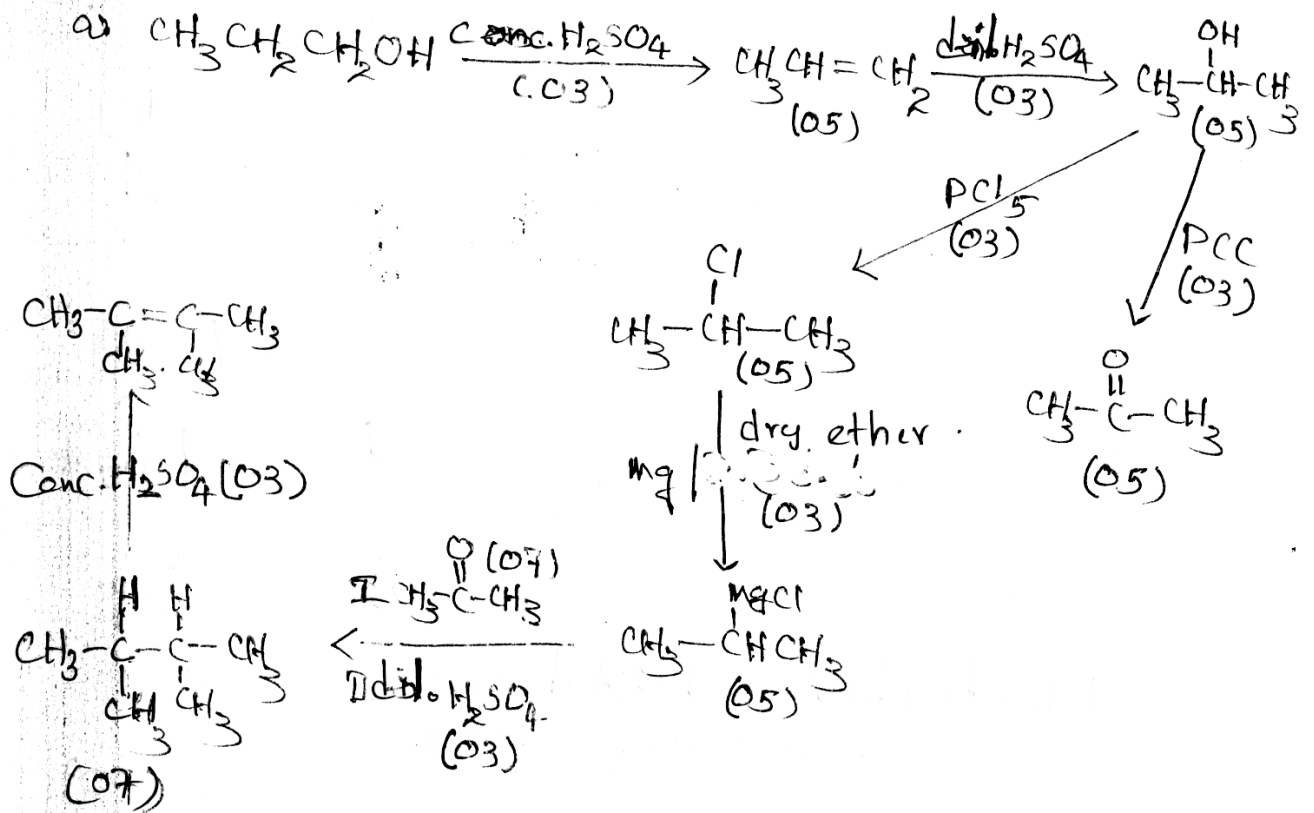
$\text{Br}^- \Rightarrow$ Light (white) ↓ dissolves when heating while reprecipitate when cooling

⑥

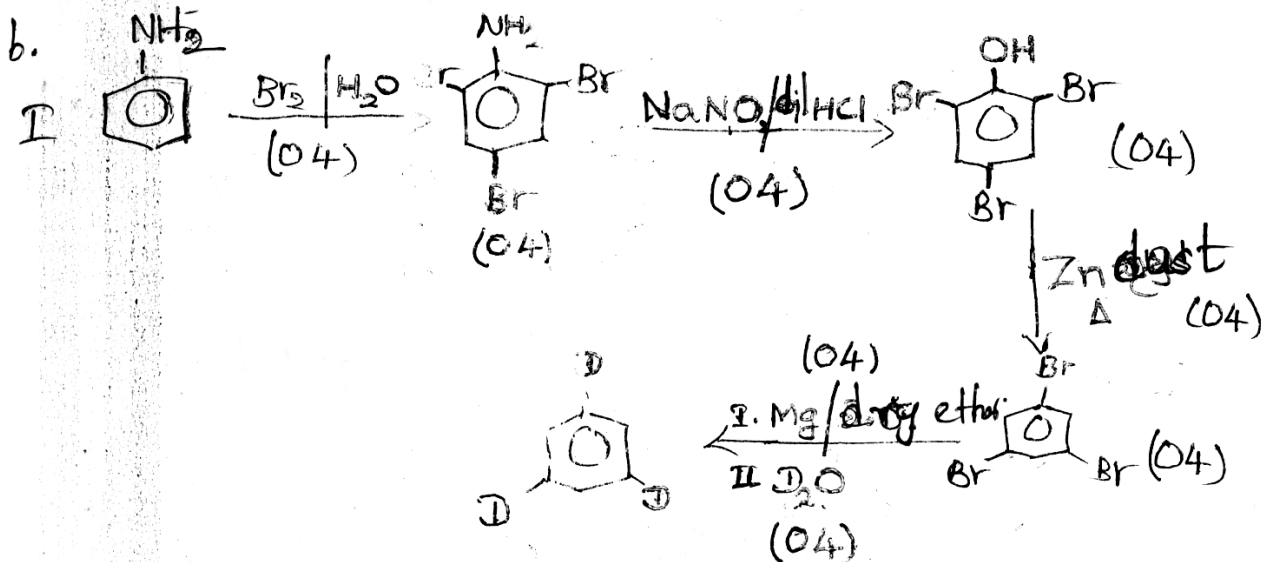
OR (Any suitable re[±] in syllabus)

196

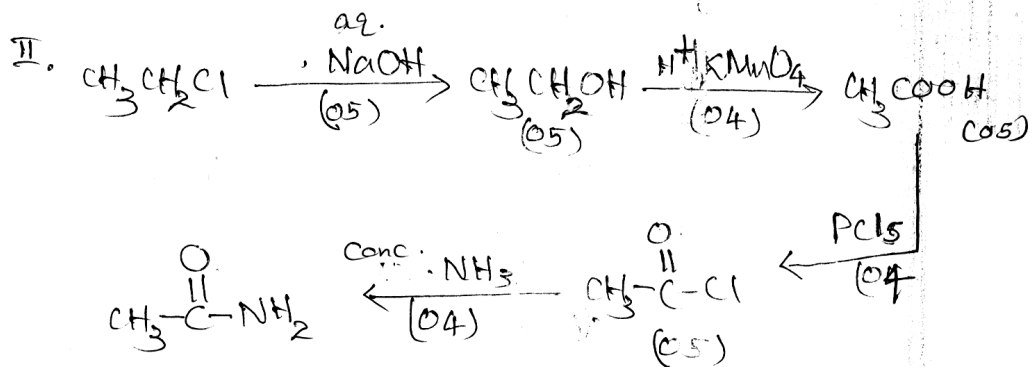
8



8(a) 60



(04) = [32]

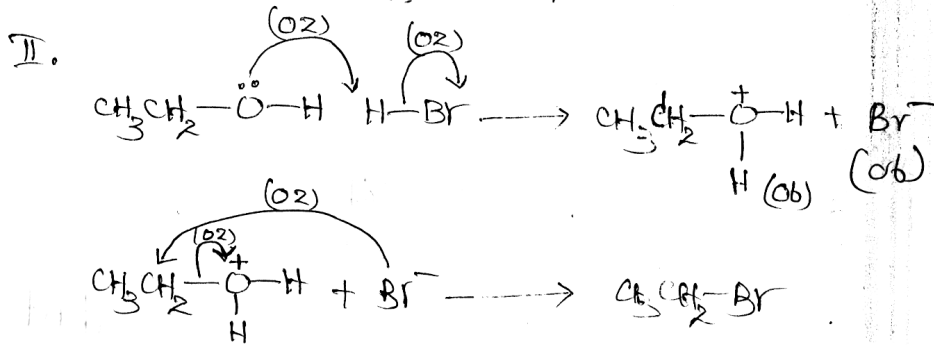


≠ 32

S.(b) = 26

C. Electrophilic substitution

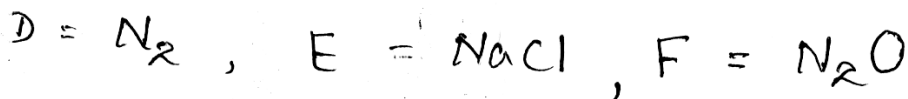
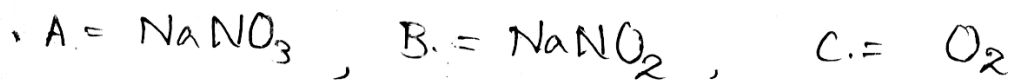
I. $\text{CH}_3\text{CH}_2\text{OH} + \text{H}^+ \rightleftharpoons \text{CH}_3\text{CH}_2\text{OH}_2^+ + \text{H}_2\text{O}$ (06)



S.(c) = 26

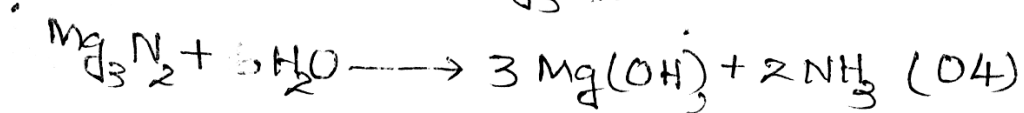
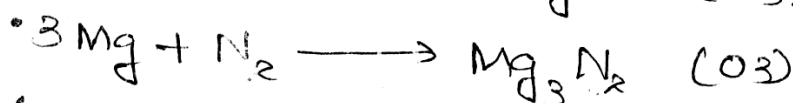
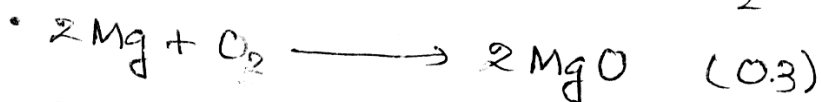
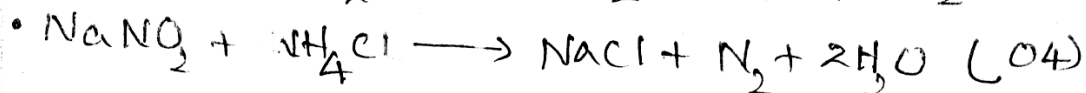
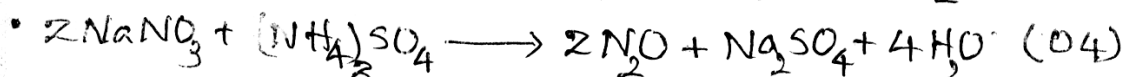
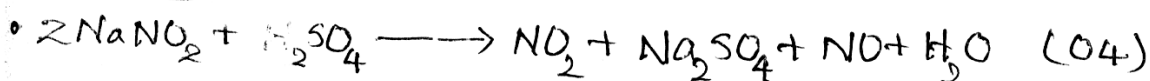
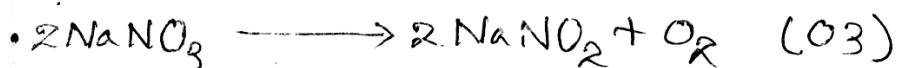
9

I



(05x7 = 35)

II

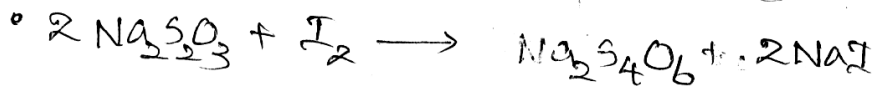
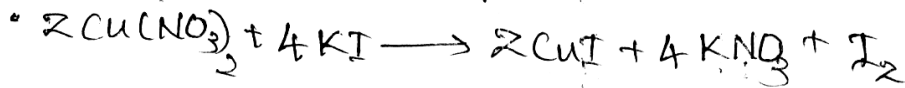
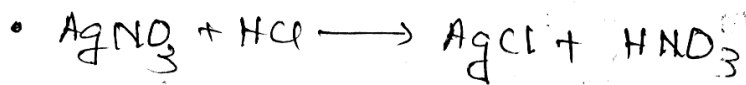
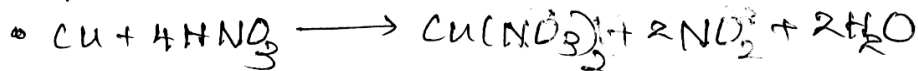
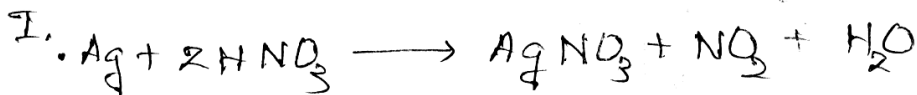


(25)

9. (a) = 60

- b.
- Add excess NaOH to each test tube (02)
 - In $\text{Zn}(\text{NO}_3)_2$ white ppt is formed and dissolves when adding excess NaOH is $\text{Zn}(\text{NO}_3)_2$. (03)
 - $(\text{NH}_4)_2\text{SO}_4$ and $\text{CH}_3\text{COONH}_4$ produce gases with pungent smell (03)
 - Remaining test tube has $\text{Ba}(\text{NO}_3)_2$ (03).
 - Add $\text{Ba}(\text{NO}_3)_2$ to remaining two solutions (03).
 - Precipitate given by $(\text{NH}_4)_2\text{SO}_4$ (03).
 - Other test tube contains $\text{CH}_3\text{COONH}_4$ (03).

C.



$0.04 \times 5 = 0.20$

II. • starch • Near end point

• Releasing I_2 exist as I_3^-

• $\text{I}_2 + \text{I}^- \rightleftharpoons \text{I}_3^-$ • At the beginning starch form solid complex with I_3^-

• I_3^- concentration is low near end point.

• Then I_3^- exist blue with starch.

$(0.2 \times 7 = 1.4)$

III. • AgCl moles = $\frac{0.287 \text{ g}}{143.5 \text{ g/mol}} = 0.002 \text{ mol}$ (0.2+0.1)

• Ag moles = 0.002 mol (0.2+0.1) • Ag mass = $0.002 \times 108 = 0.216 \text{ g}$ (0.2+0.1)

• Consumed $\text{S}_2\text{O}_3^{2-}$ moles = $0.1 \times 10^{-3} \times 40 \text{ mol}$ (0.2+0.1)

• I_2 moles = $0.1 \times 10^{-3} \times 40 \times 0.5 \text{ mol}$ (0.2+0.1)

• $\text{Cu}(\text{NO}_3)_2$ moles = $0.1 \times 10^{-3} \times 40 \text{ mol}$ (0.2+0.1)

• Cu moles = $0.1 \times 10^{-3} \times 40 \text{ mol}$ (0.2+0.1)

• Cu (mass) = $0.1 \times 10^{-3} \times 40 \text{ mol} \times 63.5 \text{ g/mol}$ (0.2+0.1)
= 0.254 g (0.2+0.1)

• Ag (mass) = $1.6 - (0.254 + 0.216) \text{ g}$ (0.3 \times 12 = 3.6)
= 1.172 g (0.2+0.1)

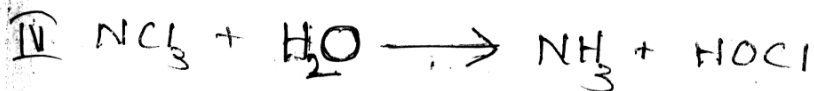
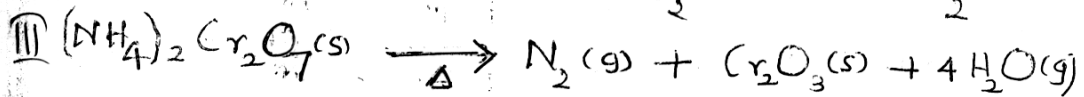
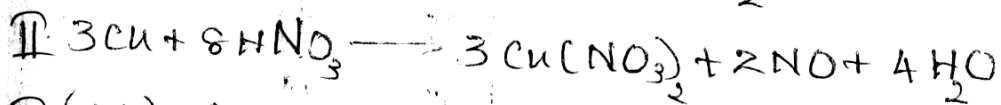
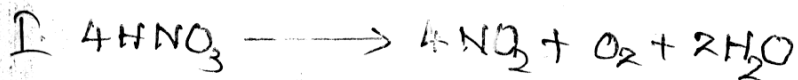
10

- (a) I tetrachloridonickelate(II) ion
 II hexaamminecobalt(II) ion
 III potassium tetrachloridocobaltate(II)
 IV hexaaquamanganese(II) iodide.

$$(08 \times 4 = 32)$$

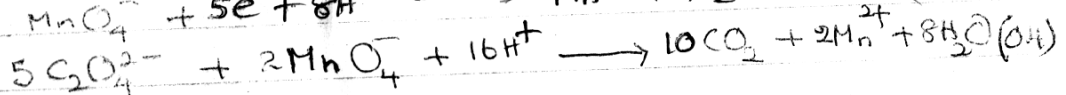
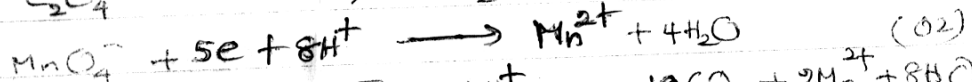
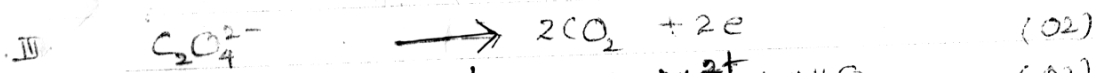
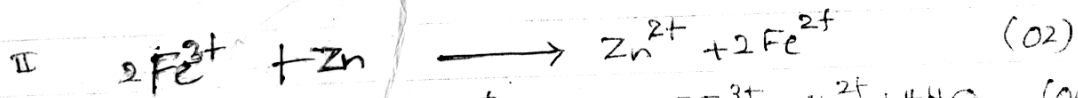
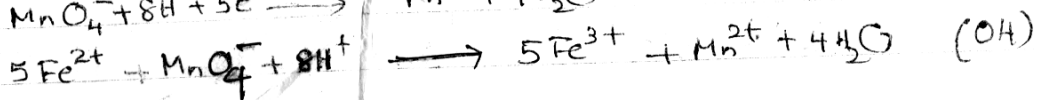
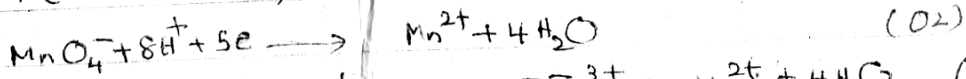
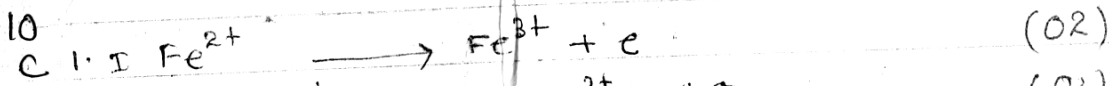
$$\underline{\underline{10.(a) : \text{Total} = 32}}$$

(b)



$$(07 \times 6 = 42)$$

$$\underline{\underline{10.(b) : \text{Total} = 42}}$$



$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} = \frac{2.52 \text{ g}}{126 \text{ g mol}^{-1}} = 0.020 \text{ mol}$ ✓

$\text{C}_2\text{O}_4^{2-}$ amount in 25 cm^3 = $\frac{0.020 \text{ mol}}{500 \text{ cm}^3} \times 25 \text{ cm}^3$ ✓

= 0.001 mol ✓

MnO_4^- required for reaction = $\frac{2}{5} \times 0.001 \text{ mol}$ ✓

= 0.0004 mol ✓

MnO_4^- Concentration = $\frac{0.0004 \text{ mol}}{24 \times 10^{-3} \text{ dm}^3}$ ✓

= 0.0167 mol dm⁻³ ✓

3) KMnO_4 consumed in I = $0.0167 \text{ mol dm}^{-3} \times 20 \times 10^{-3} \text{ dm}^3$ ✓

= $0.334 \times 10^{-3} \text{ mol}$ ✓

= $5 \times 0.334 \times 10^{-3} \text{ mol}$ ✓

Concentration of FeSO_4 = $\frac{5 \times 0.334 \times 10^{-3} \text{ mol}}{25 \times 10^{-3} \text{ dm}^3}$ ✓

= 0.0668 mol dm⁻³ ✓

= 30.0 cm³ ✓

KMnO_4 consumed in II

KMnO_4 volume consumed for Fe^{2+} from solution = $(30 - 20) \text{ cm}^3$ ✓

= 10 cm³ ✓

$$\text{KMnO}_4 \text{ consumed for } \text{Fe}^{2+} \text{ from } \text{Fe}_2(\text{SO}_4)_3 = 0.0167 \text{ mol dm}^{-3} \times 10 \times 10^{-3} \text{ dm}^3$$

Fe^{2+} from $\text{Fe}_2(\text{SO}_4)_3$

$$= 0.167 \times 10^{-3} \text{ mol}$$

$$= \frac{5}{1} \times 0.167 \times 10^{-3} \text{ mol}$$

$$= 0.835 \times 10^{-3} \text{ mol}$$

$$\text{Fe}_2(\text{SO}_4)_3 \text{ in } 25 \text{ cm}^3 = \frac{1}{2} \times 0.835 \times 10^{-3} \text{ mol}$$

$$= 0.4175 \times 10^{-3} \text{ mol}$$

$$\text{Concentration of } \text{Fe}_2(\text{SO}_4)_3 = \frac{0.4175 \times 10^{-3} \text{ mol}}{25 \times 10^{-3} \text{ dm}^3}$$

$$= 0.0167 \text{ mol dm}^{-3}$$

$$(0.3 \times 18 = 54)$$

$$c - \boxed{76}$$