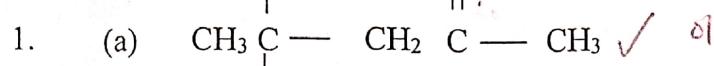
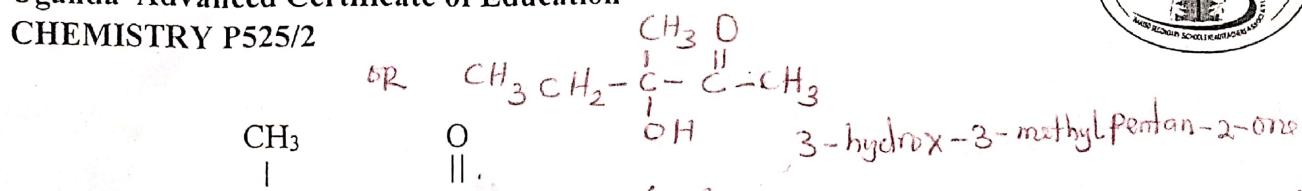


WAKISSHA JOINT MOCK EXAMINATIONS  
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CHEMISTRY P525/2

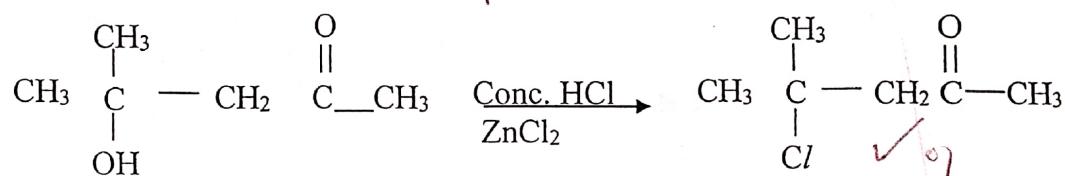
S.R.



$\text{OH}$  Accept 4-hydroxy-4-methylpentan-2-one. X 02 -  $\frac{1}{2}$  for - missing

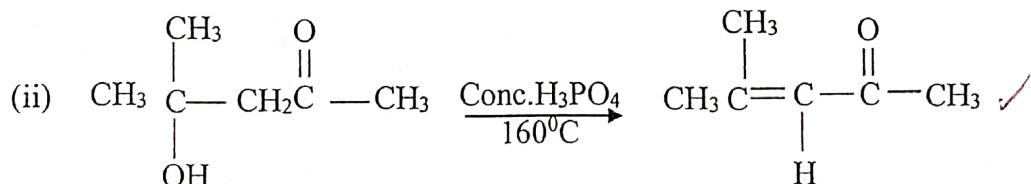
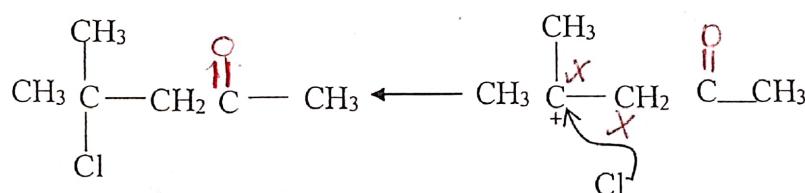
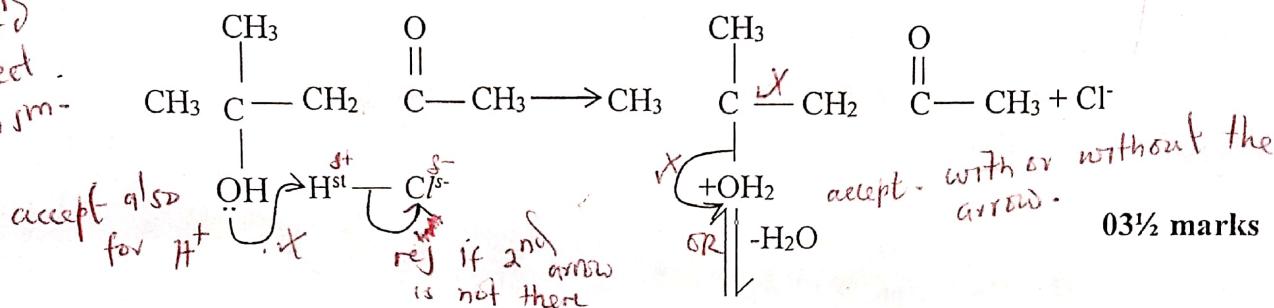
Rej. 4-hydroxyl-4-methylpentan-2-one  $\cancel{\checkmark}$  Rej 2-hydroxy-2-methylpentan-4-one

(b) (i)

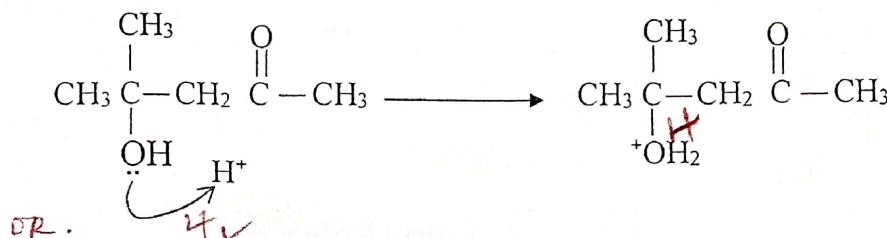
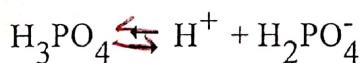


if the product  
is wrong  
we reward  
the correct  
mechanism

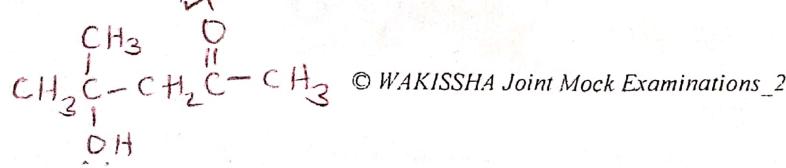
Mechanism



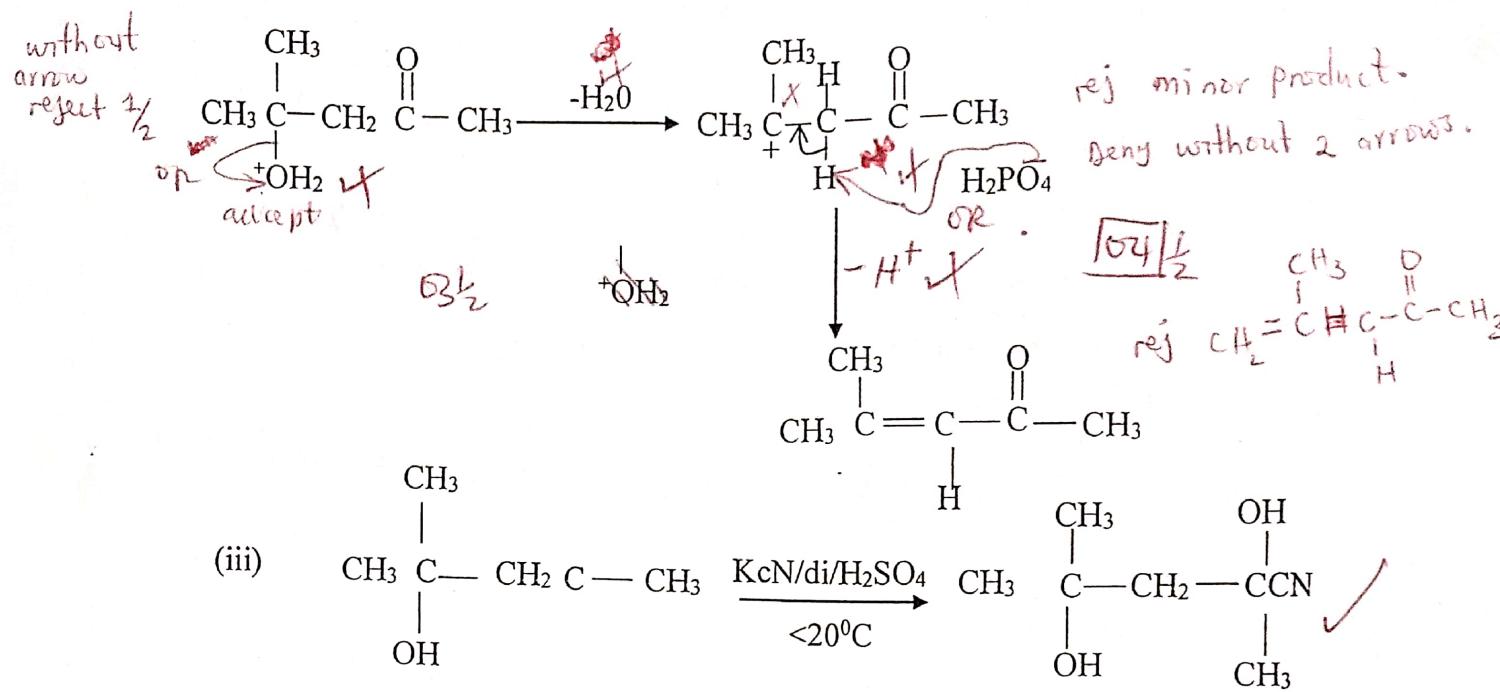
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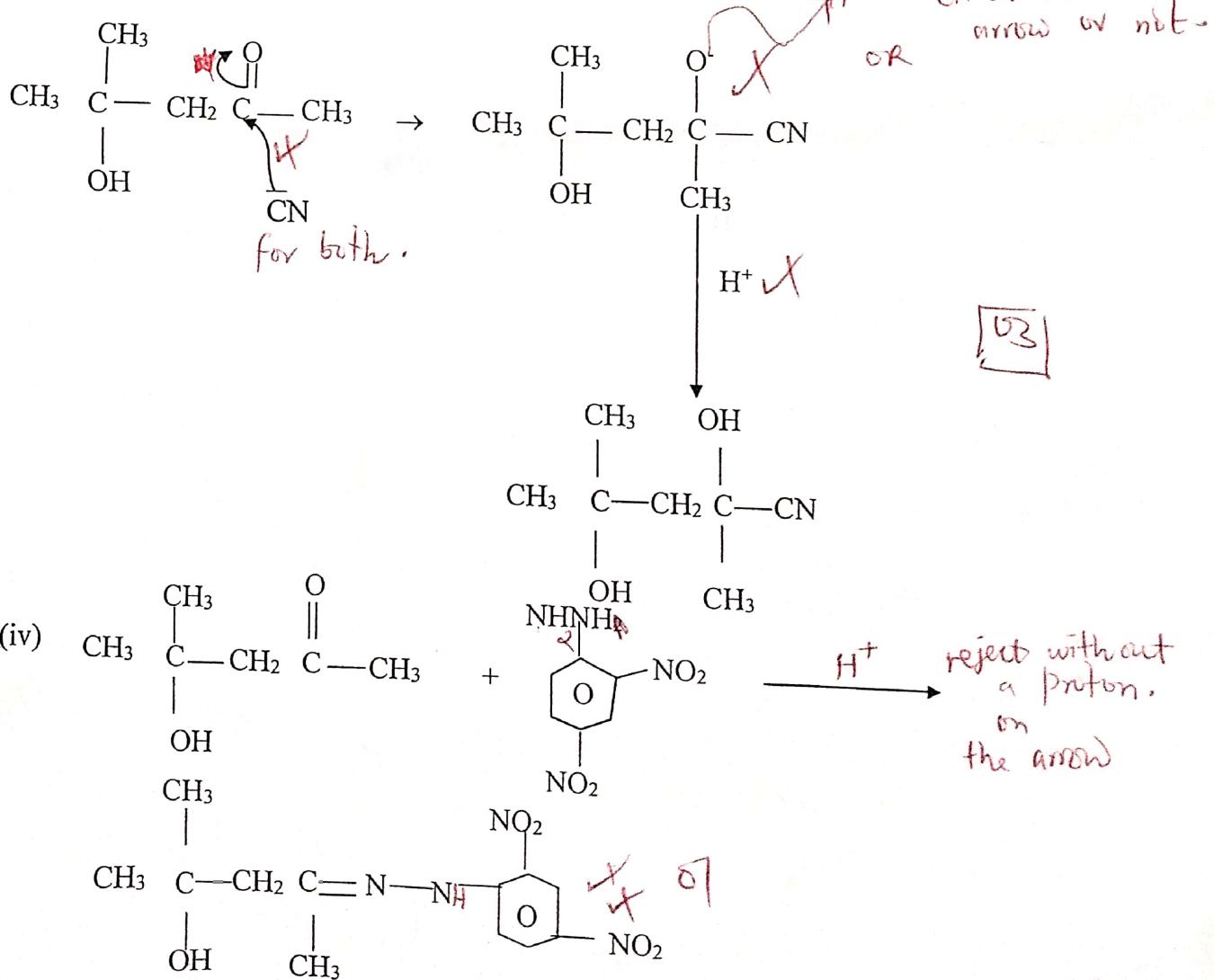
Accept major product only.  
for 1 mark.



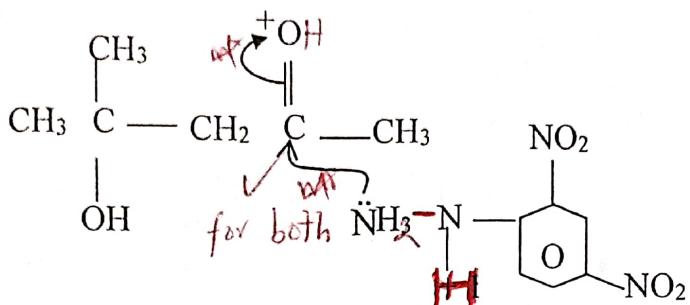
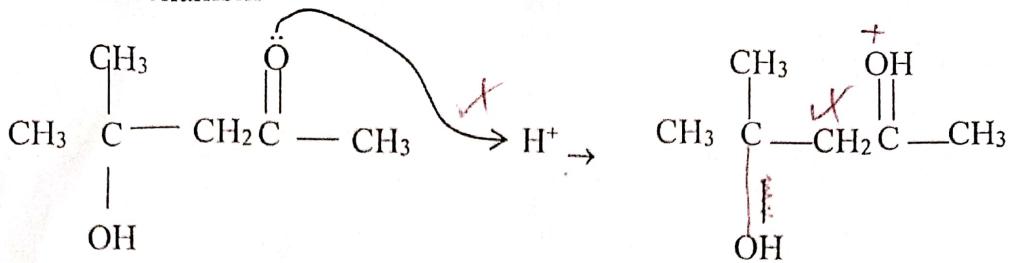
H-



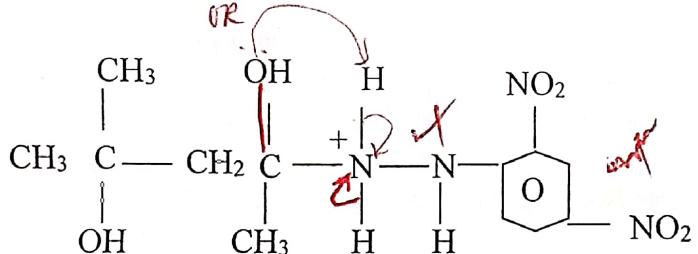
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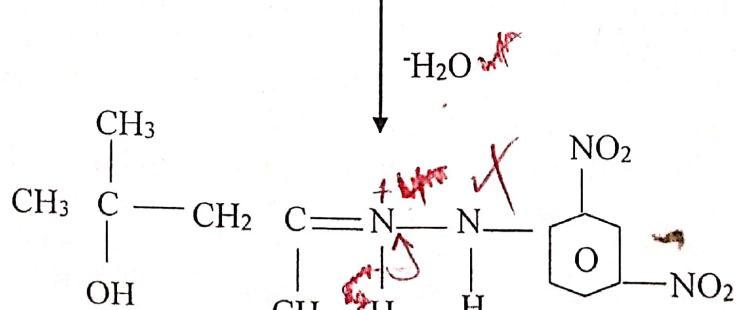
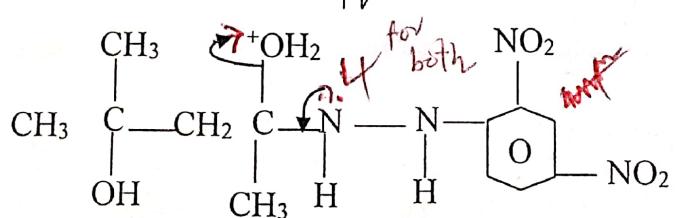
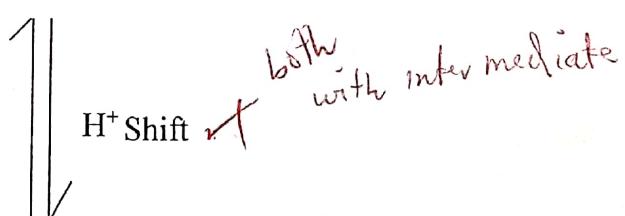
Mechanism



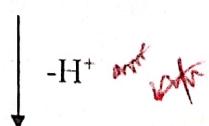
OR



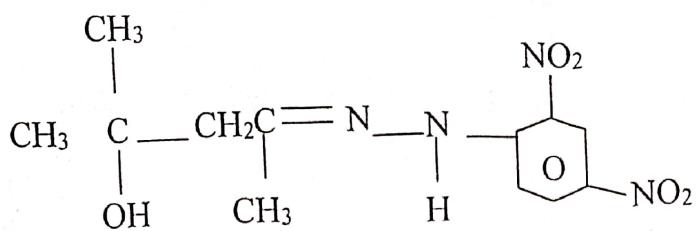
reject if the arrow is moving from Nitrogen to H



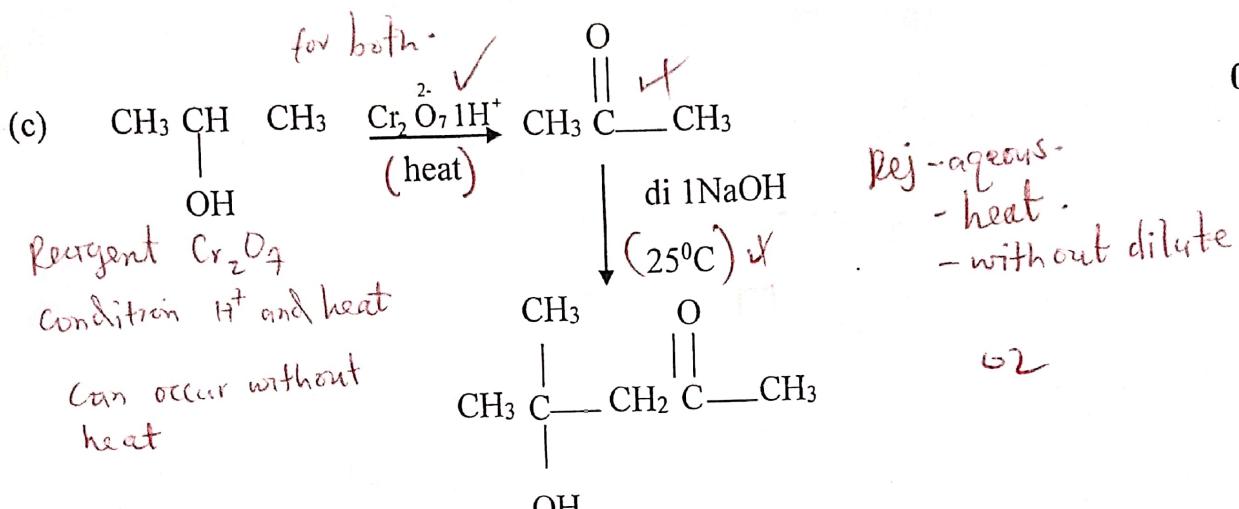
04



05



05 marks



20

2. (a) Order of reaction is the sum of the powers to which the concentration terms of the reactants are raised in an experimentally determined rate equation. ✓ 01 mark

Activation energy is the minimum energy possessed by the reactants for the reaction to occur. ✓ OR energy barrier that must be overcome before a reaction occurs. 01 mark

$$(b) \quad (i) \quad \text{Slope} = \frac{0.210 - 0.08}{0 - 13} \\ = -0.01 \text{ moldm}^{-3} \text{ min}^{-1}$$

**1 ½ mark**

- (ii) Order Zero because it is a straight line graph with negative slope. A  
must be present : 02 marks

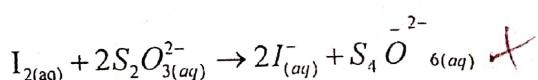
- (c) ~~dilute~~ Solutions of known concentration of propanone, iodine in Potassium iodide and an acid buffer of known PH are prepared and brought to the required temperature in a thermostat bath. The concentration of Propanone being higher than that of iodine. The reaction is started by pipetting volumes of the three solutions into a flask, and a stop watch started. After intervals of time a sample of the reacting mixture is pipetted from the solution into a sodium hydrogen Carbonate solution into a or  $\text{Na}_2\text{CO}_3$  sodium-hydrogen Carbonate solution.

This stops the reaction instantly by neutralizing the acid.

The time at which the reaction stops is recorded. The iodine that remains is determined by titrating against standard solution of Sodium thiosulphate. Iodine reacts with thiosulphate ions according to the following equation.

Iodine reacts with thiosulphate ions according to the following equation.

**06 marks**

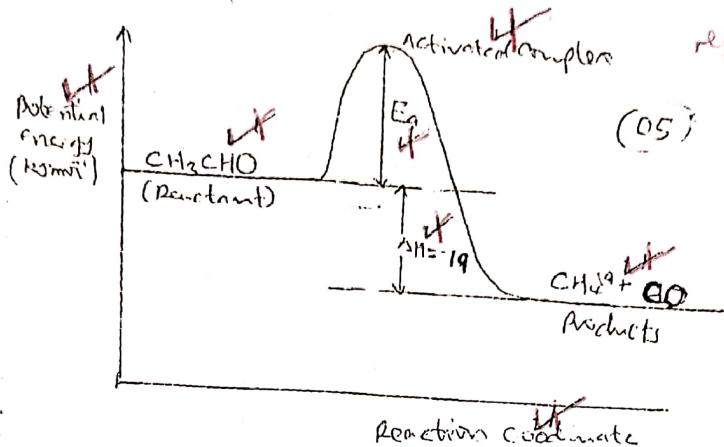


Using mole ratios, the concentration of iodine remaining in the reaction mixture can be determined. *X*

(d)  $\Delta H_{\text{reaction}} = \sum \Delta H_f^{\circ} \text{ products} - \sum \Delta H_f^{\circ} \text{ reactants}$  ✓  
 $= (-75 + -110) - (-166)$  ✓  
 $= -185 + 166$   
 $= -19 \text{ KJmol}^{-1}$  ✗

Deny if -ve is missing no mark with out the units  
 reject if with out the units

- accept if endothermic
- mark x (ex)
- activation
- Reactants



20

3. (a) (i) Partition coefficient is the ratio of the concentration of the solute in two immiscible solvents in contact at a given temperature. Deny if temp is written when equilibrium is established.
- (ii) Solvent extraction is the partial removal of a solute from one solvent system to another at a given temperature and the two solvents being immiscible and in contact.
- (b) A known mass of butane 1,4-dioic acid is added to known volumes of water and trichloromethane in a separating funnel. The funnel is stopped and the mixture shaken vigorously for some time until equilibrium is attained at a given temperature. The mixture is allowed to stand for the layers to separate. Known volumes of the trichloromethane layer are pipetted and titrated with a standard solution of Sodium hydroxide using phenolphthalein indicator. The amount of butane - 1,4-dioic acid in the trichloromethane layer is determined. By subtraction, the amount of butane - 1,4-dioic acid in the aqueous layer is determined. The concentration of butane - 1,4-dioic acid in both layers calculated and the KD of butane - 1,4-dioic acid between trichloromethane and water can be calculated from the formula.

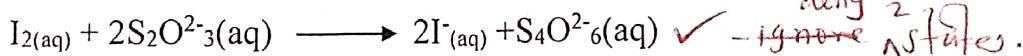
$$KD = \frac{[\text{succinic acid}]_{\text{trichlonotre}}}{[\text{succinic acid}]_{\text{water}}} \quad \text{OK}$$

06

- (c) (i)  $1000 \text{ cm}^3$  of  $\text{S}_2\text{O}_3^{2-}$  solution contain 0.15 moles.

$$26.70 \text{ cm}^3 \text{ of } \text{S}_2\text{O}_3^{2-} \text{ solution contains } \frac{0.15}{1000} \times 26.70 \quad \text{X}$$

$$4.005 \times 10^{-3} \text{ moles.} \quad \text{X}$$



Moles ratio  $\text{S}_2\text{O}_3^{2-} : \text{I}_2 = 2:1$

$$\text{No of moles I}_2 = \frac{4.005}{2} \times 10^{-3}$$

$$= 2.0025 \times 10^{-3} \quad \text{X}$$

$20 \text{ cm}^3$  of  $\text{CHCl}_3$  layer contain  $2.0025 \times 10^{-3}$  moles of Iodine. 03

$$1000 \text{ cm}^3 \text{ of } \text{CHCl}_3 \text{ layer contain } \frac{2.0025}{20} \times 10^{-3} \times 10^{-3} \quad \text{X}$$

$$= 0.100125 \text{ M} \quad \text{X}$$

03 marks

$$(ii) \quad K_D = \frac{[I_2]CHCl_3}{[I_2] \text{ free in H}_2\text{O}} \quad \checkmark$$

$$85 = \frac{[I_2]CHCl_3}{[I_2] \text{ free in H}_2\text{O}} \quad \cancel{\checkmark}$$

(02)

$$[I_2] \text{ Free in H}_2\text{O} = \frac{0.100125}{85} \quad \checkmark \\ = 1.1779 \times 10^{-3} \text{ mol dm}^{-3}$$

OR  
0.00118 mol dm<sup>-3</sup>  
OR 0.0012 mol dm<sup>-3</sup>

02 marks

(iii) 1000cm<sup>-3</sup> of S<sub>2</sub>O<sup>2-</sup><sub>3</sub> contain 0.15 moles.

$$21.30\text{cm}^3 \text{ of S}_2\text{O}^{2-}\text{3 contain } \frac{0.15}{1000} \times 21.30 \\ = 3.195 \times 10^{-3} \quad \checkmark$$

$$\text{Moles of I}_2 = \frac{1}{2} \times 3.195 \times 10^{-3} \\ = 1.5975 \times 10^{-3} \quad \checkmark \quad \text{OR } 0.005975$$

02½ marks

20cm<sup>3</sup> of solution contain 1.5975 × 10<sup>-3</sup>

$$1000\text{cm}^3 \text{ of solution contain } \frac{1.5975 \times 10^{-3} \times 10}{20} \\ = 0.079875 \text{ M} \quad \checkmark$$

(02½)

Molar concentration of complexed Iodine.

$$= 0.079875 - 1.1779 \times 10^{-3} \quad \checkmark \\ = 0.0786971 \text{ M} \quad \checkmark$$

(iv) Concentration of complexed iodide ions.

$$= 0.0786971 \text{ M} \quad \text{Iodide}$$

Concentration of free iodine ions

$$= 0.16 - 0.0786971 \quad \checkmark \\ = 0.08130229 \text{ M} \quad \cancel{\checkmark}$$

Concentration of I<sub>3</sub><sup>-</sup> formed = 0.0786971 M

$$KC = \frac{[I_3^-]}{[I_2][I^-]} \quad \checkmark \\ = \frac{0.0786971}{(1.1779 \times 10^{-3}) \times 0.0813029} \quad \checkmark \\ = 821.76 \quad \checkmark \quad \text{mol}^{-1} \text{dm}^{-3} \quad \checkmark$$

-½ if units  
are missing

821 → 826

± 6.

02½ marks

(d) (i) - Determination of complexes. ✓

- Solvent extraction ✓

- Ion exchange

- Chromatography

- Determination of KC. / equilibrium constant. ✓

} accept any 1.

01 marks

(ii) Starch forms blue-black complex with iodine which gives a sharp end-point with Sodium thiosulphate. ✓

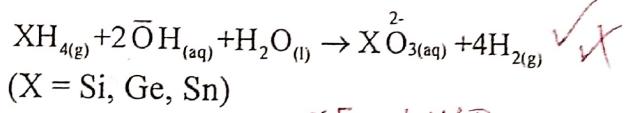
01 marks

4. (a) (i) The hydrides have simple molecular structure. The boiling points increase due to increase in relative molecular mass of the Hydrides which increase the magnitude of the Van der Waals forces. attraction between molecules 2½ marks
- (ii) There is a big difference in the electronegativity between fluorine and hydrogen with fluorine being more electronegative than hydrogen. The hydrogen-fluorine bond is highly polar and thus the hydrogen fluoride molecules associate through strong hydrogen bonds which require a lot of energy to break. In methane, there is a small difference in the electronegativity between Carbon and hydrogen and thus the molecules of methane associate through weak Van der waals force which require less heat to break. It's 3½ marks
- (iii) The relative molecular masses of the hydrides increase from hydrogen chloride to hydrogen iodide and thus the magnitude of the Van der Waals force increase and thus more energy is required to break them. X 3½ marks

(b) Hydrogen fluoride and hydrogen chloride do not react with concentrated sulphuric acid due to the strength of the hydrogen- halogen bond which cannot easily break. Hydrogen bromide reduces sulphuric acid to sulphur dioxide and itself oxidized to bromine. X 2½ marks

✓ - sulphur  
✓ - hydrogen sulphide  
✓ - SO<sub>2</sub>

- (i) Hydrogen iodide is the strongest reducing agent and will reduce sulphuric acid to hydrogen sulphide and itself oxidized to iodine. X  $6\text{HI}_{(g)} + \text{H}_2\text{SO}_{4(l)} \rightarrow 3\text{I}_{2(s)} + \text{S}\text{O}_{2(g)} + 4\text{H}_2\text{O}_{(l)}$  X 03½ marks
- (ii) Methane does not react with Sodium hydroxide. The rest of the hydrides react with hot concentrated Sodium hydroxide solution to form silicate, Germanate and stanate together with hydrogen gas. X 04 marks



- (c) (i)  $4\text{HF}_{(g)} + \text{SiO}_{2(s)} \rightarrow \text{SiF}_{4(g)} + 2\text{H}_2\text{O}_{(l)}$
- (ii)  $\text{CH}_{4(g)} + 3\text{CuO}_{(s)} \rightarrow 3\text{Cu}_{(s)} + 2\text{H}_2\text{O}_{(l)} + \text{CO}_2$
- (iii)  $2\text{KMnO}_{4(aq)} + 16\text{HCl}_{(g)} \rightarrow 2\text{KCl}_{(aq)} + 2\text{MnCl}_{2(aq)} + 5\text{Cl}_{2(g)} + 8\text{H}_2\text{O}_{(l)}$  X

5. (a) (i) PH of HA = 2.5 X  $2.4 \pm 0.2$ , ✓ or  $2.2, 2.3$ , 20

$$\text{PH} = -\log [\text{H}^+]$$

$$[\text{H}^+] = 10^{-2.5} \quad \text{X}$$

$$[\text{H}^+] = 3.1623 \times 10^{-3} \quad \text{X}$$

$$\text{But } [\text{H}^+] = \infty C$$

$$\infty \frac{[\text{H}^+]}{C}$$

$$\propto \frac{3.1623 \times 10^{-3}}{0.1}$$

$$\propto = 0.031623 \quad \text{X}$$

$$\text{PH} = -\log [\text{H}^+]$$

$$[\text{H}^+] = 10^{-2.4}$$

$$[\text{H}^+] = 0.00398 \text{ or } 3.98 \times 10^{-3}$$

$$[\text{H}^+] = \infty C \\ \alpha = \frac{[\text{H}^+]}{C} = \frac{3.1623 \times 10^{-3}}{0.1}$$

$$= 0.03981 \text{ or } 3.98 \times 10^{-2}$$

$$K_a = \frac{\alpha^2 C}{1-\alpha} \quad \times$$

$$= \frac{(0.031623)^2}{1-0.031623} \times 0.1 \quad \text{res}$$

$$= 1.0327 \times 10^{-4} \text{ moldm}^{-3} \quad K_a = 1.65 \times 10^{-4} \text{ mol dm}^{-3}$$

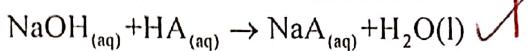
(ii) PH at end point =  $8.8 \pm 0.4$  ✓

8.9, 9, 9.1, 9.2

Volume at the end point =  $25.0 \text{ cm}^3$ . ✓

(b) (i) No of moles of HA =  $\frac{25 \times 0.1}{1000}$

$$= 2.5 \times 10^{-3} \quad \times$$



Mole ratio HA: NaOH = 1:1

No of moles of NaOH =  $2.5 \times 10^{-3}$  ✓

25cm<sup>3</sup> of NaOH contain  $2.5 \times 10^{-3}$  ✓ res 25-4

1000cm<sup>3</sup> of NaOH contain  $\frac{2.5 \times 10^{-3} \times 1000}{25} \quad \checkmark$

$$= 0.1 \text{ M} \quad \times$$

03

(ii) Mole ratio HA: NaA = 1:1

No of moles of NaA =  $2.5 \times 10^{-3}$  moles ✓

Total volumes of solution =  $25 + 25$   
=  $50 \text{ cm}^3$  ✓

50cm<sup>3</sup> of NaA contains  $2.5 \times 10 \text{ cm}^{-3}$  moles. ✓

1000cm<sup>3</sup> of NaA contains  $\frac{2.5 \times 10^{-3}}{50} \times 10^3 \quad \times$   
 $= 0.05 \text{ moldm}^{-3} \quad \checkmark$



$$K_h = \frac{[\text{HA}][\bar{\text{O}}\text{H}]}{[\text{A}^-]} \quad \times$$

Assumptions  $[\text{H}_2\text{O}] = 1$

$$[\text{HA}] = [\bar{\text{O}}\text{H}]$$

$$K_h = \frac{[\bar{\text{O}}\text{H}]^2}{[\text{A}^-]} \quad \times$$

pH at end point = 8.8

$\text{POH} = 14 - \text{pH}$

$= 14 - 8.8$

$$\text{POH} = 5.2$$

$$[\bar{\text{O}}\text{H}] = 10^{-5.2}$$

$$6.3096 \times 10^{-6} \text{ mol dm}^{-3}$$

$$K_h = \frac{(6.3096 \times 10^{-6})^2}{0.05}$$

$$= 7.962 \times 10^{-10} \text{ mol dm}^{-3}$$

ranges from  $(1.0 \times 10^{-10}$  to  $7.962 \times 10^{-10})$

- (c) Initially the PH of the acid is 2.50 (low) because the acid is weak and partially ionizes to form few hydrogen ions. Along AB, there is gradual increase in PH because the weak acid is being neutralized though still in excess. ~~Also some H<sup>+</sup> are being neutralised~~ Also the salt formed together with unreacted increase in PH because the weak acid is being neutralized though still in excess. Also the salt formed together with unreacted weak acid form buffer mixture which resists change in pH.

$\text{NaOH}$  06 marks

Point B is near the end point and any additional drop of the alkali will cause a sharp rise in PH because Sodium hydroxide is a strong alkali (base). The PH at the end point is above 7 because the salt formed undergoes hydrolysis to form hydroxide ions which make the solution alkaline. After the end point along CD, the is gradual increase in PH due to excess strong base.

- (d) Phenolphthalein because it works in alkaline conditions.

02 marks

20

6. (a) Benzene is reacted with chloromethane in the presence of aluminium chloride to form methylbenzene, methylbenzene is refluxed with acidified potassium manganite(VII) to form benzoic acid. Benzoic acid is reacted (treated) with Lithium aluminium hydride in dry ether to form phenylmethanol.

04 marks

- (b) Calcium oxide is heated with carbon at  $2000^\circ\text{C}$  to form calcium carbide. Calcium carbide is reacted with (warm) water to form ethyne. Ethyne is reacted with organo nickel complex catalyst to form benzene.

03½ marks

- (c) Nitrobenzene is mixed with tin in the presence of concentrated hydrochloric acid and the mixture refluxed. Concentrated Sodium hydroxide solution is added to the resultant mixture to form phenylamine.

Phenylamine is reacted with Sodium nitrite in the presence of concerated hydrochloric acid at  $5^\circ\text{C}$  (or less than  $10^\circ\text{C}$ ) to form benzene diazonium salt. Benzene diazonium salt is warmed with acidified water to form phenol.

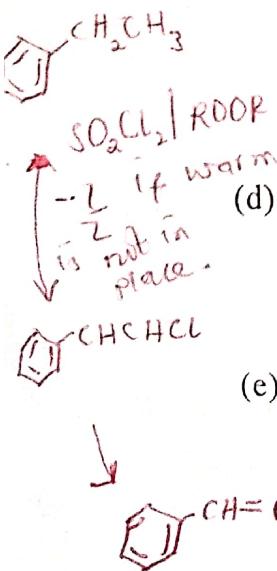
05 marks

Ethanol is warmed with acidified potassium dichromate to form ethanol. Ethanal is reacted with potassium cyanide in the presence of dilute sulphuric acid at a temperature less than  $20^\circ\text{C}$  to form 2-hydroxypropano nitrile which is refluxed with dilute nitric acid to form 2-hydroxy propanoic acid.

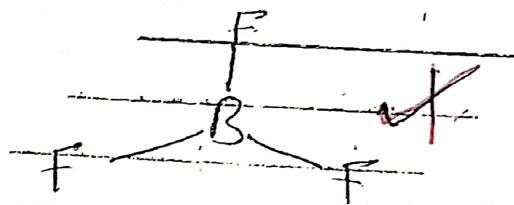
04½ marks

- (e) Phenylethene is reacted with bromine in the presence of tetrachlormethaneto form 1,2-dibromo -1- phenylethane which is refluxed with alcoholic potassium hydroxide to form phenylethyne.

20

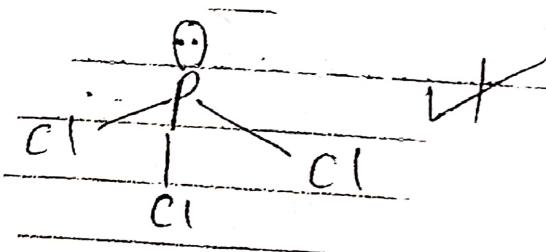


7. (a) Sodium sulphate is a salt of strong acid and strong base and thus does not undergo hydrolysis. Sodium sulphite is a salt formed from a weak acid and a strong base and undergoes hydrolysis to form alkaline solution.
- $$\text{Na}_2\text{SO}_4 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + \text{NaOH}$$
- $$\text{Na}_2\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{SO}_3^{2-} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3 + 2\text{OH}^-$$
- (b) Sodium aluminate reacts with carbon dioxide to form aluminium hydroxide which is insoluble.
- $$2\text{NaAl(OH)}_4 + \text{CO}_2 \rightarrow 2\text{Al(OH)}_3 + \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$$
- sodium hydrogen carbonate  
reject if not balancing
- (c) Concentrated nitric acid oxidises sulphur to sulphuric acid and itself reduced to nitrogendioxide gas.
- $$\text{S} + 6\text{HNO}_3 \rightarrow \text{H}_2\text{SO}_4 + 6\text{NO}_2 + 2\text{H}_2\text{O}$$
- (d) Boron uses all the three valence electrons to form three covalent bonds with fluorine atoms.
- The bond pairs will repel each other equally making the molecule to adopt a trigonal planar structure.



05 marks

In phosphorous trichloride, phosphorous uses three electrons out of four to form three covalent bonds with chlorine atoms. The lone pair of electrons on the phosphorus atom repels bond pairs greatly resulting into a trigonal pyramidal structure.



04 marks

- (e) Sodium contributes one electron per atom towards metallic bond formation while magnesium contribute two electrons per atom towards metallic bonds formation. The metallic bonds in magnesium are stronger than those in Sodium. Therefore more energy is required to break the metallic bonds in magnesium than that in Sodium.

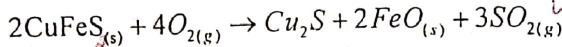
or mineral or rock

8. (a) (i) An ore is a naturally occurring substance from which a metal is extracted.
- (ii) -Copper glance  $\text{Cu}_2\text{S}$   
- Malachite  $\text{CuCO}_3 \cdot \text{Cu(OH)}_2$   
- Cuprite  $\text{Cu}_2\text{O}$   
- Azurite  $2\text{CuCO}_3 \cdot \text{Cu(OH)}_2$
- (b) Copper pyrites is crushed into powder.  
The powder is mixed with water containing a frothing agent such as pine oil.  
Air is blown into the mixture to cause agitation.

02 marks

~~Earthly impurities sink to the bottom while the ore rises to the surface as froth and can be skimmed off.~~  
 An acid is added to break the froth and the ore is filtered, washed and dried. ✓  
**03 marks**

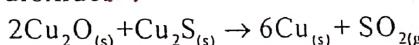
- (c) (i) To convert copper pyrites to copper(1) sulphide, iron(II) oxide and sulphur dioxide.  
 (To avoid forming copper (II) oxide and iron (III) oxide which are difficult to deal with.) ✓  
**2 ½ marks**



- (ii) To form iron (II) silicate which has a low melting point and can easily be poured away.  
 (To avoid forming iron (III) silicate which has high melting point)  
 $\text{FeO}_{(s)} + \text{SiO}_{2(s)} \rightarrow \text{FeSiO}_{3(l)}$

- (d) (i) Copper (I) sulphide is roasted in limited supply of air to form copper (I) oxide and sulphur dioxide.  
 $2\text{Cu}_2\text{S}_{(s)} + 3\text{O}_{2(g)} \rightarrow 2\text{Cu}_2\text{O}_{(s)} + 2\text{SO}_{2(g)}$

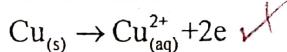
Copper (I) oxide is mixed with unreacted copper (I) sulphide and the mixture heated in the absence of air to form impure copper and sulphur dioxide. ✓



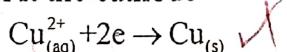
**03 marks**

- (ii) Impure copper is made the anode while pure copper is made the cathode and the electrolyte is acidified copper (II) sulphate. When current is passed through the electrolyte, impure copper dissolves to form copper (II) ions and pure copper is deposited at the Cathode.

At the anode



At the cathode

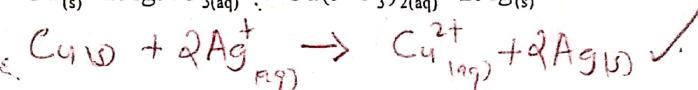


**03 marks**

- (e) (i) Copper dissolves with effervescence of a colourless gas which on exposure to air brown fumes are formed and a pale blue solution was formed.  
*Rej effervescence of brown gas*  
 $3\text{Cu}_{(s)} + 8\text{HNO}_{3(aq)} \rightarrow 3\text{Cu}(\text{NO}_3)_{2(aq)} + 2\text{NO}_{(g)} + 4\text{H}_2\text{O}_{(l)}$

**02 marks**

- (ii) Colourless solution turned to blue solution and grey solid formed.  
 $\text{Cu}_{(s)} + 2\text{AgNO}_{3(aq)} \rightarrow \text{Cu}(\text{NO}_3)_{2(aq)} + 2\text{Ag}_{(s)}$



**01½ marks**

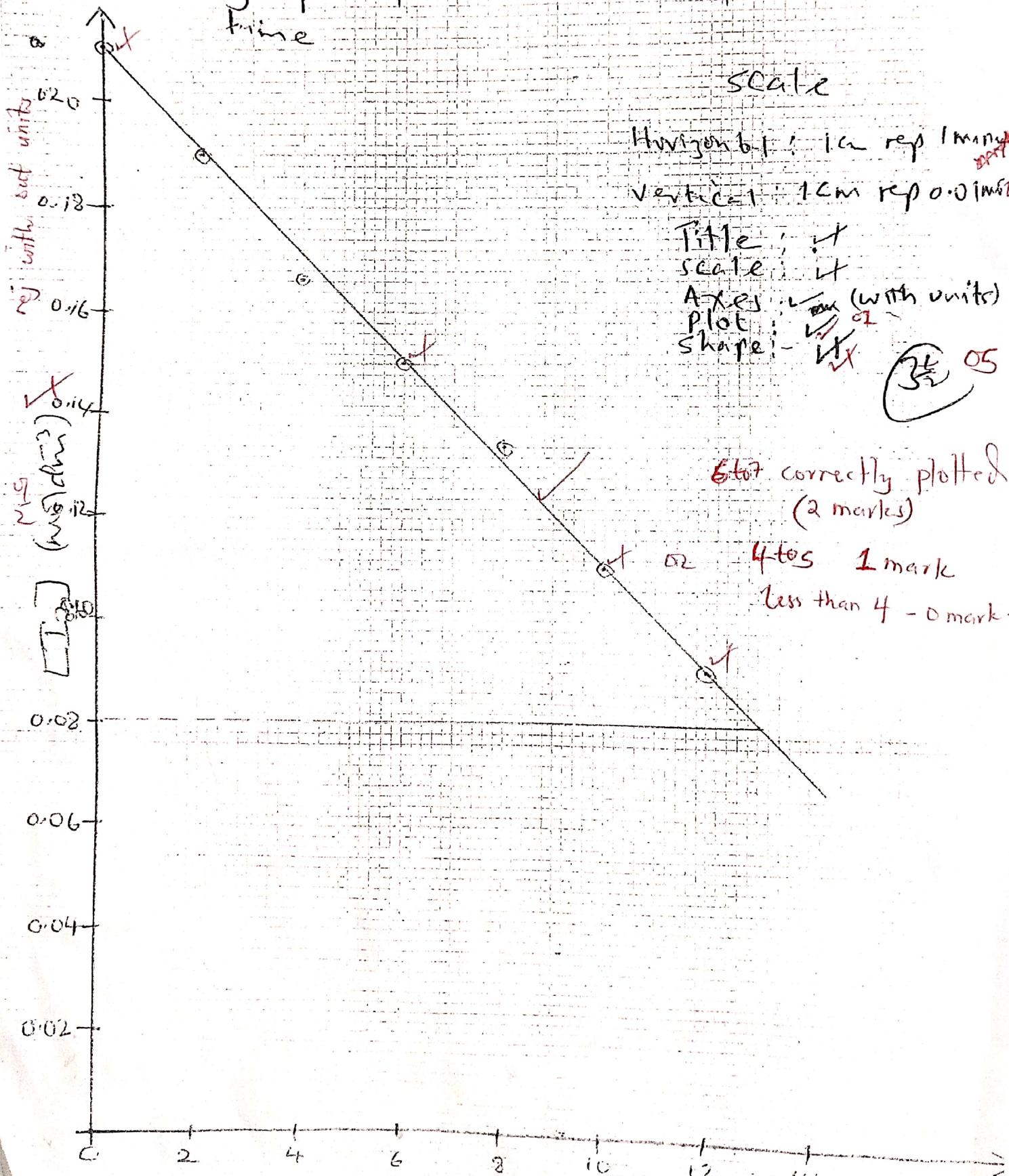
*rej silver mirror*

END

(24)

No 2(b)

A graph of concentration of iodine against time



Scale

Horizontal : 1 cm rep 1 min  
Vertical : 1 cm rep 0.01  $\text{dm}^3$

Title : rt  
scale : rt  
Axes : rt  
Plot : rt  
Shape : rt

(24) 05

Plot correctly plotted  
(2 marks)

4 to 5 - 1 mark  
less than 4 - 0 mark.

Time (min) X  $\frac{9}{2}$  re without