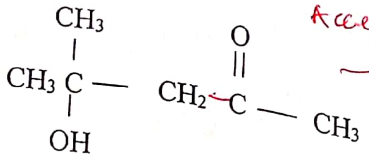
WAKISSHA JOINT MOCK EXAMINATIONS
MARKING GUIDE
Uganda Advanced Certificate of Education
CHEMISTRY P525/2

M.K

1. (a)



Accept $CH_3CH_2\overset{CH_3}{\underset{OH}{C}}-\overset{O}{\overset{||}{C}}-CH_3$ (1)

3-hydroxy-3-methylpentan-2-one (1)

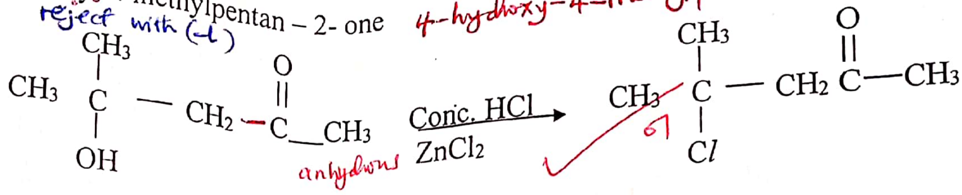
(Deny ½ mark for any hyphen missing) ~~reject without hyphen~~

02 marks

(b) (i) 4 – hydroxyl 4-methylpentan – 2- one

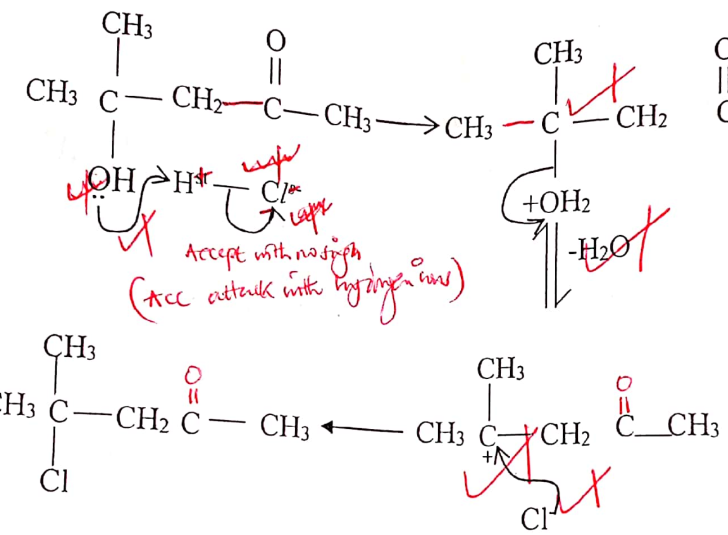
reject with (-l)

4-hydroxy-4-methylpentan-2-one (1)



anhydrous

Mechanism



Accept with no sign

(Acc attack with hydrogen ions)

reject S_N2 mechanism

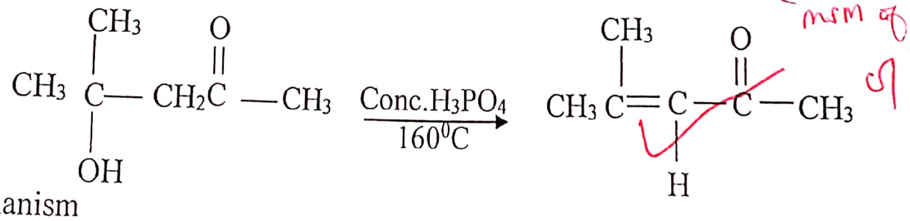
03½ marks

03½

(Acc for water as product in this step)

(mark mechanism for correct msm of tertiary alcohol even when ketone is not correct)

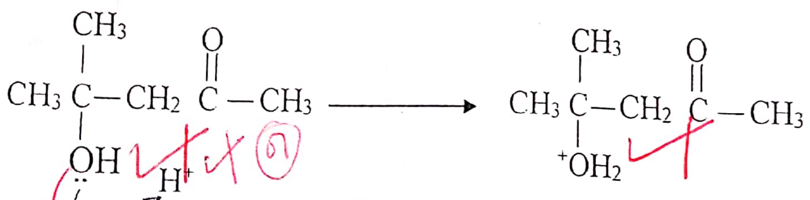
(ii)



Mechanism

$H_3PO_4 \rightleftharpoons H^+ + H_2PO_4^-$

Ignore using full arrow.

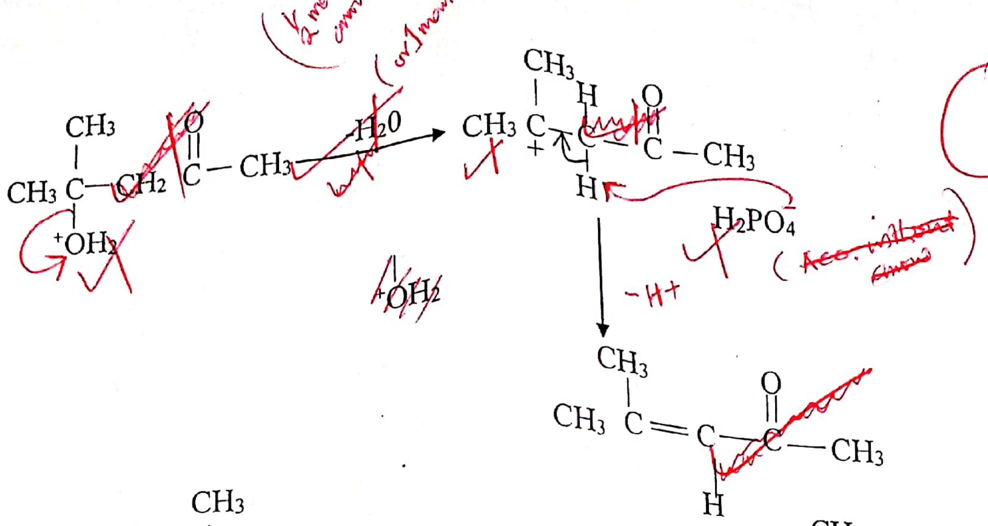


Acc $H-OPO_3H_2$

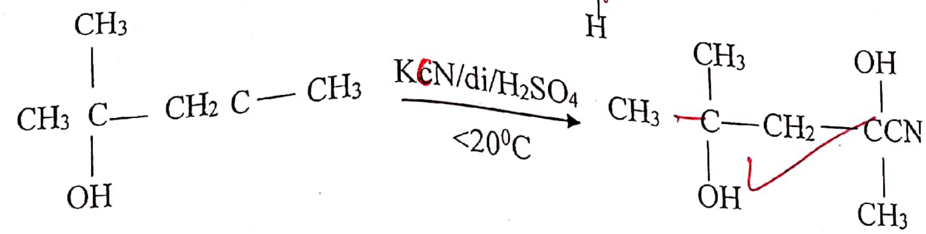
04½

reject $CH_3\underset{\underset{CH_2}{||}}{C}-CH_2\overset{O}{\overset{||}{C}}-CH_3$

01 Acc only major product



(iii)

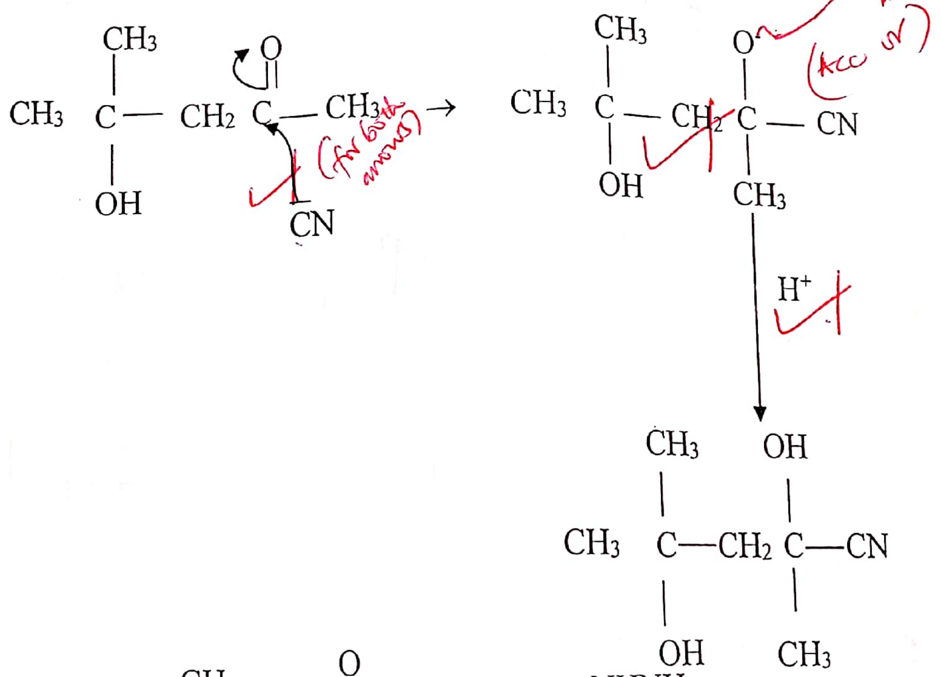


Mechanism

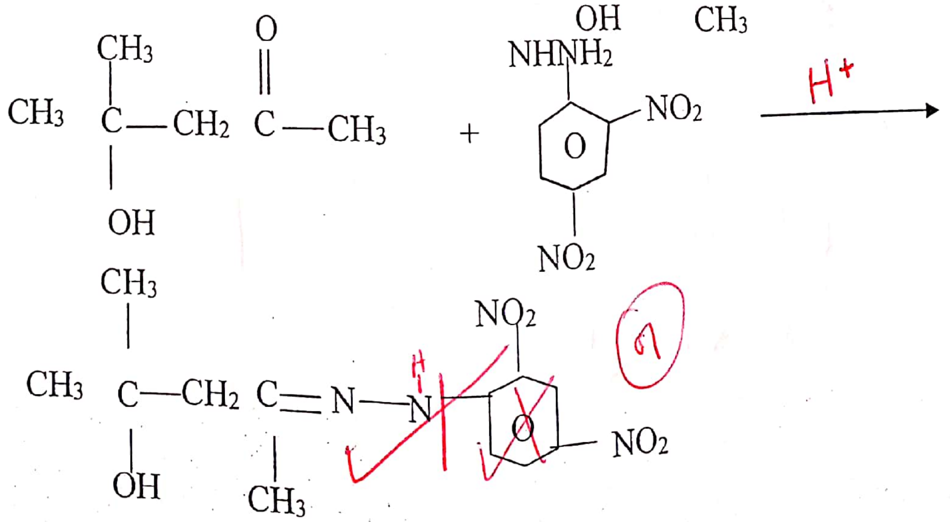
$H_2SO_4 + KCN \rightarrow KHSO_4 + HCN$

Reject K_2SO_4

$HCN \rightleftharpoons H^+ + \bar{C}N$

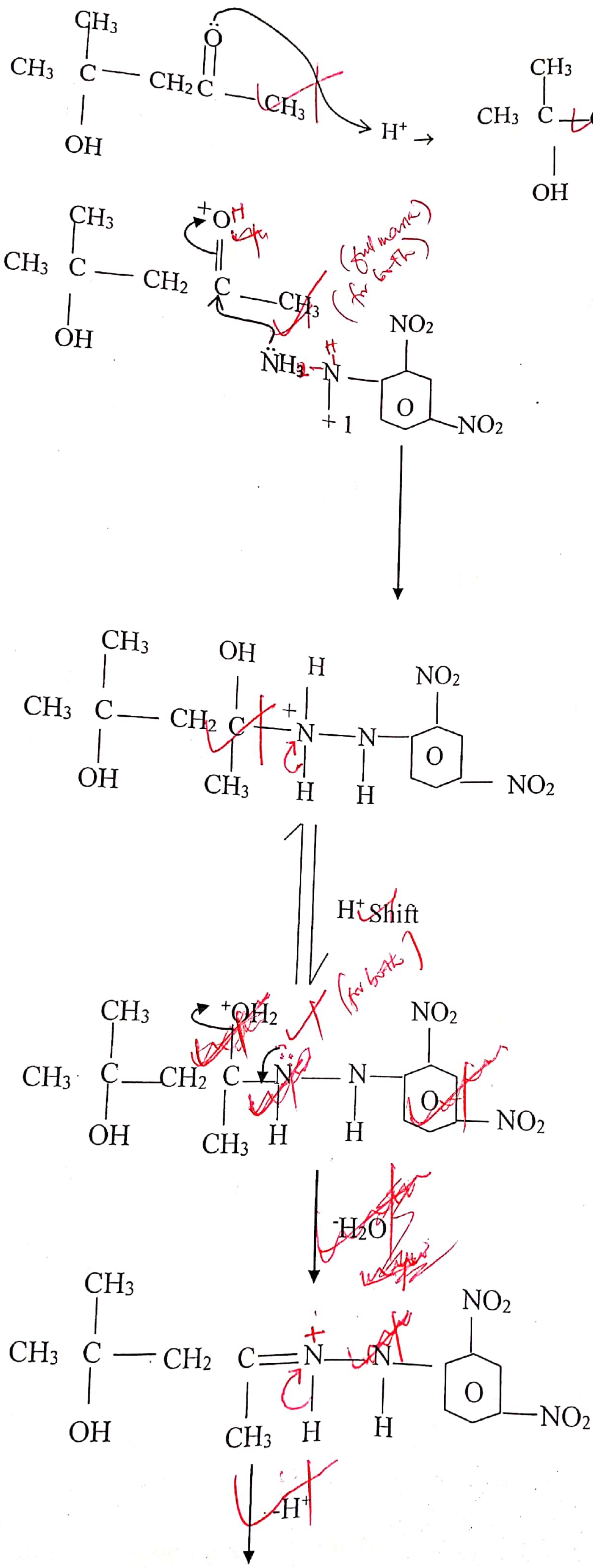


(iv)



(reject without a proton)

Mechanism

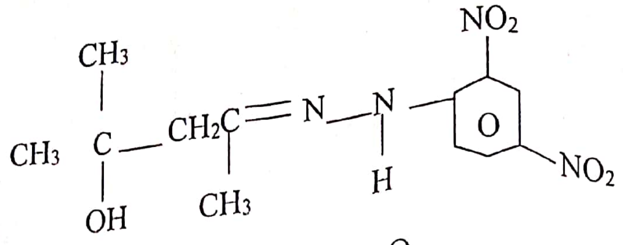


Acc without acid
(reject mark without a proton)

05 total

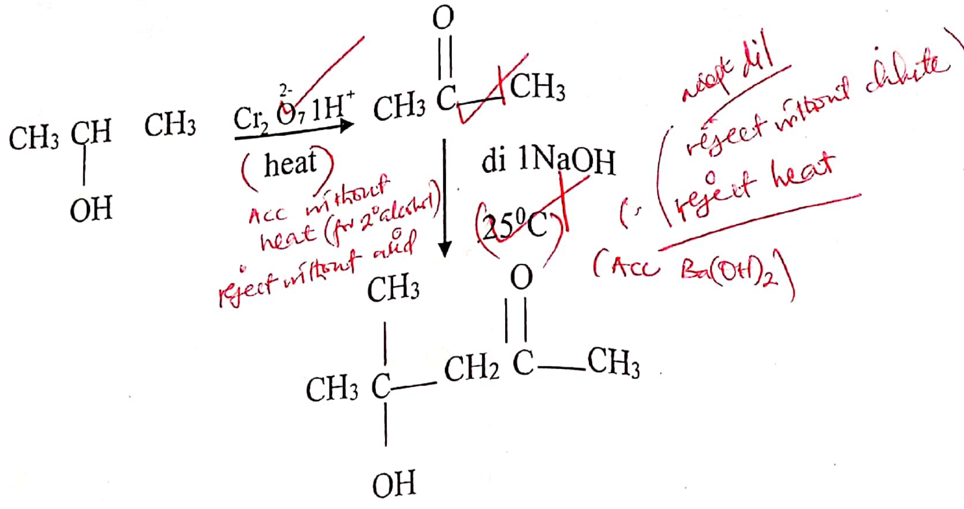
(change in direction of arrow stop marking)

5



05 marks

(c)



03 marks 2

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.
energy barrier that must be overcome for the reaction to occur.

01 mark

(b) (i) Slope = $\frac{0.210 - 0.08}{0 - 13}$

$= -0.01 \text{ moldm}^{-3} \text{ min}^{-1}$

Transfer marks to the graph

1 ½ mark

(ii) Order Zero because it is a straight line graph with negative slope.

02 marks 0½

(c) Solutions of known concentration of propanone, iodine in solution in Potassium iodide and an acid buffer of known PH sulphuric acid or hydrochloric acid 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 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.
using starch indicator near the end point

06 marks

06

$$I_{2(aq)} + 2S_2O_{3(aq)}^{2-} \rightarrow 2I^-_{(aq)} + S_4O_{6(aq)}^{2-}$$

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

(d) $\Delta H_{reaction} = \sum \Delta H_f^o \text{ products} - \sum \Delta H_f^o \text{ reactants}$

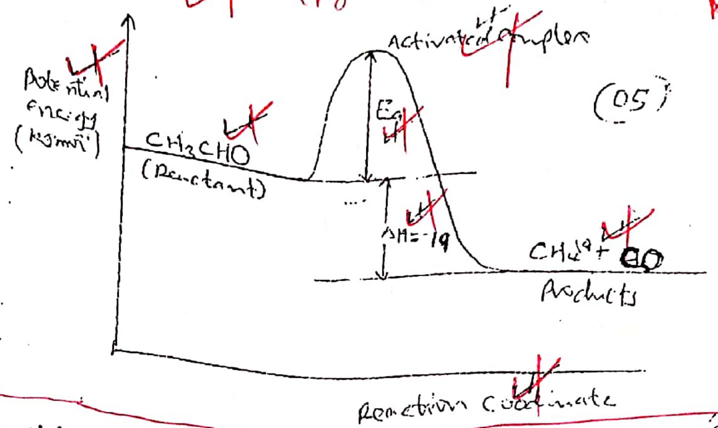
$= (-75+-110) - (-166)$

$= -185 + 166$

$= -19 KJmol^{-1}$

reject if units are missing or wrong (reject if ⊖ is missing)

Accept



05

(-½ mark activation energy, reactants -½, axes 01 for one with +19KJ)

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. (-reject if temp not (or equilibrium) stated) 01

(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. 01

(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 standard for the layers to separate. Known volumes of the trichloromethane layer are pipetted and titrated with a **standard solution** of **Sodium** hydroxide using phenolphthane indicator. 01

The amount of butane – 1,4-dioic acid is the trichloromethane layer is determined. By substraction, 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 trichlromethane and water can be calculated from the formula.

$$KD = \frac{[\text{succinicacid}]\text{ trichlonothane}}{[\text{succinicacid}]\text{ water}}$$

06

(c) (i) $1000cm^3$ of $S_2O^{2-}{}_3$ solution contain 0.15 moles.

$26.70cm^3$ of $S_2O^{2-}{}_3$ solution contains $\frac{0.15}{1000} \times 26.70$

4.005×10^{-3}moles.

$I_{2(aq)} + 2S_2O^{2-}{}_3(aq) \longrightarrow 2I^-_{(aq)} + S_4O^{2-}{}_6(aq)$ 01

(-½ when states missing or wrong) Deny when not balanced

Moles ratio $S_2O^{2-}{}_3 : I_2 = 2:1$

No of moles $I_2 = \frac{4.005}{2} \times 10^{-3}$

$= 2.0025 \times 10^{-3}$

$20cm^3$ of $CHCl_3$ layer contain 2.0025×10^{-3} moles of Iodine.

$1000cm^3$ of $CHCl_3$ layer contain $\frac{2.0025}{20} \times 10^{-3} \times 10^{-3}$.

$= 0.100125M$

03

03 marks

(ii) $KD = \frac{[I_2]CHCl_3}{[I_2]\text{free in } H_2O}$

$85 = \frac{[I_2]CHCl_3}{[I_2]\text{free in } H_2O}$

$[I_2]$ Free in $H_2O = \frac{0.100125}{85}$ (01) for substitution

$= 1.1779 \times 10^{-3} moldm^{-3}$. (02) (Atleast 4 dp)

02 marks

(iii) $1000cm^{3}$ of $S_2O_3^{2-}$ contain 0.15 moles.

$21.30cm^{-3}$ of $S_2O_3^{2-}$ contain $\frac{0.15}{1000} \times 21.30$

$= 3.195 \times 10^{-3}$

Moles of $I_2 = \frac{1}{2} \times 3.195 \times 10^{-3}$

$= 1.5975 \times 10^{-3}$ moles of Iodine

02½ marks

$20cm^3$ of solution contain 1.5975×10^{-3}

$1000cm^3$ of solution contain $\frac{1.5975 \times 10^{-3} \times 10}{20}$

$= 0.079875$ M (02½)

Molar concentration of complexed Iodine.

$= 0.079875 - 1.1779 \times 10^{-3}$

$= 0.0786971$ M

(iv) Concentration of complexed iodide ions.

$= 0.0786971M$

Concentration of free iodine ions

$= 0.16 - 0.0786971$

$= 0.08130229$ M

Concentration of I_3^- formed $= 0.0786971$ M

$Kc = \frac{[I_3^-]}{[I_2][I^-]}$

$= \frac{0.0786971}{(1.1779 \times 10^{-3}) \times 0.0813029}$ (02½)

$= 821.76 \; mol^{-1}dm^{3}$ ~~821~~. Acc. (820 – 826)

02½ marks

(d) (i) - Determination of complexes. formulae of Kc any one (1)

- Solvent extraction
- Ion exchange
- Chromatography → Determination of Kc

01 marks

(ii) Starch forms blue- black complex with iodine which gives a sharp end-point with Sodium thiosulphate. ½ 01 (01) (full mark)

01 marks

20

4. (a) (i) The boiling points increase due to increase in relative molecular mass of the Hydrides which increase the magnitude of the Van der Waals forces. between the molecules of the hydrides of the group (IV) hydrides. The hydrides have simple molecular structures

2½ marks 02½

(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 fluride molecules associate through strong hydrogen bonds which require a lot of energy to break.

In methane, there is a small difference in the electronegative between Carbon and hydrogen and thus the molecules of methane associate through weak Van der waals force which require less heat to break

3½ marks 03½

(iii) The relative molecular masses of the hyrides 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.

2½ marks 02½

(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 conc sulphuric acid to sulphur dioxide and itself oxidized to bromine.

$2HBr_{(g)} + H_2SO_{4(l)} \rightarrow Br_{2(l)} + SO_{2(g)} + 2H_2O_{(l)}$

Hydrogen iodide is the strongest reducing agent and will reduce sulphuric acid to hydrogen sulphide and itself oxidized to iodine. (statement (½))

$8HI_{(g)} + H_2SO_{4(l)} \rightarrow 4I_{2(s)} + H_2S_{(g)} + 4H_2O_{(l)}$. $\Rightarrow$ ($2HI_{(g)} + H_2SO_{4(l)} \rightarrow I_{2(s)} + SO_{2(g)} + 2H_2O_{(l)}$) 03½

• Accept any further eqn ($\Rightarrow 6HI + H_2SO_{4(l)} \rightarrow 3I_{2(s)} + S_{(s)} + 4H_2O_{(l)}$)

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.

• Germanium slightly reacts with sodium hydroxide

04 marks

(minus ½ if X not defined)

$XH_{4(g)} + 2\bar{O}H_{(aq)} + H_2O_{(l)} \rightarrow XO_{3(aq)}^{2-} + 4H_{2(g)}$

(X = Si, Ge, Sn) (Silicate (IV), Germanate (IV), and stannate)

(c) (i) $4HF_{(g)} + SiO_{2(s)} \rightarrow H_2SiF_{4(l)} + 2H_2O_{(l)}$ Acc: $4HF_{(g)} + SiO_{2(s)} \rightarrow SiF_4 + 2H_2O$

(ii) $CH_{4(g)} + 4CuO_{(s)} \rightarrow 4Cu_{(s)} + 2H_2O_{(l)} + CO_{2(g)}$

(iii) $2KMnO_{4(aq)} + 16HCl_{(g)} \rightarrow 2KCl_{(aq)} + 2MnCl_{2(aq)} + 5Cl_{2(g)} + 8H_2O_{(l)}$ Acc aq HCl

20

5. (a) (i) PH of HA = 2.4 ± 0.2

PH = -log $[H^+]$

$[H^+] = 10^{-2.5}$

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

But $[H^+] = \propto C$

$\propto = \frac{[H^+]}{C}$

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

$= 0.031623$

$[H^+] = 0.00398107$ mol dm^{-3}

$\alpha = 0.0398107$

$Ka = 1.65 \times 10^{-4}$ mol dm^{-3}

$Ka = \frac{C\alpha^2}{1-\alpha}$

$Ka = \frac{[H_3O^+][A^-]}{[Acid]}$

$= \frac{0.00398107^2}{0.1}$

$Ka = 1.5849 \times 10^{-4}$ mol

$$Ka = \frac{\propto^2 C}{1-\propto}$$

$$= \frac{(0.031623)^2}{1\text{-}0.031623} \times 0.1$$ 0.03981

$= 1.0327 \times 10^{-4}$moldm^{-3}

Ka = 1.65×10^{-4} moldm^{-3}

(ii) PH at end point = 8.8 + 0.4 01

Volume at the end point = 25.0cm^3. 01

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

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

$NaOH_{(aq)} + HA_{(aq)} \rightarrow NaA_{(aq)} + H_2O(l)$

Deduct 1½ for reject 25.4

Mole ratio HA: NaOH = 1:1

No of moles of NaOH = 2.5×10^{-3}

03

25cm^3 of NaOH contain 2.5×10^{-3}

1000cm^3 of NaOH contain $\frac{2.5 \times 10^{-3} \times 1000}{25}$

= 0.1 M

03

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

No of moles of NaA = 2.5×10^{-3} moles

Total volumes of solution = 25 + 25

= 50cm^3

50cm^3 of NaA contains 2.5x 10cm^{-3}moles.

01½

1000cm^{3}of NaA contains $\frac{2.5 \times 10^{-3}}{50} \times 10^3$

= 0.05 moldm^{-3}

$A^-_{(aq)} + H_2O_{(l)} \rightleftharpoons HA_{(aq)} + \bar{O}H_{(aq)}$ (Deny ½ without half arrows)

$$Kh = \frac{[HA][\bar{O}H]}{[A^-]}$$

Assumptions $[H_2O] = 1$

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

$$Kh = \frac{[\bar{O}H]^2}{[A^-]}$$

pH at end point = 8.8

POH = 14 – PH

= 14 – 8.8

$POH = 5.2$

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

$6.3096 \times 10^{-6} moldm^{-3}$

$Kn = \dfrac{(6.3096 \times 10^{-6})^2}{0.05}$

$= 7.962 \times 10^{-10} moldm^{-3}$

84

Acc. $(1 - 7) \times 10^{-10}$

(c) Initially the PH of the acid is 2.50(low) because the acid is weak and partially ionizes to form few hydrogen ions. 2.4

At more sodium hydroxide

Along AB, there is gradual increase in PH because the weak acid is being neutralized though still in excess.

~~Also the salt formed together with unreacted~~ acid ~~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.

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) Phenolpthalein 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**

84

(b) Calciumoxide is heated with carbon at 2000^{0}C to form calcium carbide. Calcium carbide is reacted with warm water to form ethyne.

Ethyne is reacted with organe nickel complex catalyst to form benzene. at 60°C

(Iron at 400°C) stop marking **03½ marks**

(c) Nitrobenzene is mixed with tin in the presence of concentrated hydrochloric acid and the mixture refluxed. or (heated)

Concentrated Sodium hydroxide solution is added to the resultant mixture to form phenylamine.

acc nitrous acid

Phenylamine is reacted with Sodium nitrite in the presence of concerated hydrochloric acid at 5^{0}C (or less than 10^{0}C) to form benzene diazonium salt.

Benzene diazonium salt is warmed with acidified water to form phenol.

Give two marks for alternative way warm reagent **05 marks**

(d) 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^{0}C to form 2- hyroxypano nitile which is refluxed with dilute nitric acid to form 2- hyroxy propanic acid. **04½ marks**

Phenylethane Presence of sulphuryl chloride in presence of a peroxide; heated

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

2-chlorophenylethane is heated with sodium hydroxide to form phenylethanol

20

The phenylethanol is dehydrated using excess concentrated sulphuric acid at 180°C.

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.

$Na_2SO_{3(aq)} + H_2O_{(l)} \rightleftharpoons H_2SO_{3(aq)} + NaOH_{(aq)}$

$SO_3^{2-}{}_{(aq)} + 2H_2O_{(l)} \rightleftharpoons H_2SO_{3(aq)} + 2OH^-$

reject if state symbols and arrows are missing

(b) Sodium aluminate reacts with carbondioxide to form aluminium hydroxide which is insoluble.

$2NaAl(OH)_{4(aq)} + CO_{2(g)} \rightarrow 2Al(OH)_{3(s)} + Na_2CO_3 + H_2O_{(l)}$

Sodium aluminate reacts with carbon dioxide to form aluminum hydroxide which is insoluble.

sodium hydrogen carbonate

$Na_2CO_{3(aq)} + H_2O_{(l)} + CO_{2(g)} \rightarrow 2NaHCO_{3(s)}$

04

(c) Concentrated nitric acid oxidises sulphur to sulphuric acid and itself reduced to nitrogendioxide gas.

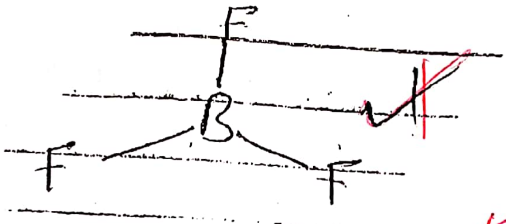
(Acc reacts)

$S_{(s)} + 6HNO_{3(aq)} \rightarrow H_2SO_{4(aq)} 6NO_{2(g)} + 2H_2O_{(l)}$

03

(d) Born uses all the three valence electrons to form three convalent bonds with fluorine atoms.

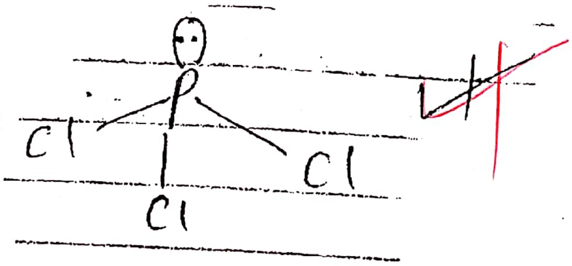
The bond paris will repel each other equally making the molecule to adopt a trigonal planar structure.



05 marks

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

05



04 marks

(e) Sodium contributes one electron per atom towards metallic bond formation will 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.

04

or rock or (mineral) (an element)

8. (a) (i) An ore is a naturally occurring substance from which a metal is extracted.

01 mark

(ii) Copper glance Cu_2S

Malachite $CuCO_3.CU(OH)_2$

Cuprite Cu_2O

– Azurite $2CuCO_3 \cdot Cu(OH)_2$ (Any 2)

– Tenorite CuO

02 marks

(b) Copper pyrites is crushed into powder. or ground

The powder is agitated mixed with water containing a frothing agent such as pine oil.

Air is blown into the mixture to cause agitation.

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 in filtered, washed and dried. 07½

03 marks

(c) (i) To converted copper pyrites to copper(1) sulphide, iron(11) oxide and sulphurdioxide. 01 or
To avoid forming copper (II) oxide and iron (III) oxide which are difficult to deal with. 01

2 ½ marks

$2CuFeS_{2(s)} + 4O_{2(g)} \rightarrow Cu_2S + 2FeO_{(s)} + 3SO_{2(g)}$

(ii) To form iron (II) silicate which has a low melting point and can easily be poured away. or
or prevent formation of iron (III) silicate 01
To avoid forming iron (III) silicate which has high melting point.
$FeO_{(s)} + SiO_{2(s)} \rightarrow FeSiO_{3(l)}$ 01

(d) (i) Copper (I) sulphide is roasted in limited supply of air to form copper (I) oxide and sulphurdioxide.
$2Cu_2S_{(s)} + 3O_{2(g)} \rightarrow 2Cu_2O_{(s)} + 2SO_{2(g)}$

All statements must be correctly written

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
$2Cu_2O_{(s)} + Cu_2S_{(s)} \rightarrow 6Cu_{(s)} + SO_{2(g)}$

Whole statement

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. 03
At the anode
$Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2e$
At the cathode
$Cu^{2+}_{(aq)} + 2e \rightarrow Cu_{(s)}$

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. 1½
pale green
$3Cu_{(s)} + 8HNO_{3(aq)} \rightarrow 3Cu(NO_3)_{2(aq)} + 2NO_{(g)} + 4H_2O_{(l)}$ 01 Acc. both green solution

reject brown fumes without exposure to air

02 marks

(ii) Colourless solution turned to blue solution and grey solid formed. whole statement
$Cu_{(s)} + 2AgNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2Ag_{(s)}$ 01½

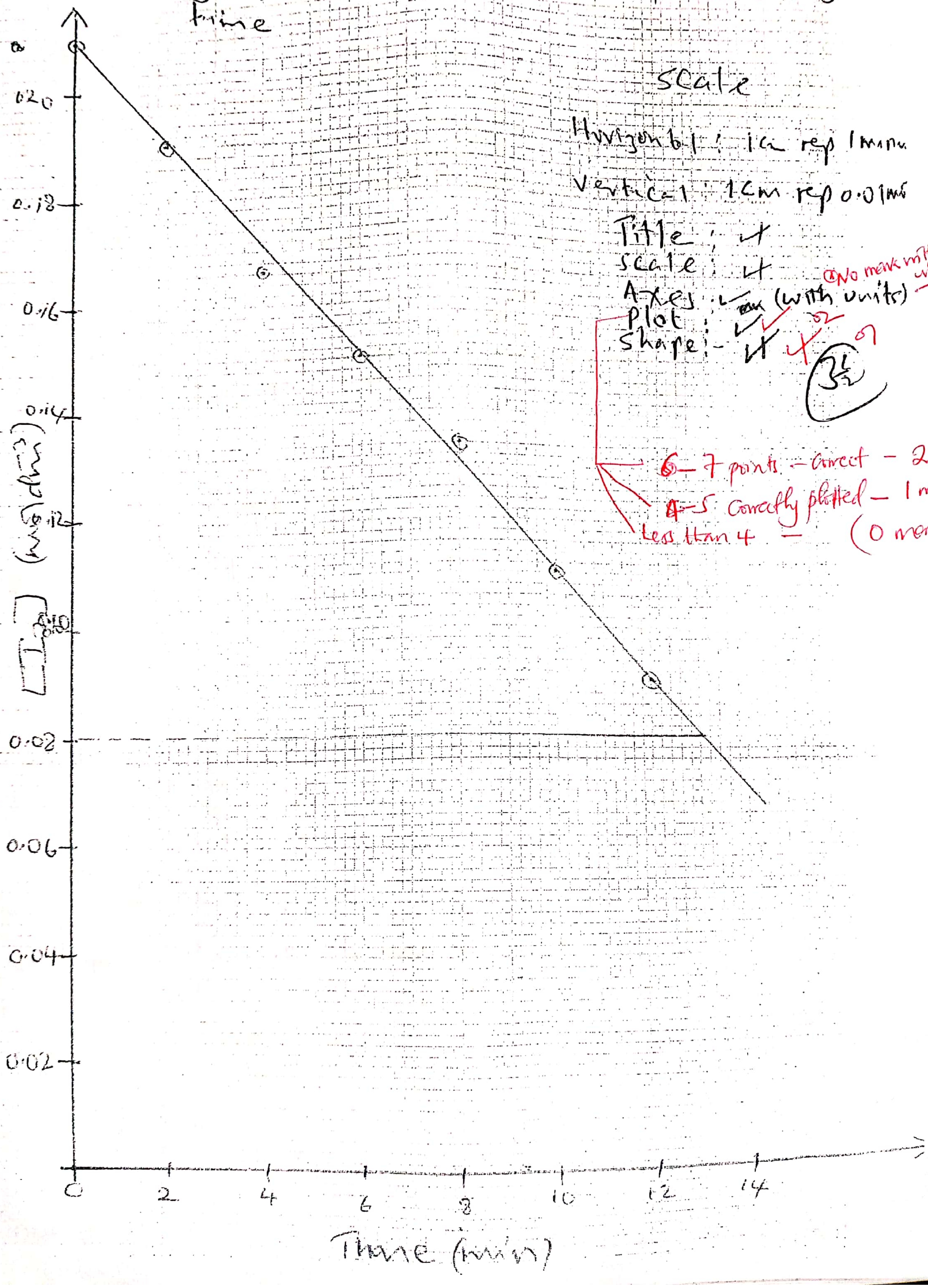
Acc ionic equation (penalize without symbols)

01½ marks

END

No 2(b)

A graph of concentration of iodine against time



Scale

Horizontal: 1cm rep 1min

Vertical: 1cm rep 0.01mol

Title; ✓

scale; ✓

Axes; ✓ (with units) ⓪ No mark without units

Plot; ✓ ✓ 02

Shape; ✓✓ ✓ 01

3½

6 – 7 points – correct – 2mks

4 – 5 correctly plotted – 1 mk

Less than 4 – (0 marks)