Candidate's Name: MUNICEL .....

Signature: .....

Random No.					Personal No.		
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(Do not write your School /Centre Name or Number anywhere on this booklet.)

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P525/1
CHEMISTRY
Paper 1
(Theory)
Nov./Dec. 2024
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1
(Theory)

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

This paper consists of **two** *Sections;* **A** *and* **B**.

Section **A** *is* **compulsory**. *Attempt* **six** *questions from Section* **B**. *Any additional question(s) attempted will* **not** *be marked.*

All questions **must** *be answered in the spaces provided. Use* **blue** *or* **black** *ink. Any work done in pencil,* **except** *drawings, will not be marked.*

The Periodic Table, with relative atomic masses, is attached at the end of the paper.

Mathematical tables (3-figure tables) are adequate or silent non-programmable scientific electronic calculators may be used.

Illustrate your answers with equations where applicable.

Where necessary, use the following:

Molar gas constant, $R = 8.31\ JK^{-1}\ mol^{-1}$.
Molar volume of gas at s.t.p. is 22.4 litres.
Standard temperature = 273 K.
Standard pressure = 101325 Nm^{-2}.

For Examiners' Use Only																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

Accept: 298K and 1Atmosphere pressure / 76cmHg / 101325 Nm^{-2}

Ignore: Reduction

Accept: potential difference

SECTION A: (46 MARKS)

Answer **all** *the questions in this section.*

1. (a) Define the term **standard electrode potential.** *(01 mark)*

This is the reduction electrode potential for an electrode measured with respect to the standard hydrogen electrode when the electrode is immersed in 1M solution of its ions at standard conditions. ✓ (1)

rej: electrode potential of a metal / element.

(b) The standard electrode potentials of some half cells reactions are given below:

rej: 1M solution of electrolyte.

rej: Standard temp and pressure

	E^{θ} (V)
$Co^{2+}_{(aq)} + 2e \longrightarrow Co_{(s)}$	−0.28
$Zn^{2+}_{(aq)} + 2e \longrightarrow Zn_{(s)}$	−0.76
$Cl_{2\,(aq)} + 2e \longrightarrow 2\,Cl^-_{(aq)}$	+1.36
$MnO^-_{4\,(aq)} + 8H^+_{(aq)} + 5e \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$	+1.52

(i) Identify the strongest reducing agent and the strongest oxidising agent. *(01 mark)*

Zinc ✓, Accept Zn ; Zinc element

Manganate (VII) ion / Permanganate ion ✓ (01)

Accept MnO_4^-

(ii) Write the cell notation of the cell constructed by combining the half cells $Co^{2+}_{(aq)} / Co_{(s)}$ and $Zn^{2+}_{(aq)} / Zn_{(s)}$. (1) *(01 mark)*

Accept: ⋮⋮

$Zn_{(s)} | Zn^{2+}_{(aq)} \,||\, Co^{2+}_{(aq)} | Co_{(s)}$ ✓ (1)

- Symbols
- physical states

(iii) Write the equation for the overall cell reaction for the cell in b(ii). *(01 mark)*

$Zn_{(s)} + Co^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Co_{(s)}$ ✓ (1)

- Symbol
- Balancing
- state

* Co, Zn; rej.

(iv) Calculate the e.m.f. of the cell in b(ii). *(01 mark)*

$E^{\theta} = E^{\theta}_{RHS} - E^{\theta}_{LHS}$ ✓ expression

$= -0.28 - -0.76$ (01)

$= +0.48V$ ✓ rej: without +ve sign

[05

Note: Electrode can be made up of elements or metals or ions

1M solution of electrolyte: might contain more than 1 mole of the ion.

Standard temperature and pressure = STP conditions; expts occur at standard conditions not STP

2. Nylon 6, 6 $\left[\underset{H}{\overset{|}{N}}-(CH_2)_6-\underset{H}{\overset{|}{N}}-\overset{O}{\overset{\|}{C}}(CH_2)_4\overset{O}{\overset{\|}{C}} \right]_n$ is formed by condensation polymerisation.

(a) State the meaning of the term condensation polymerisation. *(01 mark)*

This is the combining of two types of bifunctional molecules (monomers) to form a large molecule (polymer) with elimination of small molecules. ✓ ① req: if only one small molecule is stated, if stated, they should be at least two eg water, ammonia, HCl, CH_3OH

(b) (i) Write the structural formula(e) and name(s) of the monomers of nylon 6, 6. *(03 marks)* req: touching brackets ✓ ✓ ✓ ③

$H_2N(CH_2)_6NH_2$ Hexane 1,6 diamine req: Name if structural formula is wrong.

$HO\overset{O}{\overset{\|}{C}}(CH_2)_4COOH$ Hexane 1,6 dioic acid

Accept: $Cl\overset{O}{\overset{\|}{C}}(CH_2)_6COCl$, Hexane 1,6 dioyl dichloride.

req: $H_2N-(CH_2)_6-NH_2$ $HO\overset{O}{\overset{\|}{C}}-(CH_2)_4-COOH$

(ii) State **one** use of nylon 6, 6. *(01 mark)*

making clothes / fabric, ropes, belts, fishing nets ✓ ① [04]

3. Draw the structure and name the shape of each of the following ions in Table 1: req: Joined names eg Trigonalplanar *(4½ marks)*

Table 1 – Bond angles

Ion	Structure	Name of shape
NO_3^-	✓	Trigonal planar ✓ ✓
SO_3^{2-}	✓	Trigonal pyramidal ✓ ✓
NH_4^+	✓	Tetrahedral ✓ ✓

req: if structure is wrong

[04½]

*symbols should be correct esp oxygen

N- cannot expand its octate;

req: 180

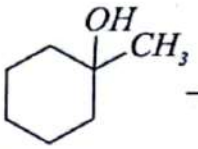
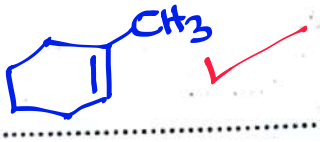
req: curved bonds, hanging bonds, displaced bonds.

4. Complete the following equations and name the major organic product:

(a) $CH_3COOH \xrightarrow{PCl_5}$  (1½ marks)

Structure must be correct to earn for name.

Name Ethanoyl chloride ✓ + neg: Ethanoylchloride

(b)   (1½ marks)

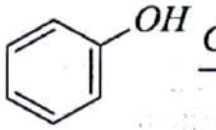
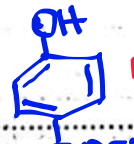
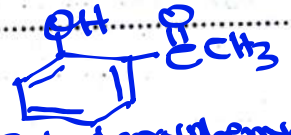
If position of methyl group changes, name also changes

Name 1-methylcyclohexene ✓ + neg: Methylcyclohexene

(c) $(CH_3COO)_2Ca \xrightarrow{Heat}$  (1½ marks)

neg: Propan-2-one

Name Propanone ✓ +

(d)   or  (1½ marks)

2-hydroxyphenylethanone

Name 4-hydroxyphenylethanone ✓ +

relate structure to name.

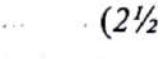
[06

5. The vapour pressure of propanone is 37330 Nm^{-2} at 30 °C. When 33.4 g of cane sugar were dissolved in 120 g of propanone, the vapour pressure reduced by 1760 Nm^{-2}.

(a) Calculate the molar mass of cane sugar. (2½ marks)

evidence

Expression

$\frac{p_o - p}{p_o}$ = $\frac{\text{Mass Solute} \times \text{Mr solvent}}{\text{Mr solute} \times \text{mass solvent}}$ ✓ +  $= 58$ ✓ + (2½)

(b) Explain why the vapour pressure of the solution is lower than that of propanone. (1½ marks)

Cane sugar is a non-volatile solute ✓ +, it covers part of surface of the solution ✓ + and reduces the escaping tendency ✓ + of solvent molecule into vapour phase. (1½)

neg: Surface of propanone / solvent

[04

$\frac{1760}{37320} = \frac{33.4 \times 58}{Mr \times 120}$ ✓ +

$Mr = 342.4$ ✓

6. (a) State what would be observed and write an equation for the reaction that takes place when dilute hydrochloric acid is added to aqueous potassium manganate(VI) solution.

Observation: *(1½ marks)*

Green solution turns purple and a brown / black sand / precipitate is formed. (1½) key: deposit

Equation: *(1½ marks)*

$3MnO_4^{2-}(aq) + 4H^+(aq) \longrightarrow 2MnO_4^-(aq) + MnO_2(s) + 2H_2O(l)$ (1½)

Allow Molecular equation

sentence did not make sense.

(b) Explain why potassium manganate(VII) is **not** acidified using hydrochloric acid. *(2½ marks)*

Manganate(VII) ions oxidise the chloride ions to chlorine gas | Accept Cl^- ions reduce $MnO_4^- \rightarrow Mn^{2+}$ (02½)

$2MnO_4^-(aq) + 16H^+(aq) + 10Cl^-(aq) \longrightarrow 2Mn^{2+}(aq) + 8H_2O + 5Cl_2(g)$

$2KMnO_4(s) + 16HCl(aq) \longrightarrow 2KCl(aq) + 2MnCl_2(aq) + 8H_2O(l) + 5Cl_2(g)$

[05½]

7. Complete the following equations and in each case write the mechanism for the reaction(s):

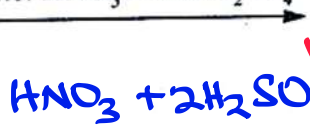
(a) $CH_3CH_2OH \xrightarrow[180\ ^\circ C]{Conc.H_2SO_4}$ $H_2C=CH_2$ *(3½ marks)*

Mechanism:

$CH_3CH_2\ddot{O}H \rightarrow CH_3CH_2\overset{+}{O}H_2 \xrightarrow{-H_2O} CH_3\overset{+}{C}H_2 \xrightarrow{-H^+} H_2C=CH_2$

(02½)

key: $CH_3CH_2-\overset{+}{O}H_2$

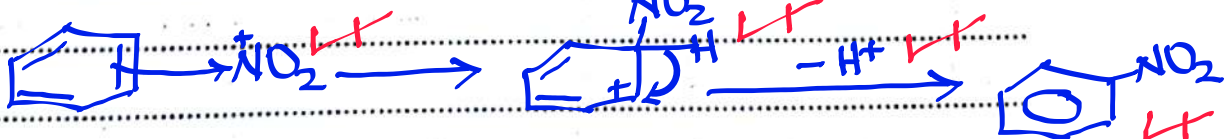
(b)  $\xrightarrow{Conc.\ HNO_3/Conc.H_2SO_4}$  *(2½ marks)*

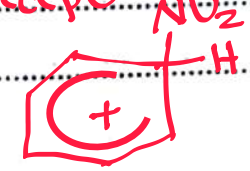
ignore balancing

3 spp must be present

Mechanism:

$HNO_3 + 2H_2SO_4 \longrightarrow H_3O^+ + 2HSO_4^- + \overset{+}{N}O_2$

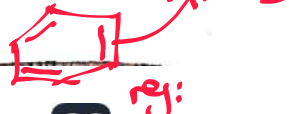


Accept: 

Accept: $HNO_3 + H_2SO_4 \rightarrow H_2O + HSO_4^- + \overset{+}{N}O_2$ (02½)

[06]

- ring must cover 5-carbon atoms

key:  ;  ;  ; 

key:

key:

8. (a) Write an equation for the reaction that takes place when methylamine is dissolved in water. *(1½ marks)*

$CH_3NH_{2(aq)} + H_2O_{(l)} \rightleftharpoons CH_3\overset{+}{N}H_{3(aq)} + \overset{-}{O}H_{(aq)}$ (1½)

deduct ½ mark for →; rej: CH_3NH_3OH

(b) The hydrogen ion concentration of a 1M methylamine solution is $2.5 \times 10^{-13}\ mol\ l^{-1}$. Calculate the base dissociation constant K_b, of methylamine. *(3½ marks)*

(The ionic product of water, $K_w = 10^{-14}\ mol^2 l^{-2}$)

$K_b = \frac{[CH_3\overset{+}{N}H_2][\overset{-}{O}H]}{[CH_3NH_2]}$; At equilibrium $[CH_3\overset{+}{N}H_3] = [\overset{-}{O}H]$; $K_b = [\overset{-}{O}H]^2 / [CH_3NH_2]$ (03½)

$[\overset{-}{O}H] = K_w / [H^+] = (1.0 \times 10^{-14} / 2.5 \times 10^{-13}) = 0.04$ molesdm^{-3}

$K_b = (0.04)^2 / 1 = 1.6 \times 10^{-3}$ moldm^{-3}

$pH = -\log[H^+]$; $-\log(2.5 \times 10^{-13}) = 12.60$; $pH + pOH = 14$;

$14 = 12.60 + pOH$; $pOH = 1.4$; $pOH = -\log[\overset{-}{O}H]$; $[\overset{-}{O}H] = 10^{-1.4}$

$[\overset{-}{O}H] = 0.0398$ moldm^{-3}; at equilibrium, $[\overset{-}{O}H] = [CH_3\overset{+}{N}H_3]$

$K_b = [\overset{-}{O}H]^2 / [CH_3NH_2]$; $\frac{(0.0398)^2}{1} = 1.584 \times 10^{-4}$ moldm^{-3}

units

05

9. The first ionisation energies and atomic radii for some elements of group(II) of the Periodic Table are given in Table 2.

Table 2

Element	Beryllium	Magnesium	Calcium	Strontium	Barium
First ionisation energy ($kJ\ mol^{-1}$)	899	738	590	550	503
Atomic radius (nm)	0.089	0.136	0.174	0.191	0.198

(a) State how the first ionisation energy varies with atomic radius. *(01 mark)*

First ionisation energy decreases with increase in atomic radius (01)

award independently

Accept:

$[\overset{-}{O}H] = C\alpha$

$\alpha = (0.04/1) = 0.04$ moldm^{-3}

$K_b = C\alpha^2 / 1-\alpha$

Assumption: $1-\alpha \simeq 1$;

$K_b = C\alpha^2$

$K_b = (0.04)^2/1$

$= 1.6 \times 10^{-3}$ moldm^{-3}

accept: Beglium to Lavium. rej: a full inner shell of electrons added down the group

(b) Explain your answer in (a). (04 marks)

rej: full shell

Down the group full inner shells of electrons is added which increase screening effect. As proton are added to the nucleus, nuclear charge increases. Screening effect increase faster than the increase in nuclear charge; reducing effective nuclear charge; nuclear attraction of outermost electrons decreases, increasing atomic radius, making outermost electrons far from the nucleus, reducing ionisation energy.

04

* Explanation should be logical and flowing. 05

* Rej: Compound explanation eg Both screening and nuclear charge increase with increase in number of electron shells.

SECTION B: (54 MARKS)

Answer any **six** *questions from this section.*
Any additional question(s) answered will **not** *be marked.*

10. The molecular formula of a compound ***P*** is $C_3H_6Cl_2$.

(a) Write the structural formulae of all the possible isomers of *P*. (02 marks)

$ClCH_2CH_2CH_2Cl$ $CH_3CH_2\overset{Cl}{\underset{Cl}{C}}-H$

$CH_3\overset{Cl}{\underset{Cl}{C}}-CH_3$ $ClCH_2\underset{Cl}{CH}CH_3$

02

rej: structure and name

(b) When ***P*** was boiled with aqueous sodium hydroxide, a compound ***R*** which reacted with hydroxylamine (NH_2OH) in the presence of an acid and reduced Fehling's solution, was formed.

(i) Identify compounds ***P*** and ***R***. (02 marks)

P $CH_3CH_2CHCl_2$ Should come from CO

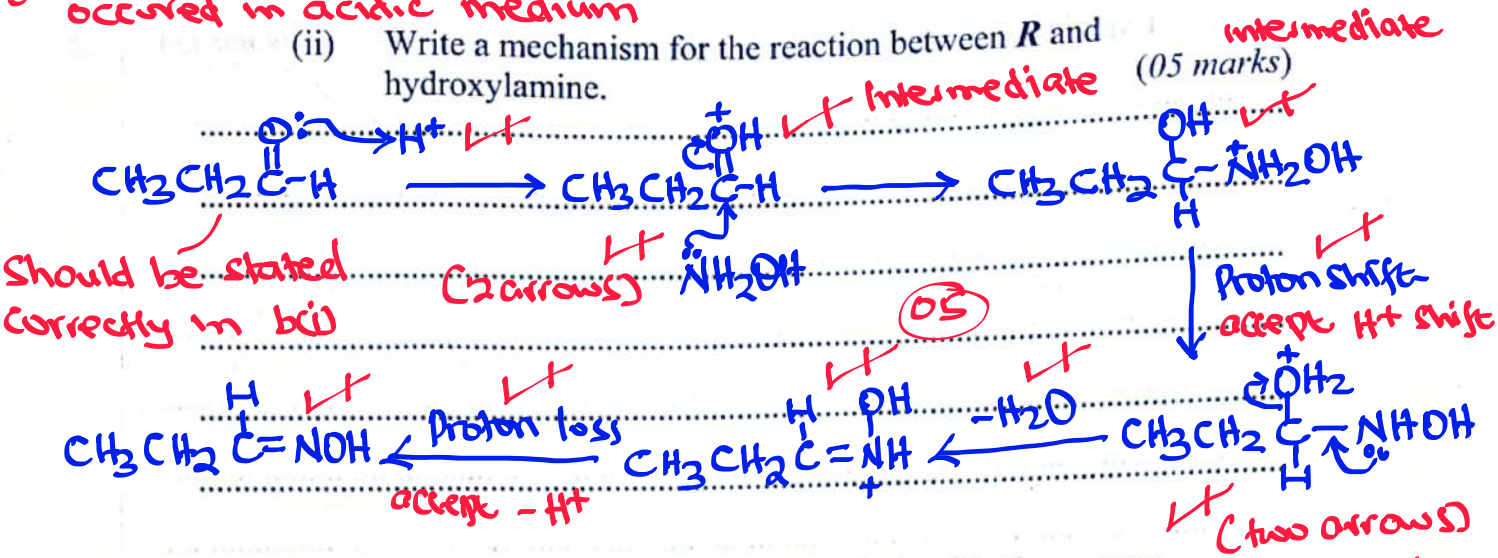
R CH_3CH_2CHO

Accept: Name since question is identify

* P - Should give the stated aldehyde

eg: Mechanism without the initial Protonation stage since reaction occured in acidic medium

(ii) Write a mechanism for the reaction between *R* and hydroxylamine. *(05 marks)*



11. (a) State **two** factors which affect the magnitude of lattice energy. *(01 mark)* 09

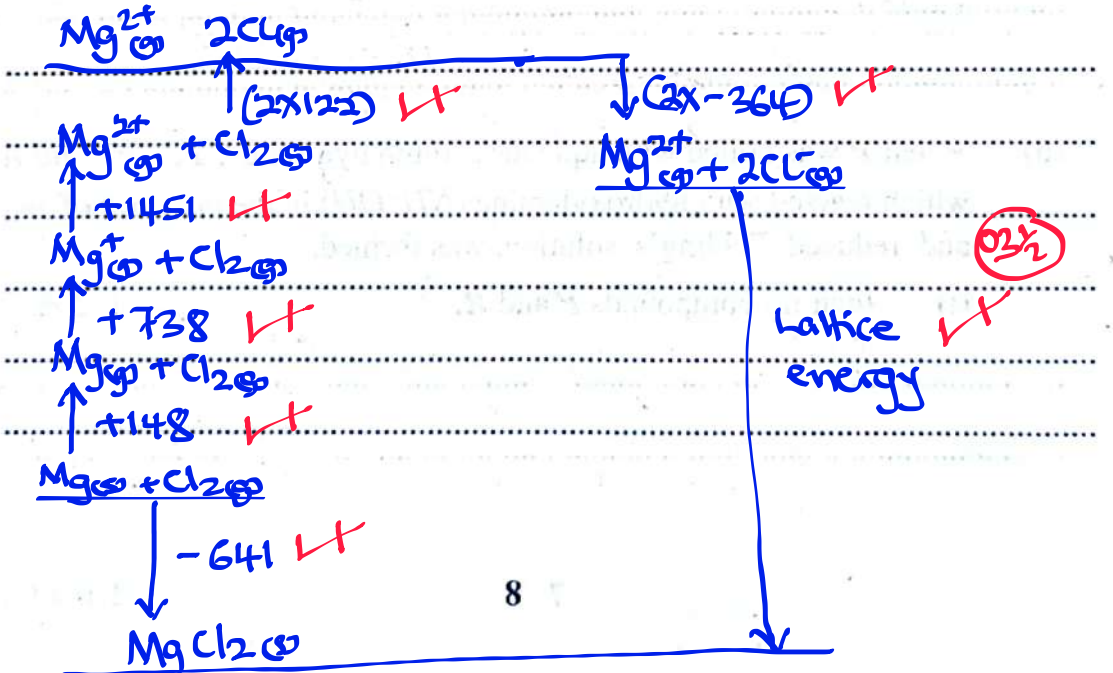
Magnitude of Ionic charge (01)

Ionic radius eg: Ionic size

(b) Some thermochemical data are shown below:

Enthalpy of atomisation of chlorine = +122 kJ mol^{-1}.
Enthalpy of atomisation of magnesium = +148 kJ mol^{-1}.
First ionisation energy of magnesium = +738 kJ mol^{-1}.
Second ionisation energy of magnesium = +1451 kJ mol^{-1}.
Enthalpy of formation of magnesium chloride = −641 kJ mol^{-1}.
First electron affinity of chlorine = −364 kJ mol^{-1}.

(i) Construct an energy level diagram for the formation of magnesium chloride. *(03 marks)*



- Each mini equation Should be correct
- Arrows should be indicated
- Starting point and final point

(ii) Determine the lattice energy of magnesium chloride. (02 marks)

$-641 = 148 + 2(122) + 738 + 1451 + 2(-364) + LE$ ✓+

Lattice energy $= -2494\ kJmol^{-1}$ ✓ (1½)

(iii) Calculate the enthalpy of solution of magnesium chloride. (03 marks)

(*The hydration energies of magnesium ions and chloride ions are -1891 and $-381\ kJ\ mol^{-1}$ respectively.*)

$\Delta H_{hydration} = \Delta H_h Mg^{2+} + 2\Delta H_h Cl^-$ ✓+

$= -1891 + 2(-381)$ ✓+ $= -2653\ kJmol^{-1}$ ✓+

$\Delta H_{solution} = \Delta H_{lattice} + \Delta H_{hydration}$ ✓+

$= +2494 + (-2653)$ ✓+ (03)

$= -159\ kJmol^{-1}$ ✓+

12. (a) One of the characteristics of transition elements, is formation of complexes. Explain how transition metal ions form complexes. (1½ marks)

reg: 3d-orbital – These are other transition series

Transition metal ions have a high charge density ✓+ to attract lone pairs ✓+ of electrons from ligands into their vacant ✓+ orbitals or d-orbitals. reg: 3d-orbital

copper also forms complexes

(b) The formulae of some complex ions are shown in Table 3. Write the name of the complex ion, its oxidation state and the co-ordination number of the central metal ion. (03 marks)

Table 3

Complex ion	Name of ion	Oxidation state	Co-ordination number
$[(Co\ (SCN)_4]^{2-}$		+2 ✓+	4 ✓+
$[Cr\ (NH_3)_4Cl_2]^+$	reg: +2; 2+	+3 ✓+	6 ✓+

reject words

accept words Four six

(c) The molecular mass of a salt, $Cu\ (NH_3)_x Cl_y \cdot ZH_2O$ is 276.

When a solution containing 1.38 g of salt was reacted with excess silver nitrate solution, 2.87 g of silver chloride was formed.

Calculate the number of moles of chloride ions in 1 mole of the salt. (02 marks)

Tetrathiocyanatocobaltate(II) ion ✓+

Tetraammine dichlorochromium(III) ion ✓+

Accept: Dichlorotetraammine chromium(III) ion.

reg: II, (iii); (ii)

Rfm of AgCl = 108 + 35.5 = 143.5 ✓+

Number of moles of AgCl = $\left(\frac{2.87}{143.5}\right)$ ✓+ = 0.02

(02)

Number of moles of Cl^- ions in 1mole of salt

= $\left(\frac{0.02}{1.38}\right)$ ✓+

= 4 ✓+

(d) When a solution containing 1.38g of the salt was mixed with aqueous sodium hydroxide and heated, the ammonia liberated completely neutralised 10 cm^3 of a 1.0 M hydrochloric acid.

Calculate the number of moles of;

(i) ammonia molecules in 1 mole of the salt. *(1½ marks)*

award the relationship →

Number of moles HCl = (10x1)/1000 = 0.01 moles

Number of moles NH_3 = moles of HCl = 0.01 moles ✓+

Number of moles of ammonia in 1mole of salt = $\left(\frac{0.01 \times 2?6}{1.38}\right)$ ✓+ (1½)

= 2 ✓+

(ii) water in 1 mole of the salt. *(01 mark)*

64 + 2(17) + (4x35.5) + 182 = 276 ✓+ (01)

Z = (36/18) = 2 ✓+

[09

Follow the student's logic

13. Write the equations to show how the following compounds can be synthesised and in each case, indicate the conditions for the reaction.

(a) $CH_3CH_2CH_2Br$ from propanone. *(04 marks)*

- Symbols of element.

Accept alternative routes that are logical and correct.

CH_3COCH_3 —($LiAlH_4$ ✓+, dry ether ✓+)→ $CH_3\underset{OH}{C}HCH_3$ ✓+ —(Conc. H_2SO_4 ✓+, 180°C ✓+)→ $CH_3\overset{H}{C}=CH_2$ ✓+ (04)

CH_3COCH_3 —(PCl_5)→ $CH_3\underset{Cl}{\overset{Cl}{C}}-CH_3$ —(excess KOH/CH_3CH_2OH, Heat)→ $CH_3\overset{H}{C}=CH_2$

Accept: 100–180°C

req: HBr(aq)

$CH_3\overset{H}{C}=CH_2$ —(HBr | ROOR ✓+)→ $CH_3CH_2CH_2Br$

req: H_2O_2

req: peroxide

Accept: organic peroxide

Accept: specific organic peroxide

Reducing agent Ni | H_2; Heat

Zn | CH_3COOH

Na | CH_3CH_2OH

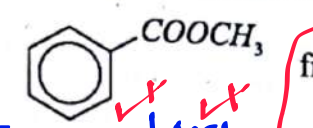
$NaBH_4$ | H_2O or CH_3OH ← req: alcohol

Dehydrating agents: Al_2O_3 300–360°C

Conc. H_3PO_4 300–360°C

req: Peroxide ≠ Inorganic peroxide cannot work

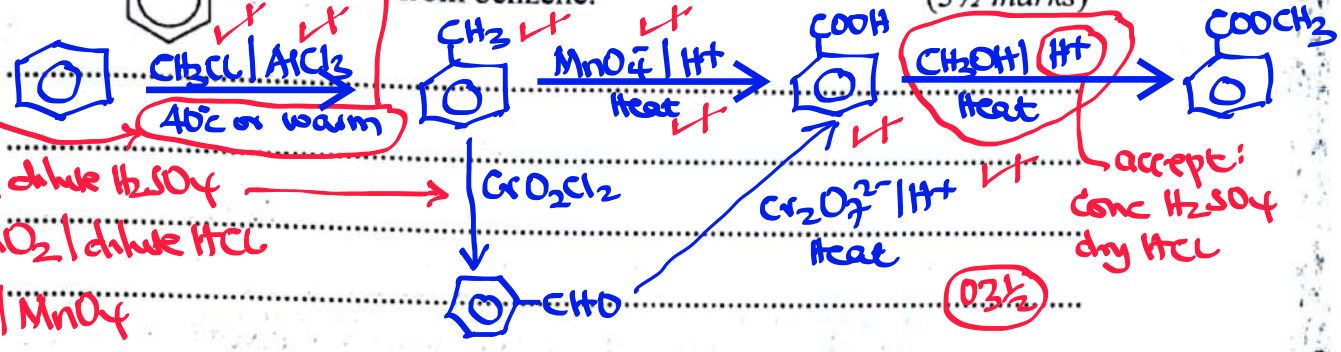
2° alcohols can dehydrate at temp below 180 but not less than 100°C

(b) 

from benzene. (3½ marks)

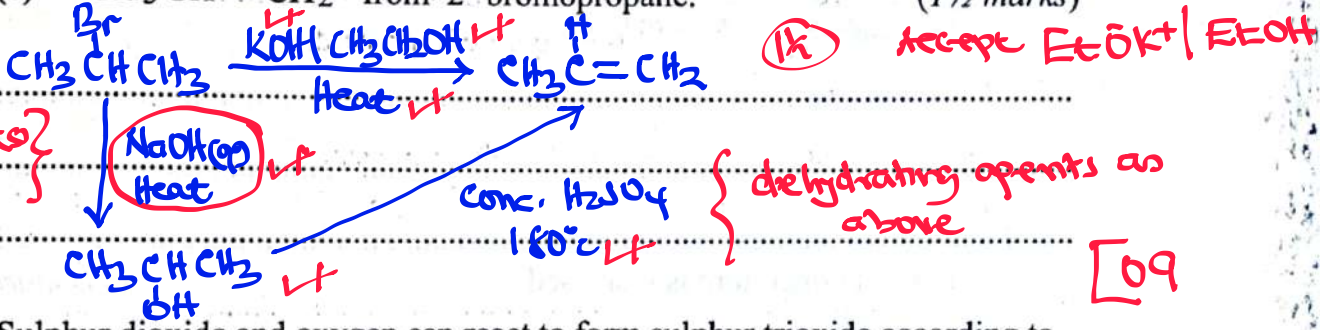
ignore: req: heat

req: temperature beyond 40°C and below 80°C



03½

(c) $CH_3CH=CH_2$ from 2–bromopropane. (1½ marks)



09

14. Sulphur dioxide and oxygen can react to form sulphur trioxide according to the following equation:

$2\,SO_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2\,SO_{3\,(g)}$; ΔH is negative.

3 moles of sulphur dioxide and 2 moles of oxygen were heated at 450 °C in a 1 dm^3 vessel at 50 atmospheres. At equilibrium the vessel contained 20 % sulphur dioxide.

req: [ ]; $P_{SO_2}, P_{SO_3}, P_{O_2}$ ← subscripts

(a) (i) Write the expression for the equilibrium constant, K_p.

$K_p = \dfrac{(P_{SO_3})^2}{(P_{SO_2})^2(P_{O_2})}$ accept $K_p = \dfrac{(P_{SO_3})^2}{(P_{SO_2})^2(P_{O_2})}$ (½ mark) ½

(ii) Calculate the value of the equilibrium constant, K_p for the reaction at 450 °C. (04 marks)

$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$

eqm (3−2x) (2−x) 2x ✓

Total moles = (3−2x) + (2−x) + 2x = 5−x ✓

$\left(\dfrac{3-2x}{5-x}\right) \times 100 = 20$; $x = 1.111$ ✓

$P_{SO_2} = \left(\frac{3-2(1.111)}{5-1.111}\right) \times 50 = 10\ Atm$ ✓+

$P_{O_2} = \left(\frac{2-1.111}{5-1.111}\right) \times 50 = 11.43\ Atm$ ✓+ (04)

$P_{SO_3} = \left(\frac{2\times 1.111}{5-1.111}\right) \times 50 = 28.57\ Atm$ ✓+

$K_p = (28.57)^2/(10^2 \times 11.43)$ ✓+

$= 0.714\ Atm^{-1}$ ✓+

Allow alternative numerical approaches which are logical

(b) State, giving reasons, how the concentration of sulphur trioxide at equilibrium would be affected if;

(i) pressure is increased. *(1½ marks)*

Concentration of sulphur trioxide increases ✓+ because the forward reaction occurs with decrease in volume ✓ / number of moles (1½)

(ii) temperature is increased. *(1½ marks)*

Concentration of sulphur trioxide reduces ✓+ because the forward reaction is exothermic ✓ / reverse reaction is endothermic (1½)

(iii) an inert gas is added at constant pressure. *(1½ marks)*

Concentration of sulphur trioxide decreases ✓+ because addition of inert gas at constant pressure increases volume of the vessel ✓+; favouring the backward ✓+ reaction which proceeds with increase in volume. (1½)

or

Partial pressure of individual gases decreases ✓+ with increase in volume of the vessel ✓+ as the inert gas is added; this reduces the concentration of ✓+ sulphur trioxide.

* Emphasise the direction and nature of reaction
eg rey: favours the forward reaction but it should be stated: favours the forward reaction that is exothermic

This the energy required to break one mole of covalent bonds to its gaseous atoms

15. (a) State the meaning of the term **bond energy**. *(01 mark)*

This is the energy given out when one mole of covalent bonds is formed from its free gaseous atoms. ✓1

key: One mole of a covalent bond

(b) The bond dissociation energies of fluorine, chlorine, bromine and iodine are 158, 242, 193 and 151 kJ mol^{-1} respectively.

(i) State the trend in the bond dissociation energies of the elements. *(1½ marks)*

Accept: Increases from F_2 to Cl_2 and decreases from Cl_2 to I_2

There is a general decrease in bond dissociation energy down the group ✓ with exception of fluorine whose bond dissociation energy is abnormally low. ✓✓ (1½)

award if trend correct

(ii) Explain your answer in (b)(i). *(3½ marks)*

From chlorine to iodine, atomic radius increases ✓, bond length increases ✓; bond strength decreases ✓; decreasing bond energy.

key: symbols in explanation - spellings of elements should be correct

Fluorine atom has a small atomic radius ✓ and lone pairs ✓ of electrons on fluorine atom in fluorine molecule are very close to each ✓ other. Great repulsion ✓ between these lone pairs of electrons weaken the fluorine-fluorine bond. ✓

key: lone pair Accept: Non bonding electrons

Accept: Halogen-halogen bond.

(c) Write an equation to show how cold dilute sodium hydroxide solution reacts with;

(i) fluorine. *(1½ marks)*

$2F_{2(g)} + 2\bar{O}H_{(aq)} \longrightarrow OF_{2(g)} + 2F^-_{(aq)} + H_2O_{(l)}$ ✓✓

(ii) chlorine. *(1½ marks)*

$Cl_{2(g)} + 2\bar{O}H_{(aq)} \longrightarrow Cl^-_{(aq)} + ClO^-_{(aq)} + H_2O_{(l)}$ ✓✓

Accept molecular equations

Principles of equation writing applies [09

* Balancing * State symbols
* Symbols

16. Propan-1-ol (boiling point 97 °C) and water (boiling point 100 °C) are miscible in all proportions. A mixture of the two liquids containing 72 % propan-1-ol boils at 88 °C.

(a) Sketch a labelled boiling point–composition diagram for the mixture of propan-1-ol and water. *(03 marks)*

award if unit included

Temperature / °C

100

vapour curve

97

liquid curve

Azeotropic point

72

% composition propan-1-ol

100% Propan-1-ol

working diagram

Working diagram
- logical shape
- Proportionality
- Values indicated

(b) Briefly explain;

(i) why propan-1-ol and water form a minimum boiling point mixture. *(04 marks)*

component should be specified

The intermolecular forces (Adhesive forces) of attraction between propan-1-ol molecules and water molecules are weaker than the forces of attraction between pure propan-1-ol molecules and pure water molecules (cohesive forces) ✓ reg: without pure

Therefore there is a greater escaping tendency of molecules of each kind from the mixture than from the pure water and pure propan-1-ol ✓

The solution will have a higher vapour pressure than that of an ideal solution/predicted by Raoult's law. ✓

* Each statement should be comparative

reg: unlike molecules or like molecules ⇒ components must be specified since they have been given in question

key: Vapour condenses to form liquid richer in propan-1-ol.
Vapour is what is richer and definately condenses to a liquid.

(ii) what would happen when a mixture containing 30 % propan–1–ol is fractionally distilled. (02 marks)

On heating the mixture containing 30% propan-1-ol, it gives a vapour richer in propan-1-ol (key: more volatile component) which on cooling yields a liquid of the same composition. ✓✓ Repeated heating and cooling yields the azeotropic mixture as distillate ✓ and pure water as residue. ✓ (02½)

* Statements should be logical [09

17. Tin and lead are elements in group(IV) of the Periodic Table. Describe the reactions of the elements with;

(a) cold water. (03 marks)

Tin doesnot react with cold water. ✓✓

Lead reacts with soft water ✓ containing oxygen ✓ to form lead(II)hydroxide accept aerated soft waters (03)

$2Pb_{(s)} + 2H_2O_{(l)} + O_{2(g)} \longrightarrow 2Pb(OH)_{2(s)}$ ✓✓

(b) sodium hydroxide solution. (3½ marks)

Tin and lead react with hot concentrated sodium hydroxide to form stannate(IV) and plumbate(II) respectively and hydrogen gas. ✓ ① award if conditions and products are stated. (03)

Accept: Separated statements and award ½ mark each.

(c) hot concentrated sulphuric acid. (2½ marks)

Tin and lead react with hot concentrated sulphuric acid to form tin(IV) sulphate and lead(II) sulphate respectively, water and sulphur dioxide gas. ✓ ①

$Sn_{(s)} + 4H_2SO_{4(l)} \longrightarrow Sn(SO_4)_{2(s)} + 4H_2O_{(l)} + 2SO_{2(g)}$ ✓ ①

$Pb_{(s)} + 2H_2SO_{4(l)} \longrightarrow PbSO_{4(s)} + 2H_2O_{(l)} + SO_{2(g)}$ ✓ ①

key: react to form salts ← be specific (sulphates)

$Sn_{(s)} + 2\bar{O}H_{(aq)} + H_2O_{(l)} \longrightarrow SnO_3^{2-}{}_{(aq)} + 2H_{2(g)}$ ✓

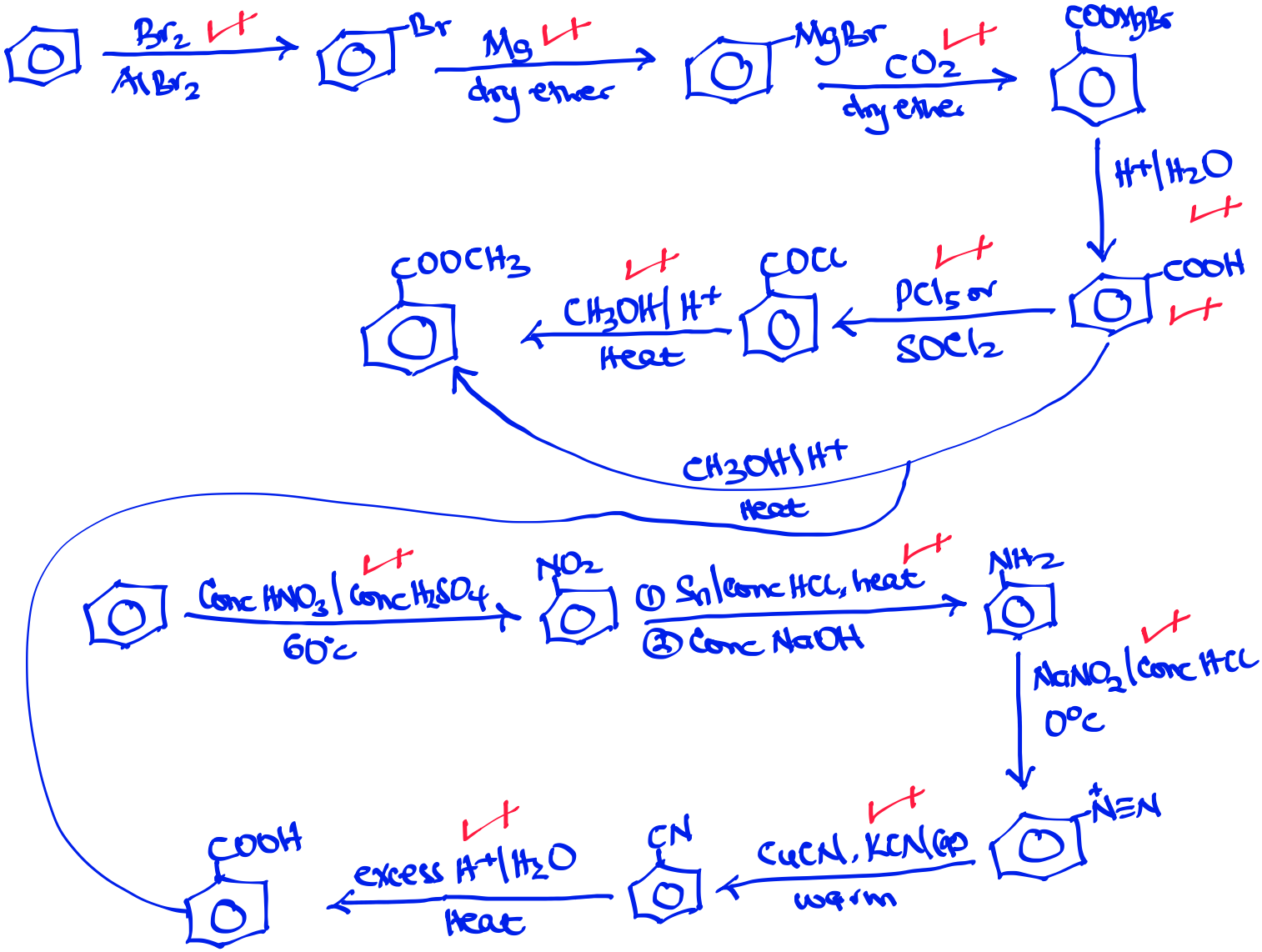
$Pb_{(s)} + 2\bar{O}H_{(aq)} \longrightarrow PbO_2^{2-}{}_{(aq)} + H_{2(g)}$ ✓

THE PERIODIC TABLE

1	2											3	4	5	6	7	8
1.0 H 1																1.0 H 1	4.0 He 2
6.9 Li 3	9.0 Be 4											10.8 B 5	12.0 C 6	14.0 N 7	16.0 O 8	19.0 F 9	20.2 Ne 10
23.0 Na 11	24.3 Mg 12											27.0 Al 13	28.1 Si 14	31.0 P 15	32.1 S 16	35.5 Cl 17	40.0 Ar 18
39.1 K 19	40.1 Ca 20	45.0 Sc 21	47.9 Ti 22	50.9 V 23	52.0 Cr 24	54.9 Mn 25	55.8 Fe 26	58.9 Co 27	58.7 Ni 28	63.5 Cu 29	65.7 Zn 30	69.7 Ga 31	72.6 Ge 32	74.9 As 33	79.0 Se 34	79.9 Br 35	83.8 Kr 36
85.5 Rb 37	87.6 Sr 38	88.9 Y 39	91.2 Zr 40	92.9 Nb 41	95.9 Mo 42	98.9 Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57	178 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	204 Tl 81	207 Pb 82	209 Bi 83	209 Po 84	210 At 85	222 Rn 86
223 Fr 87	226 Ra 88	227 Ac 89															

		139 La 57	140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
		227 Ac 89	232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	254 Es 99	257 Fm 100	256 Md 101	254 No 102	260 Lw 103

END



Note:- Award logical routes with correct chemistry.

$Pb_{(s)} + 4\bar{O}H_{(aq)} + 2H_2O_{(l)} \longrightarrow Pb(OH)_6^{4-}{}_{(aq)} + H_{2(g)}$

$Pb_{(s)} + 2\bar{O}H_{(aq)} + 2H_2O_{(l)} \longrightarrow Pb(OH)_4^{2-}{}_{(aq)} + H_{2(g)}$

$Sn_{(s)} + 2\bar{O}H_{(aq)} + 2H_2O_{(l)} \longrightarrow Sn(OH)_4^{2-}{}_{(aq)} + H_{2(g)}$

$Sn_{(s)} + 2\bar{O}H_{(aq)} \longrightarrow SnO_2^{2-}{}_{(aq)} + H_{2(g)}$

$Sn_{(s)} + 4\bar{O}H_{(aq)} + 2H_2O_{(l)} \longrightarrow Sn(OH)_6^{4-}{}_{(aq)} + H_{2(g)}$

$Sn_{(s)} + 2\bar{O}H_{(aq)} + 4H_2O_{(l)} \longrightarrow Sn(OH)_6^{2-}{}_{(aq)} + 2H_{2(g)}$

$Sn_{(s)} + 8H^+_{(aq)} + 2SO_4^{2-}{}_{(aq)} \longrightarrow Sn^{4+}{}_{(aq)} + 2SO_{2(g)} + 4H_2O_{(l)}$

$Pb_{(s)} + 4H^+_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow Pb^{2+}{}_{(aq)} + SO_{2(g)} + 2H_2O_{(l)}$

* Stannate (II); stannate(IV) → Equation should correlate to the statement.
* Accept complexes of lead in oxidation state of +2

ST JOHN 21:25