SUGGESTED MARKING GUIDE

Candidate's Name: ...JOSEPH JOBS KAHIIRA.....

Signature: .....

Random No.	Personal No.
07532470981	07[illegible]1038

(Do not write your School/Centre Name or Number anywhere on this booklet.)

P525/1
CHEMISTRY
(Theory)
Paper 1
Nov./ Dec. 2022
2¾ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of Education

CHEMISTRY
(THEORY)

Paper 1

2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **all** *questions in section* **A** *and* **six** *questions from section* **B**.

All your answers **must** *be written in the spaces provided.*

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

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

Illustrate your answers with equation(s) 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
4	4½	6	4½	6	5	5	5	6	9	9	9	9	9	9	9	9	100

Turn Over

SECTION A (46 MARKS)

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

1. Complete the following nuclear reaction equations:

(a) $^{30}_{15}P \longrightarrow {}^{30}_{16}S +$ ..... $^{0}_{-1}e$ ..... *(01 mark)*

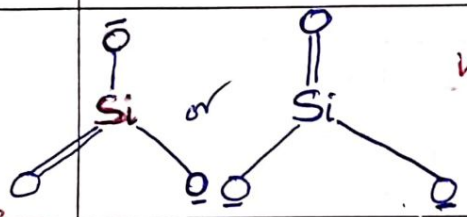
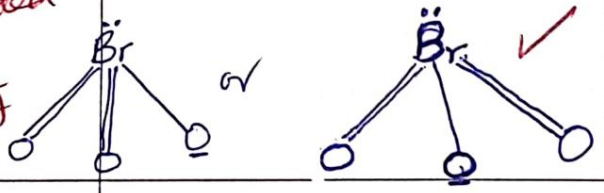
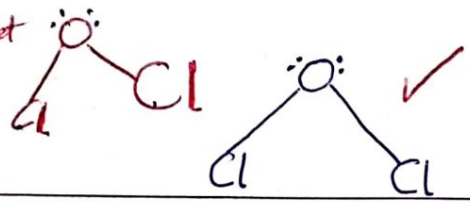
(b) $^{56}_{26}Fe + {}^{2}_{1}H \longrightarrow$ ..... $^{57}_{27}Co$ ..... $+ {}^{1}_{0}n.$ *(01 mark)*

(c) $^{1}_{1}H + {}^{7}_{3}Li \longrightarrow$ ..... $^{8}_{4}Be$ ..... *(01 mark)*

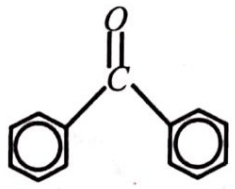
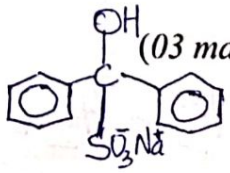
(d) $^{234}_{90}Th \longrightarrow$ ..... $^{234}_{91}Pa$ ..... $+ {}^{0}_{-1}e.$ *(01 mark)*

2. Draw the structure and state the shape of each of the following species in table 1.

Table 1 *(4½ marks)*

Species	Structure	Shape
SiO_3^{2-}		Trigonal planar
BrO_3^-		Trigonal pyramidal
Cl_2O		Bent / Accept V-shaped / reject V-shape

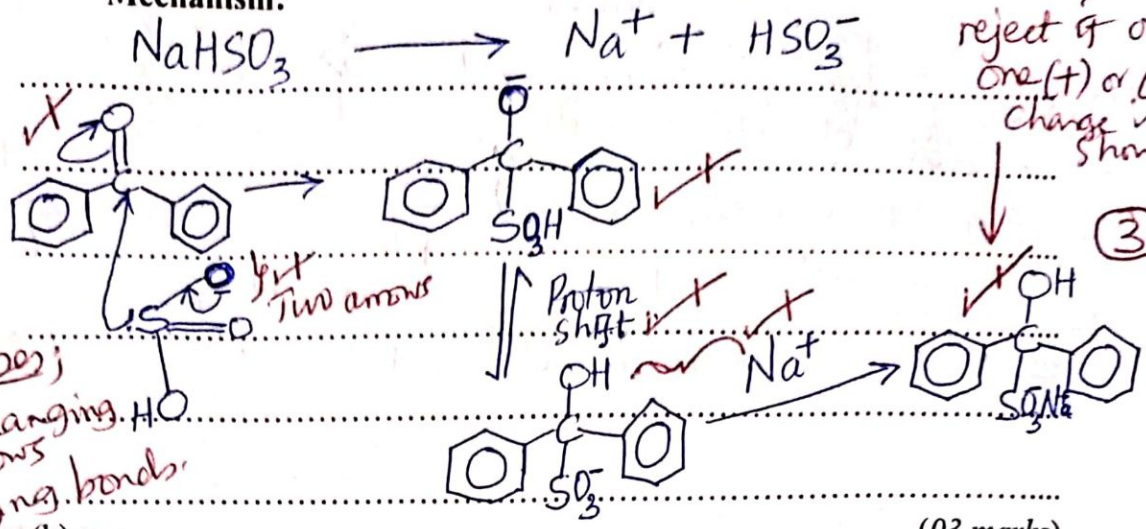
3. Complete the following equations and write a mechanism for the reaction in each case:

(a)  $+ NaHSO_3 \longrightarrow$  *(03 marks)*

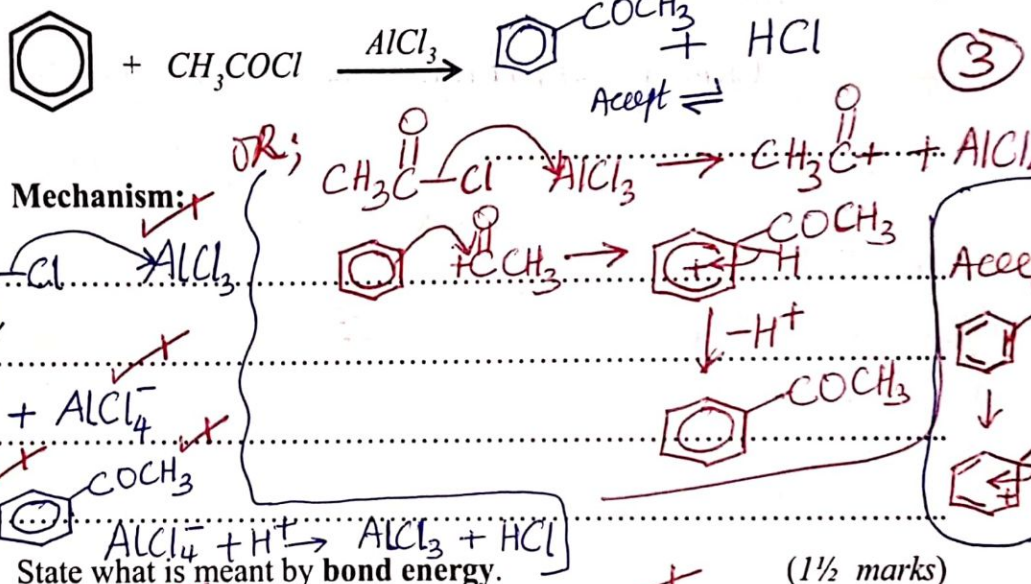
.....

Award with or without charges reject if only one (+) or (-) charge is shown.

Mechanism:



(b) (*03 marks*)



4. (a) State what is meant by **bond energy**. (*1½ marks*)

The heat given out when one mole of a covalent bond of a diatomic molecule is formed from free gaseous atoms. ✓ 1½
or Heat required/absorbed to break one mole of a covalent bond of a diatomic molecule to form free gaseous atoms.

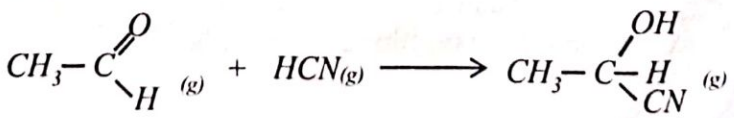
(b) Table 2 shows standard average bond energies for some selected bonds.

reject heat change ✗

Table 2

Bond	C − C	C − O	C − H	H − O	C=O
Average bond energy ($kJmol^{-1}$)	348	360	412	463	743

Use the data in the table to determine the standard enthalpy change of the reaction. (*03 marks*)



reject $\sum$Bonds broken − $\sum$Bonds formed.

$\Delta H_{reaction} = \sum$ Bond enthalpies of bonds broken $-$ $\sum$ Bond enthalpies of bonds formed ✓

ignore (C≡N) bond even if given or not = [Bond enthalpies of 4(C–H) + (C–C) + (C=O) + (C–H) + (C≡N)] − [Bond enthalpies of 4(C–H) + 2(C–C) + C–O) + (O–H) + (C≡N)]

$= [5(412) + 348 + 743 + (C\equiv N)] - [4(412) + 2(348) + 360 + 463 + (C\equiv N)]$ ✓✓

$= 3151 + (C\equiv N) - 3167 - (C\equiv N)$

$= -16\ kJmol^{-1}$ ✓ Emphasize units reject −16 or –16.

5. (a) To a mixture of chromium(III) sulphate solution and excess sodium hydroxide solution, was added hydrogen peroxide solution and the resultant mixture heated.

(i) State what was observed. *(½ mark)* ✓ Block mark

Green solution forms a yellow solution.

Ace: Green solution turns yellow.

(ii) Write an equation for the reaction that took place. *(1½ marks)*

$Cr(OH)_{4(aq)}^{-} + 2\bar{O}H_{(aq)} + 3H_2O_{2(aq)} \rightarrow 2CrO_{4(aq)}^{2-} + 8H_2O_{(l)}$ ✓✓

or $2Cr(OH)_{6(aq)}^{3-} + 3H_2O_{2(aq)} \longrightarrow 2CrO_{4(aq)}^{2-} + 8H_2O_{(l)} + 2\bar{O}H_{(aq)}$

Accept well balanced molecular equation.

(b) The resultant solution in (a) was divided into portions and treated as follows:

(i) To the first portion dilute sulphuric acid was added. State what was observed and write an equation for the reaction that took place.

Observation: *(½ mark)* ✓ Block mark

Yellow solution turned orange. ½

Equation: *(1½ marks)*

$2CrO_{4(aq)}^{2-} + 2H_{(aq)}^{+} \rightarrow Cr_2O_{7(aq)}^{2-} + H_2O_{(l)}$ ✓✓½

or $2Na_2CrO_{4(aq)} + H_2SO_{4(aq)} \rightarrow Na_2Cr_2O_{7(aq)} + H_2O_{(l)} + Na_2SO_{4(aq)}$

(ii) To the second portion, a few drops of lead(II) ethanoate solution was added. State what was observed and write an equation for the reaction that took place.

Observation:

Yellow precipitate ✓ (½ mark) ½

Equation:

$Pb^{2+}_{(aq)} + CrO_4^{2-}{}_{(aq)} \rightarrow PbCrO_4{}_{(s)}$ ✓ (1½ marks) emphasise states

Accept $(CH_3COO)_2Pb_{(aq)} + Na_2CrO_4{}_{(aq)} \rightarrow PbCrO_4{}_{(s)} + 2CH_3COONa_{(aq)}$

6. (a) State what would be observed if benzene was added to water. (*01 mark*)

Two separate layers are formed ✓ (1)

Accept benzene floats on water.

(b) An organic compound **Q** is soluble in both water and benzene.
0.5 moles of **Q** was shaken with a mixture containing 40 cm^3 of water and 20 cm^3 of benzene and the mixture allowed to stand until equilibrium was attained.
(*KD for* **Q** *between benzene and water at 25 °C is 5.*)
Calculate the number of moles of **Q** in the water. (*04 marks*)

$0.5-x$	$20cm^3$ of benzene
x	$40cm^3$ of water

Let the number of moles of Q in water be x ✓

number of moles of Q in benzene $= (0.5-x)$ ✓

$K_D = \frac{[Q]_{in\ benzene}}{[Q]_{in\ water}} = \left(\frac{0.5-x}{20} \div \frac{x}{40}\right) = 5$ ✓

$\frac{(0.5-x)40}{20x} = 5$ ✓

$0.5 - x = 2.5x$

$3.5x = 0.5$

$x = 0.142857$ ✓ Award with or without units.

(4)

0.142857 moles of Q remain in water

reject ( )

7. (a) Propylamine is a weak base.

Write an;

(i) equation for the dissolution of propylamine in water. (*1½ marks*)

$CH_3CH_2CH_2NH_{2(aq)} + H_2O_{(l)} \rightleftharpoons CH_3CH_2CH_2\overset{+}{N}H_{3(aq)} + \overset{-}{O}H_{(aq)}$ ✓ ✓ ½ for →

reject $CH_3CH_2CH_2\overset{+}{N}H_3\overset{-}{O}H \rightleftharpoons CH_3CH_2CH_2\overset{+}{N}H_3 + \overset{-}{O}H$

(ii) expression for the base dissociation constant, K_b for propylamine. *(01 mark)*

$K_b = \dfrac{[CH_3CH_2CH_2\overset{+}{N}H_3][\bar{O}H]}{[CH_3CH_2CH_2NH_2]}$ ✓

Acc $K_a = c\alpha^2$

(b) Determine the degree of dissociation of a 0.1 M propylamine solution. (K_b *for propylamine* 6.918×10^{-4}) *(2½ marks)*

Assumptions; at equilibrium;

$[\bar{O}H] = [CH_3CH_2CH_2\overset{+}{N}H_3]$ ✓

$[CH_3CH_2CH_2NH_2] = 0.1\,M$ ✓

$K_b = \dfrac{[\bar{O}H]^2}{0.1} = 6.918 \times 10^{-4}$ ✓

$[\bar{O}H] = \sqrt{0.1 \times 6.918 \times 10^{-4}}$ ✓

$[\bar{O}H] = 8.317452 \times 10^{-3}\ mol\,dm^{-3}$ (2½) ✓

But $[\bar{O}H] = c\alpha$ ✓

$\alpha = \dfrac{[\bar{O}H]}{c} = \dfrac{8.317452 \times 10^{-3}}{0.1} = 0.0832$ ✓

Acc a value in range (0.0798 – 0.0832)

OR

$K_b = \dfrac{c\alpha^2}{1-\alpha} = 6.918 \times 10^{-4}$

$0.1\alpha^2 = 6.918 \times 10^{-4}(1-\alpha)$

$0.1\alpha^2 + 6.918 \times 10^{-4}\alpha - 6.918 \times 10^{-4}$

$\alpha = \dfrac{-6.918 \times 10^{-4} \pm \sqrt{(6.918 \times 10^{-4})^2 - 4 \times 0.1 \times -6.918 \times 10^{-4}}}{2 \times 0.1}$

$\alpha = 0.0798$ or -0.0867

But $\alpha \neq$ a negative value

$\alpha = 0.0798$

8. The industrial reaction in which sulphur dioxide is converted into sulphur trioxide in the contact process is reversible and exothermic.

(a) Write equation to illustrate the reaction. *(02 marks)*

$SO_{2(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons SO_{3(g)}$ ✓ ✓ ΔH = negative value. ✓

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

(b) Giving reason(s) in each case, state the effect on the equilibrium position of the reaction in (a) if;

(i) the temperature was increased. *(1½ marks)*

Equilibrium position shifts to the left ✓ because backward reaction which is endothermic is favoured ✓ ½

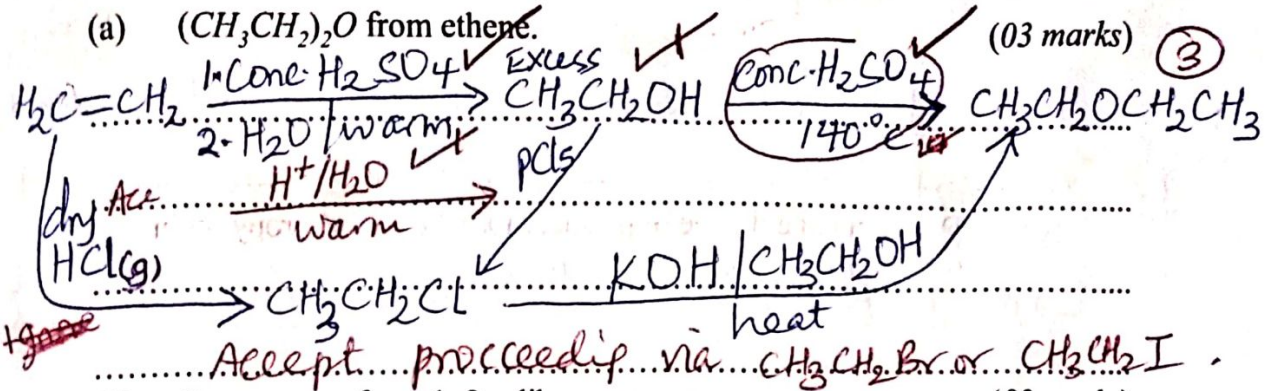
(ii) helium was added to the reaction mixture at constant volume. *(1½ marks)*

Equilibrium position is not ✓ affected because the inert gas added increases the total pressure ✓ of the system ✓ but there is no change in partial pressures/concentrations of reactants/products. ½

reject

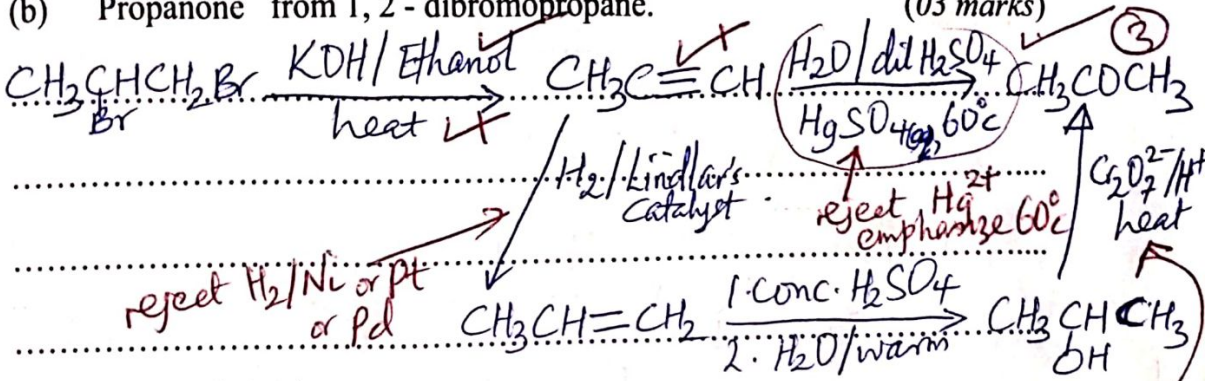
9. Write equations to show how the following compounds can be synthesized:

(a) $(CH_3CH_2)_2O$ from ethene. *(03 marks)* (3)



Accept proceeding via CH_3CH_2Br or CH_3CH_2I.

(b) Propanone from 1, 2 - dibromopropane. *(03 marks)* (3)



Acc. $H_2S/MnO_4^-/H^+$
$H_2S/CrO_3/H^+$
MnO_2/H^+

SECTION B (54 MARKS)

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

10. Nitrogen reacts with hydrogen according to the following equation:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

(a) State the condition(s) that favour formation of ammonia. *(1½ marks)*

Finely divided iron catalyst ✓ reject catalyst.
Temperature of about 500°C ✓ Acc. (450 – 550°C) reject low temperature
Pressure between 200 – 1000 atm ✓ Acc. (150 – 350 atm) reject Accept high pressure (1½)

(b) Write equation(s) to show how ammonia can be converted to nitric acid. *(4½ marks)*

$2NH_3(g) + \frac{5}{2}O_2(g) \longrightarrow 2NO(g) + 3H_2O(l)$ ✓✓
$NO(g) + \frac{1}{2}O_2(g) \longrightarrow NO_2(g)$ ✓✓
$2NO_2(g) + \frac{1}{2}O_2(g) + H_2O(l) \longrightarrow 2HNO_3(aq)$ ✓✓ reject (l)

4½

Acc. $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$
$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$
$4NO_2(g) + O_2(g) + 2H_2O(l) \rightarrow 4HNO_3(aq)$

Turn Over

(c) Write an equation for the reaction between tin and

(i) cold dilute nitric acid. *(1½ marks)*

$4Sn(s) + 10H^+(aq) + NO_3^-(aq) \rightarrow 4Sn^{2+}(aq) + NH_4^+(aq) + 3H_2O(l)$

or $4Sn(s) + 10HNO_3(aq) \rightarrow 4Sn(NO_3)_2(aq) + NH_4NO_3(aq) + 3H_2O(l)$

(ii) hot concentrated nitric acid. *(1½ marks)*

$Sn(s) + 4HNO_3(aq) \rightarrow SnO_2(s) + 4NO_2(g) + 2H_2O(l)$.

.....

11. Ethylbromide reacts with aqueous sodium hydroxide solution according to the following equation:

$$CH_3CH_2Br + NaOH_{(aq)} \xrightarrow{heat} CH_3CH_2OH + NaBr_{(aq)}$$

(a) Write the mechanism for the reaction. *(02 marks)*

$NaOH(aq) \rightarrow Na^+(aq) + \bar{O}H(aq)$

$\bar{O}H + CH_3CH_2Br \rightarrow CH_3CH_2OH + Br^-$ (2)

$Na^+ + Br^- \rightarrow NaBr$.

Accept; $\bar{O}H + CH_3CH_2Br \underset{\text{fast}}{\overset{\text{slow}}{\rightleftharpoons}} [HO\cdots CH_2\cdots Br]^- \rightarrow CH_3CH_2OH + Br^-$

(b) Name the type of mechanism in (a). *(01 mark)*

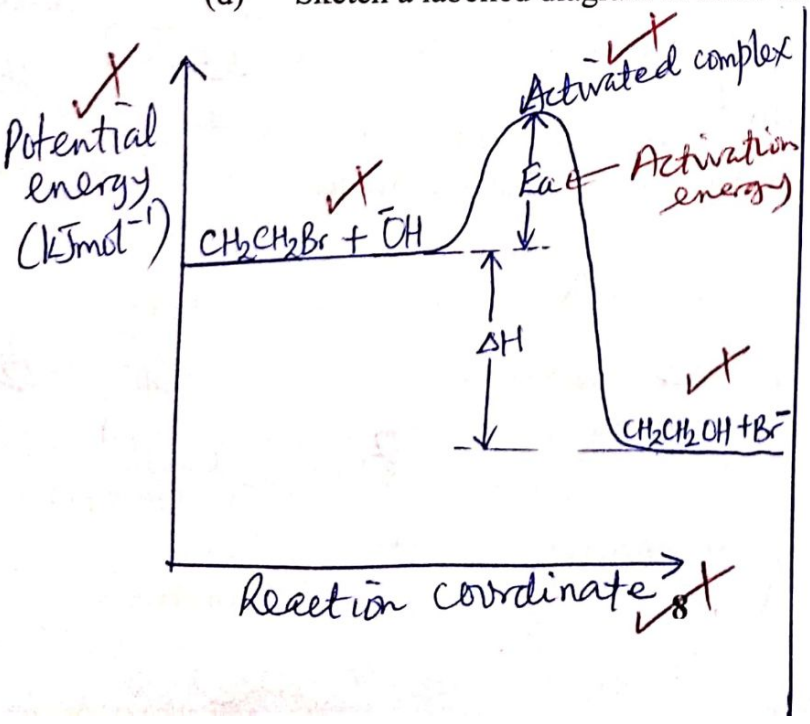
Nucleophilic substitution bimolecular. (3 words)

(c) Write the rate equation for the reaction. *(01 mark)*

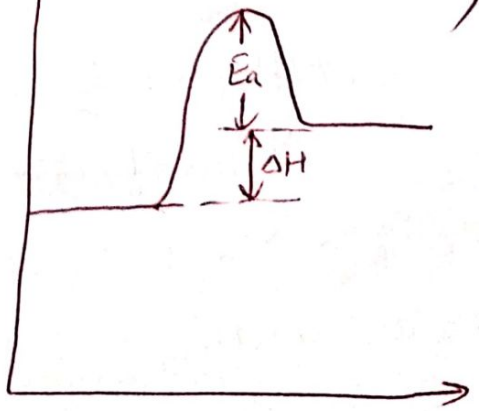
$Rate = k[CH_3CH_2Br][\bar{O}H]$ reject ( ) emphasize [ ]

reject ~~Rate~~ $\propto$, reject $Rate = k[CH_3CH_2Br][NaOH]$

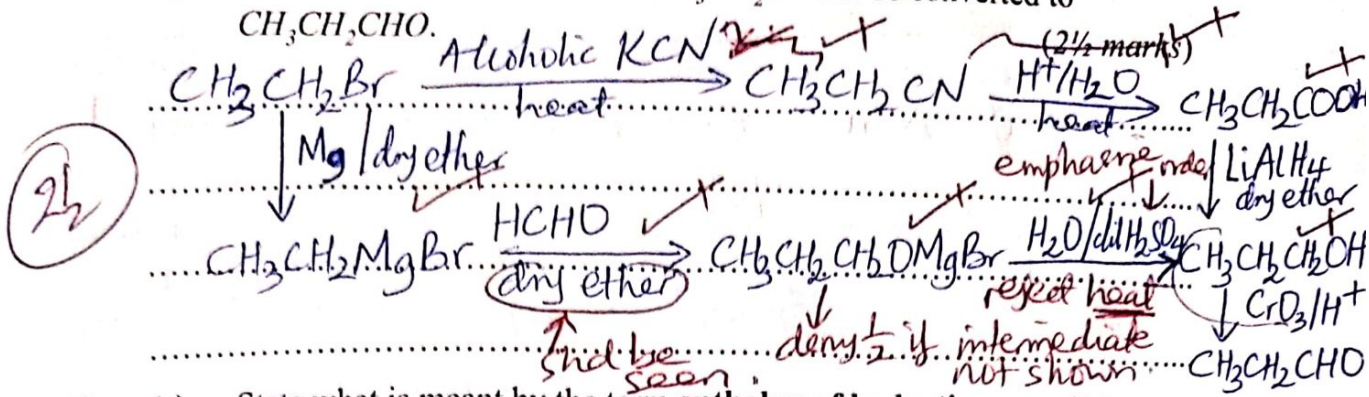
(d) Sketch a labelled diagram to show an energy profile for the reaction. *(2½ marks)*



Accept; since heat is shown on arrow;



(e) Write equations to show how CH_3CH_2Br can be converted to CH_3CH_2CHO.



12. (a) State what is meant by the term **enthalpy of hydration.** *(01 mark)*

reject heat change / reject ions or gaseous ion

Heat evolved when one mole of gaseous ions is completely surrounded by water molecules to form an infinitely dilute solution (with no change in pH).

(b) The hydration energies of barium and chloride ions are -1275 kJ mol^{-1} and -394 kJ mol^{-1} respectively and the lattice energy of barium chloride is -2056 kJ mol^{-1}.

Calculate the;

(i) hydration energy of barium chloride. *(1½ marks)*

$\Delta H_{hydration} = (\Delta H_{hydration\ of\ Ba^{2+}}) + 2(\Delta H_{hydration\ of\ Cl^-})$

$= -1275 + 2(-394) = -2063$ kJ mol^{-1}

(ii) heat of solution of barium chloride. *(1½ marks)*

reject without units

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

$= -2063 + 2056 = -7$ kJ mol^{-1}

reject super or subscripts

(c) (i) State **two** factors that can affect the magnitude of enthalpy of hydration. *(01 mark)*

Ionic charge

Ionic radius

(ii) Explain how the factors you have stated in (c) (i) affect the enthalpy of hydration. *(04 marks)*

The higher the ionic charge, the higher (more negative) the hydration energy because of the strong attraction for water molecules by ions

The smaller the ionic radius, the higher the hydration energy due to strong attraction of water molecules by the ions. (4)

Accept opposite phasing; The lower - - - - The higher - - -

13. (a) A compound **J** contains 19.1% nitrogen, 43.6% oxygen by mass, the rest being manganese.

(i) Calculate the empirical formula of **J**. *(2½ marks)*

% of Mn = 100 − 19·1 − 43·6 = 37·3 ✓+

Elements	Mn	N	O
moles	$\frac{37.3}{54.9}$	$\frac{19.1}{14}$	$\frac{43.6}{16}$ ✓+
Simplest mole ratio	$\frac{0.6794}{0.6794}$:	$\frac{1.3643}{0.6794}$:	$\frac{2.725}{0.6794}$ ✓+
	1 :	2 :	4 ✓+

Empirical formula is MnN_2O_4. ✓+ (2½)

reject $Mn(NO_2)_2$ ✗

(ii) 10 g of **J** in 1000 g of water lowered the freezing point of water by 0.127 °C. Determine the molecular formula of **J**.
(K_f *for water* = 1.86 °C mol^{-1} kg^{-1}) *(02 marks)*

1000 g of H_2O dissolve 10 g of J.

0·127°c is freezing point depression caused by 10 g of J.

1·86°c is freezing point depression caused by $\left(\frac{1.86 \times 10}{0.127}\right)$

= 146·45669

≅ 146·46g. ✓+

$(MnN_2O_4)n = 146.46.$

$[54.9 + (2\times14) + (4\times16)]n = 146.46$ ✓+

$\frac{146.9n}{146.9} = \frac{146.46}{146.9}$ (2)

$n = 0.997 \cong 1$ ✓+

10 Molecular formula is MnN_2O_4 ✓+

reject $Mn(NO_2)_2$

(b) When a few drops of concentrated nitric acid were added to a solution of **J**, followed by a little lead(IV) oxide and the mixture boiled, a purple coloured solution was formed.

Write the;

(i) formula and name of **J**. (*01 mark*)

Formula:

reject MnN_2O_4

$Mn(NO_2)_2$ ✓ ½

Name:

Manganese(II) nitrite ✓ ½

reject manganese nitrite

reject ii, II

(ii) equation for the reaction leading to formation of the purple coloured solution. (*1½ marks*)

$5PbO_{2(s)} + 2Mn^{2+}_{(aq)} + 4H^+_{(aq)} \rightarrow 5Pb^{2+}_{(aq)} + 2MnO^-_{4(aq)} + 2H_2O_{(l)}$ ✓✓

(c) A few drops of aqueous sodium carbonate was added to a solution of **J**.

(i) State what was observed. (*½ mark*)

~~Pink solution~~

A white precipitate ✓

(ii) Write an equation for the reaction that took place. (*1½ marks*)

$Mn^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow MnCO_{3(s)}$ ✓✓

except $2Mn^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} + 2OH^-_{(aq)} \rightarrow MnCO_3 \cdot Mn(OH)_{2(s)}$

14. Name a reagent that can be used to distinguish between each of the following pairs of compounds. In each case state what would be observed if each member of the pair was separately treated with the reagent you have named.

(a) C_6H_5CHO and CH_3CHO. (*03 marks*)

Reagent; Iodine solution and aqueous sodium hydroxide solution ✓

C_6H_5CHO — No observable change ✓

Age - no yellow precipitate

CH_3CHO — Yellow precipitate on warming ✓

emphasize warming

OR; Fehling's solution

C_6H_5CHO — No observable change

CH_3CHO — Reddish-brown precipitate on warming

must be seen → reject red/brown precipitate.

3

Note: In all 3 cases 14(a), (b), (c)

— Physical states, spellings, conditions for reagent(s) must be correct to award.

— Deny marks for observations if reagent not correct

reject acidified potassium permanganate solution
or " " dichromate "
or bromine water / liquid bromine

(b) $CH_3CH_2C\equiv CH$ and $CH_3CH_2CH=CH_2$. (03 marks)

Reagent; Ammoniacal silver nitrate solution.

$CH_3CH_2C\equiv CH$ — White precipitate (3)

Acc. white ppt

$CH_3CH_2CH=CH_2$ — No observable change

Accept ammoniacal copper(I) chloride solution.

$CH_3CH_2C\equiv CH$ — red precipitate

$CH_3CH_2CH=CH_2$ — no observable change

(c) CH_3CHCH_2OH and $CH_3CHCH_2CH_3$. (03 marks)

CH_3 OH

reject Zinc(II) chloride

Accept Lucas reagent

reject an hydrous / anhydrous

reject zinc chloride solution

Reagent; Anhydrous Zinc chloride and concentrated hydrochloric acid.

reject any other reagent

CH_3CHCH_2OH — No observable change at room temperature must be seen.

CH_3

reject cloudiness / turbid

$CH_3CHCH_2CH_3$ — Cloudy solution formed between within 5 minutes. (3)

OH

Accept iodine solution and aqueous sodium hydroxide solution

15. (a) Briefly explain what is meant by the term **basic buffer**. (*02 marks*)

A solution made by mixing a weak base and a salt of the weak base with a strong acid that resists changes in pH when a small amount of acid or alkali is added to it or on a little dilution

emphasize small

(b) 500 cm^3 of a 1 M solution of ammonia was mixed with 500 cm^3 of a 1 M ammonium chloride solution.

Calculate the ***pH*** of the resultant solution. (*05 marks*)

(***pK_b*** *of ammonia solution = 4.74*)

Moles of NH_3 (aq) $= \left(\frac{500\times1}{1000}\right) = 0.5$

Moles of $NH_4Cl = \left(\frac{500\times1}{1000}\right) = 0.5$

Total volume of solution $= 500+500 = 1000\,cm^3$

$[NH_3(aq)] = \left(\frac{1000}{1000}\times 0.5\right) = 0.5\,M$

$[NH_4Cl(aq)] = \left(\frac{1000}{1000}\times 0.5\right) = 0.5\,M$

$pOH = pK_b + \log\frac{[NH_4Cl]}{[NH_3(aq)]}$

$pOH = 4.74 + \log\left(\frac{0.5}{0.5}\right)$

$pOH = 4.74$

$pH = pKw - pOH = 14 - 4.74$

$pH = 9.26$ (5)

Acc; From $pK_b = 4.74 \Rightarrow K_b =$

$pK_b = -\log_{10} K_b = 4.74$

$K_b = 10^{-4.74} = 1.8197 \times 10^{-5}$ moldm^{-3}. Award accordingly.

$[OH^-] = K_b \frac{[NH_3]}{[NH_4Cl]} = 1.8197 \times 10^{-5} \times \frac{0.5}{0.5} = 1.8197 \times 10^{-5}$ M.

From $K_w = [H^+][OH^-] \Rightarrow [H^+] = \frac{K_w}{[OH^-]} = \frac{1 \times 10^{-14}}{1.8197 \times 10^{-5}} = 5.945 \times 10^{-10}$ M.

$pH = -\log_{10}[H^+] = -\log_{10}(5.94 \times 10^{-10}) = 9.26$.

(c) Two drops of dilute sodium hydroxide solution were added to the resultant solution in (b). State what happened to the ***pH*** of the solution. Give a reason for your answer. *(02 marks)*

pH remained (almost) constant / the same / unchanged
Hydroxide ions from the sodium hydroxide added react with ammonium ions in the solution to form ammonia molecules and water, resisting an increase in pH. (2)

Accept any correct physical / periodic and chemical properties

16. (a) State **three** properties in which cobalt differs from calcium. *(1½ marks)*

- Cobalt exhibits variable oxidation states in its compound unlike Calcium which has only the +2 oxidation state
- Cobalt forms coloured compounds unlike Calcium compounds which are usually white
- Cobalt forms complexes unlike calcium.
- Cobalt only reacts with steam but Calcium can react with cold water.

(b) To an aqueous solution containing cobalt(II) ions was added concentrated hydrochloric acid dropwise until in excess.

Name the cobalt species present in the solution;

(i) before addition of hydrochloric acid. *(½ mark)*

Hexaaquacobalt(II) ions

reject spaced names e.g Hexa aqua Co – –
reject formulae
reject Tetra – – – –

(ii) after addition of excess hydrochloric acid. *(½ mark)*

Tetrachlorocobaltate(II) ions

space shd only be btn (II) and ion.
reject Hexa – – – –

- Calcium reacts slowly with dilute sulphuric acid and reaction stops but cobalt reacts faster.
- ~~Cobalt is rendered passive by concentrated~~ etc.

(c) Concentrated ammonia solution was added dropwise until in excess to a solution containing cobalt(II) ions and the mixture allowed to stand.

(i) State what was observed. (02 marks)

(Pink solution formed a) blue precipitate soluble in excess to form a brown solution that turns red on standing. (2)

(ii) Write equation(s) for the reactions that took place. (4½ marks)

$Co^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Co(OH)_{2(s)}$

$Co(OH)_{2(s)} + 6NH_{3(aq)} \rightarrow Co(NH_3)^{2+}_{6(aq)} + 2OH^-_{(aq)}$

$Co(NH_3)^{2+}_{6(aq)} \rightarrow Co(NH_3)^{3+}_{6(aq)} + e^-$

17. (a) A 2% solution of a monomer, **M** has the same osmotic pressure as 11.6 cm^3 of a solution containing 1.65 g of a polymer of molecular mass 1040 at 298 K.

Calculate the relative molecular mass of **M**. (03 marks)

For the polymer;

$\pi V = \frac{m}{Mr} RT$

$\Rightarrow \pi = \frac{mRT}{MrV} = \frac{1.65 \times 8.31 \times 298}{1040 \times 11.6 \times 10^{-6}} = 338695.872\ Pa$

For the monomer;

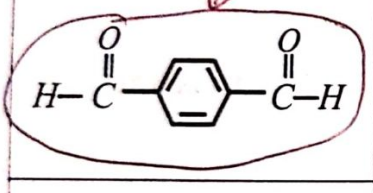
$\pi V = \frac{m}{RFM} RT$

$RFM = \frac{mRT}{\pi V} = \frac{2 \times 8.31 \times 298}{338695.872 \times 100 \times 10^{-6}}$ (3)

$RFM = 146.23$

(b) The structural formulae of some monomers are shown in the table 3. Complete the table by writing in the spaces provided; the structural formula of the polymers formed, type of polymerisation and **one** use of each polymer.

Table 3 *(06 marks)*

Structural formula of monomer (s)	**Structural formula of polymer**	**Type of Polymerisation**	**Use of Polymer**
(i) $CH_2=C(CH_3)-CH=CH_2$	$-[CH_2C(CH_3)=CHCH_2]_n-$ ✓	Addition ✓ reject additional	Making golf balls, Car tyres, Shoe soles, water proof boots, hoses and gaskets, etc (3) Any one
(ii) $HOCH_2CH_2OH$ + wrong monomer 	Suggestion; marks transfered to (c)(i) and (c)(ii)		
(iii) $CH_2=CH-CN$ Orlon or Poly(propenonitrile) or Polyacrylonitrile	$-[CH_2CH(CN)]_n-$ ✓	Addition ✓ reject additional	Making clothes, ✓ blankets or Carpets. (3)