Candidate's Name: MUNICEL 2022 GUIDE

Signature: .....

Random No.	Personal No.
0782 0752	792750

(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	6½	4	6	5	5	5	6	9	9	9	9	9	9	9	9	100

SECTION A (46 MARKS)

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

1. Complete the following nuclear reaction equations:

- Symbols should be correct
- Atomic masses
- Atomic Numbers.

β without figures eg: $^{0}_{-1}\beta$

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

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

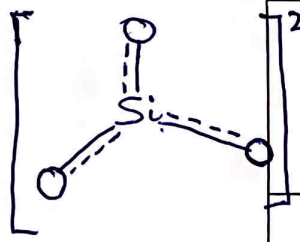
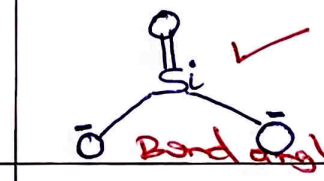
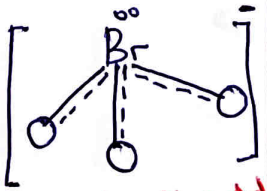
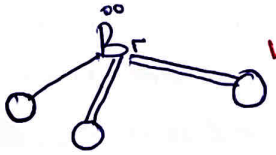
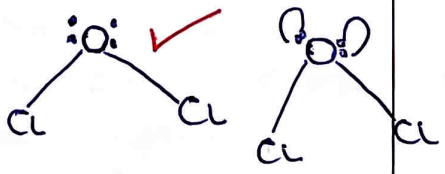
(c) $^{1}_{1}H + {}^{7}_{3}Li \longrightarrow \ldots {}^{8}_{4}Be \ldots$ eg: $2\,{}^{4}_{2}He$ or 2α *(01 mark)*

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

04

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

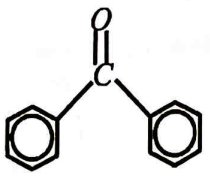
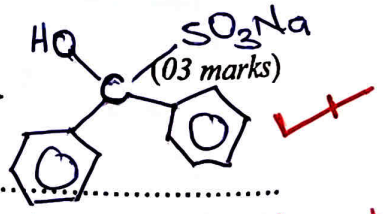
Table 1 *(4½ marks)*

Species	Structure	Shape
SiO_3^{2-}	 	Trigonal planar ✓ eg curved bonds
BrO_3^-	 	Trigonal Pyramidal ✓ - eg wrong shapes - eg wrong symbols
Cl_2O		Bent or V-shaped ✓ Name is awarded for correct structure

- Bonds should touch or nearly near the atoms.

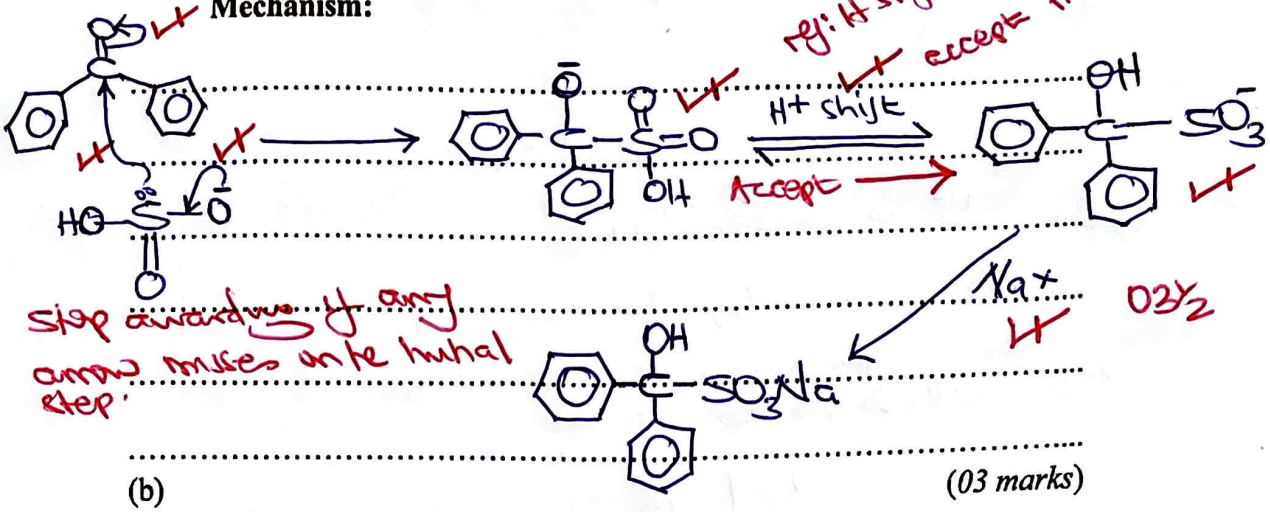
04½

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

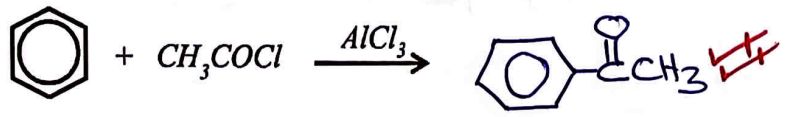
(a)  $+ NaHSO_3 \longrightarrow$  *(03 marks)*

(Award if it is similar to the products in the mechanism)

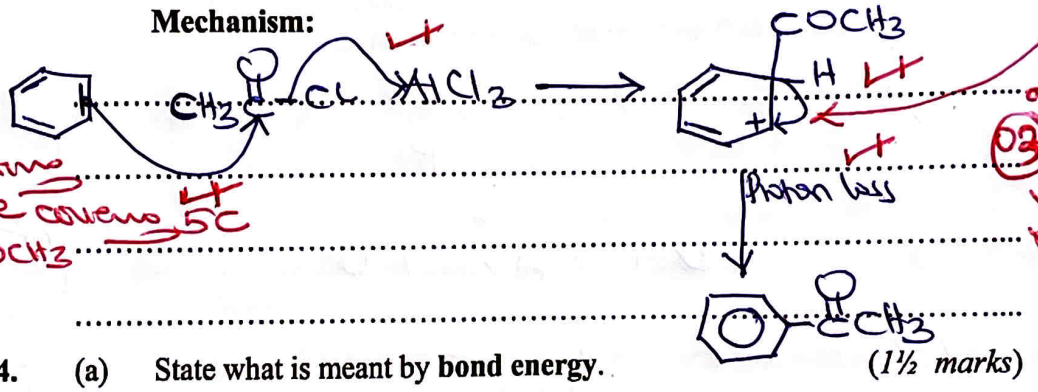
Mechanism:



(b) (03 marks)



Mechanism:



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

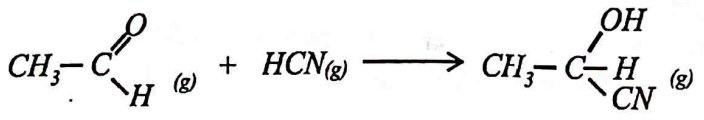
Amount of heat evolved when one mole of covalent bonds is formed from its free gaseous atoms.

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

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)



$\Delta H_{reaction} = \Sigma BE$ of bonds broken $+ \Sigma BE$ of bonds formed ✓

$= (+743 + 412) + (-360 - 463 - 348)$ ✓

$= -16 kJ mol^{-1}$ ✓ (03)

Accept alternative approaches eg Born Haber cycle.

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)

½ mark tied to both observations

green solution turned yellow ✓+

$2CrO_2^-(aq) + 3H_2O_2(aq) + 2OH^-(aq) \rightarrow 2CrO_4^{2-}(aq) + 4H_2O(l)$

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

$2Cr^{3+}(aq) + 10OH^-(aq) + 3H_2O_2(aq) \rightarrow 2CrO_4^{2-}(aq) + 8H_2O(l)$ ✓+ (1½)

$2Cr(OH)_4^-(aq) + 2OH^-(aq) + 3H_2O_2(aq) \rightarrow 2CrO_4^{2-}(aq) + 8H_2O(l)$

$2Cr(OH)_6^{3-}(aq) + 3H_2O_2(aq) \rightarrow 2CrO_4^{2-}(aq) + 2OH^-(aq) + 8H_2O(l)$

- Symbols
- Balancing
- State symbols

(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)

yellow solution turned orange ✓+ ½ both observations

Equation: (1½ marks)

$2CrO_4^{2-}(aq) + 2H^+(aq) \rightarrow Cr_2O_7^{2-}(aq) + H_2O(l)$ ✓+ 1½

$2CrO_4^{2-}(aq) + H_2SO_4(aq) \rightarrow Cr_2O_7^{2-}(aq) + H_2O(l) + SO_4^{2-}(aq)$

(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: *(½ mark)*

Yellow precipitate formed ✓ Allow ppt / solid

Equation: *(1½ marks)*

$Pb^{2+}_{(aq)} + CrO_{4(aq)}^{2-} \longrightarrow PbCrO_{4(s)}$ ✓✓

$Pb(CH_3COO)_{2(aq)} + CrO_{4(aq)}^{2-} \longrightarrow PbCrO_{4(s)} + 2CH_3COO^-_{(aq)}$ [06]

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

Two layers formed ✓(1)

Allow: Two liquid layers.

(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)*

Let moles of Q in benzene be x

$[Q]_{in\ H_2O} = \frac{0.5-x}{40}$ ✓ $[Q]_{in\ benzene} = x/20$ ✓

$K_D = \frac{[Q]_{in\ benzene}}{[Q]_{in\ water}}$ ✓

$5 = \frac{x/20}{0.5-x/40}$ ✓

$0 = x$

$5 = \frac{40x}{20(0.5-x)}$ ✓

$x = 0.357$ ✓ accept 0.36

Moles of Q in water $= (0.5 - 0.357)$ ✓

$= 0.143$ moles ✓

Accept 0.14

[05]

Accept $K_D = \frac{[Q]_{H_2O}}{[Q]_{benzene}} = \frac{1}{5}$

7. (a) Propylamine is a weak base.

Write an;

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

$CH_3CH_2CH_2NH_{2(g)} + H_2O_{(l)} \rightleftharpoons CH_3CH_2CH_2\overset{+}{N}H_{3(g)} + \bar{O}H_{(aq)}$ ✓✓

$C_3H_7NH_{2(g)} + H_2O_{(l)} \rightleftharpoons C_3H_7\overset{+}{N}H_{3(g)} + \bar{O}H_{(aq)}$

reversible sign missing deduct ½ mark

Accept: $K_b = \frac{[OH]^2}{c}$

$[OH] = \sqrt{6.918 \times 10^{-4} \times 0.1}$; $[OH] = 8.317 \times 10^{-3}$ M

$[OH] = c\alpha$; $\alpha = \left(\frac{8.317 \times 10^{-3}}{0.1}\right) = 0.0832$

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

$K_b = \frac{[CH_3CH_2CH_2\overset{+}{N}H_3][\bar{O}H]}{[CH_3CH_2CH_2NH_2]}$ ✓ (1)

tied to a(i) rej y a(i) wrong

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

Accept $K_b = \alpha^2 c$

$\alpha = \sqrt{\frac{K_b}{c}}$ ✓

$K_b = \frac{\alpha^2 c}{1-\alpha}$ ✓ ∴ $6.918 \times 10^{-4} = \frac{0.1\alpha^2}{1-\alpha}$ ✓

$0.1\alpha^2 + 6.918 \times 10^{-4}\alpha - 6.918 \times 10^{-4} = 0$ (2½)

$\alpha = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ ✓

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

$= 0.0799$ or 0.08 ✓

$= 0.0832$ [05]

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)*

$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ ✓ ✓ $\Delta H = -ve$ ✓

Balanced ✓ deduct ½ if ⇌ missing ✓ must be written before awarding.

(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 shifts from right to left ✓ because the forward reaction is exothermic ✓ or because the backward reaction is endothermic ✓

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

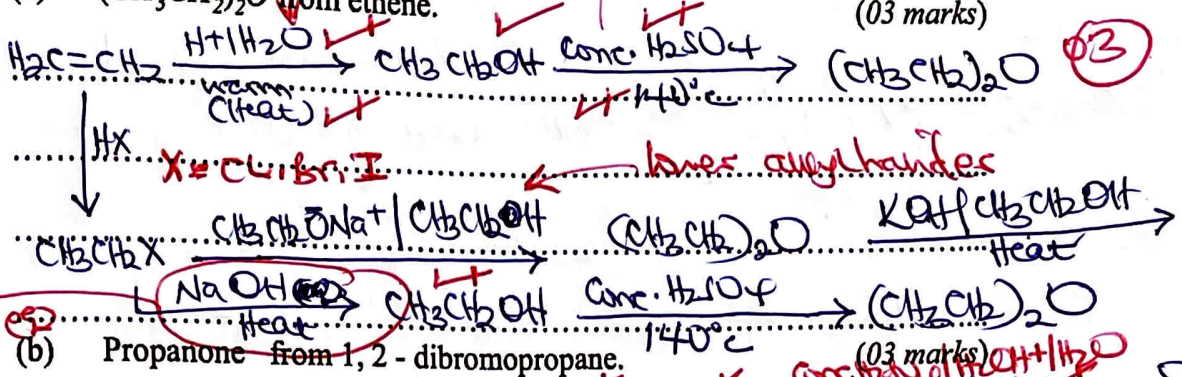
Addition of helium at constant volume increases the pressure ✓ hence equilibrium shifts from left to right ✓ because the forward reaction is accompanied by a decrease in ✓ Volume (or decrease in number of moles)

rej: Partial pressure

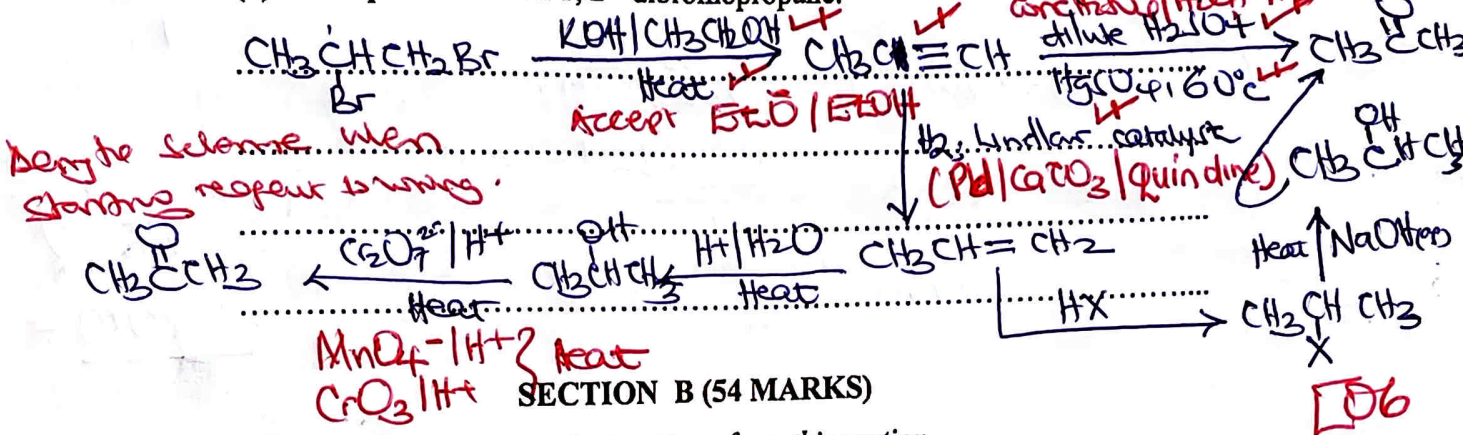
[05]

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

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



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



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:

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

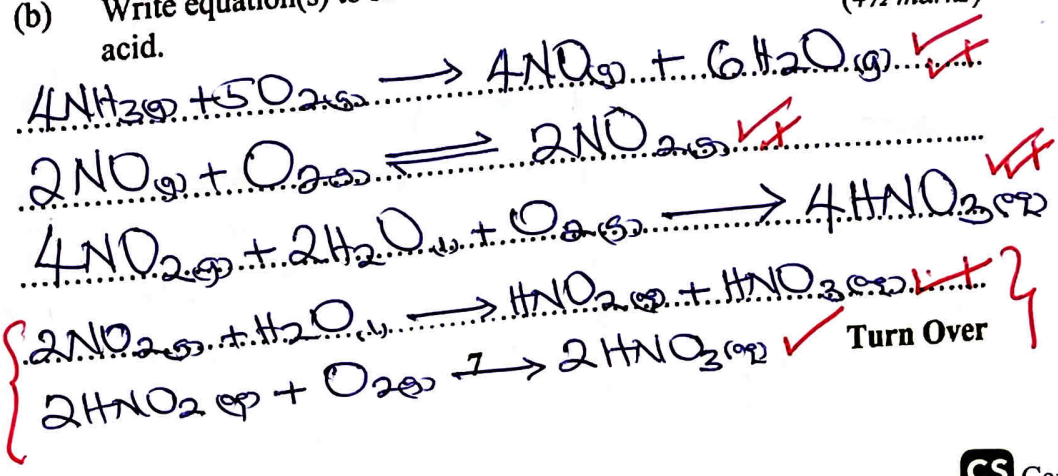
(a) State the condition(s) that favour formation of ammonia. *(1½ marks)*

iron catalyst ✓+

high pressure or 200 - 1000 Atmosphere ✓+

Low temperature or 450 - 500°C ✓+

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



Turn Over

$4Sn_{(s)} + 10H^+_{(aq)} + NO_3^-{}_{(aq)} \longrightarrow 4Sn^{2+}_{(aq)} + NH_4^+{}_{(aq)} + 3H_2O_{(l)}$

$3Sn_{(s)} + 8H^+_{(aq)} + 2NO_3^-{}_{(aq)} \longrightarrow 3Sn^{2+}_{(aq)} + 2NO_{(g)} + 4H_2O_{(l)}$

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

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

$4Sn_{(s)} + 10HNO_{3(aq)} \longrightarrow 4Sn(NO_3)_{2(aq)} + NH_4NO_{3(aq)} + 3H_2O_{(l)}$

$3Sn_{(s)} + 8HNO_{3(aq)} \longrightarrow 3Sn(NO_3)_{2(aq)} + 2NO_{(g)} + 4H_2O_{(l)}$

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

$Sn_{(s)} + 4HNO_{3(aq)} \longrightarrow SnO_{2(s)} + 4NO_{2(g)} + 2H_2O_{(l)}$

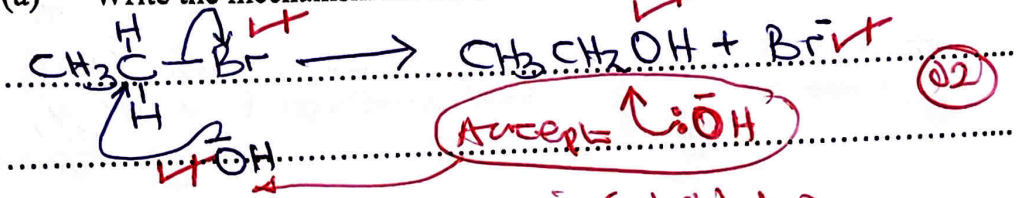
$Sn_{(s)} + 4HNO_{3(aq)} \longrightarrow SnO_2 \cdot 2H_2O_{(s)} + 4NO_{2(g)}$

$Sn_{(s)} + 4H^+_{(aq)} + 4NO_3^-{}_{(aq)} \longrightarrow SnO_{2(s)} + 4NO_{2(g)} + 2H_2O_{(l)}$

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)*



Accept: Bimolecular nucleophilic substitution

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

Substitution nucleophilic bimolecular

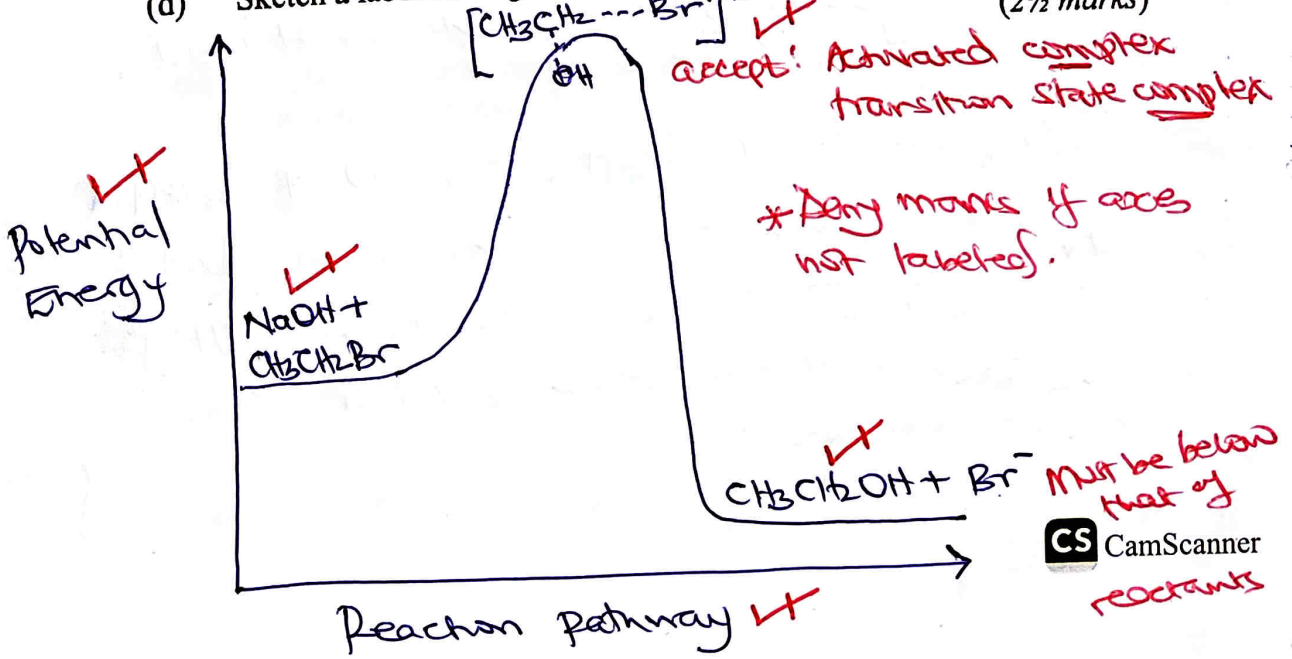
Accept: Nucleophilic substitution bimolecular

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

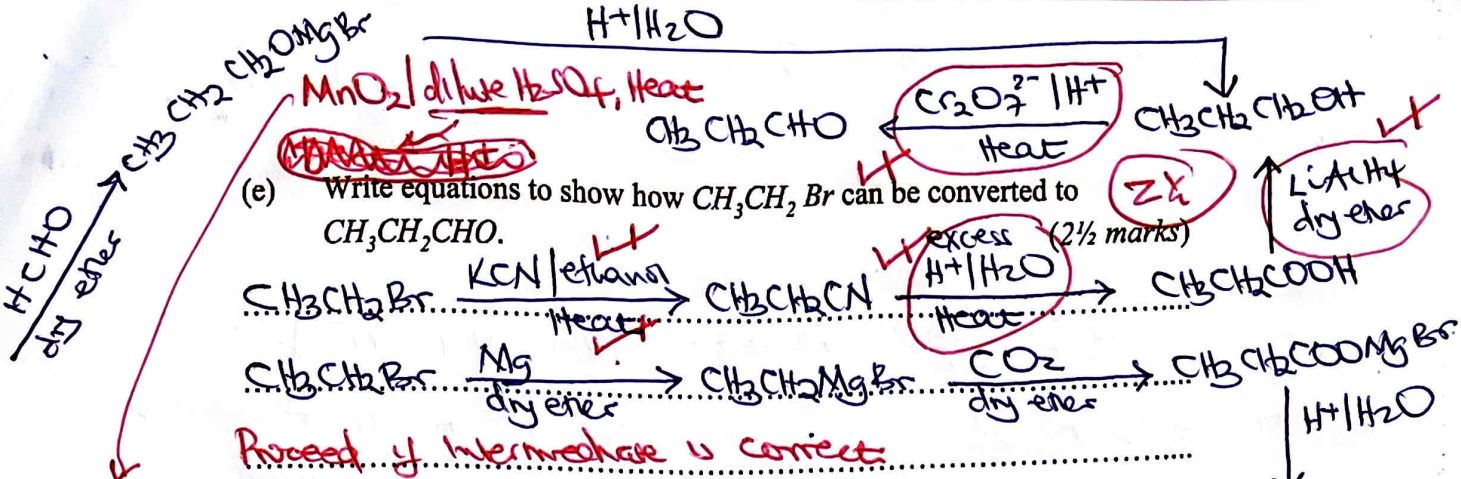
$Rate = K[CH_3CH_2Br][NaOH]$

Accept: $Rate = K[CH_3CH_2Br][\bar{O}H]$

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



*Deny marks if axes not labeled.



(e) Write equations to show how CH_3CH_2Br can be converted to CH_3CH_2CHO. *(2½ marks)*

$CH_3CH_2Br \xrightarrow[\text{Heat}]{KCN/\text{ethanol}} CH_3CH_2CN \xrightarrow[\text{Heat}]{\text{excess } H^+/H_2O} CH_3CH_2COOH$

$CH_3CH_2Br \xrightarrow[\text{dry ether}]{Mg} CH_3CH_2MgBr \xrightarrow[\text{dry ether}]{CO_2} CH_3CH_2COOMgBr \xrightarrow{H^+/H_2O} CH_3CH_2COOH$

Accept: CrO_3/H^+ CuO, 300-500°C

Proceed if intermediate is correct

$CH_3CH_2CHO \xleftarrow[\text{Heat}]{Cr_2O_7^{2-}/H^+} CH_3CH_2CH_2OH \xleftarrow[\text{dry ether}]{LiAlH_4} CH_3CH_2COOH$

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

Heat given out when one mole of gaseous ions are surrounded by water molecules (i)

Accept: Heat change, Enthalpy change

(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)*

$\Delta H_{hyd}BaCl_2 = \Delta H_{hyd}Ba^{2+} + 2\Delta H_{hyd}Cl^-$ (1½)

$= -1275 + (2 \times -394)$

$= -2063$ kJ mol^{-1}

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

$\Delta H_{solution} = \Delta H_{hydration}(BaCl_2) + \Delta H_{lattice}(BaCl_2)$

$= -2063 + 2056$ (1½)

$= -7$ kJ mol^{-1}

Eg expression if compound not indicated

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

Ionic radius – spellings

Magnitude of Ionic charge

Eg: Ionic; Ionic size

Eg: Ionic emphasise I

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

The smaller the ionic radius the higher the charge density and the stronger the attraction for water molecules leading to higher hydration energy

The higher the charge on the ions the higher the charge density and the stronger the attraction of water molecules leading to higher hydration energy.

(04)

- Award explanation if (c) (i) is correct
- Spellings of the terms.
- Accept: direction opposite of the explanation

Turn Over

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)

% Mn = 100 − (19·1 + 43·6) = 37·3 ✓+

Elements: Mn : N : O reg: $N_2 : O_2 : Mn$

No of moles: 37·3/54·9 : 19·1/14 : 43·6/16 ✓+

0·679 : 1·364 : 2·725

Mole ratio: 0·679/0·679 : 1·364/0·679 : 2·725/0·679 ✓+ (2½)

1 : 2 : 4 ✓+

← symbols must be correct

Empirical formular of J is MnN_2O_4 ✓+

(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)

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

1·86°c is depression in freezing point caused by $\frac{10 \times 1.86}{0.127}$ ✓+

= 146·5 ✓+

$(MnN_2O_4)n = 146.5$

$(54.9 + 28 + 64)n = 146.5$ (02)

$146.9n = 146.5$

$n = 1$ ✓+

Molecular formular of J is MnN_2O_4 ✓+

reg: if Ef is wrong reg: $Mn(NO_2)_2$

(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:

$Mn(NO_2)_2$ ✓ rej: $Mn(NO_2)_2$ (aq)

Name:

Manganese (II) nitrite ✓ rej: Manganese (II) nitrite solution.

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

$2Mn^{2+}_{(aq)} + 5PbO_{2(s)} + 4H^{+}_{(aq)} \rightarrow 2MnO_4^{-}{}_{(aq)} + 5Pb^{2+}_{(aq)} + 2H_2O_{(l)}$ ✓

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

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

award if b(i) is correct

White precipitate ✓ $Mn^{2+}_{(aq)} + Na_2CO_{3(aq)} \rightarrow MnCO_{3(s)} + 2Na^{+}_{(aq)}$

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

$Mn^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \longrightarrow MnCO_{3(s)}$ ✓ (1½)

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

[09]

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. *(03 marks)*

(a) C_6H_5CHO and CH_3CHO.

accept followed by

Iodine solution and sodium hydroxide solution ✓ rej: Iodoform

rej: Iodine, emphasize I or i; rej: Formulae; small L

C_6H_5CHO No observable change ✓ (03)

CH_3CHO Yellow precipitate ✓ can be included on observation

Fehling's solution or Benedict's solution (and heat)

C_6H_5CHO No observable change

CH_3CHO Reddish brown precipitate (on heating)

Allow hot Fehling's solution. accept red precipitate

Accept ppt / solid

Turn Over

Ammoniacal silver nitrate
Ammoniacal copper(I) chloride solution
$CH_3CH_2C\equiv CH$ Red precipitate reg: (Reddish brown ppt)
$CH_3CH_2CH=CH_2$ No observable change

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

Ammoniacal silver nitrate solution ✓ reg: Tollen's reagent

$CH_3CH_2C\equiv CH$ White precipitate ✓ reg: formulae

$CH_3CH_2CH=CH_2$ No observable change ✓ (03)

Allow: Aqueous ammonia and silver nitrate solution.

(c) CH_3CHCH_2OH (with CH_3) and $CH_3CHCH_2CH_3$ (with OH). *(03 marks)*

accept at room temp

Anhydrous zinc chloride and concentrated hydrochloric acid ✓

CH_3CHCH_2OH (with CH_3) ✓ No observable change at room temperature

reg: After 5 minutes. - emphasise range reg: White precipitate/cloudiness

reg: Lucas reagent.

(03)

$CH_3CH(OH)CH_2CH_3$ - Forms cloudy solution/turbid solution/two layers within 5-10 minutes.

09

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

A solution of a weak base and its salt from a strong acid that resists pH change (02) when a small amount of acid or alkali is added or diluted and has a pH greater than 7

(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*)

$pK_b = -\log K_b$ or $-\log K_b = 4.74$

$K_b = 10^{-4.74}$

$= 1.819\times10^{-5}$ moldm^{-3}

$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$

but complete dissociation of NH_4Cl:

$[NH_4^+] = [NH_4Cl] = \left(\frac{1\times500}{1000}\right)\times\frac{1}{1000}\times1000 = 0.5M$

$[NH_3] = \left(\frac{1}{1000}\times500\times\frac{1}{1000}\times1000\right) = 0.5M$

$[OH^-] = \frac{K_b[NH_3]}{[NH_4^+]} = \frac{1.819\times10^{-5}\times0.5}{0.5}$

$= 1.819\times10^{-5}$

$pOH = -\log[OH^-]$

$= -\log(1.819\times10^{-5}) = 4.74$

$pH + pOH = 14$

$pH = 14 - 4.74$

$= 9.26$ (05)

OR

$[H^+] = \frac{K_w}{[OH^-]}$

$= \frac{1.0\times10^{-14}}{1.819\times10^{-5}}$

$= 5.49\times10^{-10}$

$pH = -\log[H^+]$

$= -\log(5.49\times10^{-10})$

$= 9.26$

$pH = pK_w - pK_b + \log \frac{[base]}{[SALT]}$ $pH = -\log \frac{K_w}{K_b} \frac{[SALT]}{[BASE]}$

Accept alternative approaches involving

$pOH = pK_b - \log \frac{[base]}{[salt]}$; $pK_b =$

$pOH = pK_b + \log \frac{[SALT]}{[BASE]}$

(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 remains constant. This is because hydroxyl ion from sodium hydroxide added reacts with ammonium ion from ammonium chloride to form ammonia solution (aqueous ammonia)

reg: Ammonium hydroxide [04]

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

Cobalt form many complexes

Has variable oxidation state reg: Various

forms coloured compounds any three; deduct ½ for extra wrong one.

(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)* accept (ii)

Hexaaqua cobalt(II) ion or Hexaaquocobalt(II) ion.

(ii) after addition of excess hydrochloric acid. reg: (2) or 2, II *(½ mark)*

(01) Tetrachlorocobaltate(II) ion one word

(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)*

tied on the ppt — accept brown

A blue precipitate soluble in excess to form a dark brown solution which turns reddish-brown on standing.

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

$Co^{2+}_{(aq)} + 2\bar{O}H_{(aq)} \longrightarrow Co(OH)_{2(s)}$

$Co(OH)_{2(s)} + 6NH_{3(aq)} \longrightarrow Co(NH_3)_6^{2+}{}_{(aq)} + 2\bar{O}H_{(aq)}$

or $Co(NH_3)_6^{2+}{}_{(aq)} \longrightarrow Co(NH_3)_6^{3+}{}_{(aq)} + \bar{e}$

or $4Co(NH_3)_6^{2+}{}_{(aq)} + O_{2(g)} + 2H_2O_{(l)} \longrightarrow 4Co(NH_3)_6^{3+}{}_{(aq)} + 4\bar{O}H_{(aq)}$ or

09

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)*

accept 8.314

$\Pi V = \frac{mRT}{Mr} = \frac{1.65 \times 8.31 \times 298}{11.6 \times 10^{-6} \times 1040} = 338695.87\ Nm^{-2}$ or $338858.90\ Nm^{-2}$ (if $R = 8.314$)

Accept: $PV = \frac{m}{Mr}RT$; $\Pi V = nRT$

$Mr = \frac{mRT}{\Pi V} = \frac{2 \times 8.31 \times 298}{100 \times 10^{-6} \times 338695.87}$

$= 146.23$

03

- Follow the student's logical computation

deny marks if units indicated.

or

$\Pi = \frac{mRT}{MrV}$; $\frac{M_A RT}{Mr_A V_A} = \frac{M_B RT}{Mr_B V_B}$ A = Polymer, B = Monomer

$\frac{1.65 \times 8.31 \times 298}{1040 \times 11.6 \times 10^{-6}} = \frac{2 \times 8.31 \times 298}{100 \times 10^{-6} \times M_B}$

$M_B = 146.23$ ($R = 8.314$)

14

146.132 ($R = 0.082$)

$\frac{\Pi_1}{C_1T_1} = \frac{\Pi_2}{C_2T_2}$

$\frac{\Pi_1}{(\frac{1.65}{11.6} \times 298)} = \frac{760}{(\frac{1040}{22400} \times 273)}$

$\Pi_1 = 2541.6\ mmHg$

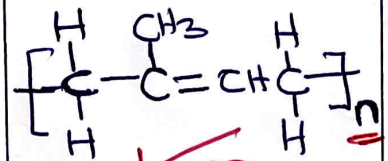
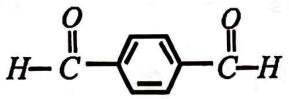
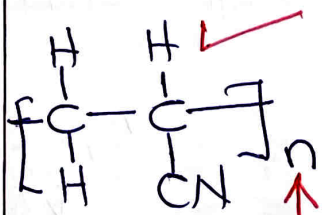
$\frac{\Pi_1}{C_1T_1} = \frac{\Pi_2}{C_2T_2}$

$(\frac{2541.6}{1000} \times 298) = \frac{760}{Mr/22400 \times 273}$

$Mr = 146.23$

(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) $CH_2=C(CH_3)-CH=CH_2$	 ✓ (1)	Addition ✓ (1)	tyres ✓ (1) shoe soles surgical glove insulators condens gumboots any one
(ii) $HOCH_2CH_2OH$ + 	* Known Polymer deny all marks. Ignored.		
(iii) $CH_2=CH-CN$	 reject without (n).	Addition ✓	clothes / fabric Artificial finger nails carpets (03)

17(a) 1.65g of polymer occupies 11.6cm³ ✓+

1040g of polymer occupies $\left(\frac{11.6}{1.65} \times 1040\right)$ ✓+ = 7311.515 ✓+ cm³.

100cm³ of solution is occupied by 2g of monomer ✓+

7311.515 cm³ solution is occupied by $\frac{2}{100} \times 7311.515$ ✓+

= 146.23 ✓+

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	35.4 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 TI 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