MASENO SCHOOL

2025 MOCK EXAMINATION

Kenya Certificate of Secondary Education

233 / 2 - Chemistry Paper 2 **Tuesday 22nd July, 2025** **8.00 a.m. - 10.00 a.m.**	**Unique Identifier No.....** **Signature.....**

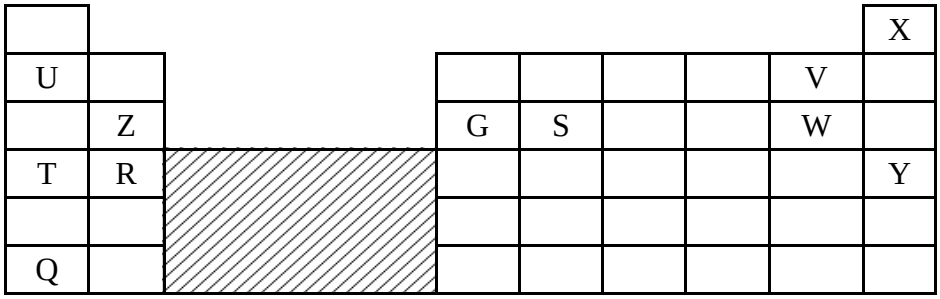
INSTRUCTIONS

- *Write your unique identifier number in the space provided.*
- *Answer **all** questions in the spaces provided*
- *Mathematical tables and silent electronic calculators **may** be used for calculations.*
- *All workings **must** be clearly shown where necessary.*
- *Candidates should check the question paper to ascertain all the pages are printed as indicated and no questions are missing.*

For Examiners Use Only

Questions	Maximum Score	Score
1	13	
2	12	
3	12	
4	10	
5	10	
6	12	
7	11	
TOTAL	**80**	

1. **Figure 1** shows part of the periodic table of elements. The letters are not the actual symbols of the elements.



(a) Identify the element with the lowest first ionization energy. (1 mark)

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(b) In terms of structure and bonding, explain the difference in the melting points of element **S** and **W** (2 marks)

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(c) Compare the ionic radii of element U and V. Give a reason for your answer. (2 marks)

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(d) Identify an element whose oxide dissolves in both strong acids and strong alkalis. (1 mark)

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(e) Explain why the melting point of U is higher than that of T. (2 marks)

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(f) Given that element R consists of two isotopes ^{40}R and ^{y}R. A sample of R was found to consists of 90% of ^{40}R. If the relative atomic mass of R is 40.2. Work out the number of neutrons in ^{y}R. (2 marks)

(g) **Table 1** shows the chlorides of elements in period 3 of the periodic table with their melting and boiling points.

Chloride	**NaCl**	**$MgCl_2$**	**$AlCl_3$**	**$SiCl_4$**	**PCl_5**	**SCl_2**
M.P (°C)	801	714	180	-70	-94	-78
B.P (°C)	1467	1437	-	57	-	59

(i) Select from the **table 1** an acidic chloride and write the equation for its reaction with water. (1 mark)

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(ii) Water was added to the chloride of aluminium, the mixture was stirred well and then two drops of methyl orange indicator were added to the solution. State and explain the observation that was made. (2 marks)

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2. (a) One mole of octane was made to undergo catalytic cracking to form two hydrocarbons P and Q. P was an alkene molecule with three carbon atoms.

(i) Write the formula of Q. (1 mark)

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(ii) Give the structural formula of P. (1 mark)

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(iii) Name the compound formed when P undergoes self-addition reaction. (1 mark)

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(iv) State **one** disadvantage of using the product named in (a) (iii) above. (1 mark)

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(v) Incomplete combustion of hydrocarbon Q may result into air pollution. Write an equation to illustrate this. (1 mark)

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(vi) Cracking can also be achieved without using a catalyst. Give the conditions under which the other type of cracking can be carried out. (1 mark)

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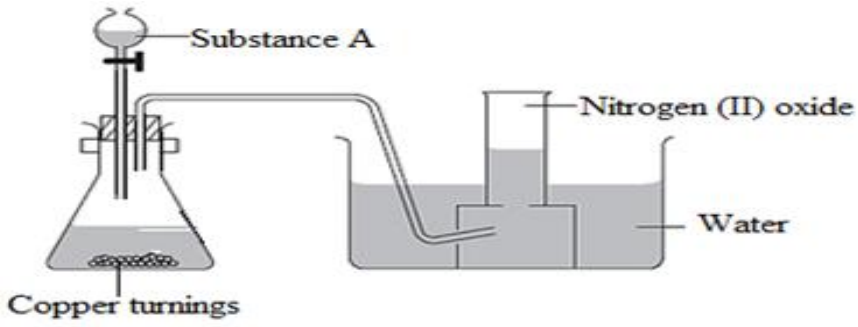
(b) An organic compound J has the following percentage composition by mass; carbon = 54.55%, hydrogen = 9.09%, and the rest is oxygen. (C = 12.0, H = 1.0, O = 16.0)

(i) Determine the molecular formula of the compound given that the molecular mass of the compound is 88. (2 marks)

(ii) If the organic compound obtained has a pleasant fruity smell, **draw** and **name** the structure of the two isomers of the molecular formula obtained in (b) (i) above. (2 marks)

3. (a) Two reagents that can be used to prepare nitrogen (IV) oxide are copper turnings and concentrated nitric (V) acid.

(i) Write an equation for the reaction that takes place to produce nitrogen (II) oxide from the set up below. (1 mark)



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(ii) Name substance A. (1 mark)

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(iii) At the beginning of the experiment, some brown gas was observed in the flask but soon disappeared. Explain these observations. (2 marks)

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(iv) Describe one chemical test for the gas produced in the set up above. (2 marks)

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(v) Motor vehicle exhaust systems are fitted with catalytic converters to prevent the emission of harmful gases such as carbon (IV) oxide and oxides of nitrogen.

I. Write an equation to illustrate some of the reactions that take place in the catalytic converter. (1 mark)

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II. Complete combustion of fuel in the internal combustion engines produces carbon (IV) oxide. What effect does the gas have when its concentration in the atmosphere exceeds the acceptable levels? (1 mark)

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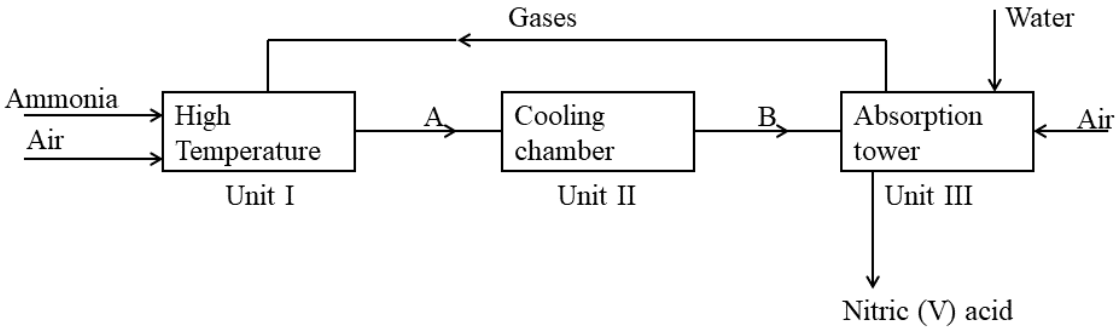
(b) Ammonia gas is used to manufacture nitric (V) acid, as shown below;



(i) This process requires the use of a catalyst. Name the catalyst used in this process? (1 mark)

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(ii) Identify the compound B. (1 mark)

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(iii) Explain why the conversion of ammonia to nitric (V) acid is known as catalytic oxidation of ammonia. (2 marks)

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4. (a) Given the following standard electrode potentials

$I_{2(g)} + 2e^- \longrightarrow 2I^-_{(aq)} \quad \epsilon^\theta = +0.54V$

$Br_{2(g)} + 2e^- \longrightarrow 2Br^-_{(aq)} \quad \epsilon^\theta = +1.09V$

(i) Write the equation for the overall cell reaction. (1 mark)

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(ii) Calculate the electromotive force for the electrochemical cell. (1 mark)

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(iii) Give:

I. the reducing agent (½ mark)

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II. the oxidizing agent (½ mark)

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(b) Metals V, W and X displace copper from its compounds. Describe an experiment that can be carried out to arrange the three metals in order of their reactivity with copper using aqueous copper (II) sulphate and a thermometer. (3 marks)

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(c) Both sodium hydroxide and chlorine are important chemicals for industrial and small scale uses that can be manufactured from electrolysis of concentrated sodium chloride (**Brine**)

(i) Describe using equations, how sodium hydroxide and hydrogen are produced in the mercury cell. (3 marks)

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(ii) The sodium hydroxide obtained is about **50% pure**. Briefly describe how **pure** sodium hydroxide is obtained. (1 mark)

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5. (a) Ethanol can be manufactured from ethene and steam as shown in the equation below:

$$C_2H_{4(g)} + H_2O_{(g)} \rightleftharpoons CH_3CH_2OH_{(g)}$$

Temperature and pressure will affect the position of equilibrium of the above reaction. Name the other factor that will affect the position of equilibrium of the above reaction. (1 mark)

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(b) The data in the table was recorded when one mole of **ethene** was reacted with excess steam. The amount of ethanol in the equilibrium mixture was recorded under different conditions of temperature and pressure. Use the data to answer the questions that follow.

Temp (°C)	Pressure (atm)	Amount of ethanol at equilibrium (moles)
300	50	0.40
300	60	0.46
300	70	0.55
250	50	0.42
350	50	0.38

(i) State whether the reaction between ethene and steam is exothermic or endothermic. Explain (3 marks)

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(ii) State and explain one advantage and one disadvantage of using extremely high pressure in this reaction.

I. Advantage (1 mark)

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II. Disadvantage (1 mark)

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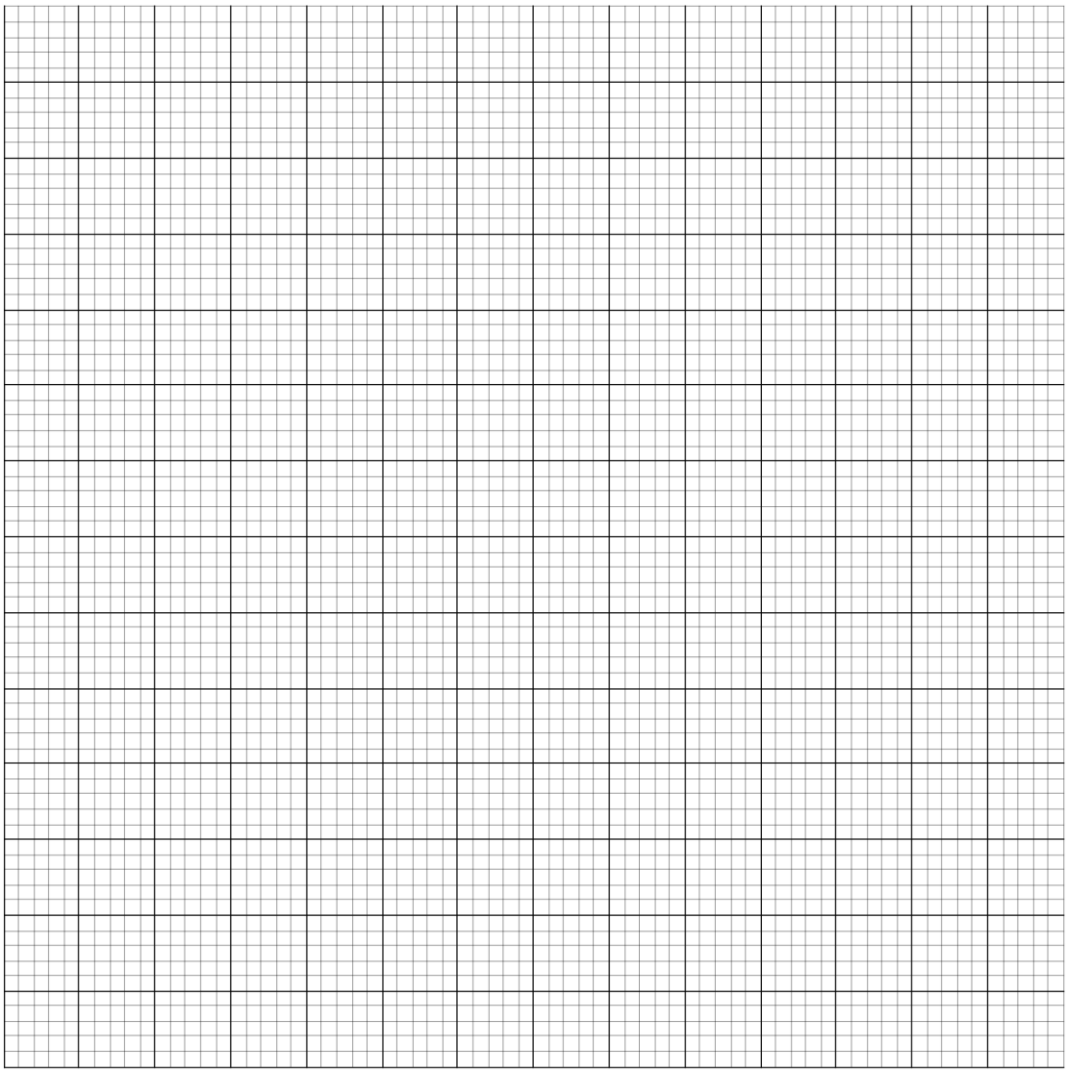
(c) In an experiment to determine the rate of reaction between calcium carbonate and dilute hydrochloric **acid 2g of $CaCO_3$** were reacted with **excess 2M** hydrochloric acid. The volume of carbon (IV) oxide evolved was recorded at regular intervals of one minute for six minutes. The results are as shown in the table below.

Time (minutes)	1	2	3	4	5	6
Volume of CO_2 (cm^3)	170	296	405	465	480	480

(i) Plot a graph of time in minutes on the horizontal axis against volume of carbon (IV) oxide on the vertical axis. (3 marks)



(ii) Determine the rate of reaction at 4 minutes (2 marks)

6. (a) State Hess' law (1 mark)

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(b) Use the following standard enthalpies of combustion of graphite, hydrogen and butane and answer the questions that follow.

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)} \quad \Delta H_1 = -393\ kJmol^{-1}$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)} \quad \Delta H_2 = -286\ kJmol^{-1}$

$C_4H_{10(g)} + {}^{13}\!/_{2}O_{2(g)} \longrightarrow 4CO_{2(g)} + 5H_2O_{(l)} \quad \Delta H = -2877\ kJmol^{-1}$

(i) Draw an energy cycle diagram linking the heat of formation of butane with its heat of combustion and heats of combustion of graphite and hydrogen. (2 marks)

(ii) Calculate the standard heat of formation of butane. (2 marks)

(iii) Propane and butane are constituents of cooking gas. Which one produces more energy per mole on combustion? Explain your answer. (2 marks)

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(iv) Give a reason why the Kenyan government is replacing the use of wood and charcoal in high schools with Liquefied Petroleum Gas (LPG). (1 mark)

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(c) (i) What is meant by the term energy level diagram? (1 mark)

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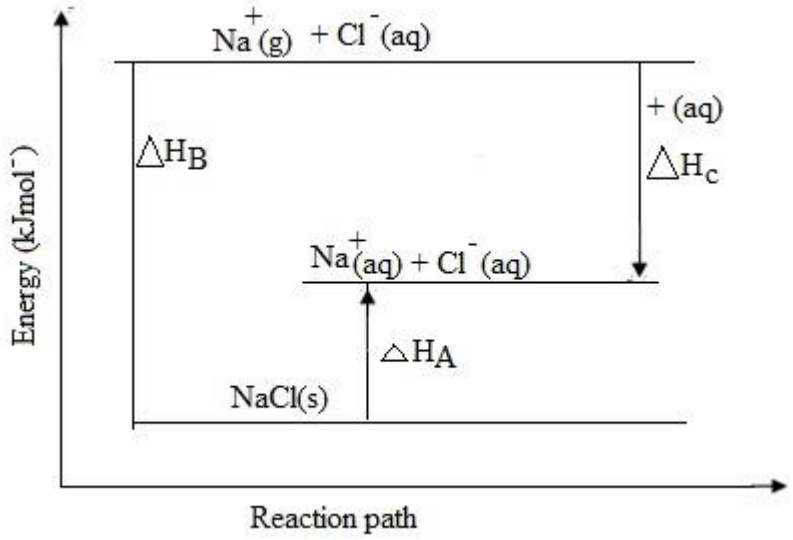
(ii) The diagram below shows an energy level diagram for the formation of sodium chloride. Study it and answer the questions that follow.



I. State the energy changes represented by:

A: …… (½ mark)

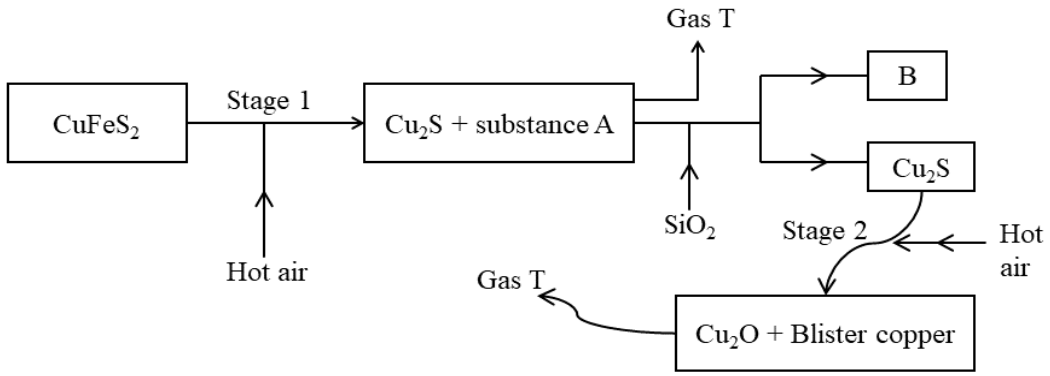
B: …… (½ mark)

C: ……... (½ mark)

II. What is the relationship between ΔH_A, ΔH_B and ΔH_C (½ mark)

III. Calculate ΔH_A given that ΔH_B = -776 $kJmol^{-1}$ and ΔH_B = -771$kJmol^{-1}$ (1 mark)

7. (a) The flow chart shows the process used to extract copper. Study it and answer the questions that follow.



i) Name;

I. Gas T (1 mark)

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II. Substance A (1 mark)

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ii) Write equations for the reaction taking place at:

I. Stage 1 (1 mark)

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II. To form substance B (1 mark)

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iii) State one effect that the above process would have on the environment. (1 mark)

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b) Draw a well labelled diagram to show how blister copper can be purified. (2 marks)

c) In an experiment like the one shown in (b) above, a current was passed through the electrolyte for 4 hours. Calculate the amount of the current passed if the mass of copper deposited at the cathode is 5kgs. ***(Cu = 63.5, 1F = 96500 coulombs)*** (3 marks)

d) Explain why copper can be extracted by electrolytic method from copper (II) sulphate solution while magnesium cannot be extracted from the aqueous magnesium sulphate by the same method. (2 marks)

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