Name .....Admission no.....Date.....

Class.....Candidate's signature.....

School.....

KALA TRIAL EXAM

Kenya Certificate of Secondary Education

CHEMISTRY

PAPER 2 JULY 2024

233/2 Chemistry (THEORY) **Time : 2HRS**

Instructions to Candidates

(a) Write your name and admission number in the spaces provided above.
(b) Write the name of your school and sign in the spaces provided above.
(c) Answer all the questions in the spaces provided in the question paper.
(d) Non-programmable silent electronic calculators and KNEC mathematical tables may be used.
(e) All working must be shown where necessary.
(f) **This paper consists of 15 printed pages.**
(g) **Candidates should check the question paper to ascertain that all pages are printed as indicated and that no questions are missing.**
(h) **Candidates should answer the questions in English.**

FOR EXAMINER'S USE ONLY

Question	Maximum Score	Candidate's Score
1	12	
2	12	
3	13	
4	11	
5	13	
6	08	
7	11	
Total Score	80	

1. a) $^{28}_{12}Mg$ is an isotope of magnesium.

i) What are isotopes (1 mk)

.....
.....
.....
.....

ii) Determine the number of protons and neutrons in an atom of $^{28}_{12}Mg$ (1 mk)

Number of protons.....

Number of neutrons.....

iii) Write the electron arrangement of an atom of $^{28}_{12}Mg$. (1 mk)

.....
.....

b) i) What is half-life? (1 mk)

.....
.....
.....

ii) Mg-28 is radioactive. Its half-life is 20.9 hours. Calculate the time taken for 50grams of Mg-28 to decay to 6.25grams (1 mk)

.....
.....
.....
.....

iii) Complete the following nuclear equation for the beta decay of Mg-28 (1 mk)

$^{28}_{12}Mg \longrightarrow$

c) Magnesium burns in oxygen, O_2 . The activation energy, Ea, for this reaction is +148kJ/mol.

i) State one observation made when magnesium burns in oxygen (1 mk)

.....
.....
.....
.....

ii) Sketch an energy level diagram for the reaction that occurs when Mg burns in O_2. Label the diagram to show the enthalpy change, ΔH, and the activation energy ,Ea, for the reaction.

(2 mks)

d) Cold water reacts slowly with a piece of magnesium to produce bubbles of hydrogen gas. Cold water reacts rapidly with burning magnesium to produce hydrogen gas.

i) Write the equation for the reaction between cold water and magnesium (1 mk)

.....

.....

.....

ii) Explain why the rate of reaction of cold water with burning magnesium is greater

(2 mks)

.....

.....

.....

.....

.....

2. The table below shows some properties and electronic arrangement of ions of elements represented by letters P to V. Study the information and answer the questions that follow. (The letters do not represent the actual symbols of the elements.)

Element	**Formula of ion**	**Electronic arrangement of ion.**	**Atomic radius (nm)**	**Ionic radius (nm)**	**Melting point of oxide (°c)**
P	P^{2+}	2.8	0.136	0.065	3075
Q	Q^{-}	2.8	0.064	0.136	-164
R	R^{+}	2.8.8	0.133	0.060	1438
S	S^{3+}	2.8	0,125	0.035	450
T	T^{2+}	2.8.18.8	0.191	0.113	2531
U	U^{+}	2.8	0.157	0.095	1132
V	V^{2-}	2.8.8	0.104	0.186	-76

a) Which elements belong to the same period of the periodic table? Explain. (2 mks)

.....

.....

b) Explain why;

i) The atomic radius of **T** is larger than it's ionic radius. (1 mk)

.....

.....

.....

.....

ii) The ionic radius of **U** is larger than that of **S**. (1 mk)

.....

.....

.....

.....

c) Explain why the melting point of the oxide of **P** is higher than that of the oxide of **U**.

.....

.....

.....

.....

.....

d) Use dots(.) and crosses (x) to illustrate the bonding in the compound formed between **U** and **V**

(1 mk)

e) Describe how a mixture of **R** chloride, **S** chloride and lead (II) chloride can be separated.

(2 mk)

.....

.....

.....

.....

.....

f) The oxide of V is a colourless gas that changes orange acidified potassium dichromate (vi) solution to green.

i) Identify the oxide of V, hence explain the observation made. (1.5 mks)

.....

.....

.....

ii) Explain the effect of an aqueous solution of V on litmus paper (2 mks)

.....

.....

3. The structures of some organic compounds are shown below

A. $CH_2\ CH_2$ B. $CH_3\ CH_2\ COOH$

C. $CH_3\ CH_2\ CH_2\ OH$ D. $CH_3\ CH\ CH\ CH_3$

E. $CH_3\ CH_3$ F. $CH_3\ CH_2\ Cl$

a) Write the structural formula and name of the organic compound formed in the following

i) A reacts with chlorine gas (1 mk)

.....

.....

.....

ii) C reacts with B in the presence of concentrated sulphuric (vi) acid (1 mk)

.....

.....

.....

iii) D reacts with acidified potassium manganate (vii) (1 mk)

.....

.....

.....

iv) B reacts with sodium carbonate (1 mk)

.....

.....

.....

b) Identify the type of reaction in the following

i) C is converted to B

..... (0.5 mk)

ii) The product in a (iv) is converted to E (0.5 mk)

.....

c) Give the reagents and conditions under which the following conversions may be brought about

i) A to E (1 mk)

Reagent.....

Condition(s).....

ii) E to F (1 mk)

Reagent.....

Condition (s) .....

d) What type of polymerization does D undergo? Draw the structure of the polymer formed (2 mks)

.....

.....

.....

e) Carboxylic acid, W, present in unripe fruit has the following composition by mass;

C , 35.8%; H, 4.5%; O; 59.7%

i) Given that the molecular mass of the acid is 134, determine its molecular formula

(C=12.0, H=1.0, O=16.0) (2 mks)

ii) 1.97g of acid W was dissolved in water and the solution titrated with 1.0M sodium hydroxide solution. 29.4 cm^3 of the sodium hydroxide solution was required for complete neutralization. Determine the basicity of acid W. (2 mks)

.....

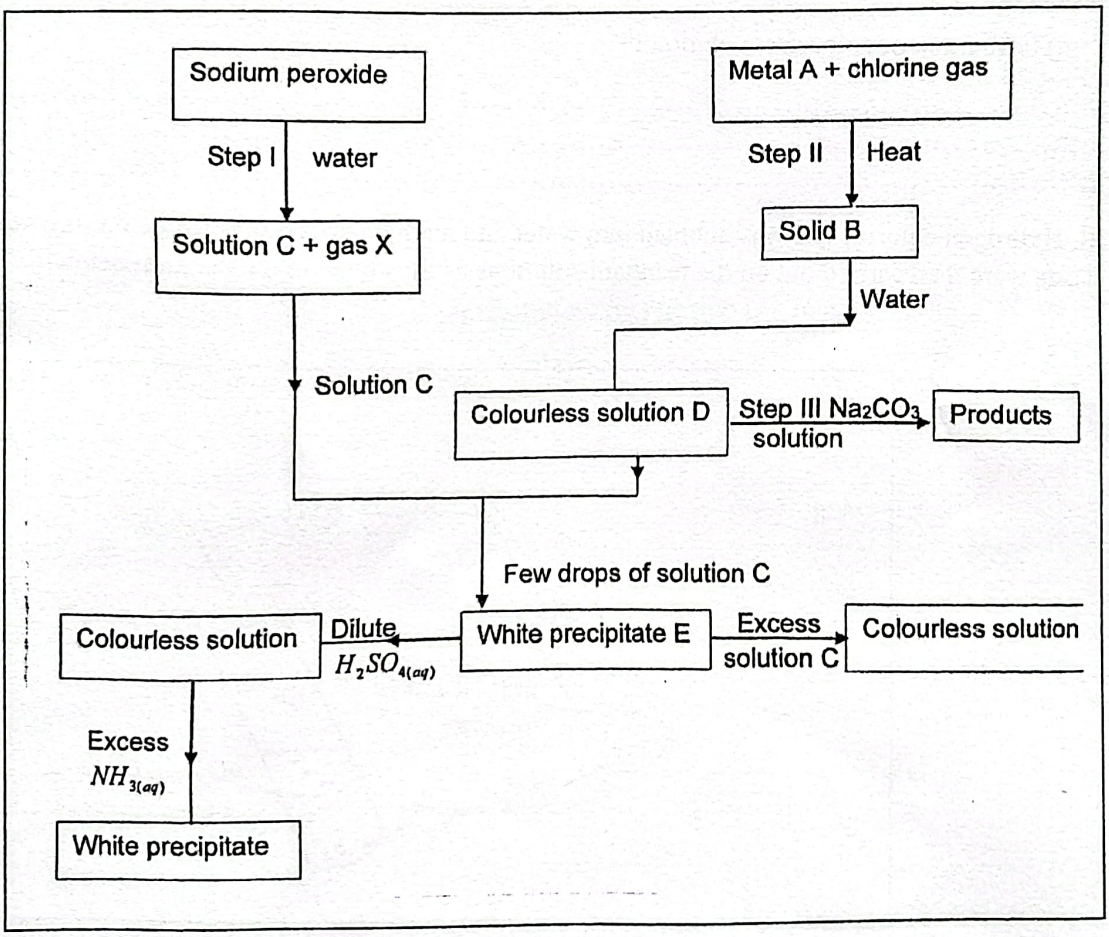
.....

.....

.....

.....

4. Study the flow diagram below and use it to answer the questions that follows.



I a) Write balanced chemical equations for the reactions in (2 mks)

Step I

Step II

b) Explain the observations made in step III (2 mks)

.....

.....

.....

.....

c) Write ionic equations for the following (2 mks)

i) Formation of white precipitate E

.....

.....

.....

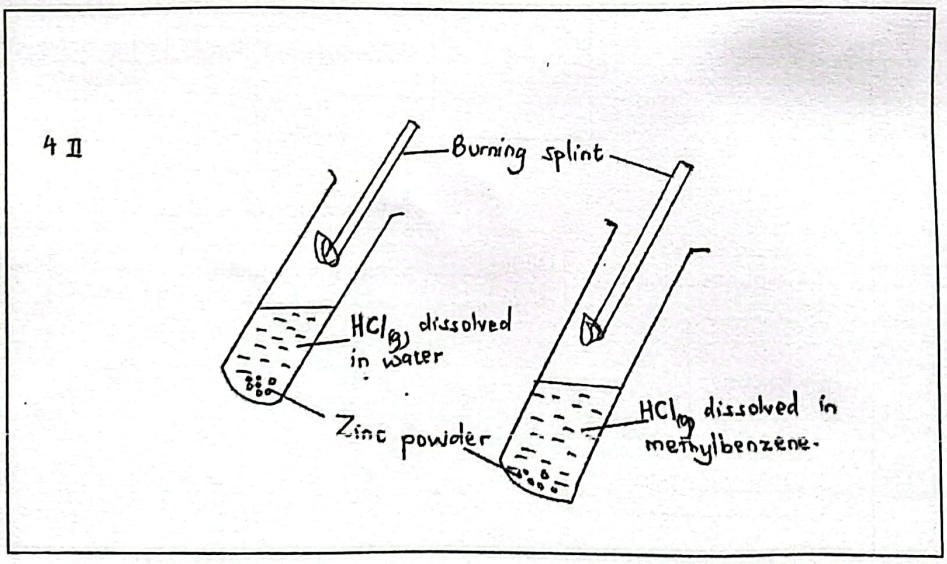
ii) Formation of colourless solution F

.....

.....

.....

II. Hydrogen chloride gas was bubbled into water and methylbenzene in separate boiling tubes. Tests were then carried out on the resultant solutions as illustrated in the diagram below.



Explain the observations made in ; (3 mks)

a) Tube A

.....

.....

.....

b) Tube B

.....
.....
.....
.....

III. a) What is hard water? (0.5 mk)

.....
.....
.....

b) A water sample was found to contain dissolved magnesium sulphate. Identify the type of hardness in the water sample and state two methods that can be used to soften it.

(1.5 mk)

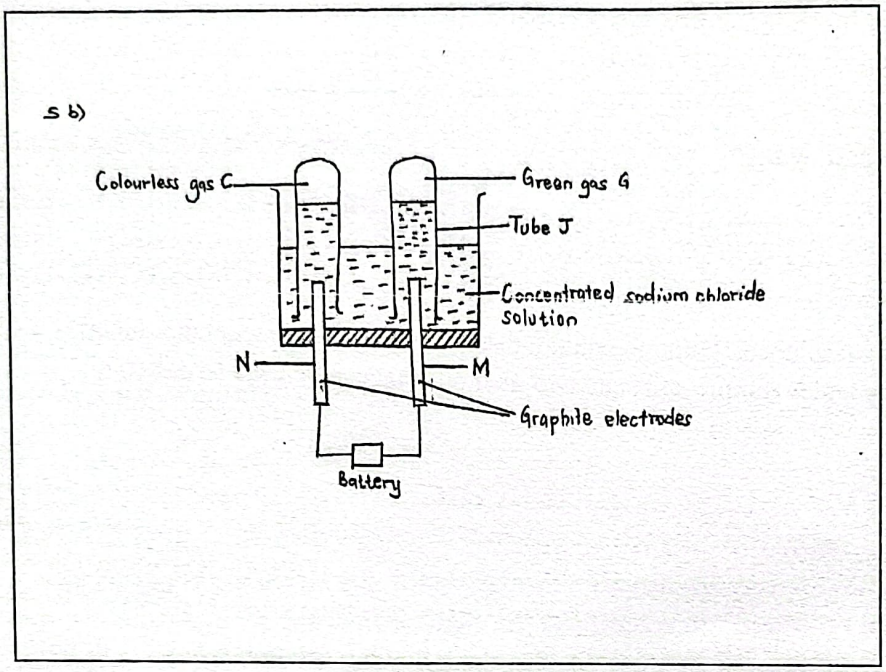
.....
.....
.....
.....

5. a) Using oxidation numbers show whether the following reaction is a redox or not (2 mks)

$CuO\,(s) + 2NH_3\,(g) \longrightarrow 3Cu\,(s) + 3H_2O\,(l) + N_2\,(g)$

.....
.....
.....
.....
.....

b) An electric current was passed through a concentrated solution of sodium chloride. The diagram below illustrates the set-up at the end of the experiment.



i) Identify electrode M (0.5 mk)

.....

.....

ii) Write the ionic equation for the reaction at electrode N (1 mk)

.....

.....

iii) After sometime, Tube J was found to contain a mixture of two gases. Explain (2 mks)

.....

.....

.....

iv) A current of 4.5A was passed through the solution for one hour. Calculate the volume of colourless gas C produced.

(1F = 96500, molar gas volume at r.t.p=24dm^3) (2 mks)

.....

.....

.....

.....

.....

c) Study the standard electrode potentials given below and answer the questions that follow. The letters do not represent the actual symbols of the element.

Half reactions	$E^{\ominus}$ (V)
$P^{+}_{(aq)} + e^{-} \longrightarrow P_{(s)}$	-2.92
$R^{3+}_{(aq)} + 3e^{-} \longrightarrow R_{(s)}$	-1.35
$S^{2+}_{(aq)} + 2e^{-} \longrightarrow S_{(s)}$	-0.76
$T^{2+}_{(aq)} + 2e^{-} \longrightarrow T_{(s)}$	+0.34
$V^{+}_{(aq)} + e^{-} \longrightarrow V_{(s)}$	+0.80
$W_{2(g)} + 2e^{-} \longrightarrow 2W^{-}_{(aq)}$	+1.36

i) Which is the strongest reducing agent? Explain. (1 mk)

.....

.....

.....

ii) Which two half-cells would give the highest e.m.f when combined ? (0.5 mk)

.....

.....

- Calculate the e.m.f of the cell (1mk)

.....

.....

.....

- Write the cell notation of the cell (1 mk)

.....

.....

ii) Explain whether a solution of V nitrate can be stored in a container made of T (2 mks)

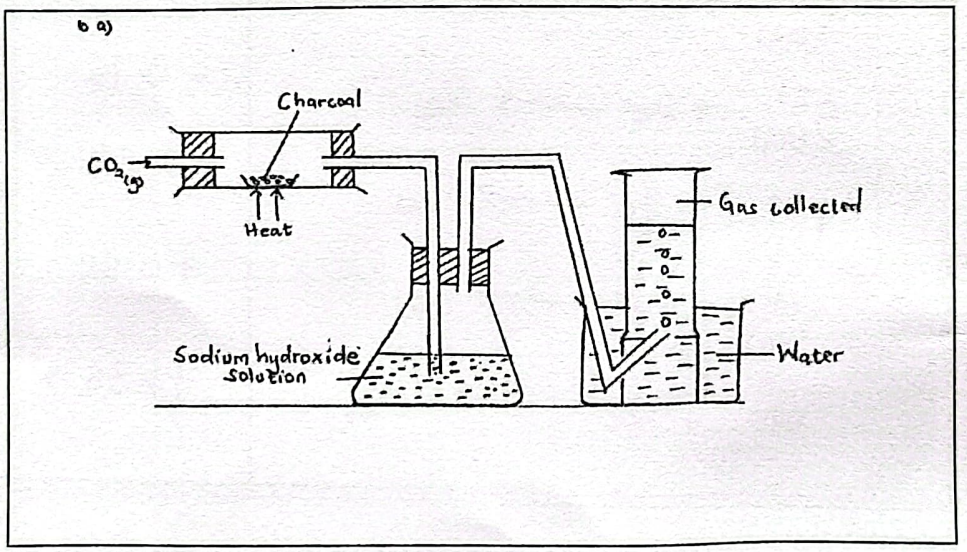
.....

.....

.....

.....

6. a) In an experiment, carbon (iv) oxide gas was passed over heated charcoal and the gas produced collected as shown in the diagram below.



i) Write an equation for the reaction that occurs in the combustion tube . (1 mk)

.....

.....

ii) Describe a simple chemical test to distinguish between carbon (ii) oxide and carbon (iv) oxide. (2 mks)

.....

.....

.....

.....

.....

iii) What property of the gas makes it possible to be collected as shown above? (1 mk)

.....

.....

iv) State one use of carbon (ii) oxide. (1 mk)

.....

.....

b) In an experiment to prepare nitrogen (i) oxide, ammonium nitrate was gently heated in a flask.

i) Write the equation for the reaction that took place in the flask. (1 mk)

.....

.....

ii) Explain the method used to collect the gas. (1 mk)

.....

.....

.....

iii) A sample of the gas was tested with moist blue and red litmus paper. State the observations that were made. (1 mk)

.....

.....

7. I In an experiment to determine the enthalpy of neutralization of sodium hydroxide with hydrochloric acid, the following procedure was carried out.

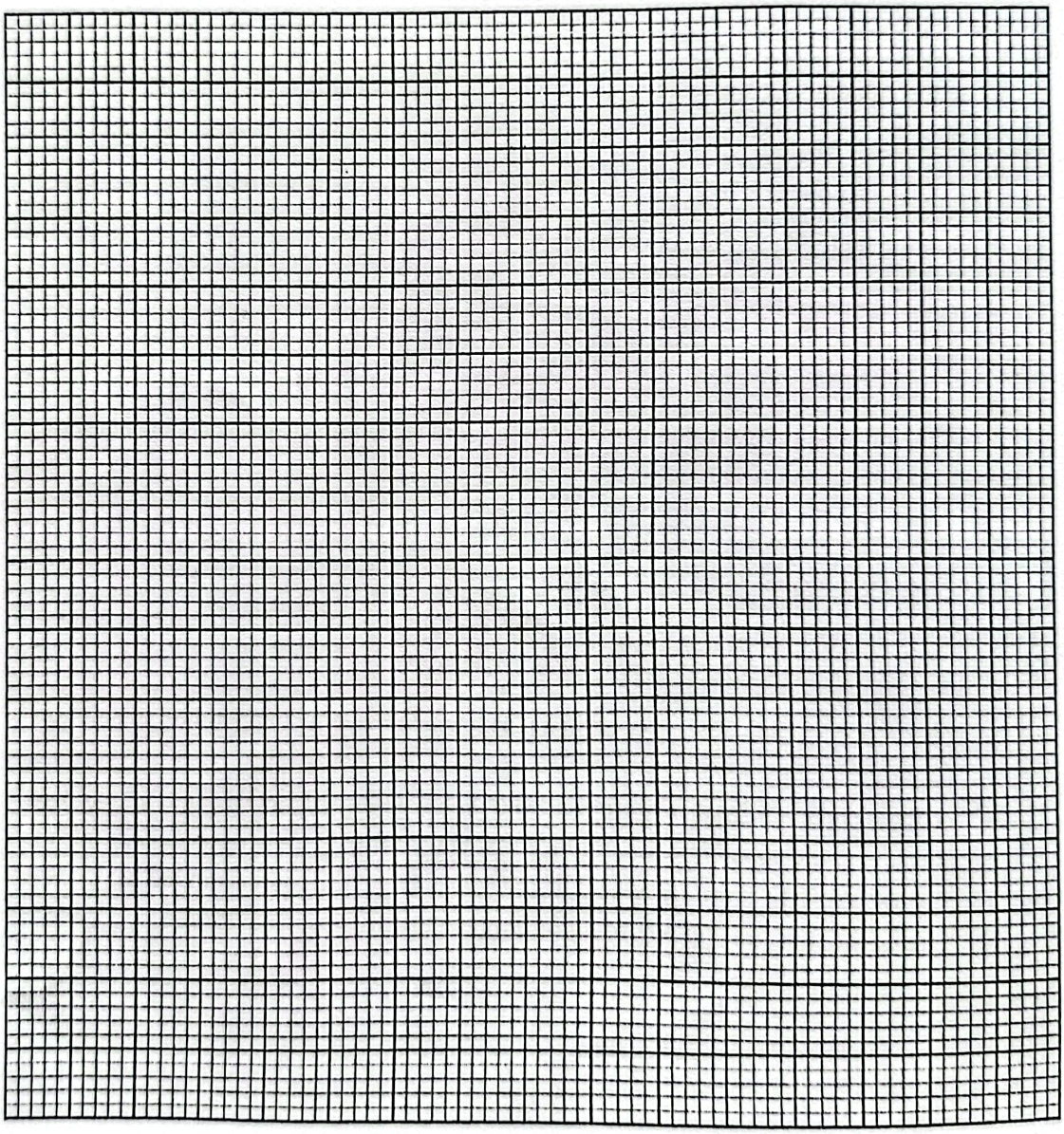
- $50cm^3$ of 1M NaOH was placed in a plastic beaker and the temperature of solution recorded.
- A $5cm^3$ portion of hydrochloric acid was added to the 1M NaOH. The mixture was stirred and the constant temperature attained recorded.
- Successive $5cm^3$ portions of acid were each added to the contents in the beaker, stirring the mixture and recording its temperature after each addition.

The results obtained are shown in the table below.

Total volume of HCl added cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
Temperature , ^0C	22.0	24.0	25.8	28.0	30.0	29.5	29.0	27.5	27.0	27.0	26.0

a) Plot a graph of temperature (vertical axis) against volume of hydrochloric acid added.

(3 mks)



b) Determine the volume of hydrochloric acid required to completely neutralize the $50cm^3$ of 1M NaOH. (1 mk)

.....

.....

c) Calculate the molarity of the hydrochloric acid solution (2 mks)

.....

.....

.....

.....

.....

.....

d) Calculate the molar enthalpy of neutralization of sodium hydroxide. (C=4.2kJ/Kg/K, density of solution=$1g/cm^3$) (2 mks)

.....

.....

.....

.....

.....

.....

II a) Define lattice energy (1 mk)

.....

.....

.....

b) Calculate the lattice energy for barium hydroxide given

ΔH_{soln} $Ba(OH)_2$ (s) = -51.8 kJ/mol

ΔH_{hyd} Ba^{2+} (g) = -1360 kJ/mol

ΔH_{hyd} OH^- (g) = -460 kJ/mol (2 mks)

.....

.....

.....

.....

.....

THIS IS THE LAST PRINTED PAGE