THE KENYA NATIONAL EXAMINATIONS COUNCIL

Kenya Certificate of Secondary Education

233/1 **CHEMISTRY (Theory)** **Paper 1**

Nov. 2024 — 2 hours

Candidate's signature: ..... Date: .....

Instructions to Candidates

(a) Confirm that this question paper has your name and the correct index number.
(b) Sign and write the date of examination 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 clearly shown where necessary.
(f) This paper consists of 16 printed pages.
(g) Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.
(h) Candidates should answer the questions in English.

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

17	18	19	20	21	22	23	24	25	26	27	Grand Total	

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1 Name the apparatus that can be used to:

(a) measure volume of solutions more accurately than a measuring cylinder; (1 mark)

.....

(b) lower a burning piece of magnesium ribbon into a gas jar; (1 mark)

.....

(c) store and keep substances free from moisture. (1 mark)

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2 A radioactive isotope decays by either emission of alpha (α) or beta (β) particles.

(a) Explain why alpha particles have a higher ionising power compared to beta particles. (1 mark)

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(b) Explain how alpha and beta particles can be distinguished in terms of their penetrating powers. (1 mark)

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3 Three bottles containing zinc nitrate, aluminium nitrate or lead(II) nitrate have their labels missing. Describe a chemical test that can be carried out using aqueous sodium sulphate and aqueous ammonia to label the bottles correctly. (3 marks)

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4 Consider the following equilibrium reaction for a mixture of gases in a gas syringe.

$2NO_2(g) \rightleftharpoons N_2O_4(g)$; $\Delta H = -ve$

(Brown) (Yellow)

(a) Give a reason why the enthalpy change is negative, exothermic reaction. (1 mark)

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(b) State and explain the observations made when the pressure in the syringe is increased.

Observation (1 mark)

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Explanation (1 mark)

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5 Ammonia gas can be prepared using ammonium sulphate and sodium hydroxide.

(a) Write an equation for the reaction. (1 mark)

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(b) Draw a labelled diagram of a set-up of the apparatus that can be used to prepare and collect a sample of dry ammonia. (2 marks)

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6 Some properties of four metals and their oxides are shown in **Table 1**.

Table 1

Metal	Reaction with water	Colour of oxide
A	Reacts slowly with steam	Green
B	Reacts rapidly with steam	Brown
C	Reacts rapidly with cold water	White
D	Does not react	Black

(a) Arrange the metals in order of their reactivity starting with the most reactive.

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(1 m

(b) State the observation that would be made when metal **B** is heated with:

(i) oxide of **D**;

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.....

(1 ma

(ii) oxide of **C**.

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(1 mar

7 In an experiment to determine the water of crystallization in sodium carbonate, $Na_2CO_3 \cdot XH_2O$, the data in **Table 2** was obtained:

Table 2

	Mass (g)
Mass of crucible	57.20
Mass of crucible + salt before heating	78.60
Mass of crucible + salt after heating	67.00

Calculate the:

(a) mass of dry salt after heating;

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(½ mark)

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(b) mass of water; (½ mark)

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(c) value of X. (2 marks)

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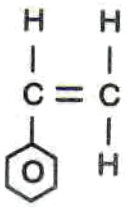
A polymer was formed using compound **M** which has the following structure.



Compound M

(a) Name compound **M**. (1 mark)

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(b) Draw a section of the polymer showing three repeat units. (1 mark)

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(c) Give **one** advantage of using this polymer over a natural polymer. (1 mark)

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9 **Figure 1** shows a set-up that was used to investigate the products of a burning candle.

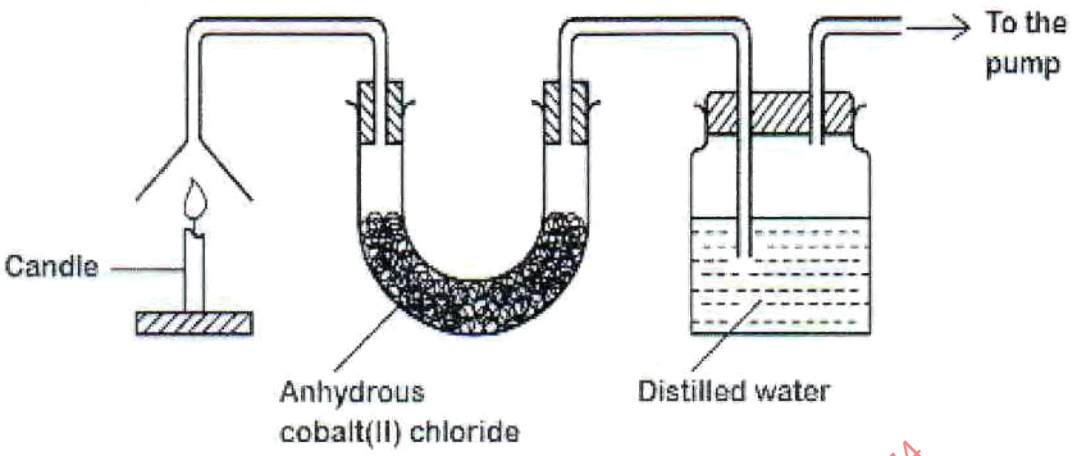

Figure 1

(a) State and explain:

(i) the observations made in the U-tube. (1 mark)

Observation .....

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Explanation .....

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(ii) how the pH of distilled water changes with time. (1 mark)

Observation .....

Explanation .....

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(b) State the role of the pump. (1 mark)

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10 In an experiment to determine the molar heat of neutralisation, 100 cm^3 of 1.0 M sodium hydroxide was added to 100 cm^3 of 1.0 M hydrochloric acid. The data obtained is shown in the **Table 3**.

Table 3

	Temperature (°C)
Initial temperature of hydrochloric acid	20.4
Maximum temperature of the mixture	26.5

(a) Calculate the:

(i) heat change; (1 mark)

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(ii) molar heat of neutralization of hydrochloric acid. (1 mark)

(Specific heat capacity of the solution = 4.2 $Jg^{-1}deg^{-1}$; Density of the solution = 1.0 gcm^{-3})

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(b) The molar heat of neutralization obtained in 10(a)(ii) differs from that obtained using aqueous ammonia and hydrochloric acid. Explain. (1 mark)

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11 Iron is extracted from its ore in a blast furnace. The raw materials used are: iron ore, coke, air and limestone.

(a) State the role of each of the following in the extraction process.

(i) Limestone. (1 mark)

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9 Fig

(ii) Coke. (1 ma

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(b) State and explain why the iron obtained is **not** suitable for making bridges. (1 ma

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12 **Table 4** shows some properties of three substances. Complete the table by filling in the types of forces and structures in each substance .

(a)

Table 4

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity		Type of forces	Structure
			Solid	Molten		
X	-101	-35	Poor	Poor		
Y	650	1110	Good	Good		
Z	714	1142	Poor	Good		

(3 ma

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13 Describe how the presence of sulphite ions in aqueous sodium sulphite can be confirmed using:

(a) aqueous barium nitrate and dilute nitric(V) acid; (2 ma

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(b)

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(b) acidified potassium dichromate(VI). (1 mark)

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Use the bond energies in **table 5** to calculate the enthalpy change for the combustion of ethene.

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$

Table 5

Bond	C = C	O = O	C - H	C = O	O - H
Bond energy (kJ mol^{-1})	612	412	496	743	463

(4 marks)

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15 Hydrogen gas can be prepared by electrolysis of acidified water.

(a) Explain why the water is acidified before electrolysis. (1 mark)

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(b) Calculate the volume of hydrogen gas produced when a current of 12 amperes is used for 2 hours (Faraday = 96,500 coulombs, Volume of 1 mole of gas = 24,000 cm^3) . (2 marks)

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16 Ethanol can be prepared from glucose ($C_6H_{12}O_6$) according to the following equation:

$$C_6H_{12}O_6(aq) \xrightarrow{30^{\circ}C} 2C_2H_5OH(aq) + 2CO_2(g)$$

(a) Explain why temperatures of more than 30 °C are **not** used. (1 mark)

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(b) The concentration of ethanol in the product is about 12%. State how the concentration of ethanol in the product can be increased. (1 mark)

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(c) State **one** use of ethanol in hospitals. (1 mark)

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17 The following steps are followed when carrying out paper chromatography of a dye.

1. The solvent is placed in a beaker.
2. A baseline is drawn with a pencil on the paper.
3. The sample is spotted on the baseline.
4. The paper is carefully placed in the beaker with the baseline above the surface of the solvent.
5. The beaker is covered and allowed to stand for sometime.

Give a reason for the following:

(a) the baseline is drawn with a pencil; (1 mark)

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(b) the paper is carefully placed in the beaker with the baseline above the surface of the solvent; (1 mark)

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(c) the beaker is covered. (1 mark)

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18 6.12 g of hydrogen peroxide were dissolved in 100 cm^3 of water. The peroxide was allowed to decompose in the presence of a catalyst and oxygen gas produced collected.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

(a) Name a suitable catalyst for the reaction. (1 mark)

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(b) Calculate the:

(i) number of moles of hydrogen peroxide in the solution (H = 1.0; O = 16.0); (1 mark)

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15 Hydr

(ii) volume of oxygen gas produced (Volume of 1 mole of gas = 24,000 cm^3). (1 ma

(a) .....

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(b) 19 Describe how a sample of ammonium nitrate can be prepared starting with ammonia as the only nitrogen containing compound. (3 ma

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16 Etha 20 The set-up in **Figure 2** is used to prepare carbon(II) oxide from ethanedioic acid. The equati for the reaction is:

C_6H $H_2C_2O_4(s) \longrightarrow CO(g) + CO_2(g) + H_2O(l)$

(a)

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(b)

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(c)

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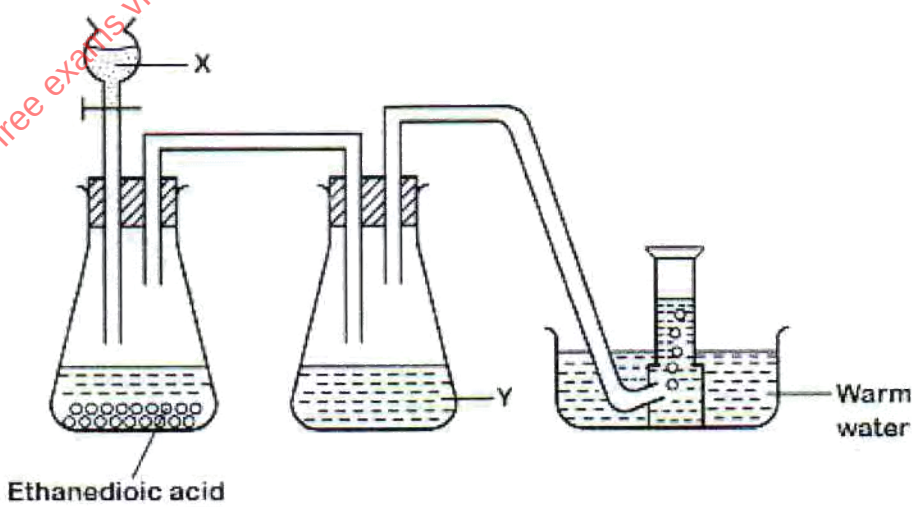

Figure 2

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(a) Identify **X** and **Y** and give the role of each. (2 marks)

(i) **X**: .....

Role .....

(ii) **Y**: .....

Role .....

(b) State a property of the gas that allows it to be collected as shown. (1 mark)

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2.0 g of hydrogen gas was reacted with 2.0 g of oxygen gas to form water. (H = 1.0; O = 16.0).

Calculate the:

(a) mass of water produced; (2 marks)

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(b) mass of unreacted gas. (1 mark)

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22 Activation energy is the energy required to initiate a reaction.

(a) Explain why reactions differ in their activation energies. (1 mark)

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(b) **Figure 3** shows energy against progress of reaction carried out in the presence of a catalyst.

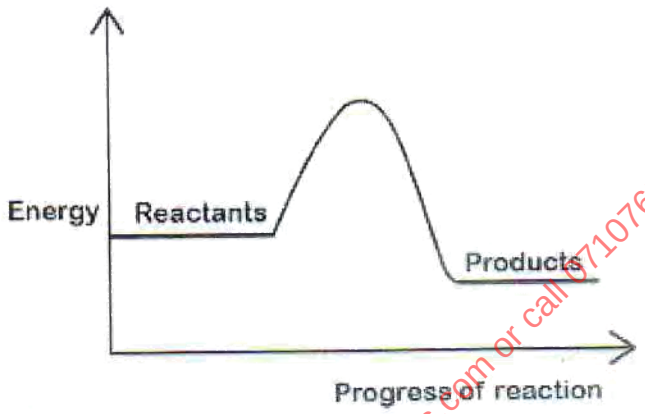

Figure 3

(i) Sketch on the same axis, the curve obtained if the reaction was carried out without a catalyst. Give a reason. (2 marks)

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23 (a) Complete **Table 6** by filling in the missing information for phosphorus and iron . (2 marks)

Table 6

Ions	Number of electrons	Number of protons	Number of neutrons
$^{31}_{15}P^{3-}$			
$^{56}Fe^{2+}$			30
$^{x}_{y}O^{n}$	10	8	9

(b) Determine the value of x, y, and n in $^{x}_{y}O^{n}$. (1 mark)

x: .....

y: .....

n: .....

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24 26 (a) Starting and sustaining a fire requires three ingredients.

Complete the fire triangle in **Figure 5** by filling in the missing ingredients. (2 marks)

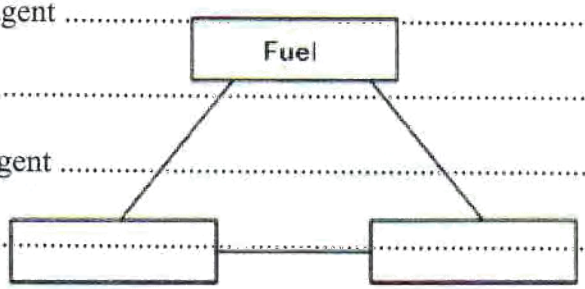


Figure 5

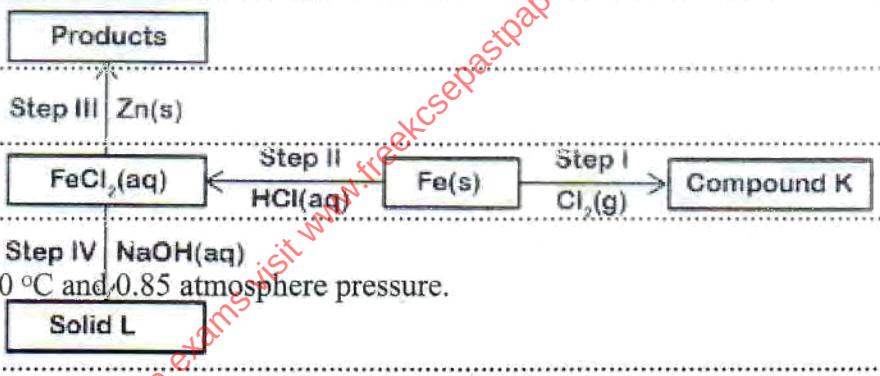
(b) Write an ionic equation for the following reaction. (1 mark)

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

27 Helium is used in weather balloons. A balloon was filled with 100 g of helium at 25 °C and 1 atmosphere pressure. Determine the volume of the balloon at:
(He = 4.0; Volume of one mole of gas = 24 dm³).

(a) 25 °C and 1 atmosphere pressure; (1 mark)

25 The flow chart in **Figure 4** shows some reactions.



(b) 10 °C and 0.85 atmosphere pressure. (2 marks)

Figure 4

(a) Name compound **K**. (1 mark)

(b) Give the formula of solid **L**. (1 mark)

(c) Write the ionic equation for the reaction for step **III**. (1 mark)

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