THE KENYA NATIONAL EXAMINATIONS COUNCIL
Kenya Certificate of Secondary Education

233/1 — CHEMISTRY — Paper 1

(THEORY)

Mar. 2021 – 2 hours

Name ..... Index Number .....

Candidate's Signature ..... Date .....

Instructions to Candidates

(a) *Write your name and index number in the spaces provided above.*
(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	28	Grand Total	

1. Element **A** has mass number 40 and 21 neutrons.

(a) Write the electron arrangement of element **A**. (1 mark)

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(b) Give the formula of the compound formed when element **A** reacts with sulphur. (S = 16.0) (1 mark)

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2. Study the setup in **Figure 1** and then answer the questions that follow.

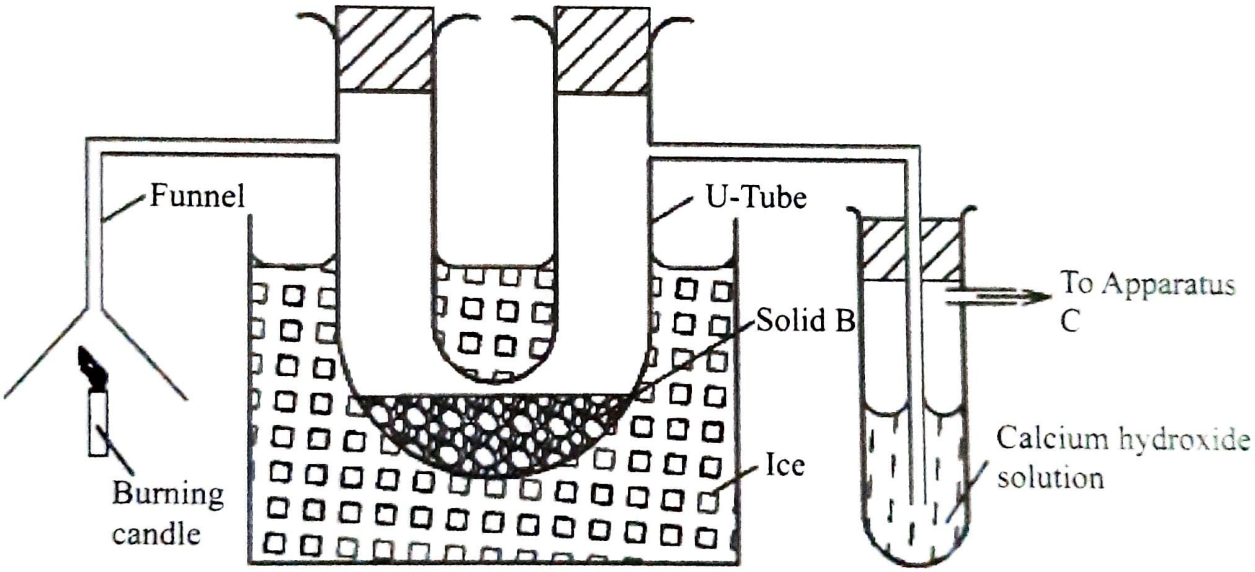

Figure 1

(a) At the end of the experiment, solid **B** changed from white to blue. Explain. (1 mark)

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(b) The other product of the burning candle formed a white precipitate with the calcium hydroxide solution. Write an equation for the reaction. (1 mark)

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(c) State the role of apparatus **C**. (1 mark)

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3. (a) State and explain the factors that are considered when collecting a gas by displacement of:

(i) air; (1 mark)

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.....

(ii) water. (1 mark)

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(b) Other than collecting a gas by displacement of air or water, state another method that can be used to collect a gas. (1 mark)

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4. (a) Carbon(II) oxide was passed over 4.1 g of heated oxide of copper in a combustion tube until there was no further change. The mass of the final substance was found to be 3.29 g. Complete **Table 1** and determine the empirical formula of the oxide.

(Cu = 64.0; O = 16.0)

Table 1

Element	Cu	O
Mass (g)		
Number of Moles		

Empirical formula ..... (2 marks)

(b) State the property of carbon(II) oxide that was demonstrated in the experiment. (1 mark)

.....

5. (a) Draw the structural formula of 2-methylbut-2-ene. (1 mark)

.....

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(b) Bromine water was added to 2-methylbut-2-ene.

(i) State the observation made. (1 mark)

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.....

(ii) Name the type of the reaction that took place. (1 mark)

.....

6. **Table 2** shows pH values of solutions of compounds **D**, **E**, **F** and **G**.

Table 2

Compound	D	E	F	G
pH value of solution	2	5	7	13

(a) State which one of the compounds is likely to be:

(i) sodium chloride; (½ mark)

.....

(ii) ammonium nitrate. (½ mark)

.....

(b) Select ***two*** compounds that can be used to illustrate the amphoteric nature of an oxide. (1 mark)

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(c) Give a reason for the answer in (b). (1 mark)

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7. Draw a labelled diagram of the setup of apparatus that can be used to electrolyse lead(II) bromide. (3 marks)

8. (a) State the difference between a covalent bond and a dative covalent bond. (1 mark)

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(b) Using dots (•) and crosses (x) to represent electrons, draw a diagram to show the bonding in ammonia. (1 mark)

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(c) Using the diagram in (b), state ***one*** property that makes ammonia react with hydrogen ion. (1 mark)

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9. **Figure 2** shows a reaction scheme starting with copper turnings. Study it and answer the questions that follow.

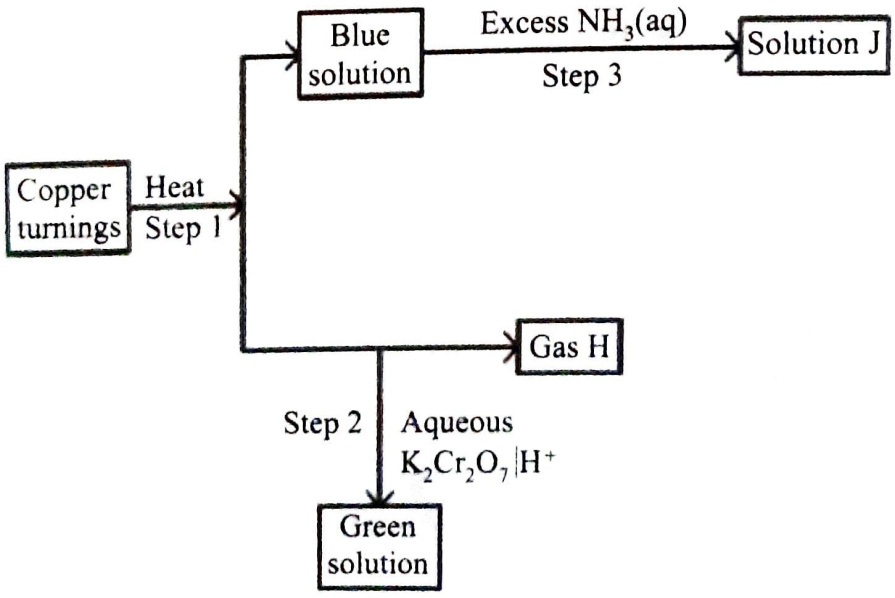

Figure 2

(a) State the reagent that is added in step **1**. (1 mark)

.....

(b) Identify gas **H** ..... (1 mark)

(c) Write the formula of the complex ion in solution **J**. (1 mark)

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10. When chlorine is bubbled through hot concentrated sodium hydroxide solution, sodium chlorate(V), sodium chloride and water are formed.

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

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.....

(b) Sodium chlorate(V) and sodium chloride have different solubilities in water. Name a method that can be used to separate the salts. (1 mark)

.....

(c) Give ***one*** use of sodium chlorate(V). (1 mark)

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11. Excess dilute hydrochloric acid was added to an alloy of copper and zinc in a beaker.

(a) State the observations made. (2 marks)

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(b) Excess aqueous sodium hydroxide was added to 2 cm^3 of the solution obtained in the reaction. Write an ionic equation for the reaction that occurred. (1 mark)

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12. Study the information in **Table 3** and answer the questions that follow. The elements belong to the same chemical family. (The letters are not actual symbols of the elements).

Table 3

Element	Atomic radius (nm)	Ionic radius (nm)	Ionisation energy kJ/mol
L	0.157	0.095	494
K	0.203	0.133	418
M	0.123	0.060	519
N	0.235	0.169	376

(a) Classify the elements as either metals or non-metals. Give a reason. (1 mark)

.....

.....

(b) (i) Identify the element which is

I. least reactive ..... (½ mark)

II. most reactive ..... (½ mark)

(ii) Give a reason for the answer in b (i). (1 mark)

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13. Nitrogen(IV) oxide is prepared by heating lead(II) nitrate.

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

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(b) At room temperature, nitrogen(IV) oxide exists as an equilibrium mixture with dinitrogen tetraoxide.

$2NO_2(g) \rightleftharpoons N_2O_4(g)$; Δ is −ve
(brown) (pale yellow)

State the observation made when the mixture is placed in an ice-bath. Give a reason. (2 marks)

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14. **Figure 3** shows an energy level diagram for the decomposition of hydrogen peroxide using a catalyst.

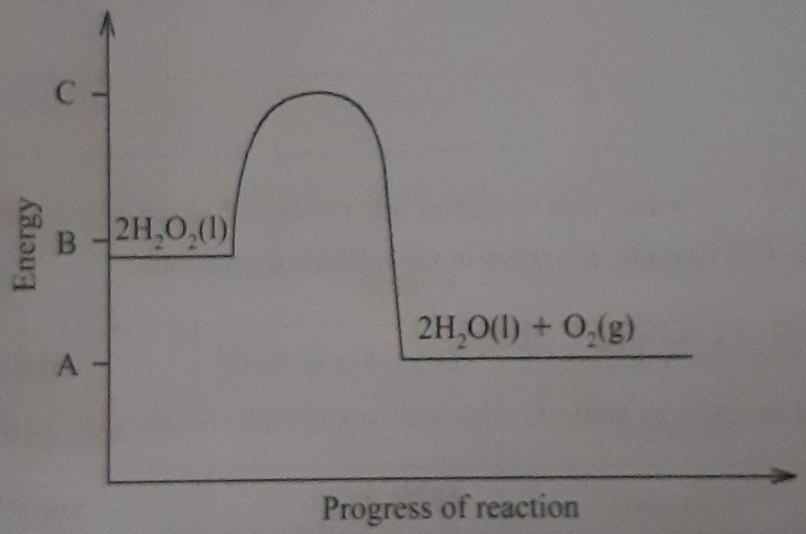

Figure 3

(a) Using the energy values **A**, **B** and **C**, write an expression for:

(i) ΔH of the reaction; (1 mark)

.....

(ii) activation energy. (1 mark)

.....

(b) On the same axis, sketch a curve that would be obtained if the reaction was carried out without a catalyst. (1 mark)

15. Sodium carbonate is prepared on large scale by the Solvay process. The equation for the main reaction that takes place in the carbonator is:

$NaCl(aq) + NH_3(g) + CO_2(g) + H_2O(l) \rightarrow NH_4Cl(aq) + NaHCO_3(s)$

(a) Describe how the sodium carbonate is obtained from the products of the carbonator. (1½ marks)

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(b) One of the by-products of the Solvay process is calcium chloride. Explain how the calcium chloride is formed in this process. (1½ marks)

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16. Methane reacts with bromine as shown in the following equation.

$CH_4(g) + Br_2(g) \rightarrow CH_3Br(g) + HBr(g)$

Using the bond energies in **Table 4**, calculate the enthalpy change, $\triangle H$ for the reaction.

Table 4

Bond	Bond energy (kJ mol^{-1})
C – H	412
C – Br	276
Br – Br	193
H – Br	366

(3 marks)

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17. Some compounds such as CFCs and DDT are regarded as environmental pollutants. Give the complete names of:

(a) CFCs; (1 mark)

.....

(b) DDT. (1 mark)

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18. Use the information in **Table 5** to answer the questions that follow.

Table 5

Liquid	Boiling point (°C)	Miscibility with water
Propanone	56	Miscible
Octane	126	Immiscible
Water	100	–

(a) State the method that can be used to separate propanone and water. (1 mark)

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(b) Describe how a mixture of water and octane can be separated. (2 marks)

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19. 6.2 g of phosphorus was reacted with excess oxygen to form phosphorus(V) oxide. Determine the mass of the oxide formed. (O = 16.0 ; P = 31.0) (2 marks)

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20. Compound **V** reacts with water as shown in the following equation.

$$V + H_2O \rightarrow CH_3CH_2CH_2OH$$

(a) Give the structural formula of compound **V**. (1 mark)

.....

.....

(b) Other than the use of the catalyst, name another condition necessary for this reaction. (1 mark)

.....

(c) This type of reaction is called hydrolysis or hydration. State another name that can be used to describe the reaction. (1 mark)

.....

21. Salts may be classified as soluble or insoluble.

(a) Select from the following list a pair of compounds that can be used to prepare a soluble and an insoluble salt.

HNO_3, $Pb(NO_3)_2$, KNO_3, BaO, NaCl

(i) Soluble salt (1 mark)

.....

(ii) Insoluble salt (1 mark)

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(b) Describe how a soluble salt is obtained from its solution. (1 mark)

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22. (a) State ***one*** factor that affects the preferential discharge of ions at the cathode. (1 mark)

.....

(b) Sodium sulphate was electrolysed using inert electrodes. Write the equation for the reaction that takes place at the:

(i) cathode; (1 mark)

.....

.....

(ii) anode. (1 mark)

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23. Consider the following reaction.

$$H_2S + Cl_2 \rightarrow 2HCl + S$$

Determine the oxidation numbers of chlorine and sulphur in the reactants and products. (2 marks)

	Reactants	Products
Sulphur		
Chlorine		

24. (a) A volume of sulphur(IV) oxide gas diffused from an apparatus in 96 seconds.

Calculate the time taken by an equal volume of carbon(IV) oxide to diffuse under the same conditions. (C = 12.0 ; O = 16.0 ; S = 32.0) (1 mark)

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(b) The rate of diffusion of neon was found to be 1.45 times faster than that of an equal volume of gas **X** at room temperature. Determine the relative formula mass of gas **X** (Ne = 20.0).

(2 marks)

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25. Complete combustion of one mole of an alkanol, C_xH_yOH gave four moles of water. (C = 12.0, H = 1.0, O = 16.0)

Determine the:

(a) values of x and y

(i) x (1 mark)

.....

(ii) y (1 mark)

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(b) number of moles of oxygen required for the complete combustion. (1 mark)

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26. Radioactive decay of $^{228}_{90}Th$ gives **X** , $^{224}_{86}Ra$ and gamma radiation.

(a) Identify **X** ..... (1 mark)

(b) Write a nuclear equation for the decay. (1 mark)

.....

(c) The half-life of $^{228}_{90}Th$ is 1.9 years. If after 5.7 years the mass of $^{228}_{90}Th$ was found to be 1.25 g. Determine the initial mass of the radioactive isotope. (1 mark)

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27. **Figure 4** shows part of the structure of a polymer.

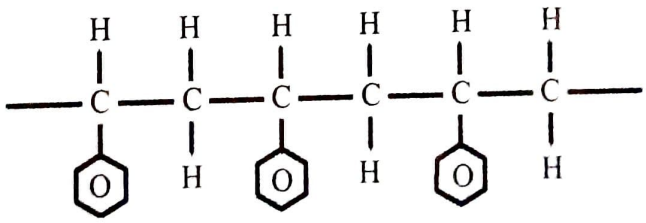

Figure 4

(a) Give the name of the polymer. (1 mark)

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(b) Draw the structure of the monomer used. (1 mark)

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(c) Give ***one*** use of the polymer. (1 mark)

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28. **Figure 5** shows variation of number of outermost electrons **(a)** with atomic number of elements in the periodic table.

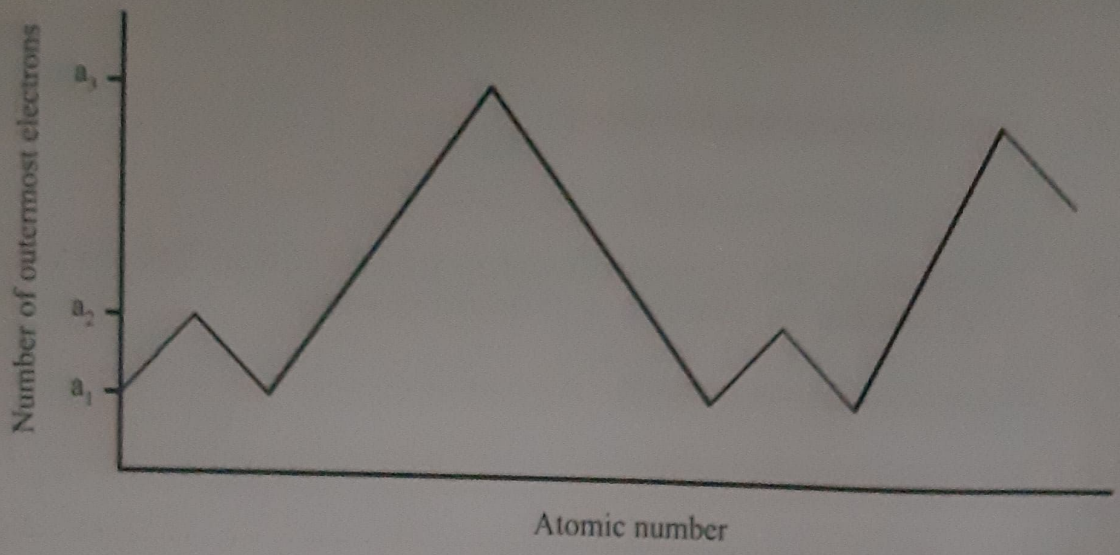

Figure 5

(a) Give the values of

(i) a_1 (1 mark)

.....

(ii) a_3 (1 mark)

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(b) State why elements with a_1 and a_2 outermost electrons do ***not*** react with each other. (1 mark)

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