1904/104
CHEMISTRY TECHNIQUES I
June/July 2023
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT CERTIFICATE IN SCIENCE LABORATORY TECHNOLOGY

MODULE I

CHEMISTRY TECHNIQUES I

3 hours

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INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Non-programmable scientific calculator.
*This paper consists of **TWO** sections; **A** and **B**.*
*Answer **ALL** the questions in section **A** and any **TWO** questions from section **B** in the answer booklet provided.*
*Each question in section **A** carries **4** marks while each question in section **B** carries **20** marks.*
Maximum marks for each part of a question are indicated.
Candidates should answer the questions in English.

This paper consists of 9 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

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SECTION A (60 marks)

Answer ALL questions in this section.

1. 0.1 g of magnesium burnt in excess oxygen yielded 0.166 g of magnesium oxide. Determine the mass of magnesium oxide produced when 0.144 g of magnesium is burnt in excess oxygen. (4 marks)

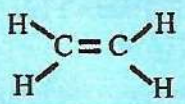
2. (a) (i) Give the general formula of alkanes. (1 mark)

   (ii) Write the structural formula of the third member in the alkane homologous series. (1 mark)

   (b) Write a balanced chemical equation for the reaction of propane with oxygen. (2 marks)

3. Table 1 gives information about some hydrocarbons.

Table 1

Name	Molecular formula	Structure
(a)	C_2H_4	
(b)	C_2H_2	(c)
But-1-ene	C_4H_8	(d)

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Complete the table by filling in the missing information represented by (a), (b), (c) and (d). (4 marks)

4. (a) Write a balanced equation for the reaction between magnesium and copper (II) sulphate solution. (2 marks)

   (b) State the expected observations in terms of colour change. (2 marks)

5. (a) Give the name of the change of state when:

   (i) a liquid changes to a solid; (1 mark)

   (ii) a gas changes to a liquid. (1 mark)

(b) Table 2 shows the melting and boiling points of four substances W, X, Y and Z

Table 2

Substances	Melting point (°C)	Boiling point (°C)
W	−220	−188
X	−101	−34
Y	−7	59
Z	114	184

Determine the letter of the substance that is:

(i) a solid at 20 °C; (1 mark)

(ii) a liquid at 20 °C. (1 mark)

6. (a) Define the term 'isotopes'. (1 marks)

(b) Match the following particles in column **A** to the respective charges in column **B**:

A	B
Electron	+1
Neutron	-1
Proton	0

(3 marks)

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7. (a) Define the term 'chemical bond'. (1 mark)

(b) Table 3 gives information concerning substances A, B and C.

Table 3

Substance	Boiling point (°C)	Solubility in water	Electrical conductivity in aqueous solution
A	−6	Low	Poor
B	600	High	Good
C	1600	Low	Poor

Identify the letter which represents:

(i) an ionic compound; (1 mark)
(ii) a simple molecular compound; (1 mark)
(iii) a giant molecular compound. (1 mark)

8. Methanol can be synthesized according to the following equation:

$$CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$$

In a certain synthesis the molar concentrations of CH_3OH and CO were found to be equal at equilibrium. If the equilibrium constant was 14.5. Determine the equilibrium concentration of H_2. (4 marks)

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9. (a) State **two** properties of acids. (2 marks)

(b) Define the term 'acid salt'. (1 mark)

(c) Identify the acid used to make chlorides. (1 mark)

10. Salts can be prepared by reacting dilute acids with metal carbonates.

(a) Identify the gaseous product. (1 mark)

(b) Describe a simple laboratory test to detect the presence of the gas named in (a). (2 marks)

(c) Name the other product of this reaction other than the salt and the gas. (1 mark)

11. (a) Explain why the melting point of magnesium is higher than that of sodium. (2 marks)

(b) Write an ionic equation for the reaction between sodium chloride and barium nitrate. (2 marks)

12. Determine the number of moles required to prepare 250 ml of 1 M sulphuric acid solution. (4 marks)

13. Determine the volume of 1000 ppm calcium ions solution required to prepare 100 ml of 10 ppm solution. (4 marks)

14. (a) Explain why it is not advisable to use a universal indicator in a titration. (2 marks)

(b) Calculate the pH of a 0.0025 M hydrochloric acid solution. (2 marks)

15. Define each of the following terms:

(a) solute; (1 mark)

(b) solvent; (1 mark)

(c) solution; (1 mark)

(d) sublimation. (1 mark)

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SECTION B (40 marks)

*Answer any **TWO** questions from this section.*

16. (a) Table 4 represents a section of the periodic table. The letters are not the actual symbols of the elements.

Table 4

I	II		III	IV	V	VI	VII	0
U								
V			W			X		
							Y	
							Z	

(i) Identify **two** letters that represent:

(I) alkali metals; (1 mark)

(II) halogens. (1 mark)

(ii) Identify a letter that represents an element capable of forming an ion with a charge of - 2. (1 mark)

(iii) Write the spdf configuration of element Y. (1 mark)

(iv) Write the formula of the compound formed when W and X reacts. (1 mark)

(v) 3.5 g of element U reacted with 4 g of element X to form a compound. Determine the empirical formula of the compound (U = 7, X = 16). (4 marks)

(vi) Draw a dot (•) and cross (X) diagram to show the bonding between element U and element Y. (2 marks)

(vii) Name the type of bond in (vi). (1 mark)

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(b) Explain each of the following observations:

(i) a solution of calcium nitrate conducts electricity while a solution of calcium carbonate does not; (2 marks)

(ii) graphite conducts electricity while diamond does not conduct, yet both of them are allotropes of carbon; (2 marks)

(iii) a magnesium ribbon continues to burn in carbon (IV) oxide, yet carbon (IV) oxide does not support combustion; (2 marks)

(iv) concentrated sulphuric acid gradually becomes less concentrated when exposed to the atmosphere. (2 marks)

17. (a) (i) Calculate the amount of pure calcium nitrate required to prepare one litre of 250 ppm nitrate ions solution. ($Ca(NO_3)_2 = 164, N = 14, O = 16$) (9 marks)

(ii) Describe how the solution in (i) is prepared in the laboratory. (5 marks)

(b) Define the following terms:

(i) element; (1 mark)
(ii) compound. (1 mark)

(c) (i) State the:

(I) Mendeleev's periodic law. (1 mark)
(II) Döbereiner's law of triads. (1 mark)

(ii) State the difference between Mendeleev's periodic table and the modern periodic table. (1 mark)

(iii) State the relationship between atomic masses of elements in a Döbereiner's triad. (1 mark)

18. (a) 1.4 g of sodium metal reacted with water.

(i) Write a balanced equation for this reaction. (2 marks)

(ii) Determine the mass of the non-gaseous product formed. ($Na = 23, O = 16, H = 1$). (4 marks)

(iii) State the observations when the non-gaseous product in (ii) was tested with:

(I) blue litmus paper; (1 mark)
(II) red litmus paper. (1 mark)

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(b) A sample contains 7.59% of lithium 6 (Li 6) and 92.41% of lithium 7 (Li 7). Calculate the relative atomic mass of lithium in the sample. (4 marks)

(c) Explain the observations made when a sample of ethene and a sample of polyethene are separately shaken with small volumes of bromine water. (4 marks)

(d) Table 5 shows information on certain experiments.

Table 5

Experiment	Observation	Type of change	Name of product
Anhydrous copper (II) sulphate is left exposed overnight	(i)	Temporary	(ii)
Iron wool is soaked in tap water and allowed to stand for two days	Colour changes to brown	(iii)	(iv)

Outline the missing information represented by (i), (ii), (iii) and (iv). (4 marks)

19. (a) Fluorine,chlorine,bromine and iodine are elements in the same group of the periodic table.

(i) Name the chemical family to which their elements belong. (1 mark)

(ii) Identify the compound formed when bromine reacts with hydrogen gas. (1 mark)

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(b) Chlorine, bromine and iodine are dissolved in water to make aqueous solutions. Potassium iodide solution is then added to each aqueous solution. Table 6 shows the observations made.

Table 6

Compound	Initial colour of aqueous solution	Colour of aqueous solution after addition of potassium iodide
Bromine	Orange	Brown
Chlorine	Pale green	Brown
Iodine	Brown	Brown

(i) Explain these observations. (3 marks)

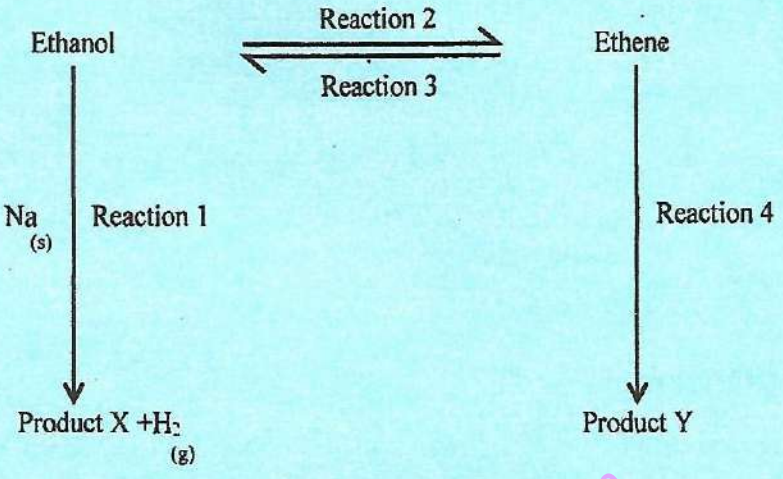
(ii) Write a balanced chemical equation for each reaction of the aqueous solutions with potassium iodide. (3 marks)

(c) 2-methlybutan-1-ol and 2-methylbutan-2-ol were separately reacted with acidified potassium dichromate solution.

(i) State the observation made in each case. (2 marks)

(ii) Give reasons for the answer in c (i). (2 marks)

(d) The following scheme shows four reactions starting with ethanol.



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(i) Write the names of:

(I) product X; (1 mark)
(II) product Y. (1 mark)

(ii) Identify the type of reaction in:

(I) reaction 2; (1 mark)
(II) reaction 3; (1 mark)
(III) reaction 4. (1 mark)

(iii) State two conditions necessary in reaction 4. (2 marks)

(iv) Write the structural formula of product Y. (1 mark)

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