1904/204
CHEMISTRY TECHNIQUES II
June/July 2023
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT CERTIFICATE IN SCIENCE LABORATORY TECHNOLOGY

MODULE II

CHEMISTRY TECHNIQUES II

3 hours

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** 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 7 printed pages.

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

Turn over

SECTION A (60 marks)

*Answer **ALL** questions in this section.*

1. A sample of calcium carbonate was completely decomposed to a constant mass. If the mass of the calcium oxide remaining was 2.8 g, determine the mass of the calcium carbonate decomposed.

   $(CaCO_3 = 100, Ca = 40, O = 16)$

   (4 marks)

2. List **four** factors which effect the efficiency of the column in column chromatography.

   (4 marks)

3. (a) Write the equation relating the absorbance of a solution to its transmittance.

   (1 mark)

   (b) Convert a transmittance of 0.35 into absorbance. (3 marks)

4. Highlight **two**:

   (a) advantages of total consumption burner in flame photometry; (2 marks)

   (b) disadvantages of flame ionisation techniques. (2 marks)

5. The molar conductivity of aqueous ethanoic acid of concentration 0.1 moles per litre was 4.6 $cm^2\ \Omega^{-1}\ mol^{-1}$ and 352 $cm^2\ \Omega^{-1}\ mol^{-1}$ at infinite dilution. Determine the:

   (a) degree of dissociation; (2 marks)

   (b) pH of the solution. (2 marks)

6. Figure 1 shows an arrangement of apparatus to separate a mixture of liquid A and B.

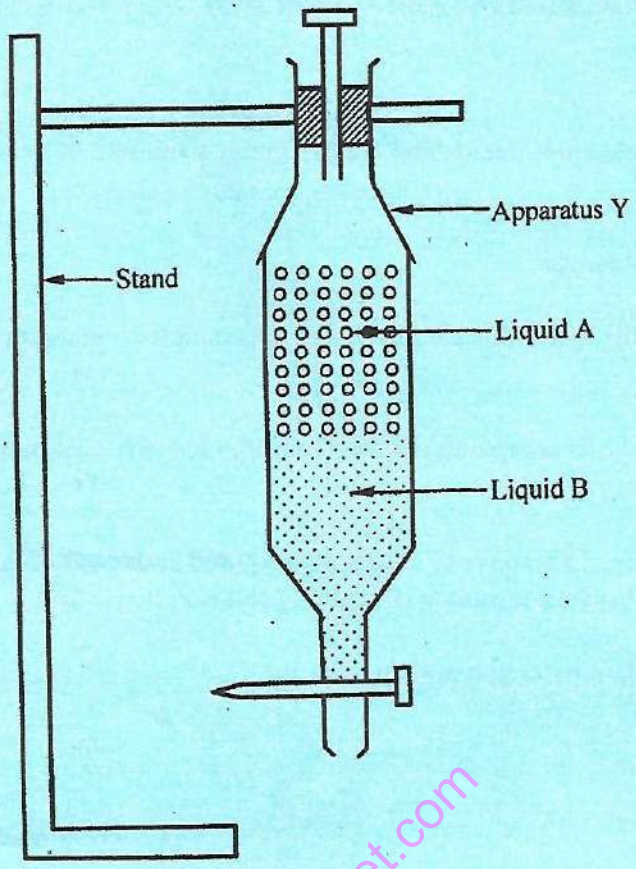

Fig. 1

(a) Name the apparatus Y. (1 mark)

(b) State the property of the liquids which enables the separation to take place. (1 mark)

(c) Given that the density of paraffin is 0.66 g/cm^3 and that of water is 1 g/cm^3. Identify:

(i) liquid A; (1 mark)

(ii) liquid B. (1 mark)

7. Given that $E^{\ominus}$ *of* $Cu_{(s)} \mid Cu_{(aq)}^{2+}$ is +0.34 V, and that of $Zn_{(s)} \mid Zn_{(aq)}^{2+}$ is -0.76 V, draw a labelled diagram of zinc and copper electrochemical cell. (4 marks)

8. Draw a labelled diagram of the set-up of apparatus that can be used to electrolyse molten lead (II) bromide. (4 marks)

9. 5 g of a food sample was completely burnt in a bomb calorimeter. The temperature of the water in the calorimeter rose by 10°C. Determine the energy content in the food sample in calories (Specific heat capacity of water = 4.2 $Jg^{-1}K^{-1}$). (4 marks)

10. List any **two**:

(a) chemical techniques that can be used to purify a mixture of common salt and water; (2 marks)

(b) filtration techniques. (2 marks)

11. Highlight **four** factors that influence the choice of a stationary phase in column chromatography. (4 marks)

12. Describe how a lovibond comparator is used to estimate the concentration of a coloured sample. (4 marks)

13. Calculate the number of Faradays of electricity required to deposit 6.3 g of copper at the cathode during electrolysis of molten copper (II) chloride (Cu = 63.5) (4 marks)

14. Determine the standard reduction potential for the $Cd^{2+}_{(aq)}|Cd_{(s)}$ electrode given the following information:

$$Cd_{(s)}|Cd^{2+}(1M)\parallel Cu^{2+}(1M)\ |Cu_{(s)}, E^{\ominus} = 0.74\,V$$

$$Cu^{2+}(1M) + 2e \longrightarrow Cu_{(s)},\ E_{Cu^{2+}}|Cu = 0.337\,V$$

(4 marks)

15. Name the products obtained at both the anode and cathode during electrolysis of:

(a) molten sodium chloride; (2 marks)

(b) dilute aqueous sodium chloride. (2 marks)

SECTION B (40 marks)

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

16. (a) Define the term 'relative molecular mass'. (1 mark)

(b) An organic compound has a relative molecular mass of 156. A mixture of 0.11 g of the organic compound and 1 g of solvent X depressed the melting point of the compound by 28.2°C.
Determine the freezing point depression constant (Kf) for solvent X. (4 marks)

(c) **Table 1** shows data obtained during the determination of melting points of varying amounts of compound Y in solvent X.

Table 1

Molarity of mixture of compound Y in solvent X (kg/1000 g)	0.0	0.02	0.04	0.06	0.08	0.10
Melting point (°C)	177.0	169.8	162.6	155.4	148.2	141.0
Freezing point depression (ΔF °C)						

(i) given that the melting point of pure camphor is 177°C, copy and complete the table for values of freezing point depression. (6 marks)

(ii) plot a graph of molality against freezing point depression. (6 marks)

(iii) determine the gradient of the graph. (2 marks)

(iv) Calculate the relative molecular mass of compound Y, given that:

R.M.M = Kf X gradient x 1000;

where Kf is the value obtained in (b).

(1 mark)

17. (a) Distinguish between electrolytic conductivity and molar conductivity. (1 mark)

(b) **Table 2** gives information about conductivities of different electrolytes.

Table 2

Solution	Electrolytic conductivity (Sm^{-1})	Molar conductivity ($Sm^2\ mol^{-1}$)	Molar conductivity at infinite dilutation $Sm^2\ mol^{-1}$	Degree of dissociation (α)
0.1 M KCl	(i)	1.29×10^{-2}	1.499×10^{-2}	(ii)
0.02 M HCl	0.814	(iii)	4.261×10^{-2}	(iv)
0.05 M $AgNO_3$	0.064	(v)	(vi)	0.96

Calculate the values of (i), (ii), (iii), (iv), (v) and (vi). (12 marks)

(c) A current of 5 A was passed through mollten lead (II) chloride for 2 hours. Determine the:

(i) quantity of electricity used; (2 marks)

(ii) number of Faradays of electricity used; (2 marks)

(iii) mass of lead deposited at the cathode (Pb = 207). (3 marks)

18. (a) Draw a labelled diagram of a bomb calorimeter. (7 marks)

(b) Describe how the energy content of a food sample is measured in a bomb calorimeter. (6 marks)

(c) The data in table 3 was obtained during a colorimetric determination of the concentration of glucose in a sample.

Table 3

Concentration of glucose ($mol\ dm^{-3}$)	**Absorbance**
0.0	0.0
1×10^{-3}	0.1
2×10^{-3}	0.2
3×10^{-3}	0.3
4×10^{-3}	0.4
5×10^{-3}	0.5
6×10^{-3}	0.6

(i) Draw a calibration curve for the analysis. (6 marks)

(ii) Using the curve, determine the concentration of an unknown sample of glucose whose absorbance was 0.16. (1 mark)

19. (a) A 15 g sample of impure potassium chloride was reacted with an excess solution of lead (II) nitrate. The mass of lead (II) chloride deposited was 18.65 g. ($PbCl_2 = 278$, $KCl = 74.5$).

(i) Name the type of reaction which took place between potassium chloride and lead (II) nitrate. (1 mark)

(ii) Explain why lead (II) nitrate was used in excess. (1 mark)

(iii) Write a balanced equation for the reaction. (2 marks)

(iv) Determine the number of moles of:

(I) lead (II) chloride produced; (2 marks)

(II) potassium chloride in the impure sample. (3 marks)

(v) Calculate:

(I) mass of potassium chloride in the sample; (3 marks)

(II) percentage by mass of potassium chloride in the sample. (2 marks)

(b) Highlight **three** properties of an ideal:

(i) wash solution in gravimetric analysis; (3 marks)

(ii) solvent in solvent extraction. (3 marks)

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