2913/102
MATHEMATICS AND
APPLIED SCIENCE
Oct./Nov. 2021
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN FOOD SCIENCE AND PROCESSING TECHNOLOGY

MODULE I

MATHEMATICS AND APPLIED SCIENCE

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 15 marks while each question in section **B** carries 20 marks.*
Maximum marks for each part of a question are as shown.
Candidates should answer the questions in English.

This paper consists of 8 printed pages.

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

SECTION A (60 marks)

Answer ALL the questions in this section.

1. (a) Without using a calculator evaluate $\frac{2}{3}$ of $\left(3\frac{1}{4} - 1\frac{3}{4} \div \frac{7}{8}\right)$. (3 marks)

(b) Solve the quadratic equation: $-4x - 5 = -x^2$. (3 marks)

(c) If $x = \begin{pmatrix} 1 & -2 \\ 0 & 1 \end{pmatrix}$ and $z = \begin{pmatrix} 3p & 5q \\ 4r & 3s \end{pmatrix}$ determine the value of p, q, r, and s, given $2x = z$ (4 marks)

(d) A trader bought a photocopier for Ksh. 36,500. He later sold it for Ksh. 44,500. Determine his percentage profit. (3 marks)

(e) Given the sequence $2, -6, 18, -54$, determine the 8^{th} term of the sequence. (2 marks)

2. (a) Convert the following to SI unit:

(i) 0.6 g; (1 mark)
(ii) 0.0001 km. (1 mark)

(b) Define the term capacitance. (1 mark)

(c) Explain how each of the following factors affect the capacitance of the capacitors.

(i) area of the overlap; (1 mark)
(ii) distance of separation. (1 mark)

(d) Figure 1 shows the behaviour of light from a distance object.

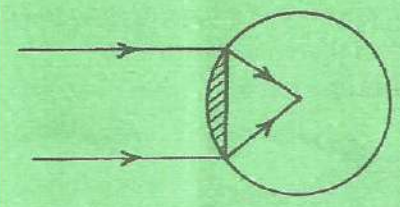

Fig. 1

(i) Identify the defect. (1 mark)
(ii) By using ray diagram, show how the defect.can be corrected. (2 marks)
(iii) The critical angle for diamond is 24.4^0, calculate the refractive index of diamond. (3 marks)

(e) (i) Define 'specific latent heat of fusion'. (1 mark)

(ii) A 2 g solid requires 12.2 J of energy to change its state. Calculate the latent heat of fusion. (3 marks)

3. (a) (i) State the Le-Chatelier principle. (1 mark)

(ii) State **two** factors which affect equilibrium constant. (2 marks)

(b) Table I gives the atomic numbers of the elements **A, B, C, D,E, F** and **G**. Study it and answer the questions that follow. The letters do not represent the actual symbols of the elements.

Table I

Element	A	B	C	D	E	F	G
Atomic Number	14	15	16	17	18	19	20

(i) Using the s.p.d.f notation, write the electron configuration of element **A**. (1 mark)

(ii) Write the formula of the compound formed when **D** reacts with **G**. (1 mark)

(iii) State the type of bond present in the compound (ii) above. (1 mark)

(c) Given that the oxidation number of oxygen (O) is -2, calculate the oxidation number of chromium in $Cr_2O_7^{2-}$. (3 marks)

(d) State **two** advantages and **one** disadvantage of detergents compared to soap. (3 marks)

(e) Balance the chemical equation $Ca(OH)_{2(s)} + NH_4Cl \longrightarrow CaCl_{2(aq)} + NH_{3(g)} + H_2O_{(l)}$. (3 marks)

4. (a) Name the basic functional unit of kidney. (1 mark)

(b) Define binomial nomenclature. (1 mark)

(c) Explain the importance of each of the following in a living organism:

(i) locomotion; (2 marks)

(ii) respiration. (1 mark)

(d) Name the cell organelles which are abundant in:

(i) sperm cell; (1 mark)
(ii) pancreas. (1 mark)

(e) Explain fish gills adaptation to gaseous exchange. (3 marks)

(f) Explain the role of each of the following hormones:

(i) prolactin; (1 mark)
(ii) testesterone; (1 mark)
(iii) progesterone. (1 mark)

(g) State the function of exoskeleton in insects. (2 marks)

SECTION B (40 marks)

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

5. (a) Calculate the standard deviation of the following set of numbers 5, 6, 7, 8, 9. (5 marks)

(b) Determine $\frac{dy}{dx}$ given that $y = \frac{x^2 + 4x + 4}{x + 2}$ (3 marks)

(c) Figure 2 shows a triangle ABC with **a** = 10 cm; **b** = 8 cm and $\angle ABC = 50^0$. Calculate $\angle BAC$. (4 marks)

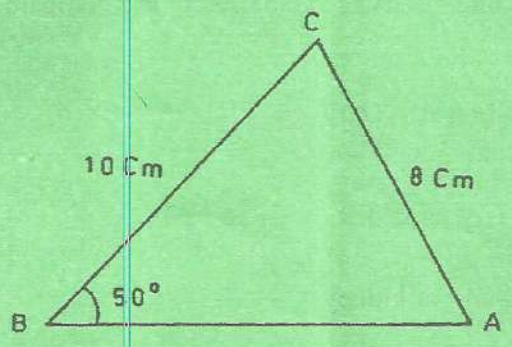

Fig. 2

(d) Given that vector $\underset{\sim}{a} = 7i + 3j - k$ and $\underset{\sim}{b} = 2i + 5j + k$, determine:

(i) $\underset{\sim}{a} + \underset{\sim}{b}$; (2 marks)

(ii) $|\underset{\sim}{a} + \underset{\sim}{b}|$. (2 marks)

(e) Express b in terms of y in the expression:

$$6\log_a b - 2\log_a b = 2\log_a b + \log_a y$$ (4 marks)

6. (a) Figure 3 shows the force between parallel conductors carrying current.

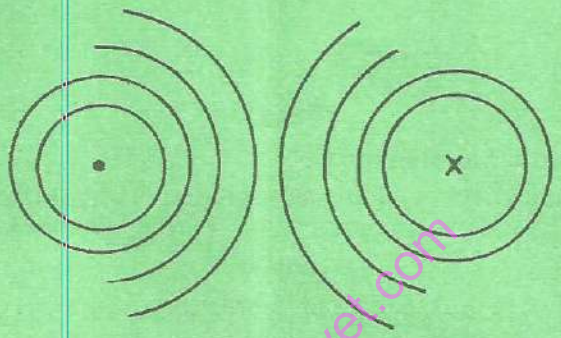

Fig. 3

On the diagram indicate the:

(i) directions of magnetic field lines. (1 mark)

(ii) direction of the force. (1 mark)

(b) State **two** properties of cathode rays. (2 marks)

(c) (i) Define centripetal force. (1 mark)

(ii) A body of mass 2 kg was tied to a string and whirled in a horizontal circle of radius 0.8 m, with a speed of 4 ms^{-1}. Calculate the tension on the string. (3 marks)

(d) Calculate the effective resistance in Figure 4. (3 marks)

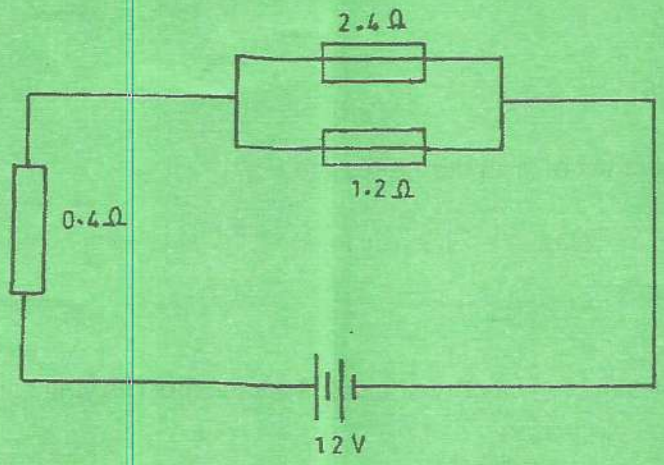

Fig 4

(e) (i) Define surface tension force. (1 mark)

(ii) Explain the effect of adding salt solution on the surface tension of a liquid. (2 marks)

(f) Differentiate between diffraction and interference of waves. (2 marks)

(g) Distinguish between elastic and inelastic collision. (2 marks)

(h) State **two** applications of Bernoullis effect. (2 marks)

7. (a) 24.6 g of hydrated salt $MSO_4 x H_2O$ on heating produced 12.0 g of anhydrous MSO. Calculate the value of x. (M = 24, S = 32, O = 17). (5 marks)

(b) When sodium hydroxide is reacted with dilute sulphuric (VI) acid, sodium chloride and water are the only products produced. Write a balanced chemical equation for the reaction. (3 marks)

(c) Study the flow chart shown in Figure 5 and answer the questions that follow.

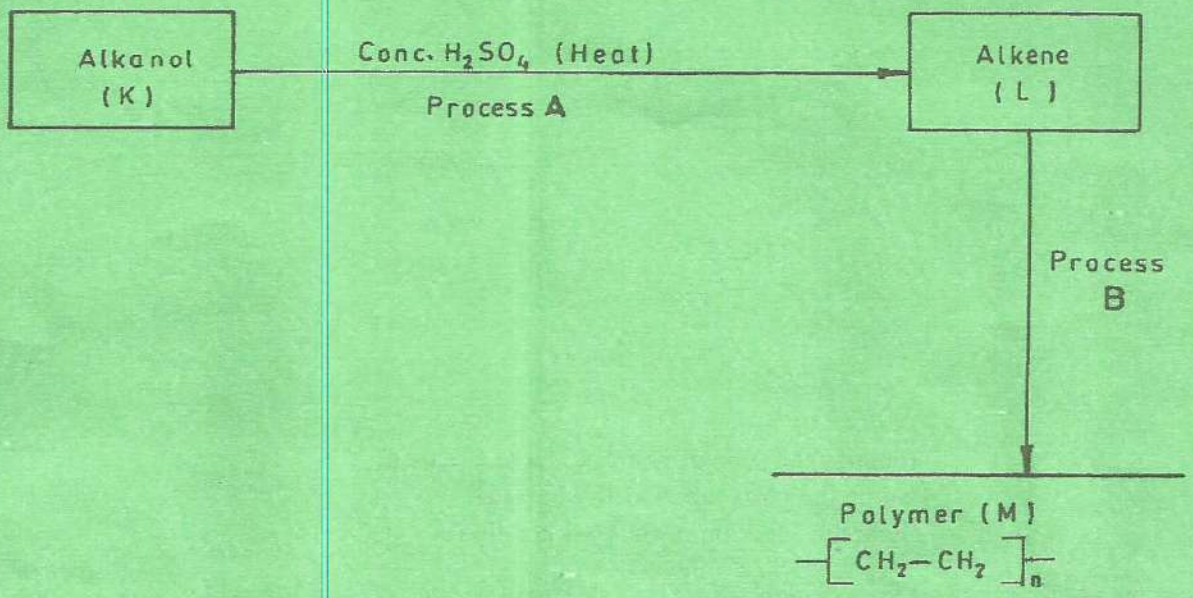

Fig.5

Write the structural formulae of:

(i) Alkanol (K); (1 mark)
(ii) Alkene (L); (1 mark)
(iii) State the IUPAC name of (L); (1 mark)
(iv) Name the process labelled **A** and **B**; (2 marks)
(v) Write an equation for the formation of polymer M from alkene (L). (2 marks)

(d) Table II shows some properties of compound **P, Q, R** and **S**. Study it and answer the questions that follow.

Table II

Compound	Melting point (m.p)	Boiling point (B.P)	Electrical conductivity in water
P	−23	77	Does not conduct
Q	−19	74	Does not conduct
R	−.85	−61	Does not conduct
S	407	724	Conduct

(i) Identify the ionic compound in table II. Explain. (2 marks)
(ii) State the compound that is gaseous at room temperature. (1 mark)

(e) Name the sub-atomic particles found in an atom. (2 marks)

8. (a) Figure 6 shows a neurone.

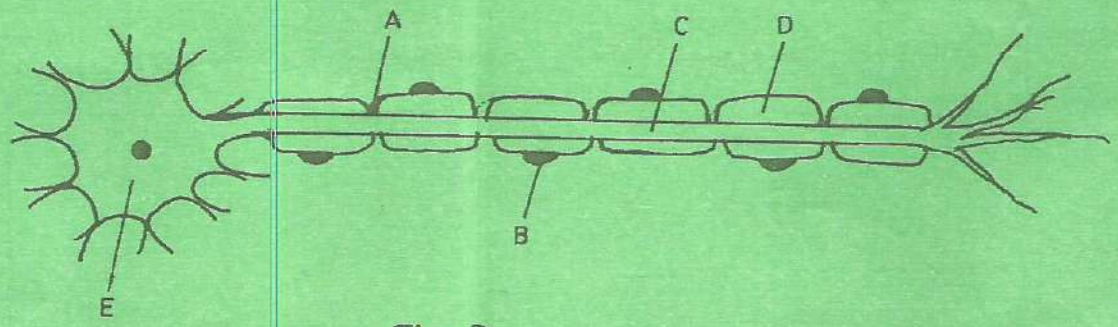

Fig. 6

(i) Identify the type of neurone. Give a reason. (2 marks)
(ii) Name the parts labelled **B**, **C** and **D**. (3 marks)
(iii) State the function of the part labelled **A**. (1 mark)

(b) Explain why plants lack complex excretory system. (3 marks)

(c) (i) Distinguish between a hinge joint and a ball & socket joint. (2 marks)
(ii) Name the cartilage found between the vertebrae of the vertebral column C. (1 mark)
(iii) Explain the functions of the cartilage named in c (ii) above. (3 marks)

(d) State **three** reasons for the loss of energy from one trophic level to the next in a food web. (3 marks)

(e) Explain the roles of the Tricuspid valve in a mammalian heart. (2 marks)

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