

2525/102
2921/102
2910/102
APPLIED SCIENCE I
Oct. / Nov. 2022
Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

**DIPLOMA IN ENTREPRENEURIAL AGRICULTURE
DIPLOMA IN SUSTAINABLE AGRICULTURE AND RURAL DEVELOPMENT**

MODULE I

APPLIED SCIENCE I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;

Mathematical table/Non-programmable scientific calculator.

This paper consists of TWO sections; A and B.

Answer any THREE questions from section A and any TWO questions from section B in the answer booklet provided.

All questions carry equal marks.

Maximum marks for each part of a question are indicated.

Candidates should answer the questions in English.

This paper consists of 10 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 any **THREE** questions from this section.

1. (a) Figure 1 shows the electronic configurations of six different atoms.

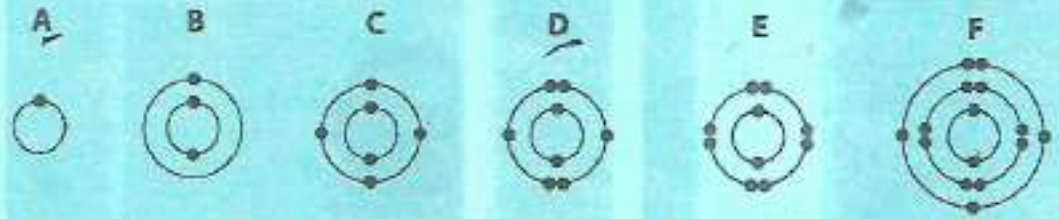


Fig. 1

(i) Give the letter that represents an atom:

- (I) of a noble gas;
- (II) that contains three protons;
- (III) of phosphorus;
- (IV) of an element in group 4 of the periodic table;
- (V) of an element in period 3 of the periodic table;
- (VI) of a fully filled outer shell.

(6 marks)

(ii) Work out the formula of the compound formed between atoms A and D.

(2 marks)

Figure 2 is a piece of apparatus containing 0.010 mol/dm^3 hydrochloric acid.



Fig. 2

2

Handwritten notes on the left side of the page:

- Hydrog - 1
- Helium - 2 - He
- Lithium - 3 - Li
- Boron - 5 - B
- Carbon - 6 - C
- Nitrogen - 7 - N
- Oxygen - 8 - O
- Fluorine - 9 - F
- Neon - 10 - Ne
- Sodium - 11 - Na
- Magnesium - 12 - Mg
- Aluminium - 13 - Al
- Silicon - 14 - Si
- Phosphorus - 15 - P
- Sulphur - 16 - S
- Chlorine - 17 - Cl
- Argon - 18 - Ar
- Potassium - 19 - K
- Calcium - 20 - Ca

Handwritten periodic table:

H			He
Li	B	Be	Ne
Na	Al	Mg	Ar
K	Ca		

Handwritten calculations:

$$\frac{0.010}{1000} = 0.00001$$

$$\frac{25}{1000} = 0.025$$

$$0.00001 \times 0.025 = 0.0000025$$

2525/102

2921/102

2910/102

Oct./Nov. 2022

- (i) Name the apparatus shown. (1 mark)
- (ii) Determine the volume of hydrochloric acid in the apparatus. (1 mark)
- (iii) Using the volume in b(ii), calculate the amount in moles of the hydrochloric acid in the apparatus. (3 marks)

(c) A student poured a solution containing 0.010 moles of hydrochloric acid into a beaker. He then added 0.0075 mol of zinc powder and collected the hydrogen gas given off in the syringe.

- (i) Write a balanced chemical equation for this reaction. (2 marks)
- (ii) Explain whether the zinc or the hydrochloric acid is in excess. (3 marks)
- (iii) Explain the effect this change would have on the rate at which the hydrogen is given off. (2 marks)

2. (a) Sulfur dioxide, SO_2 , is used as a preservative in wine. A chemist found that 25.0 cm^3 of a sample of wine reacted with exactly 15.0 cm^3 of 0.0010 mol/dm^3 aqueous iodine, $\text{I}_{2(aq)}$. The equation of the reaction is:



- (i) Calculate the amount in moles of iodine in 15.0 cm^3 of a 0.0010 mol/dm^3 solution. (2 marks)
- (ii) Deduce the amount in moles of sulfur dioxide in 25.0 cm^3 of the wine. (2 marks)
- (iii) Calculate the concentration, in mol/dm^3 , of sulfur dioxide in the wine. (2 marks)
- (iv) Calculate the concentration, in g/dm^3 , of sulfur dioxide in the wine. (3 marks)
- (v) A concentration of sulfur dioxide that is greater than 0.16 g/dm^3 makes wine unpleasant to drink. State whether the wine is drinkable. (1 mark)

- (b) Table I shows values for the solubility of copper (II) sulphate.

Table I

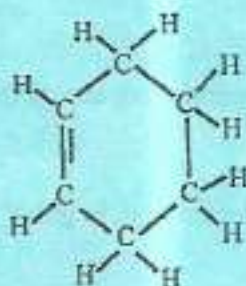
Temperature (°C)	0	20	40	60	80	100
Solubility (g/100 g water)	14	20	28	40	56	77

- (i) Plot the solubility of copper (II) sulphate (Y-axis) against the temperature. (6 marks)
- (ii) Determine the solubility of copper (II) sulphate at 50 °C. (1 mark)
- (iii) Calculate the mass of copper (II) sulphate which will saturate 10 g of water at 30 °C. (2 marks)
- (iv) Determine the temperature at which 60 g of copper (II) sulphate will saturate 100 g of water. (1 mark)

$$\frac{60 \times 80}{800}$$

3. Cyclohexane, cyclohexene, ethanol and ethanoic acid are colourless liquids at room temperature. Each one belongs to a different homologous series.

- (a) State four characteristics of a homologous series. (4 marks)
- (b) Cyclohexane is an alkane.
- (i) Write the general formula of alkanes. (1 mark)
- (ii) Draw the structural formula of ethane. (1 mark)
- (c) Cyclohexene is a hydrocarbon with the following structural formula:



- (i) Identify the functional group in cyclohexene. (1 mark)
- (ii) State why cyclohexene is described as a hydrocarbon. (1 mark)
- (iii) Name two products formed when cyclohexene is burned in excess oxygen. (2 marks)

2525/102

2921/102

2910/102

Oct./Nov. 2022

(iv) Name the two compounds formed when cyclohexene is burned in limited supply of oxygen. (2 marks)

(d) Ethanol can be made by fermentation.

(i) Describe the process of fermentation. (2 marks)

(ii) State two uses of ethanol. (2 marks)

(e) Ethanoic acid has a sharp smell.

(i) State one use of ethanoic acid. (1 mark)

(ii) Complete the following equation:



4. (a) Figure 3 shows scales of a measuring instrument.



(i) Identify the instrument. (1 mark)

(ii) State the reading of the instrument. (2 marks)

(b) The law of a machine is given as $E = 0.08L + 30$. The efficiency of the machine is 80% at an effort of 60 N. Determine velocity ratio of the machine. (5 marks)

(c) A wire of length 4 m and diameter 0.05 cm is fixed at one end and carries a mass of 15 kg at the other end. The length increases by 3 mm. Given $g = 9.81 \text{ N/m}^2$, calculate:

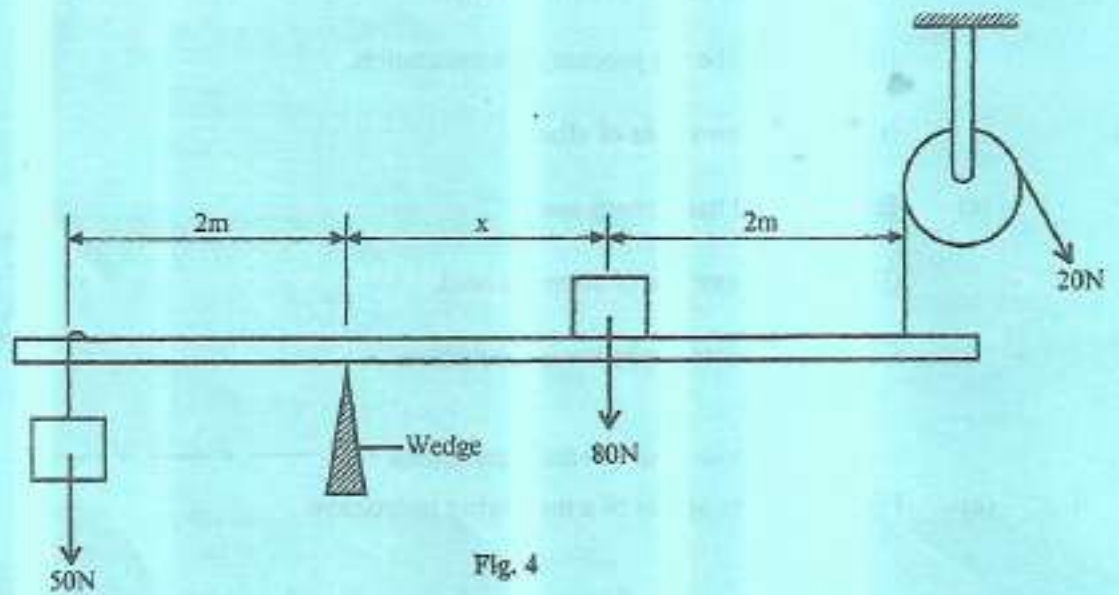
(i) stress; (3 marks)

(ii) strain; (2 marks)

(iii) Young's modulus. (2 marks)

(d) Describe the kinetic theory of matter. (5 marks)

5. (a) (i) Define the term 'moment of force' and state its SI unit. (2 marks)
- (ii) Figure 4 shows a lever at equilibrium under the action of three forces.



Determine:

- (I) distance X ; (4 marks)
- (II) reaction force at the wedge. (2 marks)
- (b) (i) State Archimedes principle. (2 marks)
- (ii) A solid weighs 150 N in air and 70 N when fully immersed in fresh water.
- (I) Calculate the upthrust force. (1 mark)
- (II) Determine the density of the solid. (5 marks)

(c) Figure 5 shows a simple relay circuit.

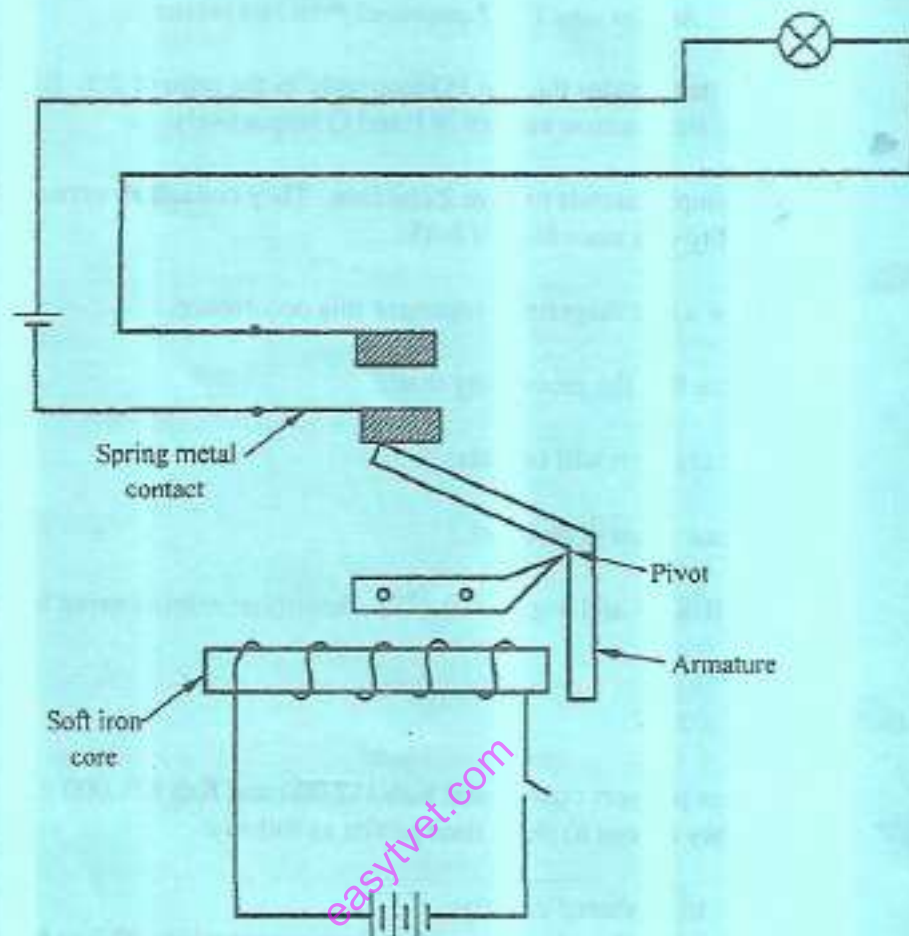


Fig. 5

Explain the observations made when the switch is closed.

(4 marks)

2525/102

2921/102

2910/102

Oct. / Nov. 2022

SECTION B (40 marks)

Answer any TWO questions from this section.

6. (a) R is a point that divides the line PQ internally in the ratio of 2:5. Express \underline{OR} in terms of \underline{p} and \underline{q} the position vectors of P and Q respectively. (4 marks)
- (b) A married couple intends to have 2 children. They consult an expert who tells them that the probability of a male birth is 0.45.
- (i) Draw a tree diagram to represent this occurrence. (2 marks)
- Hence find the probability that:
- (ii) all 2 children will be girls; (2 marks)
- (iii) at least one will be a girl. (4 marks)
- (c) If $\log_{10}2 = 0.3010$ and $\log_{10}3 = 0.4771$, determine without using tables $\log_{10}4.5$. (6 marks)
- (d) Solve $3^{2x+3} = 2187$. (2 marks)

7. (a) Two business partners contributed Ksh 112,000 and Ksh 128,000 towards a business venture. They agreed to share their profits as follows:
- 30% to be shared equally;
 30% to be shared in the ratio of their contribution; 40% to be retained for the business operational cost.
- If their total profit for the year was Ksh 84,400, calculate the amount received by each partner. (7 marks)
- (b) The 5th and 10th terms of an arithmetic progression are 18 and - 2 respectively. Find the common difference. (4 marks)
- (c) Without using logarithm tables or calculators evaluate:

$$\frac{64^{-\frac{1}{2}} \times 27000^{\frac{2}{3}}}{2^{-4} \times 3^7 \times 5^2} \quad (3 \text{ marks})$$

- (d) Simplify: (3 marks)
- $$\frac{(6a + b)(a + b) - 7b(a + b)}{2a^2 - 2b^2}$$

$$(6a + b)(a + b) - 7b(a + b)$$

$$6a^2 + 6ab + ab + b^2 - 7ab - 7b^2$$

$$6a^2 + 6a + a - 7ab + b^2 - 7b^2$$

$$6a^2 + 7a - 6b^2$$

$$\frac{6a^2 + 7a - 6b^2}{2a^2 - 2b^2}$$

2525/102

2921/102

2910/102

Oct. / Nov. 2022

- (e) Make S the subject of the formula:

$$K = \sqrt{\frac{PT}{S+T}}$$

$$(K)^2 = \left(\frac{PT}{S+T} \right)^2$$

$$K = \frac{PT}{S+T}$$

$$K(S+T) = PT$$

$$KS + KT = PT$$

$$KS + KT = PT$$

$$K(S+T) = PT$$

$$KS = PT - KT$$

$$KS = T(PT/K)$$

(3 marks)

8. Figure 6 shows a conical vessel which is supported vertically. The vessel contains water to a depth of 30 cm. The radius of the water surface in the vessel is 21 cm.

$$(K)^2 = \left(\frac{PT}{S+T} \right)^2$$

$$K = \frac{PT}{S+T}$$

$$PT = K(S+T)$$

$$PT = KS + KT$$

$$\frac{PT}{K} = \frac{KS + KT}{K}$$

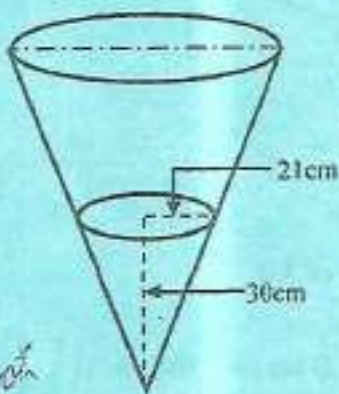


Fig. 6

- (a) Calculate the volume of the water in the vessel. (3 marks)
- (b) When a metal sphere is completely submerged in the water the level of the water in the vessel rises by 6 cm. Calculate:
- (i) the volume of the metal sphere; (5 marks)
- (ii) the radius of the sphere. (2 marks)

$$K = \frac{PT}{S+T}$$

$$K = \frac{PT}{S+T}$$

$$PT = K(S+T)$$

$$PT = KS + KT$$

$$PT = K(S+T)$$

$$PT = \frac{KS + KT}{K}$$

S1 9

2525/102

2921/102

2910/102

Oct./Nov. 2022

Turn over

- (c) In figure 7, AB is a tangent to the circle centre O and radius 12 cm. The area of the triangle AOB is 120 cm^2 . OXB is a straight line.

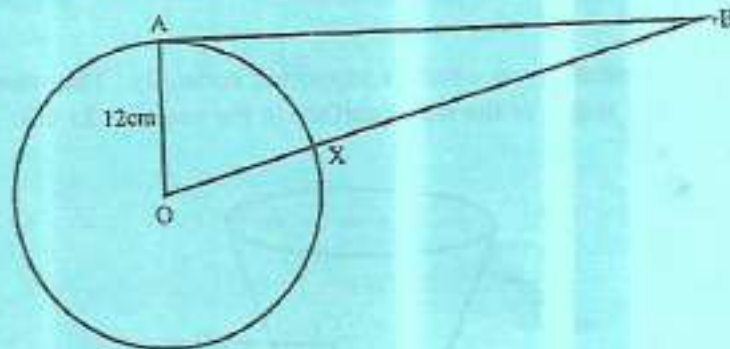


Fig. 7

Calculate the length of XB.

(6 marks)

- (d) Two matrices A and B are such that $A = \begin{pmatrix} k & 4 \\ 3 & 2 \end{pmatrix}$ and $B = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$. Given the determinant of $AB = 4$, evaluate the value of k.

(4 marks)

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