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PHYSICAL SCIENCE, MECHANICAL SCIENCE
AND ELECTRICAL ENGINEERING PRINCIPLES

June/July 2015

Time: 3 hours

Candidate's Signature _____

Date _____



THE KENYA NATIONAL EXAMINATIONS COUNCIL

**DIPLOMA IN ELECTRICAL AND ELECTRONICS ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)
MODULE I**

PHYSICAL SCIENCE, MECHANICAL SCIENCE
AND ELECTRICAL ENGINEERING PRINCIPLES

3 hours

**INSTRUCTIONS TO CANDIDATES**

Write your name and index number in the spaces provided above.

Sign and write the date of the examination in the spaces provided above.

You should have mathematical tables/scientific calculator for this examination.

*This paper consists of **EIGHT** questions in **THREE** sections; A, B and C.*

*Answer **TWO** questions from Section A, **ONE** question from Section B and **TWO** questions from Section C in the spaces provided in this question paper.*

All questions carry equal marks.

Maximum marks for each part of a question are as shown.

*Do **NOT** remove any pages from this booklet.*

Candidates should answer the questions in English.

Take $U^\circ = 4\pi \times 10^{-7} \text{ H/m}$ and $\epsilon^\circ = 8.85 \times 10^{-12} \text{ F/m}$

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Question	1	2	3	4	5	6	7	8	TOTAL SCORE
Candidate's Score									

This paper consists of 20 printed pages.

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

June 2014 (6)

SECTION A: PHYSICAL SCIENCE

Answer **TWO** questions from this section.

1. (a) The table 1 shows some elements and electronic arrangement of their ions. (letters are not actual symbols of elements).

Elements	Ion	Ion electronic configuration	Atomic radius (mm)	ionic radius (mm)
P	P^{2+}	2.8.8	0.197	0.099
Q	Q	2.8	0.072	0.136
R	R^{+}	2.8.8	0.231	0.133
S	S^{3+}	2.8	0.143	0.050
T	T^{2+}	2.8.18	0.133	0.074
U	U^{2+}	2.8	0.160	0.065
V	V^{+}	2.8	0.186	0.095
W	W^{+}	2.	0.156	0.060
X	X^{-}	2.8.8	0.099	0.181

- (i) State the atomic number of elements P and S.
- (ii) Select the most reactive metallic element. Explain.
- (iii) Select **three** elements that would react with cold water.
- (iv) Identify **three** elements from same group 7 of the periodic table.
- (v) Write the chemical formula of a compound of S and oxygen, V and X.

(12 marks)

- (b) Figure 2 shows a list of some simple members of a homologous series.

Formula	Physical state at room temperature
CH_4	gas
C_2H_4	gas
C_3H_8	gas
C_4H_{10}	gas
C_5H_{12}	liquid
C_6H_{14}	liquid



June July 2015 (2)

(i) Explain the term homologous series.

(ii) State three characteristics of a homologous series.

(iii) Explain the variation in physical state of members of homologous series.

(iv) Draw and name isomers of C_4H_{10} .

(8 marks)

2. (a) State two uses of X-rays in medicine.

(2 marks)

(b) Figure 1 shows the features of an X-ray tube.

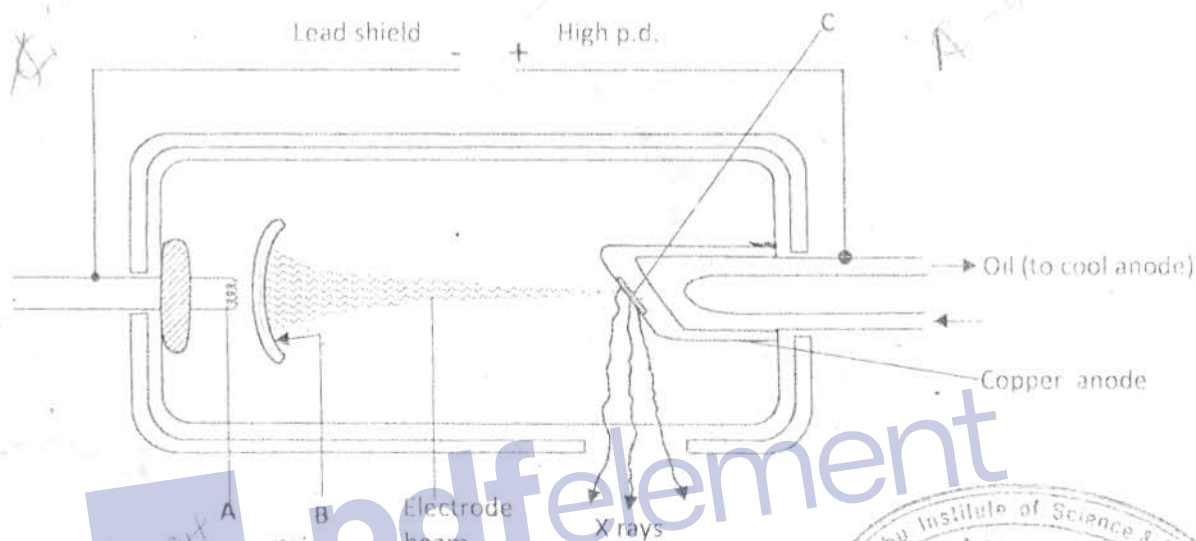


Fig. 1

(i) name the parts labelled A, B and C;

(ii) name the suitable material for the part labelled C;

(iii) explain how X-rays are produced in this tube?

(iv) why is it necessary to have oil cooling the anode;

(8 marks)

(c) The accelerating potential in certain X-ray tube is 15 kV. Determine the maximum frequency of the emitted X-rays.

Take: charge on an electron, $e = 1.6 \times 10^{-19} \text{ C}$,
Plank's constant, $h = 6.62 \times 10^{-34} \text{ Js}$.

(3 marks)

$$\frac{1.6 \times 10^{-19} \times 15 \times 10^3}{6.62 \times 10^{-34}} =$$

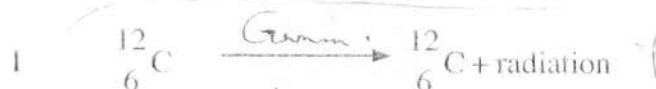
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Turn over

$$K.E = eV$$

June 2015 (6)

- (d) (i) Identify the possible radiations in each of the following nuclear reactions.



- (ii) A sample of a radioactive substance has 8.12×10^{20} atoms. The half-life of the substance is 21 minutes. Determine the number of atoms remaining undecayed after 84 minutes.

(7 marks)

- (a) An immersion heater rated 2.5 kW is placed in a liquid of mass 2 kg. When the heater is switched on for 5 minutes, the temperature of the liquid rises from 20°C to 70°C . Determine the specific heat capacity of the liquid. (4 marks)
- (b) Define the term "specific latent heat of vaporization" of a substance. (2 marks)
- (c) Figure 2 shows a simplified diagram of a domestic refrigerator. A volatile liquid circulates through the capillary tube under the action of a compression pump.

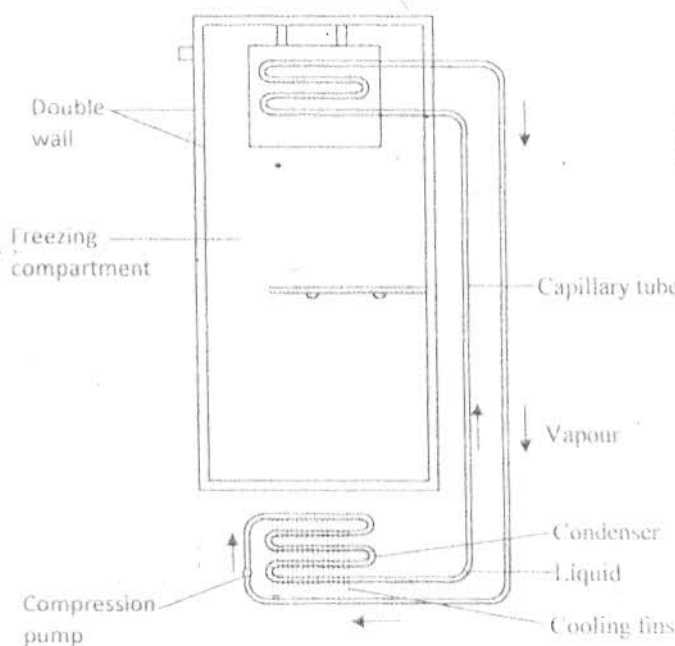


Fig. 2



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- (i) Give the reason why a volatile liquid is used.
- (ii) Explain how the volatile liquid is made to vaporize in the cooling compartment and condense in the cooling fins.
- (iii) Explain how cooling takes place in the refrigerator.
- (iv) Explain the purpose of the double wall. (8 marks)
- (d) Steam of mass 4.0 g at 100 °C is passed into water of mass 450 g at 10 °C. The final temperature of the mixture rises to T °C, and the container carrying temperature absorbs negligible heat:
- (i) derive an expression for the heat lost by the steam as it condensed to water at temperature T °C;
- (ii) derive an expression for the heat gained by the water;
- (iii) determine the value of T .

specific Latent heat of vaporization of steam = 2260 kJkg⁻¹;
specific heat capacity of water = 41.00 Jkg⁻¹K⁻¹.

(6 marks)



pdfelement

SECTION B: MECHANICAL SCIENCE

Answer *ONE* question from this Section.

4. A pile driver of mass 300 kg is used to drive a pile of mass 500 kg vertically into the ground. The pile driver falls freely through a distance of 54.0 m, rebounding with a velocity relative to the pile and equal to the relative velocity immediately before impact. Determine:
- (a) the velocity of the driver immediately before impact; (4 marks)
- (b) the velocity of the pile immediately after the impact; (7 marks)
- (c) the depth of penetration of the pile after impact given that the ground resisting force is constant and equal to 115 kN; (4 marks)
- (d) the time taken for the penetration. (5 marks)

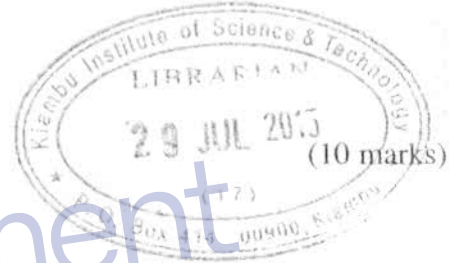
5. (a) Differentiate between a flywheel and a speed governor. (4 marks)
- (b) Describe the following characteristics of governors:
- (i) sensitivity;
 - (ii) stability;
 - (iii) isochronous. (6 marks)

- (c) The following figures were obtained during a tensile test of mild steel:

Original diameter	12.5 mm
Gauge length	200 mm
Final length	257 mm
Diameter at structure	7.85 mm
Load at yield point	34575 N
Maximum load	49023 N

Determine;

- (i) tensile strength;
- (ii) stress at yield point;
- (iii) percentage reduction in area;
- (iv) percentage elongation. (10 marks)



SECTION C: ELECTRICAL ENGINEERING PRINCIPLES

Answer *TWO* question from this Section.

6. (a) State the meaning of each of the following;
- (i) ohmic conductors;
 - (ii) electric power;
 - (iii) electrical energy. (6 marks)
- (b) Two resistors are connected in series across a 24 V supply and a current of 1 A flows in the circuit. If one of the resistors has a resistance of $2\ \Omega$ determine;
- (i) the value of the other resistor;
 - (ii) the p.d across the $2\ \Omega$ resistor;
 - (iii) the amount of energy consumed if the circuit is connected for 50 hours. (8 marks)

(c) Figure 3 shows a direct current circuit.

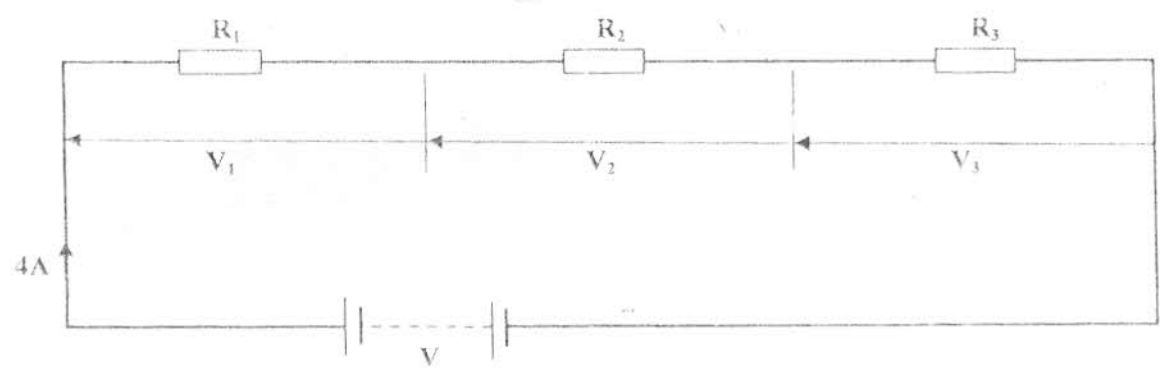


Fig. 3

Determine:

- (i) the battery voltage V and the total resistance of the circuit;
 - (ii) the values of resistors R_1 , R_2 and R_3 given that the p.d across R_1 , R_2 and R_3 are 5 V, 2 V and 6 V respectively.
- (6 marks)

7. (a) Name **five** quantities that a cathode ray oscilloscope is capable of measuring. (5 marks)
- (b) State **three** other instruments which also measure various quantities. Indicate the quantities measured by each. (6 marks)
- (c) Explain the principle of operation of a single phase transformer. (9 marks)

8. (a) (i) State **three** ways in which the capacitance of a capacitor can be varied. (6 marks)
- (ii) Name **three** types of capacitors. (6 marks)
- (b) A capacitor of $20 \mu\text{F}$ charged to 500 V is connected in parallel with another of $10 \mu\text{F}$ capacitance charged to 200 V. Determine the energy loss. (10 marks)
- (c) Differentiate between permanent and temporary weights. (4 marks)

