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Name_____ Index No._____

2601/102
2602/102
2603/102
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

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3 hours

INSTRUCTIONS TO CANDIDATES

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

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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.

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Turn over

June 2013 2014 (1)

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.

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(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

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(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.

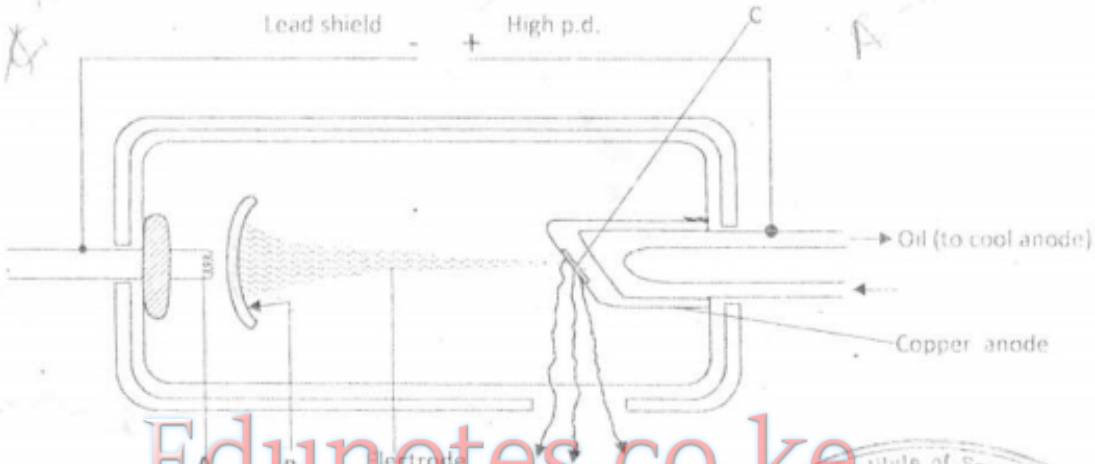


Fig. 1

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

(ii) name the suitable material for he 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 $= 1.6 \times 10^{-19}$ C,
Plank's constant, h $= 6.62 \times 10^{-34}$ Js.

(3 marks)

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

I $^{12}_{6}C \longrightarrow {}^{12}_{6}C$ + radiation

II $^{228}_{88}Ra \longrightarrow {}^{226}_{86}Rn$ + radiation

III $^{14}_{6}C \xrightarrow{\beta} {}^{14}_{7}V$ + radiation

(ii) A sample of a radioactive substance has 8.12×10^{30} atoms. The half-life of the substance is 21 minutes. Determine the number of atoms remaining undecayed after 84 minutes.

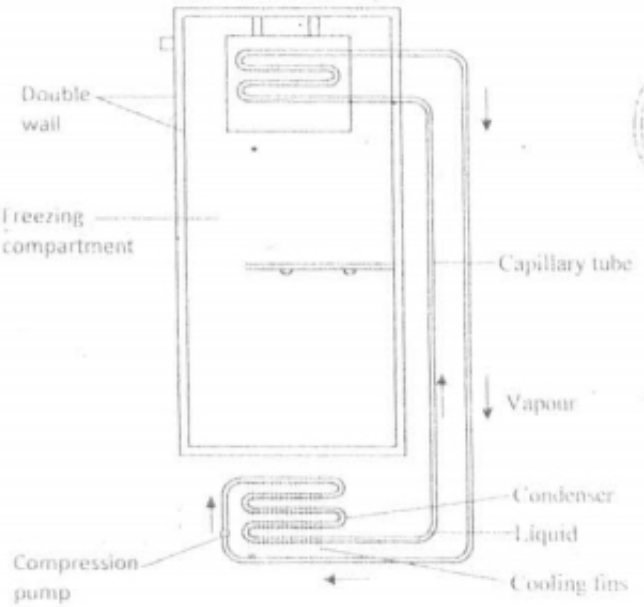
(7 marks)

3. (a) An immersion heater rated 2.5 kW is place 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 compression pump.

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Fig. 2

(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 he 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 $^{-1}$K $^{-1}$.

(6 marks)

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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)

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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 £A flour in the circuit If one of the resistors has a resistance of 2 Ω determine;
(i) the value of the other resistor;
(ii) the p.d across the 2 Ω 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.

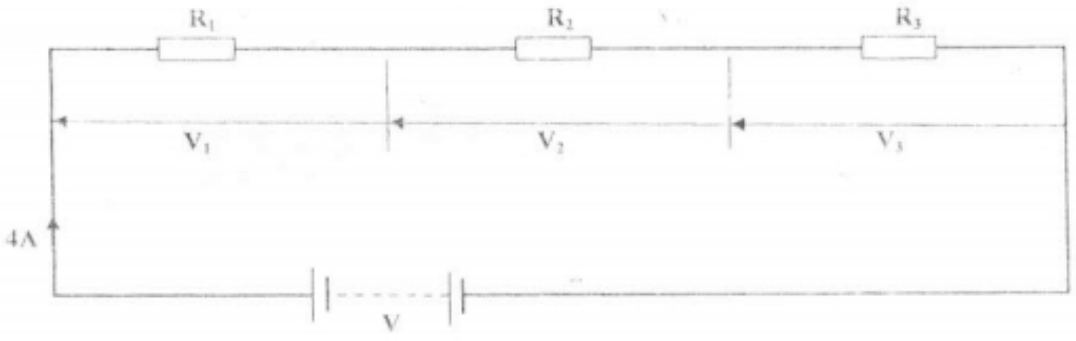


Fig. 3

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)

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(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.

(ii) Name **three** types of capacitors. (6 marks)

(b) A capacitor of 20 μF charged to 500 V is connected in parallel with another of 10 μF capacitance charged to 200 V. Determine the energy loss. (10 marks)

(c) Differentiate between permanent and temporary weights. (4 marks)

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