2601/102
2602/102
2603/102
PHYSICAL SCIENCE, MECHANICAL SCIENCE
AND ELECTRICAL ENGINEERING PRINCIPLES
Oct./Nov. 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

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

PHYSICAL SCIENCE, MECHANICAL SCIENCE
AND ELECTRICAL ENGINEERING PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

*This paper consists of **EIGHT** questions in **THREE** sections; **A, B** and **C**.*
*Answer **ONE** question from section **A**, **ONE** question from section **B** and **THREE** questions from section **C** in the answer booklet provided.*
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

Take $\mu_0 = 4\pi \times 10^{-7} H/m$ and $\varepsilon_0 = 8.85 \times 10^{-12} F/m$

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 PHYSICAL SCIENCE

*Answer **ONE** question from this section.*

1. (a) State:
   (i) **two** properties of x-rays;
   (ii) **three** applications of electrolysis.
   (5 marks)

   (b) Explain the forces acting in the nucleus of an atom. (4 marks)

   (c) Differentiate between 'lattice' and 'hydration' energy changes when ionic compound is dissolved in polar water. (4 marks)

   (d) Write:

   (i) balanced chemical equation for complete combustion of methane gas.
   (ii) the molecular formula for the following hydrocarbons:

   (I) propene;
   (II) ethane;
   (III) ethyne.
   (7 marks)

2. (a) State the laws of refraction of light. (2 marks)

   (b) A light ray passes from glass to water striking the glass-water interface at an angle of 26.3° with the normal. The refractive indices of glass and water are 1.5 and 1.33 respectively.

   Determine:
   (i) refractive index of water with respect to glass;
   (ii) angle of refraction;
   (iii) critical angle for glass-water interface.
   (6 marks)

   (c) With aid of a diagram, describe energy changes when a pendulum bob is displaced from equilibrium position released to swing freely. (7 marks)

   (d) (i) State **two** precautions taken to minimize loss of heat by calorimeter to the surrounding.

   (ii) A metallic material of mass 5 kg absorbs 184 kJ of heat energy causing its temperature to rise from 10° C to 90° C. Determine its specific heat capacity.
   (5 marks)

SECTION B: MECHANICAL SCIENCE

*Answer **ONE** question from this section.*

3. (a) (i) Define the term 'shaft coupling' as used in power transmission.

(ii) State **two** factors to consider when choosing a shaft coupling for an application.

(3 marks)

(b) A body of mass 200 kg and moving at 60 m/s is stopped in 3 seconds of impact after a collision with a stationary object of mass 120 kg.

Determine the:

(i) initial common velocity;

(ii) average impact force.

(7 marks)

(c) (i) State **two** advantages and **one** disadvantages of inertia type over centrifugal type governors.

(ii) Explain the principles of operation of centrifugal engine governors.

(6 marks)

(d) A crane lifts a 1100 kg car vertically at a constant speed to a height of 4 m in 6 seconds. Determine the:

(i) work done by the lifting force;
(ii) power of the crane.

(force of gravity is 9.8 N/kg)

(4 marks)

4. (a) State:

(i) the parallelogram law of coplanar forces;

(ii) **two** conditions for static equilibrium of coplanar forces.

(4 marks)

(b) (i) Differentiate between centrifugal and centripetal forces.

(ii) A centrifuge machine is used to separate cream from milk of mass 20 kg in a container fitted 80 cm from the centre of rotation. The machine makes one rotation in 4 seconds.
Determine the:

(I) angular velocity;
(II) centrifugal force.

(6 marks)

(c) State the following laws of thermodynamics:

(i) first law;
(ii) second law.

(4 marks)

(d) Figure 1, shows a horizontal pipe with a narrow section. A fluid of density 800 kg/m^3 flowing through the pipe passes the narrow section at a speed of 4 m/s.
Determine the:

(i) speed of fluid in the pipe;
(ii) pressure difference due to the narrow section.

(6 marks)

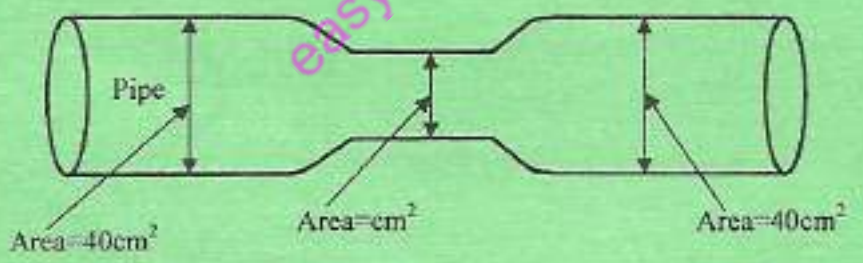

Fig. 1

SECTION C: ELECTRICAL ENGINEERING PRINCIPLE

*Answer **THREE** question from this section.*

5. (a) State **three** disadvantages of dry Lechlanch'e cells.

(b) Describe the following methods of charging a battery:

(i) Booster charging;
(ii) Trickle charging.

(6 marks)

(c) Figure 2, shows series- parallel arrangement of 5 identical cells connected across a 5 ohm resistor. Each cell has an internal resistance of 0.15 ohm and an e.m.f of 2.2 V. Using superposition theorem, determine the current through the 5 ohms resistor.

(11 marks)

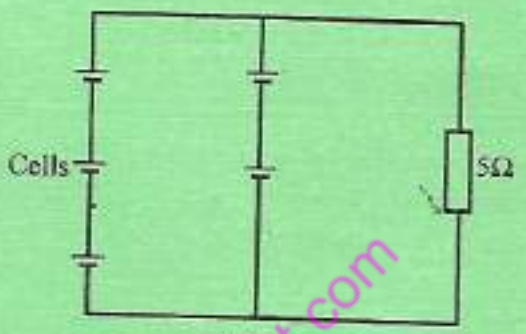

Fig. 2

6. (a) (i) Define temperature coefficient of resistance of a conductor.

(ii) Explain how temperature change affects electrical conductivity of a material.

(4 marks)

(b) The resistance of a copper coil at 20°C is 200 ohms. Determine the resistance of the coil when its temperature rises to 45°C. (Temperature coefficient of resistance of copper is 0.0043/°C at 0°C)

(4 marks)

(c) (i) Explain the term 'loading effect' of a voltmeter.

(ii) State how loading effect in C(i);

(I) alters voltmeter reading;
(II) can be minimized.

(4 marks)

(d) Figure 3 shows a voltmeter circuit connection. The voltmeter has a full-scale-deflection of 50 V and a sensitivity of 2.4 kΩ/V. Determine the:

(i) Voltage across the 60 kΩ resistor when voltmeter is not connected;
(ii) Voltage indicated by the voltmeter.

(8 marks)

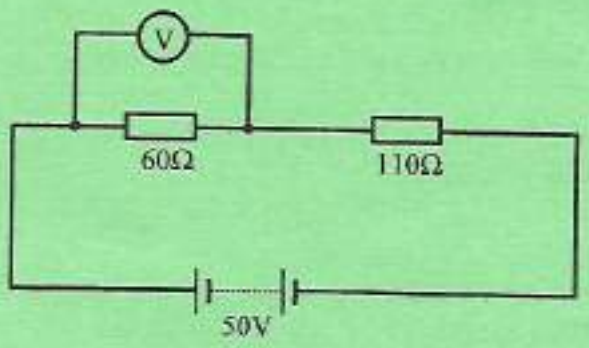

Fig. 3

7. (a) Define magnetic flux density. (2 marks)

(b) Figure 4 shows a section through a magnetic circuit of uniform cross-section area 2 cm^2 and mean length of 25 cm. The flux density in the air gap is 0.8 tesla and the field strength is 750 A/m. Determine the:

(i) circuit reluctance;
(ii) magnetomotive force;
(iii) current in the coil.

(8 marks)

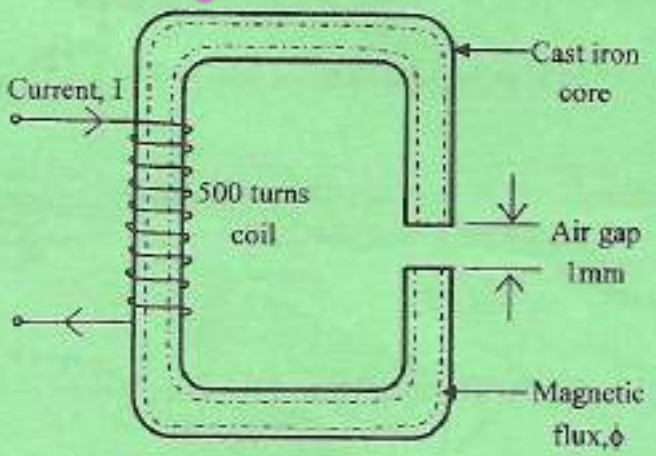

Fig. 4

(c) A static capacitor of capacitance 22 μF is connected in parallel with an 80 Ω resistive load across a 240 V, 50 Hz supply. Determine the:

(i) supply current;
(ii) power factor.

(8 marks)

(d) State **two** benefits of improving power factor of an electrical load. (2 marks)

8. (a) (i) Explain the term resistance matching.

(ii) Describe how transformer is used as a resistance matching device.

(4 marks)

(b) With the aid of a circuit diagram, describe the construction of an auto-transformer.

(6 marks)

(c) Figure 5 shows a series-parallel capacitor circuit. The capacitors X, Y and Z are identical and the total equivalent capacitance of the circuit is $2.4\mu F$. Determine the:

(i) Value of capacitor X;
(ii) Voltage across capacitor Y.

(10 marks)

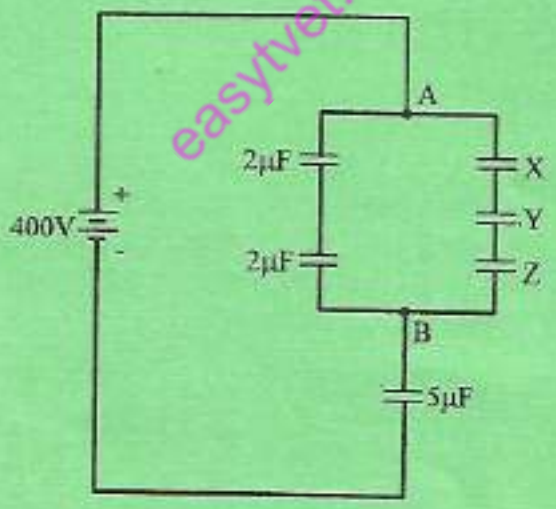

Fig. 5

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