1503/102
APPLIED SCIENCE
AND ELECTRICAL PRINCIPLES
Oct./Nov. 2016
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT CERTIFICATE IN MOTOR VEHICLE ENGINEERING

MODULE I

APPLIED SCIENCE AND ELECTRICAL PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

The candidate should have the following for this examination:
Answer booklet
Non-programmable scientific calculator
*This paper consists of **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions by choosing at least **TWO** questions from each section.*
All questions carry equal marks.
Maximum marks to each part of a question are indicated.
Write your answers in the answer booklet provided.
Take: $\varepsilon_0 = 8.854 \times 10^{-12} F/m$ *and* $\mu_0 = 4\pi \times 10^{-7} H/m$ *and* $g = 9.81\ m/s^2$
Candidates should answer the questions in English.

This paper consists of 5 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

*Answer at least **TWO** questions in this section.*

1. (a) (i) Define:

(I) mechanical advantage;

(II) velocity ratio. (2 marks)

(ii) A load of 720 kg is lifted by a 3 pulley system as shown in Figure 1 below. When a force of 3.528 kN is applied, determine the:

(I) mechanical advantage;

(II) velocity ratio;

(III) efficiency. (5 marks)

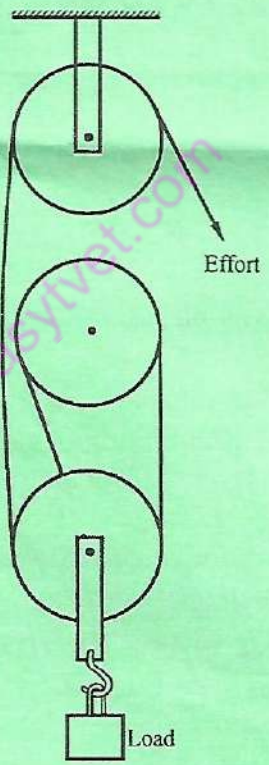

Fig. 1

(b) An electric motor provides power to a winding machine. The input power to the motor is 2.5 kW and the overall efficiency is 60%. Determine:

(i) power output

(ii) the velocity at which it can lift a 300 kg load vertically upwards.

(6 marks)

(c) A cylinder of oxygen has a volume of 600 cm^3 and contains oxygen of 200 g by weight at a temperature of 25° C. If the characteristic gas constant of oxygen is 2080 J/kgK, determine the pressure of oxygen in the cylinder. (7 marks)

2. (a) Define the following terms:

(i) isotopes;

(ii) atomic number;

(iii) mass number. (3 marks)

(b) (i) Draw and explain the structure of an atom.

(ii) An element X has two isotopes of mass numbers 235 and 238 and a relative abundance of 70% and 30% respectively. Determine the relative atomic mass of the element. (9 marks)

(c) (i) Differentiate between ionic and covalent bond.

(ii) State **four** properties of ionic compounds. (8 marks)

3. (a) (i) Define pressure.

(ii) With the aid of a diagram, differentiate between gauge pressure and absolute pressure.

(ii) Draw a Bourdon tube pressure gauge and explain it's operation. (11 marks)

(b) (i) Differentiate relative density from density.

(ii) State the law of floatation. (4 marks)

(c) A hydrometer of mass 28 g floats with 3 cm of it's stem out of water. The area of cross section of the stem is 0.75 cm^2. Determine the:

(i) total volume of the hydrometer;

(ii) the length of stem above the surface when the hydrometer floats in a liquid of relative density of 1.4. (5 marks)

4. (a) Define:

(i) electromagnetic radiation;

(ii) electromagnetic spectrum. (4 marks)

(b) (i) State the properties of electromagnetic waves.

(ii) State **three** types of electromagnetic radiation. (7 marks)

(c) With the aid of a diagram, explain the principle of operation of a cathode ray oscilloscope. (9 marks)

SECTION B

*Answer at least **TWO** questions in this section.*

5. (a) Define the following electrical quantities stating the units in each case.

(i) resistance;

(ii) electromotive force (4 marks)

(b) State **four** factors that affect the resistance of a conductor. (4 marks)

(c) An electric water heater has a rating of 1 kW, 230 V. The coil used as a heating element has a resistivity of 1.724×10^{-6} ohm-cm and is 10 m long. Determine the diameter of the coil wire. (8 marks)

(d) Explain the functions of the following parts of a DC motor:

(i) commutator;

(ii) armature. (4 marks)

6. (a) Define the following terms for circuits :

(i) period;

(ii) power factor. (4 marks)

(b) In an a.c circuit, 10 A current flows when a voltage of 230 V is supplied. If the power of the circuit is 2 kW, determine:

(i) power factor;

(ii) phase angle. (5 marks)

(c) Figure 2 shows an R-L series circuit. If the power absorbed in the circuit is 250 W, determine the:

(i) value of R and L

(ii) power absorbed when the supply is 110 V 25 Hz (11 marks)

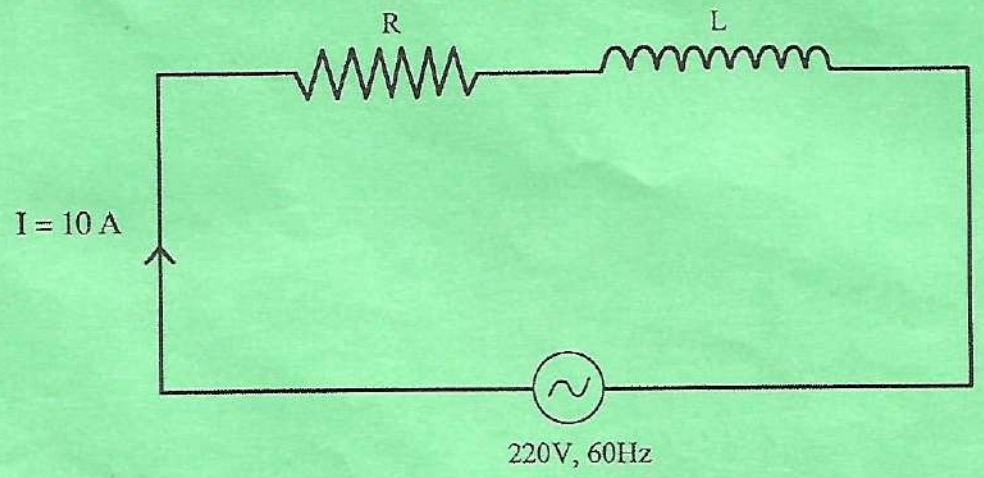

Fig. 2

7. (a) (i) State **three** differences between primary cells and secondary cells.

(ii) Outline **three** precautions that should be observed when working with batteries. (6 marks)

(b) (i) List **two** types of windings used in direct current machines and armature windings.

(ii) Describe the difference in construction between shunt -wound and series-wound d.c generators with respect to field and armature windings. (6 marks)

(c) A capacitor whose plates are 20 cm by 3 cm separated by a 1.0 mm air gap is connected across a 12 V battery. Determine the charge on each plate. (8 marks)

8. (a) State Faraday's Law of electromagnetic induction. (4 marks)

(b) With the aid of a diagram, explain the operation of an autotransformer. (6 marks)

(c) With the aid of a labelled diagram and wave forms, describe the operation of a two-diode full wave rectification, (10 marks)

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