

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:  $\epsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$  and  $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$  and  $g = 9.81 \text{ m/s}^2$*

*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.**



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)

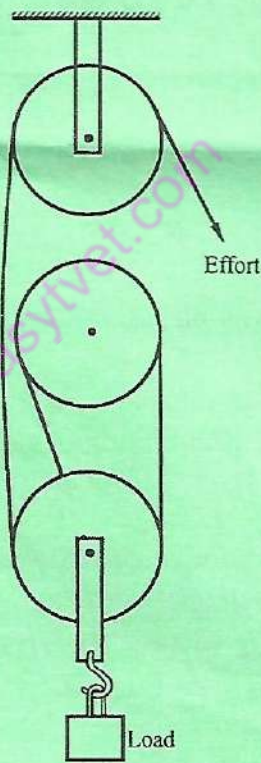


Fig. 1

- (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)

2

$$P_{\text{output}} = \frac{\text{Eff} \times \text{Power input}}{100\%}$$

$$P_{\text{output}} = \frac{60 \times 2.5}{100}$$

$$M.A. = \frac{E.F.L.}{\text{load}}$$

$$V.R. = \frac{\text{Work done by effort}}{\text{Work done by load}}$$

$$\text{Eff} = \frac{\text{output}}{2.5} \times 100\%$$

$$60\% = \frac{\text{out}}{2.5} \times 100\%$$

$$\text{out} = \frac{2.5 \times 60}{100}$$



(c) A cylinder of oxygen has a volume of  $600 \text{ cm}^3$  and contains oxygen of  $200 \text{ g}$  by weight at a temperature of  $25^\circ \text{ C}$ . If the characteristic gas constant of oxygen is  $2080 \text{ J/kgK}$ , 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)

$$\frac{V_1 P_1}{T_1} = \frac{V_2 P_2}{T_2}$$

$$\frac{600 \times 200}{25} = \dots$$

(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)

$$\left( \frac{70 \times 235}{100} + \frac{238 \times 30}{100} \right) = (164.5 + 71.4) = 235.9$$

(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 its operation.

(11 marks)

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

(ii) State the law of floatation.

(4 marks)

(c) A hydrometer of mass  $28 \text{ g}$  floats with  $3 \text{ cm}$  of its stem out of water. The area of cross section of the stem is  $0.75 \text{ cm}^2$ . 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)

*Sample*  
 - Atom of the same number of protons but different mass number  
 - Proton  
 - Neutrons



- (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  $1.724 \times 10^{-6}$  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)

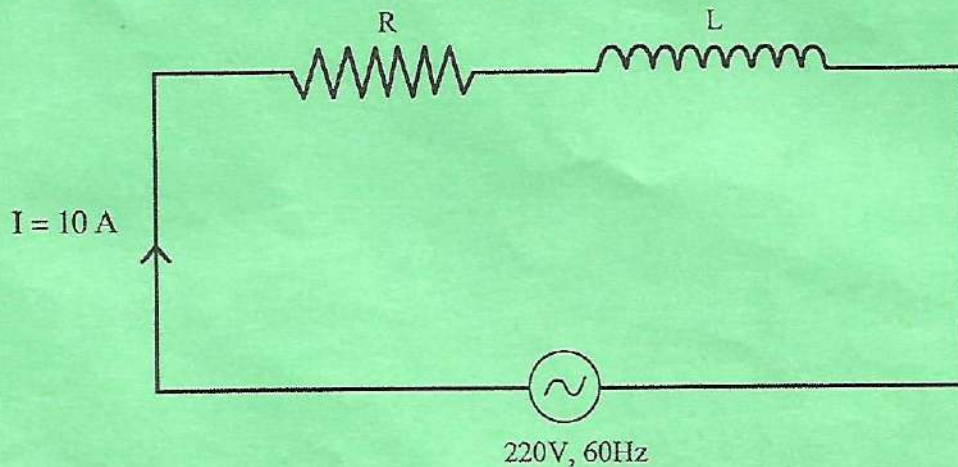


Fig. 2

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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