THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT CERTIFICATE IN MOTOR VEHICLE ENGINEERING

MODULE I

APPLIED SCIENCE AND ELECTRICAL PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
 Answer booklet;
 Mathematical tables/Non programmable scientific calculator;
 Drawing instruments.
This paper consists of EIGHT questions in TWO sections; A and B.
Answer FIVE questions by choosing at least TWO questions from each section in the answer booklet provided.
Maximum marks for each part of a question are indicated.
All questions carry equal marks.
Candidates should answer the questions in English.
 Take: acceleration due to gravity = 9.81 m/s²

This paper consists of 6 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: APPLIED SCIENCE

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

1. (a) State **three** properties of sulphuric acid. (3 marks)

   (b) (i) Name the chemical bonding in each of the following:

        (I) ethanol solvent;
        (II) lead plate of a car battery.

      (ii) Write a word equation for complete combustion of hydrocarbon fuel.

                                        (6 marks)

   (c) (i) With the aid of a ray diagram, show how an image is formed in plane mirror.
      (ii) State any **three** properties of the image formed in (c) (i).

                                        (6 marks)

   (d) (i) Define real image with respect to lenses.
      (ii) State **three** areas of application of curved mirrors.

                                        (5 marks)

2. (a) (i) Define 'echo' with respect to sound.
      (ii) State the **three** media through which sound travels.

                                        (4 marks)

   (b) Describe the following properties of sound energy:

      (i) refraction;
      (ii) absorption;
      (iii) diffraction.

                                        (6 marks)

   (c) (i) State the 'pressure law' of gases.
      (ii) A gas at a temperature of 32 °C and pressure of 160 kPa is heated to 110 °C without change in volume occupied by the gas. Determine the new gas pressure.

                                        (6 marks)

   (d) State:

      (i) the basic law of electrostatic charges;
      (ii) **two** sources of electrostatic charges.

                                        (4 marks)

3. (a) Differentiate between gauge pressure and atmospheric pressure. (4 marks)

   (b) (i) State the principle of transmission of pressure in fluid.
       (ii) Determine the liquid pressure of density $1.2 \, g/cm^3$ at a depth of 2.3 m below the surface.

       (5 marks)

   (c) (i) (I) Define 'heat capacity'.
           (II) Write an expression for heat capacity.

       (ii) Aluminium metal of mass 200 kg at 25 °C is heated to its melting point at 660 °C. If the specific heat capacity of aluminium is 900 J/kgK, determine the amount of heat absorbed.

       (6 marks)

   (d) Draw an electric circuit consisting of a battery, a switch and two electrolytic capacitors connected in parallel and state the equation of the circuit's total capacitance.

       (5 marks)

4. (a) Define each of the following with respect to machines:

       (i) velocity ratio;
       (ii) efficiency.

       (4 marks)

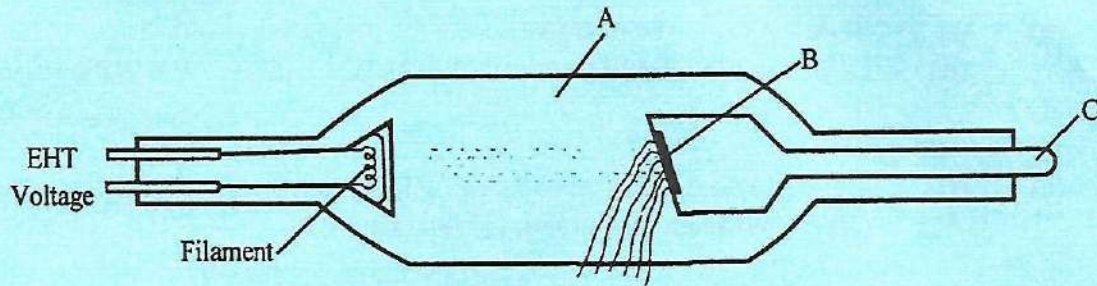   (b) **Figure 1** shows an inclined plane used to raise a 600 N load.
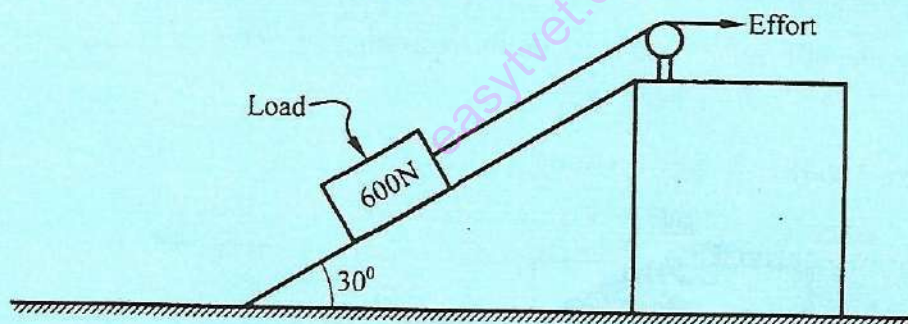
Fig. 1

   Determine the:

   (i) velocity ratio;
   (ii) effort required if the efficiency is 100%.

   (7 marks)

(c) **Figure 2** shows an X-ray tube.

Fig. 2

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

(ii) explain its operation.

(6 marks)

(d) The law of simple machine is defined by the relation $y = 0.4x + 40$. Determine the maximum load that can be lifted by an effort of 200 N. (3 marks)
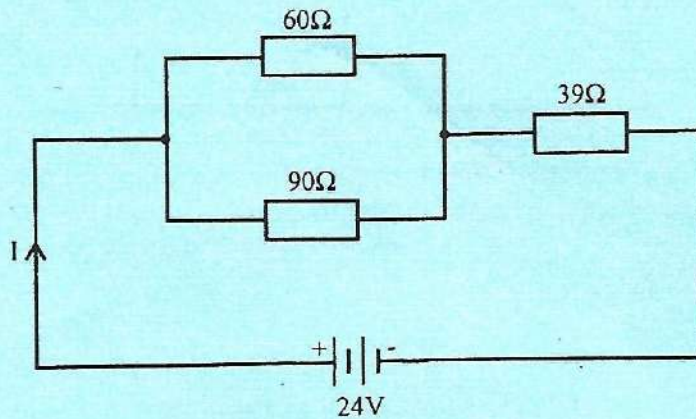
SECTION B: ELECTRICAL PRINCIPLES
*Answer at least **TWO** questions from this section.*

5. (a) State:

(i) the effect of temperature on the resistance of electrical cable;

(ii) Ohm's law.

(4 marks)

(b) **Figure 3** shows an electric circuit.

Fig. 3

Determine the:

(i) total resistance;

(ii) current, I;

(iii) energy dissipated in 15 minutes in the circuit.
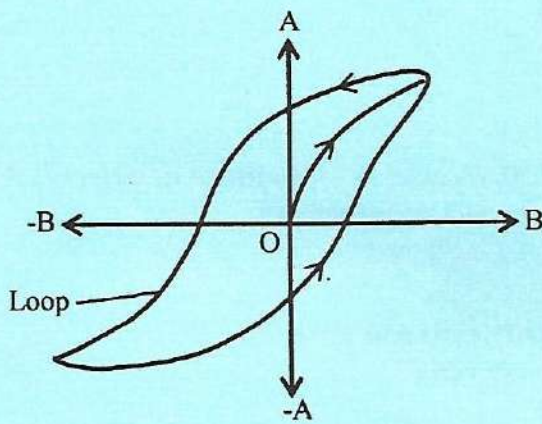
(8 marks)

(c) With the aid of a labelled diagram, explain the principle of operation of PN junction diode. (5 marks)

(d) List any **three** areas of application of thyristors. (3 marks)

6. (a) Describe:

    (i) the effect of capacitance in purely capacitive a.c circuit.
    (ii) series resonance in RLC a.c circuit.

(4 marks)

(b) The instantaneous current $i = 1.2 \sin 333\,t$ amperes flows in a series circuit of resistance 75 Ω. Determine the:

    (i) r.m.s value of the current;
    (ii) average power dissipated;
    (iii) frequency.

(7 marks)

(c) (i) An a.c machine is rated 150 VA, 120 W. Determine its power factor.
    (ii) State **two** methods of power factor correction.

(4 marks)

(d) (i) Distinguish between primary cells and secondary cells.
    (ii) State **three** merits of primary cells.

(5 marks)

7. (a) Differentiate between an element and a compound with reference to atomic theory.

(4 marks)

(b) (i) State **two** examples of semiconductor materials.
    (ii) Define the term 'doping' with reference to semiconductors citing two types of dopants.

(6 marks)

(c) A 240 V d.c supply is connected across a 2 μF capacitor. Determine the:

    (i) charge;
    (ii) energy stored in the capacitor.

(6 marks)

(d) (i) State **two** classes of amplifiers.
    (ii) Describe harmonic distortion in amplifiers.

(4 marks)

8.   (a)   State **three** types of filter circuits used in d.c power supplies.   (3 marks)

     (b)   Draw a labelled constructional diagram of each of the following types of transformers:

           (i)   core type transformer;
           (ii)   shell type transformer.

                                                                                                (6 marks)

     (c)   (i)   With the aid of waveforms, describe half wave rectification.
           (ii)   State the purpose of zener diode in a rectifier circuit.

                                                                                                (6 marks)

     (d)   **Figure 4** shows a hysteresis loop of a ferro-magnetic material.

Fig. 4

           (i)   identify the axes labelled A and B;
           (ii)   describe the hysteresis loop.

                                                                                                (5 marks)

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