1503/102
APPLIED SCIENCE AND
ELECTRICAL PRINCIPLES
Oct./Nov. 2022
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

*You should have the following for this examination:*
    *Answer booklet;*
    *Non-programmable scientific calculator;*
    *Drawing instruments.*
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions in the answer booklet provided by choosing at least **TWO** questions from each section.*
*All questions carry equal marks.*
*Maximum marks for each part of a question are as indicated.*
**Candidates should answer the questions in English.**
*Take $\mu_o = 4\pi \times 10^{-7} H/m$*
    $\varepsilon_o = 8.85 No^{-12} F/m$
    $g = 9.81 m/s^2$
    *Speed of light, $C = 3.0 \times 10^8 m/s$*

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: APPLIED SCIENCE

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

1. (a) Define the following terms as used in atomic structure:

   (i) mass number;

   (ii) atomic number.

   (2 marks)

   (b) Table 1 shows elements forming chemical bonds. Redraw and complete the table.

   (6 marks)

**Table 1**

| No | Elements | Name of Compound | Chemical formulae | Anion |
|---|---|---|---|---|
| (i) | Lithium and Flourine | | | F⁻ |
| (ii) | Calcium and Phosphorus | Calcium phosphate | | |
| (iii) | Sodium and Chlorine | | NaCl | |

   (c) Draw the atomic structure of each of the following:

   (i) magnesium;

   (ii) silicon.

   (6 marks)

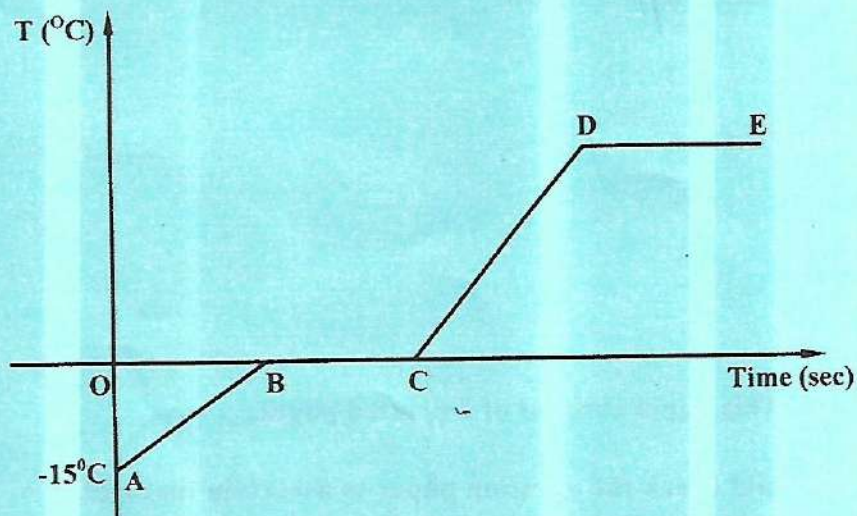   (d) **Figure 1** shows 'change of state' graph when dry ice is heated.



Fig. 1

Explain the change taking place between:

    (i)     AB;

    (ii)    BC;

    (iii)   CD.

(6 marks)

2.    (a)    State two:

        (i)     types of simple machines;

        (ii)    factors that contribute to loss of efficiency in a pulley system.

(4 marks)

    (b)    Differentiate between the following terms:

        (i)     driver and follower in respect to gears;

        (ii)    velocity ratio and efficiency.

(4 marks)

    (c)    (i)    Draw a pulley system having three pulleys in the upper block and two pulleys in the lower block.

        (ii)   A load of 1.26 kN is lifted by means of a pulley block system in 2 (c) (i). Given that the efficiency of the system is 84%, determine the:

            (I)    velocity ratio;

            (II)   mechanical advantage;

            (III)  effort required to lift the load.

(12 marks)

3. (a) Differentiate between apparent and real depths as used in determining refractive index. (4 marks)

(b) With the aid of diagrams, explain how total internal reflection of light occurs when light travels from one optical medium to another. (9 marks)

(c) An object of height 10 cm stands before a diverging lens of focal length 30 cm and at a distance of 20 cm from the lens, determine the:

(i) image distance;

(ii) height of the image;

(iii) magnification. (7 marks)

4. (a) State two:

(i) types of thermometers used in measurement of temperature;

(ii) merits of mercury as a thermometric fluid. (4 marks)

(b) A block of metal of mass 1.5 kg is suitably insulated and heated from $30°C$ to $50°C$ in 8 minutes and 20 seconds by an electric heater coil rated 54 watts. Determine the:

(i) quantity of heat supplied by the heater;

(ii) heat capacity of the block;

(iii) specific heat capacity of the block. (9 marks)

(c) With the aid of a diagram, explain the process of heat transfer by conduction. (7 marks)

# SECTION B: ELECTRICAL PRINCIPLES

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

5. (a) Define each of the following terms as used in electrostatics:

   (i) electric field intensity;

   (ii) electric flux density.

   (4 marks)

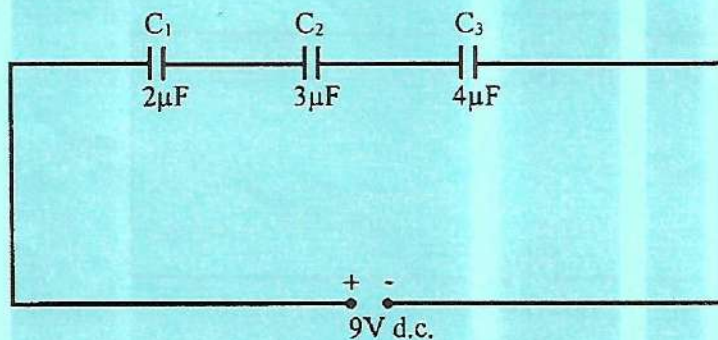   (b) **Figure 2** shows a capacitive network.



Fig. 2

Determine the:

   (i) total circuit capacitance;

   (ii) charge flowing in the circuit;

   (iii) potential difference across each capacitor.

   (9 marks)

   (c) (i) With the aid of graphical representations, differentiate between:

       (I) negative temperature coefficient;

       (II) positive temperature coefficient.

   (ii) A carbon resistor has a resistance of $20\,k\Omega$ at $20°C$, determine it's resistance at $80°C$. (Take temperature coefficient of resistance of carbon as $-0.0005$)

   (7 marks)

6. (a) State:

   (i) the difference between primary and secondary cells;

   (ii) **two** advantages of alkaline cells over chloride type electrolyte cells;   (4 marks)

(b)     With the aid of a labelled diagram, describe the construction of a wet lead acid battery.

(7 marks)

(c)     (i)     With the aid of phasor diagrams, explain the relationship between voltage and current in a circuit containing:

(I)     pure inductor;

(II)    pure capacitor.

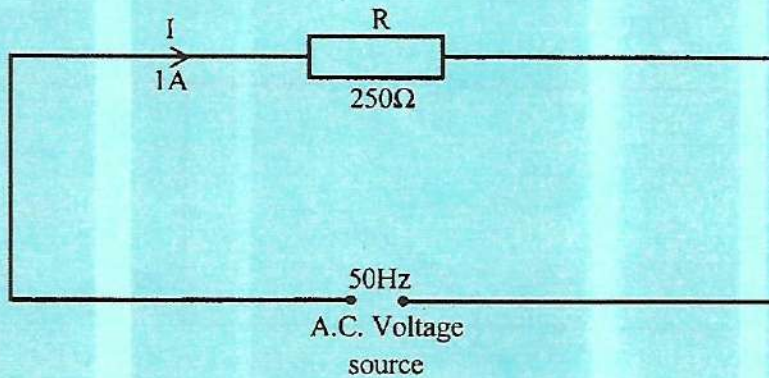(ii)    **Figure 3** shows and electric circuit.



Fig. 3

Determine the:

(i)     true power;

(ii)    apparent power;

(iii)   power factor.

(9 marks)

7.    (a)    Explain the following terms with reference to semi-conductors:

(i)     doping;

(ii)    N-type material;

(iii)   P-type material.

(6 marks)

(b)    With the aid of the V/I characteristics graph of a PN junction, explain its principle of operation.

(8 marks)

(c)    (i)     With the aid of circuit diagrams, differentiate between the following d.c motors:

(I)     series;
(II)    shunt;

(ii)    Explain why starting resistors are included in d.c motor circuits.

(6 marks)

8.    (a)    State **two:**

(i)    types of transformer limb constructions;

(ii)    practical applications of transformers.

(4 marks)

(b)    (i)    With the aid of a diagram, explain the principle of operation of a single phase power transformer.

(ii)    A 50 kVA transformer with a turns ratio of 300:20 has the primary winding connected to a 2200 V, 50 Hz supply. Determining the secondary winding:

(I)    voltage;

(II)    current

(12 marks)

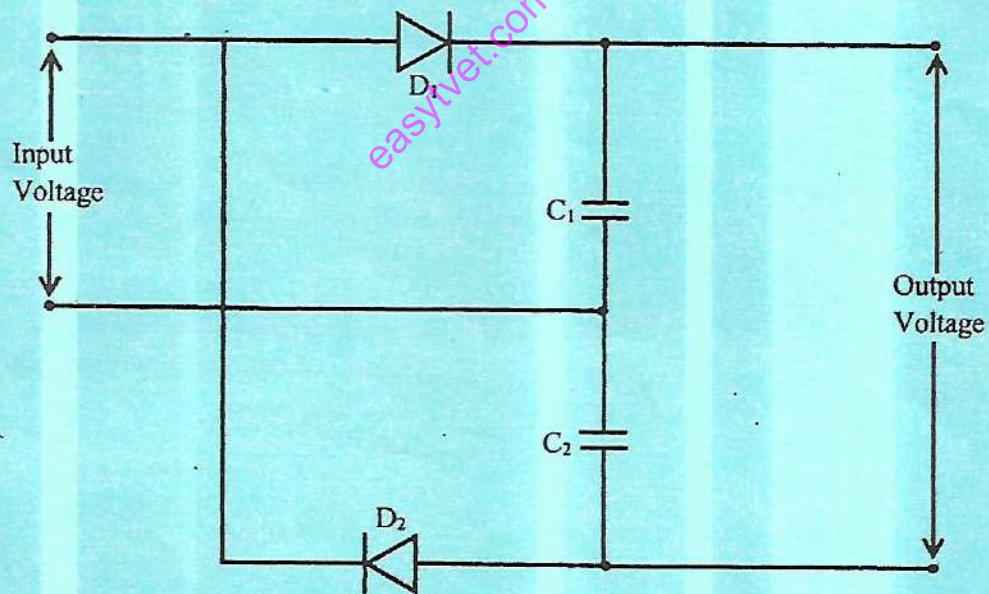(c)    **Figure 4** shows a voltage multiplier circuit.



**Fig. 4**

(b)    Explain its principle of operation.

(4 marks)

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