1503/102
APPLIED SCIENCE AND
ELECTRICAL PRINCIPLES
March/April 2023
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 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.

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: APPLIED SCIENCE

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

1. (a) Define the following terms with respect to the atomic structure:

(i) nucleus;
(ii) electrons. (2 marks)

(b) Table 1 shows the colour of the acid-base indicators in basic and acidic solutions. Redraw and complete the table. (6 marks)

Table 1

Acid-base indicator	Colour in acidic solution	Colour in basic solution
Litmus paper		
Phenolphthalein		

(c) Given that the atomic numbers of germanium and argon are 32 and 18 respectively, draw the atomic structures of the following:

(i) germanium,
(ii) argon. (6 marks)

(d) A compound weighing 42 g was found to contain 12 g magnesium, 6 g carbon and the rest is oxygen. Determine the empirical formulae of the compound.
(Atomic numbers: Mg = 24, C = 12, O = 16). (8 marks)

2. (a) Distinguish between the following terms with respect to simple machines:

(i) load and effort;
(ii) force ratio and movement ratio. (4 marks)

(b) Draw a pulley having three pulleys in the upper block and three pulleys in the lower. (4 marks)

(c) A screw jack has 2 start threads of pitch 5 mm. An effort of 40 N is applied to the bar of radius 350 mm to lift a load of 2200 N. Calculate the:

(i) efficiency of the screw jack
(ii) work done in overcoming friction when the load is raised a distance of 75 mm. (12 marks)

3. (a) (i) State the laws of reflection.

(ii) Differentiate between the following terms:

I. regular and diffuse reflection;

II. convex and concave mirrors. (6 marks)

(b) With aid of a diagram, explain how refractive index is determined using real and apparent depths. (7 marks)

(c) An object is placed 4 cm in front of a convex lens of focal length 6 cm. Determine the image:

(i) position;

(ii) magnification;

(iii) nature. (7 marks)

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

(i) types of temperature scales;

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

(b) A heater source rated 42 watts heats 50 g of water from 20° C in five minutes. Determine the final temperature of the water.
(Specific heat capacity of water is 4200 J/kg°C). (9 marks)

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

SECTION B: ELECTRICAL PRINCIPLES

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

5. (a) State Faraday's laws of electromagnetic induction. (4 marks)

(b) (i) Distinguish between soft and hard magnetic materials.

(ii) A piece of iron core has a length of 15 cm, cross-sectional area of 6 cm^2 and relative permeability of 500, determine the reluctance of the iron-core. (7 marks)

(c) Ten cells, each of e.m.f 1.5 V and internal resistance of 0.5 Ω are connected in series to a 10 Ω resistor. Determine the:

(i) terminal voltage;

(ii) power dissipated in the 10 Ω resistor;

(iii) charge, 40 seconds after switch ON. (9 marks)

6. (a) Define the following terms with reference to semi-conductors:

(i) depletion layer;
(ii) intrinsic material;
(iii) extrinsic material. (3 marks)

(b) (i) With the aid of the V - I characteristics graph of a bipolar junction transistor, explain how it acts as an amplifier.

(ii) State two merits of a transistor as a switch. (10 marks)

(c) (i) Figure 1 shows the symbol of an electronic device.

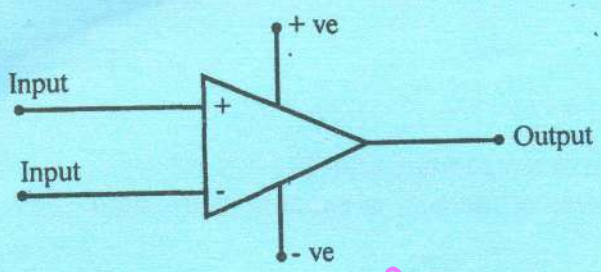

Fig. 1

Identify:

I. the device;
II. input terminals labelled (+) and (-).

(ii) State four characteristics of the device in (c)(i) in ideal case. (7 marks)

7. (a) Explain the functions of each of the following parts of a d.c generator:

(i) commutator; –
(ii) brushes. – Pi (4 marks)

(b) (i) Select with reasons the most appropriate d.c motor to be used for each of the following applications:

I. large starting torque required;
II. fairly constant speed required with irregular loads; – series
III. constant speed required from no load to full load. – compound (9 marks)

(c) Derive the equation for e.m.f generated in a d.c generator. (7 marks)

Shunt – 1 pole / winding – More volt less current
Series wound – 2 poles – winding. – More current less volts.

8. (a) (i) State Ohm's law.

(ii) Figure 2 shows a resistive network.

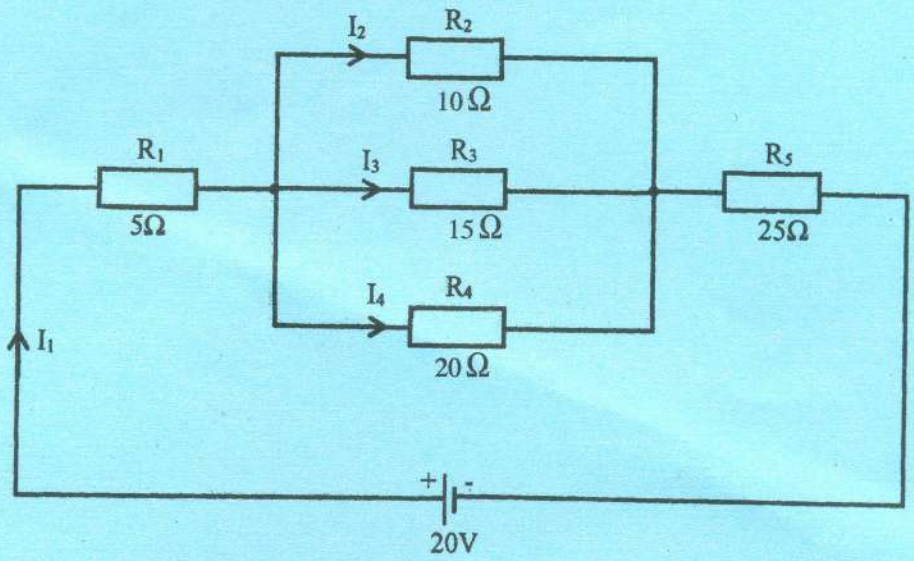

Fig. 2

Determine the:

I. total circuit resistance;
II. current I_4. (10 marks)

(b) Figure 3 shows the block diagram of an unregulated d.c power supply.

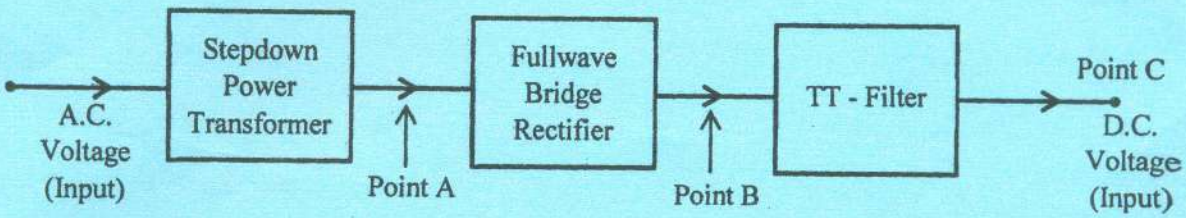

Fig. 3

Draw the:

(i) circuit diagram of the d.c power supply;
(ii) voltage waveforms at the following points:

I. A
II. B
III. C (10 marks)

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