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 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: acceleration due to gravity, $g = 9.81 \text{ m/s}^2$)

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SECTION A: APPLIED SCIENCE I

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

1. (a) State **two** properties of:

   (i) acids;
   (ii) bases.

   (4 marks)

   (b) (i) Describe **three** uses of salts.

   (ii) Draw the atomic structure for an atom whose atomic number is 16.

   (ii) With the aid of a sketch, describe the formation of a covalent bond in a hydrogen molecule.

   (10 marks)

   (c) A metal cube has a side length of 20 cm, and a relative density of 8.5. The cube rests on a flat horizontal surface. Determine the pressure on the surface. Take the density of water as 1000 kg/m³.

   (6 marks)

2. (a) Define work and state its S.I units.

   (b) State any **two**:

   (i) sources of energy;
   (ii) forms of energy.

   (6 marks)

   (b) An aircraft of mass 2 tonnes flies at a speed of 300 km/h and at a height of 1.2 km above the ground. Determine the total energy of the aircraft.   (5 marks)

   (c) Table 1 shows the values of the effort required to raise various loads using a simple machine whose velocity ratio is 4.

   Table 1

Load w(N)	5.0	12.5	15.0	22.5	25.0	30.0
Effort E(N)	2.50	4.75	5.5	7.75	8.5	10.0

   (i) Draw the effort-load graph, hence determine the law of the machine.

   (ii) Determine the efficiency of the machine while it raises a load of 20 N.

   (9 marks)

3. (a) State **two** types of:

 (i) temperature scales;
 (ii) thermometers.

(4 marks)

 (b) The following data refers to an industrial product:

 melting point = $38°C$
 boiling point = $92°C$
 specific heat capacity in solid state = 3.24 kJ/kg°C
 specific heat capacity in liquid state = 4.10 kJ/kg°C
 specific heat capacity in gaseous state = 5.36 kJ/kg°C
 specific latent heat of fusion = 260 kJ/kg
 specific latent heat of vapourization = 310 kJ/kg

 During a process, 20 kg of the product was heated from $25°C$ to $100°C$.

 (i) Sketch the temperature - time graph for the heating process.

 (ii) Neglecting the losses, determine the quantity of heat required.

(14 marks)

 (c) State any **two** engineering applications of gases. (2 marks)

4. (a) (i) Explain the term electrostatics.

 (ii) State the general law of electrostatics.

(4 marks)

 (b) (i) State the **two** laws of reflection of light.

 (ii) Explain polarization of light, and state **one** application.

 (iii) An object is placed at a distance of 10 cm from a concave lens of focal length 8 cm. Determine the:

 (I) image distance;
 (II) magnification;
 (III) nature of the image formed.

(13 marks)

 (c) List **three** materials which acquire electrostatic charge when rubbed. (3 marks)

SECTION B: ELECTRICAL PRINCIPLES

Answer at least TWO questions from this section.

5. (a) State each of the following laws:

   (i) Kirchoff's current law;

   (ii) Kirchoff's voltage law;

   (iii) Faraday's first law of electrolysis.

   (6 marks)

   (b) List **three** factors affecting the resistance of an electrical conductor.

   (3 marks)

   (c) **Figure 1** shows an electrical circuit. Determine the:

   (i) total resistance of the circuit;
   (ii) supply current;
   (iii) power dissipated by the 4Ω resistor;
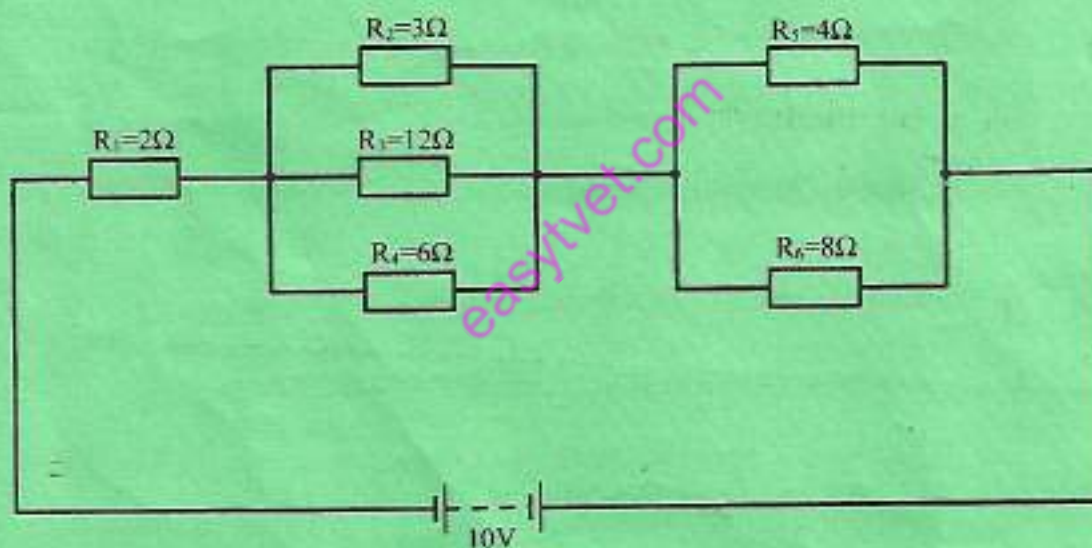   (iv) current flowing in the 6Ω resistor.

   (11 marks)

Fig. 1

6. (a) State each of the following laws as applies to electromagnetic induction:

   (i) Faraday's second law;
   (ii) Lenz's law

   (4 marks)

   (b) List any **three** types of capacitors.

   (3 marks)

(c) **Figure 2** shows an electric circuit. Determine the:

     (i)   equivalent capacitance of the circuit;
     (ii)   total charge;
     (iii)   voltage across capacitors C_1 and C_4;
     (iv)   energy stored by the $4\mu F$ capacitor.
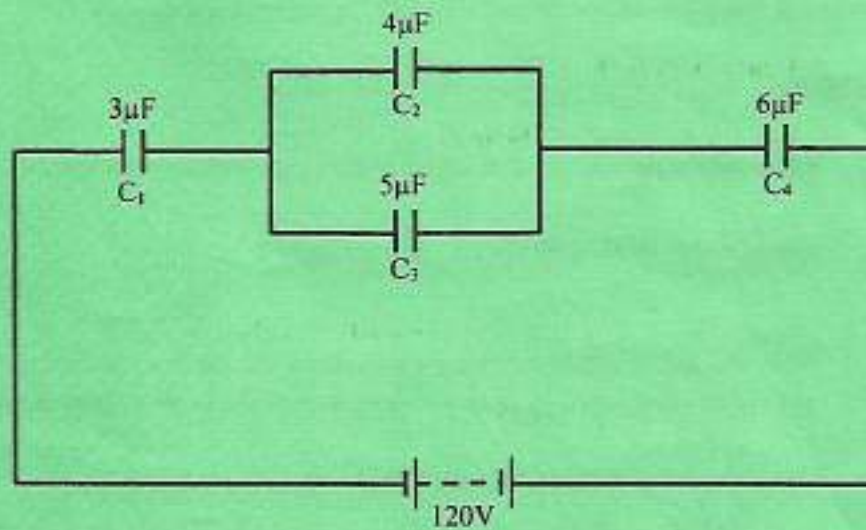
(11 marks)

Fig. 2

(d) A 6-pole, lap-wound d.c. generator has 600 conductors on its armature. The flux per pole is 0.02 Wb. If the generated voltage is 300 V, determine the speed at which the generator is run.

(2 marks)

7. (a) (i) State **three** factors that affect the force on the current carrying conductor in a magnetic field.

     (ii)   With reference to alternating currents, define the following terms:

         (I)   period;
         (II)   frequency;
         (III)   peak value.

(6 marks)

(b) The instantaneous value of voltage in an a.c circuit at any time is given by,
$V = 100 \sin(50\pi t - 0.523)$ volts. Determine the:

     (i)   peak value;
     (ii)   periodic time;
     (iii)   r.m.s value;
     (iv)   first time when the voltage is a maximum.

(9 marks)

(c)   Explain:

    (i)   why trickle charging is necessary on storage batteries.

    (ii)   local action in primary cells and state how it can be minimized.

    (5 marks)

(d)   Distinguish between intrinsic and extrinsic semiconductor.   (2 marks)

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

    (i)   pentavalent agents used in doping intrinsic semiconductors;

    (ii)   applications of thyristors.

    (6 marks)

(b)   (i)   With the aid of a test circuit, explain how the output characteristic of an NPN transistor connected in common-emitter configuration may be determined.

    (ii)   Draw the output characteristics of the test indicated in (i).

    (9 marks)

(c)   A 660/240 V transformer has 60 secondary turns. If the transformer is rated at 50 kVA and neglecting losses, determine the:

    (i)   number of primary turns;
    (ii)   full-load primary current;
    (iii)   full-load secondary current.

    (5 marks)

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