BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF ENGINEERING AND PHYSICS

PH003: INTRODUCTORY ELECTRICITY AND MAGNETISM

DURATION: THREE HOURS -- DEC 2019

Answer **ALL** parts of Section A and any **THREE** questions from Section B.Section A carries 40 marks and Section B carries 60 marks.

SECTION A

1.a. What is meant by the following?

i. Conservation of charge. [2]

ii. Quantization of charge. [2]

b. An electric heater carries a current of 13.5 A when operating at a voltage of 1.2×10^2 V. [4]
Calculate the resistance of the heater.

c. For a conductor of length L and cross-sectional area A, show that the resistance $R$is given [4]
by:

$$R = \frac{\rho L}{A}$$

where ρ is the resistivity of the conductor.

d. A cell is connected in series with a 2 Ω resistor and a switch as shown in Figure 1.1.

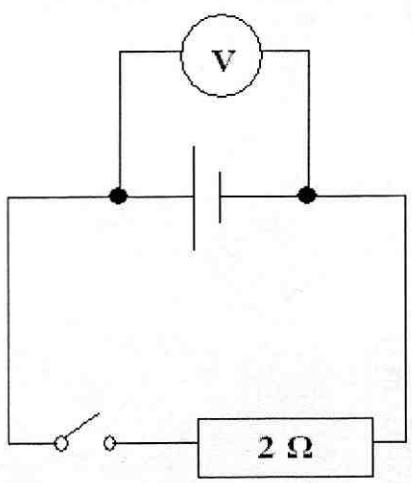


Figure 1.1: Question 1d

A voltmeter connected across the cell reads 12 V when the switch is open but 8 V when the switch is closed.

i. Calculate the current flowing through the circuit. [4]

ii Determine the internal resistance of the cell [4]

e. What is the difference between magnetic flux and magnetic flux density? [4]

f. A wire carries a current of 10 A in a direction that makes an angle of 30° with the direction of the magnetic field of strength 0.3 T. Find the magnitude of the force on a 5 m length of the wire. [4]

g. Explain Kirchhoff's first law using a clearly labeled diagram [4]

h. Fig 1.2 shows a network of capacitors connected to a 9 V battery. [6]

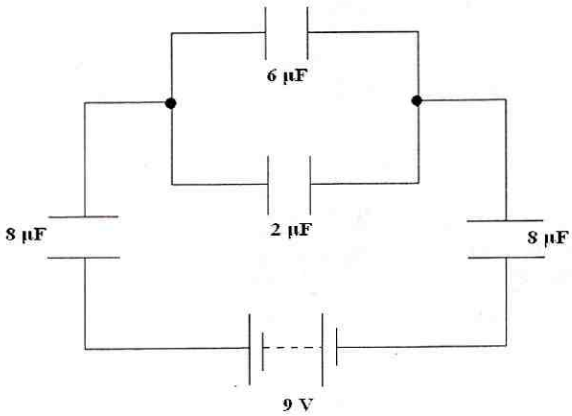


Figure 1.2: Question 1.h.

Calculate the total capacitance of the capacitors.

i. State two types of thermistors. [2]

SECTION B

2.a. With aid of diagrams, explain how you can charge an electroscope negatively. [12]

b. Giving two examples of each, explain the differences between electrical conductors and insulators [8]

3.a. Figure 3.1 shows an electrical circuit.

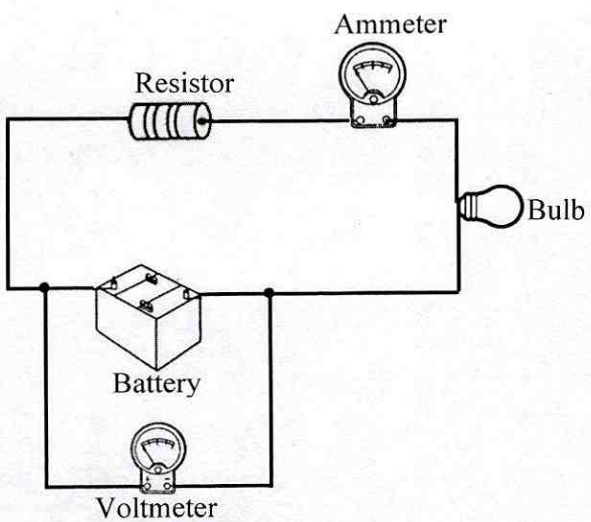


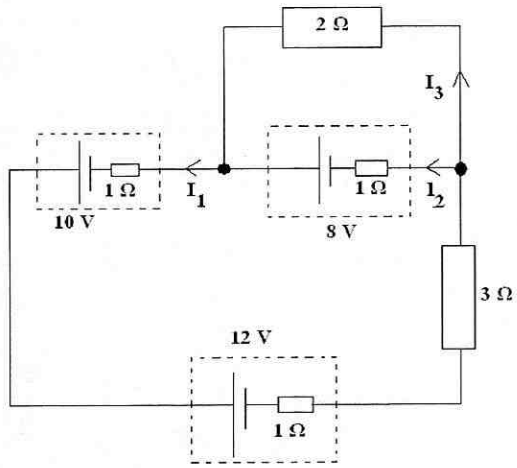
Figure 3.1: Question 3a.

i. Draw this circuit diagram using symbols including a closed switch. [6]

ii Explain what happens when the switch when the circuit is in a state shown in your diagram in (i). [3]

iii Explain what happens when the switch is open. [3]

b. In the diagram in Figure 3.2, determine the currents through the 2 Ω and 3 Ω resistors. Each [8]



cell has an internal resistance of 1 Ω.

Figure: 3.2

Hint:

This problem involves internal resistances and these have to be considered.

4. Figure4.1 shows three resistors of resistances 4 Ω, 10 Ω and 6 Ω connected in series. A potential difference of 10 V is maintained across them. [20]

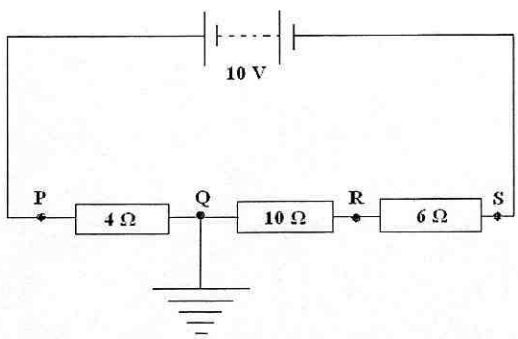


Figure 4.1: Question 4.

Giving reasons, determine the potential at points P, Q, R and S

5.a Three point charges Q_1, Q_2 and Q_3 respectively of 1 μC, -2 μC and 3 μC are fixed at the positions shown in Figure 5.1. The charges are in vacuum.

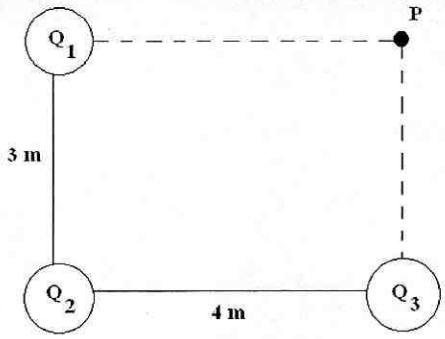


Figure 5.1: Question 5a

Calculate:

i. the potential at point P at the corner of the rectangle. [10]

ii. the work done to bring a charge of 2.5μC from infinity and place it at point P. [5]

b. What length of eureka wire of diameter 0.1 mm is required to make a coil of resistance 20 Ω (resistivity of eureka equals 49 x 10-8 Ω m)? [5]

6.a. Figure 6.1 shows three capacitors connected in series. [7]

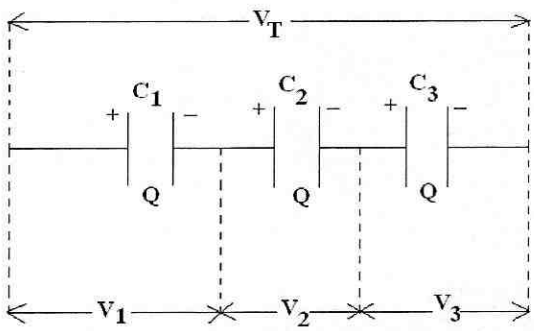


Figure 6.1: Question 6

Show that the reciprocal of total capacitance (C_T) is given by:

$$\frac{1}{C_T}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$$

b. Define voltage and current and state their relationship using Ohm's law. [6]

c. Explain how you charge pieces of paper by induction [7]