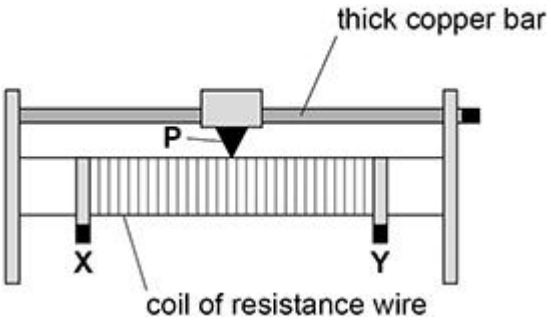
Name of the Student:_____
Max. Marks : 24 Marks **Time :** 24 **Minutes**

Q1.

Figure 1 shows a variable resistor that has a maximum resistance of $25\ \Omega$.
A sliding contact **P** is mounted on a thick copper bar. **P** can be set to any position between **X** and **Y**.

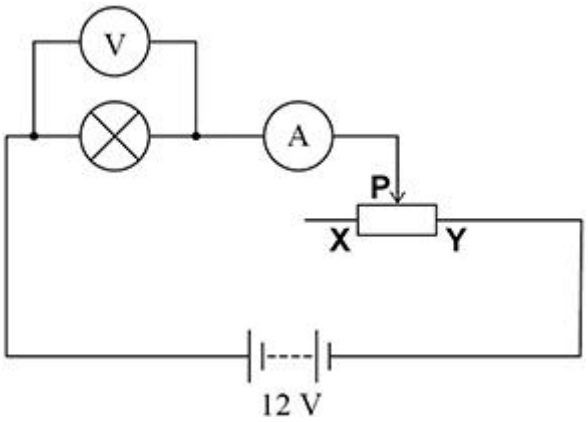
Figure 1



(a) **Figure 2** shows the variable resistor being used to investigate the variation of current with voltage for a filament lamp.
The normal operating voltage of the lamp is $12\ \text{V}$.

The $12\ \text{V}$ battery has negligible internal resistance.

Figure 2



The position of **P** is adjusted so that the reading on the voltmeter is at its minimum value of $0.75\ \text{V}$.

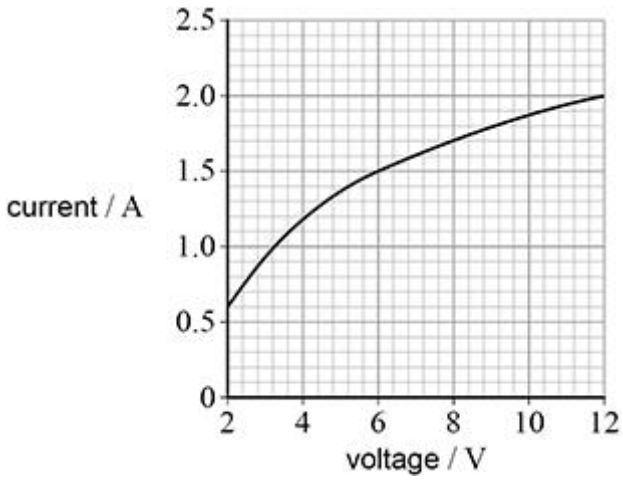
Calculate the resistance of the lamp when the voltmeter reading is $0.75\ \text{V}$.

resistance = _____ Ω

(2)

(b) **Figure 3** shows the variation of current with voltage for the lamp between 2 V and 12 V.

Figure 3



Calculate the resistance of the lamp when the voltage across the lamp is 8.0 V.

resistance = _____ Ω

(2)

(c) Explain, in terms of electron movement, why the resistance of the filament lamp changes as the voltage changes as shown in **Figure 3**.

_____

_____

_____

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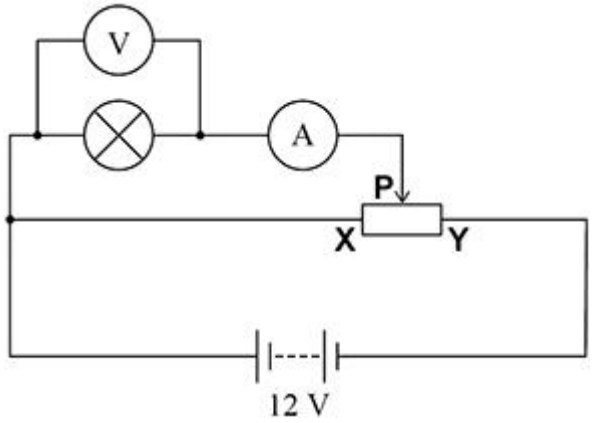
_____

(3)

(d) **Figure 4** shows an alternative circuit used to investigate the variation of current with voltage for the lamp.

Figure 4



The circuit components are the same as in **Figure 2**.
When the voltage across the lamp is $12\ \text{V}$ its resistance is $6.0\ \Omega$.

P is moved to position **Y**.

Calculate the total resistance of the circuit.

total resistance = _____ Ω

(2)

(e) Calculate the power transferred by the battery when **P** is at position **Y**.

power = _____ W

(2)

(f) A student wants to control the brightness of the lamp.

He gives two reasons why the circuit in **Figure 4** is better than the circuit in **Figure 2** for controlling the brightness. The two reasons are:

- the **Figure 4** circuit can achieve a greater range of voltages across the lamp
- the **Figure 4** circuit is more efficient at transferring energy to the lamp.

Discuss, without calculation, whether either of these two reasons is correct.

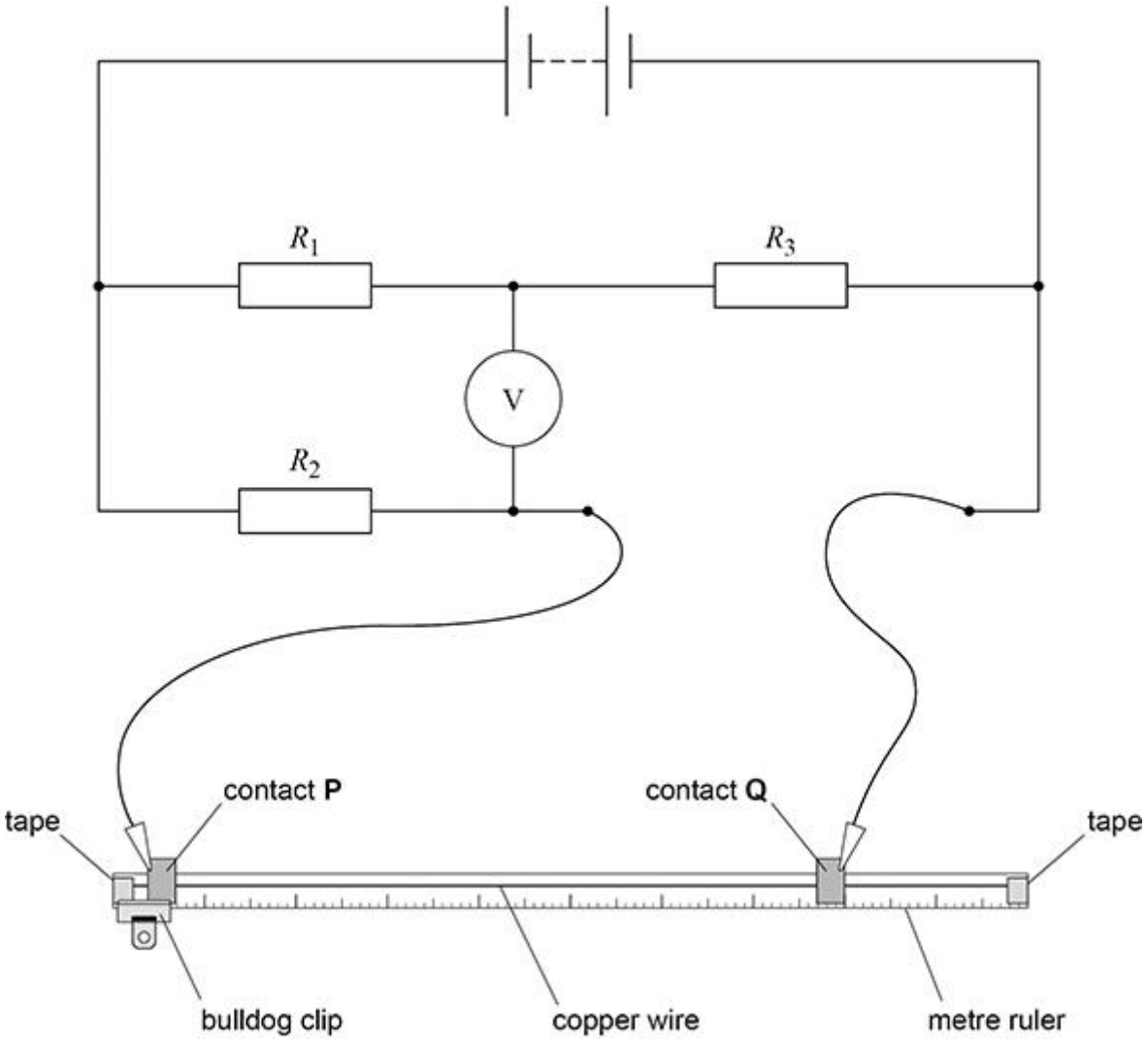
(3)

(Total 14 marks)

Q2.

Figure 1 shows a circuit used to find the resistance per unit length of a copper wire.

Figure 1

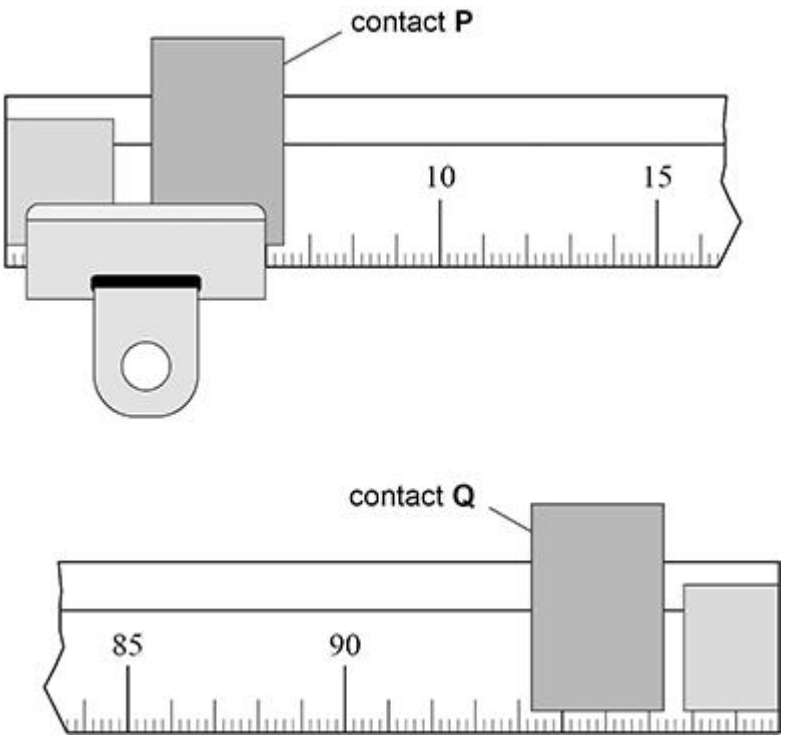


The copper wire is fixed with tape to a metre ruler that has 2 mm graduations.
Contact **P** is placed on the wire close to one end of the ruler and held firmly in place using a bulldog clip.
When contact **Q** is placed on the wire as shown in **Figure 1** the voltmeter shows a non-zero reading.

Q is moved along the wire until the voltmeter reading is zero.

Figure 2 shows enlarged views of the position of **P** and the new position of **Q**.

Figure 2



(a) Determine, in m, the length x of copper wire between **P** and **Q**.

x = _____ m

(1)

(b) When the voltmeter reading is zero:

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

where R_4 is the resistance of the copper wire between **P** and **Q**.

Determine, in $\Omega\ \text{m}^{-1}$, the resistance per unit length of the copper wire.

$R_1 = 2.2\ \text{M}\Omega$
$R_2 = 3.9\ \text{k}\Omega$
$R_3 = 75\ \Omega$

resistance per unit length = _____ $\Omega\ m^{-1}$

(2)

(c) The diameter d of the copper wire is approximately $0.4\ mm$.

Suggest:

- a suitable measuring instrument to accurately determine d
- how to reduce the effect of random error on the result for d.

_____

_____

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_____

_____

(3)

(d) Determine the resistivity ρ of copper.

diameter d of the copper wire = $0.38\ mm$

ρ = _____ $\Omega\ m$

(2)

The copper wire is replaced with a constantan wire of diameter $0.38\ mm$.

$$\frac{\text{resistivity of constantan}}{\text{resistivity of copper}} = 30$$

(e) Suggest **one** change to the circuit to make the voltmeter read zero for the same value of x as in part (a).

_____

_____

_____

(1)

(f) Calculate, in mm, the diameter of a constantan wire that has the **same** resistance per unit length as the copper wire.

diameter = _____ mm

(1)

(Total 10 marks)