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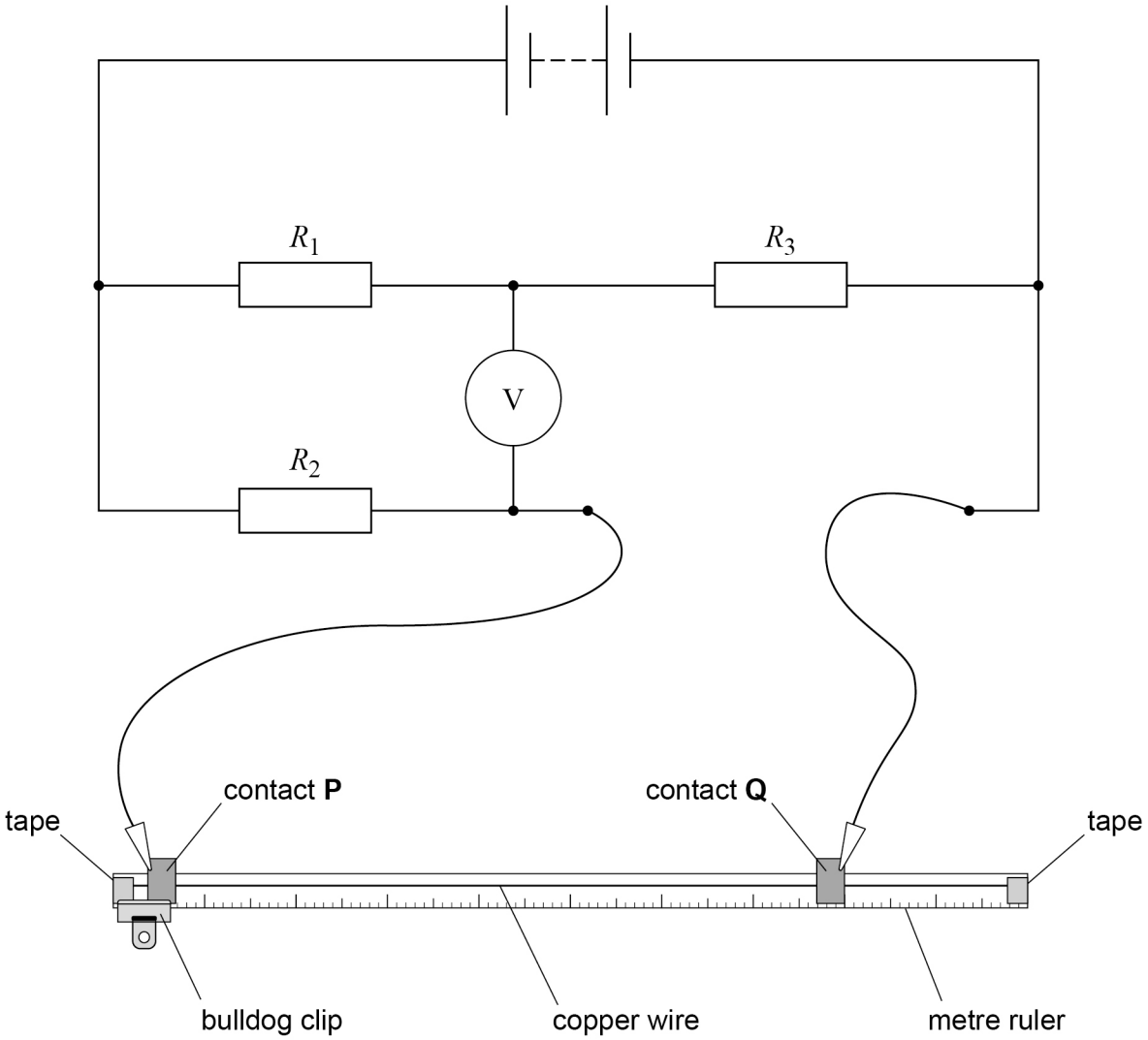
0 2 **Figure 3** shows a circuit used to find the resistance per unit length of a copper wire.

Figure 3



The copper wire is fixed with tape to a metre ruler that has $2\ \text{mm}$ 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 3** the voltmeter shows a non-zero reading.

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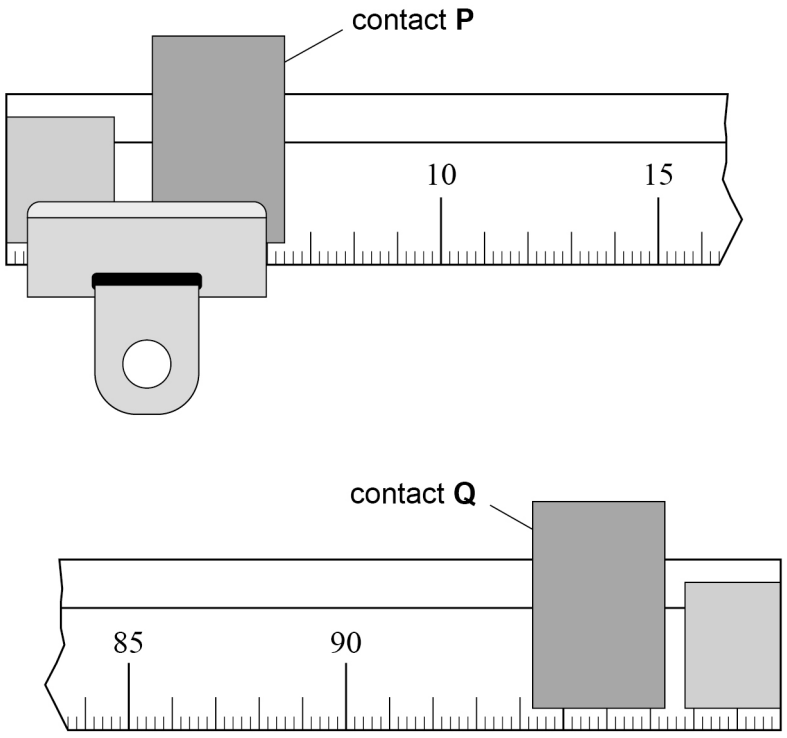
Q is moved along the wire until the voltmeter reading is zero.

Figure 4 shows enlarged views of the position of **P** and the new position of **Q**.

Figure 4



0 2 . 1 Determine, in m, the length x of copper wire between **P** and **Q**.

[1 mark]

$x =$ _____ m

Question 2 continues on the next page

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0 2 . 2 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 $\Omega\ \mathrm{m}^{-1}$, the resistance per unit length of the copper wire.

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

[2 marks]

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

0 2 . 3 The diameter d of the copper wire is approximately $0.4\ \mathrm{mm}$.

Suggest:

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

[3 marks]

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0 2 . 4 Determine the resistivity ρ of copper.

diameter d of the copper wire $= 0.38$ mm

[2 marks]

$\rho =$ _____ Ω m

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

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

0 2 . 5 Suggest **one** change to the circuit to make the voltmeter read zero for the same value of x as in Question **02.1**.

[1 mark]

_____

_____

_____

0 2 . 6 Calculate, in mm, the diameter of a constantan wire that has the **same** resistance per unit length as the copper wire.

[1 mark]

diameter = _____ mm

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END OF SECTION A

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2 9 A wire is made from a material of Young modulus E.
The wire obeys Hooke's law.
The wire has an unstretched length L and a cross-sectional area A.
When a force is applied to the wire, the extension of the wire is e.

What is the elastic strain energy stored in the wire?

[1 mark]

A $\frac{AEe^2}{2L}$ ⬭

B $\frac{L}{2Ae}$ ⬭

C $\frac{Ae^2}{2EL}$ ⬭

D $\frac{AEL}{2e}$ ⬭

3 0 As the temperature of a copper wire increases, its resistance

[1 mark]

A remains constant. ⬭

B increases. ⬭

C decreases. ⬭

D remains constant at first and then decreases. ⬭

3 1 A $12\ \Omega$ resistor is connected across the terminals of a cell that has an emf of $2.0\ \text{V}$ and an internal resistance of $4.0\ \Omega$.

What is the terminal pd?

[1 mark]

A $0.50\ \text{V}$ ⬭

B $0.75\ \text{V}$ ⬭

C $1.30\ \text{V}$ ⬭

D $1.50\ \text{V}$ ⬭

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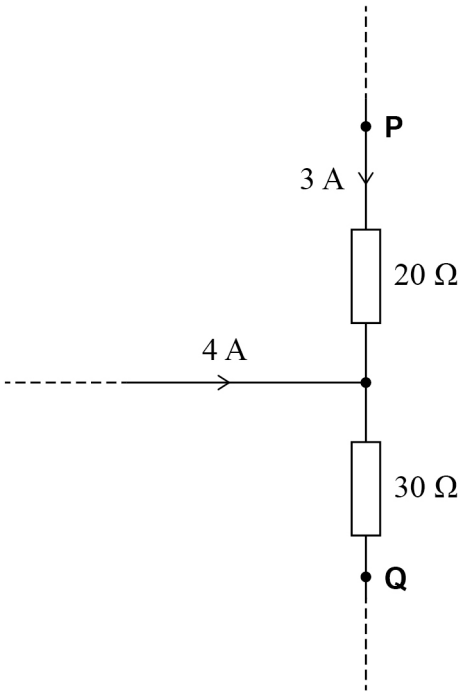
3 2 The diagram shows the currents in part of a circuit.



What is the potential difference between points **P** and **Q**?

[1 mark]

A 60 V ⬭

B 70 V ⬭

C 180 V ⬭

D 270 V ⬭

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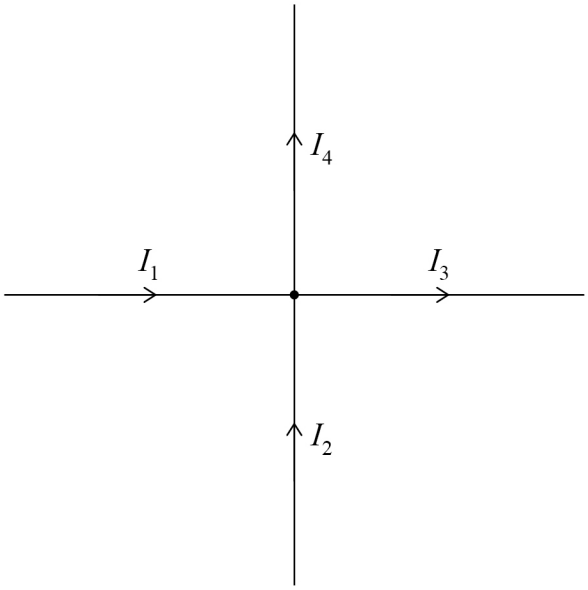
3 3 The currents in the four wires obey the relationship $I_1 + I_2 + I_3 + I_4 = 0$



This relationship is an expression of the law of conservation of

[1 mark]

A charge. ⬭

B energy. ⬭

C potential difference. ⬭

D power. ⬭

3 4 A practical power supply provides a steady current I for a time t to an external circuit.

The emf of the power supply during t is equivalent to

[1 mark]

A the energy dissipated in the external circuit. ⬭

B the energy dissipated in the whole circuit. ⬭

C the energy dissipated in the whole circuit, divided by the product It. ⬭

D the potential difference across the terminals of the power supply. ⬭

30

END OF QUESTIONS

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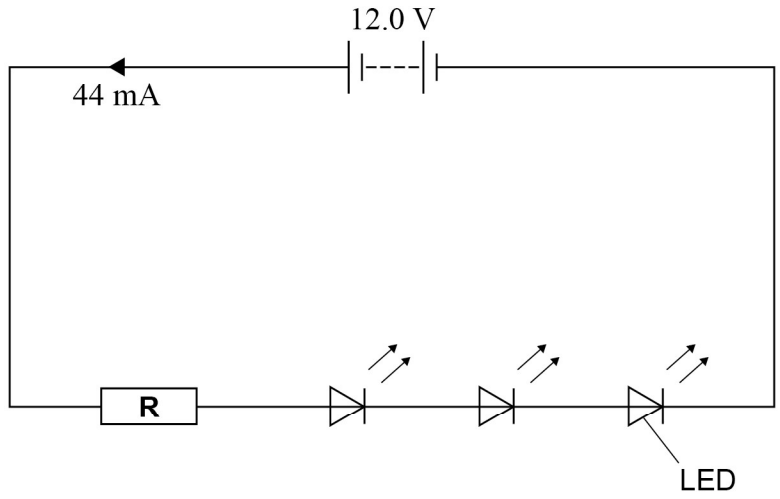
0 6 . 1 State what is meant by the emf (electromotive force) of a battery.

[1 mark]

Figure 10 shows the circuit diagram for a battery-powered torch.
The circuit contains three identical light emitting diodes (LEDs) and a resistor **R**.
The current in the circuit is 44 mA.

Figure 10



0 6 . 2 Calculate the number of electrons that pass a point in the circuit in 37 minutes.

[2 marks]

number of electrons = _____

Question 6 continues on the next page

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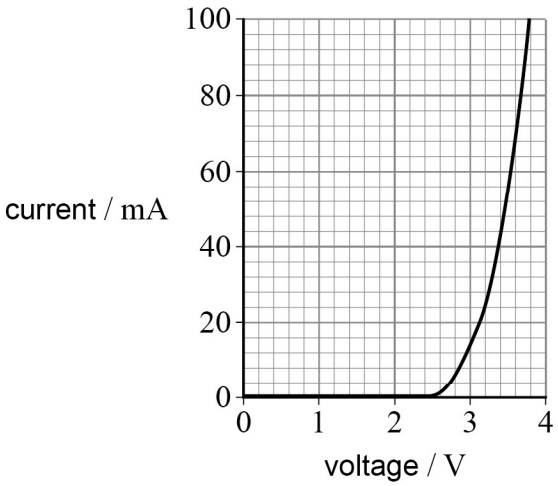
Figure 11 is the current–voltage characteristic for an LED used in the torch.

Figure 11



0 6 . 3 Determine the power output of one LED when the torch is on.

[3 marks]

power output = _____ W

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The battery has an emf of $12.0\ \text{V}$ and an internal resistance of $1.5\ \Omega$.

0 6 . 4 Determine the resistance of **R** in **Figure 10**.

[4 marks]

resistance = _____ Ω

Question 6 continues on the next page

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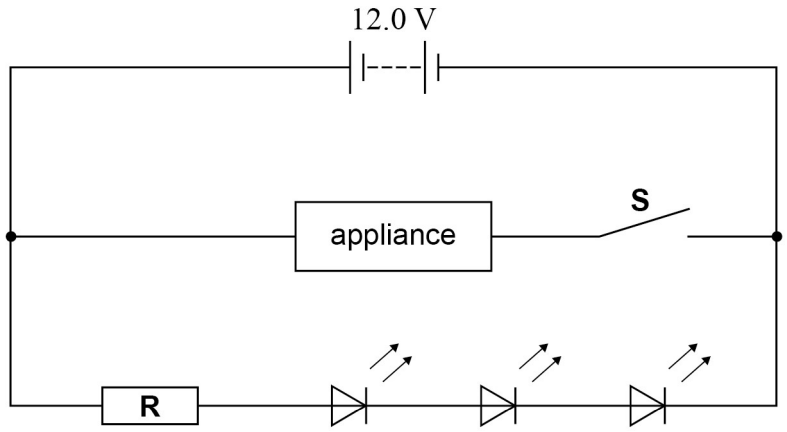
0 6 . 5 Another appliance is connected to the battery as shown in **Figure 12**.

The current in the battery is 3.5 A when switch **S** is closed.

Figure 12



Each LED requires a voltage of at least 2.9 V to light.

Deduce whether the LEDs will light when **S** is closed.

[3 marks]

13

END OF QUESTIONS