

Questions

Q1.

Answer the question with a cross in the box you think is correct ☐ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐ .

Two copper wires are placed in series in a complete circuit. The electrons in the two wires have different values of drift velocity.

Which of the following must be different for the two wires?

- ☐ **A** charge carrier density
- ☐ **B** cross-sectional area
- ☐ **C** current
- ☐ **D** length

(Total for question = 1 mark)

Q2.

Answer the question with a cross in the box you think is correct ☐ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐ .

In a current-carrying copper wire, the drift velocity of the electrons is very small.

Which of the following best explains this?

- ☐ **A** The charge on an electron is very small.
- ☐ **B** The cross-sectional area of the wire is very small.
- ☐ **C** The current in the wire is very large.
- ☐ **D** The number of electrons per unit volume for copper is very large.

(Total for question = 1 mark)

Q3.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The equation $I = nqvA$ relates the current in a sample of a material to the movement of free charge carriers in the sample.

Which of the following is a correct definition of one of the terms in this equation?

- ☐ **A** n represents the number of charge carriers in the sample.
- ☐ **B** q represents the total charge stored in the sample.
- ☐ **C** v represents the drift velocity of the charge carriers in the sample.
- ☐ **D** A represents the surface area of the sample.

(Total for question = 1 mark)

Q4.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☐).

Two wires, X and Y, are made of the same material. The wires are connected in series. The current in the wires is I , as shown.



Wire X has twice the diameter of wire Y.

The mean drift velocity of electrons in wire X is v .

Which of the following is the mean drift velocity of electrons in wire Y?

- ☐ **A** 0.25 v
- ☐ **B** 0.5 v
- ☐ **C** 2 v
- ☐ **D** 4 v

(Total for question = 1 mark)

Q5.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

The formula for the current I in a conductor is $I = nqvA$.

Which of the following gives the meaning of n ?

- ☐ **A** number of conduction electrons in a wire of length 1 m
- ☐ **B** number of conduction electrons in 1 m^3 of a material
- ☐ **C** total number of electrons in a wire of length 1 m
- ☐ **D** total number of electrons in 1 m^3 of a material

(Total for question = 1 mark)

Q6.

Wire P and wire Q are connected in series across a battery.
Wire P has a charge carrier density n and a diameter d .
Wire Q has a charge carrier density $2n$ and a diameter $2d$.
The drift velocity of the charge carriers in wire P is v .

Which of the following is the drift velocity of the charge carriers in wire Q?

☐ **A** $\frac{v}{8}$

☐ **B** $\frac{v}{4}$

☐ **C** v

☐ **D** $4v$

(Total for question = 1 mark)

Q7.

A wire of cross-sectional area $2.8 \times 10^{-6} \text{ m}^2$ is connected in a circuit. There is a current of 2.5 A in the wire.

Calculate the drift velocity of the electrons in the wire.

number of charge carriers per unit volume = $8.5 \times 10^{28} \text{ m}^{-3}$

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Drift velocity =

(Total for question = 2 marks)

Q8.

A copper wire of radius 0.40 mm carries a current of 5.1 A.

Calculate the drift velocity of the electrons in the wire.

number of charge carriers per m^3 for copper = 8.5×10^{28}

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Drift velocity =

(Total for question = 2 marks)

Q9.

There is a current of 1.25 A in a wire.

Calculate the drift velocity of the conduction electrons in the wire.

number of conduction electrons per $\text{m}^3 = 9.0 \times 10^{28} \text{m}^{-3}$
cross-sectional area of wire = $2.7 \times 10^{-7} \text{m}^2$

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Drift velocity =

(Total for question = 2 marks)

Q10.

The equation $I = nqvA$ can be used to establish the drift velocity v of electrons in a copper wire.

(a) State what is meant by drift velocity.

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(b) A copper wire has a cross-sectional area of $2.64 \times 10^{-7} \text{ m}^2$ and carries a current of 1.31 A. Calculate the drift velocity of the electrons in this copper wire.

$$n = 8.49 \times 10^{28} \text{ m}^{-3}$$

(2)

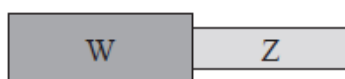
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Drift velocity =

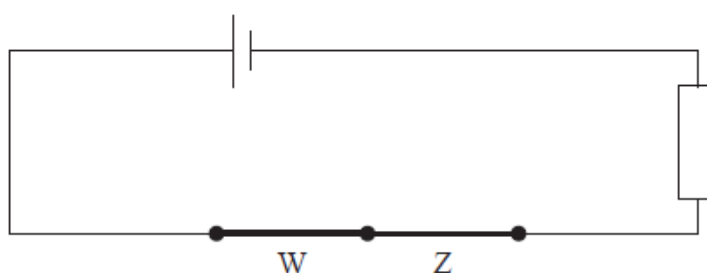
(Total for question = 3 marks)

Q11.

Two copper wires, W and Z, are joined as shown. Wire W has twice the diameter of wire Z.



W and Z are connected in series with a cell and resistor, as shown.



(a) State the purpose of the resistor in this circuit.

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(b) The current I in a conductor is given by the formula

$$I = nqvA$$

Complete the following table, which shows ratios of quantities for wires W and Z.
The first row has been completed for you.

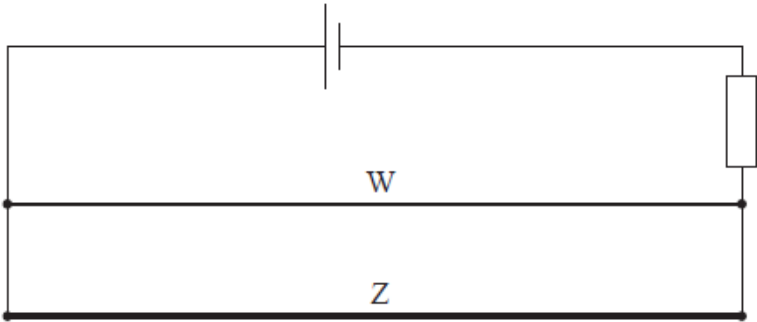
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Ratio	Value	Reason
$\frac{n_w}{n_z}$	1	Both wires are made of the same material
$\frac{I_w}{I_z}$		
$\frac{v_w}{v_z}$		

(Total for question = 5 marks)

Q12.

Equal lengths of two copper wires, W and Z, are connected in parallel in a circuit as shown.



Wire Z has twice the diameter of wire W.

(a) Explain why the drift velocity of the charge carriers is the same value in wires W and Z.

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(b) Wires W and Z are now connected in series as shown.



Complete the table by placing a cross in the correct box for each quantity.

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Quantity	Same value for W and Z	Larger value in W	Larger value in Z
Current in the wires			
Resistance of the wires			
Potential difference across the wires			
Drift velocity of the charge carriers in the wires			

(Total for question = 8 marks)

A nichrome wire of length 0.45 m has a cross-sectional area of $2.5 \times 10^{-7} \text{ m}^2$.
The resistance of the wire is $2.0 \, \Omega$.

(a) Calculate the resistivity of nichrome.

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Resistivity =

(b) A potential difference of 3.0 V is applied across the nichrome wire.

Calculate the drift velocity of the conduction electrons in the nichrome wire.

number of conduction electrons per $\text{m}^3 = 9.0 \times 10^{28} \text{ m}^{-3}$

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Drift velocity =

(c) A student suggests that the drift velocity will double if the length of wire used in the circuit is halved.

Comment on this suggestion.

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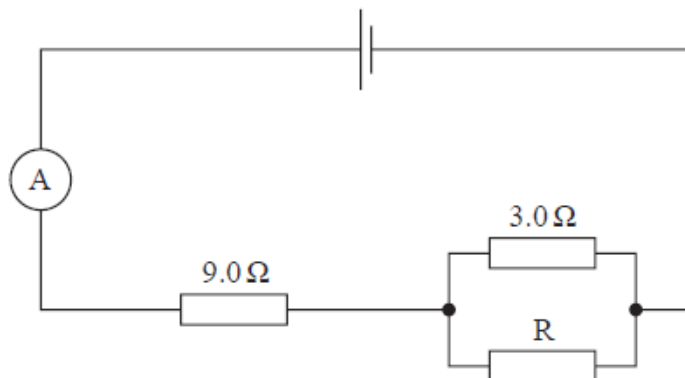
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(Total for question = 8 marks)

Q14.

A student sets up the circuit shown with a cell of negligible internal resistance.

The ammeter displays a current of 0.14 A.



(a) Calculate a value for the resistance of the resistor R.

e.m.f. of the cell = 1.54 V

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Resistance =

(b) The student made the 9.0 Ω resistor using a thin copper wire with a diameter of 0.15 mm.

(i) Show that the cross-sectional area of this wire was about $2 \times 10^{-8} \text{ m}^2$.

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(ii) Calculate the length of copper wire used by the student.

resistivity of copper = $1.68 \times 10^{-8} \Omega \text{ m}$

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Length of copper wire =

(iii) Calculate the drift velocity of the electrons in this copper wire.

number of charge carriers per unit volume = $8.49 \times 10^{28} \text{ m}^{-3}$

current in copper wire = 0.14 A

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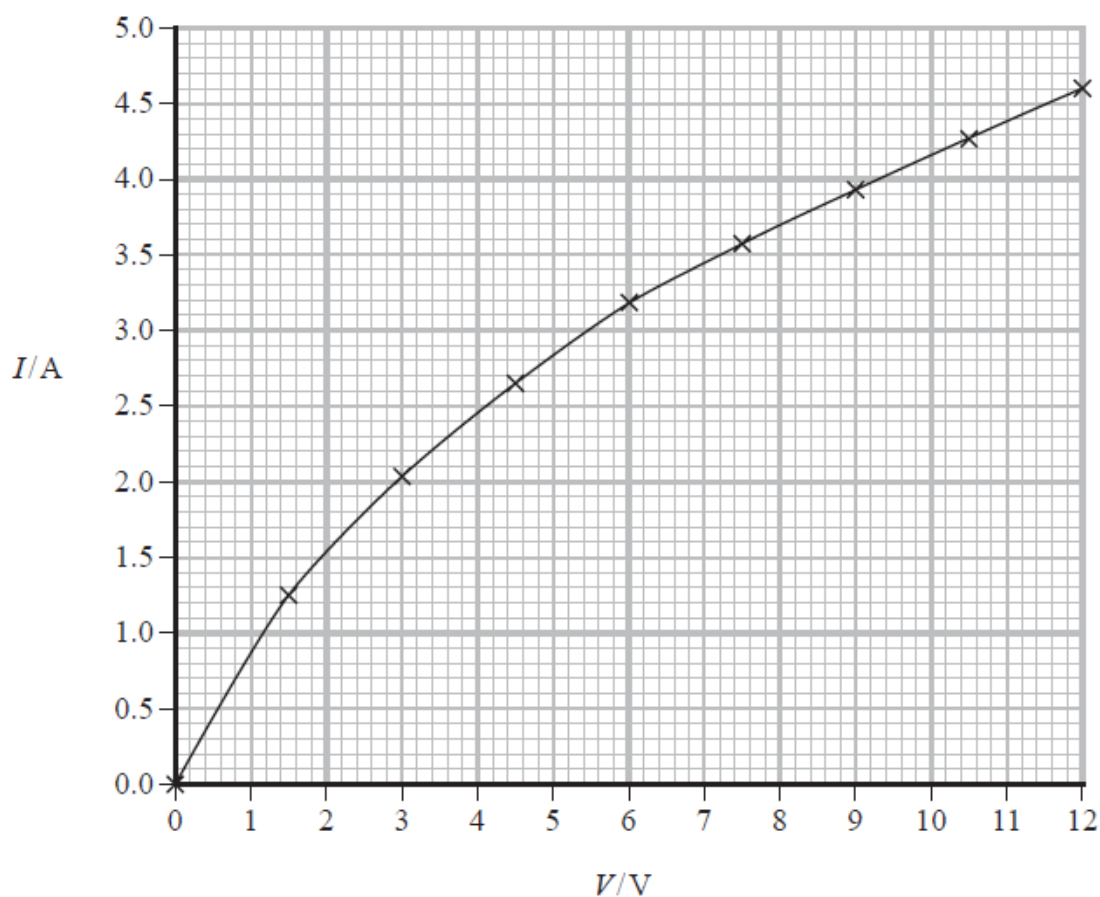
Drift velocity =

(Total for question = 10 marks)

Q15.

Drivers use car headlights to emit light in dark conditions.

The graph shows how current I varies with potential difference V for a car headlight.



The headlight will emit light when it dissipates at least 35 W of power.

(a) Determine the minimum potential difference for which the headlight will emit light.

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Minimum potential difference = V

(b) In a car, two headlights are connected in parallel with a 12.0 V battery. The battery has negligible internal resistance.

(i) Explain the advantages of connecting the headlights in parallel with the battery rather than in series.

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(ii) A student writes the following statement.

When connected to the 12.0 V battery, the combined resistance of two headlights in parallel is one quarter of the combined resistance of two headlights in series.

Deduce whether the student is correct.

Your answer should include calculations using data from the graph.

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(c) The headlights are connected in the circuit using copper wire. The current in the wire is 4.60 A.

Calculate the drift velocity of electrons in the copper wire.

number of charge carriers per m³ of copper = $8.49 \times 10^{28} \text{ m}^{-3}$
resistivity of copper = $1.72 \times 10^{-8} \Omega \text{ m}$
resistance per unit length of the copper wire = $1.75 \times 10^{-2} \Omega \text{ m}^{-1}$

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Drift velocity =

(Total for question = 12 marks)