Electrical Quantities

Question Paper

Course	CIE IGCSE Physics
Section	4. Electricity & Magnetism
Topic	Electrical Quantities
Difficulty	Medium

Time Allowed 80

Score /61

Percentage /100

Question 1a

A student investigates how the resistance of a filament lamp changes with the potential difference (p.d.) across it.

He uses the circuit shown in Fig. 1.1.

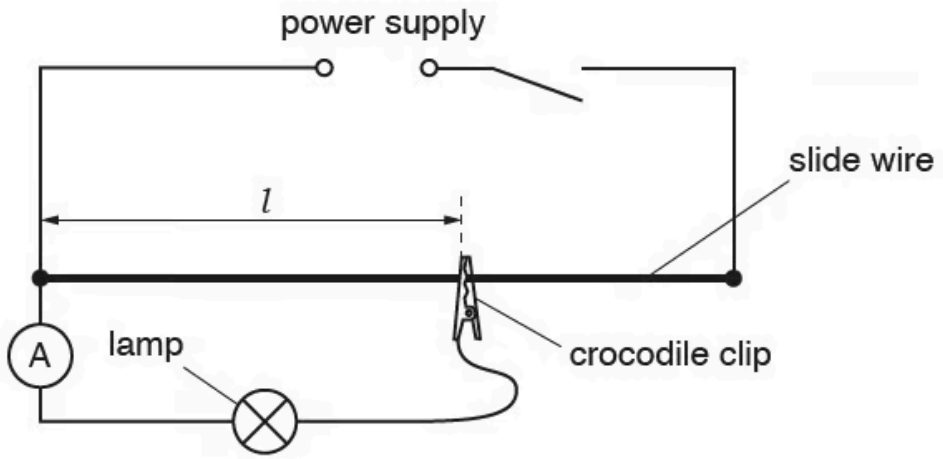


Fig. 1.1

On Fig. 1.1, draw the symbol for a voltmeter connected to measure the potential difference across the lamp.

[1 mark]

Question 1b

The student connects the crocodile clip to a length l = 20.0 cm of the slide wire.
He measures the potential difference, *V*, and the current, I, for the lamp.

(i) Record the voltmeter and ammeter readings shown in Fig. 1.2 for a value of l = 20.0 cm.

V = ...

I = ...

[1]

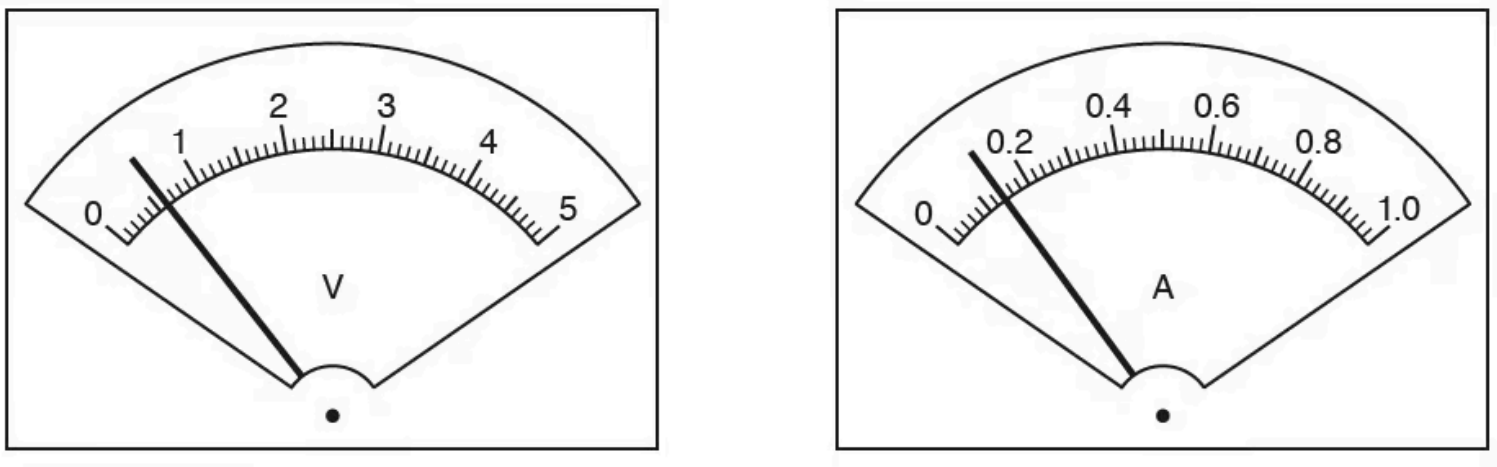


Fig. 1.2

(ii) Calculate, and record in Table 1.1, the resistance *R* of the lamp at l = 20.0 cm.

Use your readings from **(b)(i)** and the equation $R = \frac{V}{I}$

[1]

Table 1.1

l/cm	*R*/Ω
20.0	

40.0	7.5
60.0	10
80.0	12
100.0	13

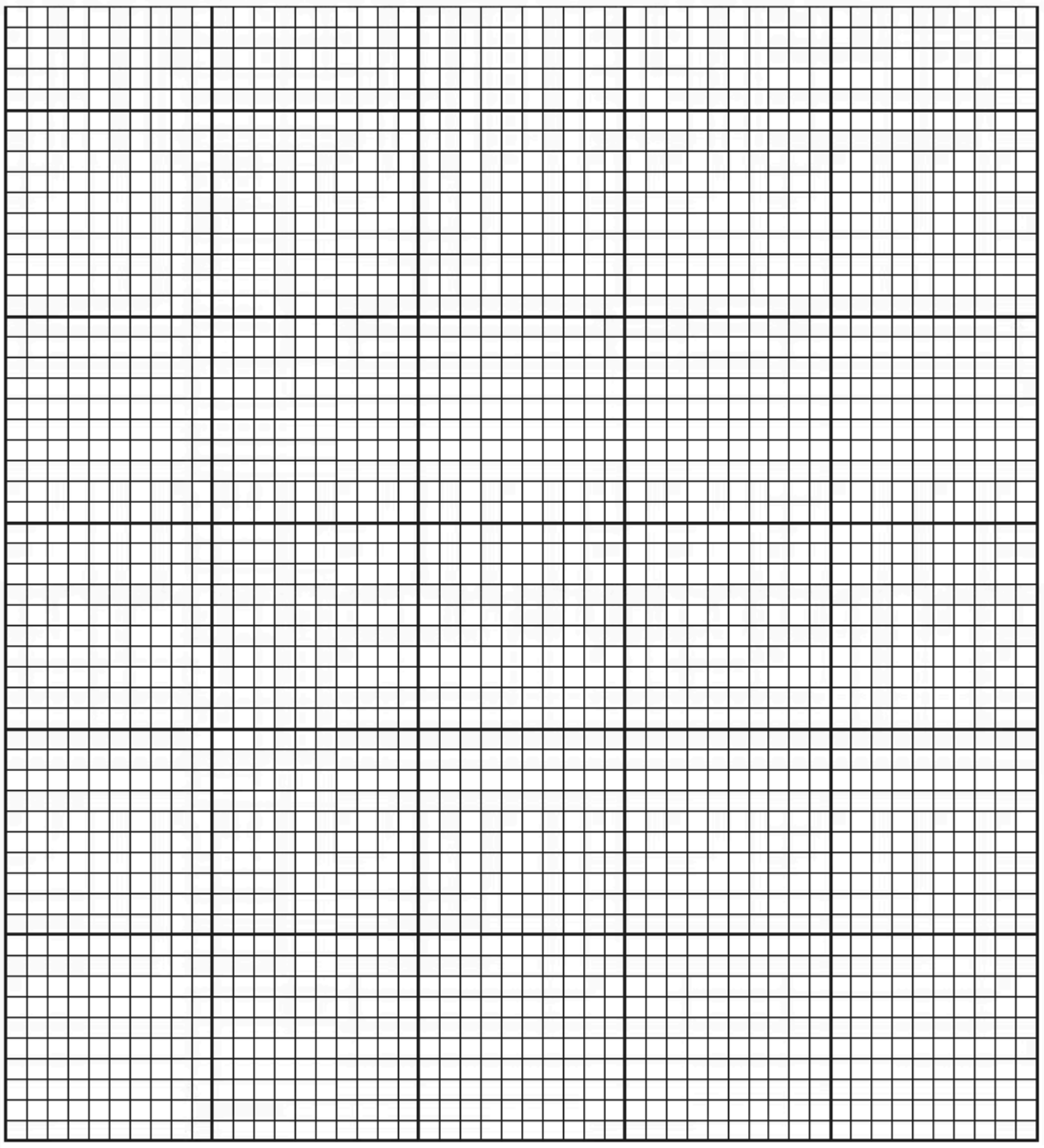
[2 marks]

Question 1c

The student connects the crocodile clip to other lengths l of the slide wire.

He measures the potential difference *V* and the current I for the lamp and calculates the resistance each time. His results are shown in Table 1.1.

Plot a graph of *R* / Ω (y-axis) against l / cm (x-axis).



[4 marks]

Question 1d

Extended tier only

The student notices that the lamp is very dim when l = 20.0 cm but becomes very bright when l = 100.0 cm.

State what the shape of the graph tells you about how the resistance of the lamp changes with the temperature of the filament.

Justify your statement using your results from the graph.

[2 marks]

Question 1e

In this type of experiment, it is possible to change the current in the lamp by using a variable resistor instead of a slide wire.

On Fig. 1.3, complete the circuit diagram to show a variable resistor used for this purpose.

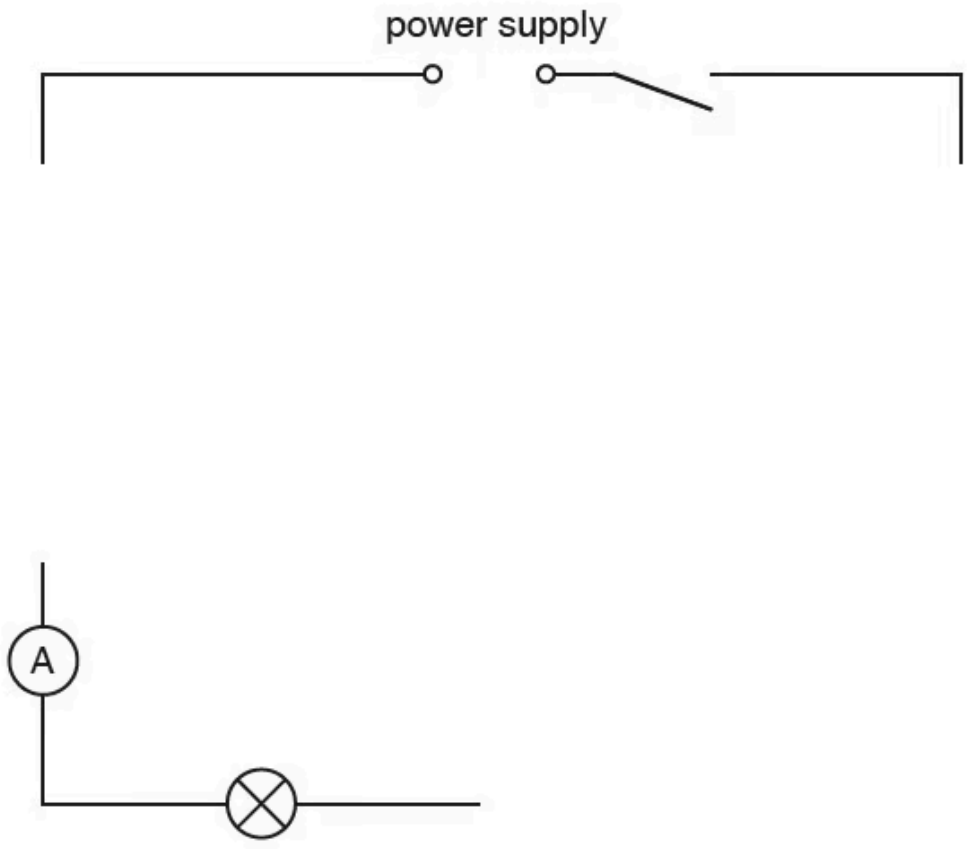


Fig. 1.3

[2 marks]

Question 2a

A student is investigating a power supply.
She is using the circuit shown in Fig. 3.1.

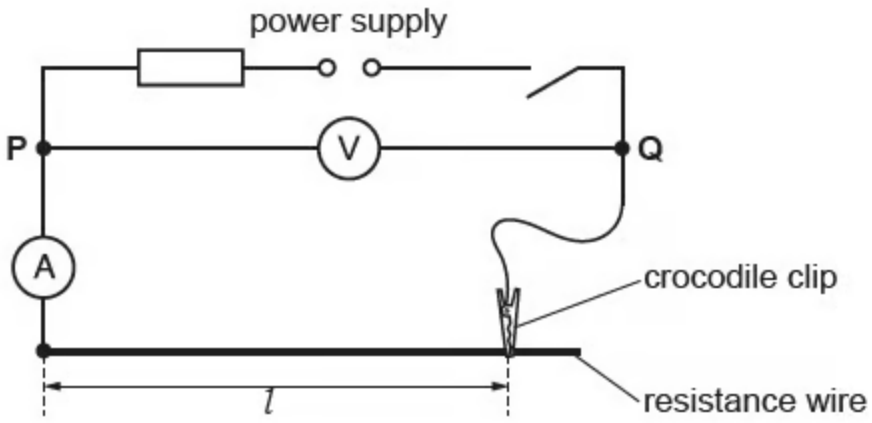


Fig. 3.1

The student connects the crocodile clip to a length l = 100.0 cm of the resistance wire and measures the potential difference V_0 across terminals **P** and **Q** and the current I_0 in the circuit.

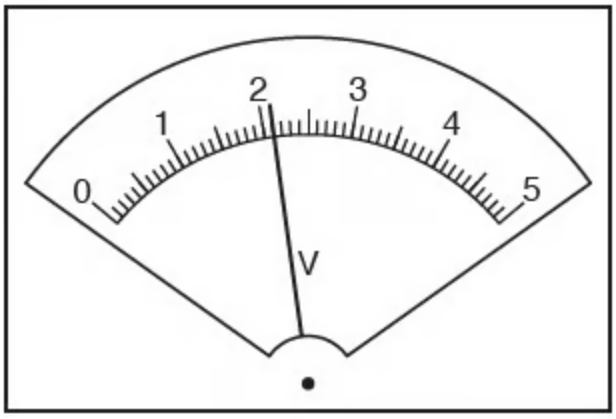


Fig. 3.2

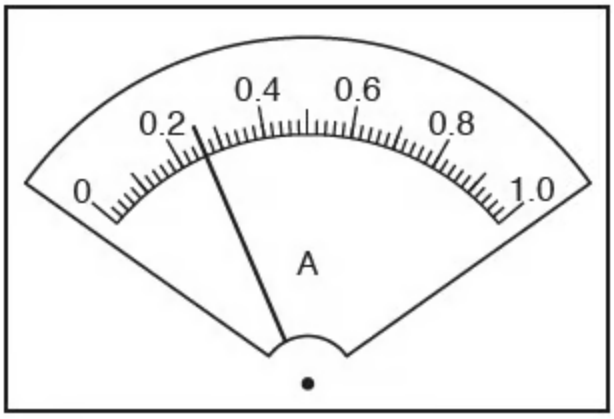


Fig. 3.3

(i) Record the values of V_0 and I_0 shown on the meters in Fig. 3.2 and Fig. 3.3.

V_0 = ... V

I_0 = ... A

[1]

(ii) Calculate the resistance R_0 of 100.0 cm of the wire. Use your values of V_0 and I_0 and the equation $R_0 = \frac{V_0}{I_0}$

R_0 = ...Ω

[1]

[2 marks]

Question 2b

The student then connects the crocodile clip to lengths *l* = 70.0 cm, 60.0 cm, 50.0 cm, 40.0 cm and 30.0 cm of the resistance wire. She measures the current *I* in the circuit for each length.

Her readings are shown in Table 3.1.

Table 3.1

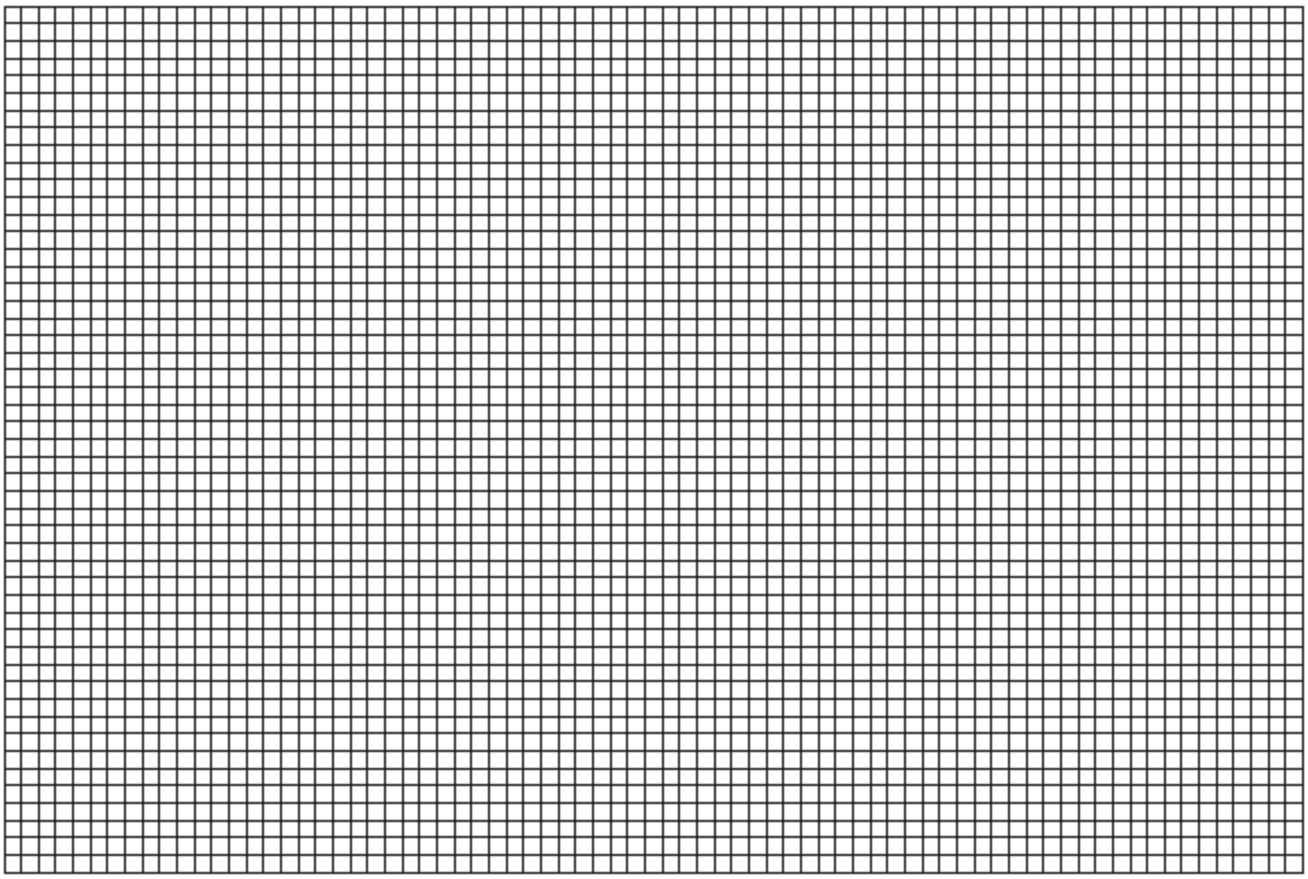
l/cm	I/A	$\frac{1}{I}/\frac{1}{\text{A}}$
70.0	0.35	
60.0	0.40	2.50
50.0	0.44	2.27
40.0	0.53	1.89
30.0	0.65	1.54

Calculate, and record in Table 3.1, the value of $\frac{1}{I}$ for length *l* = 70.0 cm of the wire.

[1 mark]

Question 2c

Plot a graph of I / cm (y-axis) against $\frac{1}{I} / \frac{1}{\mathrm{A}}$ (x-axis). You do **not** need to start your axes at the origin (0,0).



[4 marks]

Question 2d

(i) Determine the gradient *G* of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [1]

(ii) Calculate the electromotive force (e.m.f.) *E* of the power supply. Use your value of R_0 from **(a)(ii)** and the equation $E = \frac{G \times R_0}{k}$, where *k* = 100 cm.

E = ... [1]

[2 marks]

Question 2e

The ammeter in this circuit has a small resistance which affects the current. The effect of this resistance on the measured current I will be different for each measured length l of the resistance wire.

State and explain which length l will be most affected by the resistance of the ammeter.

[2 marks]

Question 3a

A student is determining the resistance of a piece of wire.

Fig. 2.1 shows the circuit she uses.

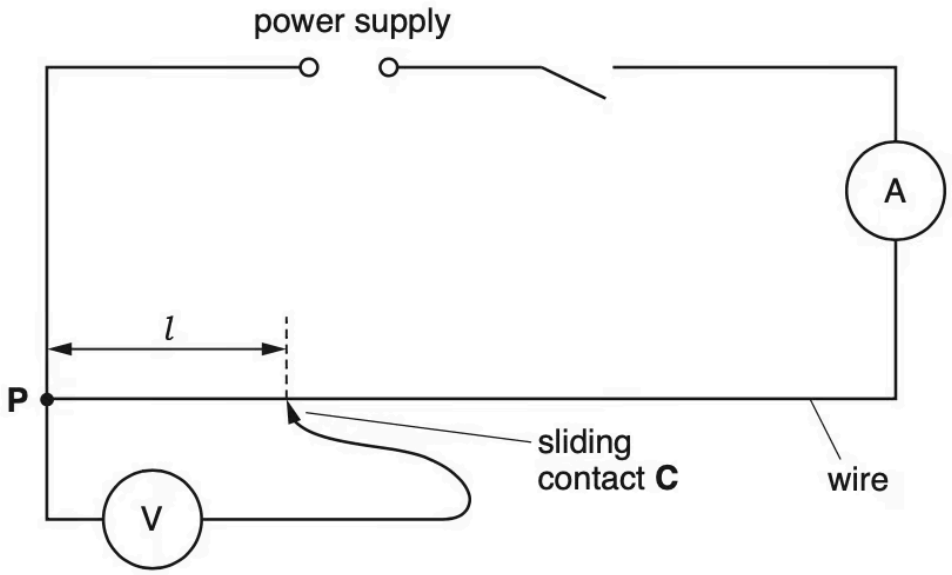


Fig. 2.1

Record the current I in the circuit, as shown on the ammeter in Fig. 2.2.

I = ...

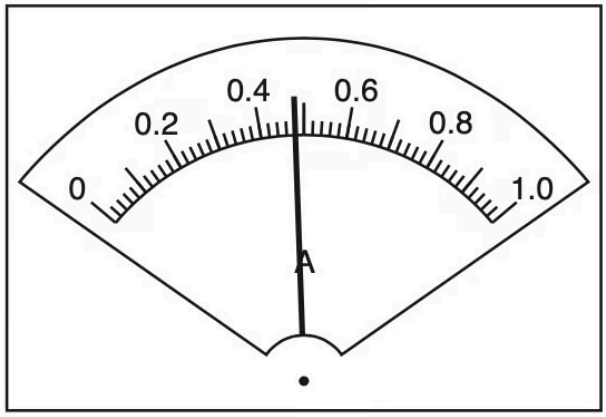


Fig. 2.2

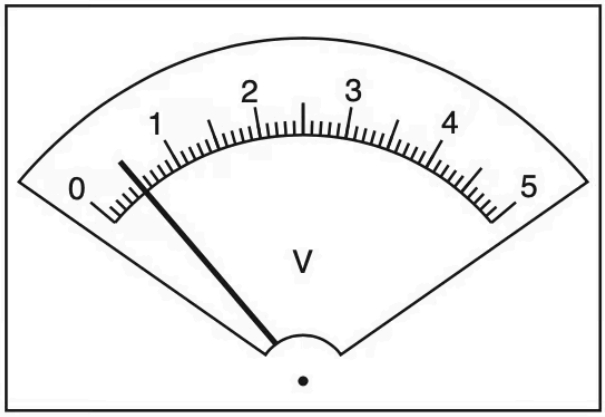


Fig. 2.3

[1 mark]

Question 3b

The student places the sliding contact **C** at a distance l = 20.0 cm from **P**. The voltmeter reading is shown in Fig. 2.3. Record the voltmeter reading in Table 2.1 for l = 20.0 cm.

Table 2.1

l/	V/
20.0	
40.0	0.9
60.0	1.6
80.0	2.0
100.0	2.4

[1 mark]

Question 3c

The student repeats the procedure using values of l = 40.0 cm, 60.0 cm, 80.0 cm and 100.0 cm.
The readings are shown in Table 2.1.

Complete the column headings in the table.

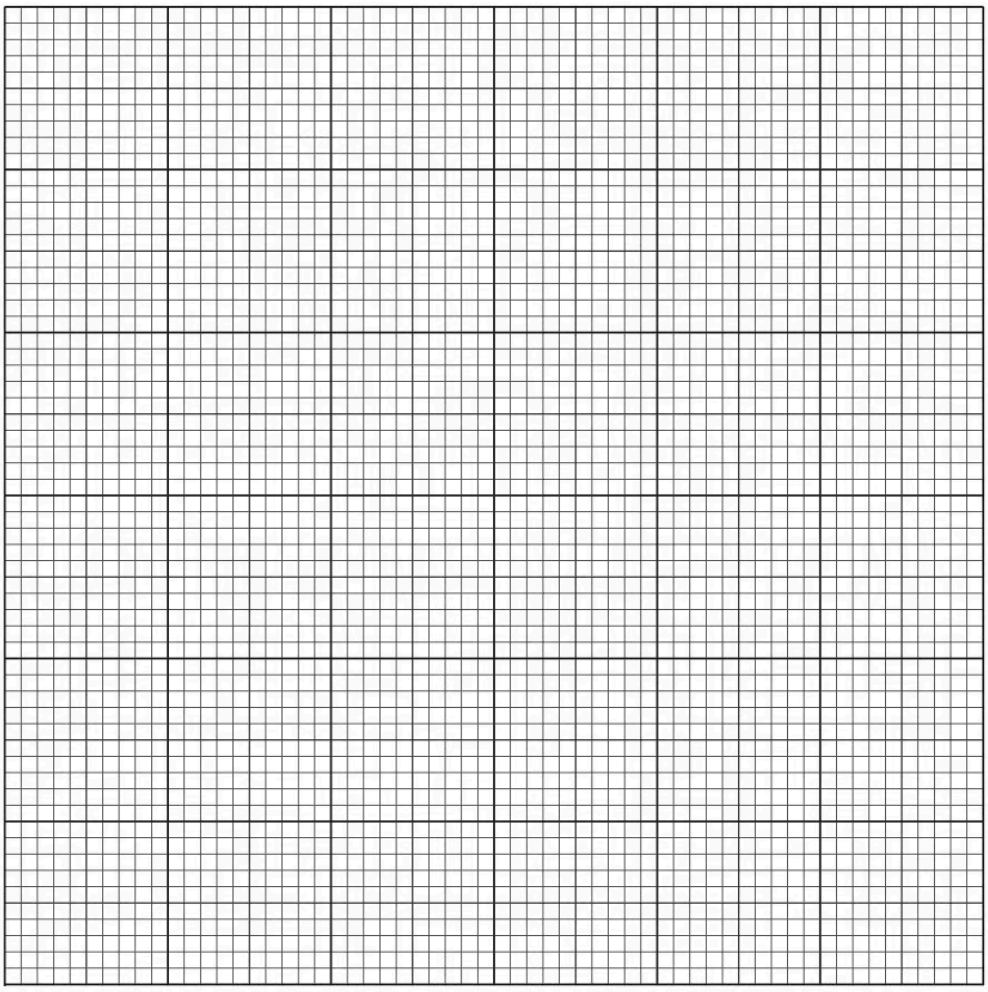
Table 2.1

l/	V/
20.0	
40.0	0.9
60.0	1.6
80.0	2.0
100.0	2.4

[1 mark]

Question 3d

Plot a graph of V / V (y-axis) against I / cm (x-axis). Start both axes at the origin (0, 0).



[4 marks]

Question 3e

Extended tier only

(i) Determine the gradient *G* of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

(ii) Calculate the resistance *R* of each centimetre of the wire. Use the following equation:

$$R = \frac{Gk}{I},$$

where *k* = 1.0 V/cm and where I is the current recorded in **(a)**.

Include the unit.

R = ... [2]

[4 marks]

Question 4a

A student is investigating a resistance wire. She uses the circuit shown in Fig. 3.1.

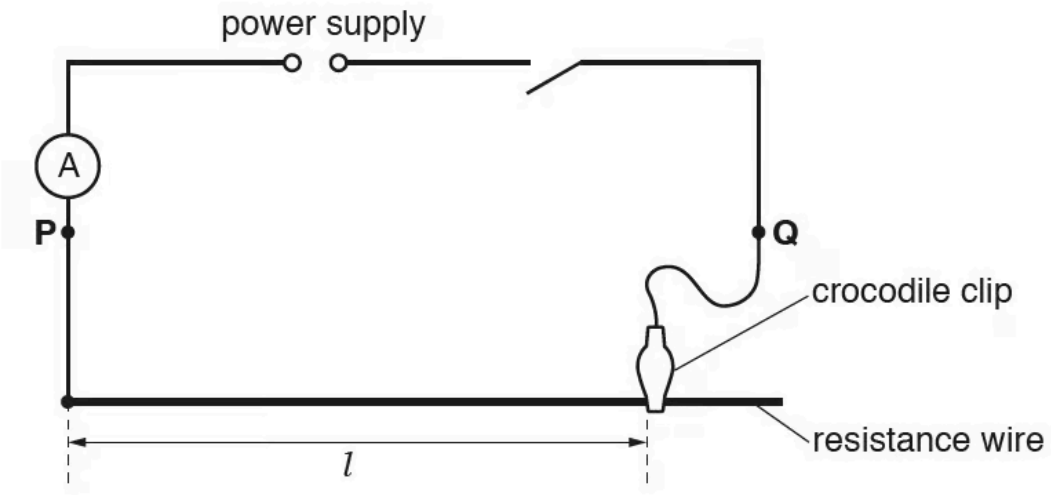


Fig. 3.1

(i) On Fig. 3.1, draw a voltmeter connected to measure the potential difference *V* across terminals **P** and **Q**.

[1]

(ii) The student connects the crocodile clip to a length l = 90.0 cm of the resistance wire and measures the potential difference *V* across terminals **P** and **Q** and the current I in the circuit.

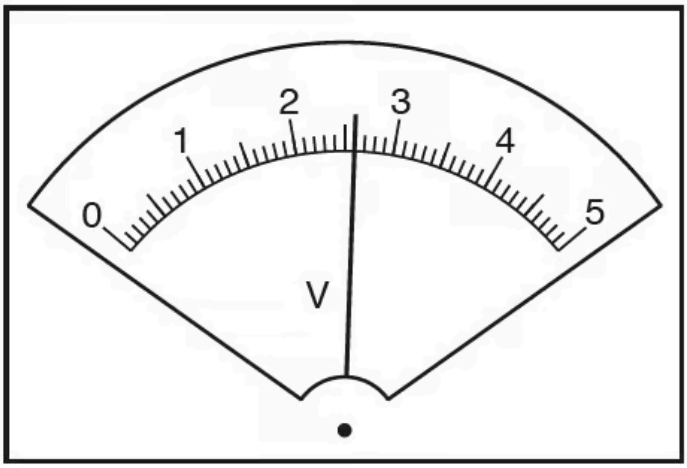


Fig. 3.2

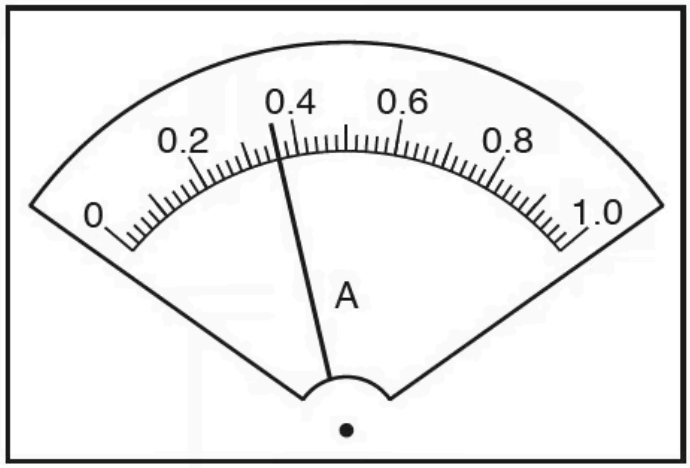


Fig. 3.3

Read, and record in Table 3.1, the values of V and I shown on the meters in Fig. 3.2 and Fig. 3.3.

[2]

Table 3.1

l/cm	V/	I/	R/Ω	$\frac{R}{l}$/$\frac{\Omega}{\text{cm}}$
90.0				
60.0	2.5	0.52		
40.0	2.3	0.71		

[3 marks]

Question 4b

The student then connects the crocodile clip to lengths l = 60.0 cm and I = 40.0 cm of the resistance wire. She measures the potential difference *V* across terminals **P** and **Q** and the current I in the circuit. Her readings are shown in Table 3.1.

Complete the column headings in Table 3.1.

[1 mark]

Question 4c

(i) Calculate, and record in Table 3.1, the resistance *R* of each length l of the wire.

Use the readings from Table 3.1 and the equation $R = \frac{V}{I}$

[2]

(ii) Calculate, and record in Table 3.1, the value of R/l for each length of wire.

[1]

[3 marks]

Question 4d

Use your results in Table 3.1 to calculate the resistance R_{25} of a 25.0 cm length of the resistance wire.
Show your working.

R_{25} = ... Ω

[1 mark]

Question 4e

Suggest **one** reason why different students, carrying out the experiment carefully with the same equipment, may **not** obtain identical results.

[1 mark]

Question 4f

The student finds that, during the experiment, the wire becomes hot because of a high current.

She decides to use a variable resistor to prevent this.

Complete the circuit in Fig. 3.4 to show a variable resistor used for this purpose in the experiment.

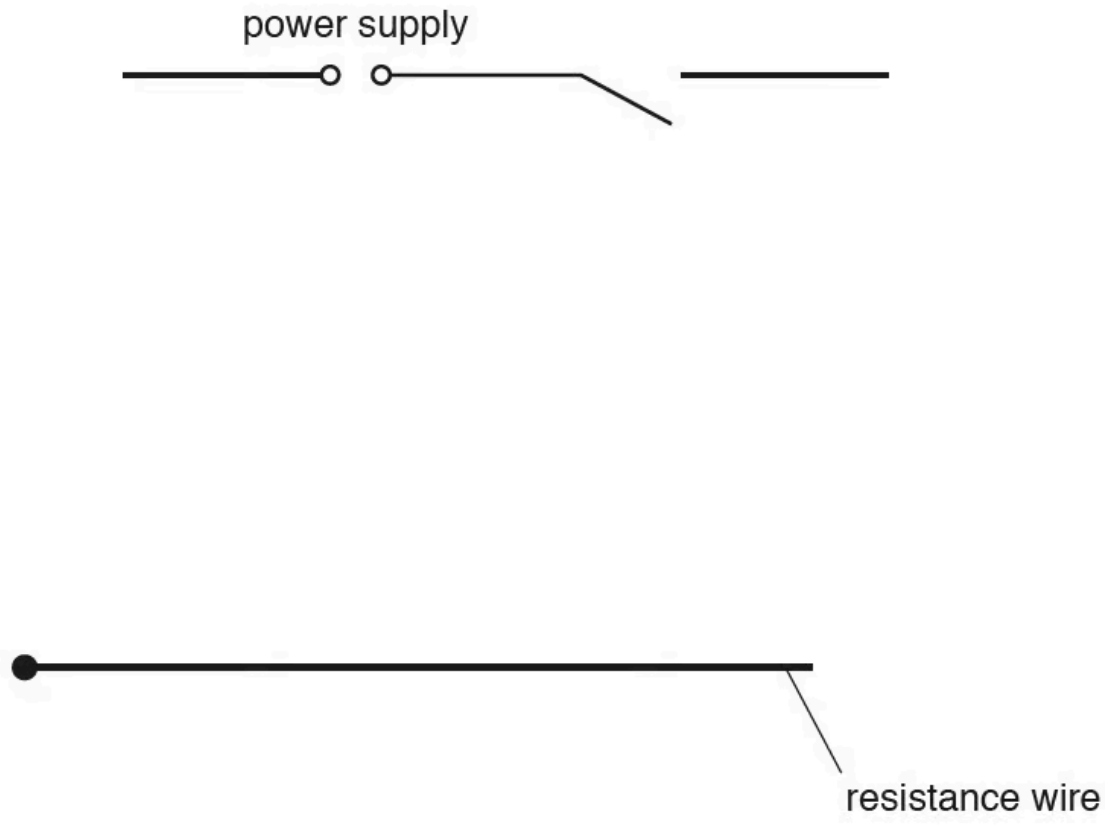


Fig. 3.4

[2 marks]

Question 5a

A student is determining the resistance of a resistance wire.

The circuit is shown in Fig. 2.1.

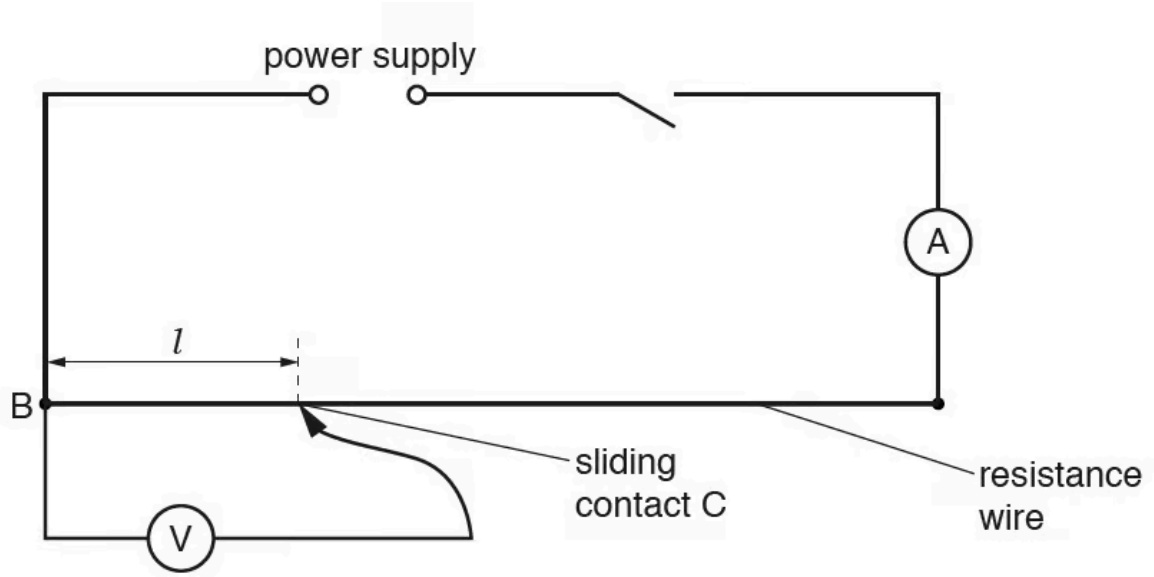


Fig. 2.1

Record the current I in the circuit, as shown on the ammeter in Fig. 2.2.

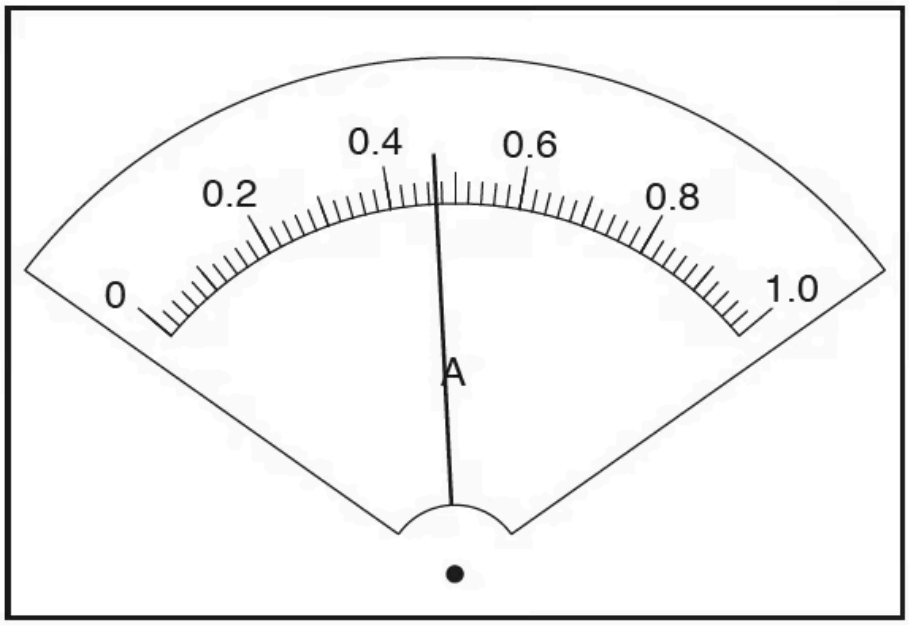


Fig. 2.2

I = ...

[1 mark]

Question 5b

The student places the sliding contact C at a distance l = 20.0 cm from B.

She records the potential difference *V* across the length l of the resistance wire.

She repeats the procedure using l values of 40.0 cm, 60.0 cm, 80.0 cm and 100.0 cm. All the readings are shown in Table 2.1.

Calculate, and record in Table 2.1, $\frac{V}{l}$ for each value of l.

Complete the $\frac{V}{l}$ column heading.

Table 2.1

l/cm	V/V	$\frac{V}{l}$/
20.0	0.50	
40.0	0.92	
60.0	1.62	
80.0	2.08	
100.0	2.40	

[3 marks]

Question 5c

Look carefully at the values in Table 2.1.

(i) Tick the box to show your conclusion from the results.

☐ $\frac{V}{I}$ is approximately constant.

☐ $\frac{V}{I}$ is decreasing as V increases.

☐ $\frac{V}{I}$ is increasing as V increases.

☐ There is no simple pattern for $\frac{V}{I}$ in the results.

[1]

(ii) Justify your conclusion by reference to your results.

[1]

[1 mark]

Question 5d

Calculate the resistance of 100 cm of the resistance wire.

Use the equation $R = \frac{V}{I}$ where *V* is the potential difference across 100 cm of the resistance wire. Use the value of current I from part **(a)**. Give your answer to a suitable number of significant figures for this experiment and include the unit.

R = ...

[3 marks]

Question 5e

In this type of experiment, it is sensible to keep the temperature of the resistance wire as close to room temperature as possible. Suggest one way to minimise the rise in temperature of the resistance wire.

[1 mark]

Question 5f

Draw the circuit symbol for a variable resistor.

[1 mark]

Question 6

A student is investigating the relationship between the power produced by an electrical heater and the time taken to heat a beaker of water. The power of the heater is given by the equation $P = VI$, where V is the potential difference (p.d.) across the heater and I is the current in the heater.

Plan an experiment to investigate the relationship between the power produced by an electrical heater and the time taken to heat a beaker of water.

The following apparatus is available:

ammeter
voltmeter
0–12 V variable power supply
250 cm^3 beaker
heater
thermometer
stopwatch

The student can also use other apparatus and materials that are usually available in a school laboratory.

You should:

- complete the diagram in Fig. 4.1 to show the circuit that you would use
- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- explain how you would use your results to reach a conclusion.

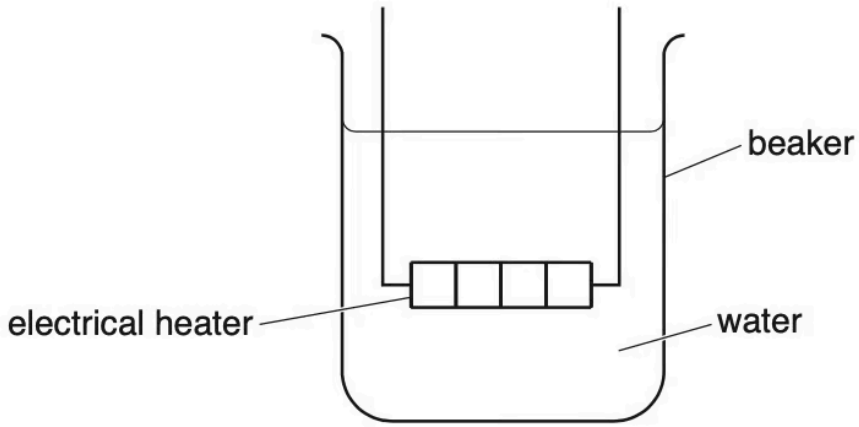


Fig. 4.1

[7 marks]