Required Practical Review

Physics Practical – Resistance

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GCSEpod: https://members.gcsepod.com/shared/podcasts/title/10976

Know it

Resistance is the property of an electrical component or material to restrict the flow of current through it.

It is measured in Ohms (Ω) and is calculated by using the following equation.

Resistance = potential difference (Volts) ÷ current (Amps)

$$R = V \div I$$

There are two parts to this practical:

1. **Investigating how does the resistance of a wire depend on its length?**
2. **Investigating resistance in series and parallel circuits.**

The resistance of the wire is proportional to its length. A graph of resistance against length should be a straight line through the origin. This experiment is a good one to use to discuss zero error as it is hard to attach the crocodile precisely to the zero end of the wire, and there will be some contact resistances. The potential difference will not vary very much during the experiment.

Activity 1: How does the resistance of a wire depend on its length?
A dimmer switch allows you to control the brightness of a lamp.

You will investigate how the dimmer switch works. You will construct a circuit to measure the potential difference across a wire and the current in the wire. You will do this for different lengths of wire.

Method

You are provided with the following:

- a battery or suitable power supply
- ammeter or multimeter
- voltmeter or multimeter
- crocodile clips
- resistance wire eg constantan of different diameters attached to a metre ruler
- connecting leads.

Read these instructions carefully before you start work.

1. Connect the circuit.

   It may be helpful to start at the positive side of the battery or power supply. This may be indicated by a red socket.

2. Connect a lead from the red socket to the positive side of the ammeter.

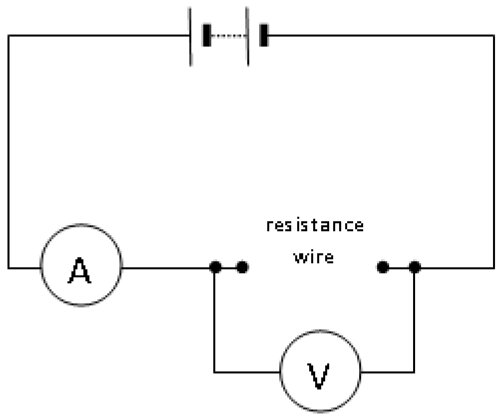
3. Connect a lead from the negative side of the ammeter (this may be black) to the crocodile clip at the zero end of the ruler.

4. Connect a lead from the other crocodile clip to the negative side of the battery.

   The main loop of the circuit is now complete. Use this lead as a switch to disconnect the battery between readings.

5. Connect a lead from the positive side of the voltmeter to the crocodile clip the ammeter is connected to.

6. Connect a lead from the negative side of the voltmeter to the other crocodile clip.



7. Record on a table the:
   - length of the wire between the crocodile clips
   - the readings on the ammeter
   - the readings on the voltmeter.

   You will need four columns in total.

Length of wire in cm	Potential difference in V	Current in A	Resistance in Ω

8. Move the crocodile clip and record the new ammeter and voltmeter readings. Note that the voltmeter reading may not change.

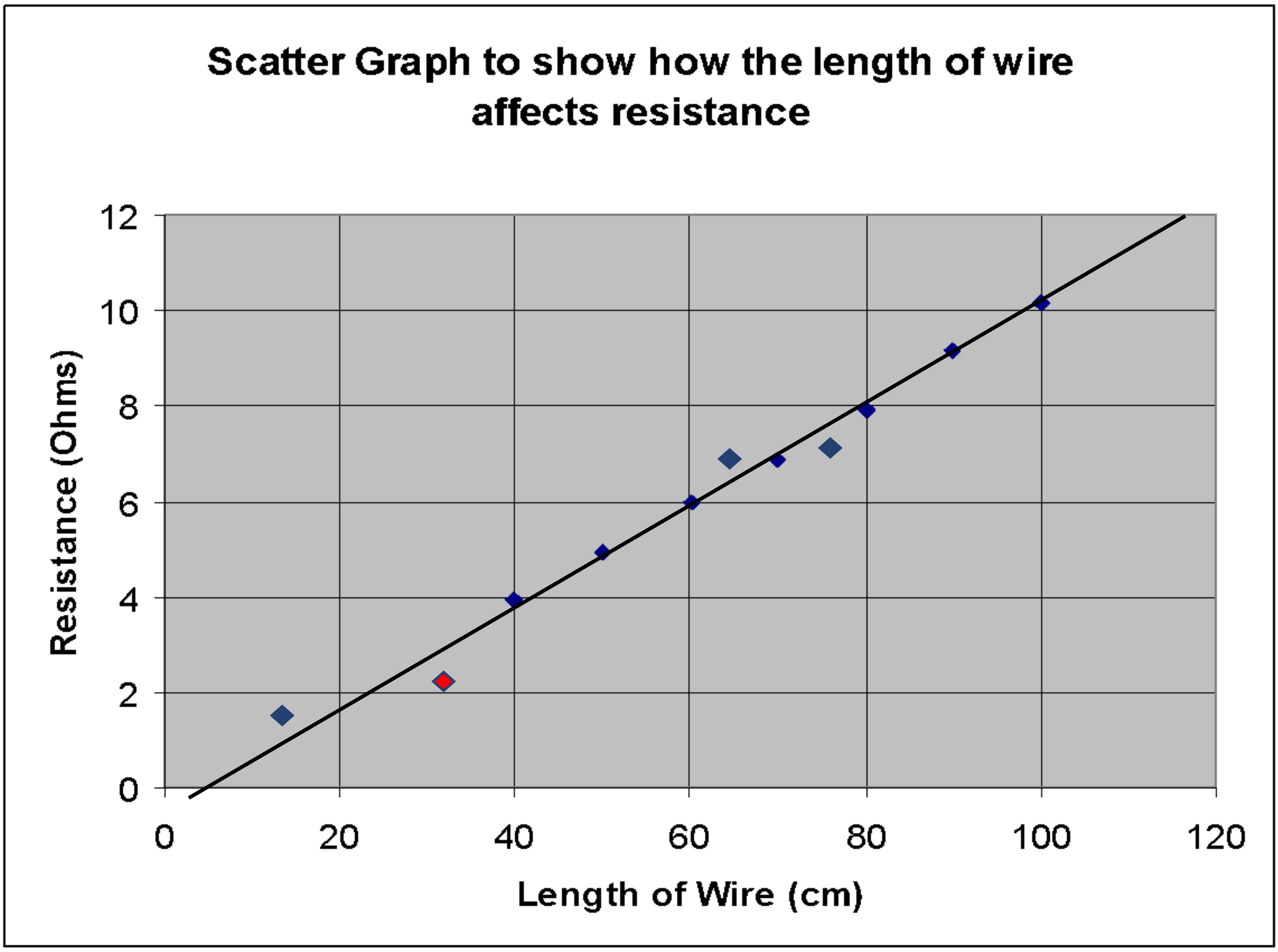
   Repeat this to obtain several pairs of meter readings for different lengths of wire.

9. Calculate and record the resistance for each length of wire using the equation above.

10. Plot a graph of length and resistance

Expected Results

The graph produced should be a straight line graph, it may not go through the origin and is likely to have many points away from the line of best fit. An example is shown below



This shows that resistance increases with length. This is due to more positive ions getting the way of the moving electrons.

Sources of error include:

Zero error on meter readings for current and voltage, particularly on analogue meters.
Misread the value of distance – it is hard to locate the crocodile clip exactly on the wire.
Heating may cause some changes of resistance, although in this experiment a wire is chosen that is unaffected by temperature.

Activity 2: Investigating resistors in series and in parallel

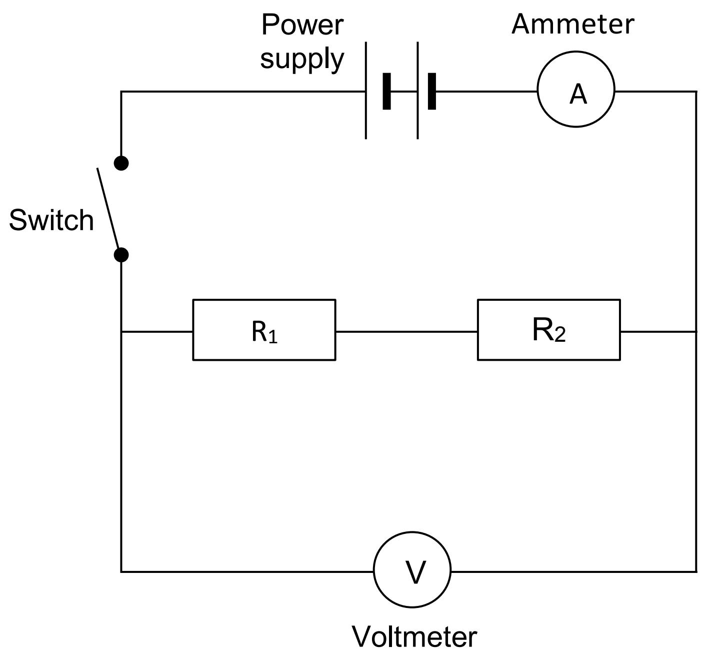
Method

You are provided with the following:

- a battery or suitable power supply
- ammeter or multimeter
- voltmeter or multimeter
- crocodile clips
- two 10 Ω resistors
- connecting leads.

Read these instructions carefully before you start work.

1. Connect the circuit for two resistors in series, as shown in the diagram.

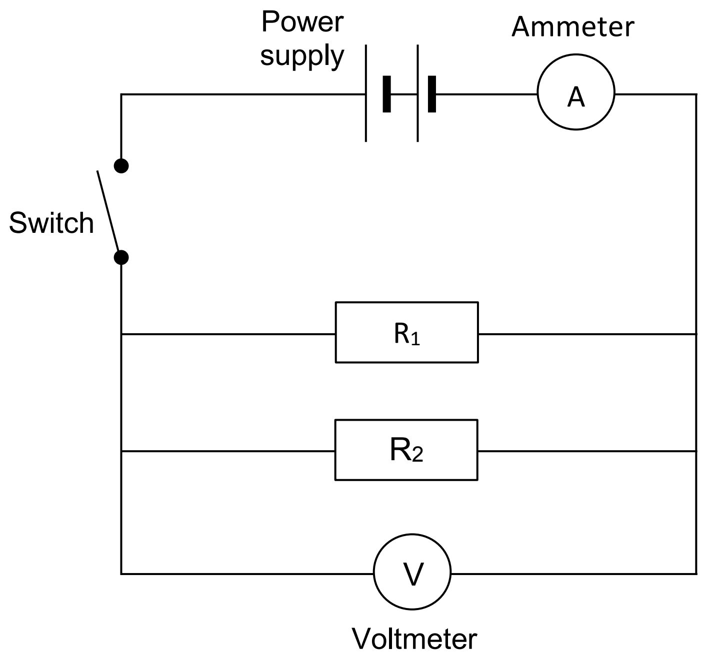


2. Switch on and record the readings on the ammeter and the voltmeter.

3. Use these readings to calculate the total resistance of the circuit.

Expected results

The resistance of each individual resistor is 10 Ω, when combined together in **series the resistances add up** so the total resistance would be 20 Ω. Each extra resistor makes it harder for the current to flow meaning overall current is reduced. As the voltage remains the same the resistance must have increased.



4. Now set up the circuit for two resistors in parallel.
5. Switch on and record the readings on the ammeter and the voltmeter.

6. Use these readings to calculate the total resistance of the circuit.

Expected results

In this version of the experiment, the total resistance calculated is around 5 Ω. This is lower than either of the two individual resistors. In parallel circuits each additional path allows more current to flow, meaning the resistance is less. In fact **the resistance of two resistors in parallel is always less than the lowest resistor**.

Review it

Complete the tasks below in your book.

Up to grade 4

a. State the equation and units for resistance.

b. List the independent, dependent and control variables in this practical.

c. Draw a circuit diagram of the practical.

Grade 5-7

d) Describe what will happen to the resistance as you increase the length of the wire. Explain your answer.

e) What is the largest source of inaccuracy in this practical?

Grade 7+

f) Suggest improvements to the method.

g) What would happen to the resistance if you:

1. Increase the diameter of the wire.
2. Increase the temperature of the wire.

Explain your answers.

Question it

Question 1

Fig. 3.1 shows the circuit.

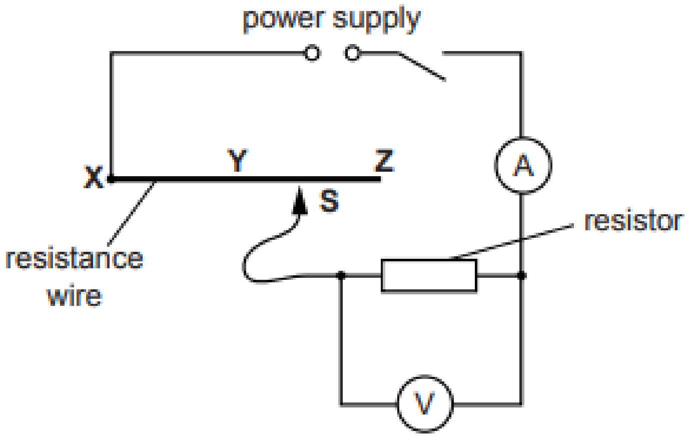


Fig. 3.1

(a) A student connects the sliding contact **S** to point **X** in the circuit. She measures the potential difference V across the resistor and the current I in the circuit. The meters are shown in Fig. 3.2.

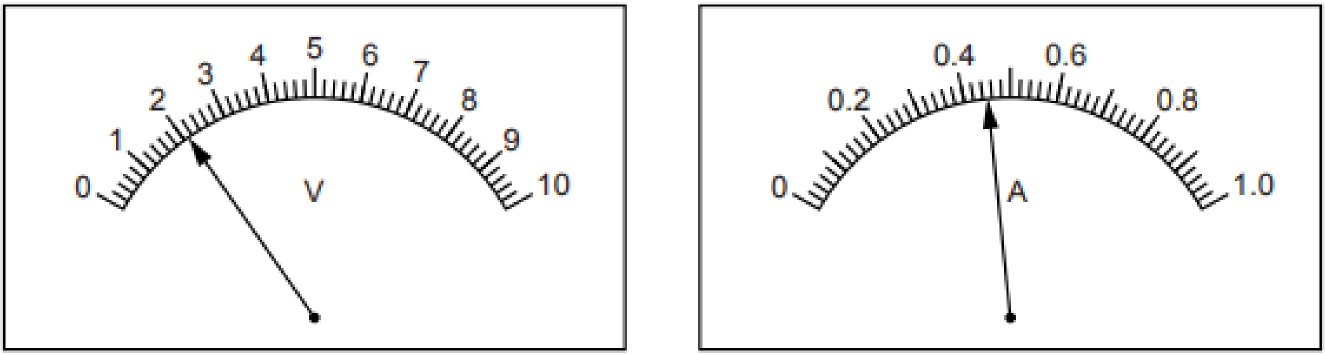


Fig. 3.2

(i) Write down the readings shown on the meters in Fig. 3.2.

V = ...

I = ...

[2]

(ii) Calculate the resistance R of the resistor using the equation $R = \frac{V}{I}$.

R = ... [2]

(b) The student repeats the steps in **(a)**, moving the sliding contact to point **Y** and then to point **Z**.

Comment on the effect, if any, on the current I in the circuit of changing the position of the sliding contact in this way.

....

....[1]

(c) In this experiment, the resistance wire **XYZ** acts as a variable resistor (rheostat).

Draw the standard circuit symbol for a variable resistor.

[1]

(d) A student carries out this experiment using a different resistor. He takes readings using various lengths of resistance wire in the circuit. He plots a graph of V/V against I/A.

Fig. 3.3 is a sketch of the graph.

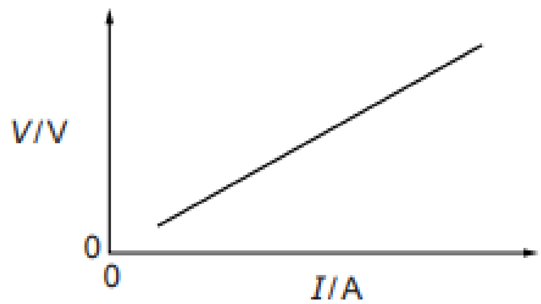


Fig. 3.3

Explain briefly how the student would use the graph to determine the gradient of the line. You may draw on the graph of Fig. 3.3. You are not asked to calculate the value of the gradient.

....

....

....[2]

[Total: 8]

Mark it

(a)	**(i)**	2.1 (V)	[1]
		0.45 (A)	[1]
	(ii)	*R* = 4.7 accept 4.67 (Ω) e.c.f. **(a)(i)**	[1]
		all units correct, V, A, Ω, symbols or words	[1]
(b)		(current) decreases	[1]
(c)		correct symbol for variable resistor (rectangle with strike-through arrow)	[1]
(d)		clear description or diagram showing triangle method with large triangle **or** taking **two** co-ordinates far apart on line	[1]
		how to calculate gradient, e.g. equation or rise / run, etc.	[1]
			[Total: 8]

Question 2

A student is investigating the resistance of a lamp.

He is using the circuit shown in Fig. 3.1.

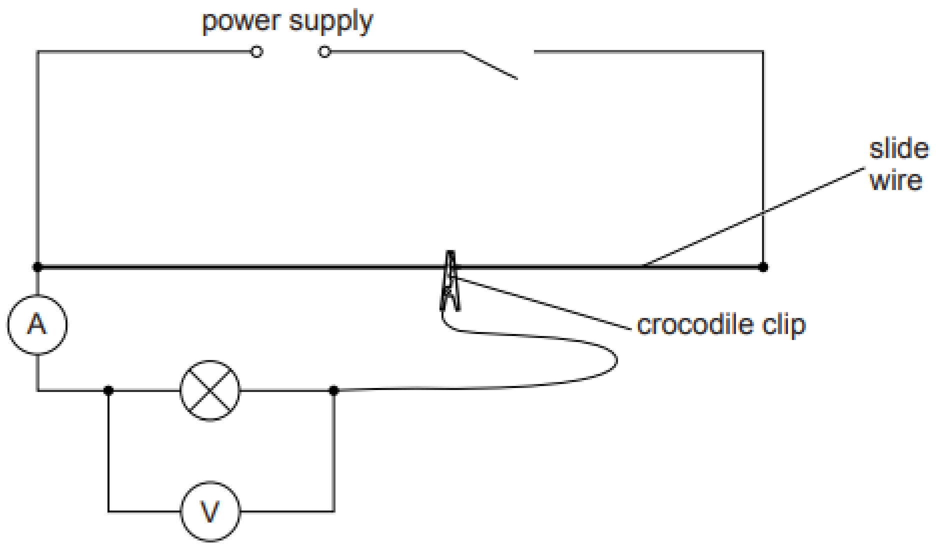


Fig. 3.1

(a) The student connects the crocodile clip on the slide wire to give particular values of the potential difference *V* across the lamp. He measures the current *I* in the lamp for each position.

Figs. 3.2 to 3.6 show the ammeter readings for values of *V* = 0.5V, 1.0V, 1.5V, 2.0V and 2.5V, respectively.

Read, and record in Table 3.1, the value of *I* for each value of potential difference *V*. Record each value to 2 significant figures.

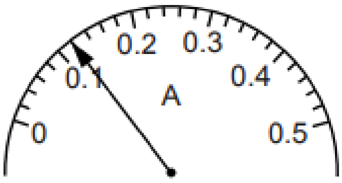


Fig. 3.2

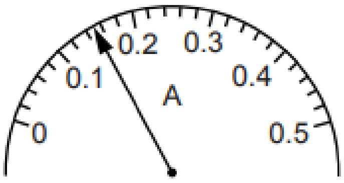


Fig. 3.3

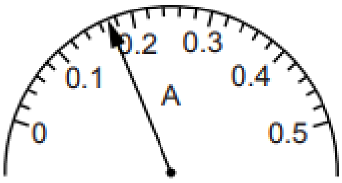


Fig. 3.4

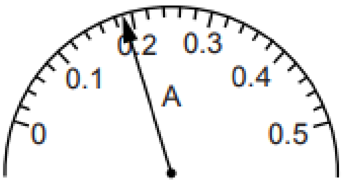


Fig. 3.5

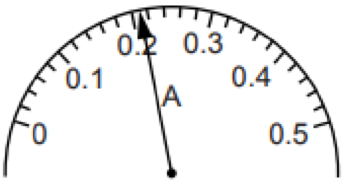


Fig. 3.6

[2]

(b) Calculate, and record in Table 3.1, the resistance R of the lamp at each value of V.

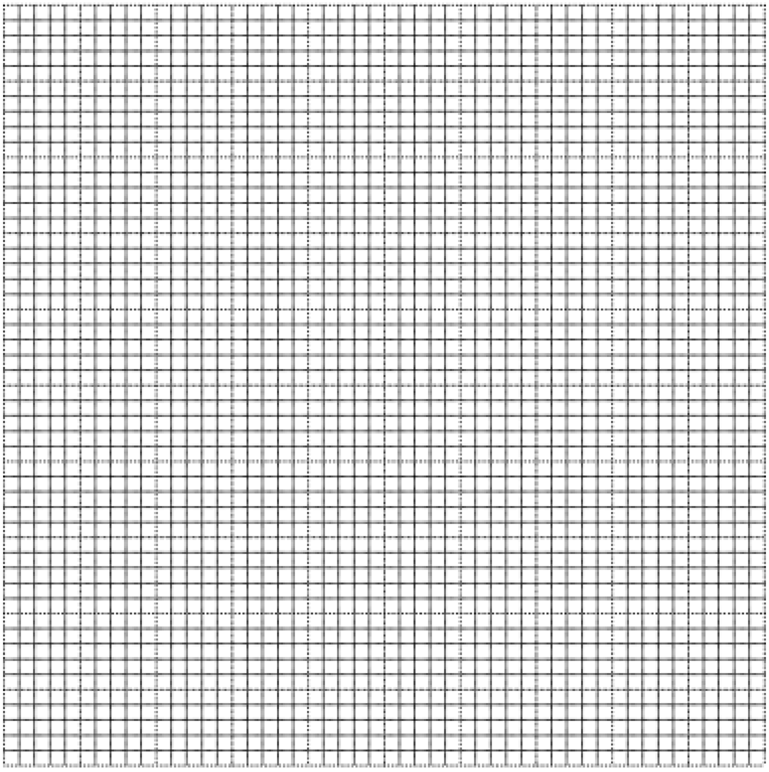
Use the equation $R = \frac{V}{I}$.

[1]

Table 3.1

V/V	I/A	R/Ω
0.5		
1.0		
1.5		
2.0		
2.5		

(c) Plot a graph of R/Ω (y-axis) against V/V (x-axis).



[4]

(d) State what the shape of the graph tells you about the change, if any, in the resistance of the lamp during the experiment.

....

....

(e) In this type of experiment, it is possible to change the current and potential difference for the lamp by using a variable resistor rather than a slide wire.

On Fig. 3.7, complete the circuit diagram to show a variable resistor used for this purpose.

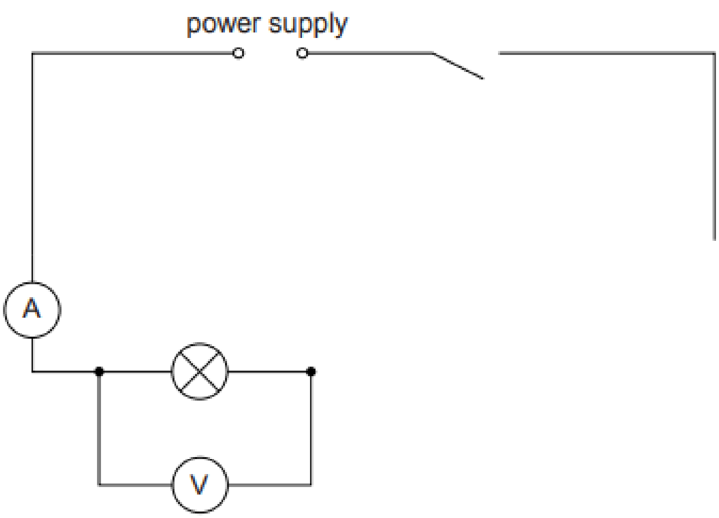


Fig. 3.7

[2]

[Total: 11]

Answers

(a)	Four correct *I* values (0.12, 0.15, 0.17, 0.19 and 0.21) present The fifth one is also correct	1 1
(b)	correct calculations of *R* (4.2, 6.7, 8.8, 10.5, 11.9) or ecf from **(a)**	1
(c)	graph: axes correct way round, labelled with quantity and unit appropriate scales (plots occupying at least ½ grid) plots all correct to ½ small square well-judged line <u>and</u> thin line, precise plots	 1 1 1 1
(d)	simple statement matching candidate's line (e.g. resistance increases with p.d.) qualified (e.g. changes less rapidly for greater p.d. values)	1 1
(e)	correct symbol for variable resistor (rectangle with strike-through arrow only) in correct series circuit	1 1
	Total	**11**

Question 3

(a) Circuit 1 is shown in Fig. 5.1.

circuit 1

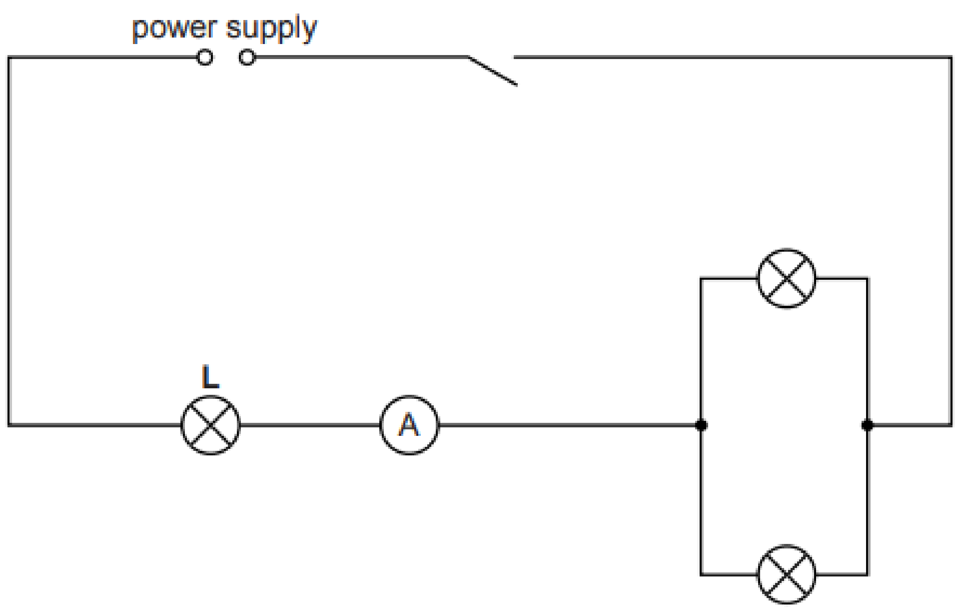


Fig. 5.1

On Fig. 5.1, draw a voltmeter connected to measure the potential difference across lamp **L**.
[1]

(b) The switch is closed.

Fig. 5.2 shows the readings on the voltmeter and ammeter measuring the potential difference and the current for lamp **L**.

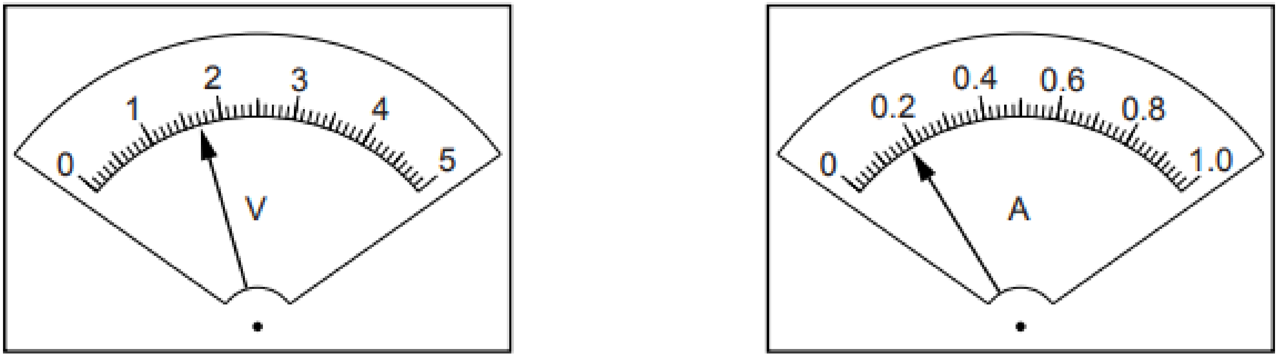


Fig. 5.2

Read, and record in Table 5.1, the potential difference *V* and the current *I*.

circuit	*V* /	*I* /	*R* /	appearance of lamp **L**
1				bright
2	0.91	0.12		dim

(c) The circuit is reconnected as shown in Fig. 5.3.

circuit 2

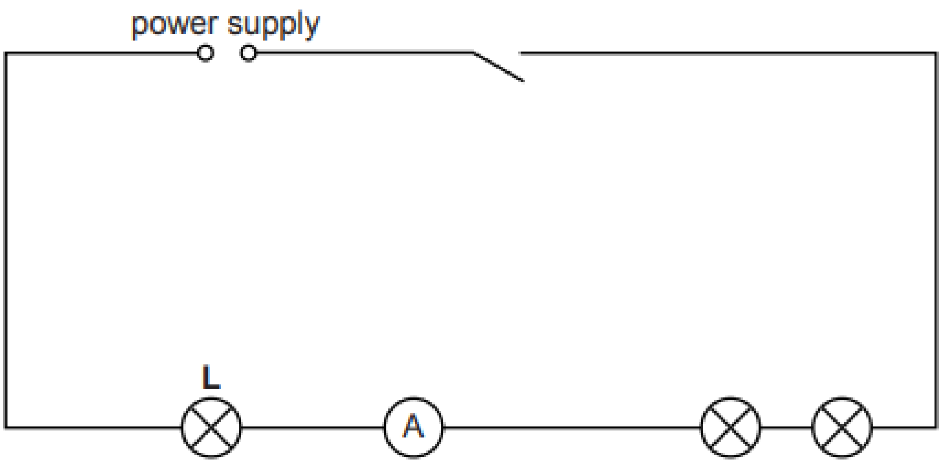


Fig. 5.3

The potential difference *V* and the current *I* for lamp **L** in this circuit are shown in the table.

(i) Using the equation $R = \frac{V}{I}$, calculate and record in the table the resistance R of lamp **L** when connected in each circuit.

(ii) Complete the column headings in the table.

[4]

(d) A student suggests that, as the same lamp **L** is used throughout the experiment, its resistance in each circuit should be the same.

State whether the findings agree with this idea. Justify your answer by reference to the results.

statement ....

....

justification ....

....

....

[1]

(e) Theory suggests that the resistance of a lamp increases when its temperature rises.

Explain whether the observations in Table 5.1 support this.

....

....

.... [1]

(f) It is possible to change the current in this type of experiment by using a variable resistor rather than rearranging the circuit.

In the space below, draw a circuit with a power supply, a lamp, an ammeter and a variable resistor used for this purpose.

[2]

Answers

(a) voltmeter in parallel with lamp **L** and with correct symbol [1]

(b)(c) table:
V = 1.7 (V) [1]
I = 0.18 (A) [1]
R = 9.4(4) ecf **(b)**, 7.6 / 7.58 with 2 or 3 sig. figs. [1]
all units correct (V, A, Ω) [1]

(d) statement matches results, with matching justification which refers to values being 'too different' / 'difference beyond limits of experimental accuracy' owtte [1]

(e) lamp in circuit 1 brighter than in circuit 2
and has greater resistance [1]

(f) correct circuit symbol for variable resistor (rectangle with strike-through arrow only) [1]

connected in correct series circuit [1]

[Total: 9]