AQA GCSE Physics | 8463

SPECIFICATION POINT 4.2.1.1

Standard circuit diagram symbols

Past-paper questions

Tier	**Higher**
Question groups	**16**
Available paper years	**2004–2024**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

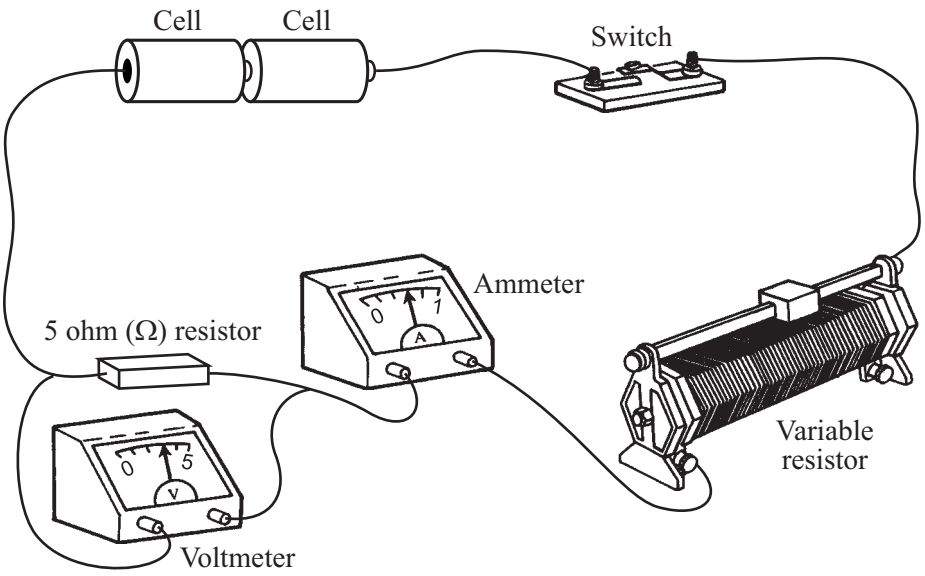
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.2.1.1 Standard circuit diagram symbols

Question 01

June 2004 | 3451H | Original Q1 | Legacy

1 The drawing shows the circuit used to investigate how the current through a 5 ohm (Ω) resistor changes as the potential difference (voltage) across the resistor changes.



(a) Draw, in the space below, a circuit diagram of this circuit. Use the correct symbols for each part of the circuit.

(2 marks)

4.2.1.1 Standard circuit diagram symbols

Question 01 · continued

MARGIN BLANK

(b) (i) Write down the equation that links current, potential difference and resistance.

.....

(1 mark)

(ii) Calculate the potential difference across the 5 ohm (Ω) resistor when the current through the resistor equals 0.4 A. Show clearly how you work out your final answer.

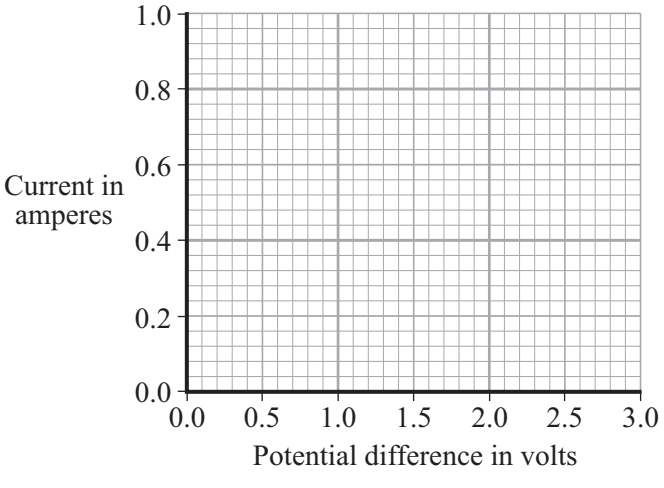
.....

.....

potential difference =.....volts

(2 marks)

(iii) Complete the graph to show how the current through the resistor changes as the potential difference across the resistor increases from 0 V to 3 V. Assume the resistor stays at a constant temperature.



(2 marks)

(c) The resistor is replaced by a 3 V filament lamp. The resistance of the lamp increases as the potential difference across it increases. Why?

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(1 mark)

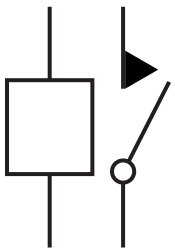
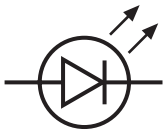
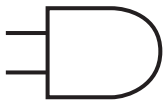
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4.2.1.1 Standard circuit diagram symbols

Question 02

June 2004 | 3451H | Original Q7 | Legacy

7 (a) In circuit diagrams, symbols are used for the different components. Complete the table by identifying each of these components and finish each sentence which says what the component does.

Symbol	Name of component	What the component does
	.....	It allows a small current to ....
	.....	It lights if a current flows through it ....
	.....	It switches on if ....

(6 marks)

4.2.1.1 Standard circuit diagram symbols

Question 02 · continued

MARGIN BLANK

(b) We now make use of many electronic systems. Two of these systems are mobile phones and the Internet.

Apart from their costs, explain **one** benefit and **one** drawback of each of these.

To gain full marks you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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(4 marks)

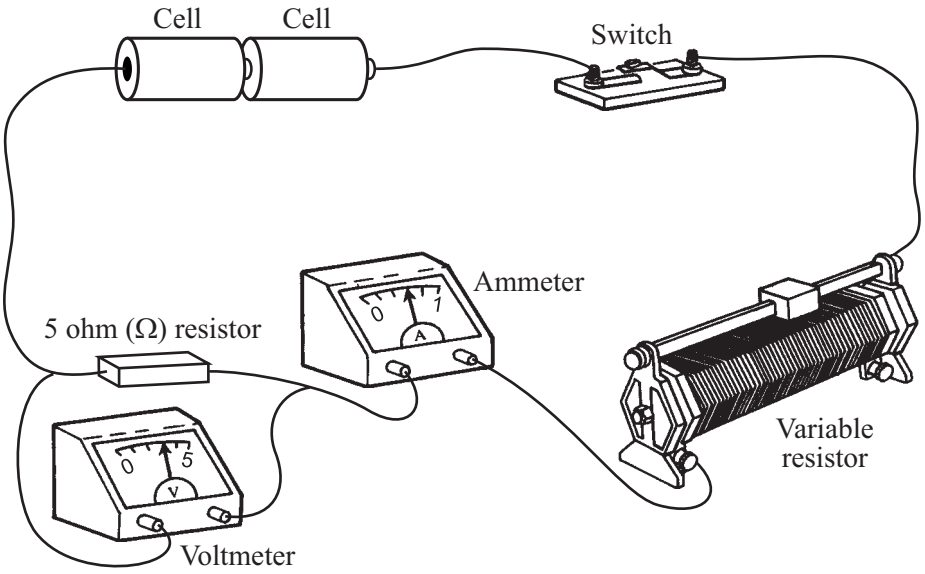
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4.2.1.1 Standard circuit diagram symbols

Question 03

June 2004 | 3462H3 | Original Q1 | Legacy

1 The drawing shows the circuit used to investigate how the current through a 5 ohm (Ω) resistor changes as the potential difference (voltage) across the resistor changes.



(a) Draw, in the space below, a circuit diagram of this circuit. Use the correct symbols for each part of the circuit.

(2 marks)

4.2.1.1 Standard circuit diagram symbols

Question 03 · continued

MARGIN BLANK

(b) (i) Write down the equation that links current, potential difference and resistance.

.....

(1 mark)

(ii) Calculate the potential difference across the 5 ohm (Ω) resistor when the current through the resistor equals 0.4 A. Show clearly how you work out your final answer.

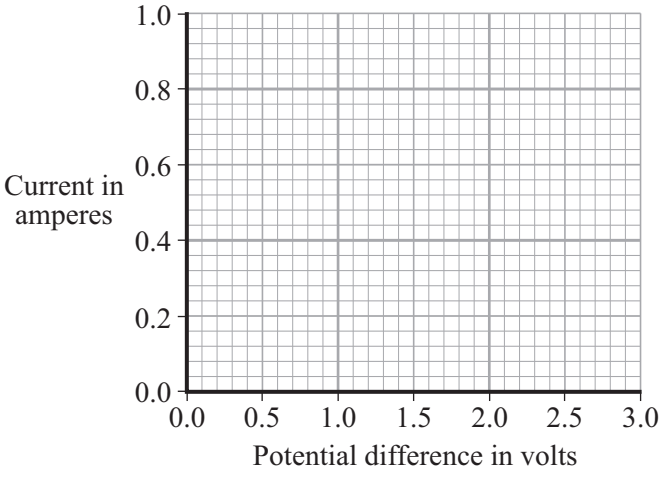
.....

.....

potential difference =.....volts

(2 marks)

(iii) Complete the graph to show how the current through the resistor changes as the potential difference across the resistor increases from 0 V to 3 V. Assume the resistor stays at a constant temperature.



(2 marks)

(c) The resistor is replaced by a 3 V filament lamp. The resistance of the lamp increases as the potential difference across it increases. Why?

.....

.....

(1 mark)

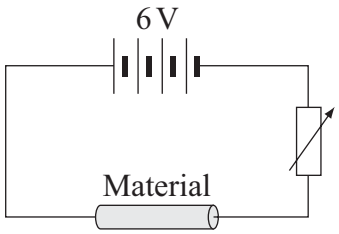
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4.2.1.1 Standard circuit diagram symbols

Question 04

January 2008 | PHY2H | Original Q1 | Legacy

1 (a) The diagram shows the circuit used to investigate the resistance of a material.
The diagram is incomplete: the ammeter and voltmeter are missing.



(i) Draw the symbols for the ammeter and voltmeter on the diagram in the correct places. *(2 marks)*

(ii) How can the current through the material be changed?

.....

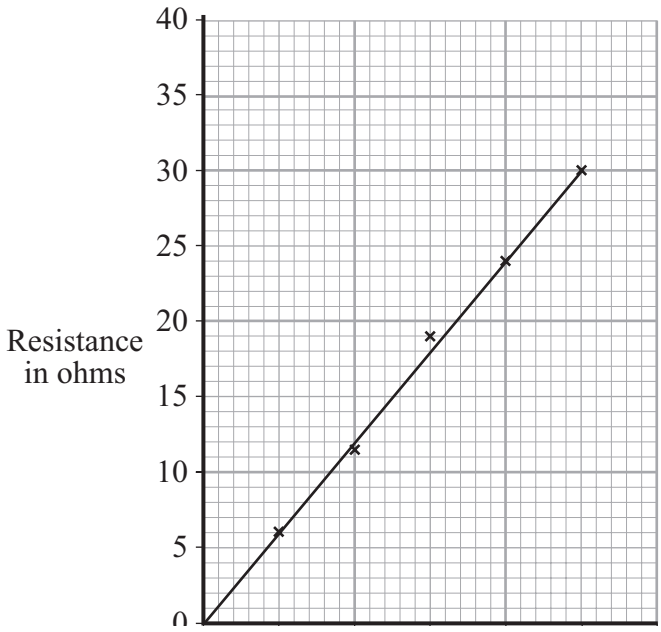
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(1 mark)

(b) The material, called conducting putty, is rolled into cylinders of different lengths but with equal thicknesses.

Graph 1 shows how the resistance changes with length.

Graph 1



4.2.1.1 Standard circuit diagram symbols

Question 04 · continued

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(i) Why has the data been shown as a line graph rather than a bar chart?

.....

.....

(1 mark)

(ii) The current through a 30 cm length of conducting putty was 0.15 A.

Use **Graph 1** to find the resistance of a 30 cm length of conducting putty.

Resistance = ... ohms

(1 mark)

(iii) Use your answer to (b)(ii) and the equation in the box to calculate the potential difference across a 30 cm length of conducting putty.

potential difference = current × resistance

Show clearly how you work out your answer.

.....

.....

.....

Potential difference = ... volts

(2 marks)

Question 1 continues on the next page

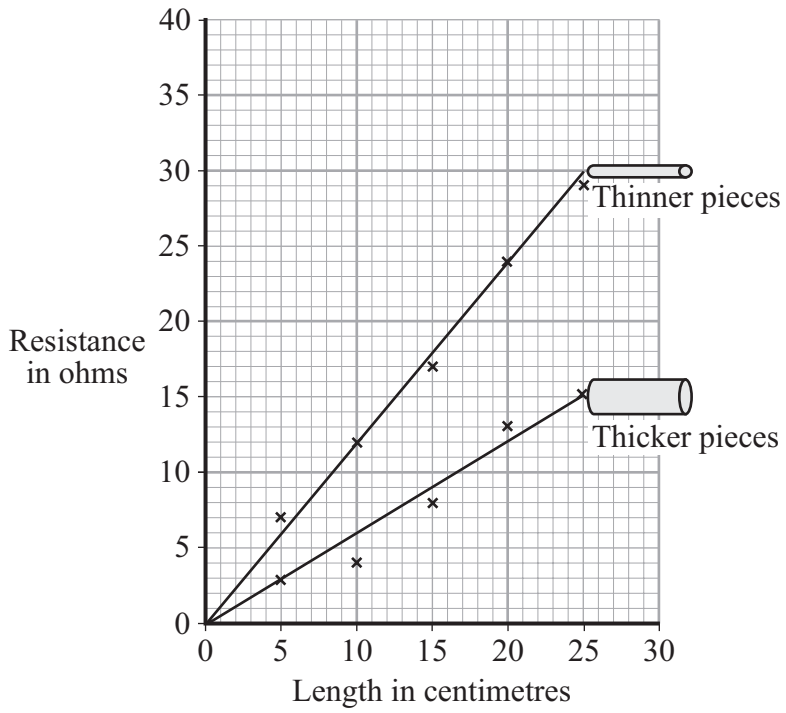
4.2.1.1 Standard circuit diagram symbols

Question 04 · continued

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(c) A second set of data was obtained using thicker pieces of conducting putty. Both sets of results are shown in **Graph 2**.

Graph 2



(i) What is the relationship between the resistance and the thickness of the conducting putty?

.....

.....

(1 mark)

(ii) Name **one** error that may have reduced the accuracy of the results.

.....

(1 mark)

(iii) How could the reliability of the data have been improved?

.....

.....

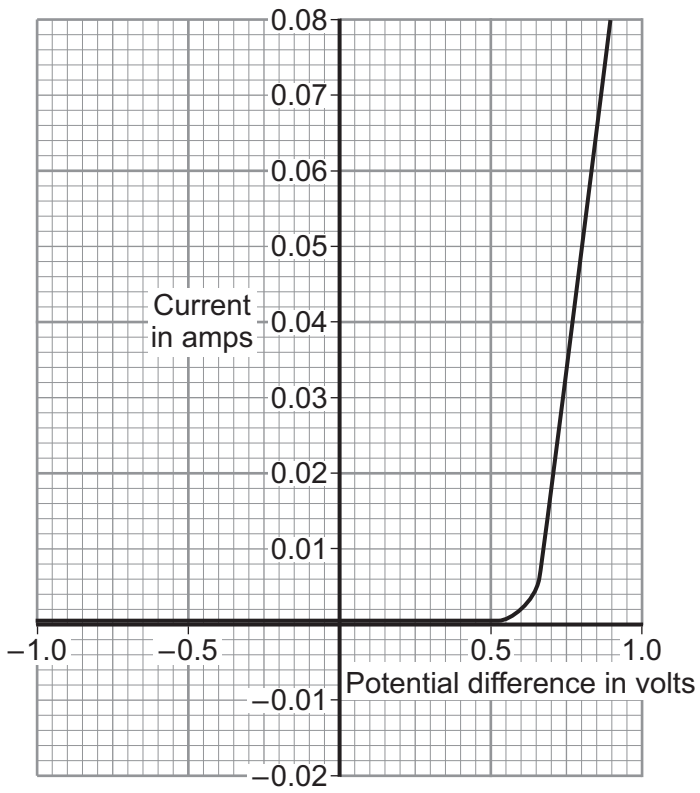
(1 mark)

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4.2.1.1 Standard circuit diagram symbols

Question 05

5 The current – potential difference graph for one type of electrical component is drawn below.



5 (a) What is the component?

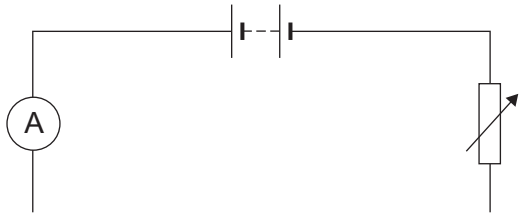
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(1 mark)

4.2.1.1 Standard circuit diagram symbols

Question 05 · continued

5 (b) Complete the diagram to show a circuit that can be used to obtain the data needed to plot the graph. Use the correct circuit symbol for each component that you add to the diagram.



(2 marks)

5 (c) (i) What is the current through the component when the potential difference across the component is 0.8 volts?

Current ..... amps

(1 mark)

5 (c) (ii) Use the equation in the box to calculate the resistance of the component when the potential difference across it is 0.8 volts.

potential difference = current × resistance

Show clearly how you work out your answer.

.....

.....

Resistance = ... Ω

(2 marks)

6

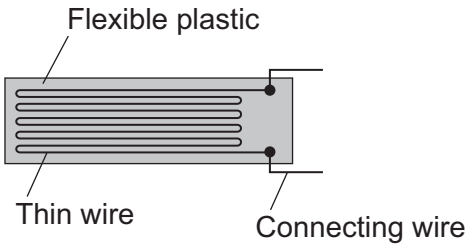
4.2.1.1 Standard circuit diagram symbols

Question 06

June 2011 | PHY2H | Original Q6 | Legacy

6 The diagram shows a strain gauge, which is an electrical device used to monitor a changing force.

Applying a force to the gauge causes it to stretch.
This makes the electrical resistance of the wire change.



6 (a) (i) Using the correct symbols, **add** to the diagram to show how a battery, an ammeter and a voltmeter can be used to find the resistance of the strain gauge drawn above.

(2 marks)

6 (a) (ii) When in use, the strain gauge is always connected to a d.c. power supply, such as a battery.

How is a d.c. (direct current) power supply different from an a.c. (alternating current) power supply?

.....

.....

.....

(1 mark)

4.2.1.1 Standard circuit diagram symbols

Question 06 · continued

6 (b) Before any force is applied, the unstretched gauge, correctly connected to a 3.0 V battery, has a current of 0.040 A flowing through it.

6 (b) (i) Use the equation in the box to calculate the resistance of the unstretched gauge.

potential difference = current × resistance

Show clearly how you work out your answer.

.....

.....

Resistance = ... Ω

(2 marks)

6 (b) (ii) Stretching the gauge causes the current flowing through the gauge to decrease.

What happens to the resistance of the gauge when it is stretched?

.....

.....

(1 mark)

6 (b) (iii) What form of energy is stored in the gauge when a force is applied and the gauge stretches?

.....

(1 mark)

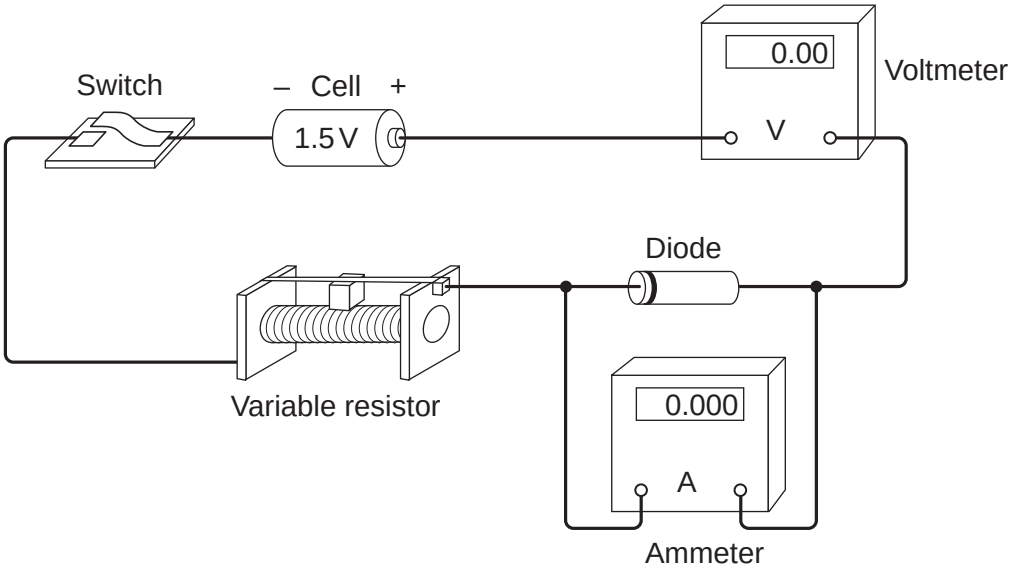
7

4.2.1.1 Standard circuit diagram symbols

Question 07

January 2013 | PH2HP | Original Q4 | Legacy

4 (a) A student set up the circuit shown in the diagram. The student uses the circuit to obtain the data needed to plot a current - potential difference graph for a diode.



4 (a) (i) Draw, in the boxes, the circuit symbol for a diode and the circuit symbol for a variable resistor.

Diode	**Variable resistor**

(2 marks)

4 (a) (ii) The student made two mistakes when setting up the circuit.

What **two** mistakes did the student make?

1 .....

.....

2 .....

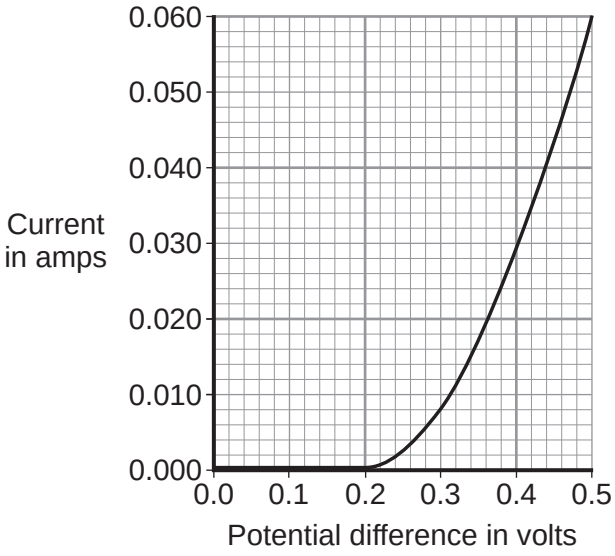
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(2 marks)

4.2.1.1 Standard circuit diagram symbols

Question 07 · continued

4 (b) After correcting the circuit, the student obtained a set of data and plotted the graph below.



4 (b) (i) At what potential difference did the diode start to conduct an electric current?

..... V
(1 mark)

4 (b) (ii) Use data from the graph to calculate the resistance of the diode when the potential difference across the diode is 0.3 V.

Use the correct equation from the Physics Equations Sheet.

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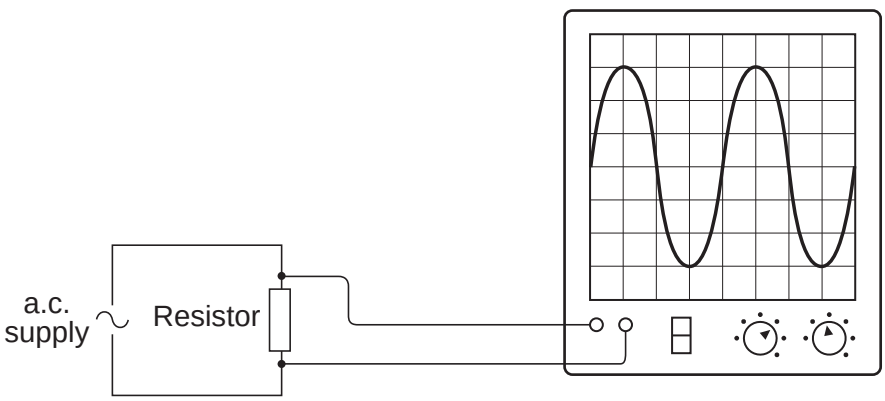
Resistance = ... ohms
(3 marks)

Question 4 continues on the next page

4.2.1.1 Standard circuit diagram symbols

Question 07 · continued

4 (c) The diagram shows the trace produced by an alternating current (a.c.) supply on an oscilloscope.



Each horizontal division on the oscilloscope screen represents a time of 0.01s.

4 (c) (i) Calculate the frequency of the a.c. supply.

.....

.....

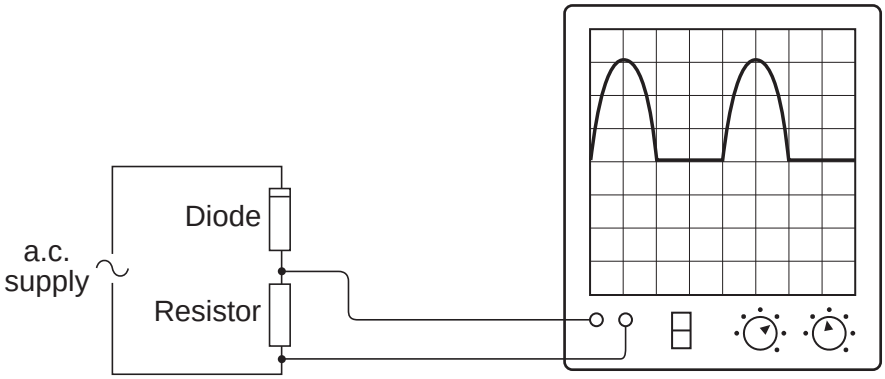
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Frequency = ... hertz
(2 marks)

4.2.1.1 Standard circuit diagram symbols

Question 07 · continued

4 (c) (ii) A diode is now connected in series with the a.c. power supply.



Why does the diode cause the trace on the oscilloscope screen to change?

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(2 marks)

12

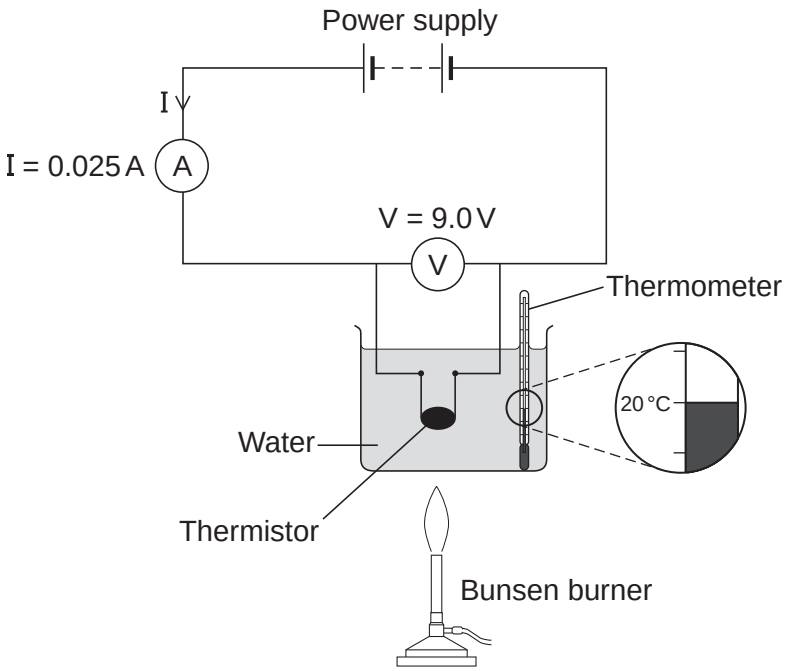
4.2.1.1 Standard circuit diagram symbols

Question 08

June 2014 | PH2HP | Original Q4 | Legacy

4 (a) **Figure 4** shows the apparatus used to obtain the data needed to calculate the resistance of a thermistor at different temperatures.

Figure 4



4 (a) (i) In the box below, draw the circuit symbol for a thermistor.

[1 mark]

4 (a) (ii) Use the data given in **Figure 4** to calculate the resistance of the thermistor at 20 °C.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

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.....

Resistance = ... ohms

Question 4 continues on the next page

4.2.1.1 Standard circuit diagram symbols

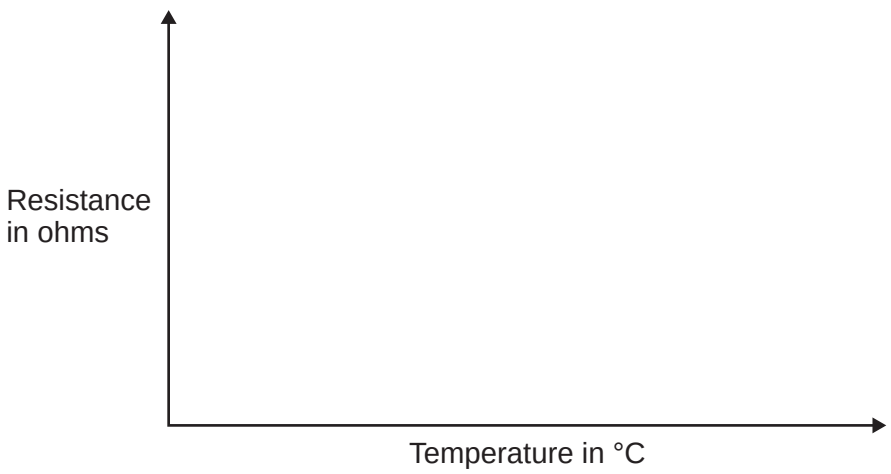
Question 08 · continued

4 (a) (iii) **Figure 5** shows the axes for a sketch graph.

Complete **Figure 5** to show how the resistance of the thermistor will change as the temperature of the thermistor increases from 20 °C to 100 °C.

[1 mark]

Figure 5



4 (a) (iv) Which **one** of the following is most likely to include a thermistor?

Tick (✓) **one** box.

[1 mark]

An automatic circuit to switch a plant watering system on and off. ☐

An automatic circuit to switch an outside light on when it gets dark. ☐

An automatic circuit to switch a heating system on and off. ☐

4 (b) The ammeter used in the circuit has a very low resistance.

Why is it important that ammeters have a very low resistance?

[1 mark]

.....

.....

4.2.1.1 Standard circuit diagram symbols

Question 08 · continued

4 (c) **Table 2** gives the temperature of boiling water using three different temperature scales.

Table 2

Temperature	Scale
100	Celsius (°C)
212	Fahrenheit (°F)
80	Réaumur (°Re)

Scientists in different countries use the same temperature scale to measure temperature.

Suggest **one** advantage of doing this.

[1 mark]

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4 (d) A student plans to investigate how the resistance of a light-dependent resistor (LDR) changes with light intensity.

The student starts with the apparatus shown in **Figure 4** but makes three changes to the apparatus.

One of the changes the student makes is to replace the thermistor with an LDR.

Describe what other changes the student should make to the apparatus.

[2 marks]

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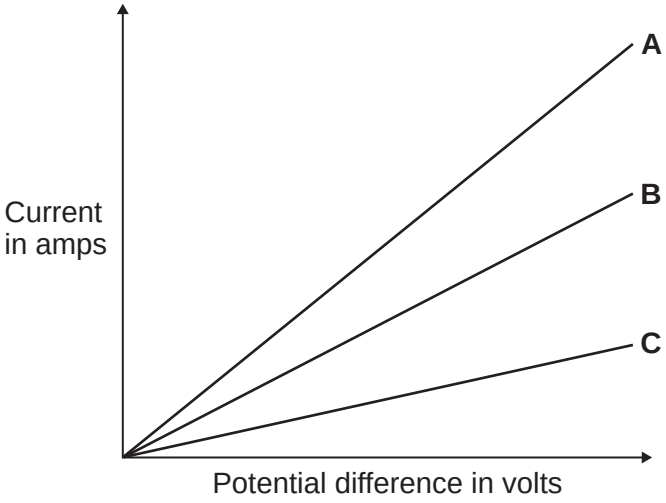
4.2.1.1 Standard circuit diagram symbols

Question 09

June 2015 | PH2HP | Original Q1 | Legacy

1 (a) **Figure 1** shows the current–potential difference graph for three wires, **A**, **B** and **C**.

Figure 1



1 (a) (i) Using **Figure 1**, how can you tell that the temperature of each wire is constant?

[1 mark]

.....

.....

1 (a) (ii) Which **one** of the wires, **A**, **B** or **C**, has the greatest resistance?

[2 marks]

Write the correct answer in the box. ☐

Give a reason for your answer.

.....

.....

.....

4.2.1.1 Standard circuit diagram symbols

Question 09 · continued

1 (b) A student measured the resistance of four wires.

Table 1 shows the resistance of, and other data about, each of the four wires, **J**, **K**, **L** and **M**.

Table 1

Wire	Type of metal	Length in cm	Diameter in mm	Resistance in …….
J	copper	50	0.17	0.36
K	copper	50	0.30	0.12
L	copper	100	0.30	0.24
M	constantan	100	0.30	7.00

1 (b) (i) The last column of **Table 1** should include the unit of resistance.

[1 mark]

What is the unit of resistance?

.....

1 (b) (ii) The resistance of a wire depends on many factors.

Look at **Table 1**. Which **two** wires from **J**, **K**, **L** and **M** show that the resistance of a wire depends on the **length** of the wire?

[2 marks]

Wire ☐ and wire ☐

Give a reason for your answer.

.....

.....

.....

Question 1 continues on the next page

4.2.1.1 Standard circuit diagram symbols

Question 09 · continued

1 (b) (iii) A student looked at the data in **Table 1** and wrote this conclusion:

'The resistance of a wire depends on the type of metal from which the wire is made.'

The student could **not** be certain that her conclusion is true for **all** types of metal.

Suggest what extra data is needed for the student to be more certain that the conclusion is correct.

[1 mark]

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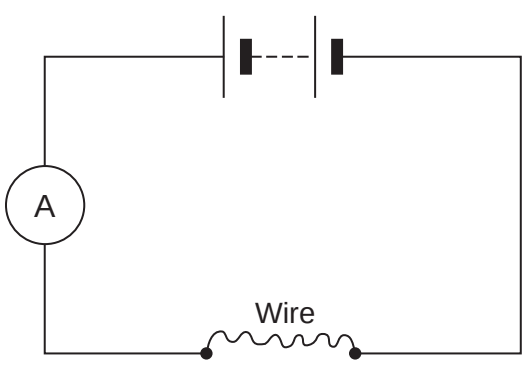
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1 (c) The resistance of a wire can be calculated using the readings from an ammeter and a voltmeter.

1 (c) (i) Complete **Figure 2** by drawing a voltmeter in the correct position in the circuit. Use the correct circuit symbol for a voltmeter.

[1 mark]

Figure 2



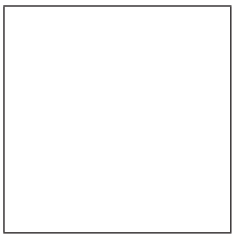
4.2.1.1 Standard circuit diagram symbols

Question 09 · continued

1 (c) (ii) In a circuit diagram, a wire can be represented by the symbol for a resistor.

In the box below, draw the circuit symbol for a resistor.

[1 mark]



9

Turn over for the next question

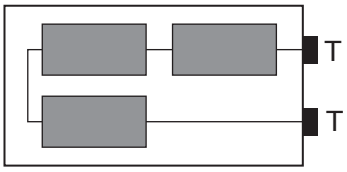
4.2.1.1 Standard circuit diagram symbols

Question 10

June 2016 | PH2HP | Original Q3 | Legacy

3 (a) **Figure 5** shows the inside of a battery pack designed to hold three identical 1.5 V cells.

Figure 5

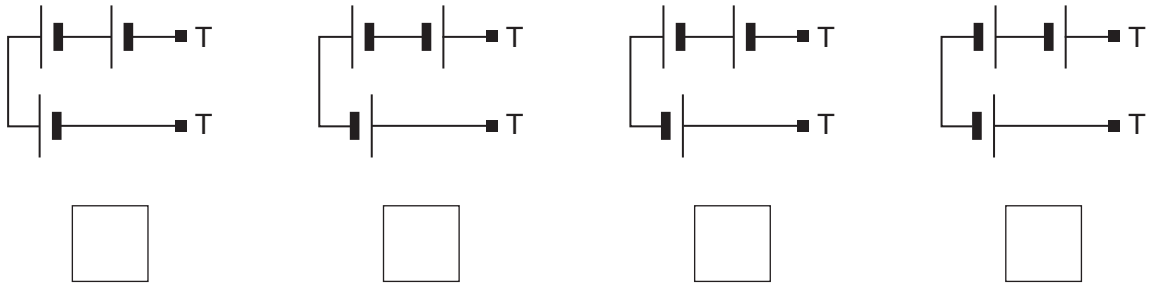


Which **one** of the arrangements shown in **Figure 6** would give a 4.5 V output across the battery pack terminals **T**?

[1 mark]

Tick (✓) **one** box.

Figure 6

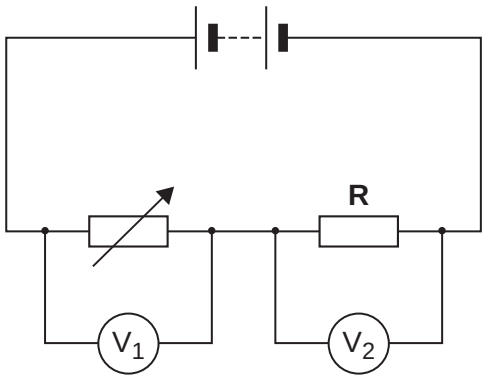


4.2.1.1 Standard circuit diagram symbols

Question 10 · continued

3 (b) **Figure 7** shows a variable resistor and a fixed value resistor connected in series in a circuit.

Figure 7



Complete **Figure 7** to show how an ammeter would be connected to measure the current through the circuit.
Use the correct circuit symbol for an ammeter.

[1 mark]

Question 3 continues on the next page

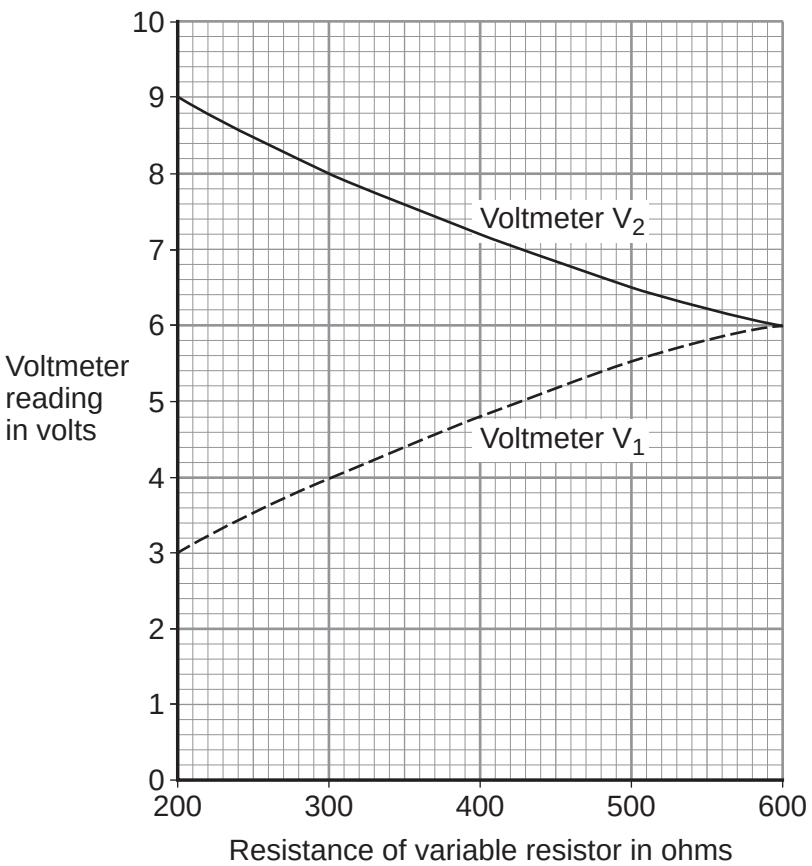
4.2.1.1 Standard circuit diagram symbols

Question 10 · continued

3 (c) The variable resistor can be adjusted to have any value from 200 ohms to 600 ohms.

Figure 8 shows how the reading on voltmeter $\mathbf{V_1}$ and the reading on voltmeter $\mathbf{V_2}$ change as the resistance of the variable resistor changes.

Figure 8



3 (c) (i) How could the potential difference of the battery be calculated from **Figure 8**?

[2 marks]

Tick (✓) **one** box.

9 + 3 = 12 V ☐

9 – 3 = 6 V ☐

9 ÷ 3 = 3 V ☐

Give the reason for your answer.

_____

_____

4.2.1.1 Standard circuit diagram symbols

Question 10 · continued

3 (c) (ii) Use **Figure 8** to determine the resistance of the fixed resistor, **R**.

[2 marks]

Resistance of **R** = _____ Ω

Give the reason for your answer.

_____

_____

3 (c) (iii) Calculate the current through the circuit when the resistance of the variable resistor equals 200 Ω.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

_____

_____

_____

Current = _____ A

9

4.2.1.1 Standard circuit diagram symbols

Question 11

June 2017 | PH2HP | Original Q5 | Legacy

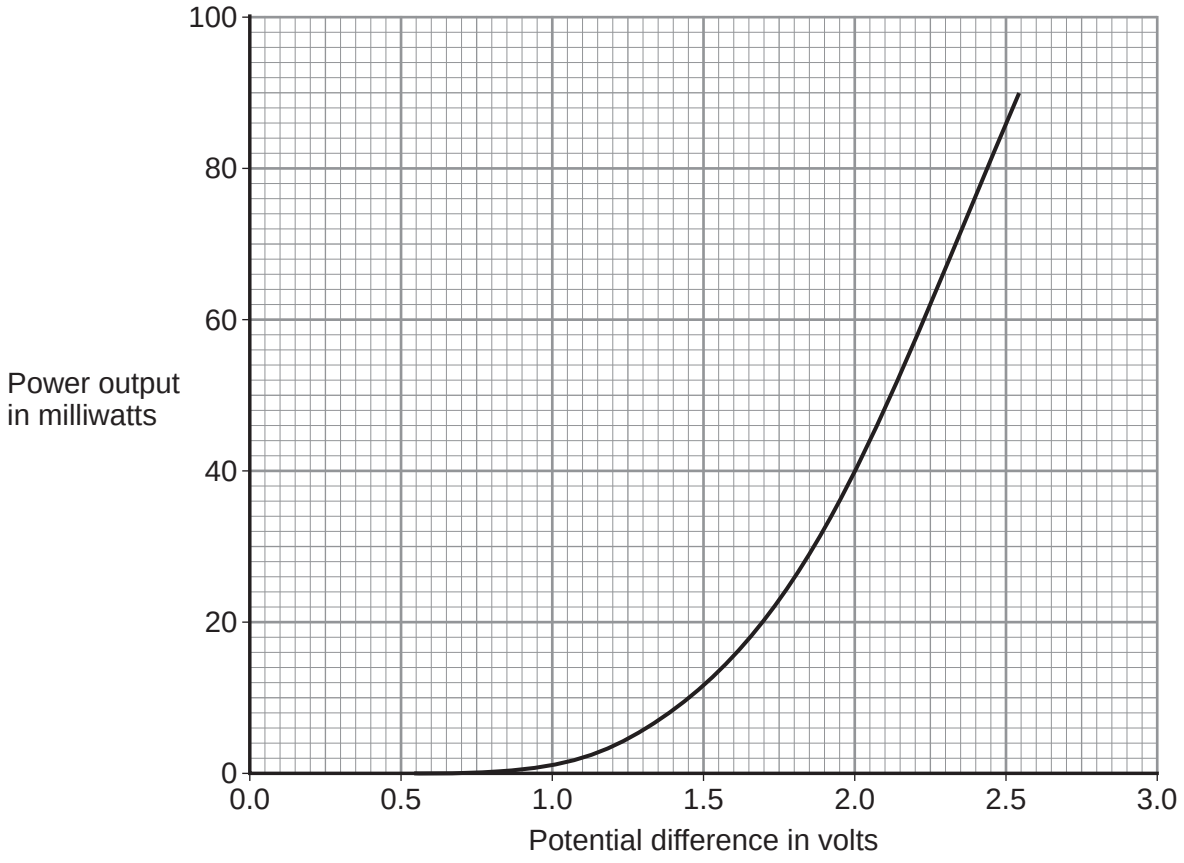
5 The lighting in a home may be provided by LED bulbs, filament bulbs or halogen bulbs.

5 (a) (i) In the box below, draw the circuit symbol for an LED.

[1 mark]

5 (a) (ii) **Figure 6** shows how the power output from one type of LED varies with the potential difference across the LED.

Figure 6



1 milliwatt = 0.001 W

4.2.1.1 Standard circuit diagram symbols

Question 11 · continued

The LED is connected in series with a battery and resistor.
The potential difference across the LED is 2.0 V

Use data from **Figure 6** to calculate the energy transferred by the LED in 5 minutes.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Energy transferred = _____ J

5 (b) The resistance of a filament bulb increases as the temperature of the filament increases.

Explain, in terms of the electrons and ions inside the filament, why the resistance increases.

[2 marks]

5 (c) Why are LED bulbs cheaper to use than filament bulbs or halogen bulbs that produce the same brightness of light?

[1 mark]

7

4.2.1.1 Standard circuit diagram symbols

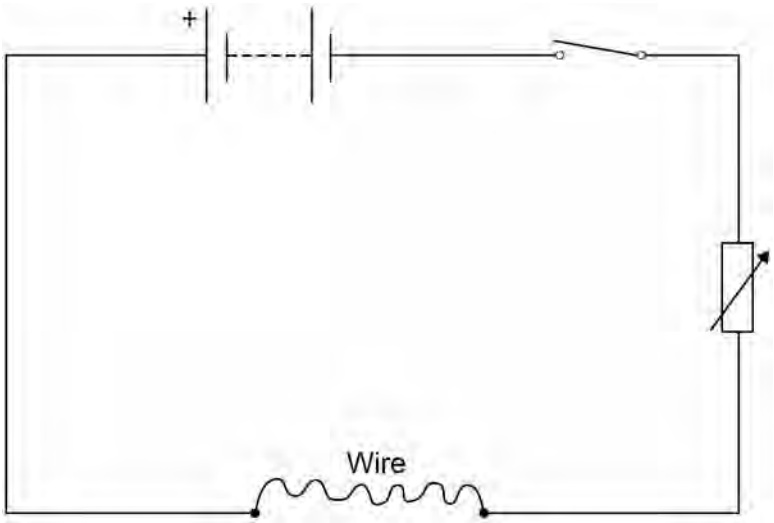
Question 12

June 2018 | 8463/1H | Original Q3

0 3 A student investigated how the resistance of a piece of nichrome wire varies with length.

Figure 3 shows part of the circuit that the student used.

Figure 3



0 3 . 1 Complete **Figure 3** by adding an ammeter and a voltmeter.

Use the correct circuit symbols.

[3 marks]

4.2.1.1 Standard circuit diagram symbols

Question 12 · continued

0 3 . 2 Describe how the student would obtain the data needed for the investigation.

Your answer should include a risk assessment for **one** hazard in the investigation.

[6 marks]

0 3 . 3 Why would switching off the circuit between readings have improved the accuracy of the student's investigation?

Tick **one** box.

[1 mark]

- The charge flow through the wire would not change. ☐
- The potential difference of the battery would not increase. ☐
- The power output of the battery would not increase. ☐
- The temperature of the wire would not change. ☐

0 3 . 4 The student used crocodile clips to make connections to the wire.

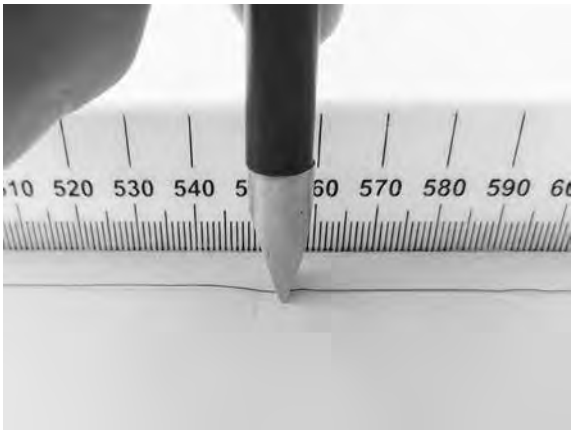
They could have used a piece of equipment called a 'jockey'.

Figure 4 shows a crocodile clip and a jockey in contact with a wire.

Figure 4



Crocodile clip



Jockey

How would using the jockey have affected the accuracy and resolution of the student's results compared to using the crocodile clip?

Tick **two** boxes.

[2 marks]

The accuracy of the student's results would be higher. ☐

The accuracy of the student's results would be lower. ☐

The accuracy of the student's results would be the same. ☐

The resolution of the length measurement would be higher. ☐

The resolution of the length measurement would be lower. ☐

The resolution of the length measurement would be the same. ☐

12

4.2.1.1 Standard circuit diagram symbols

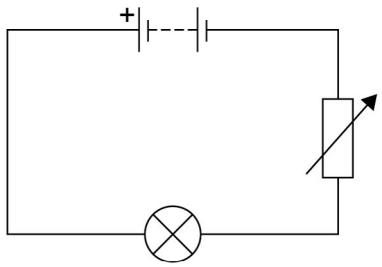
Question 13

November 2020 | 8463/1H | Original Q1

0 1 A student investigated how the current in a filament lamp varied with the potential difference across the filament lamp.

Figure 1 shows part of the circuit used.

Figure 1



0 1 . 1 Complete **Figure 1** by adding an ammeter and a voltmeter.

Use the correct circuit symbols.

[3 marks]

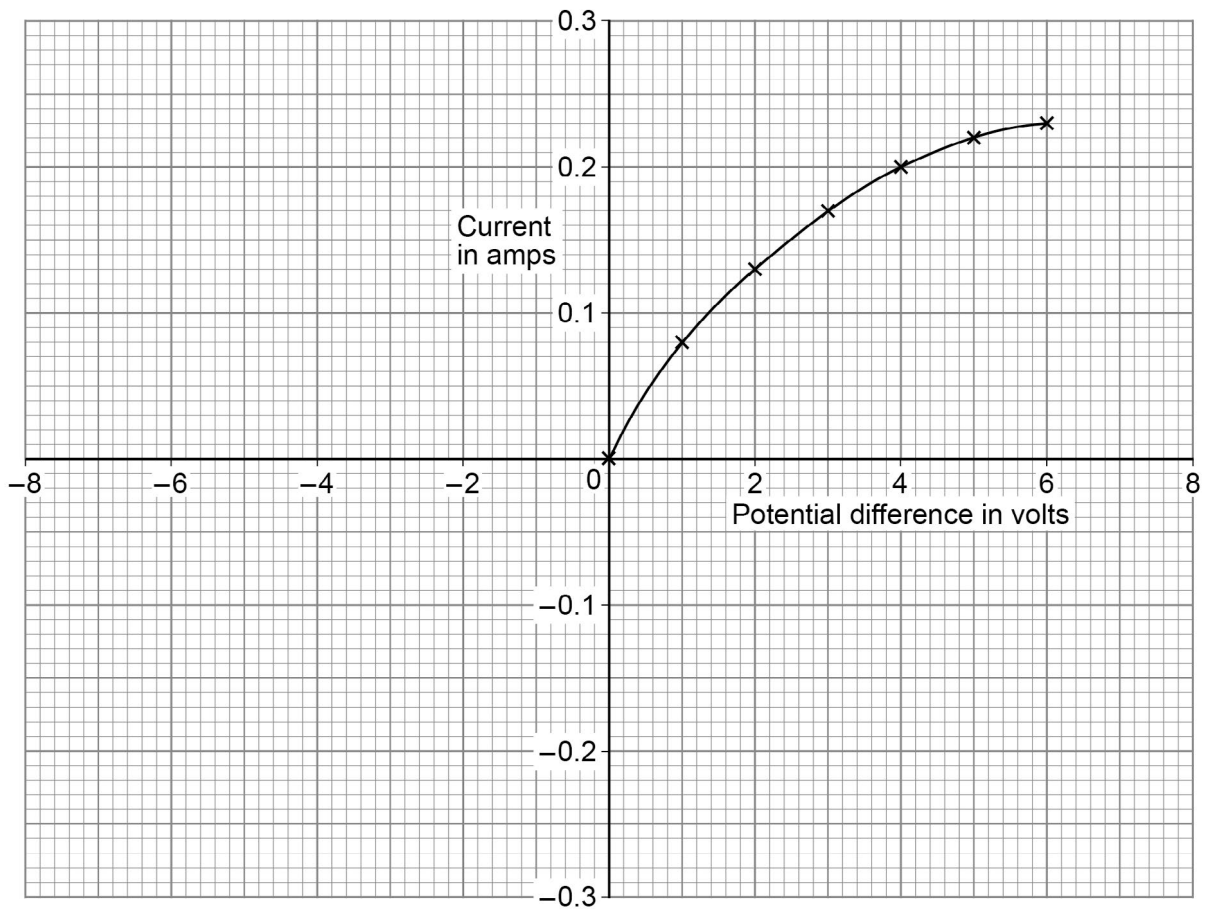
Question 1 continues on the next page

4.2.1.1 Standard circuit diagram symbols

Question 13 · continued

Figure 2 shows some of the results.

Figure 2



0 1 . 2 The student reversed the connections to the power supply and obtained negative values for the current and potential difference.

Draw a line on **Figure 2** to show the relationship between the negative values of current and potential difference.

[2 marks]

4.2.1.1 Standard circuit diagram symbols

Question 13 · continued

0 1 . 3 Write down the equation which links current (I), potential difference (V) and resistance (R).

[1 mark]

0 1 . 4 Determine the resistance of the filament lamp when the potential difference across it is 1.0 V.

Use data from **Figure 2**.

[4 marks]

Resistance = _____ Ω

0 1 . 5 A second student did the same investigation. The ammeter used had a zero error.

What is meant by a zero error?

[1 mark]

11

4.2.1.1 Standard circuit diagram symbols

Question 14

June 2022 | 8463/1H | Original Q11

1 1 **Figure 12** shows some hair straighteners.

Hair straighteners contain heating elements.

Figure 12



1 1 . 1 When the hair straighteners reach normal operating temperature, an LED turns on.

Draw the circuit symbol for an LED in the box.

[1 mark]

4.2.1.1 Standard circuit diagram symbols

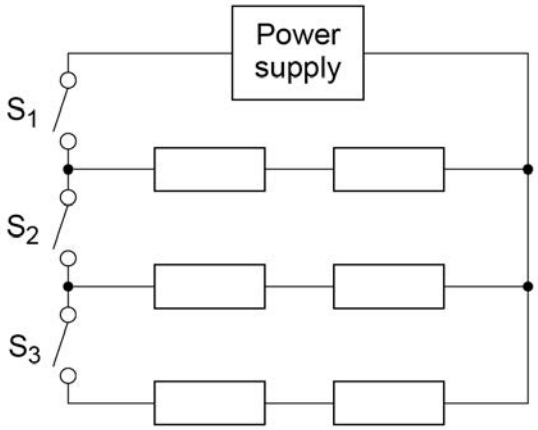
Question 14 · continued

Figure 13 shows the circuit diagram for the hair straighteners.

Each resistor represents a heating element.

The power output of the hair straighteners can be changed by closing different switches.

Figure 13



11.2 Why do the hair straighteners **not** turn on when only switch S_2 is closed?

[1 mark]

Question 11 continues on the next page

4.2.1.1 Standard circuit diagram symbols

Question 14 · continued

11.3 The hair straighteners have a maximum power output of 120 W.

The energy transferred to the hair straighteners to reach normal operating temperature is 3.6 kJ.

Calculate the time taken for the hair straighteners to reach normal operating temperature when operating at maximum power.

Use the Physics Equations Sheet.

[4 marks]

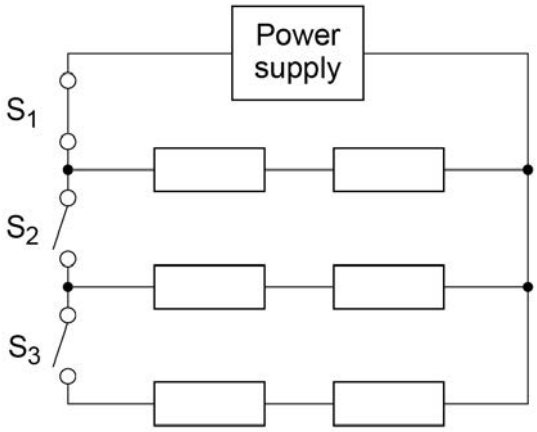
Time = _____ seconds

4.2.1.1 Standard circuit diagram symbols

Question 14 · continued

1 1 . 4 **Figure 14** shows the hair straighteners circuit with switch S_1 closed.

Figure 14



Switch S_2 and switch S_3 are then closed at the same time.

Explain what happens to the power output of the power supply.

[3 marks]

9

4.2.1.1 Standard circuit diagram symbols

Question 15

0 5 **Figure 7** shows a student putting a coin into a vending machine that sells food.

Figure 7



0 5 . 1 The vending machine is connected to the mains electricity supply.

What is the frequency and the potential difference of the mains electricity supply in the UK?

[2 marks]

Frequency = _____ Hz

Potential difference = _____ V

4.2.1.1 Standard circuit diagram symbols

Question 15 · continued

The vending machine identifies the value of the coin by measuring the resistance of the coin.

0 5 . 2 The power dissipated by the coin is 340 mW when the current in the coin is 0.75 A.

Calculate the resistance of the coin.

Use the Physics Equations Sheet.

[4 marks]

Resistance = _____ Ω

0 5 . 3 Coins that are dirty are **not** recognised by the vending machine.

Suggest **one** reason why.

[1 mark]

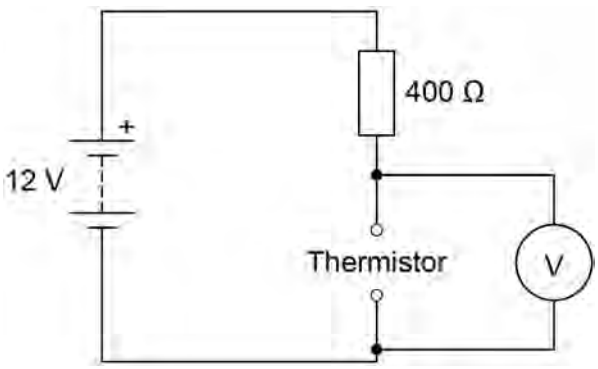
Question 5 continues on the next page

4.2.1.1 Standard circuit diagram symbols

Question 15 · continued

Figure 8 shows part of a different circuit that is used to monitor the temperature inside the vending machine.

Figure 8



0 5 . 4 The circuit symbol for a thermistor has not been included.

Draw the circuit symbol for a thermistor in the box below.

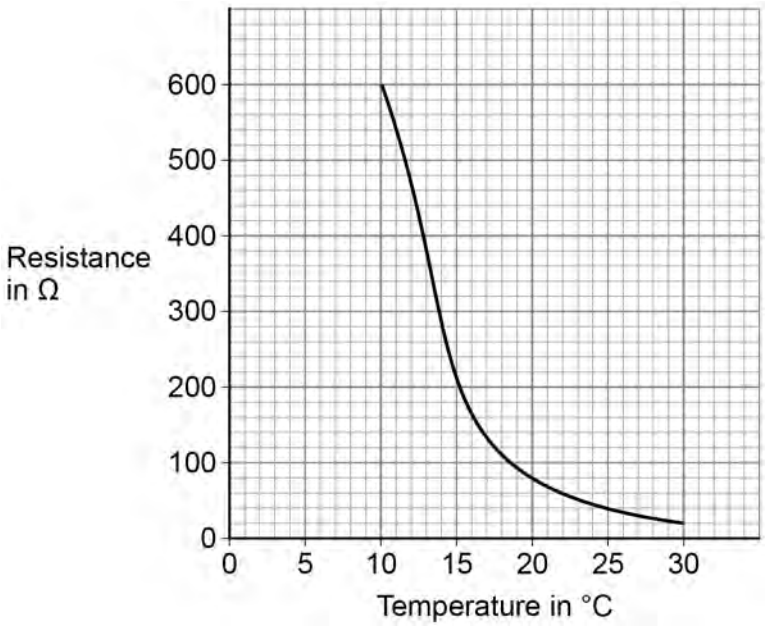
[1 mark]

4.2.1.1 Standard circuit diagram symbols

Question 15 · continued

Figure 9 shows how the resistance of the thermistor varies with temperature.

Figure 9



0 5 . 5 The cooling system inside the vending machine turns on when the temperature of the thermistor is above 20 °C.

Determine the potential difference across the thermistor when the temperature is 20 °C.

Use the Physics Equations Sheet.

[5 marks]

Potential difference = _____ V

13

4.2.1.1 Standard circuit diagram symbols

Question 16

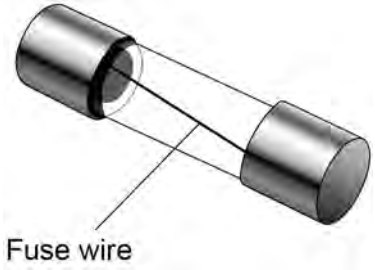
June 2024 | 8463/1H | Original Q10

1 0 The live wire in a three-core cable is connected to a fuse inside a plug.

A fuse contains a wire that is designed to melt when the current gets too great.

Figure 17 shows a fuse.

Figure 17

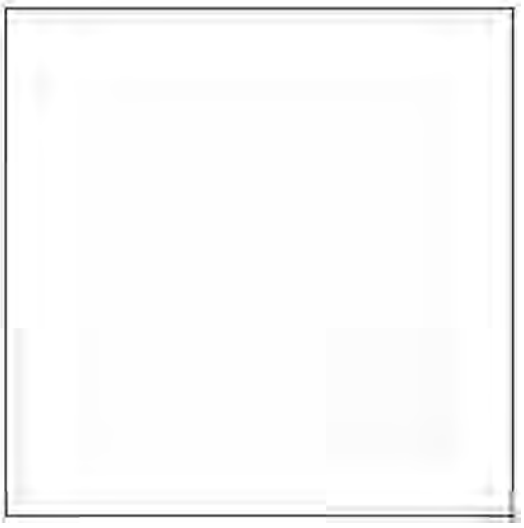


1 0 . 1 What colour is the insulation covering the live wire in a three-core cable?

[1 mark]

1 0 . 2 Draw the circuit symbol for a fuse in the box below.

[1 mark]



4.2.1.1 Standard circuit diagram symbols

Question 16 · continued

1 0 . 3 The fuse wire melts when there is a charge flow of 2.0 C for 400 ms.

Calculate the current in the fuse wire.

Use the Physics Equations Sheet.

[4 marks]

Current = _____ A

1 0 . 4 When the fuse wire is at its melting point, the additional energy needed to melt the wire is 1.02 J.

specific latent heat of fuse wire = 60 kJ/kg

Calculate the mass of the fuse wire.

Use the Physics Equations Sheet.

[4 marks]

Mass = _____ kg

Question 10 continues on the next page

4.2.1.1 Standard circuit diagram symbols

Question 16 · continued

1 0 . 5 The calculation in Question **10.4** assumes there is no energy transferred to the surroundings.

How would the time taken for the wire to melt be affected if some energy was transferred to the surroundings?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

Time taken would decrease ☐

Time taken would stay the same ☐

Time taken would increase ☐

Reason _____

_____

_____

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