Current, PD and Resistance

These practice questions can be used by students and teachers and is

Suitable for GCSE AQA Physics Topic Question 8463

Level: GSCE AQA 8463

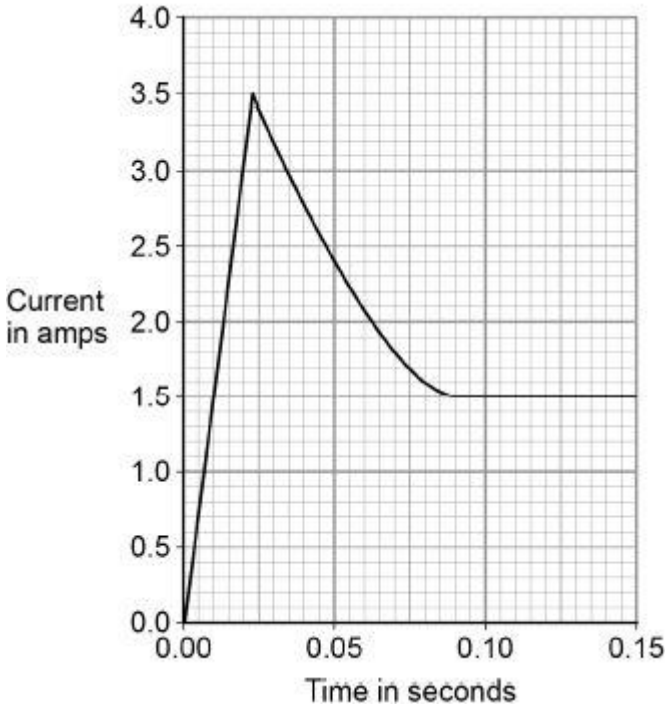
Subject: Physics

Exam Board: GCSE AQA

Topic: Current, PD and Resistance

Q1.

The graph below shows how the current through a filament lamp changes after the lamp is switched on.



(a) The normal current through the filament lamp is 1.5 A.

For how many seconds is the current through the filament lamp greater than 1.5 A?

Tick **one** box.

0.01 s ☐

0.08 s ☐

0.09 s ☐

0.14 s ☐

(1)

(b) Why might the filament inside a lamp melt when the lamp is first switched on?

_____

_____

(1)

(c) The lamp is connected to a 24 V power supply. The current through the lamp is 1.5 A.

Calculate the power of the lamp.

Use the equation:

power = potential difference × current

_____

_____

_____

_____

Power = _____ W

(2)

(d) LED lamps are much more efficient than filament lamps.

What does this statement mean?

Tick **one** box.

LED lamps have a similar power output to filament lamps.	☐
LED lamps waste a smaller proportion of the input energy than filament lamps.	☐
LED lamps have a higher power input than filament lamps.	☐
LED lamps waste a larger proportion of the input energy than filament lamps.	☐

(1)

(Total 5 marks)

Q2.

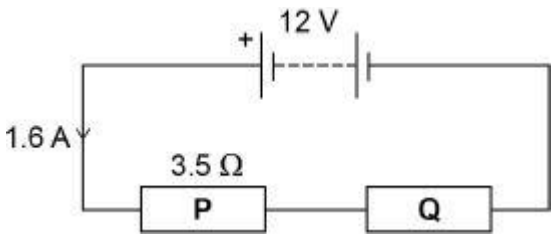
(a) Draw a diagram to show how 1.5 V cells should be connected together to give a

potential difference of 4.5 V.

Use the correct circuit symbol for a cell.

(2)

A student built the circuit shown in the diagram below.



(b) Calculate the total resistance of the circuit in the diagram above.

Use the equation:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

Total resistance = _____ Ω

(2)

(c) The resistance of **P** is 3.5 Ω.

Calculate the resistance of **Q**.

_____

_____

_____

_____

Resistance of **Q** = _____ Ω

(1)

(d) The student connects the two resistors in the diagram above in parallel.

What happens to the total resistance of the circuit?

Tick **one** box.

It decreases ☐

It increases ☐

It does not change ☐

(1)

Give a reason for your answer.

_____

_____

_____

_____

(1)

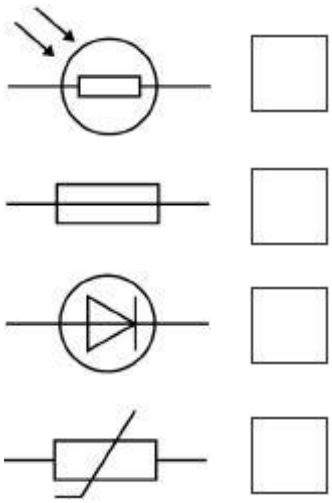
(Total 7 marks)

Q3.

The plug of an electrical appliance contains a fuse.

(a) What is the correct circuit symbol for a fuse?

Tick **one** box.



(1)

(b) The appliance is connected to the mains electrical supply. The mains potential difference is 230 V.

Calculate the energy transferred when 13 C of charge flows through the appliance.

Use the equation:

energy transferred = charge flow × potential difference

_____

_____

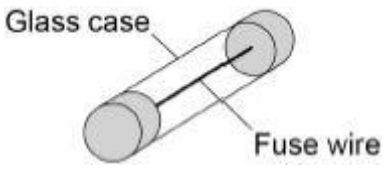
_____

_____

Energy transferred = _____ J

(2)

The diagram below shows the structure of a fuse.



(c) Write down the equation that links charge flow, current and time.

_____

(1)

(d) The fuse wire melts when 1.52 coulombs of charge flows through the fuse in 0.40 seconds.

Calculate the current at which the fuse wire melts.

_____

_____

_____

_____

Current = _____ A

(3)

(e) The mass of the fuse wire is 0.00175 kg. The specific latent heat of fusion of the fuse wire is 205 000 J/kg.

Calculate the energy needed to melt the fuse wire.

Use the Physics Equations Sheet.

_____

_____

_____

_____

Energy = _____ J

(2)

(Total 9 marks)

Q4.

Figure 1 shows a lift inside a building.

Figure 1

(a) The motor in the lift does 120 000 J of work in 8.0 seconds.

Calculate the power output of the motor in the lift.

Use the equation:

$$\text{Power output} = \frac{\text{work done}}{\text{time}}$$

_____

_____

_____

_____

Power output = _____ W

(2)

(b) The power input to the motor is greater than the power output.

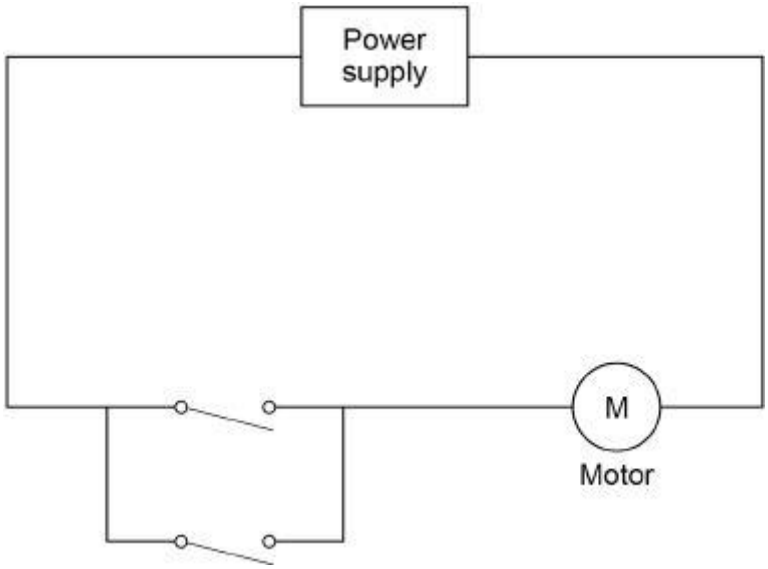
Tick **two** reasons why.

Energy is transferred in heating the surroundings.	☐
Friction causes energy to be transferred in non-useful ways.	☐
The motor is connected to the mains electricity supply.	☐
The motor is more than 100% efficient.	☐
There are only four people in the lift.	☐

(2)

(c) **Figure 2** shows part of the circuit that operates the lift motor.

Figure 2



The lift can be operated using either of the two switches.

Explain why.

_____

_____

_____

_____

_____

(2)

(d) Write down the equation that links gravitational field strength, gravitational potential energy, height and mass.

_____

_____

(1)

(e) The lift goes up 14 m. The total mass of the people in the lift is 280 kg.

gravitational field strength = 9.8 N/kg

Calculate the increase in gravitational potential energy of the people in the lift.

Give your answer to 2 significant figures.

_____

_____

_____

_____

Increase in gravitational potential energy = _____ J

(3)

(Total 10 marks)

Q5.

Figure 1 shows a student walking on a carpet.

Figure 1

(a) The student becomes negatively charged because of the friction between her socks and the carpet.

Explain why the friction causes the student to become charged.

_____

_____

_____

_____

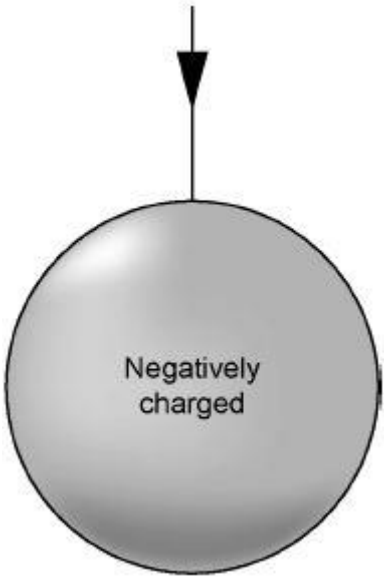
(2)

(b) The student's head is represented by the sphere in **Figure 2**.

The student is negatively charged. The arrow shows part of the electric field around the student's head.

Draw **three** more arrows on **Figure 2** to complete the electric field pattern.

Figure 2



(1)

(c) The negatively charged student touches a metal tap and receives an electric shock.

Explain why.

(3)

(d) Some carpets have thin copper wires running through them. The student is less likely to receive an electric shock after walking on this type of carpet.

Suggest why.

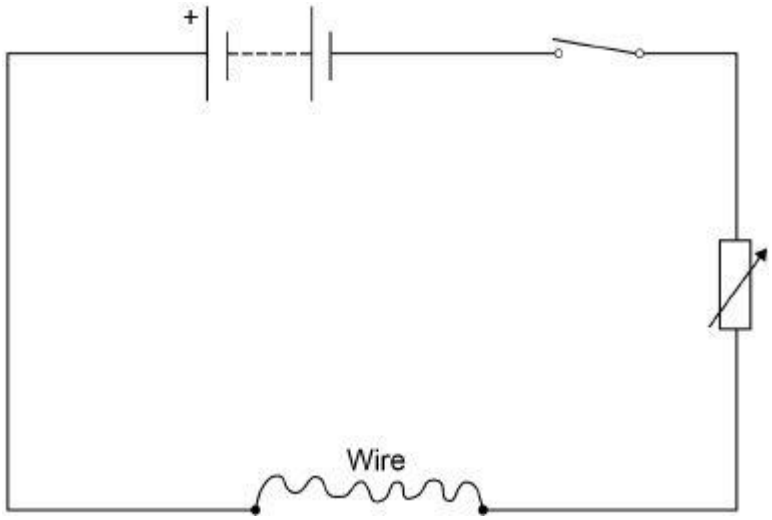
(2)
(Total 8 marks)

Q6.

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

Figure 1 shows part of the circuit the student used.

Figure 1



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

Use the correct circuit symbols.

(3)

(b) 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)

(c) Why would switching off the circuit between readings have improved the accuracy of the student's investigation?

Tick **one** box.

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.	☐

(1)

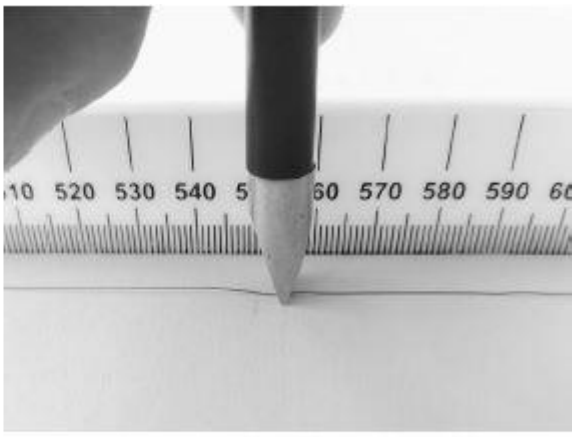
(d) The student used crocodile clips to make connections to the wire.

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

Figure 2 shows a crocodile clip and a jockey in contact with a wire.

Figure 2

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.

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.	☐

(2)

(Total 12 marks)

Q7.

(a) Complete the sentence. Choose answers from the box.

charge	**potential difference**	**power**	**temperature**	**time**

The current through an ohmic conductor is directly proportional to the

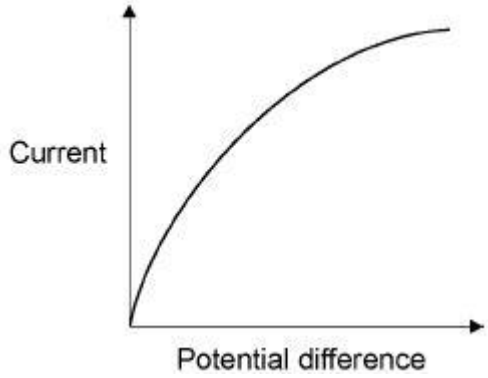
_____ across the component, provided

that the _____ remains constant.

(2)

(b) **Figure 1** shows a current − potential difference graph for a filament lamp.

Figure 1



Explain how the resistance of a filament lamp changes as the potential difference across it increases.

_____

_____

_____

_____

_____

_____

(3)

(c) Many householders are replacing their filament lamps with LED lamps which are more energy efficient.

What does more energy efficient mean?

_____

_____

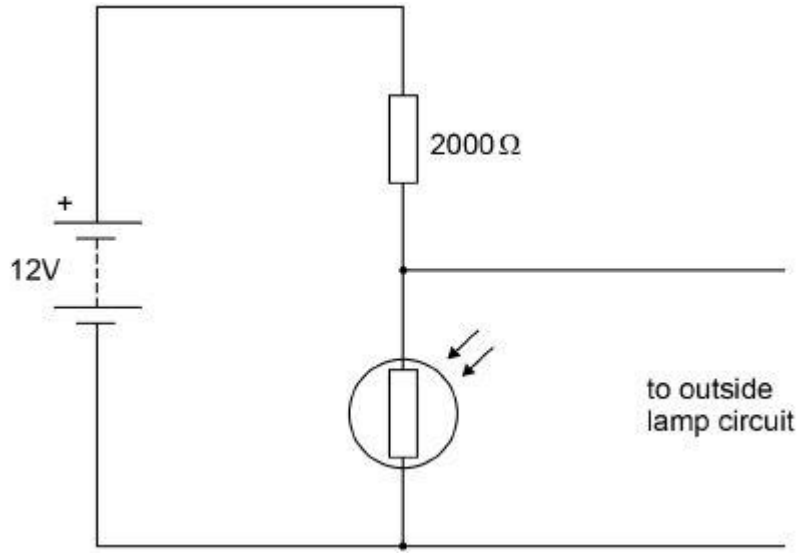
_____

(1)

A Light Dependent Resistor (LDR) is used to turn on an outside lamp when it gets dark.

Part of the circuit is shown in **Figure 2**.

Figure 2



(d) The light intensity decreases.

What happens to the potential difference across the LDR and the current in the LDR?

Potential difference _____

Current _____

(2)

(e) What is the resistance of the LDR when the potential difference across it is 4 V?

Give a reason for your answer.

Explain your answer.

Resistance = _____ Ω

Reason _____

_____

_____

(2)

(f) Calculate the current through the LDR when the resistance of the LDR is 5000 Ω.

Give your answer to 2 significant figures.

_____

_____

_____

_____

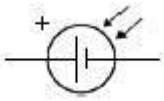
Current = _____ A

(4)

(Total 14 marks)

Q8.

Solar cells produce electricity using light from the Sun.

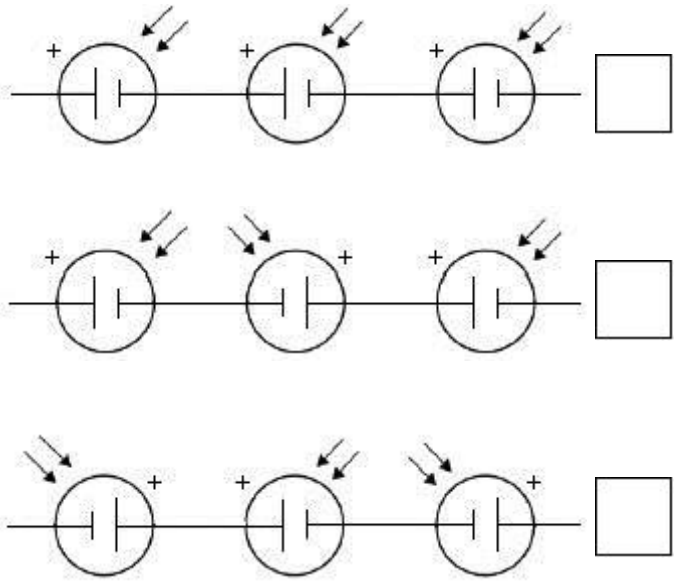
The symbol for a solar cell is: 

A householder has three solar cells.

Each solar cell has an output potential difference of 0.70 V

(a) Which arrangement of three solar cells will give a potential difference of 2.10 V?

Tick **one** box.



(1)

(b) A solar cell has a resistance of 2.5 Ω when the output potential difference is 0.70 V

Calculate the current through the solar cell.

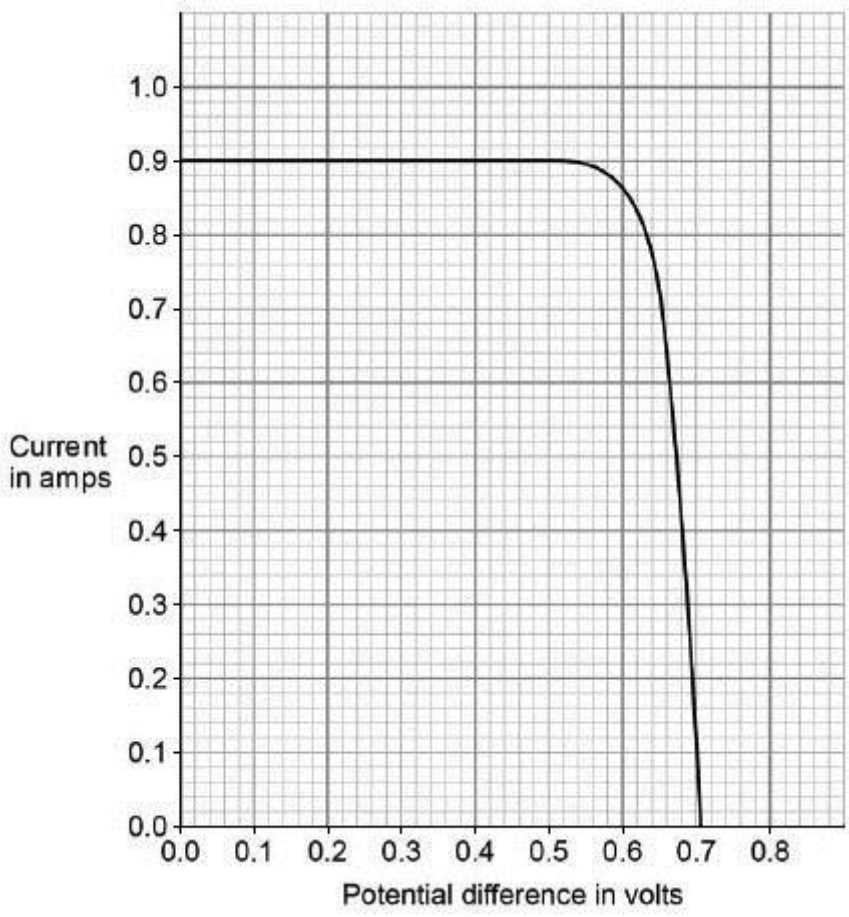
Use the equation:

$$\text{current} = \frac{\text{potential difference}}{\text{resistance}}$$

Current = _____ A

(2)

The graph below shows a graph of current against potential difference for a different type of solar cell.



(c) The power output of the solar cell is calculated using the equation.

power = current × potential difference

Which value of potential difference on the graph above gives the maximum power output of the solar cell?

Tick **one** box.

0.1 V ☐ 0.3 V ☐ 0.6 V ☐ 0.7 V ☐

Give the reason for your answer.

_____

_____

_____

(2)

(d) Write down the equation that links efficiency, total power input and useful power output.

_____

_____

(1)

(e) The total power input to the solar cell is 2.4 W when the efficiency is 0.20

Calculate the useful power output of the solar cell.

_____

_____

_____

_____

Useful power output = _____ W

(3)

(Total 9 marks)

Q9.

Most electric kettles use the ac mains electricity supply.

(a) Complete the sentence.

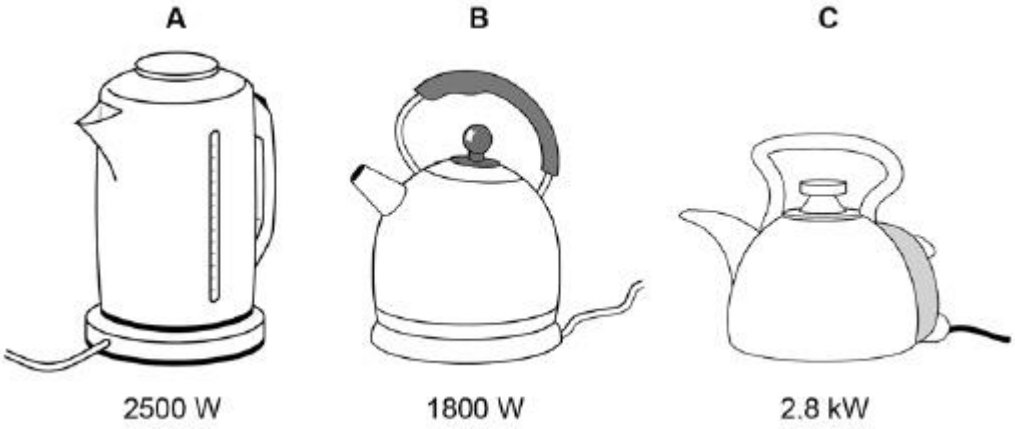
The ac mains supply has a potential difference that continuously

_____ polarity

(1)

Figure 1 gives the power output of three electric kettles.

Figure 1



A student investigated how the power output of a kettle affected the time taken to boil a fixed volume of water.

The water in all three kettles had an initial temperature of 25 °C.

(b) What type of variable was the time?

Tick **one** box.

Control ☐

Dependent ☐

Independent ☐

(1)

(c) Which kettle will boil the water in the shortest time?

Give a reason for your answer.

Kettle _____

Reason _____

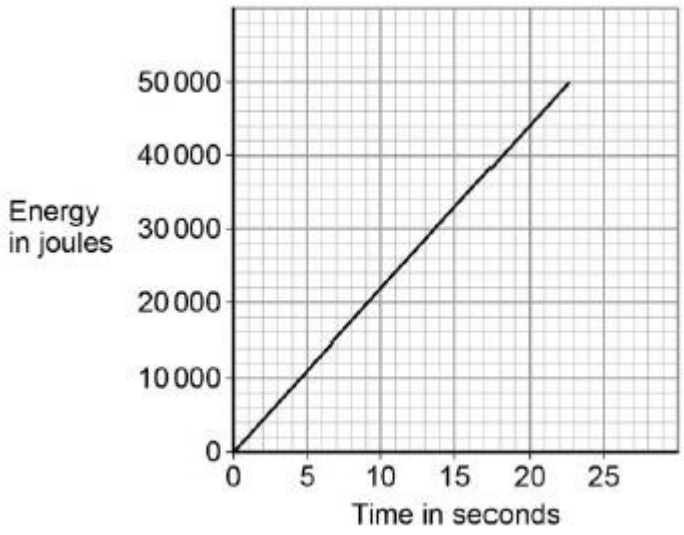
_____

_____

(2)

(d) **Figure 2** shows how the amount of energy transferred by a kettle varies with time.

Figure 2



The power output of the kettle is given by the gradient of the graph.

Calculate the power output of the kettle.

_____

_____

Power output = _____ W

(2)

(e) Write down the equation that links charge flow, current and time.

_____

(1)

(f) Calculate the current through the kettle when 2400 coulombs of charge flows in 250 seconds.

_____

_____

_____

_____

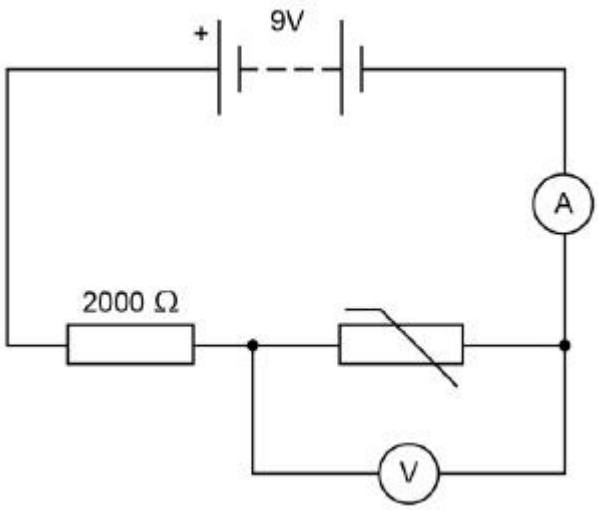
Current = _____ A

(3)

(Total 10 marks)

Q10.

The diagram shows a temperature sensing circuit used to control a heating system in a house.



(a) What quantity does the ammeter measure?

_____

(1)

(b) The current in the circuit is 3.5 mA when the potential difference across the thermistor is 4.2 V

Calculate the resistance of the thermistor.

_____

_____

_____

Resistance = _____ Ω

(3)

(c) Calculate the charge that flows through the thermistor in 5 minutes when the current

is 3.5 mA.

_____

_____

_____

Charge = _____ C

(3)

(d) Explain why the potential difference across the thermistor changes as the temperature in the house decreases.

_____

_____

_____

_____

(2)

(e) The circuit shown in the diagram can be modified to turn lights on and off by replacing the thermistor with a Light Dependent Resistor (LDR).

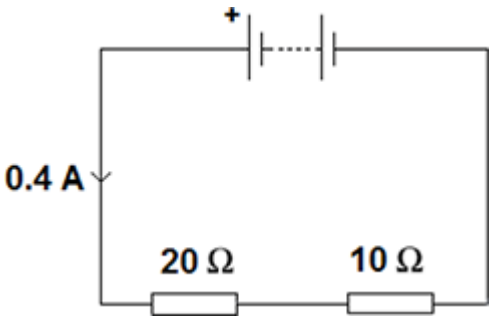
Draw the circuit symbol for an LDR in the space below.

(1)

(Total 10 marks)

Q11.

An electrical circuit is shown in the figure below.



(a) The current in the circuit is direct current.

What is meant by direct current?

Tick **one** box.

Current that continuously changes direction.	☐
Current that travels directly to the component.	☐
Current that is always in the same direction.	☐

(1)

(b) The equation which links current, potential difference and resistance is:

potential difference = current × resistance

Calculate the potential difference across the battery in the circuit in the figure above.

_____

_____

Potential difference = _____ V

(3)

(c) The equation which links current, potential difference and power is:

power = current × potential difference

Calculate the power output of the battery in the figure above.

Give your answer to one significant figure.

_____

Power = _____ W

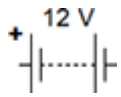
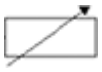
(2)

(Total 6 marks)

Q12.

A student wants to investigate how the current through a filament lamp affects its resistance.

(a) Use the circuit symbols in the boxes to draw a circuit diagram that she could use.

12 V battery	variable resistor	filament lamp	voltmeter	ammeter
				

(2)

(b) Describe how the student could use her circuit to investigate how the current through a filament lamp affects its resistance.

_____

_____

_____

_____

_____

_____

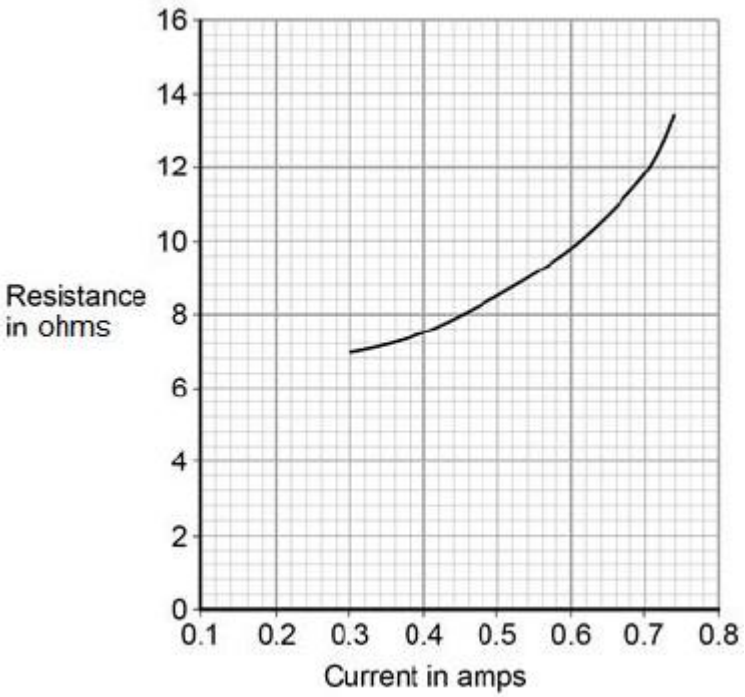
_____

_____

(4)

(c) The student's results are shown in **Figure 1**.

Figure 1



Describe how the resistance of the filament lamp changes as the current through it increases.

_____

_____

(1)

(d) Use **Figure 1** to estimate the resistance of the filament lamp when a current of 0.10 A passes through the lamp.

Resistance = _____ Ω

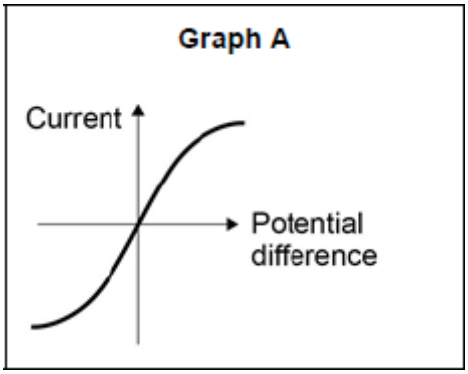
(1)

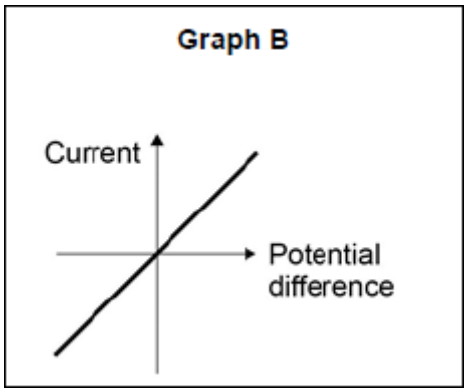
(e) The current-potential difference graphs of three components are shown in **Figure 2**.

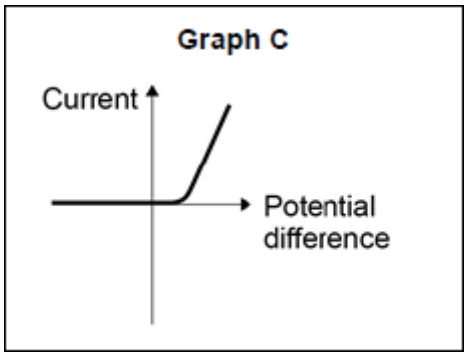
Use answers from the box to identify each component.

diode	**filament lamp**	**light dependent resistor**
resistor at constant temperature		**thermistor**

Figure 2





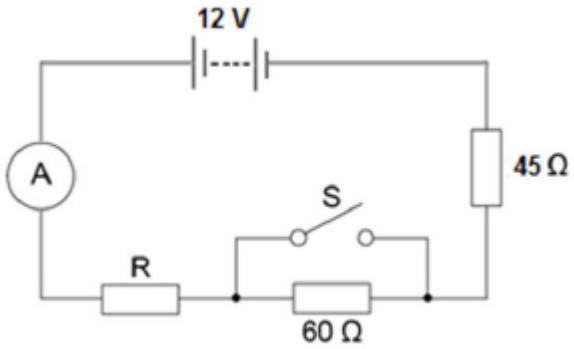


(3)

(Total 11 marks)

Q13.

A student set up the electrical circuit shown in the figure below.



(a) The ammeter displays a reading of 0.10 A.

Calculate the potential difference across the 45 Ω resistor.

Potential difference = _____ V

(2)

(b) Calculate the resistance of the resistor labelled **R**.

Resistance = _____ Ω

(3)

(c) State what happens to the total resistance of the circuit and the current through the circuit when switch **S** is closed.

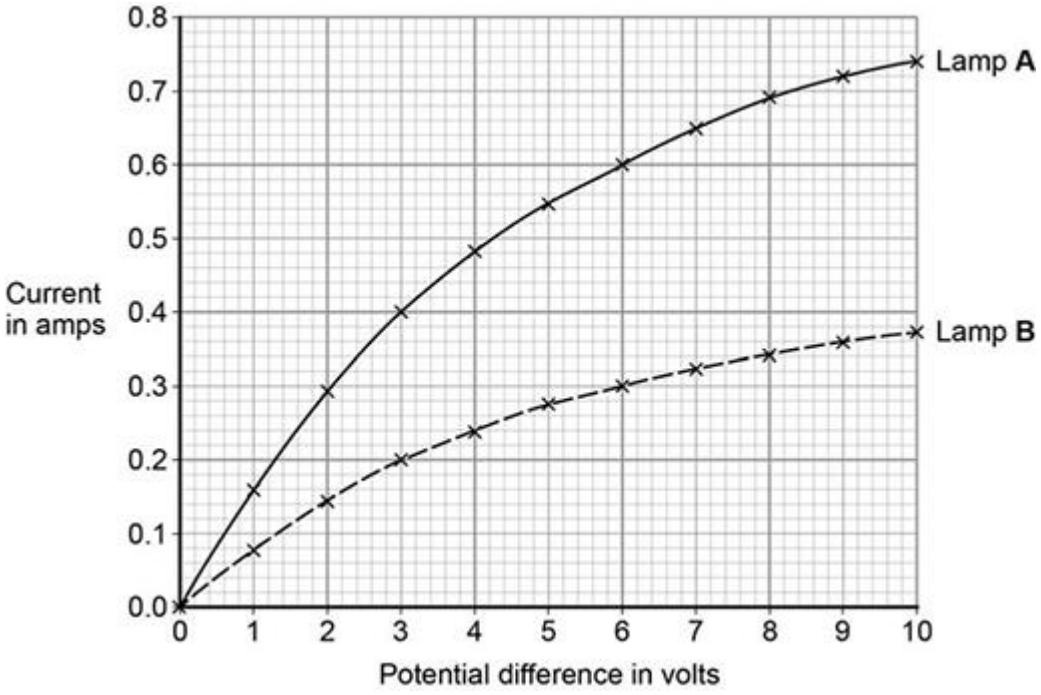
(2)

(Total 7 marks)

Q14.

A student investigated how current varies with potential difference for two different lamps.

Her results are shown in the figure below.



(a) Complete the circuit diagram for the circuit that the student could have used to obtain the results shown in the figure above.

(3)

(b) Which lamp will be brighter at any potential difference?

Explain your answer.

Use the figure above to aid your explanation

_____

_____

_____

_____

(2)

(c) Lamp **B** has the higher resistance at any potential difference.

Explain how the figure above shows this.

_____

_____

_____

_____

(2)

(d) Both lamps behave like ohmic conductors through a range of values of potential difference.

Use the figure above to determine the range for these lamps.

Explain your answer.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q15.

An electrician is replacing an old electric shower with a new one.

The inside of the old shower is shown in **Figure 1**.

Figure 1

(a) If the electrician touches the live wire he will receive an electric shock.

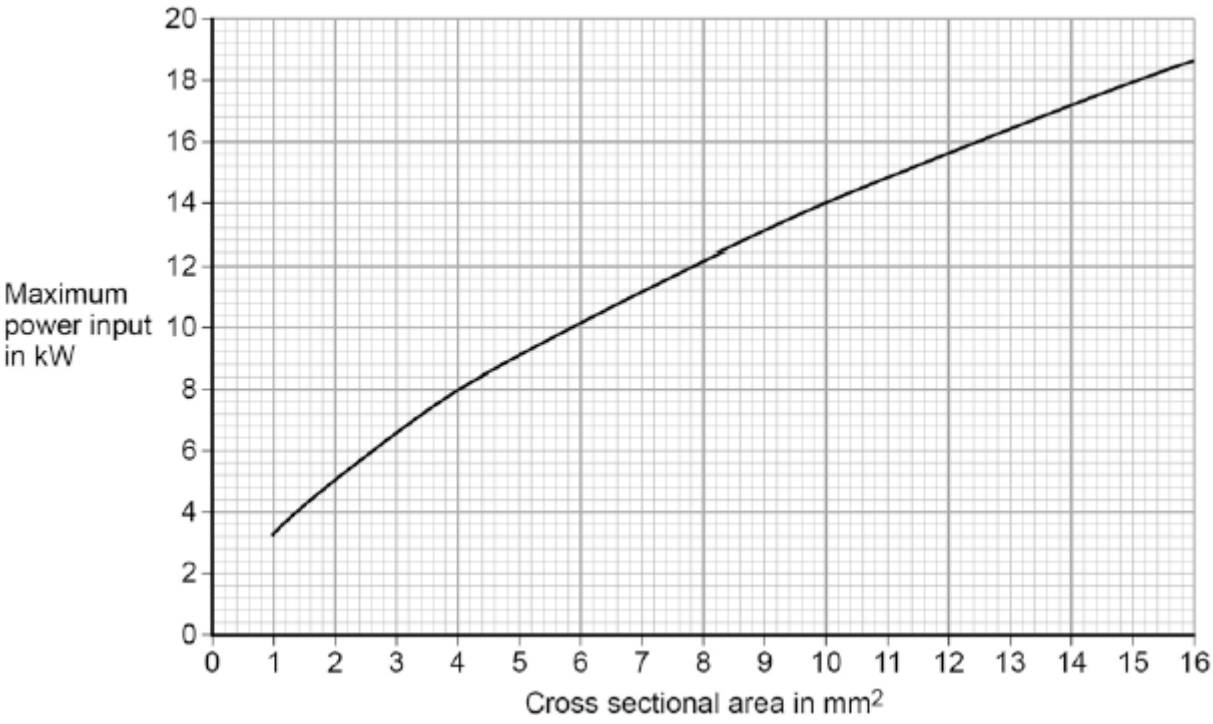
Explain why.

(4)

(b) Different electrical wires need to have a cross-sectional area that is suitable for the power output.

Figure 2 shows the recommended maximum power input to wires of different cross-sectional areas.

Figure 2



The new electric shower has a power input of 13.8 kW.

Determine the minimum **diameter** of wire that should be used for the new shower.

The diameter, d, can be calculated using the equation:

$$d = \sqrt{\frac{4A}{\pi}}$$

A is the cross-sectional area of the wire.

_____

_____

Minimum diameter = _____ mm

(2)

(c) The charge that flows through the new shower in 300 seconds is 18 000 C.
The new electric shower has a power of 13.8 kW.

Calculate the resistance of the heating element in the new shower.

Write down any equations you use.

Resistance = _____ Ω

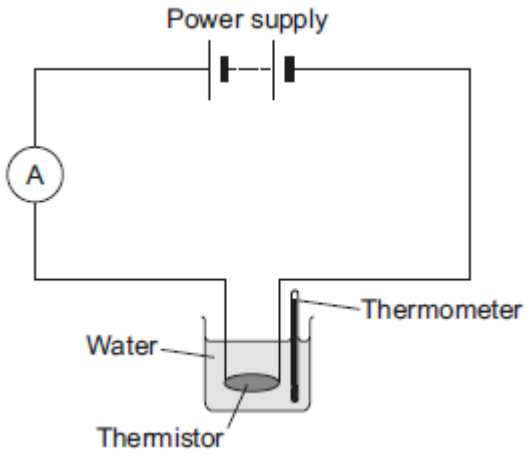
(5)

(Total 11 marks)

Q16.

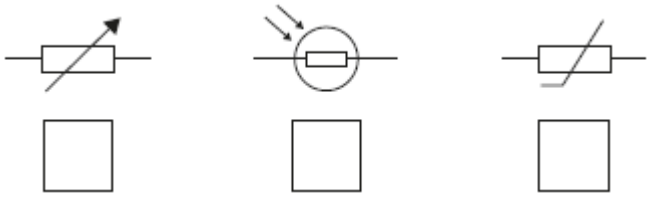
Figure 1 shows the apparatus used to investigate how the current through a thermistor depends on the temperature of the thermistor.

Figure 1



(a) Which **one** of the following is the correct circuit symbol for a thermistor?

Tick (✔) **one** box.

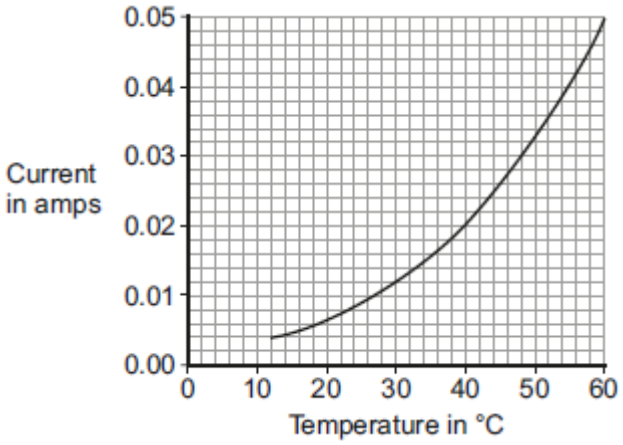


(1)

(b) To get a range of results, hot water at 60 °C was poured into the beaker.
The temperature of the water and current through the thermistor were then recorded as the water cooled.

The results of the investigation are shown in **Figure 2**.

Figure 2



(i) Suggest **one** way the investigation could have been changed to give a wider range of temperatures.

_____

_____

(1)

(ii) Describe how the current through the thermistor depends on the temperature of the thermistor.

_____

_____

(1)

(iii) Use **Figure 2** to determine the current through the thermistor at 40 °C.

Current at 40 °C = _____ A

(1)

(iv) At 40 °C the thermistor has a resistance of 250 Ω.

Use your answer to part **(iii)** and the resistance of the thermistor to calculate the potential difference across the thermistor.

_____

_____

_____

_____

Potential difference = _____ V

(2)

(v) The potential difference across the thermistor stays the same all through the investigation.

What conclusion can be made from the results in **Figure 2** about the resistance of the thermistor as the temperature of the thermistor **decreases?**

Tick (✔) **one** box.

the resistance increases	☐
the resistance does not change	☐
the resistance decreases	☐

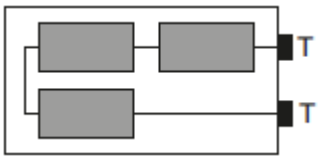
(1)

(Total 7 marks)

Q17.

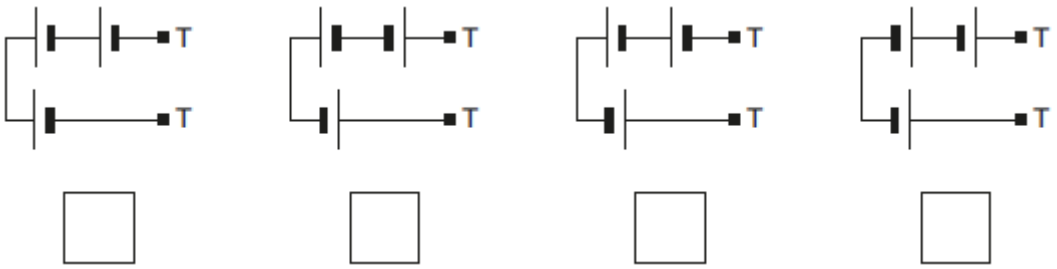
(a) **Figure 1** shows the inside of a battery pack designed to hold three identical 1.5 V cells.

Figure 1



Which **one** of the arrangements shown in **Figure 2** would give a 4.5 V output across the battery pack terminals **T**?

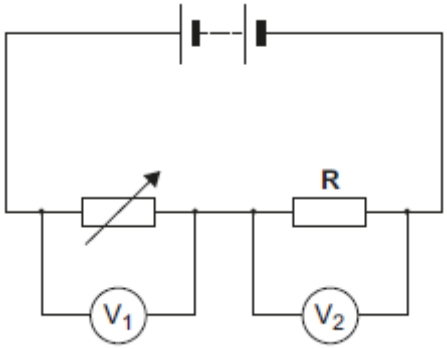
Figure 2



(1)

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

Figure 3



Complete **Figure 3** to show how an ammeter would be connected to measure the current through the circuit.

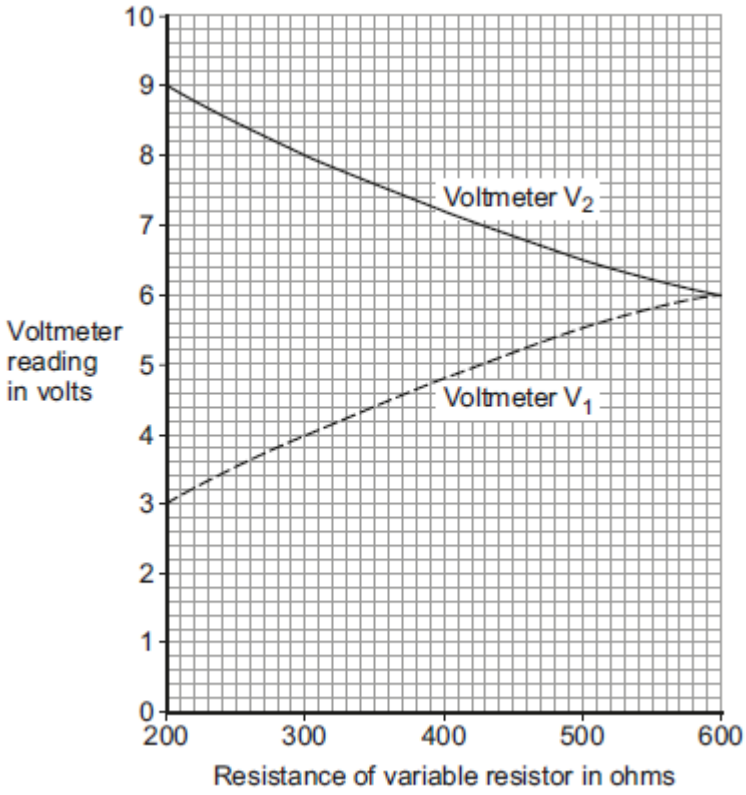
Use the correct circuit symbol for an ammeter.

(1)

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

Figure 4 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 4



(i) How could the potential difference of the battery be calculated from **Figure 4**?

Tick (✔) **one** box.

9 + 3 = 12 V ☐

9 – 3 = 6 V ☐

9 ÷ 3 = 3 V ☐

Give the reason for your answer.

_____

_____

(2)

(ii) Use **Figure 4** to determine the resistance of the fixed resistor, **R**.

Resistance of R = _____ Ω

Give the reason for your answer.

_____

_____

(2)

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

_____

_____

_____

Current = _____ A

(3)

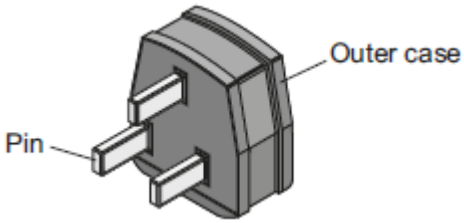
(Total 9 marks)

Q18.

(a) A washing machine is connected to the mains electricity supply using a cable and three-pin plug.

Figure 1 shows a three-pin plug.

Figure 1



Name the materials used in the structure of a plug. Give the reason why each material is used.

Pin _____

_____

Outer case _____

_____

(1)

(b) The three-pin plug contains a fuse. The fuse is connected to one of the wires inside the cable.

(i) Which **one** of the wires inside the cable is the fuse connected to?

_____

(1)

(ii) The fuse is a thin wire inside a closed glass tube. The wire acts as a resistor.

What effect does a current through a wire have on the wire?

_____

(1)

(iii) The power of the washing machine varies between 0.7 kW and 2 kW depending on which part of the wash cycle is operating.

Calculate the maximum current drawn from the mains electricity supply by the washing machine.

The mains electricity supply is at a potential difference of 230 V.

_____

_____

_____

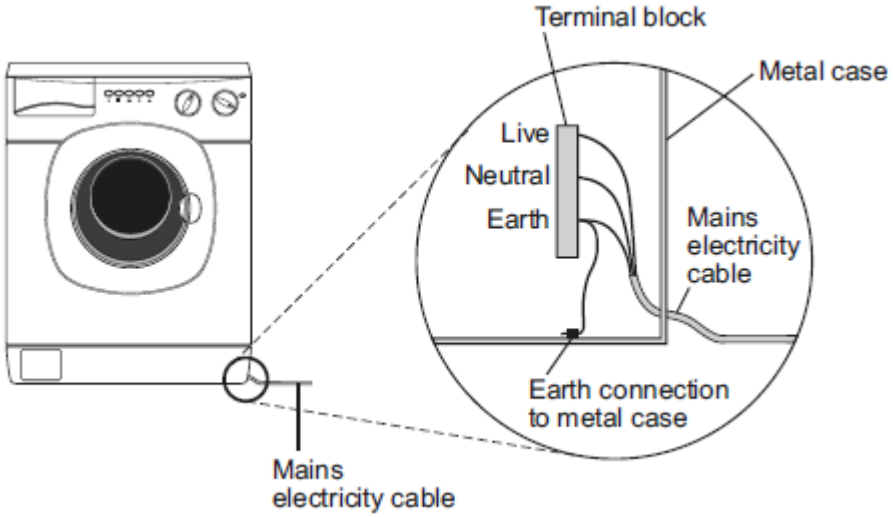
Current = _____ A

(2)

(c) **Figure 2** shows how the mains electricity cable is connected to the washing machine.

The earth wire is connected to the metal case of the washing machine.

Figure 2



If a fault makes the metal case live, the earth wire and fuse inside the plug prevent the mains cable from overheating and causing a fire.

Explain how.

_____

_____

_____

_____

(2)

(d) New research has shown that many people underestimate the hazards of using mains electricity.

It is important that people do understand the hazards of using mains electricity.

Suggest why.

_____

_____

_____

(1)

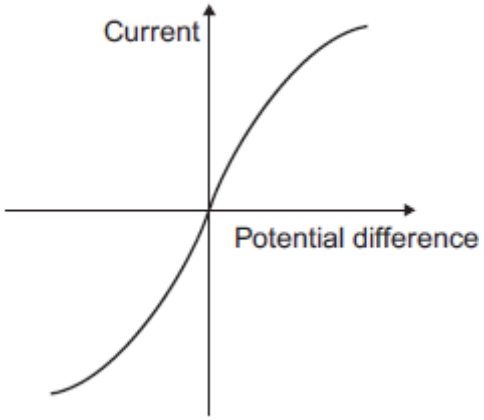
(Total 9 marks)

Q19.

The current in a circuit depends on the potential difference provided by the cells and the total resistance of the circuit.

(a) **Figure 1** shows the graph of current against potential difference for a component.

Figure 1



What is the name of the component?

Draw a ring around the correct answer.

diode **filament bulb** **thermistor**

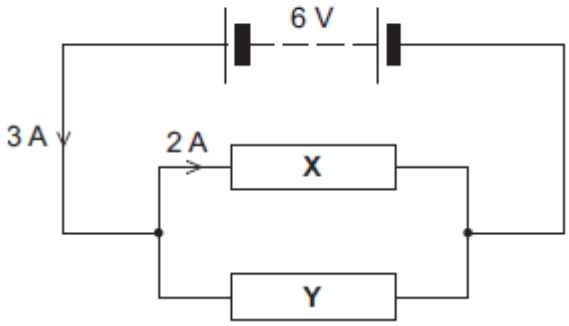
(1)

(b) **Figure 2** shows a circuit containing a 6 V battery.

Two resistors, **X** and **Y**, are connected in parallel.

The current in some parts of the circuit is shown.

Figure 2



(i) What is the potential difference across **X**?

Potential difference across **X** = _____ V

(1)

(ii) Calculate the resistance of **X**.

_____

_____

Resistance of **X** = _____ Ω

(2)

(iii) What is the current in **Y**?

Current in **Y** = _____ A

(1)

(iv) Calculate the resistance of **Y**.

_____

Resistance of **Y** = _____ Ω

(1)

(v) When the temperature of resistor **X** increases, its resistance increases.

What would happen to the:

- potential difference across **X**
- current in **X**
- total current in the circuit?

Tick (✓) **three** boxes.

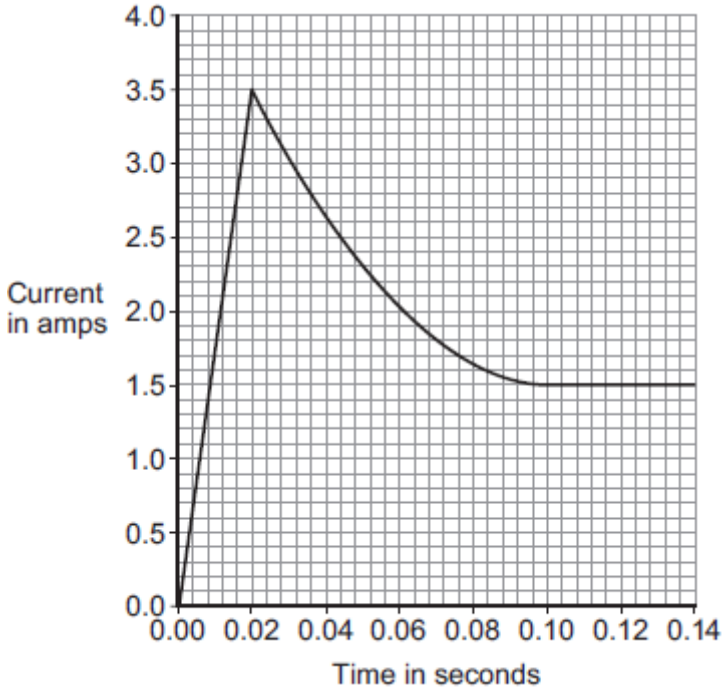
	Decrease	**Stay the same**	**Increase**
Potential difference across **X**			
Current in **X**			
Total current in the circuit			

(3)

(Total 9 marks)

Q20.

The graph shows how the current through a filament bulb changes after the bulb is switched on.



(a) What happens to the current through the bulb in the first 0.02 seconds after the bulb is switched on?

_____

(1)

(b) Between 0.02 seconds and 0.08 seconds the current through the bulb decreases.

(i) What, if anything, happens to the **resistance** of the bulb between 0.02 seconds and 0.08 seconds?

Draw a ring around the correct answer.

decreases **does not change** **increases**

(1)

(ii) What, if anything, happens to the **temperature** of the bulb between 0.02 seconds and 0.08 seconds?

Draw a ring around the correct answer.

decreases **does not change** **increases**

(1)

(c) The bulb is connected to a 12 V power supply.

Calculate the power of the bulb when the current through the bulb is 1.5 A.

Choose the unit from the list below.

coulomb **joule** **watt**

_____

_____

Power = _____ unit _____

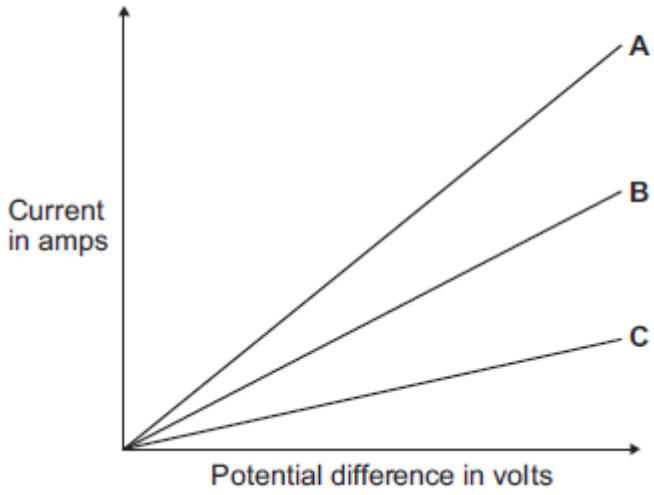
(3)

(Total 6 marks)

Q21.

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

Figure 1



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

_____

_____

(1)

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

Write the correct answer in the box. ☐

Give a reason for your answer.

_____

_____

_____

(2)

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

The table below shows the resistance of, and other data about, each of the four wires, **J**, **K**, **L** and **M**.

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

(i) The last column of the table should include the unit of resistance.

What is the unit of resistance?

_____

(1)

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

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

Wire ☐ and wire ☐

Give a reason for your answer.

_____

_____

_____

(2)

(iii) A student looked at the data in the table 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

_____

_____

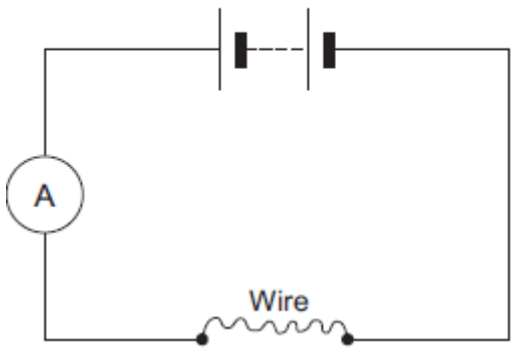
_____

(1)

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

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

Figure 2



(1)

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

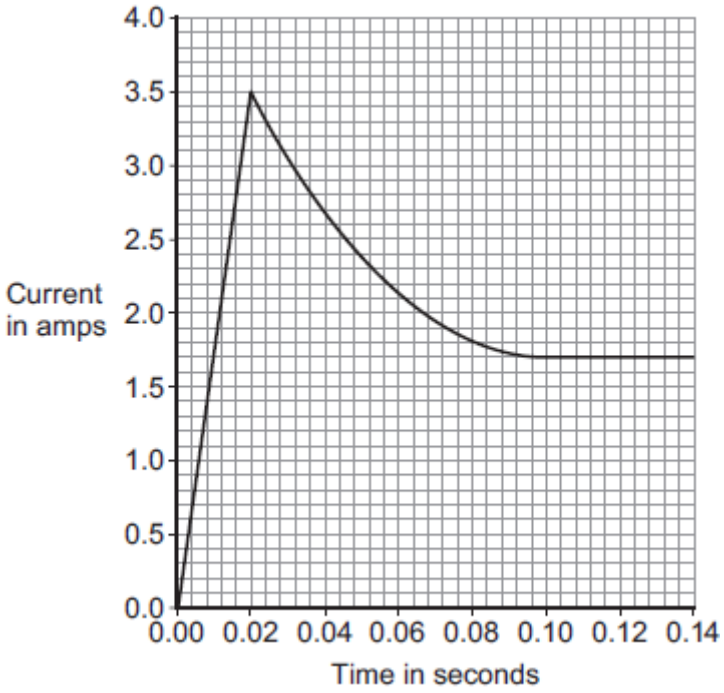
In the box below, draw the circuit symbol for a resistor.

(1)

(Total 9 marks)

Q22.

A 12 V filament bulb is connected to a 12 V power supply.
The graph shows how the current changes after the bulb is switched on.



(a) (i) After 0.10 seconds, the bulb works at its normal brightness.

What is the current through the bulb when it is working at normal brightness?

Current = _____ A

(1)

(ii) The bulb works at normal brightness for 30 seconds before it is switched off.

Calculate the charge that flows through the bulb in the 30 seconds before it is switched off. Give the unit.

_____

_____

_____

Charge = _____ unit _____

(3)

(iii) Calculate the energy transferred by the 12 V bulb when it is working at normal brightness for 30 seconds.

_____

_____

Energy transferred = _____ J

(2)

(b) Between 0.02 seconds and 0.08 seconds, there is an increase in both the resistance and the temperature of the metal filament inside the bulb.

Explain, in terms of the electrons and ions inside the filament, why both the temperature and the resistance increase.

_____

_____

_____

_____

_____

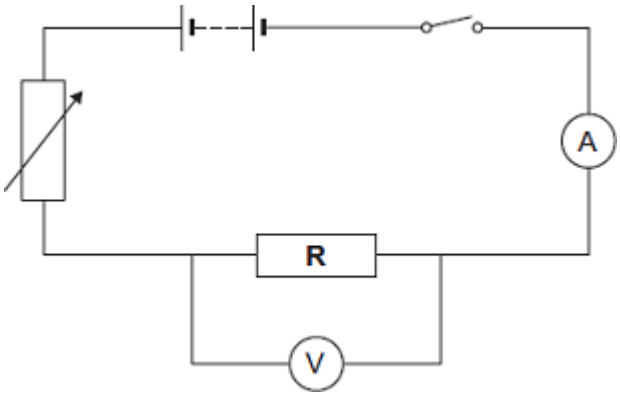
_____

(2)

(Total 8 marks)

Q23.

(a) A resistor is a component that is used in an electric circuit.



(i) Describe how a student would use the circuit to take the readings necessary to determine the resistance of resistor **R**.

(6)

(ii) Explain why the student should open the switch after each reading.

_____

_____

(2)

(iii) In an experiment using this circuit, an ammeter reading was 0.75 A.
The calculated value of the resistance of resistor **R** was 16 Ω.

What is the voltmeter reading?

_____

_____

Voltmeter reading = _____ V

(2)

(iv) The student told his teacher that the resistance of resistor **R** was 16 Ω.

The teacher explained that the resistors used could only have one of the following values of resistance.

10 Ω **12 Ω** **15 Ω** **18 Ω** **22 Ω**

Suggest which of these resistors the student had used in his experiment.

Give a reason for your answer.

_____

_____

_____

_____

(2)

(b) The diagram shows a fuse.

Describe the action of the fuse in a circuit.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 15 marks)

Q24.

The current in a circuit depends on the potential difference (p.d.) provided by the cells and the total resistance of the circuit.

(a) Using the correct circuit symbols, draw a diagram to show how you would connect 1.5 V cells together to give a p.d. of 6 V.

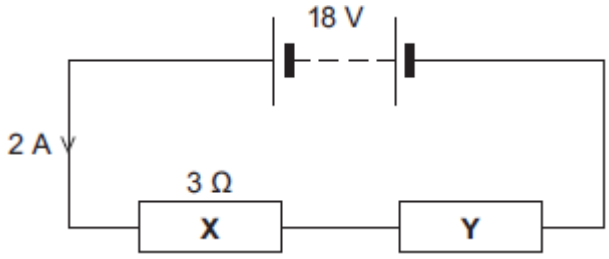
(2)

(b) **Figure 1** shows a circuit containing an 18 V battery.

Two resistors, **X** and **Y**, are connected in series.

- **X** has a resistance of 3 Ω.
- There is a current of 2 A in **X**.

Figure 1



(i) Calculate the p.d. across **X**.

_____

_____

P.d. across **X** = _____ V

(2)

(ii) Calculate the p.d. across **Y**.

P.d. across **Y** = _____ V

(2)

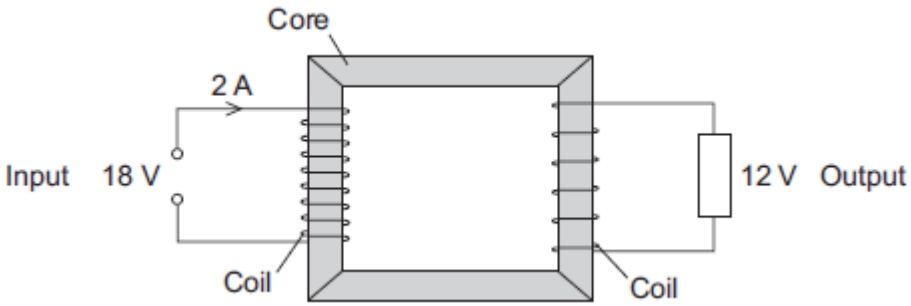
(iii) Calculate the total resistance of **X** and **Y**.

Total resistance of **X** and **Y** = _____ Ω

(2)

(c) **Figure 2** shows a transformer.

Figure 2



(i) An 18 V battery could **not** be used as the input of a transformer.

Explain why.

(2)

(ii) The transformer is 100% efficient.

Calculate the output current for the transformer shown in **Figure 2**.

_____

_____

_____

Output current = _____ A

(2)

(Total 12 marks)

Q25.

If a fault develops in an electrical circuit, the current may become too great. The circuit needs to be protected by being disconnected.

A fuse or a circuit breaker may be used to protect the circuit.
One type of circuit breaker is a Residual Current Circuit Breaker (RCCB).

(a) (i) Use the correct answer from the box to complete the sentence.

earth	**live**	**neutral**

A fuse is connected in the _____ wire.

(1)

(ii) Use the correct answer from the box to complete the sentence.

are bigger	**are cheaper**	**react faster**

RCCBs are sometimes preferred to fuses because they _____ .

(1)

(iii) RCCBs operate by detecting a difference in the current between two wires.

Use the correct answer from the box to complete the sentence.

earth and live	**earth and neutral**	**live and neutral**

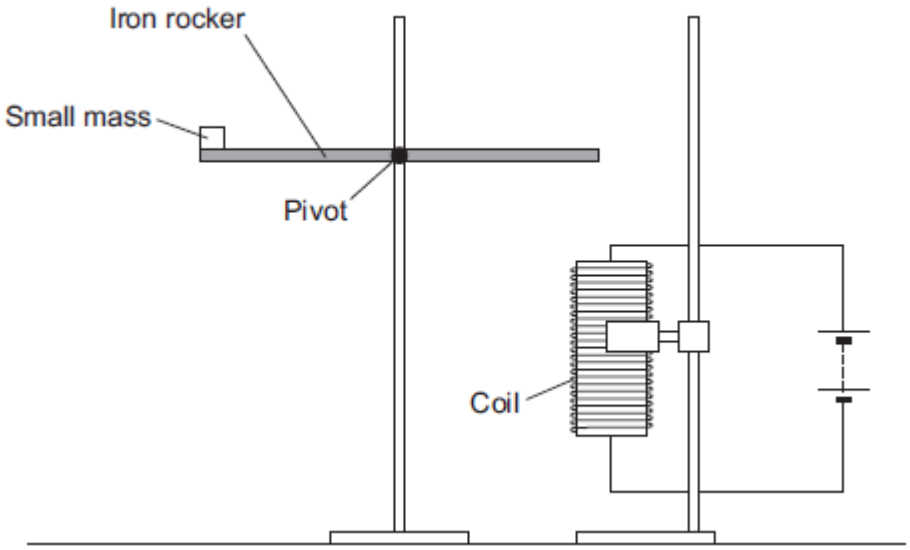
The two wires are the _____ wires.

(1)

(b) An RCCB contains an iron rocker and a coil.

A student investigated how the force of attraction, between a coil and an iron rocker, varies with the current in the coil.

She supported a coil vertically and connected it in an electrical circuit, part of which is shown in the figure below .



She put a small mass on the end of the rocker and increased the current in the coil until the rocker balanced. She repeated the procedure for different masses.

Some of her results are shown in the table below.

Mass in grams	**Current needed for the rocker to balance in amps**
5	0.5
10	1.0
15	1.5
20	2.0

(i) State **two** extra components that must have been included in the circuit in the figure above to allow the data in the above table to be collected.

Give reasons for your answers.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(ii) A teacher said that the values of current were too high to be safe.

Suggest **two** changes that would allow lower values of current to be used in this investigation.

Change 1 _____

_____

Change 2 _____

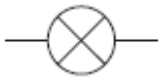
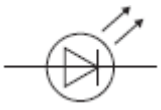
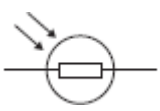
_____

(2)

(Total 9 marks)

Q26.

(a) Draw **one** line from each circuit symbol to its correct name.

Circuit symbol	Name
	Diode
	Light-dependent resistor (LDR)
	Lamp
	

Light-emitting diode (LED)

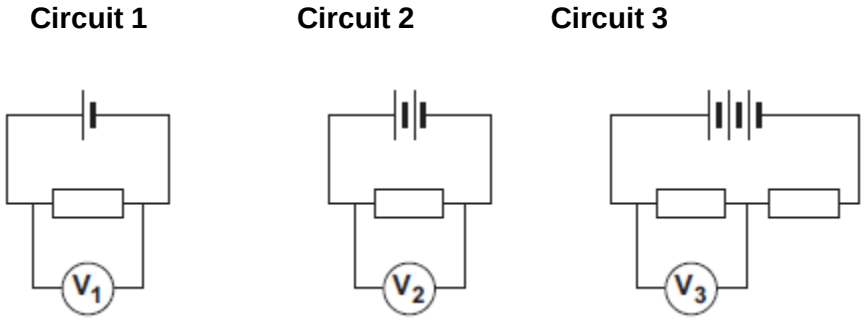
(3)

(b) **Figure 1** shows three circuits.

The resistors in the circuits are identical.

Each of the cells has a potential difference of 1.5 volts.

Figure 1



(i) Use the correct answer from the box to complete the sentence.

half	**twice**	**the same as**

The resistance of **circuit 1** is _____ the resistance of **circuit 3**.

(1)

(ii) Calculate the reading on voltmeter $\mathbf{V_2}$.

_____

Voltmeter reading $\mathbf{V_2}$ = _____ V

(1)

(iii) Which voltmeter, $\mathbf{V_1}$, $\mathbf{V_2}$ or $\mathbf{V_3}$, will give the lowest reading?

Draw a ring around the correct answer.

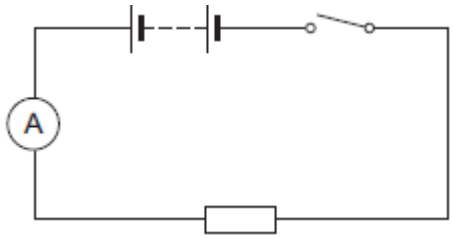
$\mathbf{V_1}$ $\mathbf{V_2}$ $\mathbf{V_3}$

(1)

(c) A student wanted to find out how the number of resistors affects the current in a series circuit.

Figure 2 shows the circuit used by the student.

Figure 2



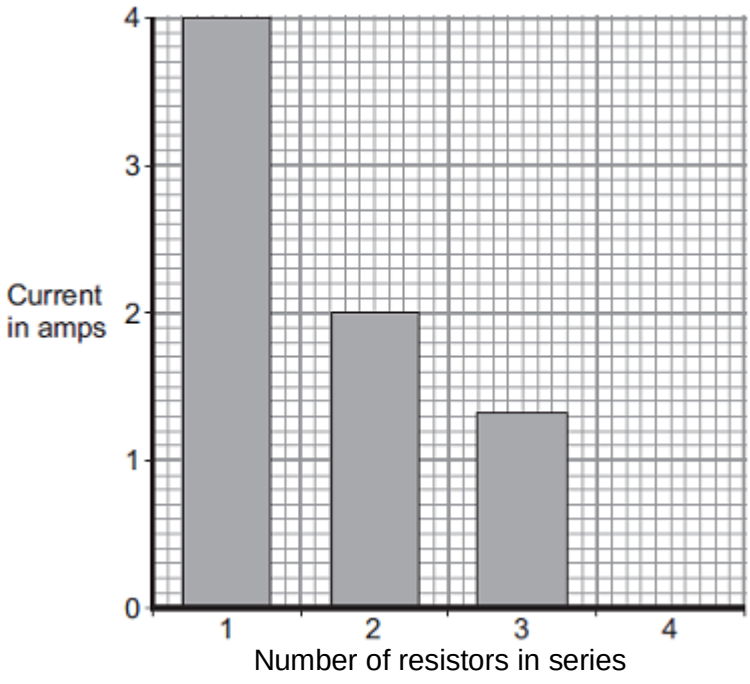
The student started with one resistor and then added more identical resistors to the circuit.

Each time a resistor was added, the student closed the switch and took the ammeter reading.

The student used a total of 4 resistors.

Figure 3 shows three of the results obtained by the student.

Figure 3



(i) To get valid results, the student kept one variable the same throughout the experiment.

Which variable did the student keep the same?

_____

(1)

(ii) The bar chart in **Figure 3** is not complete. The result using 4 resistors is not shown.

Complete the bar chart to show the current in the circuit when 4 resistors were used.

(2)

(iii) What conclusion should the student make from the bar chart?

_____

_____

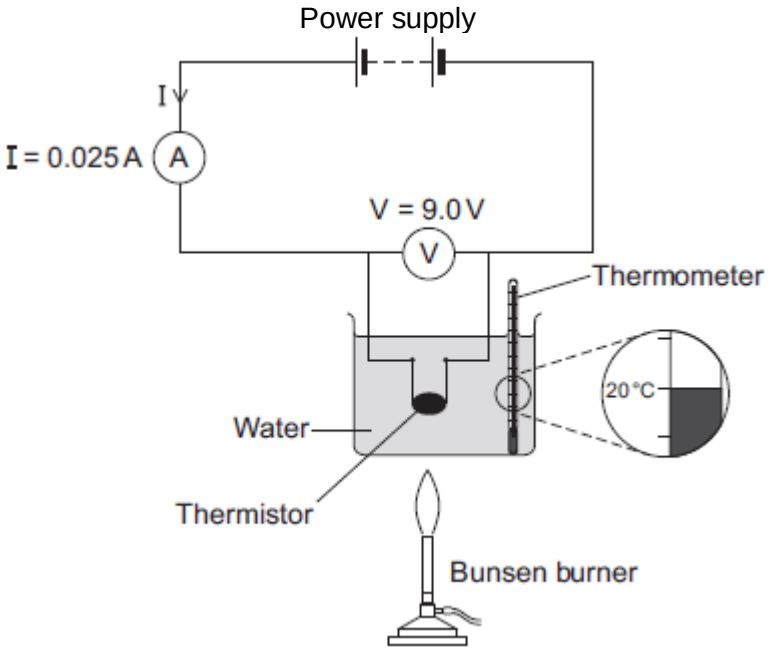
(1)

(Total 10 marks)

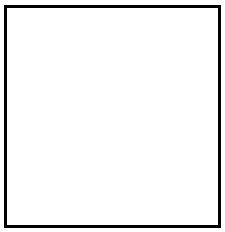
Q27.

(a) **Figure 1** shows the apparatus used to obtain the data needed to calculate the resistance of a thermistor at different temperatures.

Figure 1



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



(1)

(ii) Use the data given in **Figure 1** to calculate the resistance of the thermistor at 20 °C.

_____

_____

_____

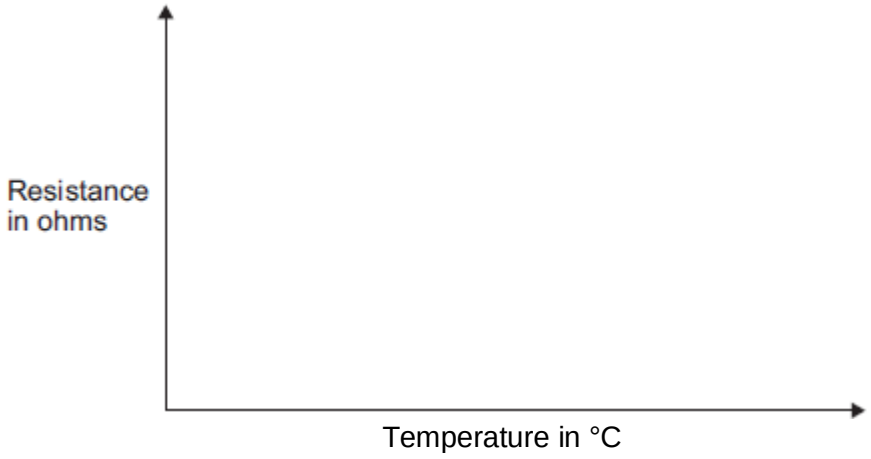
Resistance = _____ ohms

(2)

(iii) **Figure 2** shows the axes for a sketch graph.

Complete **Figure 2** to show how the resistance of the thermistor will change as the temperature of the thermistor increases from 20 °C to 100 °C.

Figure 2



(1)

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

Tick (✓) **one** box.

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. ☐

(1)

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

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

_____

_____

(1)

(c) The table below gives the temperature of boiling water using three different temperature scales.

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)

(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 2** 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)

(Total 9 marks)

Q28.

Electrical circuits have resistance.

(a) Draw a ring around the correct answer to complete the sentence.

When the resistance of a circuit increases, the current in the circuit

decreases.
increases.
stays the same.

(1)

(b) Use the correct answer from the box to complete each sentence.

a filament bulb	**an LED**	**an LDR**

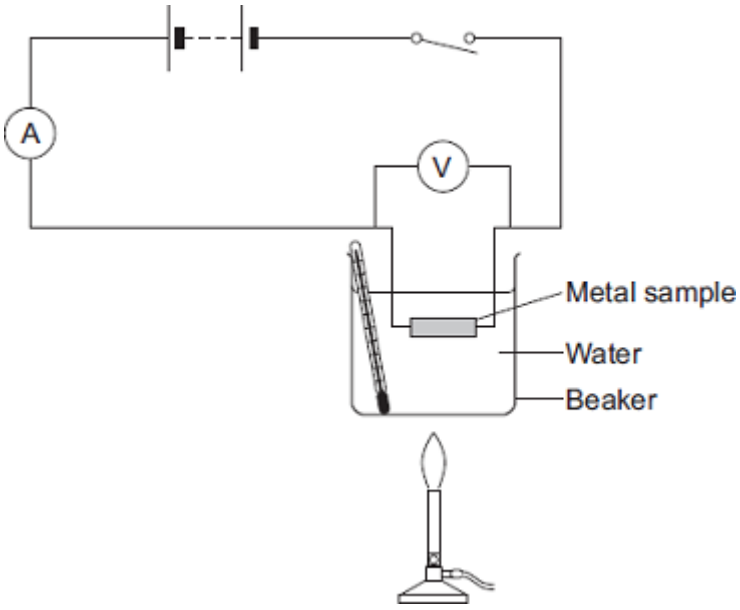
An electrical component which has a resistance that increases as the temperature increases is _____ .

An electrical component which emits light only when a current flows through it in the forward direction is _____ .

(2)

(c) When some metals are heated the resistance of the metal changes.

The equipment for investigating how the resistance of a metal changes when it is heated is shown in the diagram.



In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Describe an investigation a student could do to find how the resistance of a metal sample varies with temperature. The student uses the equipment shown.

Include in your answer:

- how the student should use the equipment
- the measurements the student should make
- how the student should use these measurements to determine the resistance
- how to make sure the results are valid.

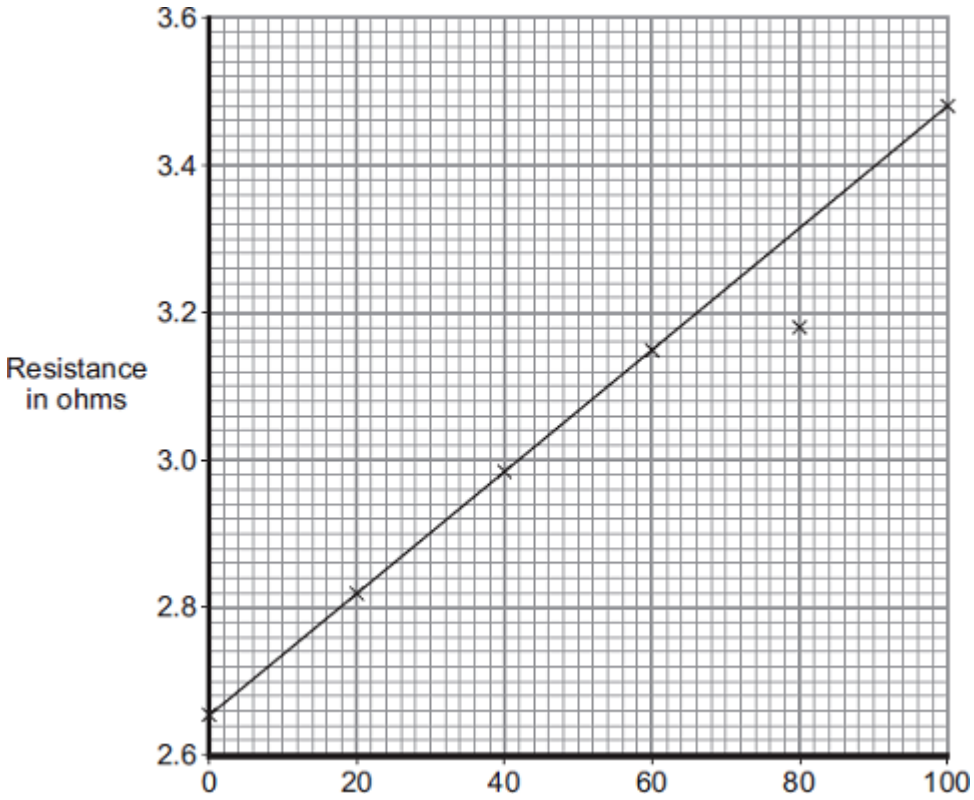
(6)

(d) The table shows some data for samples of four metals **P**, **Q**, **R** and **S**.

The metal samples all had the same cross-sectional area and were the same length.

Metal sample	Resistance at 0°C in ohms	Resistance at 100°C in ohms
P	4.05	5.67
Q	2.65	3.48
R	6.0	9.17
S	1.70	2.23

A graph of the results for one of the metal samples is shown.



(i) Which metal sample, **P**, **Q**, **R** or **S**, has the data shown in the graph?

(1)

(ii) One of the results is anomalous. Circle this result on the graph.

(1)

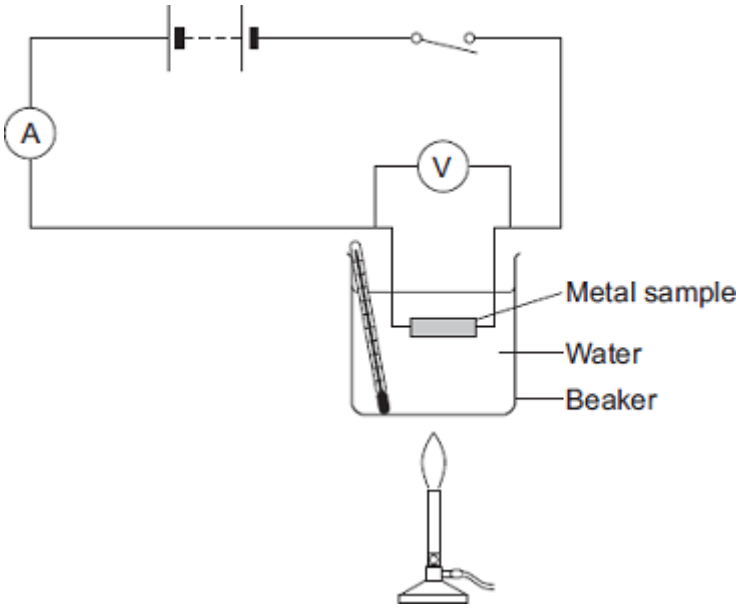
(iii) Suggest a reason for the anomalous result.

_____

_____

(1)

(iv) The same equipment used in the investigation could be used as a thermometer known as a 'resistance thermometer.'



Suggest **two** disadvantages of using this equipment as a thermometer compared to a liquid-in-glass thermometer.

1. _____

_____

2. _____

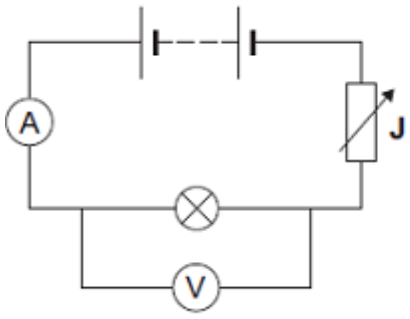
_____

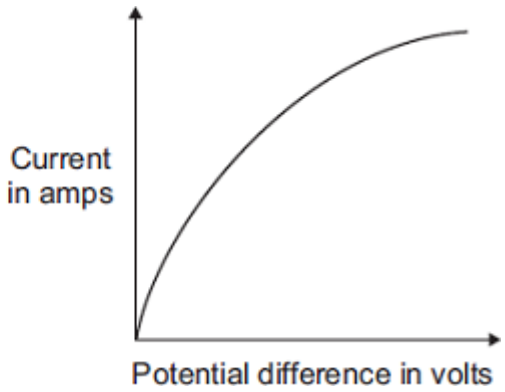
(2)

(Total 14 marks)

Q29.

(a) The diagram shows the circuit used to obtain the data needed to plot the current–potential difference graph for a filament bulb.





(i) Why is the component labelled '**J**' included in the circuit?

_____

_____

(1)

(ii) The resistance of the bulb increases as the potential difference across the bulb increases. Why?

_____

_____

(1)

(iii) The bulb is at full brightness when the potential difference across the bulb is 12 V.
The current through the bulb is then 3 A.

Calculate the power of the bulb when it is at full brightness and give the unit.

_____

_____

_____

Power = _____

(3)

(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The table gives data about two types of light bulb people may use in their homes.

Type of light bulb	Energy efficiency	Cost of one light bulb	Average lifetime in hours
Halogen	10%	£1.95	2 000
Light Emitting Diode (LED)	32%	£11.70	36 000

Both types of light bulb produce the same amount of light.

Evaluate, in terms of cost and energy efficiency, the use of the two types of light bulb.

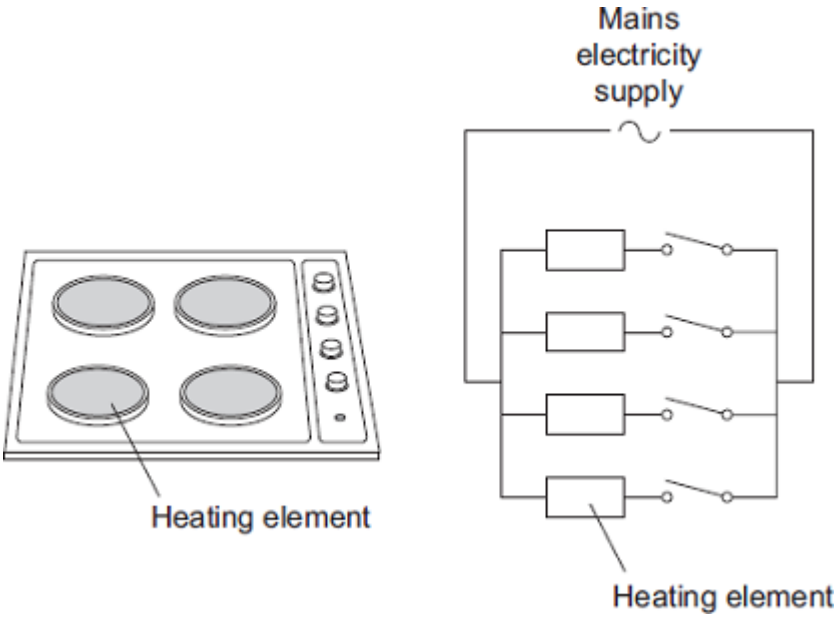
To gain full marks you must compare both types of light bulb and conclude which light bulb would be the best to use.

(6)

(Total 11 marks)

Q30.

The picture shows an electric cooker hob. The simplified circuit diagram shows how the four heating elements connect to the mains electricity supply. The heating elements are identical.



When all four heating elements are switched on at full power the hob draws a current of 26 A from the 230 V mains electricity supply.

(a) Calculate the resistance of one heating element when the hob is switched on at full power.

Give your answer to 2 significant figures.

Resistance = _____ Ω

(3)

(b) The table gives the maximum current that can safely pass through copper wires of different cross-sectional area.

Cross-sectional area in mm^2	Maximum safe current in amps
1.0	**11.5**
2.5	**20.0**
4.0	**27.0**
6.0	**34.0**

The power sockets in a home are wired to the mains electricity supply using cables containing 2.5 mm^2 copper wires. Most electrical appliances are connected to the mains electricity supply by plugging them into a standard power socket.

It would **not** be safe to connect the electric cooker hob to the mains electricity supply by plugging it into a standard power socket.

Why?

(2)

(c) Mains electricity is an alternating current supply. Batteries supply a direct current.

What is the difference between an alternating current and a direct current?

_____

_____

_____

_____

(2)

(Total 7 marks)

Q31.

(a) Electrical circuits often contain resistors.

The diagram shows **two** resistors joined in series.

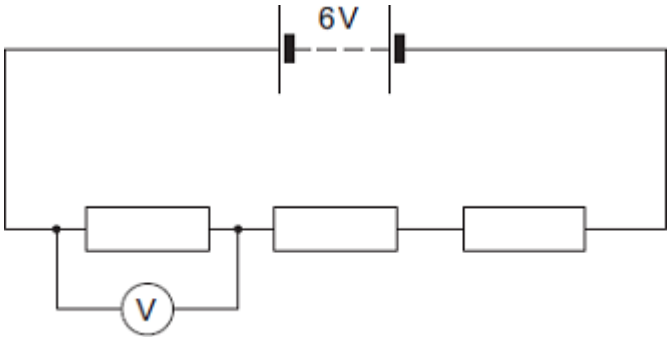
Calculate the total resistance of the **two** resistors.

_____

Total resistance = _____ Ω

(1)

(b) A circuit was set up as shown in the diagram. The three resistors are identical.



(i) Calculate the reading on the voltmeter.

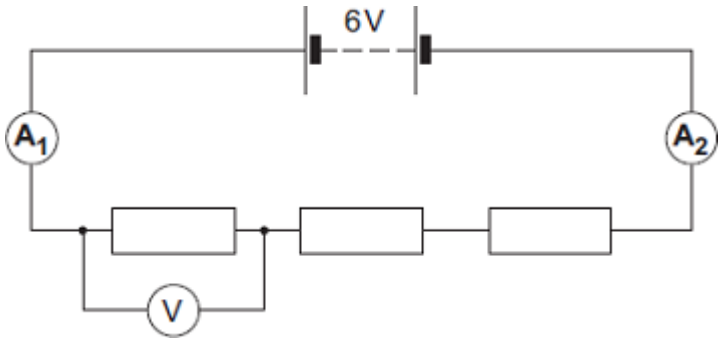
_____

_____

Reading on voltmeter = _____ V

(2)

(ii) The same circuit has now been set up with two ammeters.



Draw a ring around the correct answer in the box to complete the sentence.

The reading on ammeter **A_2** will be

smaller than
equal to
greater than

the reading on ammeter **A_1**.

(1)

(Total 4 marks)

Q32.

(a) The diagram shows the information plate on an electric kettle. The kettle is plugged into the a.c. mains electricity supply.

230 V	**2760 W**
50 Hz	

Use the information from the plate to answer the following questions.

(i) What is the frequency of the a.c. mains electricity supply?

_____

(1)

(ii) What is the power of the electric kettle?

_____

(1)

(b) To boil the water in the kettle, 2400 coulombs of charge pass through the heating element in 200 seconds.

Calculate the current flowing through the heating element and give the unit.

Choose the unit from the list below.

amps **volts** **watts**

_____

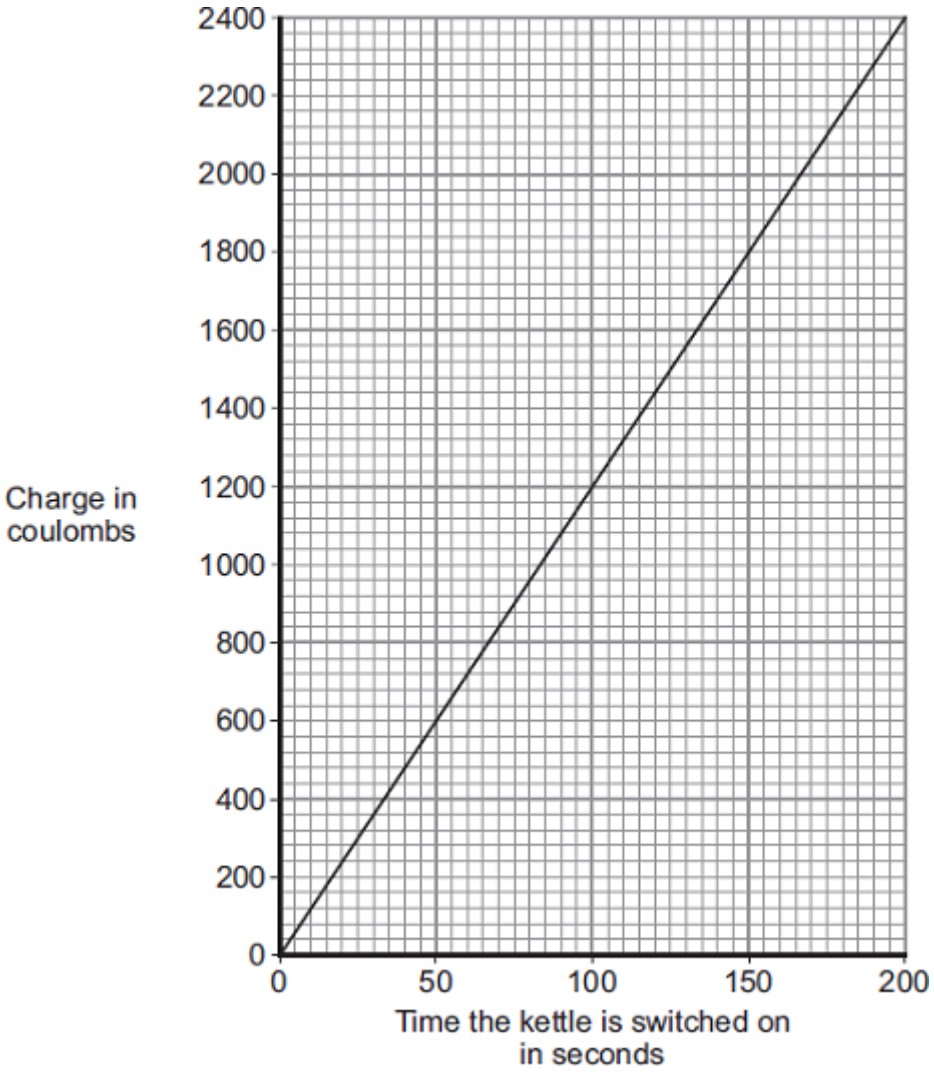
_____

_____

Current = _____

(3)

(c) The amount of charge passing through the heating element of an electric kettle depends on the time the kettle is switched on.



What pattern links the amount of charge passing through the heating element and the time the kettle is switched on?

_____

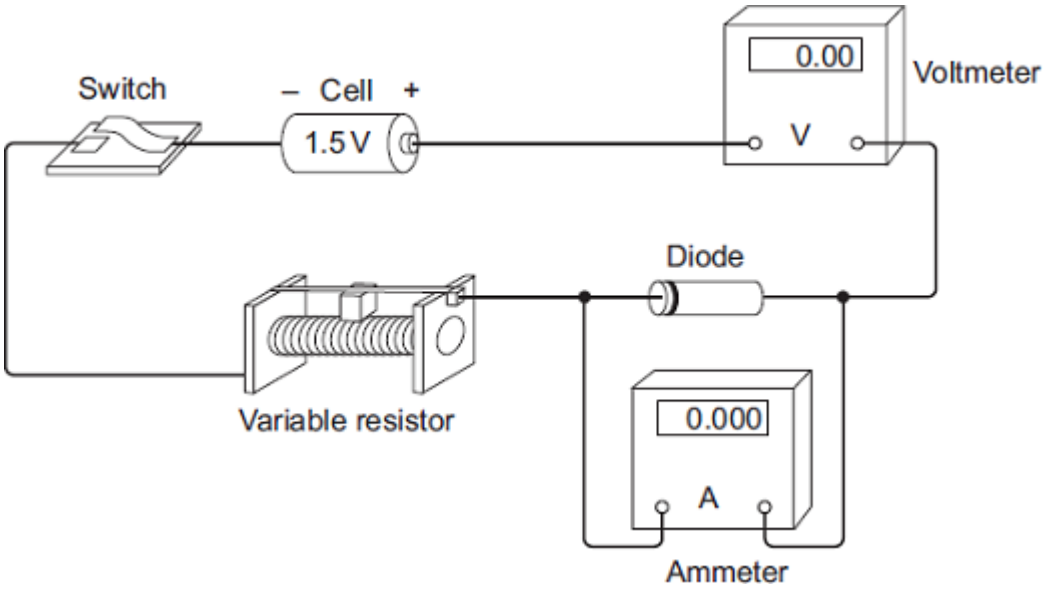
_____

(2)

(Total 7 marks)

Q33.

(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.



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

Diode	**Variable resistor**

(2)

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

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

1. _____

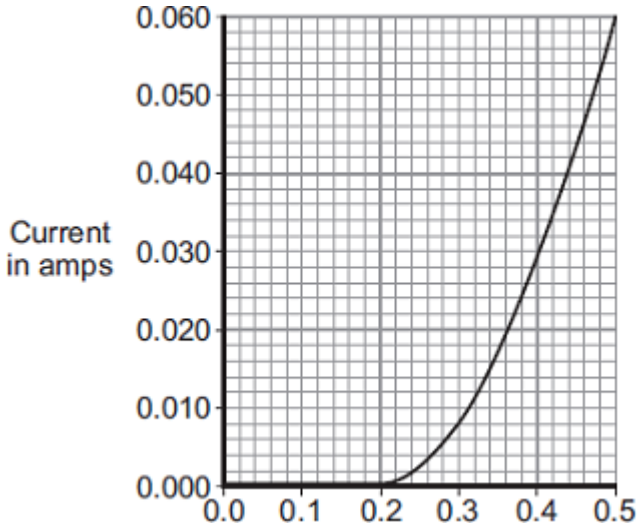
_____

2. _____

_____

(2)

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



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

_____ V

(1)

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

_____

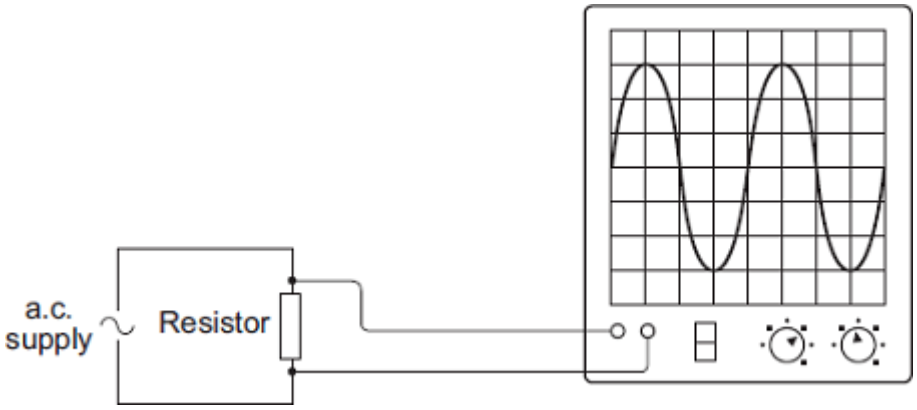
_____

_____

Resistance = _____ ohms

(3)

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



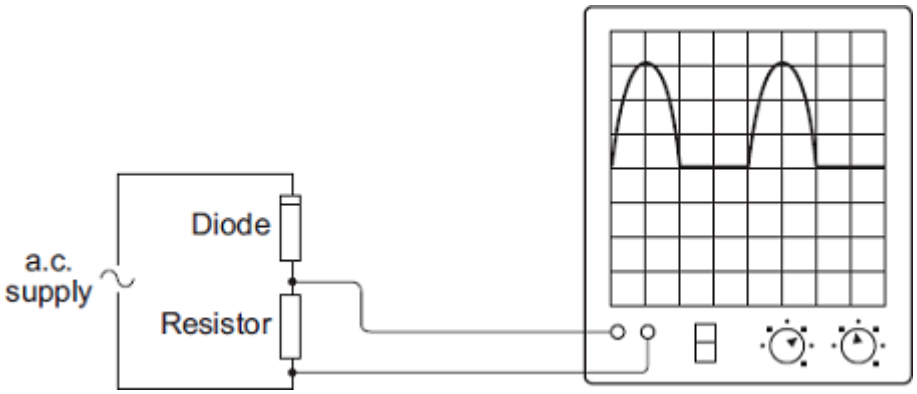
Each horizontal division on the oscilloscope screen represents a time of 0.01s.

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

Frequency = _____ hertz

(2)

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



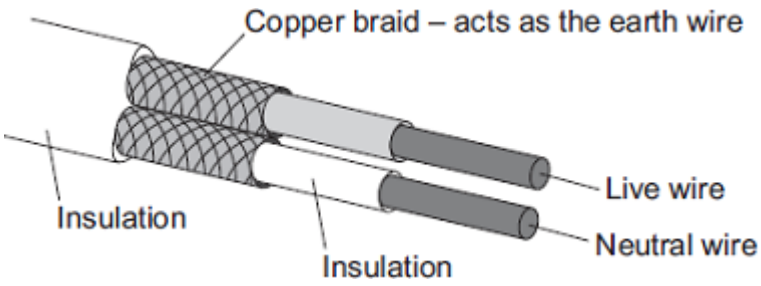
Why does the diode cause the trace on the oscilloscope screen to change?

(2)

(Total 12 marks)

Q34.

The diagram shows the structure of a cable. The cable is part of an undersoil heating circuit inside a large greenhouse.



(a) The cable is connected to the mains electricity supply through a residual current circuit breaker. If the cable is accidentally cut the circuit breaker automatically switches the circuit off.

(i) What is the frequency of the mains electricity supply in the UK?

_____

(1)

(ii) What happens, as the cable is cut, to cause the circuit breaker to switch the circuit off?

_____

_____

_____

_____

(2)

(iii) A circuit can also be switched off by the action of a fuse.

Give **one** advantage of using a circuit breaker to switch off a circuit rather than a fuse.

_____

_____

(1)

(b) The 230 volt mains electricity supply causes a current of 11 amps to flow through the cable.

(i) Calculate the amount of charge that flows through the cable when the cable is switched on for 2 hours and give the unit.

_____

_____

_____

Charge = _____

(3)

(ii) Calculate the energy transferred from the cable to the soil in 2 hours.

_____

_____

Energy transferred =_____ J

(2)

(c) The heating circuit includes a thermistor. The thermistor is buried in the soil and acts as a thermostat to control the increase in the temperature of the soil.

Describe how an **increase** in the temperature of the soil affects the thermistor.

_____

_____

_____

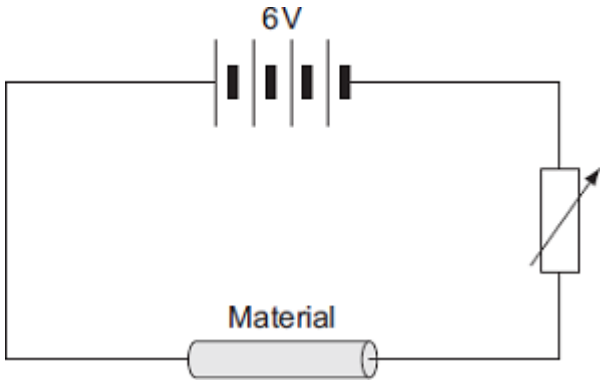
_____

(2)

(Total 11 marks)

Q35.

(a) The diagram shows the circuit used to investigate the resistance of a sample of a material.
The diagram is not complete; the ammeter and voltmeter are missing.



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

(2)

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

_____

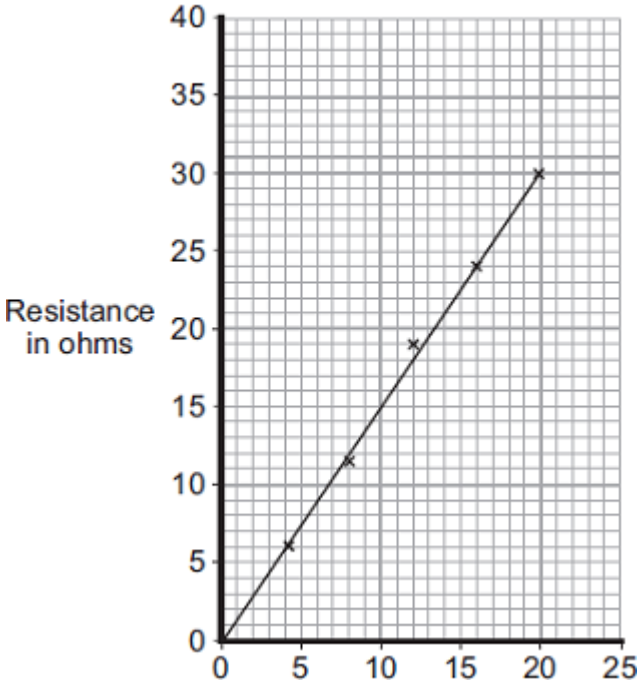
_____

(1)

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

Graph 1 shows how the resistance changes with length.

Graph 1



(i) The current through a 25 cm length of conducting putty was 0.15 A.

Use **Graph 1** to find the resistance of a 25 cm length of conducting putty.

Resistance = _____ ohms

(1)

(ii) Use your answer to **(b) (i)** to calculate the potential difference across a 25 cm length of conducting putty.

Show clearly how you work out your answer.

_____

_____

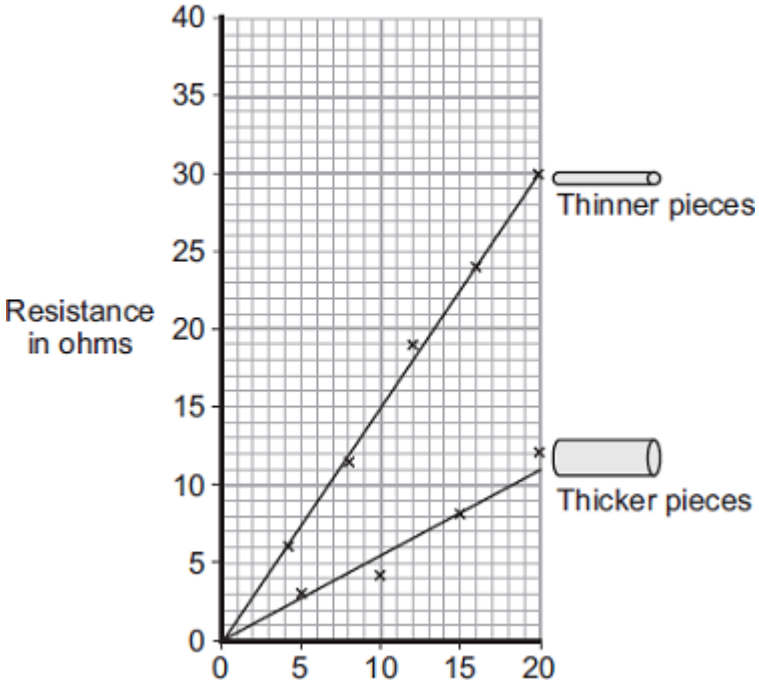
_____

Potential difference = _____ volts

(2)

(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)

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

_____

(1)

(Total 8 marks)

Mark schemes

Q1.

(a) 0.08 (s)

1

(b) the current goes higher than normal value

allow the current goes (too) high

or

the current goes higher than 1.5 A

1

(c) P = 1.5 × 24

1

P = 36 (W)

1

*an answer of 36 (W) scores **2** marks*

(d) LED lamps waste a smaller proportion of the input energy than filament lamps

1

[5]

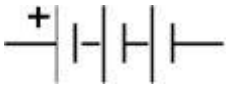
Q2.

(a) correct circuit symbol

1

3 cells joined in series in correct orientation

e.g.



ignore absence of + symbol

1

(b) $R = \frac{12}{1.6}$

1

R = 7.5 (Ω)

1

*an answer of 7.5 (Ω) scores **2** marks*

(c) 4.0 (Ω)

*allow their answer to part **(b)** − 3.5 correctly calculated*

1

(d) it decreases

1

the current would be higher (for the same p.d.)

reason only scores if correct box is chosen

or

more than one path for charge to flow

allow current for charge

or

total resistance is always less than the smallest individual resistance

1

[7]

Q3.

(a) 

1

(b) E = 13 × 230

1

E = 2990 (J)

1

*an answer 2990 (J) scores **2** marks*

(c) charge flow = current × time

allow Q = It

1

(d) 1.52 = I × 0.40

1

$$I = \frac{1.52}{0.40}$$

1

I = 3.8 (A)

1

*an answer of 3.8 (A) scores **3** marks*

(e) E = 0.00175 × 205 000

1

E = 359 (J)

*allow an answer that rounds to 360 (J) for **2** marks*

1

*an answer of 359 (J) scores **2** marks*

[9]

Q4.

(a) $P = \frac{120\,000}{8.0}$

1

P = 15 000 (W)

1

*an answer of 15 000 (W) scores **2** marks*

(b) energy is transferred in heating the surroundings

1

friction causes energy to be transferred in non-useful ways

1

(c) the switches are in parallel

1

(so) closing either switch completes the circuit

1

(d) gravitational potential energy = mass × gravitational field strength × height

allow $E_p = m\ g\ h$

1

(e) $E_p = 280 \times 9.8 \times 14$

1

$E_p = 38\,416$ (J)

1

$E_p = 38\,000$ (J)

*an answer that rounds to 38 000 scores **2** marks*

1

*an answer of 38 000 scores **3** marks*

[10]

Q5.

(a) transfer of <u>electrons</u>

mention of positive charge moving negates both marks

1

from the carpet to the student

1

(b) three arrows perpendicular to sphere's surface with all arrows directed inwards and distributed evenly around sphere

1

(c) there is a potential difference between the student and the tap

*do **not** accept the tap / sink is charged*

1

which causes electrons / charges to transfer from the student
or
which causes electrons / charges to transfer to the tap

1

which earths the charge

allow the tap is earthed

1

(d) carpet / copper has a low resistance

allow carpet is a conductor
or
copper is a conductor

1

lower / no build-up of charge (on the student)
or
(so there is a) smaller / no potential difference between student and tap / earth

1

[8]

Q6.

(a) ammeter and voltmeter symbols correct

1

voltmeter in parallel with wire

1

ammeter in series with wire

1

(b) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- length measured
- length varied
- current measured
- potential difference measured
- repeat readings
- calculate resistance for each length
- $\text{resistance} = \frac{\text{potential difference}}{\text{current}}$
- plot a graph of resistance against length

- hazard: high current
- may cause wire to melt / overheat
- may cause burns (to skin)
- use low currents

(c) the temperature of the wire would not change

1

(d) the accuracy of the student's results would be higher

1

the resolution of the length measurement would be higher

1

[12]

Q7.

(a) potential difference

allow p.d.
allow voltage

1

temperature

1

in this order only

(b) the current increases (when the potential difference increases)

1

(which) causes the temperature of the filament to increase

1

(so) the resistance increases

*do **not** accept resistance increases and then levels off*

1

(c) a higher proportion / percentage of the (total) power / energy input is usefully transferred

wastes less energy is insufficient

or

higher (useful) power / energy output for the same (total) power / energy input

1

(d) potential difference increases

1

current decreases

1

(e) 1000 (Ω)

reason only scores if R = 1000 (Ω)

1

potential difference is shared in proportion to the resistance

allow a justification using a correct calculation

1

(f) $12 = I \times 7000$

1

$$I = \frac{12}{7000}$$

1

$I = 1.71 \times 10^{-3}$ (A)

*an answer that rounds to 1.7×10^{-3} (A) scores **3** marks*

1

$I = 1.7 \times 10^{-3}$ (A)

this answer only

or

I = 0.0017 (A)

*an answer of 2.4×10^{-3} (A) scores **2** marks*

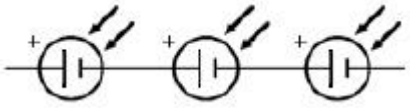
*if no other marks scored allow **1** mark for calculation of total resistance (7000 Ω)*

1

*an answer of 1.7×10^{-3} (A) scores **4** marks*

[14]

Q8.

(a) 

1

(b) $\text{current} = \frac{0.70}{2.5}$

1

current = 0.28 (A)

*an answer of 0.28 (A) scores **2** marks*

1

(c) 0.60 (V)

1

product of potential difference and current gives highest value

1

(d) $\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$

1

(e) $0.20 = \frac{\text{useful power output}}{2.4}$

1

useful power output = 0.20 × 2.4

1

useful power output = 0.48 (W)

*an answer of 0.48 (W) scores **3** marks*

1

[9]

Q9.

(a) changes

allow reverses

1

(b) dependent

1

(c) kettle **C**
or
2.8 kW

1

highest power (output)

allow higher power (output)

1

(d) values for gradient calculation shown on graph or on answer lines

1

power input = 2200 (W)

*accept an answer that rounds to 2200 (W) for **2** marks*

1

(e) charge flow = current × time

allow Q = It

1

(f) 2400 = I × 250

1

$$I = \frac{2400}{250}$$

1

I = 9.6 (A)

an answer of 9.6 (A) scores 3 marks

1

[10]

Q10.

(a) current

1

(b) $4.2 = 3.5 \times 10^{-3} \times R$

1

$R = 4.2 / 3.5 \times 10^{-3}$

1

R = 1200 (Ω)

*an answer of 1200 (Ω) scores **3** marks*

*an answer of 1.2 scores **2** marks*

1

(c) conversion from minutes to seconds (300 s)

1

Q = 0.0035 × (5 × 60)

1

Q = 1.05 C

*an answer of 1.05 (C) scores **3** marks*
*an answer of 17.5 scores **1** mark*
*an answer of 1050 or 0.0175 scores **2** marks*

1

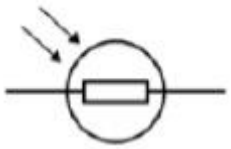
(d) (potential difference) increases

1

(because thermistor) resistance increases

2nd mark dependent on scoring 1st mark

1

(e) 

1

[10]

Q11.

(a) current that is always in the same direction

1

(b) total resistance = 30 (Ω)

1

V = 0.4 × 30

1

12 (V)

1

*allow 12 (V) with no working shown for **3** marks*
*an answer of 8 (V) or 4 (V) gains **2** marks only*

(c) P = 0.4 × 12 = 4.8

1

5 (W)

1

*allow 5 (W) with no working shown for **2** marks*
*allow 4.8 (W) with no working shown for **1** mark*

[6]

Q12.

(a) battery, lamp and ammeter connected in series with variable resistor

1

voltmeter in parallel with (filament) lamp

1

(b) **Level 2 (3–4 marks):**
A detailed and coherent description of a plan covering all the major steps is provided.
The steps are set out in a logical manner that could be followed by another person to
obtain valid results.

Level 1 (1–2 marks):
Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to obtain valid results.

0 marks:
No relevant content

Indicative content

- ammeter used to measure current
- voltmeter used to measure potential difference
- resistance of variable resistor altered to change current in circuit **or** change potential difference (across filament lamp)
- resistance (of filament lamp) calculated **or** R=V / I statement
- resistance calculated for a large enough range of different currents that would allow a valid conclusion about the relationship to be made

4

(c) (as current increases) resistance increases (at an increasing rate)

1

(d) any value between 6.3 and 6.9 (Ω)

1

(e) **A**: Filament lamp

1

B: Resistor at constant temperature

1

C: Diode

1

[11]

Q13.

(a) V = 0.10 × 45

1

4.5 (V)

1

(b) R = 12 / 0.10

1

total resistance = 120 (Ω)

1

R = 120 – 105 = 15 (Ω)

1

(c) (total) resistance decreases

1

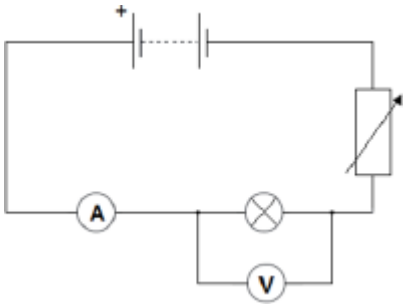
(so) current increases

1

[7]

Q14.

(a)



battery in series with bulb and ammeter

1

voltmeter in parallel with bulb

1

variable resistor
or
variable power pack
or
potentiometer

1

(b) A is brighter because it has a higher current (than lamp B at any p.d.)

1

(therefore A has a) higher power output (than bulb B)
accept higher energy output per second

1

(c) lower current (than lamp A) for the same potential difference
accept answer in terms of R = V / I

1

lower gradient (than lamp A)

1

(d) 0 – 2 Volts

allow a range from 0 V up to any value between 1 and 2 V.

1

(for an ohmic conductor) current is directly proportional to potential difference

allow lines (of best fit) are straight and pass through the origin

1

(so) resistance is constant

1

[10]

Q15.

(a) (because the) potential of the live wire is 230 V

1

(and the) potential of the electrician is 0 V

1

(so there is a) large potential difference between live wire and electrician

1

charge / current passes through his body

allow voltage for potential difference

1

(b) diameter between 3.50 and 3.55 (mm)

*allow correct use of value of cross-sectional area of 9.5 to 9.9 (mm^2) with no final answer given for **1** mark*

2

(c) $18000 = I \times 300$

1

$I = 18000 / 300 = 60$

1

$13\ 800 = (60^2) \times R$

1

$R = 13\ 800 / 60^2$

1

3.83 (Ω)

1

*allow 3.83(Ω) with no working shown for **5** marks*

answer may also be correctly calculated using P = IV and V = IR if 230 V is used.

[11]

Q16.

(a) last box ticked

1

(b) (i) use hotter water (than 60 °C)

accept use boiling water

accept use water at any stated temperature above 60 °C

or

add ice cubes

accept add water at any stated temperature below 12 °C

use different temperatures is insufficient

1

(ii) the current increases as the temperature increases

1

(iii) 0.02 (A)

1

(iv) 5 (V)

or

their **(b)(iii)** × 250 correctly calculated

*allow **1** mark for correct substitution ie V = 0.02 × 250*

or

*V = their **(b)(iii)** × 250*

2

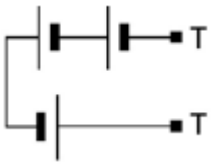
(v) the resistance increases

1

[7]

Q17.

(a) 3rd box from the left ticked



1

(b) correct symbol drawn in series with other components

symbol must have upper case A

1

(c) (i) 9 + 3 = 12V

reason only scores if this mark scored

1

pd of battery is shared between the variable resistor and fixed resistor

accept $V_1 + V_2$ = pd of the battery

accept p.d. is shared in a series circuit

accept voltage for p.d.

1

(ii) 600

reason only scores if this mark scored

1

p.d. of supply shared equally when resistors have the same value

or

ratio of the p.d. is the same as the ratio of the resistance

1

(iii) 0.015

or

their (c)(i) ÷ (their (c)(ii) + 200) correctly calculated

*allow **2** marks for correct substitution ie 12 = I × 800*

or

their (c)(i) = I × (their (c)(ii) + 200)

*allow **1** mark for total resistance = 800 (Ω) or their (c)(ii) + 200*

or

*allow **1** mark for a substitution of 12 = I × 200*

or

their (c)(i) = I × 200

or

alternative method using the graph

V = 3 V (1)

3 = I × 200 (1)

3

[9]

Q18.

(a) pin
made from brass because it is (hard and) a (good electrical) conductor
accept copper for brass
metal is insufficient
heat conductor on its own negates
1

outer case
plastic/rubber because it is a (good electrical) insulator
heat insulator on its own negates
1

(b) (i) live
1

(ii) makes it hot/warm
melts is insufficient
1

(iii) 8.7
accept an answer that rounds to 8.7
*allow **1** mark for correct substitution ie 2000 = 230 × I*
*an answer of 0.0087 **or** 0.009 **or** 3.0(4) **or** 5.65 **or** 5.7 gains **1** mark*
2

(c) a (large) current goes from the live wire to the earth wire
accept metal case for live wire
accept a current goes from live to earth
do not accept electricity for current
1

(which causes) the fuse to (overheat and) melt
accept blow for melt
break is insufficient
do not accept snap / blow up for melt
1

(d) reduce chance of an electric shock
accept to reduce the risk of an accident
accept prevent electric shock
accept prevent electrocution
accept prevent or reduce the risk of an (electrical) fire

accept an electric shock can kill you
accept it can kill you
accept so you can use it safely

1

[9]

Q19.

(a) filament bulb

1

(b) (i) 6 V

1

(ii) 3 Ω or their $\frac{\text{(i)}}{2}$ correctly calculated

allow 1 mark for correct substitution ie
6 = 2 × R
or their (i) = 2 × R

2

(iii) 1 A

1

(iv) 6 Ω or their (i) / their (iii) correctly calculated

1

(v)

Decrease	Stay the same	Increase
	✓	
✓		
✓		

1
1
1

[9]

Q20.

(a) increases

accept reaches highest value
*do **not** accept increases and decreases*

1

(b) (i) increases

1

(ii) increases

1

(c) 18

*allow **1** mark for correct substitution i.e. 12 × 1.5 provided no subsequent step*

2

watt

accept W
answer may be indicated in the list

1

[6]

Q21.

(a) (i) p.d. is (directly) proportional to current
or
gradient / slope is constant
or
the lines show constant resistance

accept lines are straight / diagonal

1

(ii) C

reason only scores if C is chosen

1

for the same p.d. the current is the smallest

*accept lowest gradient **and** the gradient = 1 / R*

1

(b) (i) ohm

accept correct symbol Ω
accept an answer written in the table if not given in answer space

1

(ii) K and L

reason only scores if both K and L are chosen

1

only length varies

accept type of metal and the diameter are the same

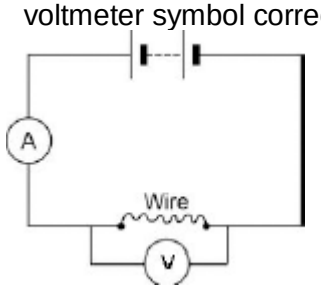
1

(iii) measure the resistance of more wires made from different metals

accept test more (types of) metals
measure the resistance of more wires is insufficient
they only use two metals is insufficient

1

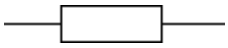
(c) (i) voltmeter symbol correct and drawn in parallel with the wire



accept voltmeter symbol correct and drawn in parallel with the battery

1

(ii) correct symbol drawn



symbol must be rectangular

1

[9]

Q22.

(a) (i) 1.7

1

(ii) 51
or
30 × their (i) correctly calculated

*allow **1** mark for correct substitution i.e.* $1.7 = \frac{Q}{30}$

or their (i) $= \frac{Q}{30}$

2

coulomb / C

*do **not** accept c*

1

(iii) 612
or
their (ii) × 12 correctly calculated
or
their (i) × 360 correctly calculated

*allow **1** mark for correct substitution i.e. E = 12 × 51*
or 12 × their (ii)
or their (i) × 360

2

(b) ions vibrate faster
or
ions vibrate with a bigger amplitude

accept atoms for ions throughout
accept ions gain energy
accept ions vibrate more
ions start to vibrate is insufficient

1

electrons collide more (frequently) with the ions
or
(drift) velocity of electrons decreases

electrons start to collide is insufficient
there are more collisions is insufficient, unless both electrons and ions are implied

1

[8]

Q23.

(a) (i) any **six** from:

- switch on
- read both ammeter and voltmeter

  allow read the meters
- adjust variable resistor to change the current
- take further readings
- draw graph
- (of) V against I

  allow take mean
- R = V / I

  allow take the gradient of the graph

6

(ii) resistor would get hot if current left on

1

so its resistance would increase

1

(iii) 12 (V)

*0.75 × 16 gains **1** mark*

2

(iv) 15 (Ω)

1

16 is nearer to that value than any other

1

(b) if current is above 5 A / value of fuse

1

fuse melts

allow blows / breaks

*do **not** accept exploded*

1

breaks circuit

1

[15]

Q24.

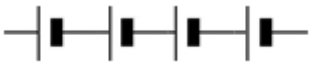
(a) *attempt to draw four cells in series*

1

correct circuit symbols

circuit symbol should show a long line and a short line, correctly joined together

example of correct circuit symbol:



1

(b) (i) 6 (V)

*allow **1** mark for correct substitution, ie*

*V = 3 × 2 scores **1** mark*

provided no subsequent step

2

(ii) 12 (V)

ecf from part (b)(i)

18 – 6

or

*18 – their part (b)(i) scores **1** mark*

2

(iii) 9 (Ω)

ecf from part (b)(ii) correctly calculated

3 + their part (b)(ii) / 2

or

*18 / 2 scores **1** mark*
provided no subsequent step

2

(c) (i) need a.c.

1

battery is d.c.

1

(ii) 3 (A)

*allow **1** mark for correct substitution, ie*
*18 × 2 = 12 × I_s scores **1** mark*

2

[12]

Q25.

(a) (i) live

1

(ii) react faster

1

(iii) live and neutral

1

(b) (i) ammeter

1

to measure current

accept to measure amps

1

plus any **one** from:

- *variable resistor* (1)
  to vary current (1)
  accept variable power supply
  accept change or control

- *switch* (1)
  to stop apparatus getting hot / protect battery
  or
  to reset equipment (1)

- fuse (1)
  to break circuit if current is too big (1)

2

(ii) any **two** from:

- use smaller mass(es)
- move mass closer to pivot
- reduce gap between coil and rocker
- more turns (on coil)*coil / loop*
- iron core in coil

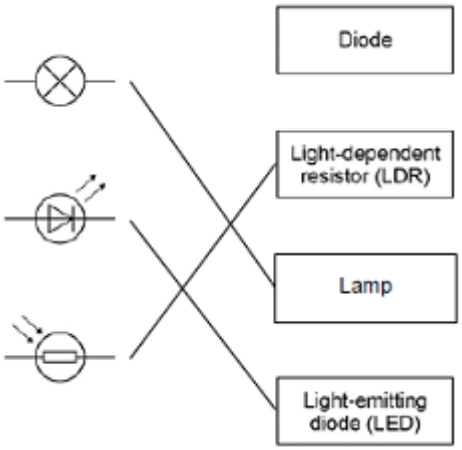
accept use smaller weight(s)

2

[9]

Q26.

(a)



*allow **1** mark for each correct line if more than one line is drawn from any symbol then all of those lines are wrong*

3

(b) (i) half

1

(ii) 3(V)

1

(iii) V_1

1

(c) (i) potential difference / voltage of the power supply

accept the power supply
accept the voltage / volts
accept number of cells / batteries
accept (same) cells / batteries
do not accept same ammeter / switch / wires

1

(ii) bar drawn – height 1.(00)A

ignore width of bar

*allow **1** mark for bar shorter than 3rd bar*

2

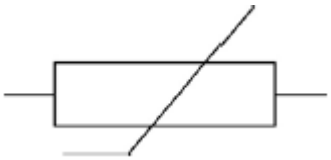
(iii) as the number of resistors increases the current decreases

1

[10]

Q27.

(a) (i)



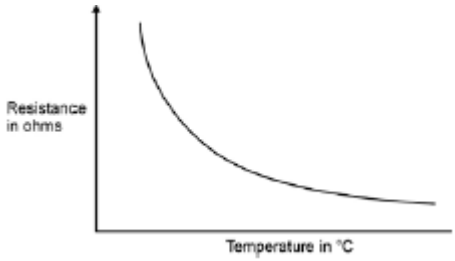
1

(ii) 360

*allow **1** mark for correct substitution, ie 9 = 0.025 × R*

2

(iii) sketch graph of correct shape, ie



1

(iv) An automatic circuit to switch a heating system on and off.

1

(b) so ammeter reduces / affects current as little as possible

accept so does not reduce / change the current (it is measuring)

accurate reading is insufficient

not change the resistance is insufficient

1

(c) gives a common understanding

accept is easier to share results

accept can compare results

do not need to be converted is insufficient

prevent errors is insufficient

1

(d) replace Bunsen (and water) with a lamp

accept any way of changing light level

1

replace thermometer with light sensor

accept any way of measuring a change in light level

datalogger alone is insufficient

1

[9]

Q28.

(a) decreases

1

(b) a filament bulb

allow bulb

1

an LED

1

(c) Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response.

0 marks
No relevant content.

Level 1 (1−2 marks)
There is a basic description of the method. This is incomplete and would not lead to any useful results.

Level 2 (3−4 marks)
There is a description of the method which is almost complete with a few minor omissions and would lead to some results.

Level 3 (5−6 marks)
There is a detailed description of the method which would lead to valid results. To gain full marks an answer including graph, or another appropriate representation of results, must be given.

examples of the physics points made in the response:

- read V and I
- read temperature
- apply heat

  allow hot water to cool
- read V and I at least one other temperature

- determine R from V / I
- range of temperatures above 50 °C

extra detail:
- use thermometer to read temperature at regular intervals of temperature
- remove source of heat and stir before taking readings
- details of attaining 0 °C or 100 °C
- last reading taken while boiling
- graph of R against T
- at least 3 different temperatures

6

(d) (i) Q

1

(ii) (80, 3.18)

1

(iii) any **one** from:

- measurement of V too small
- measurement of I too big
- incorrect calculation of R
- thermometer misread

allow misread meter

ignore any references to an error that is systematic

1

(iv) any **two** from:

- not portable

allow requires a lot of equipment allow takes time to set up
- needs an electrical supply
- cannot be read directly

accept it is more difficult to read compared to liquid-in-glass

2

[14]

Q29.

(a) (i) to obtain a range of p.d. values

accept increase / decrease current / p.d. / voltage / resistance

accept to change / control the current / p.d. / voltage / resistance

to provide resistance is insufficient

a variable resistor is insufficient

*do **not** accept electricity for current*

1

(ii) temperature of the bulb increases

accept bulb gets hot(ter)

accept answers correctly

expressed in terms of collisions between (free) electrons and ions / atoms

bulb gets brighter is insufficient

1

(iii) 36

*allow **1** mark for correct substitution, ie 12 × 3 provided no subsequent step shown*

2

watt(s) / W

accept joules per second / J/s

*do **not** accept w*

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a basic comparison of either a cost aspect or an energy efficiency aspect.

Level 2 (3-4 marks)
There is a clear comparison of either the cost aspect or energy efficiency aspect
OR
a basic comparison of both cost and energy efficiency aspects.

Level 3 (5-6 marks)
There is a detailed comparison of both the cost aspect and the energy efficiency aspect.

For full marks the comparisons made should support a conclusion as to which type of bulb is preferable.

Examples of the points made in the response:

cost

- halogen are cheaper to buy

simply giving cost figures is insufficient

- 6 halogen lamps cost the same as one LED
- LEDs last longer
- need to buy 18 / more halogen lamps to last the same time as one LED
- 18 halogens cost £35.10
- costs more to run a halogen than LED
- LED has lower maintenance cost (where many used, eg large departmental store lighting)

energy efficiency

- LED works using a smaller current
- LED wastes less energy
- LEDs are more efficient
- LED is 22% more energy efficient
- LED produces less heat
- LED requires smaller input (power) for same output (power)

6

[11]

Q30.

(a) 35

*an answer with more than 2 sig figs that rounds to 35 gains **2** marks*

*allow **2** marks for correct method, ie* $\frac{230}{6.5}$

*allow **1** mark for I = 6.5 (A) **or** R =* $\frac{230}{26}$

*an answer 8.8 gains **2** marks*

*an answer with more than 2 sig figs that rounds to 8.8 gains **1** mark*

3

(b) (maximum) current exceeds maximum safe current for a 2.5 mm^2 wire

accept power exceeds maximum safe power for a 2.5 mm^2 wire

or

(maximum) current exceeds 20 (A)

(maximum) current = 26 (A) is insufficient

1

a 2.5 mm^2 wire would overheat / melt

accept socket for wire

*do **not** accept plug for wire*

1

(c) a.c. is constantly changing direction

accept a.c. flows in two directions

accept a.c. changes direction

a.c. travels in different directions is insufficient

1

d.c. flows in one direction only

1

[7]

Q31.

(a) 25(Ω)

1

(b) (i) 2(V)

*allow **1** mark for showing a correct method, ie 6 / 3*

2

(ii) equal to

1

[4]

Q32.

(a) (i) 50 (Hz)

1

(ii) 2760 (W)

1

(b) 12

*allow **1** mark for correct substitution, ie 2400/200*

or

*allow **1** mark for 2760/230 provided no subsequent step shown*

2

amps

1

(c) the charge is directly proportional to the time switched on for

*accept for **1** mark the longer time (to boil), the greater amount of charge*

***or** positive correlation*

***or** they are proportional*

2

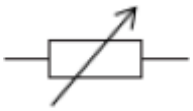
[7]

Q33.

(a) (i) symbol for a diode 

accept 

1

symbol for a variable resistor 

1

(ii) voltmeter is in series **or** voltmeter is not in parallel

1

ammeter is in parallel **or** ammeter is not in series

accept an answer in terms of how the circuit should be corrected

voltmeter and ammeter are wrong way around is insufficient

1

(b) (i) 0.2 (V)

accept any value between 0.20 and 0.21 inclusive

1

(ii) 37.5

*allow **1** mark for I = 0.008*

or

*allow **2** marks for correct substitution, ie 0.3 = 0.008 × R*

or

*allow **1** mark for a correct substitution using I = 0.8 **or** I = 0.08*

***or** I = 0.009*

or

*allow **2** marks for answers of 0.375 **or** 3.75 **or** 33(.3)*

3

(c) (i) 25

*allow **1** mark for obtaining period = 0.04(s)*

2

(ii) diode has large resistance in reverse / one direction

1

so stops current flow in that / one direction

allow diodes only let current flow one way / direction

*allow **1** mark for the diode has half-rectified the (a.c. power) supply*

1

[12]

Q34.

(a) (i) 50(Hz)

ignore any unit given

1

(ii) any **two** from:

- (some) current flows to Earth
  accept ground for Earth
- current flows through copper braid
  accept current flows through the earth wire
  accept electricity for current in either the first or second marking point but not both
- RCCB detects difference between current in live and neutral wire

2

(iii) can be reset

accept does not need replacing

or

faster acting

accept switches circuit off faster

1

(b) (i) 79 200

*allow **1** mark for correct substitution, ie* $11 = \frac{Q}{2 \times 3600}$

*an answer 22 gains **1** mark*

2

coulombs / C

*do **not** accept c*

1

(ii) 18 216 000

*accept for **2** marks 18 216 kJ **or** 18.216 MJ*

or

230 × their (b)(i) correctly calculated

*allow **1** mark for correct substitution, ie 230 × their (b)(i) **or** allow **1** mark for power calculated as 2530(W)*

2

(c) increases temperature of thermistor

1

changes resistance (of thermistor)

*do **not** accept increases resistance (of thermistor)*

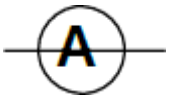
*an answer decreases resistance (of thermistor) gains **2** marks*

1

[11]

Q35.

(a) (i) ammeter symbol correct and drawn in series

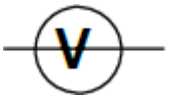


accept

*do **not** accept lower case a*

1

voltmeter symbol correct and drawn in parallel with the material



*do **not** accept*

1

(ii) adjust / use the variable resistor

accept change the resistance

or

change the number of cells

accept battery for cell

accept change the pd / accept change the voltage

accept increase / decrease for change

1

(b) (i) 37.5 (Ω)

accept answer between 36 and 39 inclusive

1

(ii) 5.6(25) **or** their (b)(i) × 0.15

*allow **1** mark for correct substitution ie 37.5 **or** their (b)(i) × 0.15 provided no subsequent step shown*

2

(c) (i) the thicker the putty the lower the resistance

answer must be comparative
accept the converse

1

(ii) any **one** from:

- measuring length incorrectly
  accept may be different length
- measuring current incorrectly
  *do **not** accept different currents*
- measuring voltage incorrectly
  *do **not** accept different voltage*
- ammeter / voltmeter incorrectly calibrated
- thickness of putty not uniform
  *do **not** accept pieces of putty not the same unless qualified*
- meter has a zero error
  *do **not** accept systematic / random error*
  accept any sensible source of error eg putty at different temperatures
  *do **not** accept human error without an explanation*
  *do **not** accept amount of putty not same*

1

[8]