Questions

Q1.

Mains electricity is used in circuits at home.

(a) Double insulation is needed for safety when there is

(1)

- ☒ **A** no circuit breaker
- ☒ **B** no earth connection
- ☒ **C** no fuse
- ☒ **D** no switch

(b) A fuse is used so that

(1)

- ☒ **A** an earth connection is not needed
- ☒ **B** the appliances are more efficient
- ☒ **C** the circuit cannot overheat if there is a fault
- ☒ **D** the user cannot touch a live wire

(c) Most lamps at home have their own switch.

This is because the lamps are connected

(1)

- ☒ **A** in parallel
- ☒ **B** in series
- ☒ **C** to a fuse
- ☒ **D** to an earth wire

(Total for question = 3 marks)

Q2.

A washing machine has an electric motor and an electric heater.

The resistance of the heater is 22 Ω.

The mains voltage is 230 V.

(a) (i) State the equation linking voltage, current and resistance.

(1)

(ii) Show that the current in the heater is about 10 A when it is working.

(2)

(b) The washing machine is fitted with a fuse rated at 13 A.

(i) Explain why the washing machine is fitted with a fuse.

(2)

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(ii) When the motor is working, the current in it is 1.74 A.

Explain why it would **not** be sensible to replace the 13 A fuse with a 2 A fuse.

(2)

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(Total for question = 7 marks)

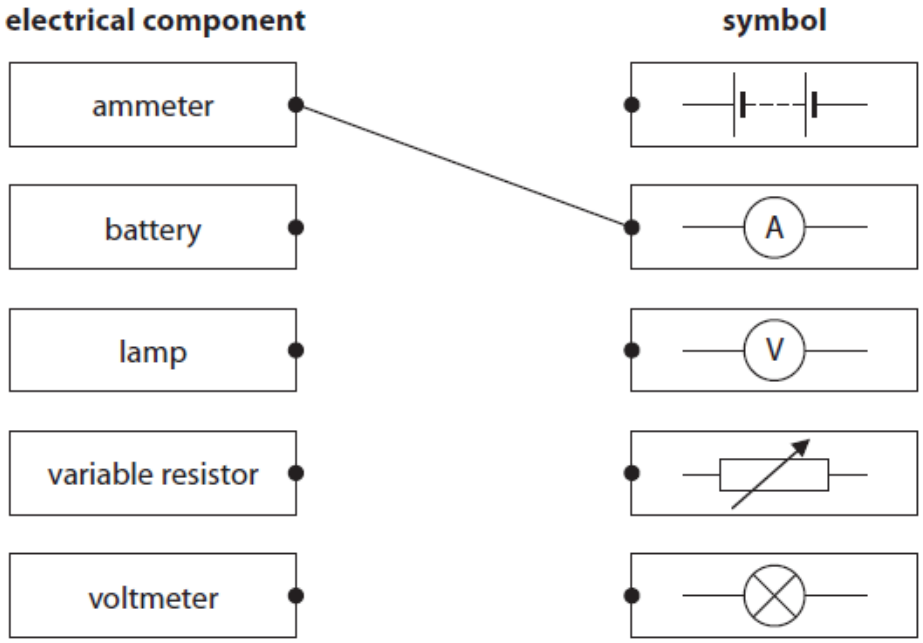
Q3.

This question is about electrical components.

(a) Draw a straight line from each electrical component to its correct symbol.

One has been done for you.

(3)



(b) (i) Name an electrical component whose resistance decreases when it is moved into brighter light.

(1)

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(ii) Name an electrical component whose resistance decreases as its temperature increases.

(1)

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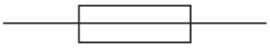
(Total for question = 5 marks)

Q4.

(a) The table shows the names and circuit symbols of some electrical components.

Complete the table by giving the missing information.

(4)

Component	Circuit symbol
fixed resistor	
variable resistor	
	
lamp	
	

(b) A student wants to find the resistance of a fixed resistor.

She measures a current of 0.50 A in the resistor when the voltage across it is 8.0 V.

(i) State the equation linking voltage, current and resistance.

(1)

(ii) Calculate the resistance of the resistor.

(2)

resistance = ... Ω

(c) The student replaces the fixed resistor with a light dependent resistor (LDR) and measures its resistance at different light intensities.

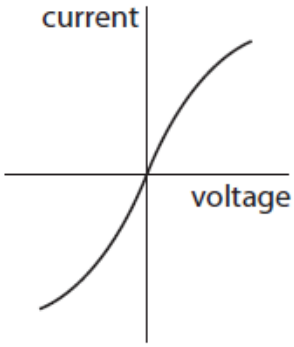
Sketch a graph of the expected results.

(3)

(Total for question = 10 marks)

Q5.

The graph shows how current and voltage vary for a filament lamp.



(a) Draw a circuit diagram to show how you should connect the equipment needed to make the measurements needed to plot the graph.

(4)

(b) The resistance of the filament lamp changes as the voltage is increased.

(i) How can you tell this from the graph?

(1)

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(ii) Explain these changes in resistance.

(3)

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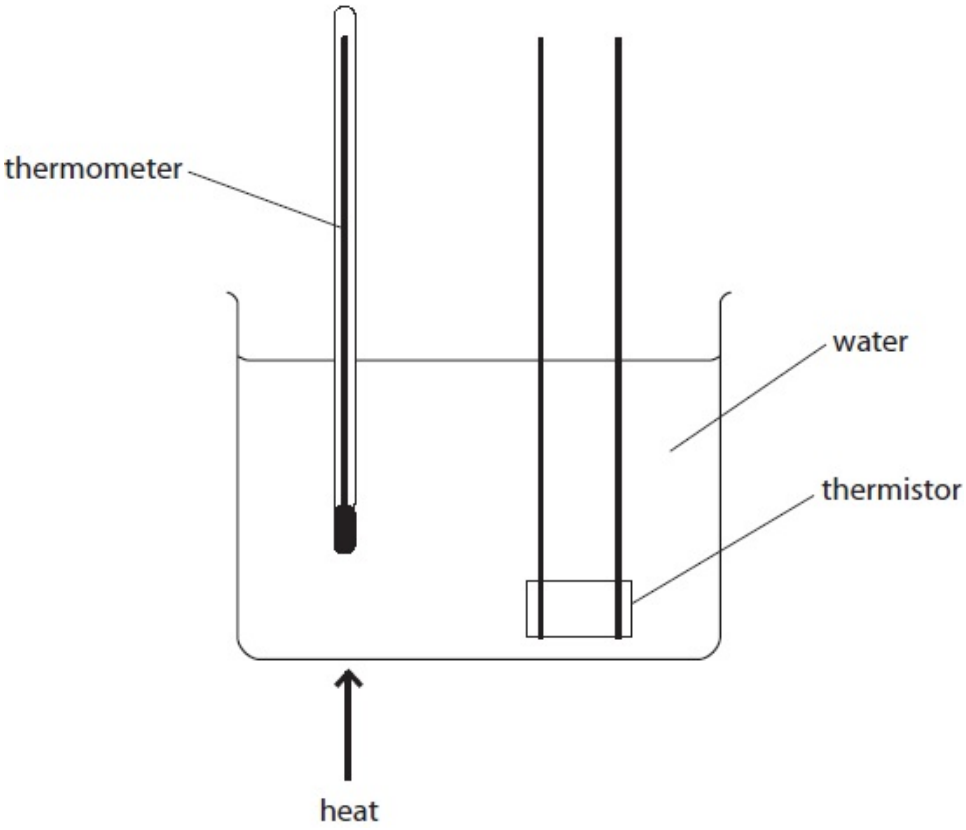
(Total for question = 8 marks)

Q6.

A student investigates how the voltage across a thermistor varies with temperature.

The student keeps the current in the thermistor constant, but varies the temperatures between 20 °C and 100 °C.

(a) The diagram shows how the student sets up his apparatus.



Suggest three changes to this set up that would improve the accuracy of the measurement of the thermistor temperature.

(3)

1 .....

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2 .....

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3 .....

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(b) What instrument should the student use to measure the current in the thermistor?

(1)

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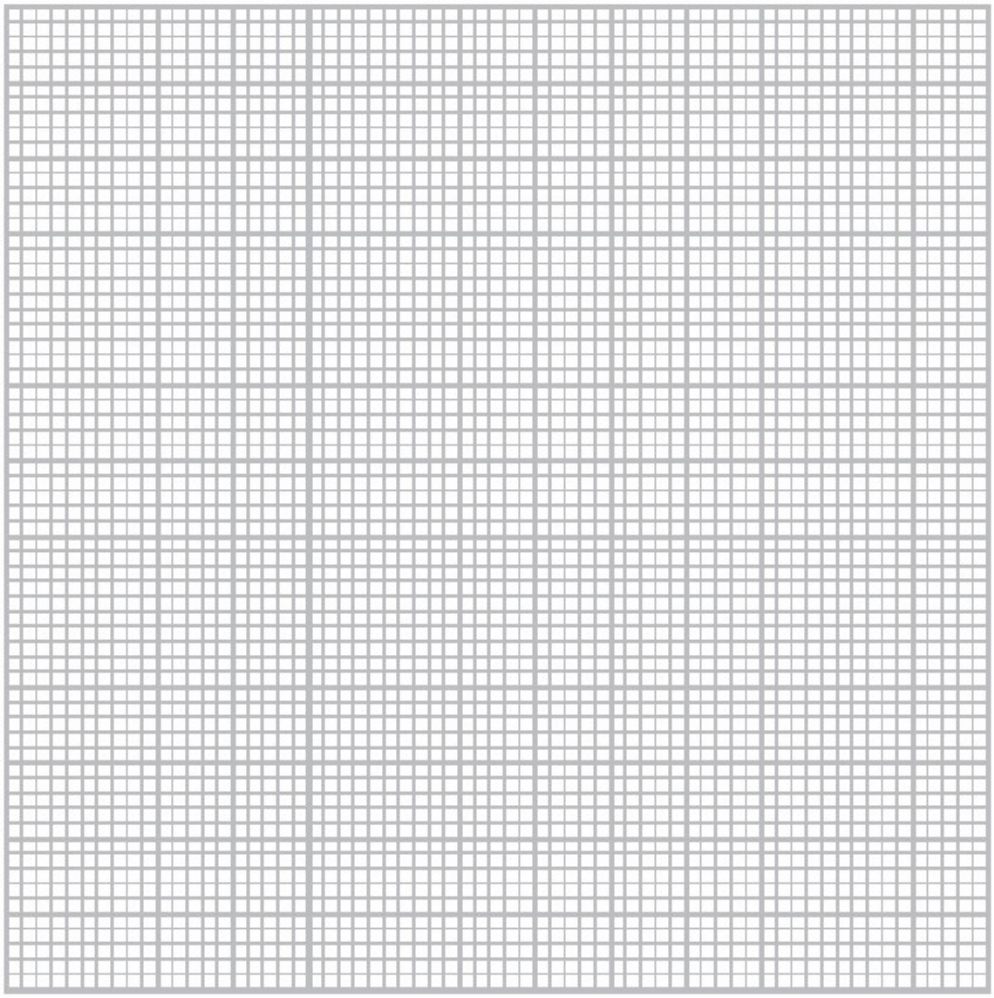
(c) The table shows the student's results.

Temperature in °C	Voltage in V
20	6.0
40	2.2
60	1.1
80	0.2
100	0.4

(i) Plot a graph of voltage against temperature and draw the line of best fit.

(5)



(ii) Circle the anomalous point on your graph.

(1)

(d) (i) State the equation linking voltage, current and resistance.

(1)

(ii) At room temperature the thermistor has a resistance of 680 Ω.

The voltage across it is 5.9 V.

Show that the current in the thermistor is about 8.5 mA.

(3)

(Total for Question = 14 marks)

Q7.

An electric kettle is connected to the 230 V mains supply.

The power of the kettle is 960 W.

(a) (i) A power of 960 watts is the same as

(1)

☒ **A** 960 joules per coulomb

☒ **B** 960 joules per second

☒ **C** 960 newtons per metre

☒ **D** 960 newtons per second

(ii) State the equation linking power, current and voltage.

(1)

(iii) Show that the current in the kettle is about 4 A.

(2)

(b) The 960 W kettle is earthed and fitted with a fuse.

(i) Explain how this can protect the person using the kettle if there is a fault.

(3)

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(ii) Another kettle has twice as much power.

It is connected to the same mains supply.

Which of these fuse ratings should be used for this kettle?

(1)

☒ **A** 1 A

☒ **B** 3 A

☒ **C** 5 A

☒ **D** 13 A

(c) A student has a pack of fuses labelled 2 A.

Explain how she could use one of these fuses to check that the label is correct.

You may draw a circuit diagram to help your answer.

(3)

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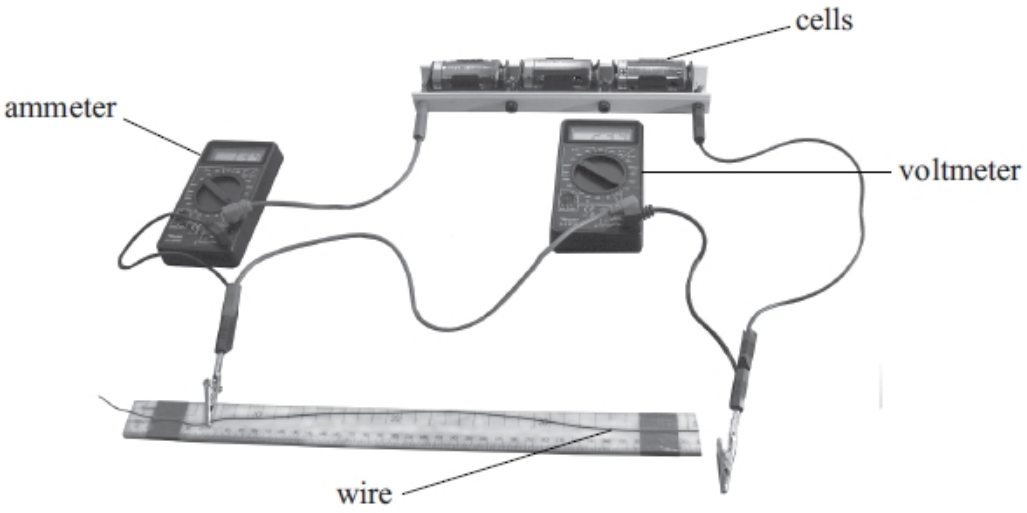
(Total for question = 11 marks)

Q8.

A student investigates how the resistance of a wire depends on its length.

The photograph shows the circuit that the student uses.



(a) Draw a circuit diagram to show how the components in the photograph are connected.

(3)

(b) (i) Complete the table by naming the key variables in this investigation.

(1)

independent variable	
dependent variable	

(ii) Describe the method the student should use for this investigation.

(5)

(c) The table shows the student's measurements.

Length of wire in cm	Voltage in V	Current in A	Resistance of wire in Ω
20	4.5	3.6	1.3
40	4.5	1.8	2.5
60	4.5	1.2	3.8
80	4.5	0.9	5.0
100	4.5	0.7	

(i) State the equation linking voltage, current and resistance.

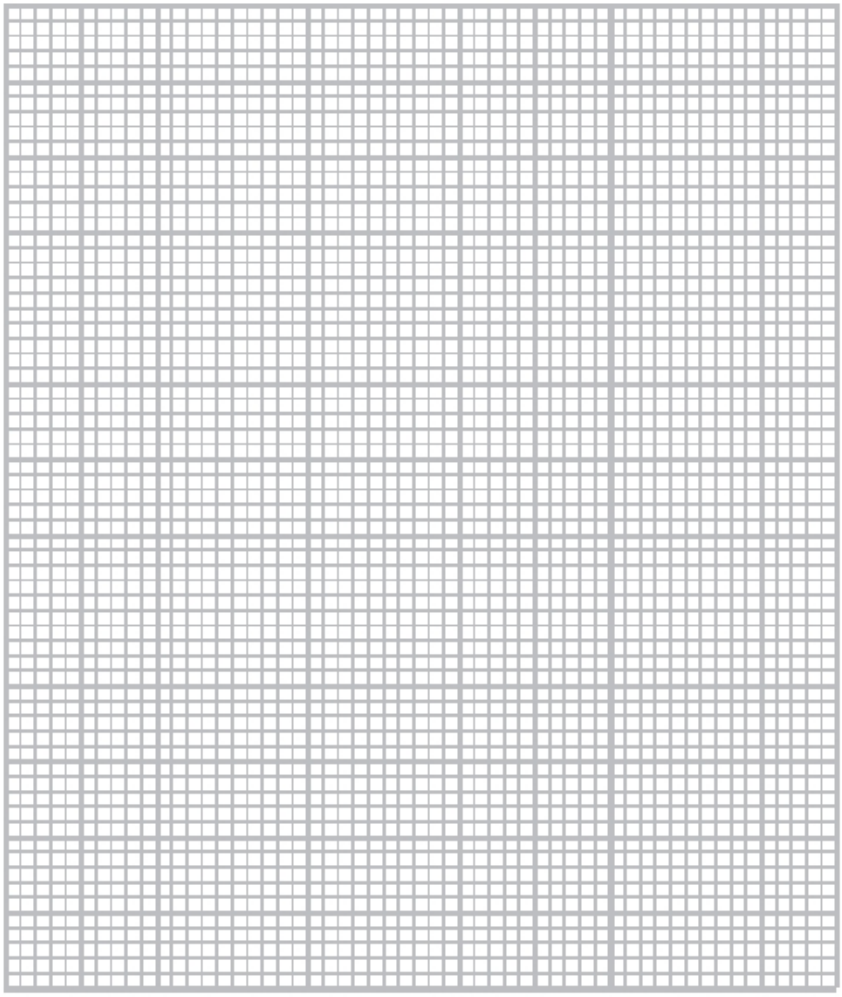
(1)

(ii) Complete the table by calculating the missing value of resistance.

(1)

(d) (i) Use the results from the table opposite to plot a graph of resistance (*y*-axis) against length of wire (*x*-axis) and draw the line of best fit.

(5)



(ii) Write a conclusion for the investigation.

(1)

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(iii) Explain how the graph supports this conclusion.

(2)

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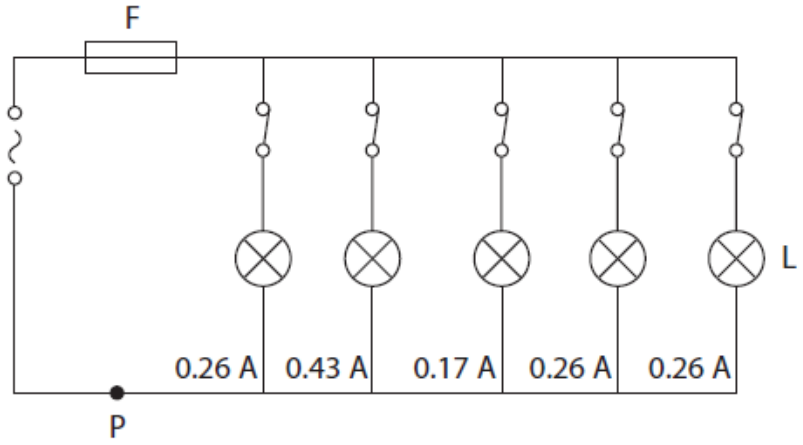
(Total for question = 19 marks)

Q9.

The diagram shows part of a lighting circuit in a house.

The circuit is protected by fuse F.



(a) Give two reasons why the lamps are wired in parallel.

(2)

1 .....

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2 .....

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(b) What is the current at P?

(1)

☒ **A** 0.17 A

☒ **B** 0.26 A

☒ **C** 0.43 A

☒ **D** 1.38 A

(c) Explain how the fuse protects the circuit.

(3)

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(d) (i) State the equation linking power, current and voltage.

(1)

(ii) Calculate the power of lamp L.

[assume the mains voltage is 230 V]

(2)

power = ... W

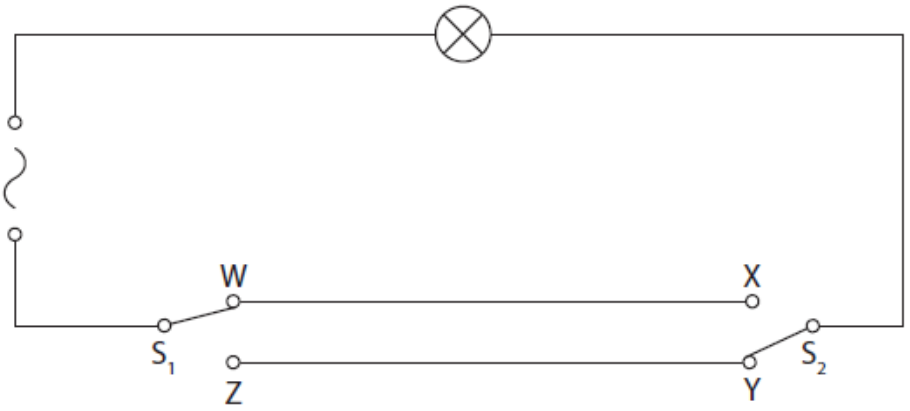
(iii) Calculate the amount of energy transferred by lamp L in 3 minutes.

Give the unit.

(3)

energy transferred = ... unit .....

(e) This diagram shows another lighting circuit.



(i) Complete the table by putting a tick (✓) in the box if the lamp is lit and a cross (✗) in the box if the lamp is not lit.

(2)

S_1 position	S_2 position	lamp lit (✓ or ×)
W	X	
W	Y	
Z	X	
Z	Y	

(ii) Suggest where this circuit would be useful in a house.

(1)

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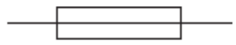
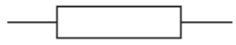
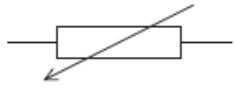
(Total for question = 15 marks)

Q10.

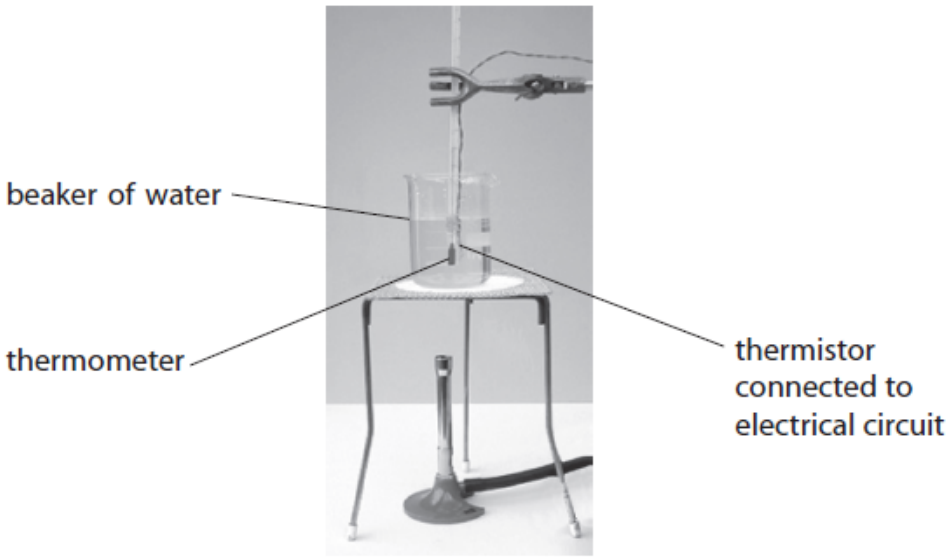
A student investigates the resistance of a thermistor.

(a) Which of these is the correct symbol for a thermistor

(1)

☐	A	
☐	B	
☐	C	
☐	D	

(b) The student uses this apparatus to investigate how the resistance of a thermistor changes with temperature.



(i) Explain why the student places the thermistor in a beaker of water.

(2)

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(ii) The student also uses a voltmeter and an ammeter.

How should the voltmeter and the ammeter be connected in his circuit?

(1)

	Voltmeter	Ammeter
☒ **A**	in parallel across the power supply	in parallel across the thermistor
☒ **B**	in parallel across the thermistor	in series with the thermistor
☒ **C**	in series with the power supply	in series with the thermistor
☒ **D**	in series with the thermistor	in parallel across the thermistor

(c) The table shows the student's results.

Temperature in °C	Resistance in Ω
0	10 000
10	7 060
20	5 000
40	2 670
60	2 350
80	1 080
100	609

(i) Plot a graph of these results on the grid.

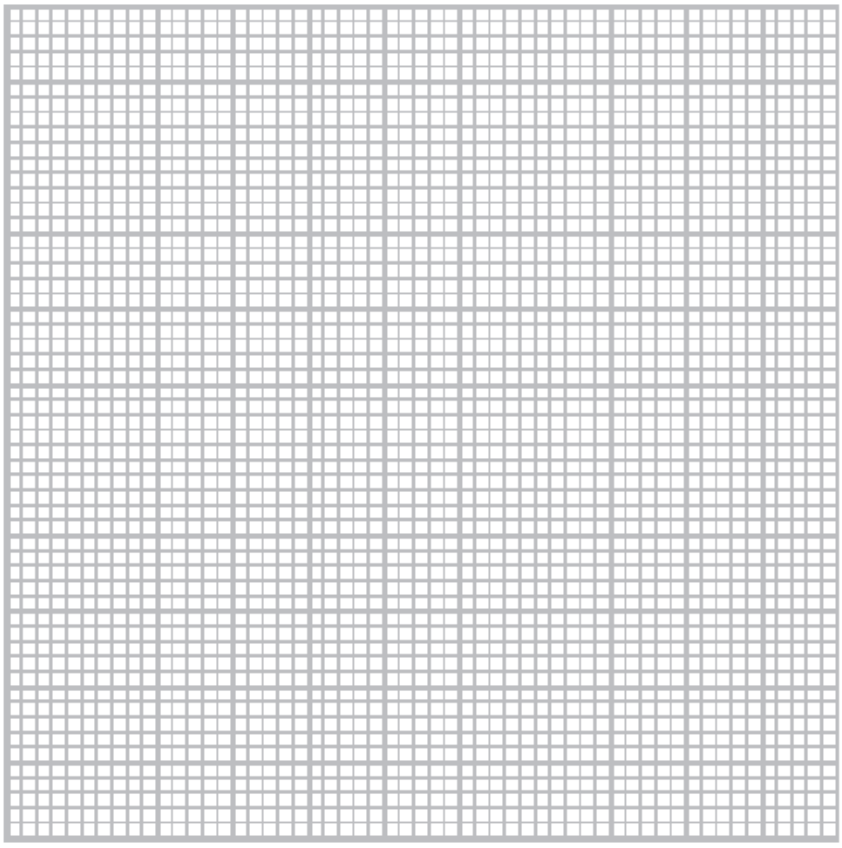
(4)

(ii) Circle the anomalous point on the graph.

(1)

(iii) Draw a curve of best fit.

(1)



(d) (i) Why is the maximum temperature in the student's investigation limited to 100°C?

(1)

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(ii) Suggest how the student obtains readings below room temperature.

(1)

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(Total for question = 12 marks)

Q11.

A student has some LEDs connected in a circuit. They emit light of different colours.

(a) (i) The different colours of light are waves which must have

(1)

☒ **A** the same amplitude in free space

☒ **B** the same frequency in free space

☒ **C** the same speed in free space

☒ **D** the same wavelength in free space

(ii) When an LED is on, it shows that

(1)

☒ **A** there must be alternating current in the circuit

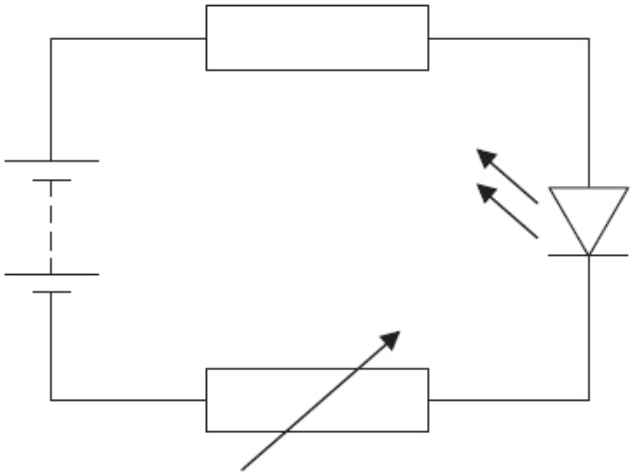
☒ **B** there must be a current in the circuit

☒ **C** there is a fault in the LED

☒ **D** a fuse has blown

(b) An LED needs a minimum voltage to make it emit light.

The student investigates this minimum voltage using the circuit shown.



(i) The student uses a voltmeter to measure the voltage across the LED.

Add this voltmeter to the circuit diagram.

(2)

(ii) The student gradually increases the voltage across the LED and records the minimum voltage at which the LED emits light.

The results for some different LEDs are shown in the table.

Colour of light from LED	Minimum voltage in V
Red	1.7
Blue	3.6
Yellow	2.1
Orange	2.0
Green	3.0

Display the results of the student's investigation on the grid.

(4)

(iii) The student concludes:

The minimum voltage depends on the wavelength of the light emitted.

Evaluate the student's conclusion.

(2)

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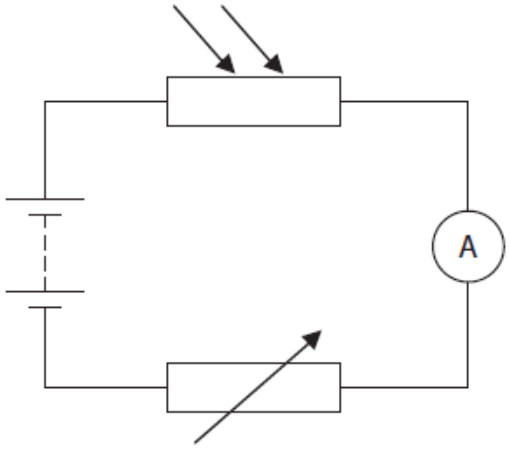
(Total for question = 10 marks)

Q12.

The resistance of a Light Dependent Resistor (LDR) is affected by the amount of light that shines on it.

A student investigates this relationship using the circuit shown.



(a) (i) The student uses a voltmeter to measure the voltage across the LDR.

Add this voltmeter to the circuit diagram.

(2)

(ii) Explain how the student can work out the resistance of the LDR using this circuit.

(2)

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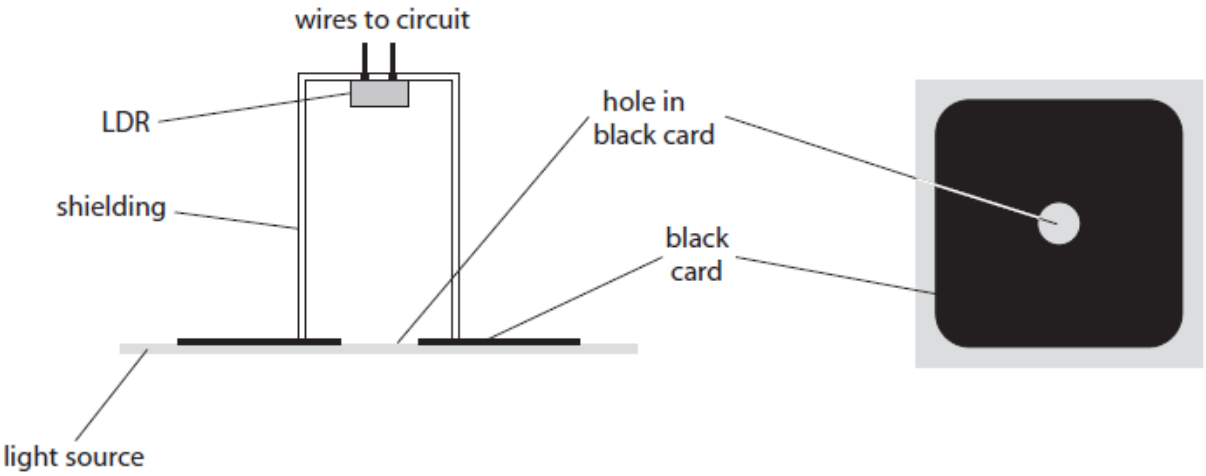
(b) The student shines light on the LDR through a circular hole in a piece of black card, as shown in the diagram.

The student repeats the experiment using cards with holes of different diameter.

The distance from the card to the LDR is always 5 cm.

The student varies the current in the circuit by adjusting the variable resistor.



(i) The independent variable in this experiment is

(1)

☒ **A** the brightness of the light source

☒ **B** the diameter of the hole

☒ **C** the distance from the card to the LDR

☒ **D** the resistance of the LDR

(ii) A controlled variable in this experiment is

(1)

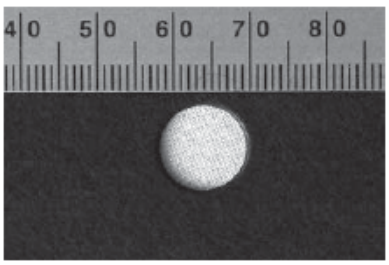
☒ **A** the current in the circuit

☒ **B** the diameter of the hole

☒ **C** the distance from the card to the LDR

☒ **D** the resistance of the LDR

(iii) The photograph shows how the student places a metal ruler to measure the diameter of one of the holes.



Suggest how the student can improve this technique while still using the same ruler.

(1)

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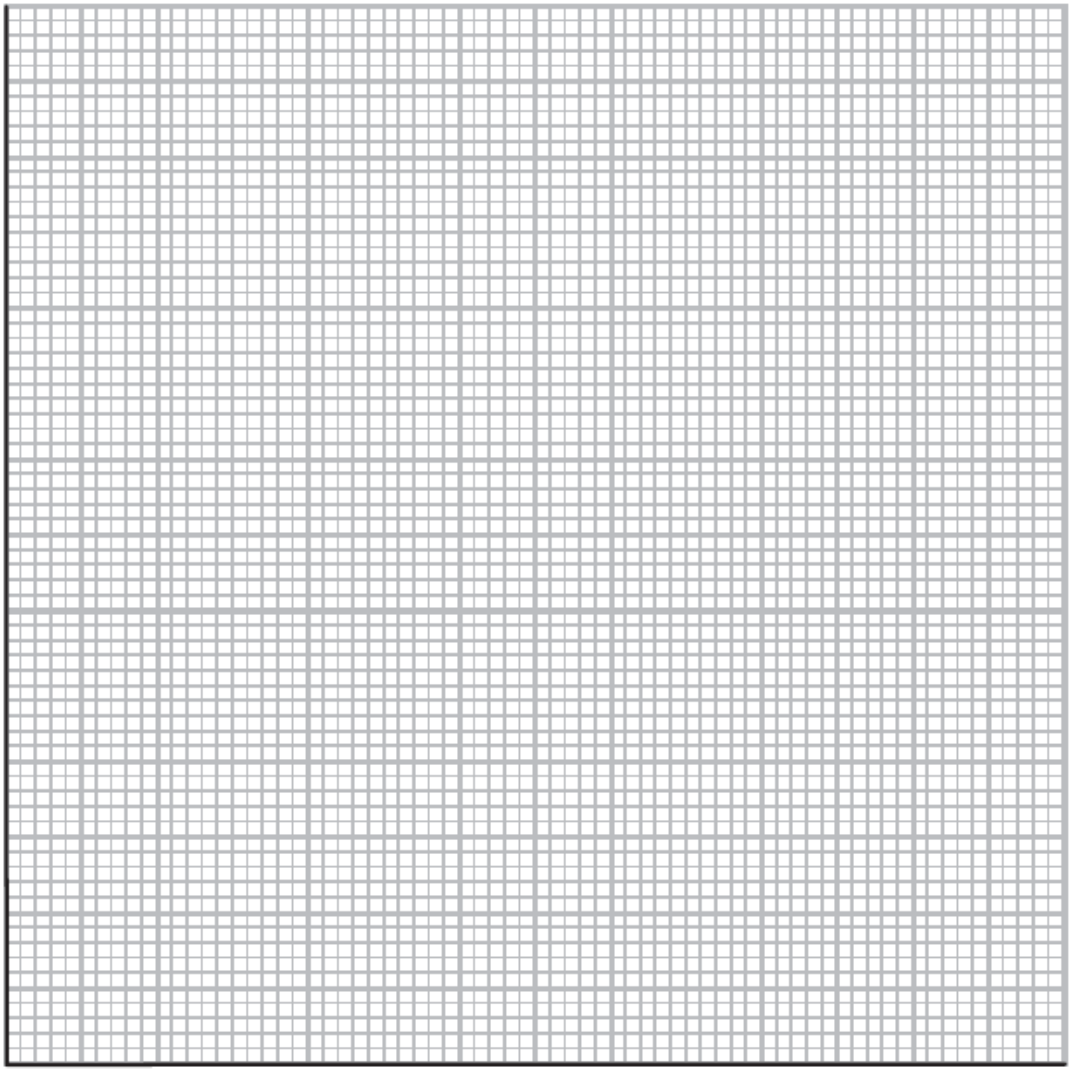
(c) The table shows the student's results.

Diameter of hole in mm	Resistance of LDR in Ω
8	1050
10	890
15	640
20	490
23	430
30	340

(i) Plot the student's results on the grid.

(4)



(ii) Draw a curve of best fit on the graph.

(1)

(iii) Describe the relationship between the resistance of the LDR and the diameter of the hole.

(2)

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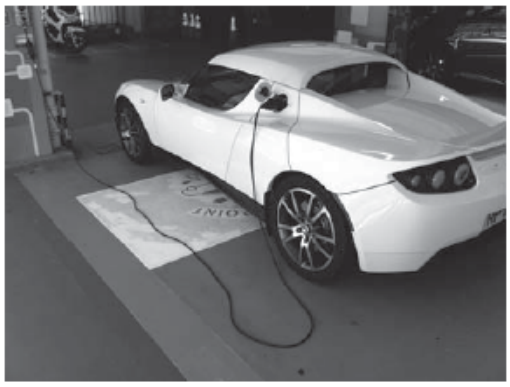
(Total for question = 14 marks)

Q13.

An electric vehicle has a rechargeable battery.

The battery is recharged by connecting it to a charging station.



© Epattloamer

(a) The battery voltage is 385 V.

(i) State the amount of energy transferred when one coulomb of charge passes through a potential difference of 385 V.

(1)

energy transferred = ... J

(ii) Show that, when a charge of 180000 C passes through the battery, the total amount of energy transferred to the battery is about 70 MJ.

(2)

(iii) During the charging process, energy is also transferred to the charging station from the mains supply.

Explain why the amount of energy transferred from the mains supply is more than 70 MJ.

(2)

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(b) Charging takes 110 minutes and causes a total charge of 180000 C to pass through the battery.

(i) State the equation linking charge, current and time.

(1)

(ii) Calculate the average charging current in the battery.

(3)

current = ... A

(Total for question = 9 marks)

Q14.

A student investigates how the current in a filament lamp varies as the voltage across it changes.

(a) Draw a suitable circuit diagram for this investigation.

(3)

(b) Describe a method the student could use for this investigation.

(4)

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(Total for question = 7 marks)

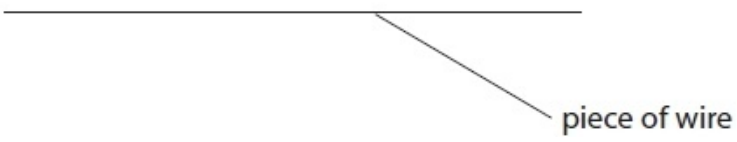
Q15.

A student investigates how the resistance of a piece of wire changes with voltage across the wire.

The student connects an ammeter, a voltmeter, a battery, a variable resistor and the wire in an electrical circuit.

(a) (i) Complete the diagram to show how the student should connect the circuit.

(3)



(ii) Describe what she should do to obtain a set of results for her investigation.

(3)

(b) The student keeps the temperature of the wire constant during the investigation.

(i) Suggest **why** she does this.

(1)

(ii) Suggest **how** she does this.

(1)

(c) When the student looks at her results, she notices that the voltage across the wire is directly proportional to the current in it.

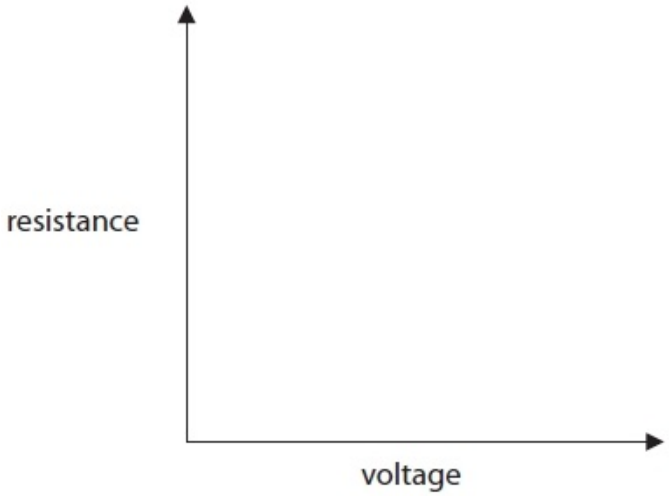
(i) State the relationship linking voltage, current and resistance.

(1)

(ii) The student calculates the resistance and then plots a graph of resistance against voltage.

On the axes, sketch the shape of her graph.

(1)

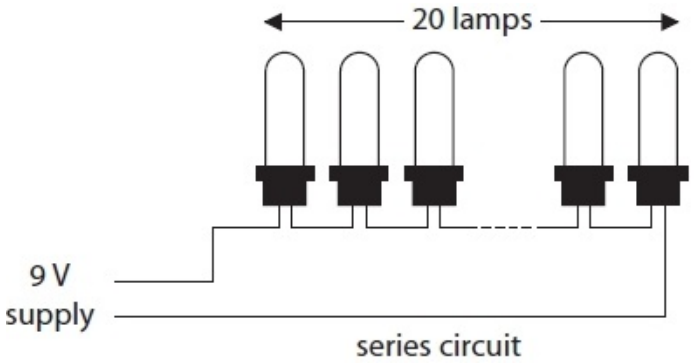


(Total for question = 10 marks)

Q16.

The diagram shows some lamps connected together.

There are 20 small lamps connected in series with a 9 V supply.



(a) (i) What is the voltage across each lamp in the series circuit?

(1)

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(ii) Each lamp has a power of 1.5 W.

State the equation linking power, current and voltage.

(1)

(iii) Show that the current in the circuit is about 3 A.

(2)

(b) (i) The lamps are on for 7 hours a day for 5 days.

Calculate the total energy transferred during this time.

(3)

energy transferred = ... J

(ii) Describe the energy changes that take place in the lamps when they are connected to the power supply.

(2)

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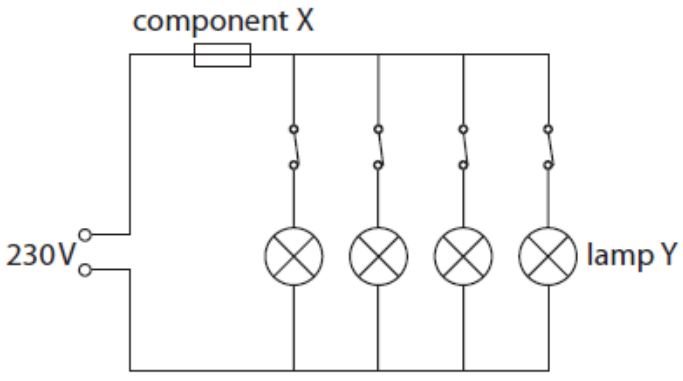
(Total for question = 9 marks)

Q17.

The diagram shows a lighting circuit in a house.



(a) (i) Component X is

(1)

☒ **A** a double insulated wire

☒ **B** an earth connection

☒ **C** a fuse

☒ **D** a switch

(ii) The lamps are connected in parallel.

State an advantage of using a parallel circuit for lighting.

(1)

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(b) The lighting circuit is connected to a mains supply that provides an alternating current.

Explain what is meant by an alternating current.

You may draw a diagram to help your answer.

(2)

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(c) Lamp Y is removed and replaced with a low-energy lamp.

When the low-energy lamp is connected to a 230 V supply, the current in it is 0.12 A.

(i) Calculate the amount of energy transferred by the low-energy lamp in 7 hours.

(3)

energy transferred = ... J

(ii) The low-energy lamp gives the same amount of light as lamp Y, but uses much less power.

Which row of the table compares the low-energy lamp correctly to lamp Y?

(1)

	Voltage across low-energy lamp compared to voltage across lamp Y	Current in low-energy lamp compared to current in lamp Y
☒ **A**	less than	same as
☒ **B**	same as	less than
☒ **C**	less than	less than
☒ **D**	same as	same as

(Total for question = 8 marks)

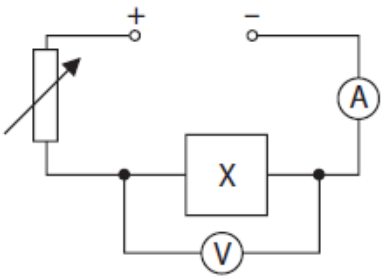
Q18.

A student is given an unknown electrical component, X.

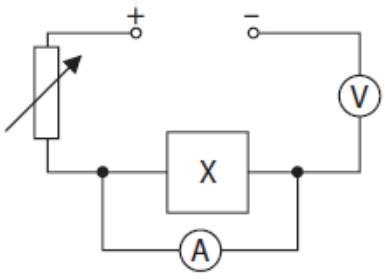
He uses a circuit to investigate how the current in X varies with the voltage across it.

(a) Which of these circuits is correct for his investigation?

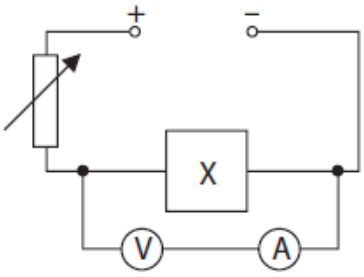
(1)



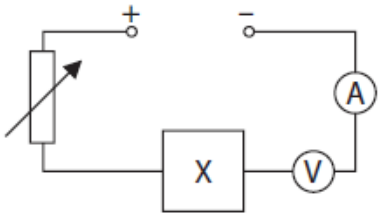
A ☒



B ☒



C ☒



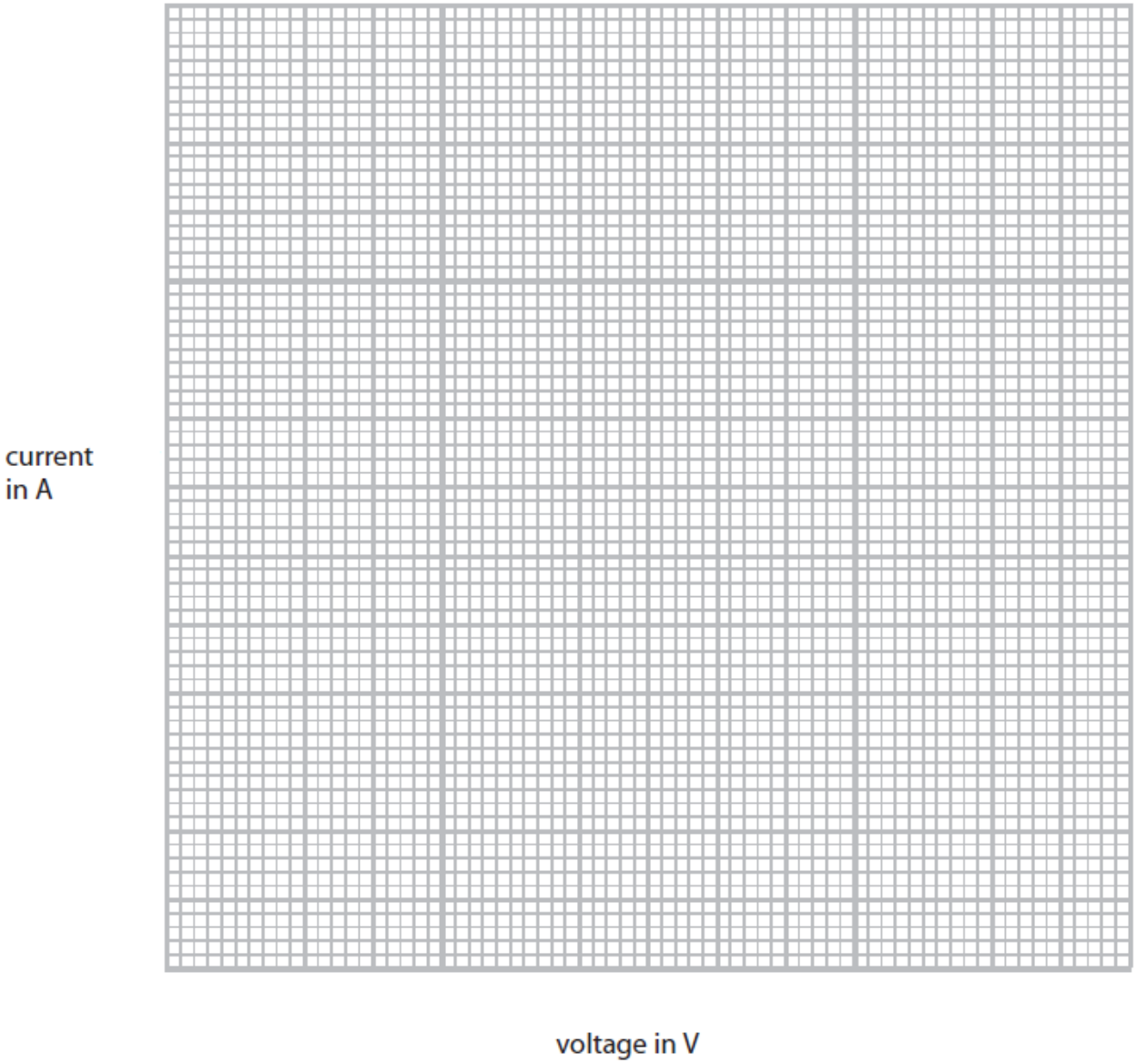
D ☒

(b) The table shows the student's results.

Voltage across X in V	Current in X in A
0	0
3.0	0.5
14.5	2.3
19.5	2.9
25.0	3.2
29.5	3.3

(i) Plot a graph of these results and draw a curve of best fit.

(4)



(ii) State the equation linking voltage, current and resistance.

(1)

(iii) Calculate the resistance of component X when the voltage across it is 10.0 V.

Give the unit.

(4)

resistance = ... unit .....

(iv) Describe the pattern shown by this graph.

(3)

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(v) Suggest a conclusion for the investigation.

(2)

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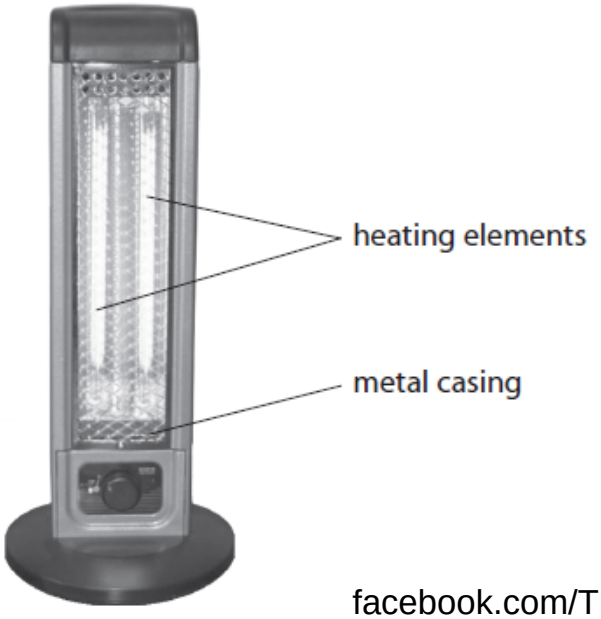
(Total for question = 15 marks)

Q19.

The photograph shows an electric heater.



(a) The power of the heater is 2000 W.

The heater is connected to a 230 V mains supply.

(i) State the equation linking power, current and voltage.

(1)

(ii) Calculate the current in the heater.

(2)

current = ... A

(iii) Which of these fuses should be used with the heater?

(1)

☒ **A** 1A

☒ **B** 5A

☒ **C** 7A

☒ **D** 13A

(b) The two heating elements can be connected in series or in parallel.

Describe an advantage of each method.

(2)

series

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parallel

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(c) Some electrical appliances are fitted with an earth wire.

(i) Describe how an earth wire acts as a safety feature.

(4)

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(ii) Explain why this heater should be fitted with an earth wire.

(2)

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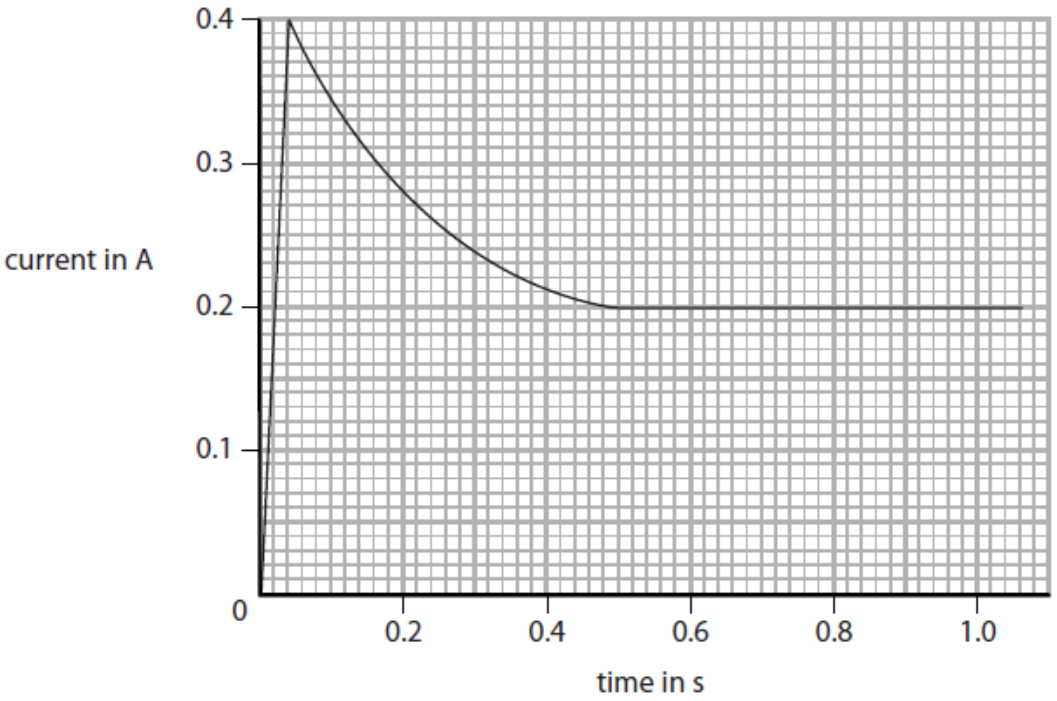
(Total for question = 12 marks)

Q20.

A filament lamp is connected to a battery.

The lamp is switched on and a data logger records the current.

The graph shows the results from the data logger.



(a) Describe in detail how the current varies with time.

Refer to data from the graph in your answer.

(3)

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(b) The battery has a voltage of 12 V.

The lamp reaches its normal operating temperature after a short while.

(i) State the current in the lamp when it is at its normal operating temperature.

(1)

current = ... A

(ii) State the relationship between voltage, current and resistance.

(1)

(iii) Calculate the resistance of the lamp at its normal operating temperature.

Give the unit.

(4)

resistance = ... unit .....

(iv) State the relationship between power, current and voltage.

(1)

(v) Calculate the power of the lamp at its normal operating temperature.

(2)

power = ... W

(c) Suggest why a filament lamp is most likely to fail when it is first switched on.

(2)

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(Total for question = 14 marks)

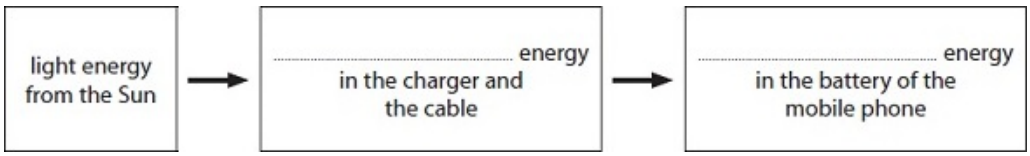
Q21.

The photograph shows a solar-powered battery charger connected to a mobile phone.

When the battery charger is used, it transfers light energy from the Sun to the battery of the mobile phone.

(a) Complete the energy transfer diagram.

(2)



(b) It takes 3.5 hours to recharge the battery fully.

The average current supplied by the charger is 400 mA.

(i) State the equation linking charge, current and time.

(1)

(ii) Calculate the amount of charge needed to recharge the battery fully, and give the unit.

(3)

charge = ... unit .....

(c) If the charger is moved into the shade, the output power decreases.

The voltage across the charger stays the same.

Explain how moving the charger into the shade affects the time needed to recharge the battery fully.

(2)

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(Total for Question = 8 marks)

Q22.

A student investigates how the resistance of a thermistor varies with temperature.

(a) Draw the circuit symbol for a thermistor.

(1)

(b) The student uses voltmeter and ammeter readings to find the resistance at each temperature.

One set of readings is shown below.

temperature in °C	voltmeter reading in V	ammeter reading in mA
80	13.2	2.60

(i) State the equation linking voltage, current and resistance.

(1)

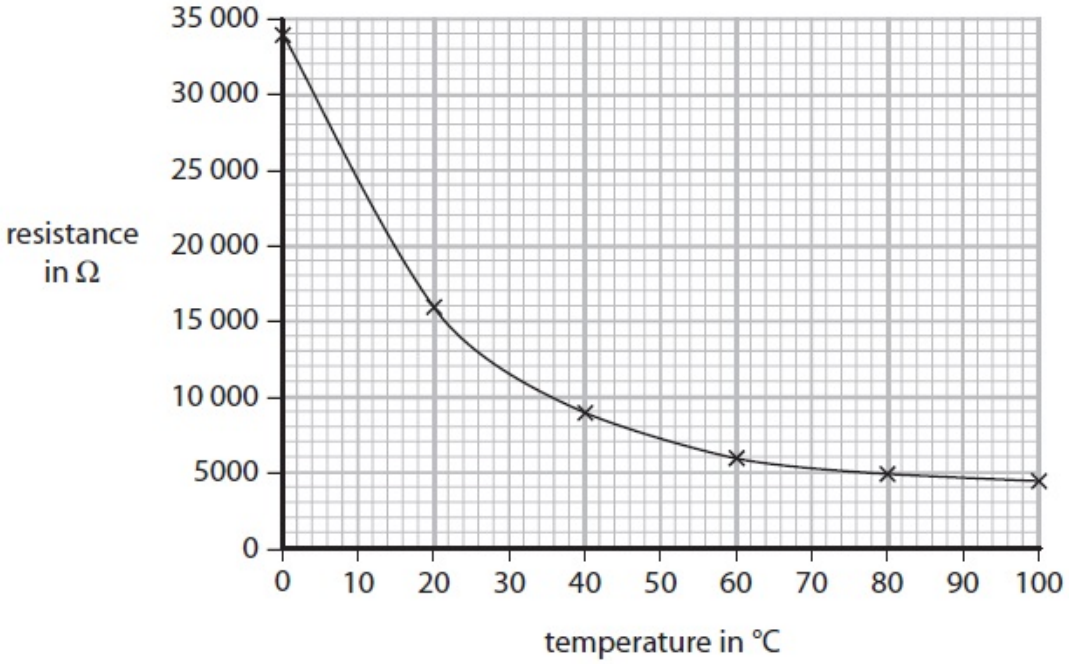
(ii) Show that the resistance of the thermistor at 80 °C is about 5000 Ω.

(3)

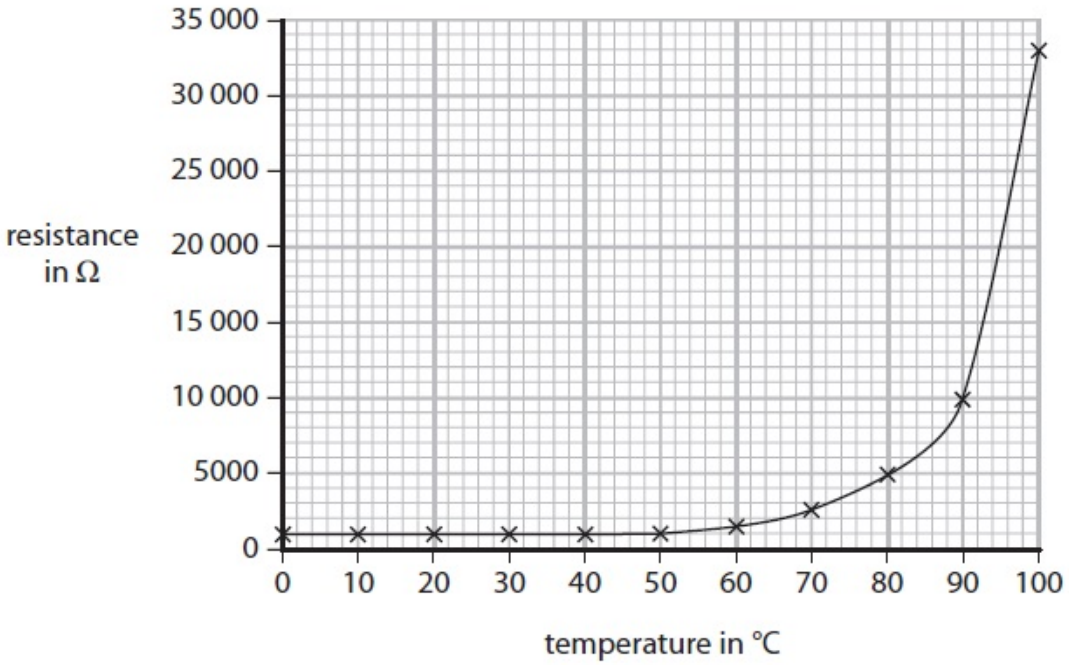
(c) Another student takes measurements for two more components, A and B.

The graphs show the results.

Component A



Component B



Compare the results for component A and component B.

(5)

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(Total for question = 10 marks)

Q23.

A student sets up a circuit to investigate how the current in different components varies with voltage.

He investigates these components.

- a short thick copper wire
- a filament lamp
- a long thin copper wire
- a diode

(a) State four other pieces of equipment the student needs.

(4)

1 .....

2 .....

3 .....

4 .....

(b) During the investigation, the student keeps the two copper wires at a constant temperature.

(i) Give a reason why he should keep the wires at a constant temperature.

(1)

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(ii) Describe how he could keep the wires at a constant temperature.

(2)

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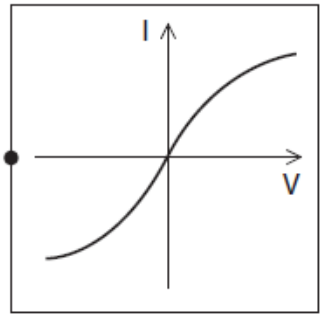
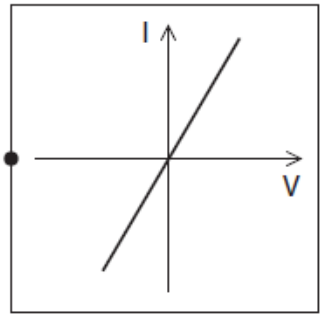
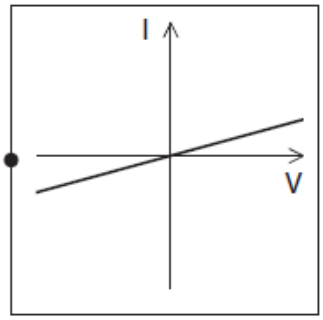
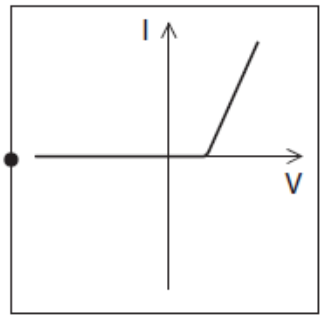
(c) The student obtains a graph for each component.

Draw a straight line linking each component to its correct graph.

(3)

component	graph
short thick copper wire	
filament lamp	
long thin copper wire	
diode	

(Total for question = 10 marks)

Q24.

Electrical energy can be transmitted using a high voltage of 132 kV.

(a) A voltage of 132 kV is the same as

(1)

- ☒ **A** 132 V
- ☒ **B** 1320 V
- ☒ **C** 132 000 V
- ☒ **D** 132 000 000 V

(b) Using a high voltage increases the

(1)

- ☒ **A** current in the wires
- ☒ **B** efficiency of transmission
- ☒ **C** energy lost as heat
- ☒ **D** resistance of the wires

(c) The high voltage can be reduced using a

(1)

- ☒ **A** generator
- ☒ **B** magnet
- ☒ **C** transformer
- ☒ **D** transmitter

(Total for question = 3 marks)

Q25.

A light dependent resistor (LDR) can be used as a sensor to detect light intensity.

Describe how the resistance of an LDR varies as the light intensity changes.

You may sketch a graph to help your answer.

(3)

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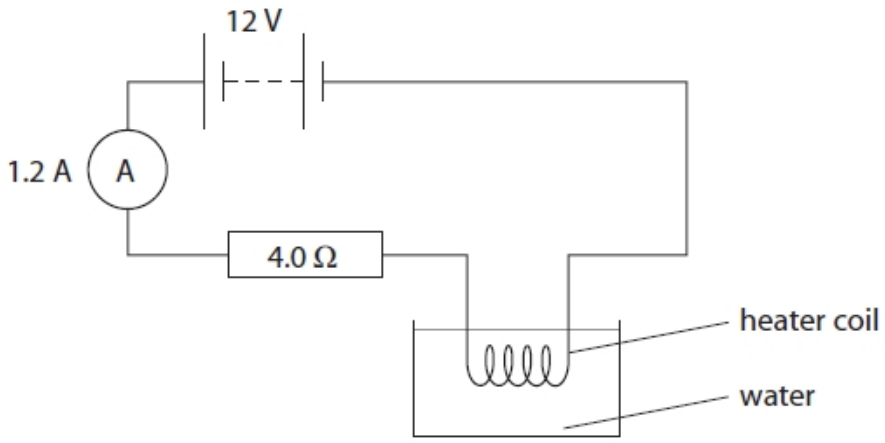
(Total for question = 3 marks)

Q26.

The diagram shows a heater coil and a resistor connected to a 12 V battery and an ammeter.
The ammeter reading is 1.2 A.



(a) (i) State the equation linking voltage, current and resistance.

(1)

(ii) Calculate the voltage across the 4.0 Ω resistor.

(2)

Voltage = ... V

(iii) Show that the voltage across the heater coil is about 7 V.

(2)

(iv) Calculate the energy transferred to the heater coil in 5.0 minutes.

(3)

Energy transferred = ... J

(v) At first, the temperature of the water increases.

After a while, the temperature reaches a steady value below the boiling point of water.

Explain why the temperature reaches a steady value.

(2)

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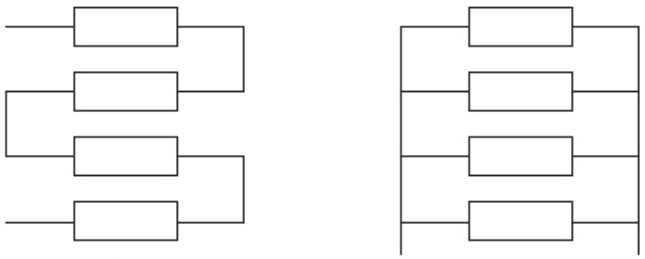
(b) Resistors can be used as heating elements in the rear windows of cars.

The diagram shows two possible designs.



(i) Complete the table by placing a tick (✓) in the correct boxes.

(1)

Design	Series	Parallel
X		
Y		

(ii) Describe the advantages and disadvantages of design **X** when used as a heater in a car window.

(3)

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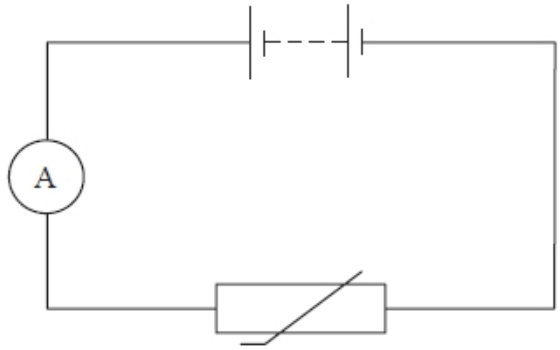
(Total for question = 14 marks)

Q27.

A student investigates how the resistance of a thermistor changes with temperature.
He measures a current and a voltage.

The diagram shows part of the circuit that the student uses.



(a) (i) Label the thermistor on the diagram.

(1)

(ii) Add to the diagram to show how a voltmeter should be connected.

(2)

(b) The student varies the temperature of the thermistor and obtains the results below.

Temperature in °C	0	20	40	60	80	100
Current in mA	0.8	2.0	4.2	8.2	15.1	26.6

(i) State the equation linking voltage, current and resistance.

(1)

(ii) The voltage across the thermistor is 12 V.

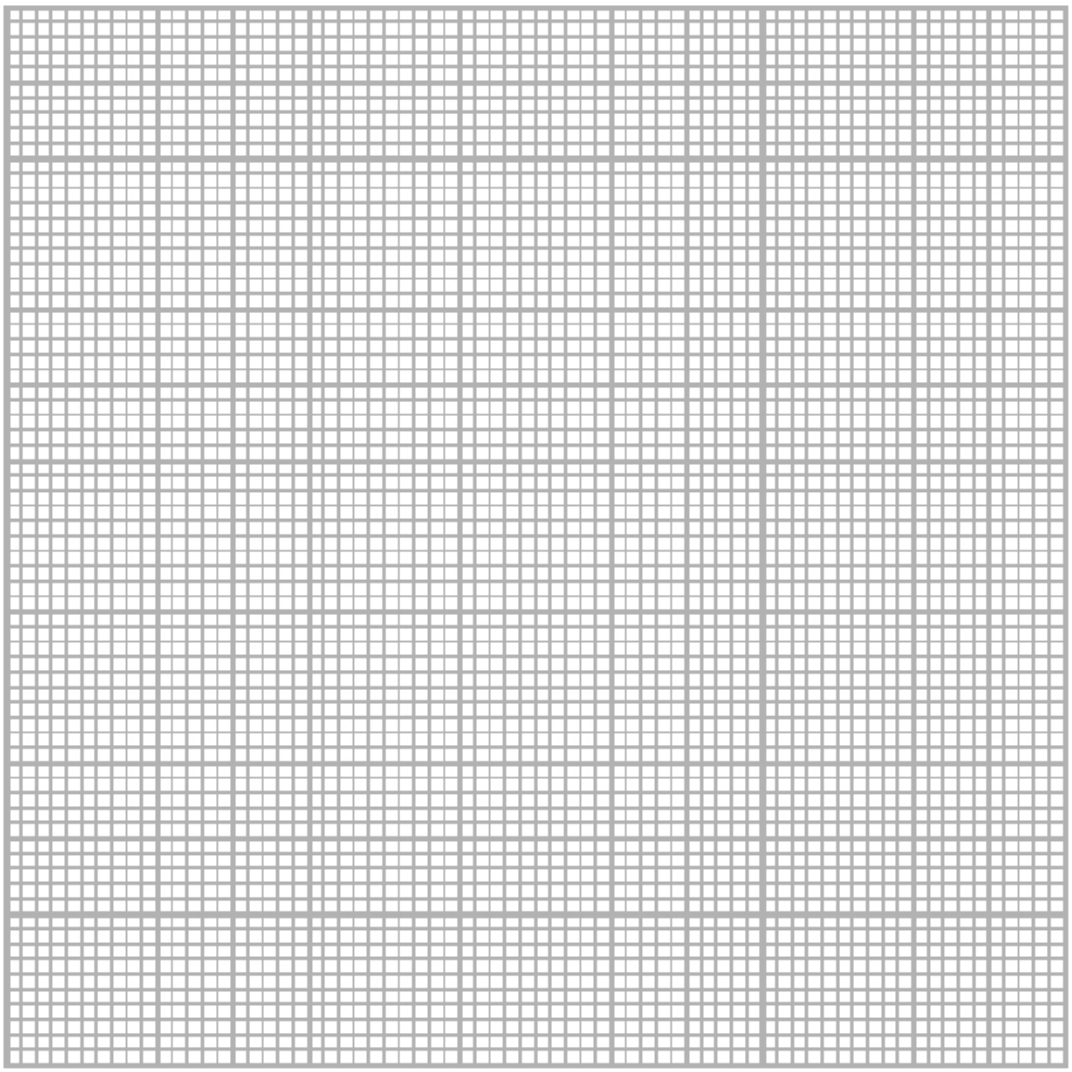
Calculate the resistance of the thermistor at 20 °C.

(2)

Resistance = ... Ω

(iii) Use the results from the table opposite to plot a graph of current against temperature.

(5)



(iv) Use your graph to describe how the current in the thermistor changes as the temperature increases.

(2)

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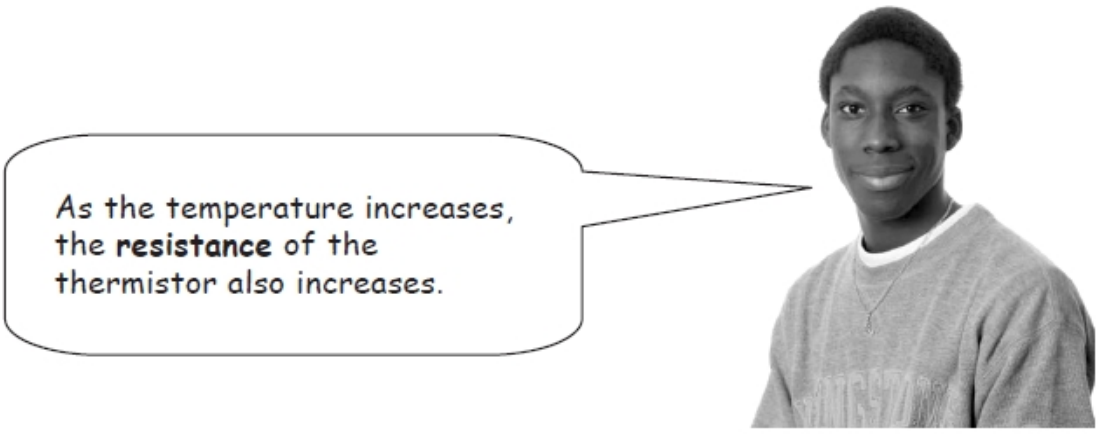
(v) The student concludes:



Evaluate this conclusion.

(2)

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(Total for question = 15 marks)

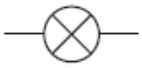
Q28.

(a) The diagram shows part of an electric circuit.

Complete the circuit diagram by adding

- a resistor in series with the lamp and battery
- a second lamp in parallel with the first lamp
- a voltmeter that measures the voltage across the resistor
- an ammeter that measures the current in the resistor

(4)



(b) The current in a resistor is measured for different voltages.

The table shows the results.

Voltage in V	Current in A
1.0	0.10
2.5	0.25
3.0	0.30
4.5	0.40
5.0	0.50
6.0	0.60

(i) Plot a graph of this data on the grid.

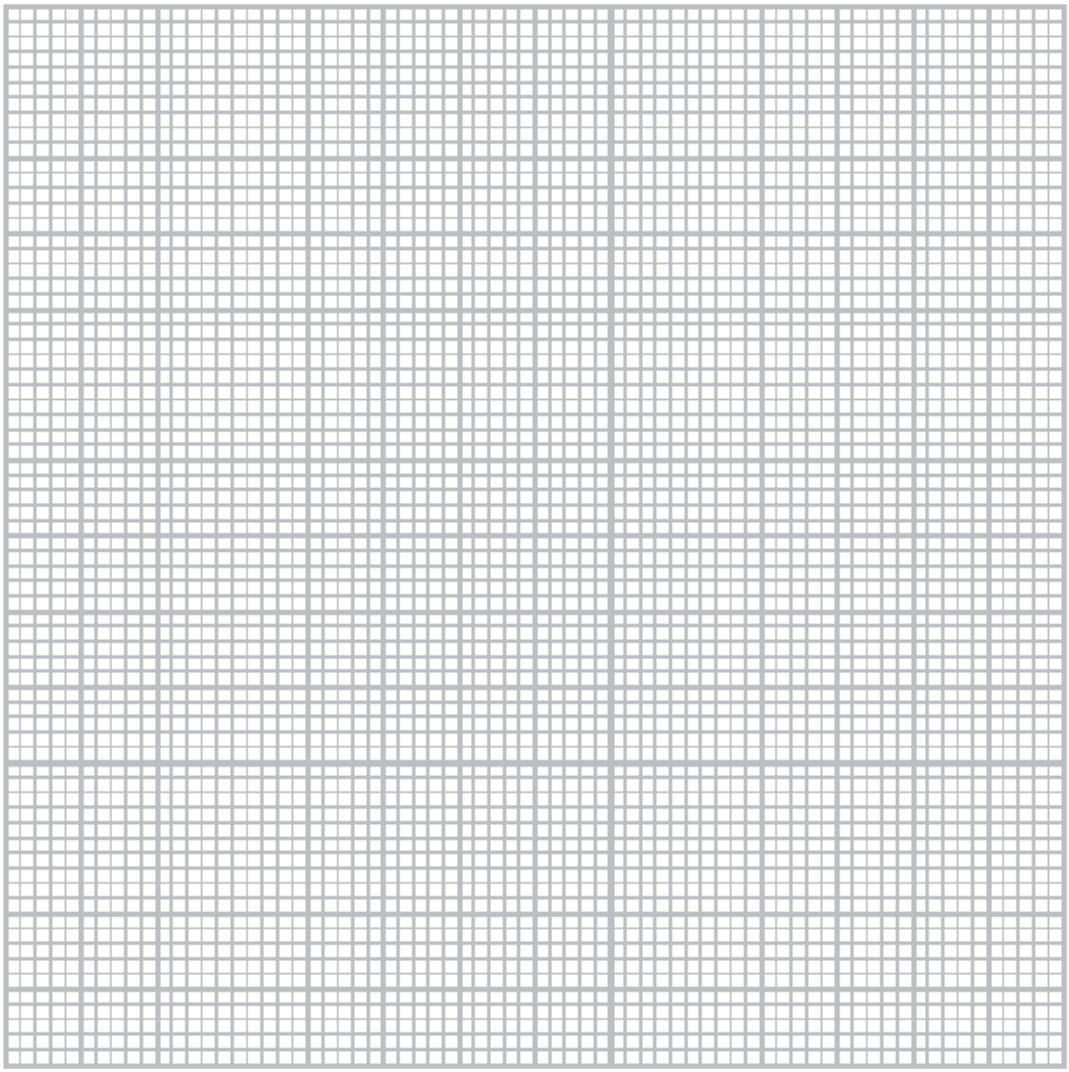
(4)

(ii) Circle the anomalous point on the graph.

(1)

(iii) Draw a line of best fit.

(1)



(iv) State the equation linking voltage, current and resistance.

(1)

(v) Use your graph to find a value for the resistance of the resistor.

(2)

resistance ..... Ω

(Total for question = 13 marks)

Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	B (no earth connection);		1
(b)	C (the circuit cannot overheat if there is a fault);		1
(c)	A (in parallel);		1

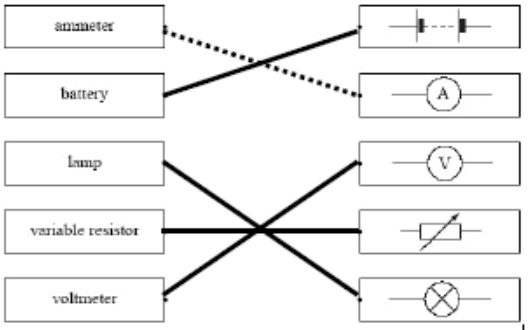
Total 3 marks

Q2.

Question number	Answer	Accept	Reject	Marks
(a) (i)	voltage = current x resistance;	V = I x R Accept rearrangements		1
(ii)	Substitution and rearrangement (of correct equation); Answer given to at least 3 s.f.; e.g. 230 / 22 = 10.45 (A) (≈ 10 A)	Ignore calculations of voltage or resistance 10.5 A (= 10 A)		2
(b) (i)	Any two of: MP1 As a safety device / reduces danger /reduces hazards; MP2 In case of fault / short; MP3 Idea of excessive current; MP4 Prevents (wires or appliance) overheating/fire;	Ignore any reference to electric shock More than 13A		2
(ii)	MP1 Because total current (in motor and heater) is more than 2A; MP2 A 2 A fuse would blow / melt / would need to be replaced / circuit would be broken;	Accept reverse arguments		2

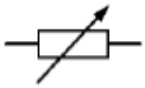
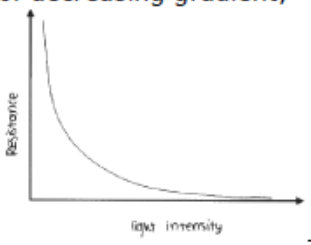
Total 7 marks

Q3.

Question number	Answer	Notes	Marks
(a)	 all 4 lines;;; any 2 lines;; any one line;	(dotted line is given)	3
(b) (i)	light dependent resistor / LDR;	allow • photo sensitive resistor • light sensitive resistor allow recognisable spellings	1
(ii)	thermistor;	allow recognisable spellings total marks = 5	1

(Total for question = 5 marks)

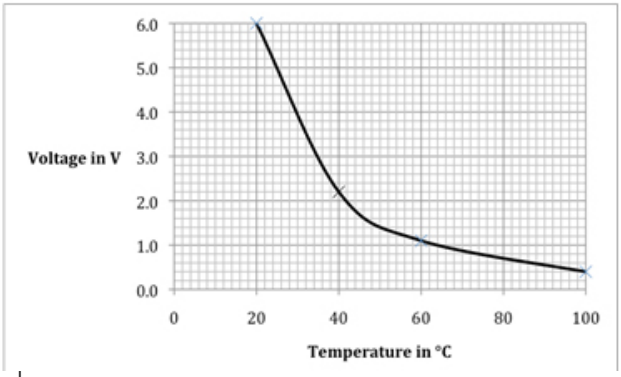
Q4.

Question number	Answer	Notes	Marks
(a)	1 mark for each correct line;;;; Name of component / Circuit symbol fixed resistor  variable resistor  cell lamp  fuse / circuit breaker 	symbols do not need to have connecting wires shown at each side arrow can be any direction but must be diagonal only ignore 'battery' allow filament lamp symbol 	4
(b) (i)	voltage = current x resistance;	allow in standard symbols or in words e.g. V = I x R	1
(ii)	substitution OR rearrangement; evaluation; e.g. R = V/I = 8.0/0.50 R = 16 (ohms)	either seen	2
(c)	axes labelled with resistance and {light intensity / light / intensity / brightness}; resistance decreasing as light intensity increases; curve of decreasing gradient; e.g.  	ignore units and orientation allow 'dark' and 'light' labels DOP DOP	3
		Total for question = 10 marks	

Q5.

Question number	Answer	Notes	Marks
a	MP1. series circuit containing lamp and some form of power supply; MP2. ammeter in series with lamp; MP3. voltmeter in parallel across lamp; MP4. variable resistor in series OR use of variable power supply;	incorrect symbols or substantial gaps =-1 ONCE allow either symbol for lamp ignore other components e.g. switch	4
b i	idea that gradient changes; e.g. voltage increases more rapidly than the current	look for a rate change expressed in student terms Accept • line is curved • not a straight line • V is not proportional to I	1
ii	MP1. Lamp heats up; MP2. Greater chance of electron collisions; MP3. (hence) resistance increases;	do not award marks for a description of the shape of the graph	3

Q6.

Question number	Answer	Notes	Marks
(a)	Any three of - MP1 use a stirrer / stir with thermometer; MP2 centralise / spread heat source; MP3 move thermistor and thermometer to same level; MP4 move thermistor and thermometer closer together; MP5 Use thermometer with finer scale / digital thermometer;	Ignore repeat readings Assume horizontal separation meant Allow ampmeter	Max 3
(b)	(milli)Ammeter;	Accept axes reversed	1
(c) (i)	Scale; (at least half the grid) Axes labelled including units; Plotting ±½ small square;; Line of best fit;  	-1 each plotting error, minimum 0 for plotting Curve through either (80, 0.2) or (100, 0.4) Allow line bisecting these two points Temperature in °C / Voltage in V 20 / 6.0 40 / 2.2 60 / 1.1 80 / 0.2 100 / 0.4	5
(d) (i)	voltage = current x resistance;	Accept rearrangements and symbols e.g. current = voltage ÷ resistance, V=IR, R=V/I	1
(ii)	Substitution into correctly rearranged equation; Conversion between amps and milliamps; Calculation yielding value correct to at least 2 s.f.; e.g. I = 5.9 ÷ 680 = 0.00868 (A) = 8.7 (mA)	Accept x 1000 in calculation Allow 1 mark max if response is only a successful reverse argument leading to 5.8 V or 5.78 V	3

Total 14 marks

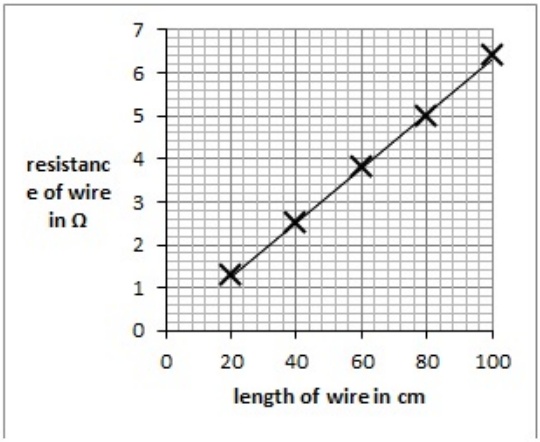
Q7.

Question number	Answer	Notes	Marks
(a) (i)	B - 960 joules per second;		1
(ii)	power = current x voltage;	allow equation as correct symbols and/or rearrangement e.g. I = P ÷ V	1
(iii)	appropriate calculation (including substitution OR rearrangement); answer to at least 2 sf seen anywhere; e.g. 960 = I × 230 (I =) 4.2 (A)	using 4 (A) to calculate power (920 W) or voltage (240 V) scores 1 mark max. (4.17391) allow 4.1 (A)	2
(b) (i)	any 3 of: MP1. large **current** to earth / in earth wire; MP2. fuse blows / melts / breaks; MP3. idea that circuit is broken; MP4. idea that the risk of shock is reduced / prevented;	ignore references to electricity or charge allow 'current surge' for large current 'ground' for earth ignore references to fire	3
(ii)	D - 13 A;		1
(c)	MP1. a way of measuring current e.g. ammeter; MP2. a **method** to vary current in fuse; MP3. a **method** of identifying that the fuse has broken e.g. lamp goes out, idea that current falls to zero etc.;	accept any points seen in diagram allow data logger allow **variable** power supply, **variable** resistor	3

Total 11 marks

Q8.

Question number	Answer	Notes	Marks
(a)	CIRCUIT DIAGRAM – Correct symbols for ammeter, voltmeter and battery; Ammeter in series with cells; Voltmeter in parallel with wire / as shown in photograph;	 ALLOW three separate cells in series ALLOW anything reasonable for the wire (e.g. straight line, variable resistor, resistor)	 1 1 1
(b) (i)	(independent variable) – length (of wire) (dependent variable) - resistance	BOTH NEEDED	1
(ii)	ANY FIVE APPROPRIATE, e.g. Connect the circuit / connect (crocodile) clip to wire; Read ammeter; Read voltmeter; For known /particular / quoted value length; measure length with a ruler; Repeat readings / average (in different places along the wire); Take readings for different lengths; Check meters for zero errors; Disconnect/switch off between readings; To avoid heating the wire;	IGNORE references to calculating resistance, plotting graphs –	5
(c) (i)	Voltage = current x resistance;	ALLOW standard symbols, V = I X R ALLOW correct rearrangements DO NOT ALLOW equation given as unit symbols	1
(ii)	6.4;	ALLOW correct answer if it follows an equation given in unit symbols IGNORE s.f. BUT must be correctly rounded from 6.4285...	1

(d) (i)	Sample graph –  scale; at least half the paper axes labelled including units; Plotting; Plotting; Best fit line;	<table><tr><td>20</td><td>1.3</td></tr><tr><td>40</td><td>2.5</td></tr><tr><td>60</td><td>3.8</td></tr><tr><td>80</td><td>5.0</td></tr><tr><td>100</td><td>(6.4)</td></tr></table> Points to plot IF AXES REVERSED, LOSE THE AXES MARK Ignore (100 cm, 6.4) ALLOW as length increases resistance increases ALLOW conclusions in terms of resistance per metre etc	5
(d) (ii) MARK tog With (iii)	MARK (ii) and (iii) together, credit points wherever seen (directly) proportional; any TWO of Straight line; Through (0,0); line slopes upwards; quoting appropriate values from the graph;	IGNORE 'as length increases current decreases' / conclusions relating to current ALLOW constant gradient ALLOW positive correlation	1 1 1
		Total	**19**

Q9.

Question number	Answer	Notes	Marks
(a)	any 2 of: MP1. so that lamps work independently; MP2. so that they all get mains/same voltage/230V; MP3. so that different areas/rooms can have different brightness/power/light intensities of lamps;	 so that can light some rooms without all being on or off/each lamp has its own switch/if 1 lamp blows the others will still work allow no reduction in light output for main voltage allow different currents	2
(b)	D 1.38 A;		1
(c)	any 3 of: MP1. **current** increases over max value of fuse; MP2. fuse wire melts; MP3. cuts off current; MP4. prevents wire(s) in circuit from overheating;	 allow **current** gets too high blows/breaks breaks circuit ignore 'stops electricity' ignore electric shocks	3

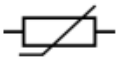
(d) (i)	power = voltage x current	allow in standard symbols or in words	1
(ii)	substitution into correct equation; evaluation; e.g. 0.26 X 230 60 (W)	allow 240 V for mains but not incorrect current (62.4 W) allow 59.8 (W) condone 317(.4) (W) for 1 mark	2
(iii)	 answer from (d)(ii) x **180** ; evaluation; unit; e.g. 60 X 180 11000 joules/J	accept correct use of E = V x I x t allow ecf from (d)(ii) mark independently allow 10800, 10764	3

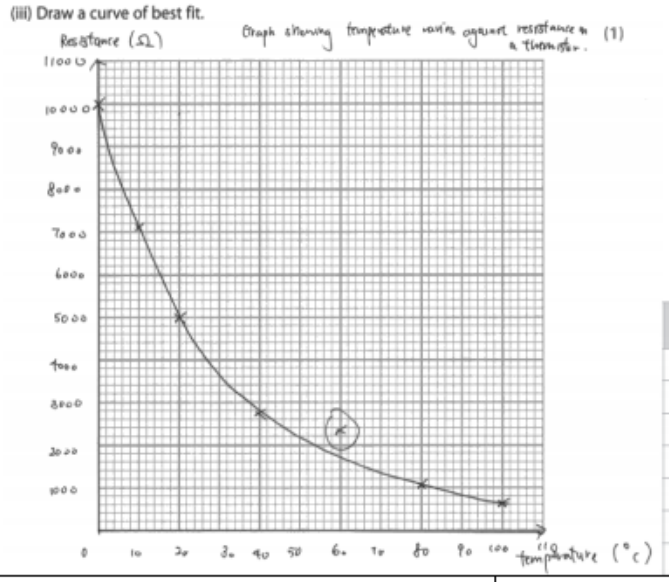
<table>
<tr>
<td>(e) (i)</td>
<td>
<table>
<tr><th>S_1 position</th><th>S_2 position</th><th>lamp is lit</th></tr>
<tr><td>W</td><td>X</td><td>(yes)✓</td></tr>
<tr><td>W</td><td>Y</td><td>(no) ×</td></tr>
<tr><td>Z</td><td>X</td><td>(no) ×</td></tr>
<tr><td>Z</td><td>Y</td><td>(yes)✓</td></tr>
</table>
any three correct;
all 4 correct;;
</td>
<td>allow 1 mark when middle two rows blank, but otherwise correct

allow 1 mark when top and bottom rows blank but otherwise correct</td>
<td>2</td>
</tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr>
<td>(ii)</td>
<td>any sensible suggestion of 2 way switching;
e.g.
on a corridor
on stairs
basement/cellar
bedroom/kitchen light
room with 2 doorways</td>
<td>allow clear description of 2 switches controlling the same light</td>
<td>1</td>
</tr>
</table>

Total 15 marks

Q10.

Question number			Answer	Notes	Marks
	a		 D		1
	b	i	Any two ideas from: MP1. it acts as water bath; MP2. gives more gradual heating or cooling OR gives (easier/better) control of temperature; MP3. protects the thermistor against direct heating/prevents intense heating;	allow water distributes temperature (more) evenly /RA for air very high temperature	2
		ii	B; in parallel across the thermistor in series with the thermistor		1
	c	i	ignore orientation of the graph suitable scales marked on both axes (> 50% of grid used); both axes labelled with quantity and unit; points within ± ½ small square;;		4
		ii	anomalous point at 60, 2350;		1
		iii	LOBF; should go through 60, 1750 approx no obvious abrupt changes of gradient		1

			(iii) Draw a curve of best fit.  **Temperature in °C** / **Resistance in Ω** 0 / 10 000 10 / 7 060 20 / 5 000 40 / 2 670 60 / 2 350 80 / 1 080 100 / 609		
	d	i	water boils at 100°C/OWTTE;		1
		ii	any sensible **method** to get temp between 0 and 20; e.g. add ice to water use cold water from tap/fridge	doing experiment in a fridge is not sensible, but allow if 'walk-in' fridge is mentioned	1
				total = 12 marks	

Total 12 marks

Q11.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a) (i)</td><td>C (the same speed in free space)</td><td></td><td>1</td></tr>
<tr><td>(ii)</td><td>B (there must be a current in the circuit)</td><td></td><td>1</td></tr>
<tr><td>(b) (i)</td><td>Voltmeter connected in parallel with any circuit component;
Component chosen is the LED;</td><td>Ignore a line through the voltmeter symbol</td><td>2</td></tr>
<tr><td>(ii)</td><td>Axes labelled- quantity and unit ;

Linear scale such that longest bar occupies at least half the grid;

Plotting---ignore order of bars
5 bars correctly plotted;;
If only 3 bars correctly plotted allow 1 mark for plotting

<table><tr><th>Colour of light from LED</th><th>Minimum voltage in V</th></tr><tr><td>Red</td><td>1.7</td></tr><tr><td>Blue</td><td>3.6</td></tr><tr><td>Yellow</td><td>2.1</td></tr><tr><td>Orange</td><td>2.0</td></tr><tr><td>Green</td><td>3.0</td></tr></table></td><td>voltage in V (or V/V) AND
all bars (or points) labelled
Ignore orientation
Allow non-zero origin

Bar length plotted to nearest ½ small square

ALL data plotted correctly as floating “x’s” gets only one mark for plotting

Reject both plotting marks if a line graph is drawn (only scale and axes marks are available in this case)</td><td>4</td></tr>
<tr><td>(iii)</td><td>Student is right/wrong - no mark

Any two of
MP1 idea that the visible spectrum is a sequence, with the end colours identified;

MP2 Colour correctly related to wavelength (e.g. red has longest wavelength);

MP3 Colour correctly related to voltage (e.g. blue needs highest voltage);</td><td>

Red to blue (start either end)
Allow ROYGBIV etc

Wavelength (or frequency) correctly related to voltage = 2 marks, e.g.
f increases with V
λ increases with 1/V</td><td>

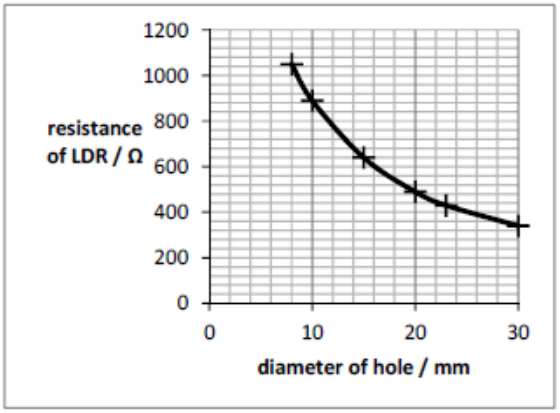
2</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

Total for question = 10 marks

Q12.

Question number	Answer	Notes	Marks
(a) (i)	Voltmeter connected in parallel with a component; component is LDR;	not in parallel with wire	2
(ii)	measure current / take current reading; divide voltage (reading) by current (reading);	accept • number of amps for current • p.d. or number of volts for voltage • R = V/I Ignore triangle mnemonics	2
(b) (i)	B – the diameter of the hole;		1
(ii)	C – the distance from the card to the LDR;		1
(iii)	Any one of - Move ruler to cover half the hole/halfway down the hole; Draw guide lines; Use set square;	idea of measuring across/over the diameter at right angles to ruler Placed against ruler Ignore: move ruler nearer the hole/start from 0 on the ruler	1

(c)	(i)	suitable scales; axes labelled; Plotting of points;;	Must use > half width and half height of grid units on axis labels ignore orientation of graph to nearest ½ square, up to two marks available for this, -1 each error	4
	(ii)	line of best fit;	reject dot to dot allow a reasonably smooth curve, points should be evenly distributed about the line	1
	(iii)	MP1 Idea of an inverse relationship; OR Pattern sentence linking resistance and diameter; MP2 Idea of a non-linear relationship;	ignore 'negative correlation' e.g. "the bigger the diameter, the lower the resistance" allow exponential decrease	2



diameter /mm	resistance /Ω
8	1050
10	890
15	640
20	490
23	430
30	340

(Total for question = 14 marks)

Q13.

Question number	Answer	Notes	Marks
(a) (i)	385 (J);		1
(ii)		reverse calculation e.g. calculating a voltage or charge gains 1 mark max.	
	substitution into E=QV; evaluation to at least 2 s.f.;		2
		if no other mark given allow 1 mark for 10^6 or 1000000 seen in working	
	e.g. (E =) 385 × 180 000 (E =) 69 000 000 (J) / 69 (MJ)	allow ecf from 8(a)(i) value	
(iii)	MP1. idea of <u>energy</u> wasted; MP2. appropriate mechanism;	allow not 100% efficient, <u>energy</u> lost e.g. heat in wires	2
(b) (i)	charge = current × time;	allow abbreviations e.g. Q = I × t or rearrangements	1
(ii)	substitution; rearrangement; evaluation;	ignore not converting time to seconds until evaluation	3
	e.g. 180 000 = current x (110 x 60) (current =) 180 000 / (110 × 60) (current =) 27 (A)	allow 27.3, 27.27… 1600, 1640, 1636 etc. gain 2 marks if no other mark given allow 1 mark for 60 seen anywhere in working (attempt to convert to seconds)	

(Total for question = 9 marks)

Q14.

Question number	Answer	Notes	Marks
(a)	MP1. ammeter connected in <u>series</u> with filament lamp; MP2. voltmeter connected in <u>parallel</u> with filament lamp; MP3. suitable **method** of varying the voltage (e.g. by using variable resistor or using **variable** power supply);	marks are for how components are connected so ignore circuit symbols throughout allow voltmeter connected in parallel with lamp and ammeter	3
(b)	any 4 of: MP1. read ammeter / voltmeter **OR** record current / voltage; MP2. current is measured for more than one voltage; MP3. repeat readings and calculate average (mean); MP4. plot graph; MP5. suitable experimental precaution, e.g. check meters for zero error / switch off current between readings;		4

Total for question = 7 marks

Q15.

Question number	Answer	Notes	Marks
(a) i	MP1 Any circuit including **correct circuit symbols** for all three of • battery /cell / d.c. power supply • ammeter • voltmeter ;	ignore other components for MP1	3
ii	MP2 ammeter clearly measures current through the wire; MP3 voltmeter clearly across wire; Idea of measuring current through the wire; Idea of measuring voltage across the wire; Idea of a range of values (of I and V); e.g. alter variable resistor OR repeat for different voltages	allow even if voltmeter in series with ammeter allow circuit line drawn through meter allow voltmeter across a section of the test wire	3
(b)	any one of		1
i	resistance changes (with temperature) ;	Reject incorrect relationship between R and Θ	1
ii	wire gets hot **and** melts/burns/catches fire/dangerous;	Ignore damage to wire	1
(c) i	V proportional to I only at constant temperature; Ohms Law is only true if temperature constant; any one of putting the wire in a water bath ; taking the reading quickly; switching off between readings; using only small currents; voltage = current × resistance ;	Reject insulating the wire Allow to return to room temperature Allow V = I × R and rearrangements	
ii	horizontal line above axis;		1
		Total	10

Q16.

Question number	Answer	Notes	Marks
(a) i	0.45;	no unit penalty	1
ii	Power = current × voltage;		1
iii	Substitution; Evaluation; e.g. 1.5= I x 0.45 I = 3.3 (A) (answer to at least 2 s.f.)	Allow P = I × V and rearrangements Allow reverse argument yielding 1.35 (W) for 1mark	2
(b) i	conversion of time to seconds; substitution into correct equation (E = I × V × t); evaluation; e.g. time = 7 × 5 × 60 × 60 (= 126 000) E = 3.3 x 9 x 7 x 5 x 60 x 60 3 742 000 (J)	Allow solution in stages i.e. from P=IV and P =E/t Allow for full marks 3 402 000 (J) (from use of 3 A given above) 3 780 000 (J) (from 1.5 x 20 x 7 x 5 x 60 x 60) Allow max of 1 if time not in seconds, e.g. 1040 (J) (from 3.3 x 9 x 7 x 5, time in hours) 62400 (J) (from 3.3 x 9 x 7 x 5 x 60, time in minutes)	3
ii	A description to include electrical; to **light** (and heat);	Reject "electricity" for the first mark Allow chemical to electrical to light for 1 mark only	2
		Total	9

Q17.

Question number	Answer	Notes	Marks
(a) (i)	C – a fuse		1
(ii)	Idea of independent switching for lamps / rooms;	Allow idea of one bulb blowing but not affecting others idea that bulbs in parallel are bright(er than in series)	1
(b)	MP1. Idea of current changing **direction**; MP2. Continuously;	vary is not enough Allow + and – current Can be shown as a diagram /graph (assume axes labels) Minimum requirement: MP1 shows both + and - (e.g. approximate sine curve) MP2 more than one cycle	2
(c) (i)	Conversion to seconds; Substitution in correct formula; Evaluation; e.g. t = 7 × 3600 (= 25200 s) E = 0.12 × 230 × 7 × 3600 700 000(J)	Allow 3600 or 25200 seen anywhere in working (695520) Correct answer without working scores full marks Accept alternative matching unit e.g. 696 kJ 11592 = 2 marks (time in mins) 193.2 = 2 marks (time in hours) Answer in Wh or Wmin with matching unit scores full marks.	3
(ii)	**B** - same as - less than		1

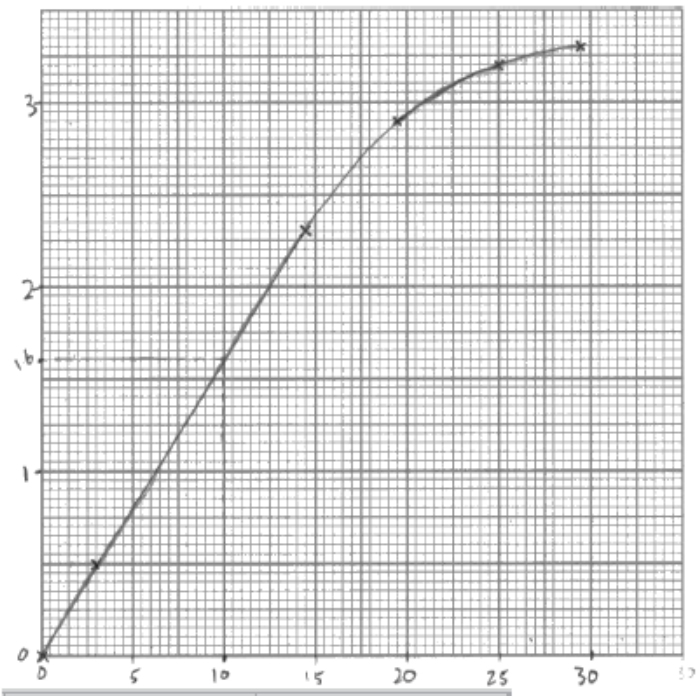
Total 8 marks

Q18.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a)</td><td>A</td><td></td><td>1</td></tr>
<tr><td>(b) (i)</td><td>suitable scales;

6 points plotted;;

curve of best fit;

<table>
<tr><th>Voltage across X in V</th><th>Current in X in A</th></tr>
<tr><td>0</td><td>0</td></tr>
<tr><td>3.0</td><td>0.5</td></tr>
<tr><td>14.5</td><td>2.3</td></tr>
<tr><td>19.5</td><td>2.9</td></tr>
<tr><td>25.0</td><td>3.2</td></tr>
<tr><td>29.5</td><td>3.3</td></tr>
</table></td><td>• Must use > half width and half height of grid
• to nearest ½ square, up to two marks available for this, -1 each error
• reject dot to dot
• allow a reasonably smooth curve, points should be evenly distributed about the line</td><td>4</td></tr>
</table>

(ii)	V= I x R	in words, or accepted symbols or rearranged	1
(iii)	value of I from graph; rearranged equation/sub into equation; evaluation; unit; e.g. I= 1.6 (±1/2 a small square) 10 = 1.6 x R OR R = 10/1.6 R= 6.3 Ω / ohms	allow ECF from graph answers without working can gain full marks R= 6.25 allow answers which round to a number in the range 5.8 to 6.3	4
(iv)	any three **descriptions** from:- MP1. as V increases I increases (at first); MP2. constant gradient/constant R (at first); MP3. I is proportional to V; MP4. gradient changes at high voltage/eq; MP5. ΔI smaller (than previously) for V > 15V;	allow as I increases V increases graph line linear (at first) nonlinear above ~ 15 V graph is less steep at high voltage R increases for V > 15V (to ~8Ω) ignore slows down positive correlation	3

(v)	any two **conclusions** from:- MP1. resistance is constant at first; MP2. **resistance** is not constant / **resistance** increases as V (or I) increases; MP3. because X gets hot(ter); MP4. X is a filament lamp;	allow V and I are proportional at first, it obeys Ohms law at first non-ohmic /does not obey Ohms law / V and I are not proportional increasing temperature total marks = 15	2

(Total for question = 15 marks)

Q19.

Question number	Answer	Notes	Marks
a i	Power = current x voltage;	Accept • rearranged equation • equation in recognised symbols	1
ii	Substitution and rearrangement; Evaluation; eg I = 2000 / 230 8.7 (A)	Accept • 9 (A) • 8.695.....(A) ETC NOT • 8.6 incorrect truncation • 9.0 incorrect rounding	1 1
iii	D 13 A		1
b	Series – single switch to control both; Parallel – independent control;	Allow idea of one element failing (and the other continuing) ignore comments about voltages or currents there is no mark for getting the 2 answers reversed	1

c i	ANY FOUR FROM – MP1. earth connected to (metal) casing; MP2. If casing becomes live/ live wire touches case; MP3. Provides low resistance path (to earth); MP4. (So) large/surge current <u>in earth wire</u>; MP5. (hence) fuse breaks/melts/blows; MP6. (so) circuit switches off or current stops or supply cuts off;	Allow circuit breaker(RCCB) DO NOT CREDIT: the electricity goes to the ground/eq for MP3	4
ii	any two from MP1. It has a metal case; MP2. Metals/the case conducts (electricity); MP3. to prevent (user getting) a shock;		1 1

Q20.

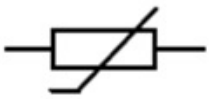
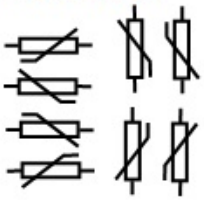
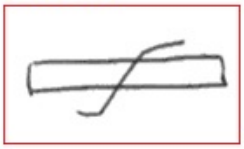
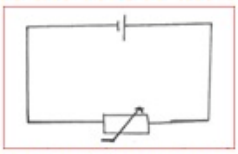
Question number	Answer	Notes	Marks
(a)	any three of the following: MP1. current increases during first **0.04s**/ to maximum of **0.4A**; MP2. current increase is **linear** /proportionate to time; MP3. (then) current drops for next **0.44s** / by **0.48s**; MP4. current decrease is **nonlinear**; MP5. (final)current constant value is **0.2 A**/ from **0.48s** onwards;	 allow 'at first' for first 0.04s allow 0.5s allow 0.5s	3
b i	0.2 A;		1
ii	V= I R;	accept words or standard symbols	1
iii	substitution; rearrangement; evaluation; unit; e.g. 12 =0.2×R R= 12/0.2 =60 Ω	**accept ecf from bi** independent mark	4
iv	P= IV;	accept words or standard symbols	1
v	substitution; evaluation; e.g. P= 0.2 ×12 2.4 (W)	**accept ecf from bi**	2
c	filament heats up very rapidly (at the start); causing it to melt/ break;	allow wire for filament	2

Q21.

Question number			Answer	Notes	Marks
	(a)		Electrical; Chemical / potential;		2
	(b)	(i)	Charge = current x time;	Accept rearrangements and standard symbols e.g. current = $\frac{\text{charge}}{\text{time}}$ Q = I x t I=Q/t ignore units	1
		(ii)	Substitution; Calculation; Matching correct unit i.e. coulomb/C; e.g. Q = $\frac{400 \times 3.5 \times 3600}{1000}$ 5000 C	 Allow mC Allow 5040 **MAX 2 if** time not converted into s (1.4, 1400, 60, 60 000,seen) POT error seen	3
	(c)		Longer (charging) time needed; Any **one** of P=IV; Lower current OR charge (supplied at a) lower rate; rate of charging lower/ less energy available;		2

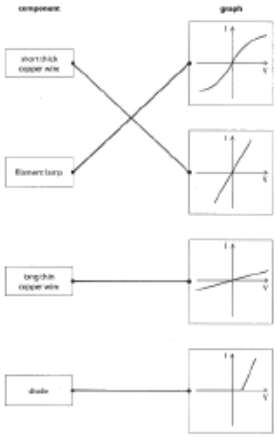
Total 8 marks

Q22.

Question number	Answer	Notes	Marks
(a)	 Symbol can be in any orientation, e.g. 	the line through the rectangle **must** be correct  =0 Ignore the size Ignore the rest of the circuit  e.g. =0 as the line through is incorrect Allow without the connection leads  =1	1
(b) (i) (ii)	Voltage = current x resistance; Convert milliamps to amps OR kilo-ohms to ohms; Substitution into *correct* equation & rearrangement; Calculation to greater than 1SF; 2.6 mA = 0.0026 A (R) = $\frac{13.2}{0.0026}$ = 5077 (Ω)	Allow V = IR Allow rearrangements ignore a bald 'triangle' 'show that' question, working must be shown for full mark Allow 5080, 5076 (truncation) 5.080 with working is worth 2 marks 5.08 with no working is worth 1 mark	1 3

(c)	Any **five** of *ABOUT A* 1. Resistance of A decreases with temperature; 2. For A, {largest slope / rate of change} is at lower temperature ORA {smallest slope /rate of change} is at higher temperature; 3. A is a thermistor (ntc); *ABOUT B* 4. Resistance of B increases with temperature; 5. For B, {largest slope / rate of change} is at higher temperature(s) ORA {smallest slope /rate of change} is at lower temperature; 6. For B, resistance is constant below 50 °C; *ABOUT BOTH* 7. More results for B/ fewer results for A; 8. stated both relationships are non-linear; 9. Range of (temperature/resistance) values for both is similar; 10. data comparison e.g. both have the same resistance at 80 °C;	**Accept** • (MP1) for A, when the temperature is low, the resistance is high, ORA • (MP4) for B, when the temperature is low, the resistance is low, ORA **Allow** component B is a ptc thermistor ORA Up to 60 °C **Ignore:** inversely proportional positive/negative correlation Do **not** take implication of MP8 when MP 1,2,4,5 is given	5
		Total	**10**

Q23.

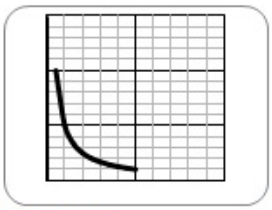
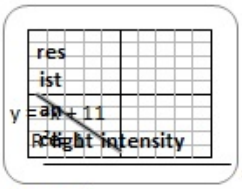
Question number	Answer	Notes	Marks
(a)	any four in any order voltmeter; ammeter; power supply; **variable** resistor/connecting wires/switch;	 accept battery accept variable power supply for 2 marks	4
(b) i	any 1 of the following: MP1. resistance changes with temperature; MP2. temperature affects current; MP3. the wire will get hot because of the current;		1
ii	any suitable method; further detail; e.g. use a switch only on for short time allow wire to cool between readings use only low current	 allow water bath	2
(c)	4 correct lines score 3 marks;;; 2 or 3 correct lines score 2 marks;; 1 correct line scores 1 mark;  -1 if multiple lines drawn to or from the same box		3

Q24.

Question number	Answer	Notes	Marks
(a)	C (132 000 V);		1
(b)	B (efficiency of transmission);		1
(c)	C (transformer);		1

Total 3 marks

Q25.

Question number	Answer	Notes	Marks
	Bright light low resistance/Dim light high resistance; Idea of an inverse relationship between R and intensity; e.g. 'bright at lower resistance' ORA =2 marks Idea of non-linear relationship;	ACCEPT Correct answers shown on a labelled sketch graph (light / intensity / light intensity acceptable for one axis, resistance for the other)  = 0 (axis/axes not labelled)  = 2 (first two marking points)  = 3 marks If diagram and text contradict, use list principle REJECT Negative values of resistance or light intensity in sketch graph for 1 mark	3

Total 3 Marks

Q26.

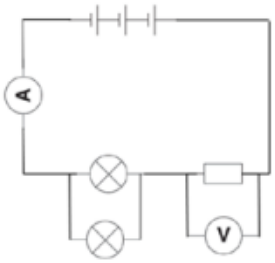
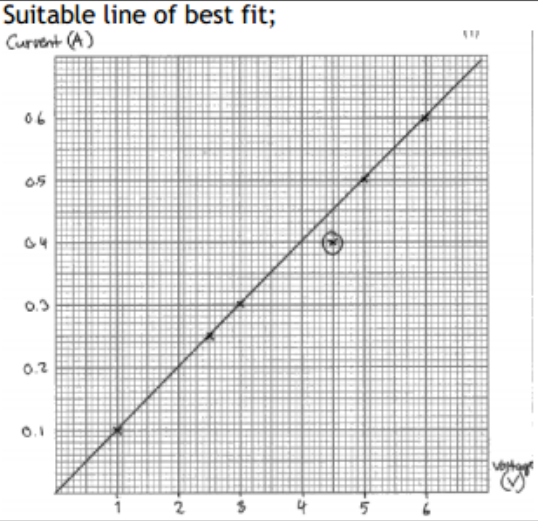
Question number	Answer	Notes	Marks
(a) (i)	voltage = current x resistance	ACCEPT equivalent rearrangement ACCEPT suitable abbreviations e.g. V = I x R REJECT V = I x □ REJECT equation 'triangles' alone	1
(ii)	1.2 x 4.0; 4.8 (V);		2
(iii)	12 – 4.8; 7.2 (V);	ECF on (ii)	2
(iv)	E = VIt (NO MARK) time conversion to seconds (5.0 x 60); 7.2 x 1.2 x (5.0 x 60); 2600 (J);	ECF on (iii) Allow 2592 or 2590 ALLOW 2500/2520 (J) for full marks (using 7 V) ALLOW 42 (J) or 43.2 (J) for 2 marks (using 5 mins)	3
(v)	idea of energy losses rate of energy loss = rate of energy supply (at steady temp)	 NB this statement alone scores (2) as it includes idea of energy loss	2
(b) (i)	X – series, Y – parallel	BOTH REQUIRED for the mark	1
(ii)	THREE SUITABLE, e.g.- series advantage – fewer wires; series advantage – lower resistance values; series disadvantage – one fails, circuit fails; series disadvantage – no independent control;	ALLOW REVERSE ARGUMENTS in terms of parallel circuits but do not award the same mark twice IGNORE refs to efficiency ACCEPT correct answers that link to battery voltage / current, etc	Max 3

Q27.

Question number	Answer	Notes	Marks
(a) (i)	thermistor labelled correctly	ACCEPT: ringed thermistor	1
(ii)	correct voltmeter symbol ; connected in parallel with thermistor ;	REJECT: connected in parallel with battery	2
(b) (i)	voltage = current x resistance	Or equivalent – resistance = voltage ÷ current V = I x R	1
(ii)	Substitution 12 = 0.002 x R; Calculation R = 12 / 0.002 = 6000 (Ω);	If (i) is blank, but correct equation written in (ii), then credit. 12 = 2 x R = 6 (Ω) gets 1 mark Bald answer 2 marks 6 kΩ gets 2 marks	2
(iii)	Suitable size chosen (>50% of grid used); Axes labelled with quantities and units (either way around); Plotting to nearest half square (minus one for each plotting error);; Curved line of best fit acceptable;	ACCEPT: ° OR C REJECT: joining the dots Bar chart for 4 max	5
(iv)	current increases with temperature ; non-linear relationship OWTTE ;	ACCEPT: positive correlation	2
(v)	Any **two** of student is wrong ; because current increases with temp (for constant voltage) ; so resistance decrease with temp ;	"student is correct" scores 0 marks Because it is an ntc thermistor for 1 mark ACCEPT: relevant use of figures for resistance from graph/table	2

Total 15 marks

Q28.

Question number	Answer	Notes	Marks
(a)	mark each of these independently: MP1. a **resistor** in series with the lamp only; MP2. a second lamp in parallel with the first lamp; MP3. a voltmeter that measures the voltage across the **resistor**; MP4. an ammeter that measures the total current in the circuit;	circuit symbols used must be correct (no square voltmeter/ammeter etc.)  	4
(b) (i)	labels on axes including units; scales on axes; plotting;;	axes can be either way round must occupy >50% in each direction -1 for each error	4
(ii)	I = 0.4, V = 4.5 clearly indicated;		1
(iii)	Suitable line of best fit;  	<table><tr><th>Voltage in V</th><th>Current in A</th></tr><tr><td>1.0</td><td>0.10</td></tr><tr><td>2.5</td><td>0.25</td></tr><tr><td>3.0</td><td>0.30</td></tr><tr><td>4.5</td><td>0.40</td></tr><tr><td>5.0</td><td>0.50</td></tr><tr><td>6.0</td><td>0.60</td></tr></table>	1
(iv)	voltage = current x resistance;	in words or standard symbols	1
(v)	substitution into correct equation using any suitable pair of values taken from the graph line or table; evaluation of R = 10 (Ω);	allow (0.1,1), (0.6,6) etc	2

Total 13 marks