Exampro GCSE Physics

Name:

Class:

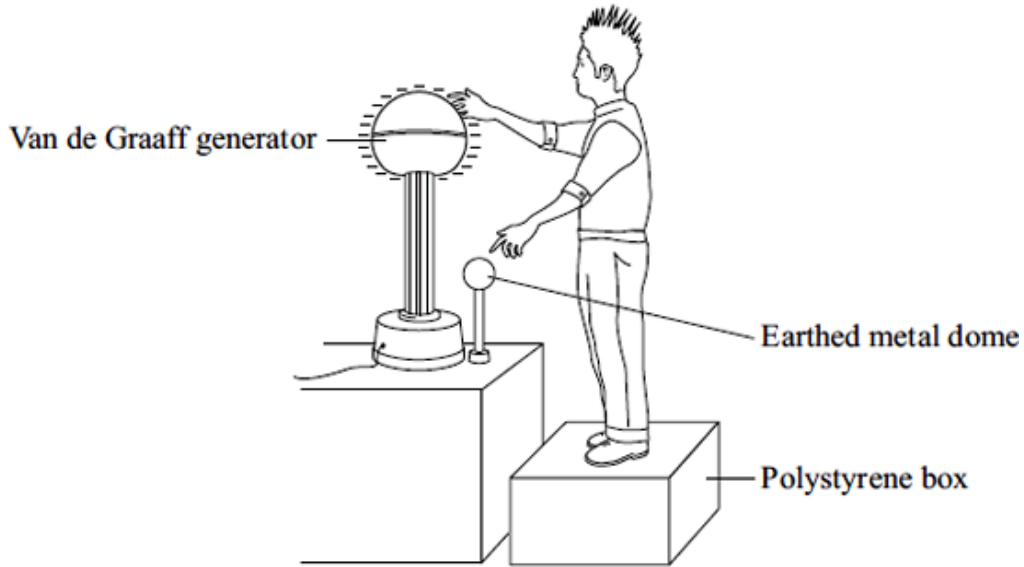## P2 Circuits and Electricity Self Study Questions Higher tier

Author:

Date:

Time: 90

Marks: 90

Comments:

Q1. (a)   The diagram shows a student touching the metal dome of a Van de Graaff generator. When the generator is switched on, the metal dome becomes negatively charged.

Explain why the student's hair stands on end when the generator is switched on.

....

....

....

(2)

(b)   When the potential difference between the student and a nearby earthed metal dome reached 15 kV, a spark jumped between the student and the earthed dome. The spark transformed 30 mJ of energy into heat, light and sound. (1 mJ = 0.001 J)

Use the equation in the box to calculate the charge carried by the spark.

energy transformed = potential difference × charge

....

....

Charge transferred =.. coulombs

(2)

(c)   What name is given to the rate of flow of charge?

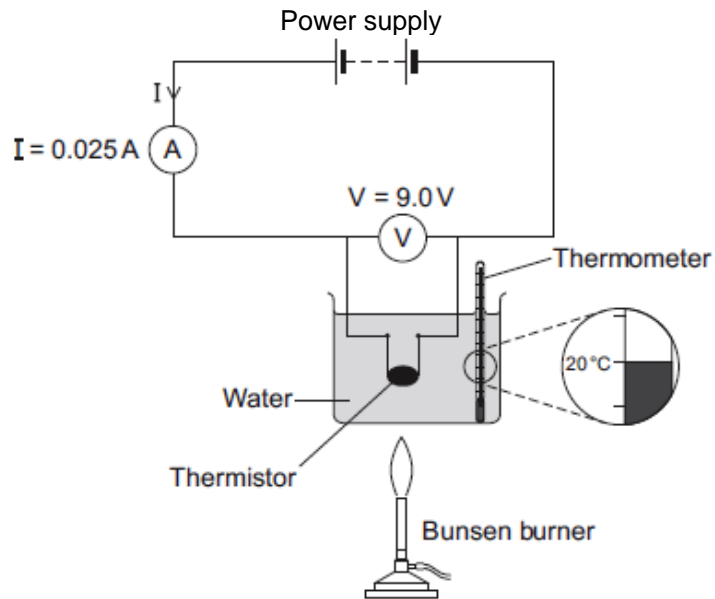...
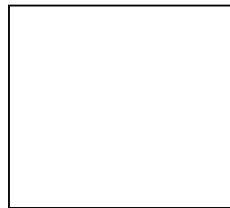
(1)
(Total 5 marks)

Q2. (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.

Use the correct equation from the Physics Equations Sheet.

....

....

....

Resistance = ... ohms
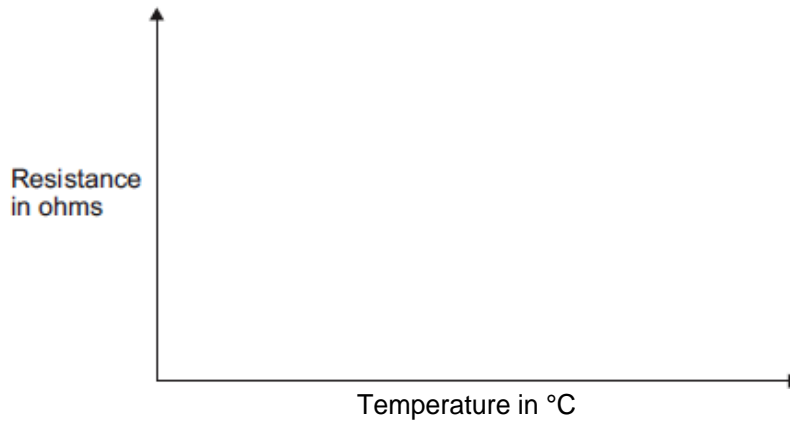
(2)

(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

Resistance in ohms

Temperature in °C

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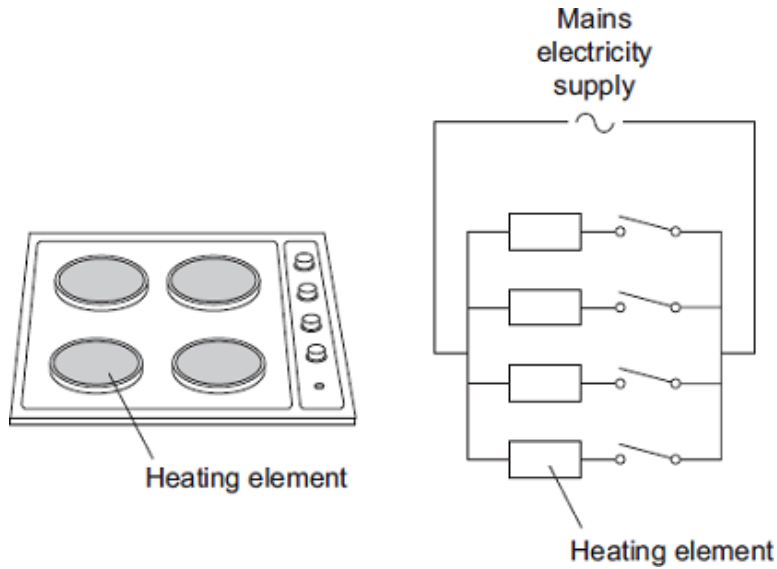
Describe what other changes the student should make to the apparatus.

....

....

....

....

(2)
(Total 9 marks)

Q3.   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.

Heating element

Heating element

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.

Use the correct equation from the Physics Equations Sheet.

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

(i)   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)

(ii)   Describe the structure of the cable that should be used to connect the electric cooker hob to the mains electricity supply.

....

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....

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....

(3)

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

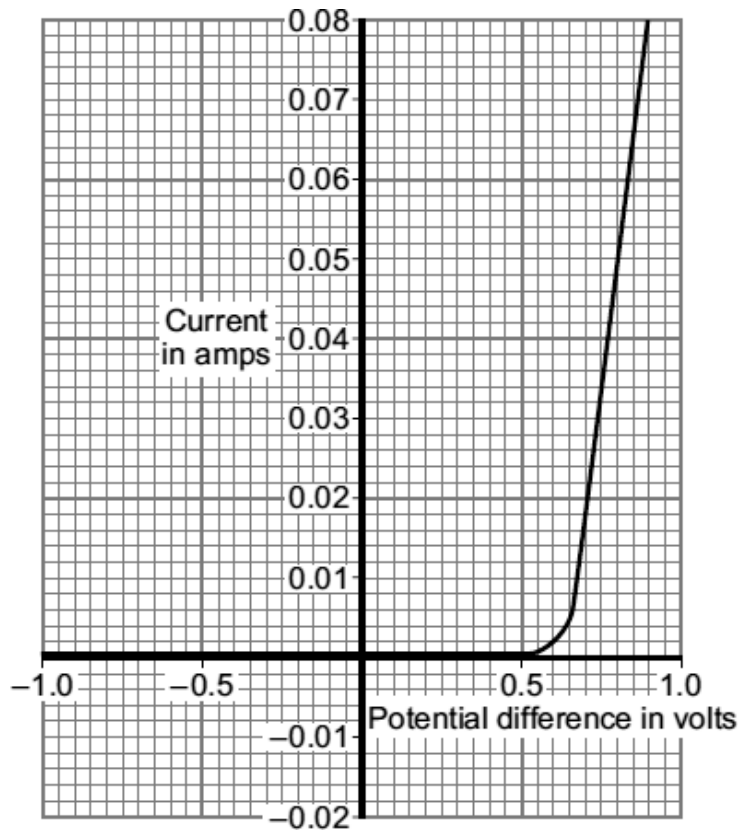What is the difference between an alternating current and a direct current?

....

....

....

....

(2)
(Total 10 marks)

Q4.   The current–potential difference graph for one type of electrical component is drawn below.

(a)   What is the component?

....

(1)

(b)   Complete the diagram to show a circuit that can be used to obtain the data needed to plot the graph. Use the correct circuit symbol for each component that you add to the diagram.
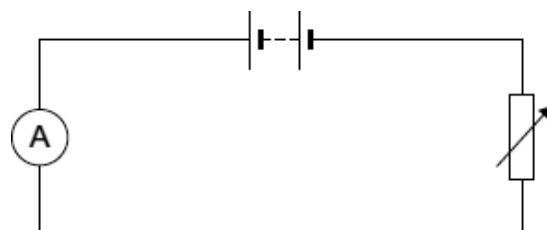
(2)

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

Current .... amps

(1)

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

potential difference   =   current   ×   resistance
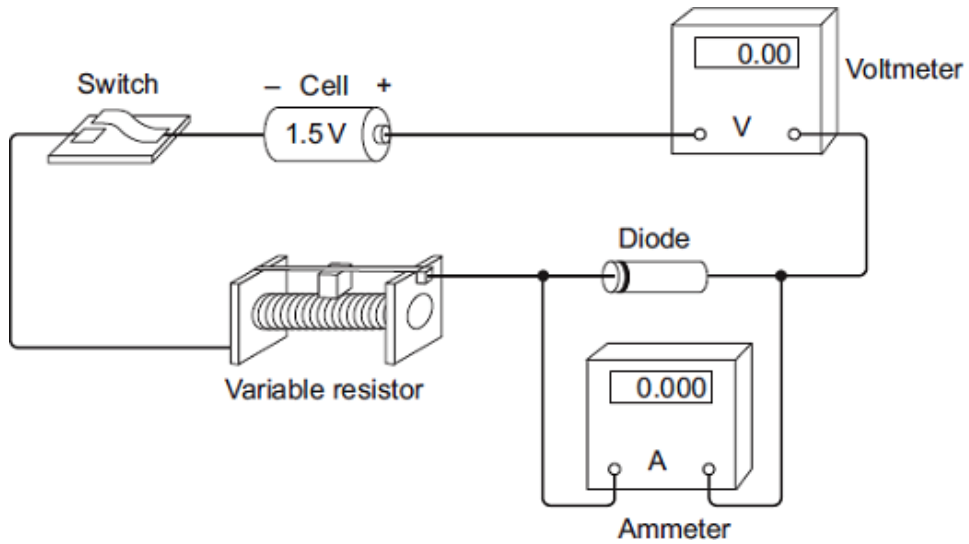
Show clearly how you work out your answer.

....

....

Resistance = ... Ω

(2)

(Total 6 marks)

Q5.   (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.
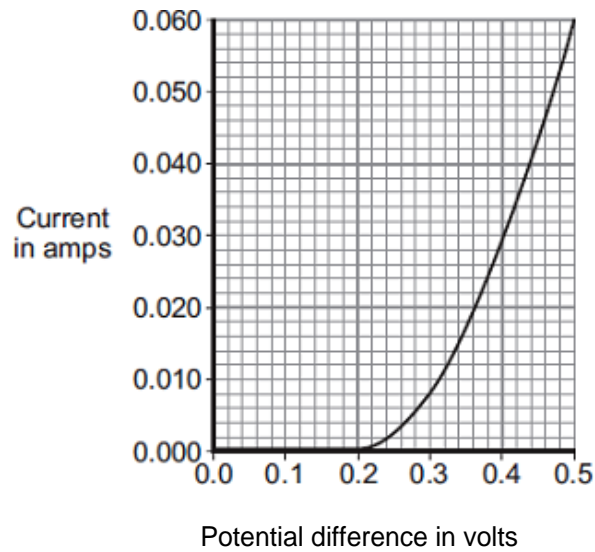
Diode

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.

Potential difference in volts

(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.

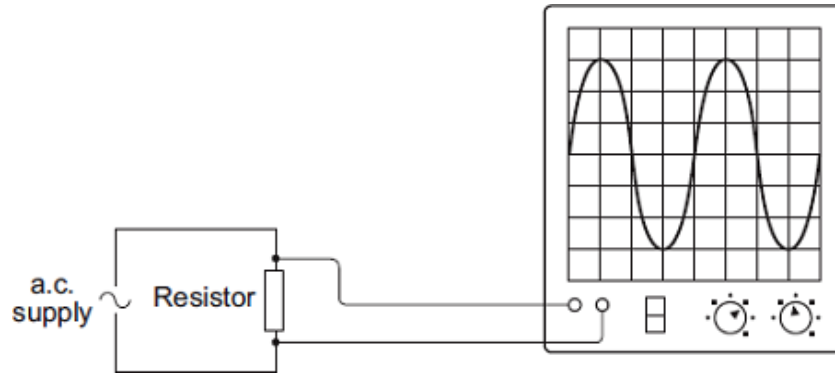Use the correct equation from the Physics Equations Sheet.

....

....

....

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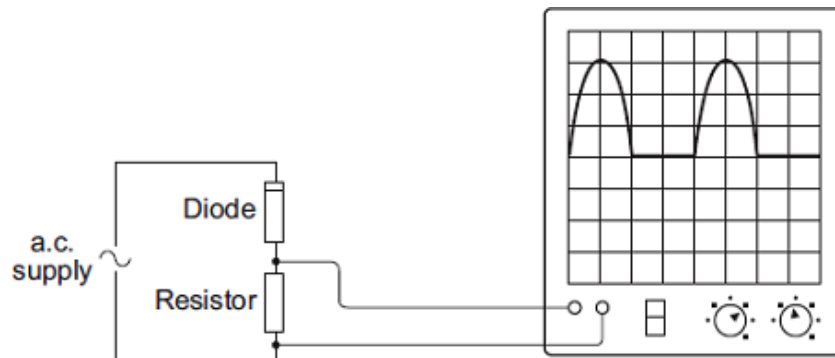
(i) Calculate the frequency of the a.c. supply.

....

....

....

Frequency = ... hertz

(2)

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

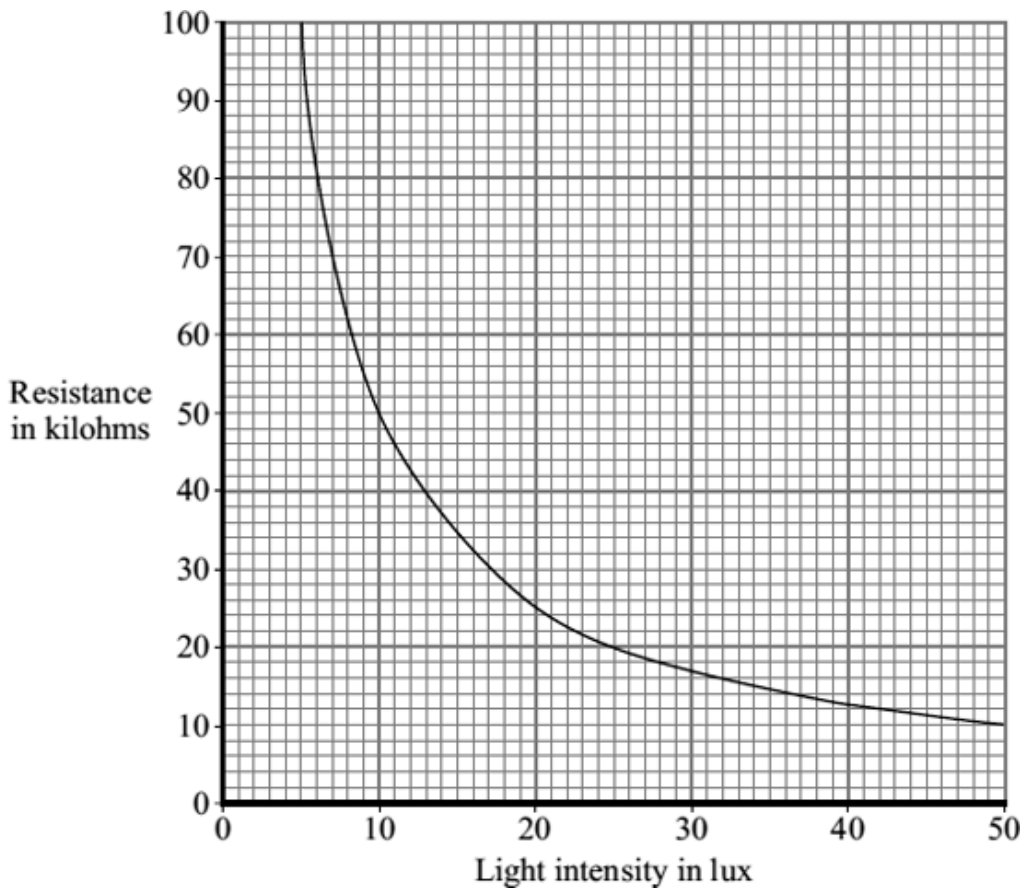Why does the diode cause the trace on the oscilloscope screen to change?

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(2)
(Total 12 marks)

Q6. The diagram shows a simple light-sensing circuit.
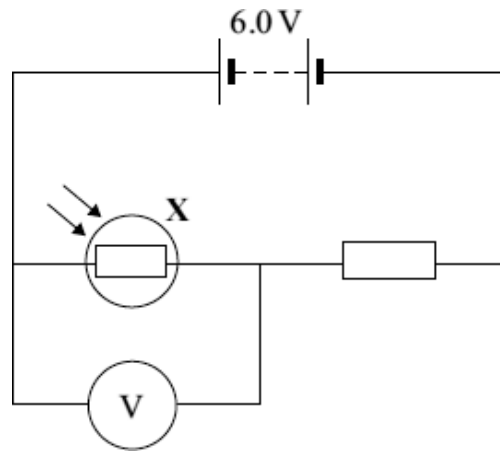
(a) The graph, supplied by the manufacturer, shows how the resistance of the component labelled **X** varies with light intensity.

(i) What is component **X**?

....

(1)

(ii) Use the graph to find the resistance of component **X** when the light intensity is 20 lux.

....

(1)

(iii)   When the light intensity is 20 lux, the current through the circuit is 0.0002 A.

Use the equation in the box to calculate the reading on the voltmeter when the light intensity is 20 lux.

$$potential\ difference\ =\ current\ \times\ resistance$$

Show clearly how you work out your answer.

....

....

Voltmeter reading =.. volts

(2)

(b)   Use the grid below to show how the voltmeter reading in the light-sensing circuit varies with light intensity.

(i)   Add a suitable scale to the *y*-axis (vertical axis).

(1)

(ii)   Complete the sketch graph by drawing a line on the grid to show how the voltmeter reading will vary with light intensity.

Voltmeter
reading
in volts

0   10   20   30   40   50
Light intensity in lux
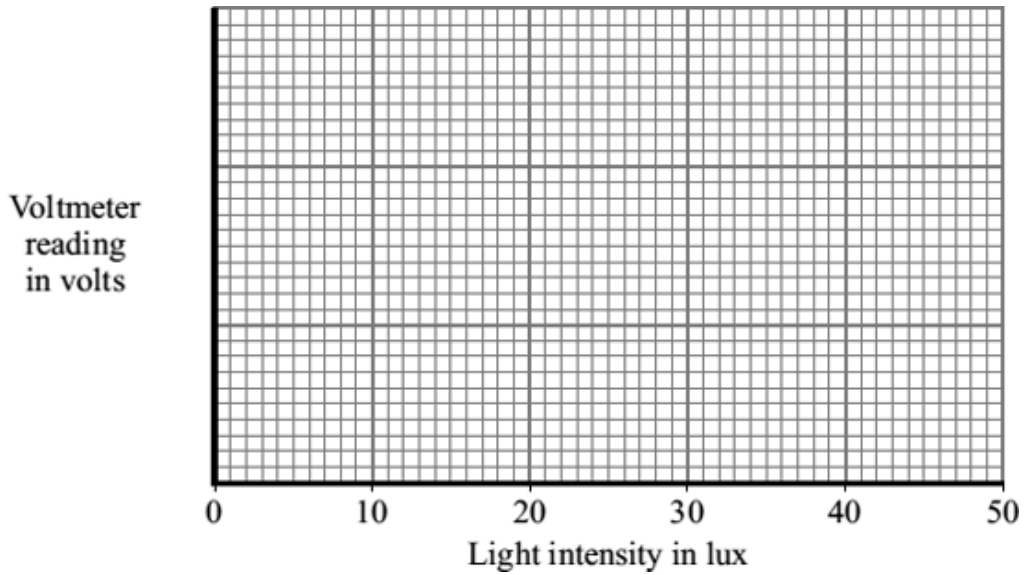
(2)

(c)   The following passage is taken from the technical data supplied for component **X** by the manufacturer.

> For any given light intensity, the resistance of this component can vary by plus or minus 50% of the value shown on the **graph of light intensity and resistance**.

(i)   Calculate the maximum resistance that component **X** could have at 20 lux light intensity.

....

Maximum resistance =.. kilohms

(1)

(ii)   Explain why this light-sensing circuit would **not** be used to measure values of light intensity.

....

....

....
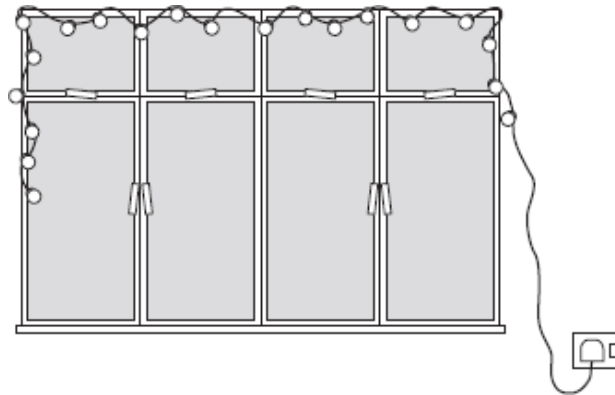
(2)
(Total 10 marks)

Q7.   A set of lights consists of 20 lamps connected in series to the 230 V mains electricity supply.

(a)   When the lights are switched on and working correctly, the current through each lamp is 0.25 A.

(i)   What is the total current drawn from the mains supply?

....

(1)

(ii) Use the equation in the box to calculate the charge passing through **one** of the lamps in 5 minutes.

charge = current × time

Show clearly how you work out your answer and give the unit.

....

....

....

....

Total charge = ...

(3)

(b) One of the lamps in the set is a fuse lamp. This contains a filament which melts if a fault occurs. A short time after the lights are switched on, a fault causes the filament inside the fuse lamp to melt and all the lamps go out.

The householder cannot find another fuse lamp so connects a piece of aluminium foil across the contacts inside the fuse lamp holder.
When switched on, the nineteen remaining lamps work.
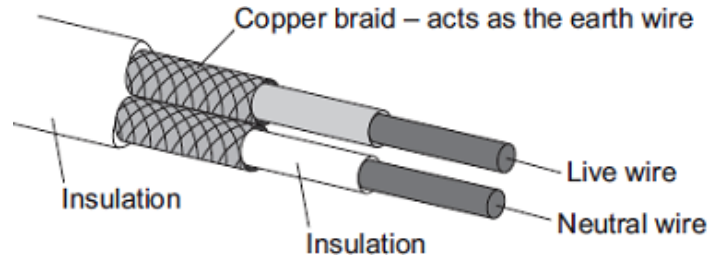What the householder has done is dangerous.

Explain why.

....

....

....

....

(2)
(Total 6 marks)

Q8. 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 (RCCB). If the cable is accidentally cut the RCCB 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 RCCB 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 RCCB 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.

Use the correct equation from the Physics Equations Sheet.

....

....

....

Charge = ...

(3)

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

Use the correct equation from the Physics Equations Sheet.

....

....

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.

....

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....

....

(2)
(Total 11 marks)

Q9.   (a)   Describe the difference between an alternating current (a.c.) and a direct current (d.c.).

....

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....

....

(2)

(b)   The diagram shows how the electric supply cable is connected to an electric kettle. The earth wire is connected to the metal case of the kettle.
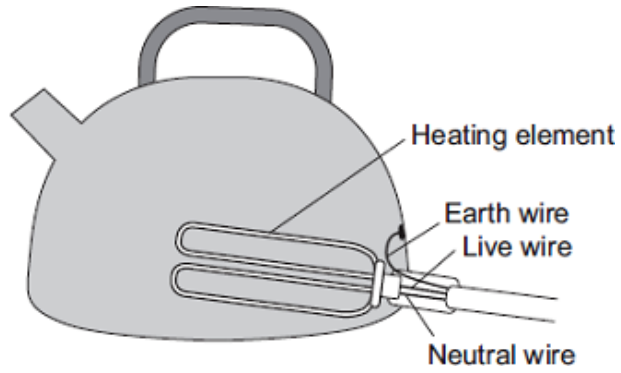
If a fault makes the metal case live, the earth wire and the fuse inside the plug protect anyone using the kettle from an electric shock.

Explain how.

....

....

....

....

(2)
(Total 4 marks)

Q10. (a) The picture shows a person using a set of electronic 'Body Fat Scales'. When the person stands on the scales, a small, harmless, electric current passes through the person's body. The scales then calculate the resistance of the person's body and convert the resistance into a *prediction* of body fat content.

(i) The scales contain two 3 V cells joined in series.

Calculate the resistance of a person's body, if when he stands on the scales, a current of 0.12 mA passes through his body.

1000 mA = 1 A

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer and give the unit.

....

....

....

Resistance = ...

(3)

(ii) The scales can only produce a *prediction* of body fat content and not an accurate measurement.

Suggest why.

....

....

....

(1)

(iii)   It is recommended that the scales are **not** used immediately after a person has drunk a large amount of water.

Suggest why.

....

....

....

....

....

(2)

(b)   The diagram shows how someone could get an electric shock from accidentally cutting into an electric cable. If this happens, and a Residual Current Circuit Breaker (RCCB) is being used, the circuit will switch off automatically.
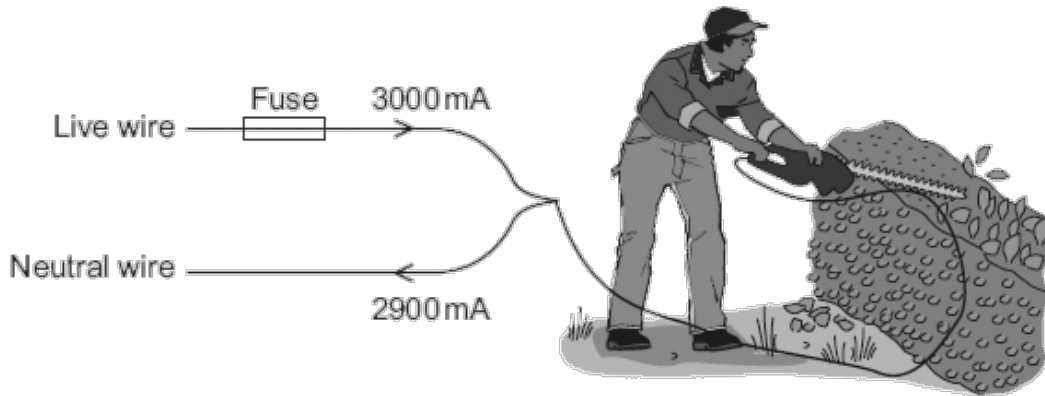
(i)   A faulty appliance or circuit can be switched off by a RCCB or a fuse.

Compare the action of a RCCB with the action of a fuse.

....

....

....

....

....

(2)

(ii)   The graph shows how the severity of an electric shock depends on the size of the current and the time that the current flows through the body.
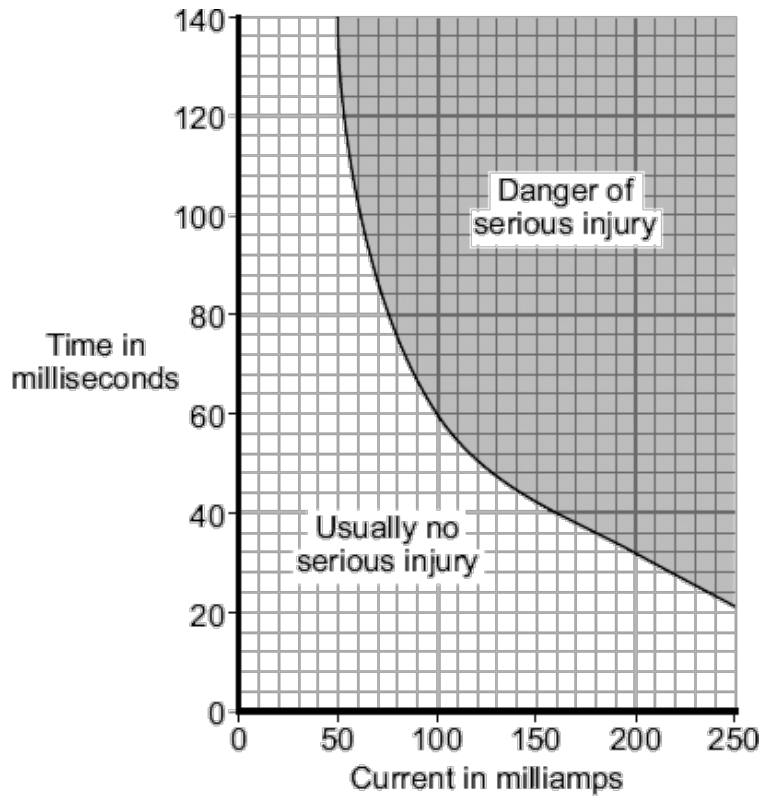
Using the RCCB helps prevent an electric shock seriously injuring the person using the hedge trimmers.

Using information from both the diagram and the graph explain how.

....

....

....

....

....

(2)
(Total 10 marks)

Q11.   (a)   The resistance of a 24 W, 12 V filament lamp depends on the current flowing through the lamp. For currents up to 0.8 A, the resistance has a constant value of 2.5 Ω.

(i)   Use the equation in the box to calculate the potential difference across the lamp when a current of 0.8 A flows through the lamp.

> potential difference   =   current   ×   resistance

Show clearly how you work out your answer.

....

....

Potential difference = ... V

(2)

(ii)   When the potential difference across the lamp is 12 V, the current through the lamp is 2 A.

On the axes below, draw a current–potential difference graph for the filament lamp over the range of potential difference from 0 to 12 volts.
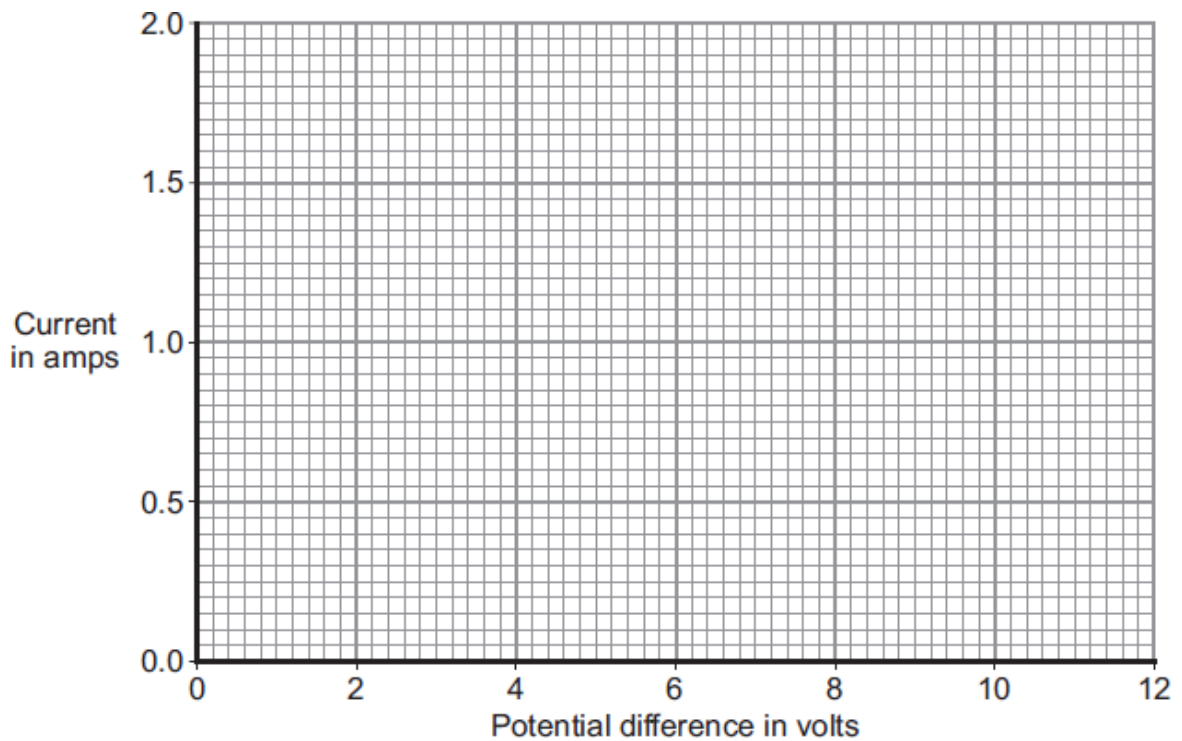
(2)

(iii)   Why does the resistance of the lamp change when the current through the lamp exceeds 0.8 A?

....

....

(1)

(b)   The lamp is now included in a circuit. The circuit is switched on for 2 minutes. During this time, 72 coulombs of charge pass through the lamp.
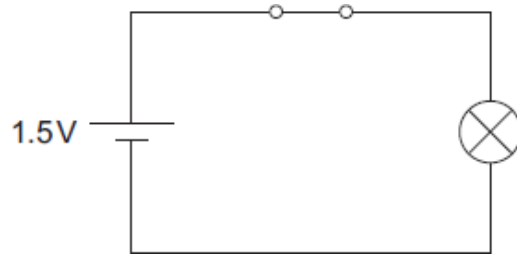
Use the equation in the box to calculate the energy transformed by the lamp while the circuit is switched on.

energy transformed   =   potential difference   ×   charge

Show clearly how you work out your answer.

....

....

Energy transformed = ... J

(2)
(Total 7 marks)

M1. (a)   each hair gains the <u>same</u> (type of) charge
  or
  (each) hair is negatively charged
      *do **not** accept hair becomes positively charged*
  or
  (each) hair gains electrons

1

  similar charges repel
      accept positive charges repel
      providing first marking point is in terms of positive charge
  or
  negative charges repel
  or
  electrons repel

1

(b)   0.000002
      *accept correct substitution and transformation for **1** mark*
  or
  2×10^{-6}
      ie 30 / 15 or .03 / 15000 or 30 / 15000 or .03 / 15
  or
  $2\,\mu C$
      *answers 2 and 0.002 gain **1** mark*

2

(c)   current
      *do **not** accept amp / amperes*

1

[5]

M2. (a) (i)
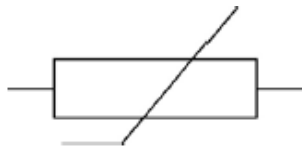
1

(ii)   360
      *allow **1** mark for correct substitution, ie 9 = 0.025 × R*

2

(iii)   sketch graph of correct shape, ie
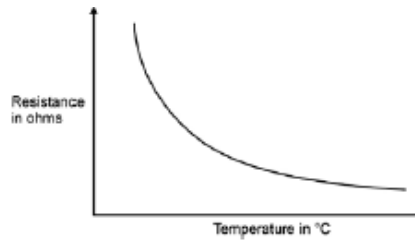
         1

(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]

M3.   (a)   35

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

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

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

        *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)　(i)　(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

　　(ii)　(contains) live, neutral and earth wires

　　　　　accept is a three-core cable

1

　　　　cross-sectional area of (live and neutral) wire(s) (minimum of) 4 mm^2

　　　　　accept 6 mm^2 for 4 mm^2

1

　　　　wire / cable should be insulated

　　　　　accept a suitable named insulator, eg PVC / rubber / plastic

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

[10]

M4.　　(a)　diode

　　　　　accept LED

1

　　(b)　all symbols correct

　　　　　must include at least voltmeter and diode

1
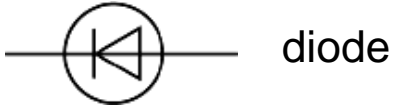
diode

allow ecf from part (a) if the component is not identified as a diode

allow symbol without the line through triangle

ignore polarity of diode

voltmeter in parallel with component added in series

*any additional components must not affect the ability to measure **V** and **I** for the diode / their (a)*

1

(c)　(i)　0.05

accept 50 mA

accept between 0.048 and 0.050 inclusive

1

(ii)　16

$$\frac{\quad 0.8 \quad}{}$$

their (c)(i) correctly calculated gains both marks

*allow **1** mark for correct transformation and substitution*

$$\frac{0.8}{0.05} \; or \; \frac{0.8}{their\ (c)(i)}$$

allow 17 if using 0.048

2

[6]

M5.　(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]

M6.   (a)   (i)   light dependent resistor / LDR
accept ldr

1

(ii)   25 (kilohms)
accept 24 - 26 inclusive
accept 25 000 Ω

1

(iii)   5 (V) or their (a)(ii) correctly converted to ohms × 0.0002 correctly calculated
*allow **1** mark for converting 25 kΩ /*
their (a)(ii) to ohms
or
*allow **1** mark for correct substitution*
ie 0.0002 × 25(000)
or 0.0002 × their (a)(ii)
allow an incorrect conversion from kilohms providing this is clearly
shown

2

(b)   (i)   linear scale
using all of the available axis
must cover the range 4 - 6 v
or their (a)(iii) - 6 v and lie within the range 0 - 15 inc.

1

(ii)   negative gradient line
*do **not** allow lines with both positive and negative gradients*

1

passing through 20 lux and their (a)(iii)

only scores if the first mark is awarded

only scores if line does not go above 6 volts

1

(c)   (i)   37.5 (kΩ) or their (a)(ii) + 50 % (a)(ii) correctly calculated

1

(ii)   light intensity value would be unreliable / not accurate

1

due to variation in <u>resistance</u> value

accept because resistance varies by ± 50 %

accept tolerance of resistor is too great

*do **not** accept results are not accurate*

1

[10]

M7.   (a)   (i)   0.25 (A)

1

(ii)   75

*allow **1** mark for converting 5 minutes to 300 seconds*

***or** allow **1** mark for correct substitution*

ie 0.25 × 300

*allow **1** mark for an answer 1.25*

*allow **1** mark only for their (a)(i) × 300 correctly calculated*

2

coulombs or C

*do **not** accept c*

1

(b)   any **two** from:

- fault not repaired

  accept if a fault was to occur

- larger current will (still) flow

- aluminium foil will not melt (if a fault)

  accept aluminium foil needs a higher current / charge to melt

- wiring will overheat / (may) cause a fire

  accept idea of fire hazard

  *do **not** accept explode etc*

2

[6]

M8.   (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 <u>current</u> 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]

M9. (a) d.c. flows in (only) one direction

1

a.c. <u>changes</u> direction (twice every cycle)
> *accept a.c. constantly changing direction*
> *ignore references to frequency*

1

(b) a current flows through from the live wire / metal case to the earth wire
> *accept a current flows from live to earth*
> *do **not** accept on its own if the current is too high*

1

this current causes the fuse to melt
> *accept blow for melt*
> *do **not** accept break / snap / blow up for melt*

1

[4]

M10. (a) (i) 50 000
> *allow **1** mark for correct substitution, ie*
> $6 = 0.00012 \times R$
> **or** $6 = 0.12 \times R$
> **or** *answers of 25 000 or 50 gain **1** mark*
> **or** *allow 1 mark for an incorrect answer caused by one error only ie using 3V or an incorrect conversion of current*

2

ohm / Ω
> *an answer 50kΩ gains **3** marks*

1

(ii) (body) resistance changes

or

body fat/resistance affected by (many) factors
> *accept named factor, eg age, gender, height, fitness, bone structure, muscle, drinking water related to body fat / resistance*

1

(iii) gives misleading / wrong/inaccurate value
> *do not credit if specifically linked to a change in mass / weight*

1

(because) high water content changes body resistance
> *accept a specific change to resistance*
> *water changes body mass is insufficient*

1

(b) (i) RCCB – detects difference between current in live and neutral (wires)
> *accept RCCB can be reset*

1

fuse – (overheats and) melts

accept blows for melts

1

(ii) switches the circuit / hedge trimmers off within 60 milliseconds

*allow for **1** mark the RCCB / it is (very) fast.*

do not accept the bigger the current the faster the RCCB switches off

2

[10]

M11. (a) (i) 2

*allow **1** mark for correct substitution i.e. 0.8 × 2.5 provided no further step shown*

2

(ii) straight line drawn from origin to 2, 0.8
or
their (a)(i), 0.8

1

curve from 2, 0.8 to 12,2
or
their (a)(i) 0.8 to 12,2

accept curve from 2, 0.9 to 12,2

or

their (a)(i) 0.9 to 12,2

'convex' curve required

accept a curve that flattens between 10 and 12V

1

(iii) filament / lamp gets hot

accept temperature increases

1

(b) 108

*allow **1** mark for correct substitution i.e. 1.5 × 72 provided no further step shown*

2

[7]