Q1.
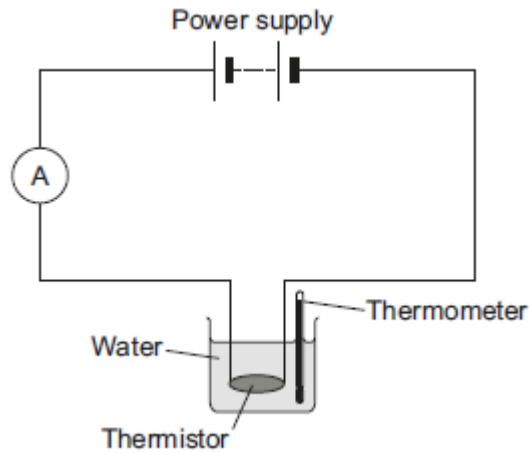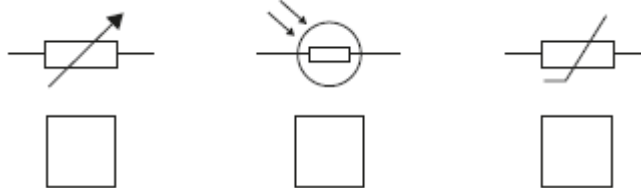
Figure 1 shows the apparatus used to investigate how the current through a thermistor depends on the temperature of the thermistor.

Figure 1

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

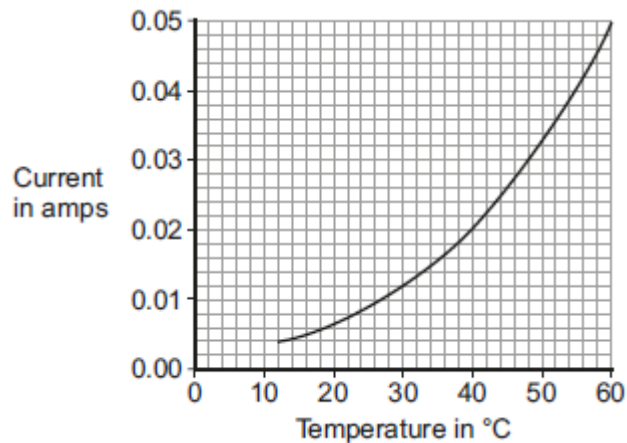Tick (✓) **one** box.

(1)

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

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

Figure 2

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

_____

_____

(1)

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

_____

_____

(1)

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

Current at 40 °C = _____ A

(1)

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

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

_____

_____

_____

_____

Potential difference = _____ V

(2)

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

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

Tick (✓) **one** box.

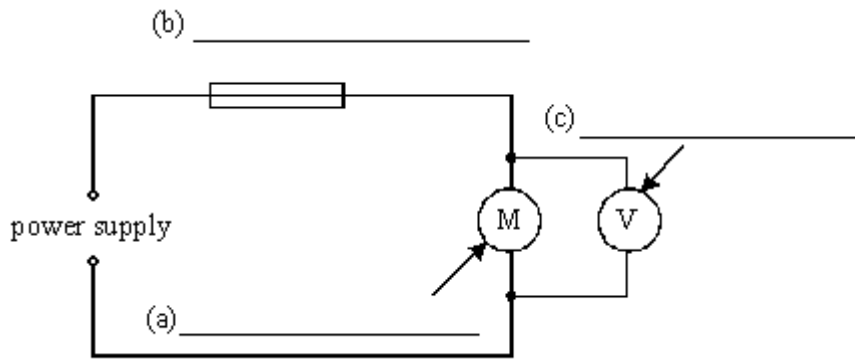the resistance increases   ☐

the resistance does not change   ☐

the resistance decreases   ☐

(1)
(Total 7 marks)

Q2.

Label the parts of the electric circuit below.

(b) _____

power supply

(c) _____

M

V

(a) _____

(Total 3 marks)

## Q3.

(a) Complete the sentence below to name the instrument used to measure electrical current.

The instrument used to measure electrical current is called _____

(1)

(b) In the diagram below each box contains an electrical component or a circuit symbol. Draw straight lines to link each electrical component to its circuit symbol. The first one has been done for you.

voltmeter		▭
lamp		—|—
battery		—|⋯|—
fuse		—(V)—
cell		—(X)—
diode		—(◁)—
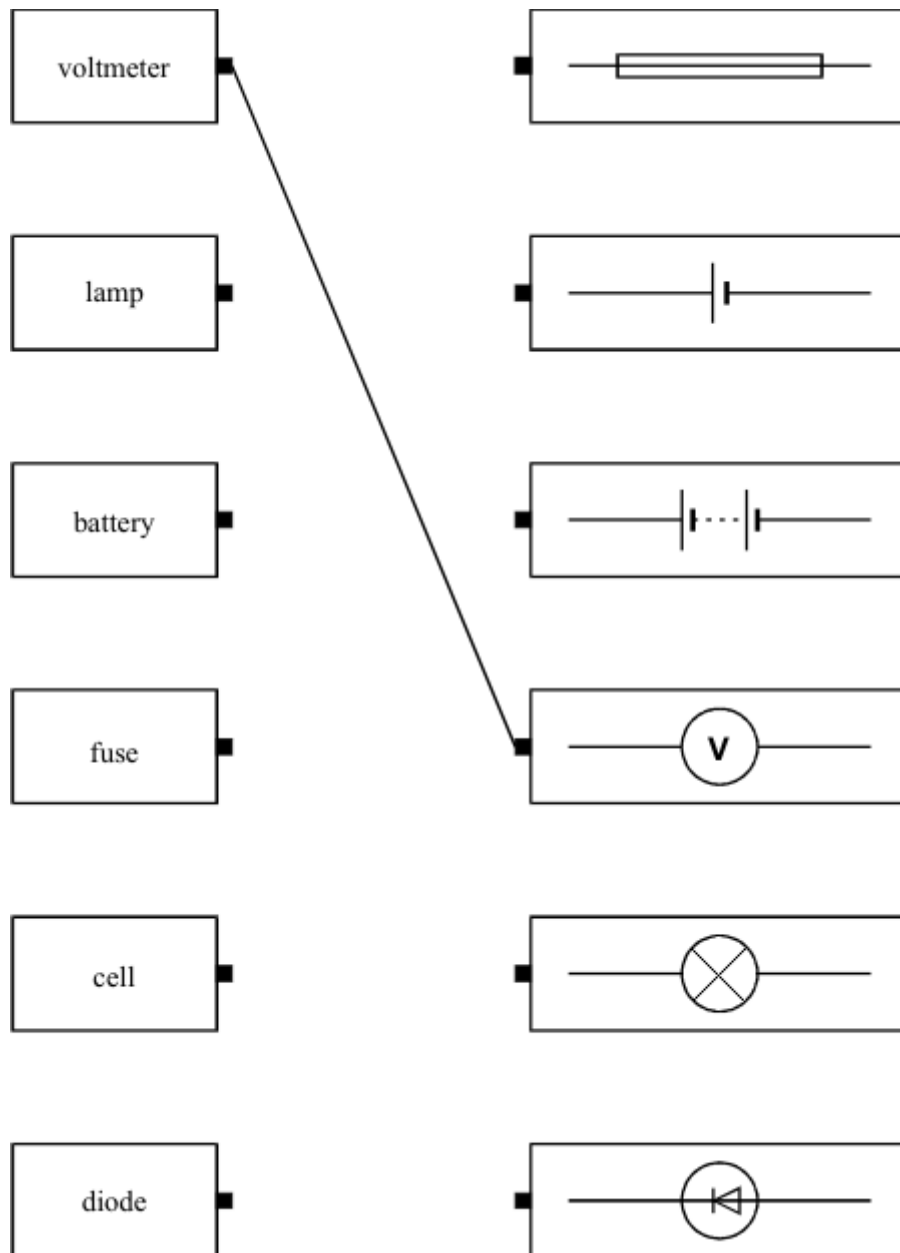
(4)
(Total 5 marks)

Q4.

The graph shows how the current through a filament bulb changes after the bulb is switched on.
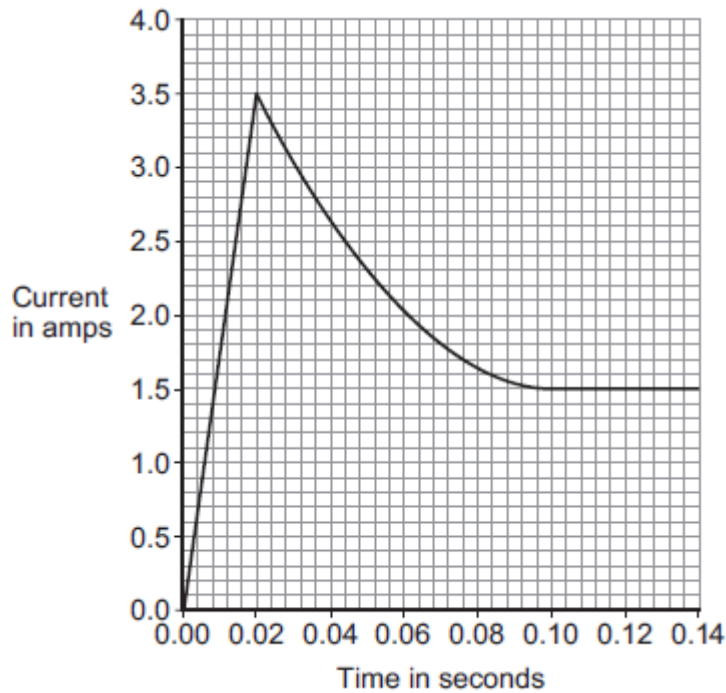
(a)   What happens to the current through the bulb in the first 0.02 seconds after the bulb
       is switched on?

_____

                                                                                    (1)

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

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

              Draw a ring around the correct answer.

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

                                                                                    (1)

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

              Draw a ring around the correct answer.

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

                                                                                    (1)

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

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

       Choose the unit from the list below.

              coulomb   **joule**   **watt**

       _____

       _____

Power = _____ unit _____

Q5.

Table 1 shows information about different light bulbs.

The bulbs all have the same brightness.

Table 1

Type of bulb	Input power in watts	Efficiency
Halogen	40	0.15
Compact fluorescent (CFL)	14	0.42
LED	7	0.85

(a)　(i)　Calculate the useful power output of the CFL bulb.

_____

_____

_____

Useful power output = _____ watts

(2)

(ii)　Use your answer to part **(i)** to calculate the waste energy produced each second by a CFL bulb.

_____

Waste energy per second = _____ joules

(1)

(b)　(i)　A growth cabinet is used to investigate the effect of light on the rate of growth of plants.

The figure below shows a growth cabinet.

In the cabinet the factors that affect growth can be controlled.

A cooler unit is used to keep the temperature in the cabinet constant. The cooler unit is programmed to operate when the temperature rises above 20 °C.

The growth cabinet is lit using 50 halogen bulbs.

Changing from using halogen bulbs to LED bulbs would reduce the cost of running the growth cabinet.

Explain why.

_____

_____

_____

_____

_____

_____

(4)

(ii)   A scientist measured the rate of growth of plants for different intensities of light.

What type of graph should be drawn to present the results?

_____

Give a reason for your answer.

_____

_____

(1)

(c)   **Table 2** gives further information about both a halogen bulb and a LED bulb.

Table 2

Type of	Cost to	Lifetime in	Operating cost over the

bulb	buy	hours	lifetime of one bulb
Halogen	£1.50	2 000	£16.00
LED	£30.00	48 000	£67.20

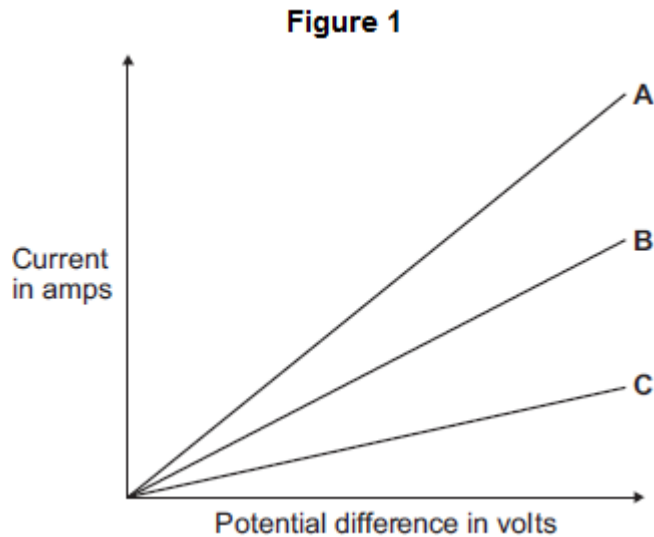A householder needs to replace a broken halogen light bulb.

Compare the cost efficiency of buying and using halogen bulbs rather than a LED bulb over a time span of 48 000 hours of use.

Your comparison must include calculations.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 12 marks)

Q6.

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

Figure 1

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

_____

_____

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

Write the correct answer in the box.

Give a reason for your answer.

_____

_____

_____

(2)

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

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

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

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

What is the unit of resistance?

_____

(1)

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

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

Wire ☐ and wire ☐

Give a reason for your answer.

_____

_____

_____

(2)

(iii) A student looked at the data in the table and wrote this conclusion:

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

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

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

_____

_____

_____

(1)

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

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

Figure 2
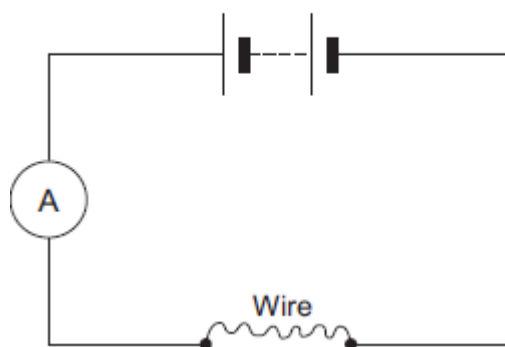
(1)

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

In the box below, draw the circuit symbol for a resistor.
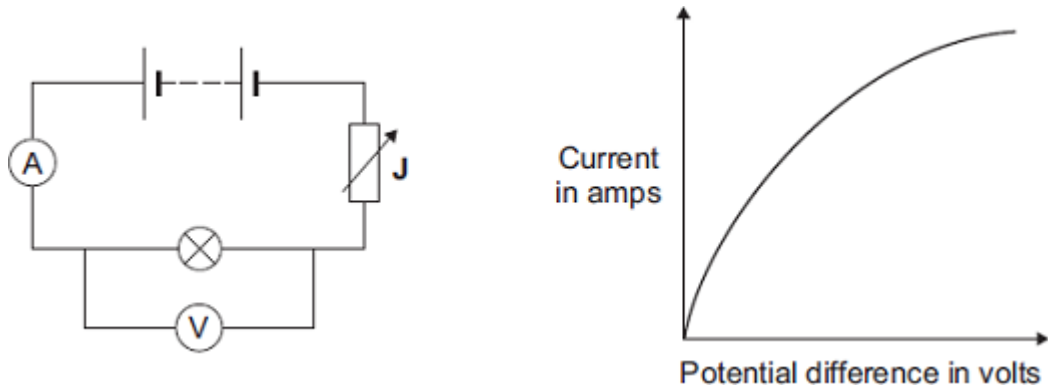
(1)
(Total 9 marks)

Q7.

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

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

_____

_____

(1)

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

_____

_____

(1)

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

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

_____

_____

_____

Power = _____

(3)

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

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

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

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

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

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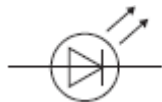
_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 11 marks)

Q8.

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

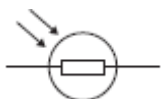| Circuit symbol	Name

Diode

Light-dependent resistor (LDR)
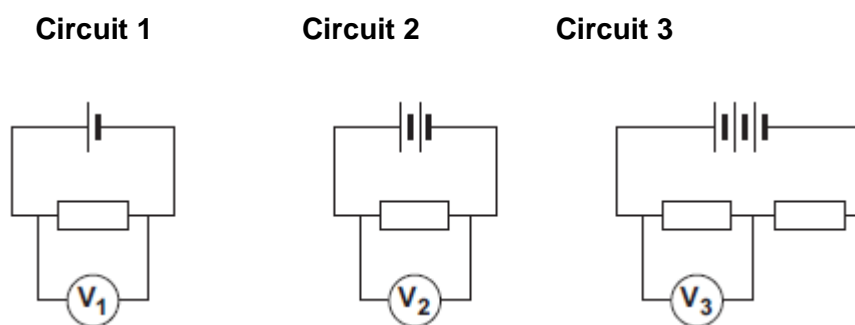
Lamp

Light-emitting diode (LED)

(3)

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

The resistors in the circuits are identical.

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

Figure 1

Circuit 1   Circuit 2   Circuit 3

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

half	twice	the same as

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

(1)

(ii)   Calculate the reading on voltmeter **V₂**.

_____

Voltmeter reading **V₂** = _____ V

(1)

(iii) Which voltmeter, **V₁**, **V₂** or **V₃**, will give the lowest reading?

Draw a ring around the correct answer.

V₁   **V₂**   **V₃**

(1)

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

Figure 2 shows the circuit used by the student.
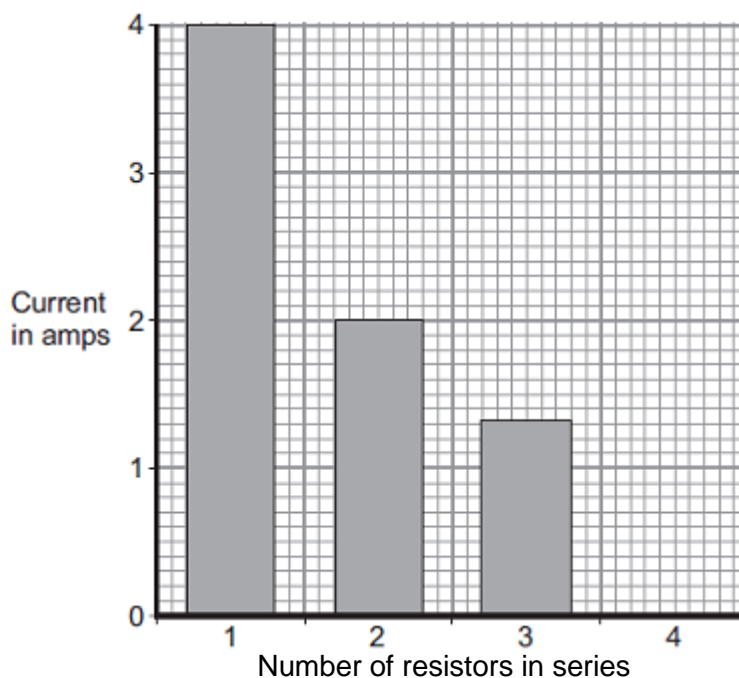
Figure 2

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

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

The student used a total of 4 resistors.

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

Figure 3

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

Which variable did the student keep the same?

_____

(1)

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

Complete the bar chart to show the current in the circuit when 4 resistors were used.
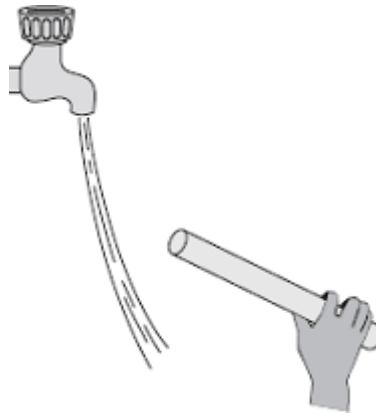
(2)

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

_____

_____

(1)
(Total 10 marks)

Q9.

(a) The diagram shows a negatively charged plastic rod held near to a thin stream of water. The water is attracted towards the rod.

Which **one** of the following statements explains what is happening to the charge in the water?

Tick (✓) **one** box.

The positive and the negative charges in the water are attracted to the rod. ☐

The positive and the negative charges in the water are repelled by the rod. ☐

The negative charge in the water is repelled by the rod and the positive charge is attracted to the rod. ☐

The negative charge in the water is attracted to the rod and the positive charge is repelled by the rod. ☐

(1)

(b)   A company that produces bottles of mouthwash found a problem with the automatic filling system.

As the bottles go towards the filler, the bottles move around on the conveyor belt and become electrostatically charged. This causes the stream of mouthwash to move sideways, missing the open top of the bottle.
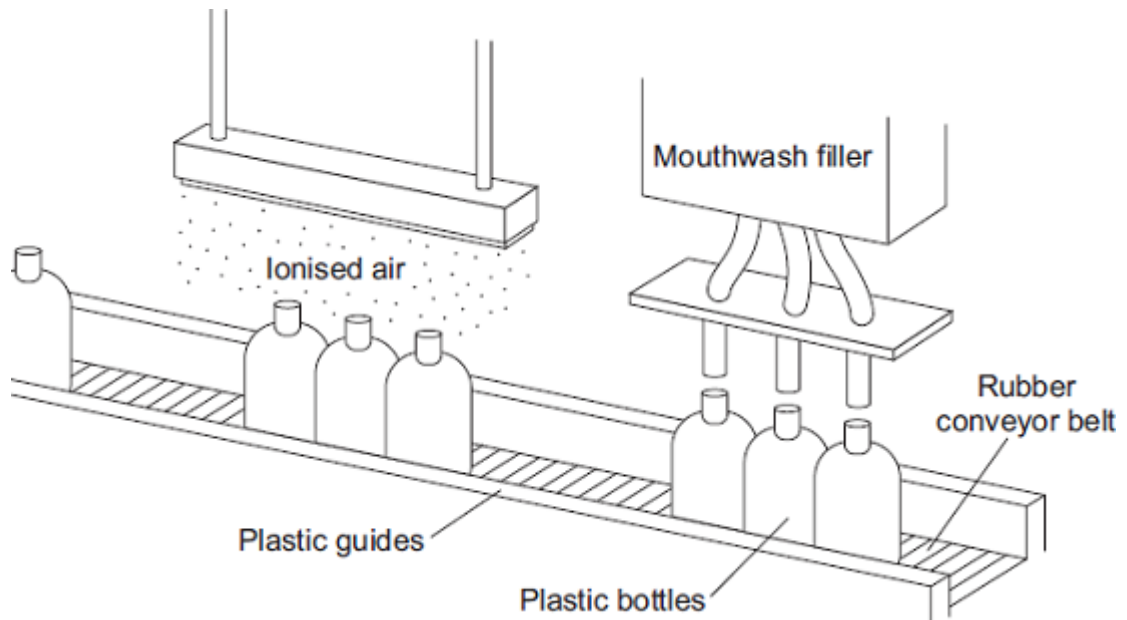
The company came up with an answer to the problem. Before the bottles reach the dfiller, the bottles pass through a stream of ionised air. The ions in the air neutralise the charge on the bottles.

(i)   Explain why the plastic bottles became charged.

_____

_____

_____

_____

(2)

(ii)   What happens to the structure of an atom to change the atom into an ion?
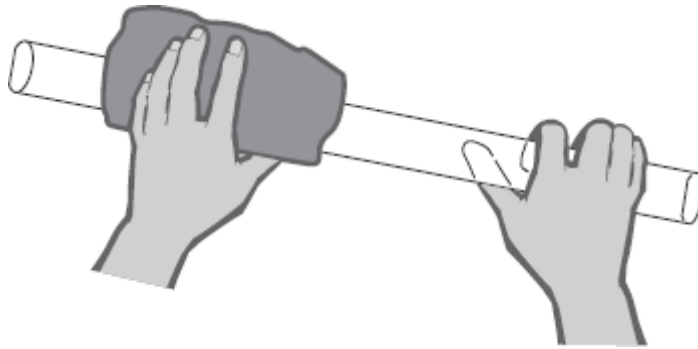
_____

_____

(1)

(iii)   Earthing the conveyor belt with a conducting wire would not have solved this problem.
Give a reason why.

_____

_____

(1)
(Total 5 marks)

Q10.
(a)   The diagram shows a polythene rod being rubbed with a woollen cloth.

The polythene rod becomes negatively charged.

Explain how this happens.

_____

_____

_____

_____

(2)

(b)   A student put the charged polythene rod on to a balance. The rod was separated from the metal pan of the balance by a thin block of insulating material.
The student then held a second charged polythene rod above, but **not** touching, the first rod. The reading on the balance increased.
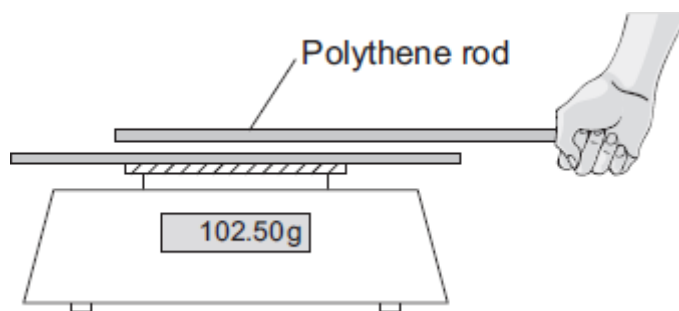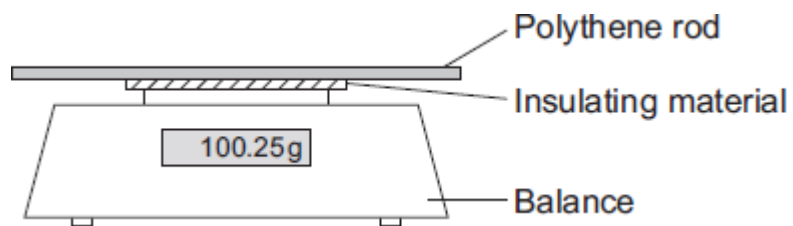
(i)   Explain why the reading on the balance increases.

_____

_____

_____

_____

(2)

(ii)   The student observed that the nearer the two rods are to each other, the bigger the increase in the balance reading.

What should the student conclude from this observation?

_____
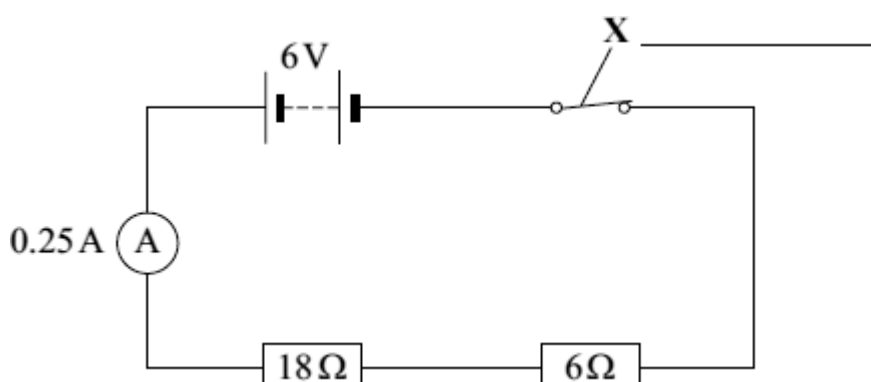
_____

_____

_____

(2)

(Total 6 marks)

Q11.

A circuit diagram is shown below.

(a)   Use a word from the box to label component **X**.

fuse	switch	thermistor

(1)

(b)   Calculate the total resistance of the two resistors in the circuit.

_____

Total resistance = _____ Ω

(1)

(c)   The reading on the ammeter is 0.25 A.

The current through the 6 Ω resistor will be:

bigger than 0.25 A   equal to 0.25 A   smaller than 0.25 A

Draw a ring around your answer

(1)

(d)   The 6 V battery is made by correctly joining several 1.5 V cells in series.

Calculate the number of cells needed to make the battery.

_____
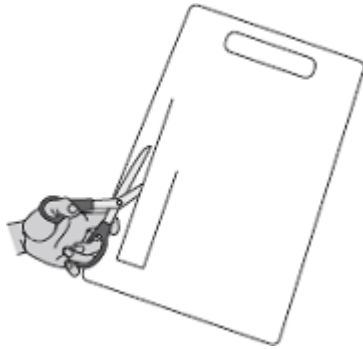
<div align="center">Number of cells = _____</div>
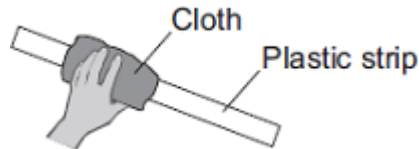
<div align="right">(1)</div>
<div align="right">(Total 4 marks)</div>

Q12.

(a)   A student uses some everyday items to investigate static electricity.

| 1 A strip of plastic is cut from a plastic carrier bag | 2 The plastic strip is rubbed with a cloth | 3 The plastic strip is hung over a wooden rod |
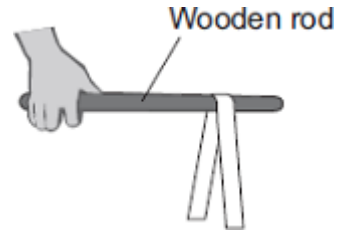
(i)   Draw a ring around the correct answer in the box to complete each sentence.

Rubbing the plastic strip with a cloth causes the strip to become negatively charged.

This happens because

electrons
neutrons
protons

move from the cloth onto the plastic strip.

The cloth is left with

a negative
a positive
zero

charge.

<div align="right">(2)</div>

(ii)   When the plastic strip is hung over the wooden rod, the two halves of the strip move equally away from each other.

What **two** conclusions should the student make about the forces acting on the two halves of the plastic strip?

1. _____

_____

2. _____

_____

<div align="right">(2)</div>

(b)   Electrical charges move more easily through some materials than through other materials.

Through which **one** of the following materials would an electrical charge move most easily?

Draw a ring around your answer.

aluminium   **glass**   **rubber**

(1)
(Total 5 marks)

Q13.

The circuit contains three identical lamps.
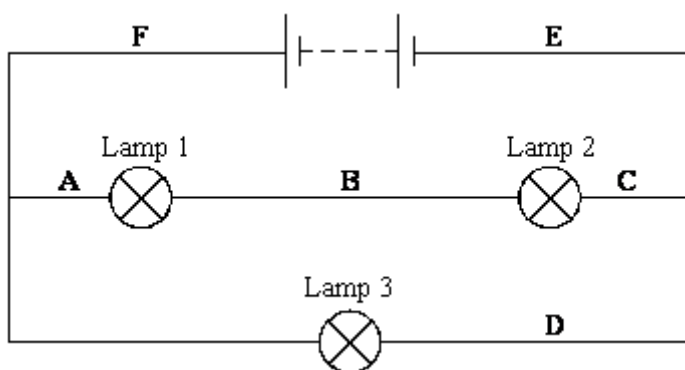
(a)   Complete each of the sentences about the circuit, using one of the phrases in the box.

more than   less than   the same as

(i)   The current at **A** is _____ the current at **B**.

(1)

(ii)   The current at **A** is _____ the current at **D**.

(1)

(iii)   The current at **F** is _____ the current at **E**.

(1)

(iv)   The current at **F** is _____ the current at **D**.

(1)

(b)   In the circuit, which lamp is brightest? _____

Give a reason for your answer.

_____

_____

(2)
(Total 6 marks)

Q14.

The circuit contains two cells, an ammeter and a lamp. The reading on the ammeter is 0.2 A.
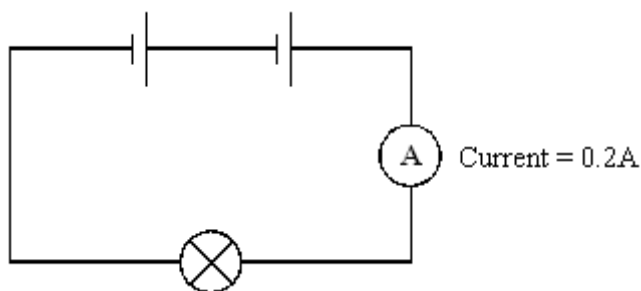
(a)   What will be the reading on the ammeters in each of the circuits below?
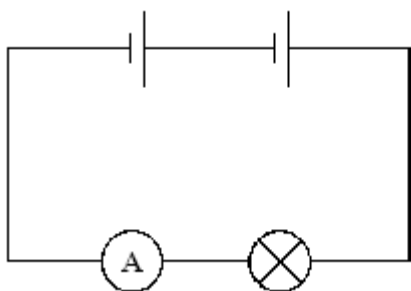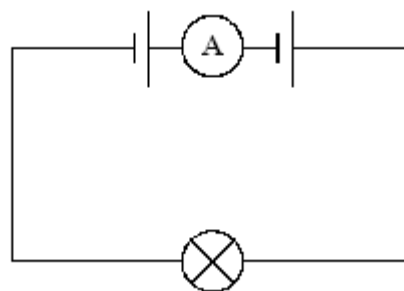
(i)   Current is _____ A   (ii)   Current is _____ A

(2)

(b)   An ammeter was in a series circuit with two cells and a variable resistor.

The ammeter showed a reading of 0.3 A.

(i)   Draw a circuit diagram for the circuit.

(2)

(ii)   What will happen to the reading on the ammeter if the resistance of the variable resistor is **increased?**

_____

(1)

(Total 5 marks)

Q15.

(i)   Write the equation which shows the relationship between the electric *current*, the *power* and the *voltage*.

_____

_____

(1)

(ii)   Calculate the power if the current is 5 A and the voltage is 400 000 V. Show clearly
        how you work out your answer and give the unit.

_____

_____

Power = _____

(2)
(Total 3 marks)

Mark schemes

Q1.

(a)   last box ticked

        1

(b)   (i)   use hotter water (than 60 °C)

accept use boiling water

accept use water at any stated temperature above 60 °C

or

add ice cubes

accept add water at any stated temperature below 12 °C

use different temperatures is insufficient

        1

(ii)   the current increases as the temperature increases

        1

(iii)   0.02 (A)

        1

(iv)   5 (V)

or

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

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

or

*V = their **(b)(iii)** × 250*

        2

(v)   the resistance increases

        1

        [7]

Q2.

(a)   motor

        1

(b)   fuse or circuit breaker

        1

(c)   voltmeter

each for 1 mark

        1

        [3]

Q3.

(a)   ... ammeter

for 1 mark

        1

(b)   5 right

gains 4 marks

   4 right

gains 3 marks

   3 right

gains 2 marks

   2 right

gains 1 mark

4

[5]

Q4.

(a)   increases

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

1

(b)   (i)   increases

1

   (ii)   increases

1

(c)   18

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

2

   watt

accept W
answer may be indicated in the list

1

[6]

Q5.

(a)   (i)   5.88 (watts)

*an answer of 5.9 scores **2** marks*
*allow **1** mark for correct substitution ie*

$0.42 = \dfrac{\text{power out}}{14}$

*allow **1** mark for an answer of 0.0588 or 0.059*

2

   (ii)   8.12

allow 14 – their (a)(i) correctly calculated

1

(b)   (i)   input power / energy would be (much) less (reducing cost of running)
accept the converse
electricity is insufficient

1

(also) produce less waste energy / power
accept 'heat' for waste energy

1

(as the waste energy / power) increases temperature of the cabinet

1

so cooler on for less time

1

(ii) line graph
need to get both parts correct
accept scattergram or scatter graph

both variables are continuous
allow the data is continuous

1

(c)   number of bulbs used-halogen=24 (LED=1)

1

total cost of LED = £30 + £67.20 = £97.20
accept a comparison of buying costs of halogen £36 and LED £30

1

total cost of halogen= 24 x £1.50 + 24 x £16.00 = £420
or
buying cost of halogen is £36 **and** operating cost is £384
accept a comparison of operating costs of halogen £384 and LED £67.20
*allow for **3** marks the difference in total cost is £322.80 if the number 24 has not been credited*

1

statement based on correct calculations that overall LED is cheaper
*must be **both** buying **and** operating costs*

an alternative way of answering is in terms of cost per hour:

buying cost per hour for LED $\left(\frac{£30.00}{48000}\right)$ = 0.0625p/£0.000625

buying cost per hour for halogen = $\left(\frac{£1.50}{2000}\right)$ = 0.075p/£0.00075
*a calculation of both buying costs scores **1** mark*

operating cost per hour for LED = $\left(\frac{£67.20}{48000}\right)$ = 0.14p/£0.0014

operating cost per hour for halogen= $\left(\frac{£16.00}{2000}\right)$ = 0.8p/£0.008
*a calculation of both operating costs scores **1** mark*

all calculations show a correct unit
*all units correct scores **1** mark*

statement based on correct calculations of **both** buying **and** operating costs, that overall LED is cheaper
*correct statement scores **1** mark*

Q6.

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

1

(ii)   C
reason only scores if C is chosen

1

for the same p.d. the current is the smallest
*accept lowest gradient **and** the gradient = 1 / R*

1

(b) (i)   ohm
accept correct symbol Ω
accept an answer written in the table if not given in answer space

1

(ii)   K and L
reason only scores if both K and L are chosen

1

only length varies
accept type of metal and the diameter are the same

1

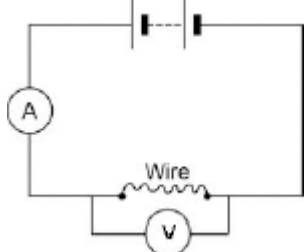(iii)   measure the resistance of more wires made from different metals
accept test more (types of) metals
measure the resistance of more wires is insufficient
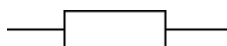*they only use two metals is insufficient*

1

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

accept voltmeter symbol correct and drawn in parallel with the battery

1

(ii)   correct symbol drawn

symbol must be rectangular

1

Q7.

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

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

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

to provide resistance is insufficient

a variable resistor is insufficient

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

1

(ii) temperature of the bulb increases

accept bulb gets hot(ter)

accept answers correctly

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

bulb gets brighter is insufficient

1

(iii) 36

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

2

watt(s) / W

accept joules per second / J/s

*do **not** accept w*

1

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

0 marks
No relevant content.

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

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

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

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

Examples of the points made in the response:

cost

- halogen are cheaper to buy
  simply giving cost figures is insufficient

- 6 halogen lamps cost the same as one LED

- LEDs last longer

- need to buy 18 / more halogen lamps to last the same time as one LED

- 18 halogens cost £35.10

- costs more to run a halogen than LED

- LED has lower maintenance cost (where many used, eg large departmental store lighting)

energy efficiency

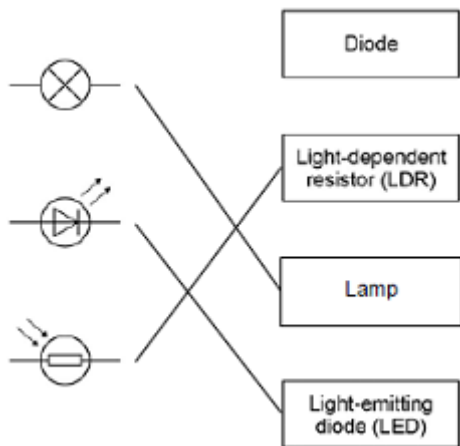- LED works using a smaller current

- LED wastes less energy

- LEDs are more efficient

- LED is 22% more energy efficient

- LED produces less heat

- LED requires smaller input (power) for same output (power)

6

[11]

Q8.
(a)

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

3

(b) (i) half

1

(ii) 3(V)

1

(iii) V_1

1

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

1

(ii)   bar drawn – height 1.(00)A
ignore width of bar
*allow **1** mark for bar shorter than 3rd bar*

2

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

1

[10]

Q9.

(a)   3rd box
The negative charge in the water is repelled by the rod and the positive charge is attracted to the rod.

1

(b)   (i)   friction between bottles and conveyor belt / (plastic) guides
accept bottles rub against conveyor belt / (plastic) guides

1

charge transfers between bottles and conveyor belt / (plastic) guides
accept specific reference eg electrons move onto / off the bottles
reference to positive electrons / protons negates this mark

1

(ii)   (the atom) loses or gains one (or more) electrons

1

(iii)   charge will not (easily) flow off the conveyor belt / bottles
accept the conveyor belt / bottles is an insulator / not a conductor accept conveyor belt is rubber

1

[5]

Q10.

(a)   electrons transfer / removed
*do **not** accept negatively charged atoms for electrons*
this only scores if first mark given

1

to the rod / from the cloth
this does not score if there is reference to any original charge on cloth or rod
'it' refers to the rod

*accept negative charge transfer to rod / removed from cloth
for 1 mark*

transfer of positive charge / positive electrons scores zero

1

(b)   (i)   rods / charges repel

1

creating downward / extra force (on the balance)
accept pushing (bottom) rod downwards
do not accept increasing the weight / mass
charges attracting scores zero

1

(ii)   the (repulsion) force increases as the distance between the <u>charges</u>
decreases
*accept there is a negative correlation between (repulsion)
force and distance between <u>charges</u>*
or
*(repulsion) force and distance between <u>charges</u> are inversely
proportional*
for both marks
examples of 1 mark answers
force increases as distance decreases
force and distance are inversely proportional
negative correlation between force and distance
repels more as distance decreases
*if given in terms of attracting or attraction force this mark
does not score*

2

[6]

Q11.

(a)   switch
allow answer circled in box

1

(b)   24

1

(c)   equal to 0.25 A

1

(d)   4

1

[4]

Q12.

(a)   (i)   electrons

1

a positive

1

(ii)   (forces are) equal
accept (forces are) the same

forces are balanced is insufficient

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　　　(forces act in) opposite directions
　　　　　　　　　　accept (forces) repel
　　　　　　　　　　both sides have the same charge is insufficient

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　(b)　　aluminium

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[5]

Q13.

　(a)　(i)　　the same as

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　(ii)　　less than

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　(iii)　　the same as

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　(iv)　　more than

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　(b)　　3
　　　　　　　　　　accept D

　　　　 because there is more **or** twice the current in this part of the circuit
　　　　or the resistance is less
　　　　　　　　　　*accept only one lamp to go through, (not two) **or** on its own*
　　　　　　　　　　*not sharing the voltage **or** energy with another*
　　　　　　　　　　*do not credit one lamp to go through **or** sharing current*

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　2

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[6]

Q14.

　(a)　(i)　　0.2

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　(ii)　　0.2

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　(b)　(i)　　a series circuit must contain two cells the correct way round and an ammeter
　　　　　　　　　accept the components in any order in
　　　　　　　　　the series circuit but there must be no
　　　　　　　　　obvious gaps in the wires at corners
　　　　　　　　　***or** joins*

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　　　the symbol for a variable resistor a rectangle with a diagonal arrow drawn
　　　　　　through it
　　　　　　　　　accept a diagram for a 'slide resistor'

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　(ii)　　decrease

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[5]

Q15.

(i)   power = current × voltage
       or any correctly transposed version

              accept watts = amps × volts

              accept P = IV

              do not credit P = CV

              accept p.d. for voltage triangle acceptable only if used
              correctly in (ii)

                                                              1

(ii)   2 000 000 (1)

              2000 kilowatts/kW (2)

              accept KW

    watts/W (1)

              2 megawatts/MW (2)

              do not credit mW (1) if correct method is clearly shown but
              *answer is numerically incorrect **or** unit is absent **or** incorrect*

              do not credit any working from an incorrect equation in (d)(i)
              but an appropriate unit should be credited

                                                              2

                                                                         [3]