1 Energy resources can be renewable or non-renewable.

(a) Coal is a non-renewable energy resource.

Name **two** other non-renewable energy resources.

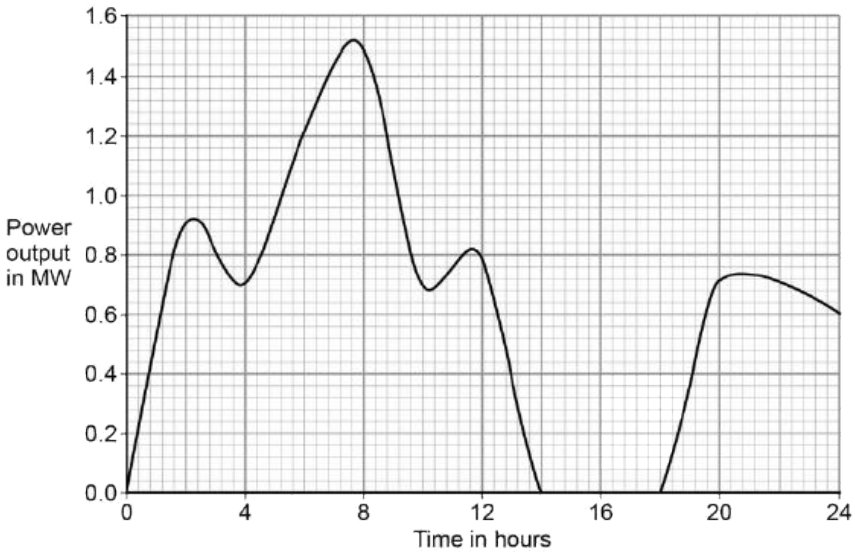
1 .....

2 .....

(2)

(b) Wind turbines are used to generate electricity.

The graph below shows how the power output of a wind turbine changes over one day.



A wind turbine does not generate electricity constantly.

For how many hours did the wind turbine generate no electricity?

.....

Time = ... hours

(1)

(c) Electrical power is transferred from power stations to the National Grid.

What is the National Grid?

Tick **one** box.

a system of cables and pylons ☐

a system of cables and transformers ☐

a system of cables, transformers and power stations ☐

(1)

(d) An island has a large number of wind turbines and a coal-fired power station.

The island needs to use the electricity generated by the coal-fired power station at certain times.

Choose **one** reason why.

Tick **one** box.

Wind is a renewable energy resource. ☐

Wind turbine power output is constant. ☐

The power output of wind turbines is unpredictable. ☐

The fuel cost for wind turbines is very high. ☐

(1)

(e) A wind turbine has an average power output of 0.60 MW.

A coal-fired power station has a continuous power output of 1500 MW.

Calculate how many wind turbines would be needed to generate the same power output as one coal-fired power station.

.....

.....

Number of wind turbines = ...

(2)

(f) It is important that scientists develop new energy resources.

Choose **one** reason why.

Tick **one** box.

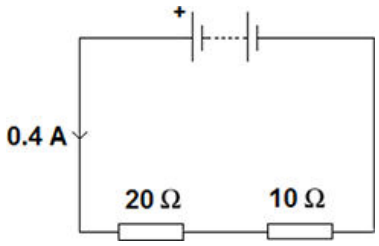
All energy resources are running out. ☐

All energy resources are used to generate electricity. ☐

Most energy resources have negative environmental effects. ☐

(1)
(Total 8 marks)

2 An electrical circuit is shown in the figure below.



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

What is meant by direct current?

Tick **one** box.

Current that continuously changes direction. ☐

Current that travels directly to the component. ☐

Current that is always in the same direction. ☐

(1)

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

potential difference = current × resistance

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

.....

.....

Potential difference = ... V

(3)

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

power = current × potential difference

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

Give your answer to one significant figure.

.....

Power = ... W

(2)

(Total 6 marks)

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

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

12 V battery	variable resistor	filament lamp	voltmeter	ammeter
				

(2)

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

.....

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.....

.....

.....

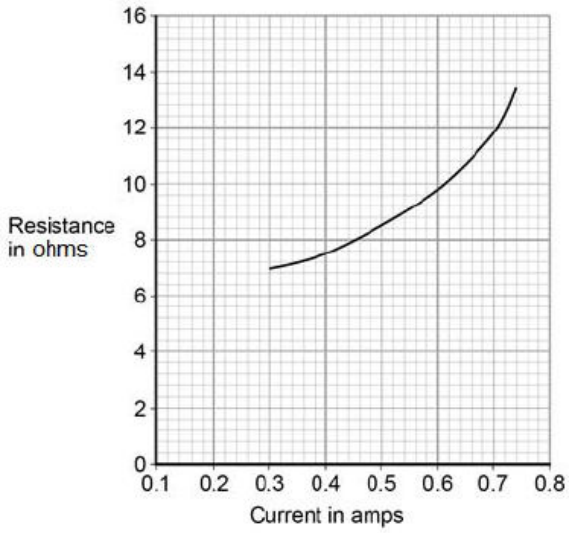
.....

.....

(4)

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

Figure 1



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

.....

.....

(1)

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

Resistance = ... Ω

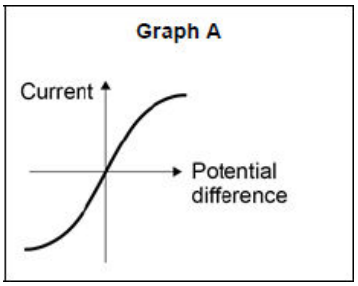
(1)

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

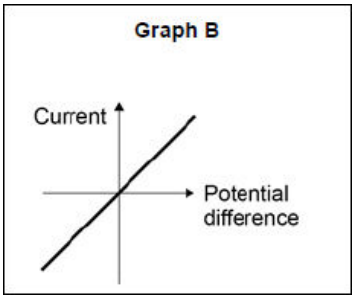
Use answers from the box to identify each component.

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

Figure 2



.....



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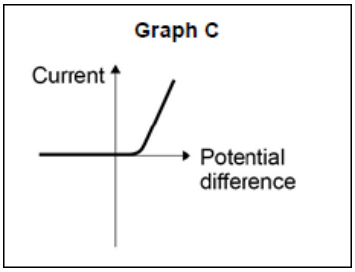


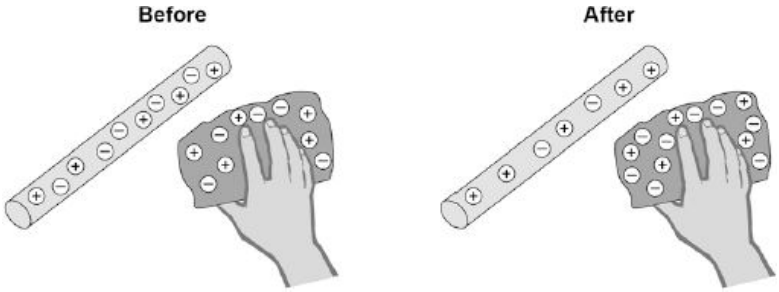
.....

(3)
(Total 11 marks)

4 A student rubs an acetate rod with a cloth.

Figure 1 shows the charges on the acetate rod and cloth before and after rubbing.

Figure 1



(a) Explain how rubbing an acetate rod with a cloth causes the rod and cloth to become charged.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(b) After charging them, the student moves the acetate rod and the cloth closer together.

Which statement is correct?

Tick **one** box.

There is no force between the acetate rod and the cloth. ☐

There is a force of attraction between the acetate rod and the cloth. ☐

There is a force of repulsion between the acetate rod and the cloth. ☐

Give a reason for your answer.

.....

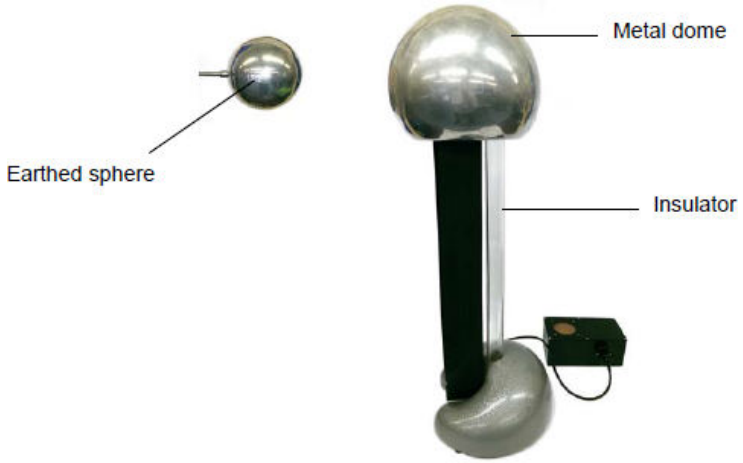
.....

.....

(2)

(c) **Figure 2** shows a Van de Graaff generator, which is used to generate static electricity.

Figure 2



The longer the Van de Graaff generator is switched on, the more charge is stored on the metal dome.

Use an answer from the box to complete the sentence.

decrease	**increase**	**stay the same**

The amount of charge on the metal dome is increased, which causes the potential difference between the metal dome and the earthed sphere to

..... .

(1)

(d) When the potential difference between the Van de Graaff generator and the earthed sphere is 60 kV, a spark jumps between the metal dome and the earthed sphere.

The spark transfers 0.000025 coulombs of charge to the earthed sphere.

The equation which links charge, energy and potential difference is:

energy transferred = charge × potential difference

Calculate the energy transferred by the spark.

.....

.....

.....

Energy transferred = ... J

(2)
(Total 9 marks)

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

The inside of the old shower is shown in the figure below.

© Michael Priest

(a) The electrician should **not** change the shower unless he switches off the mains electricity supply.

Explain why.

.....

.....

.....

.....

(2)

(b) The new shower has a power output of 10 690 W when it is connected to the 230 V mains electricity supply.

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

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

Calculate the current passing through the new shower.

Give your answer to two significant figures.

.....

.....

.....

Current = ... A

(4)

(c) The new shower has a higher power rating than the old shower.

How does the power of the new shower affect the cost of using the shower?

Give a reason for your answer.

.....

.....

.....

.....

(2)
(Total 8 marks)

6 **Figure 1** shows a Van de Graaff generator that is used to investigate static electricity.

Before it is switched on, the metal dome has no net charge.

After it is switched on, the metal dome becomes positively charged.

Figure 1

© Michael Priest

(a) Explain how an uncharged object may become positively charged.

.....

.....

.....

.....

.....

.....

(3)

(b) **Figure 2** shows a plan view of the positively charged metal dome of a Van de Graaff generator.

Draw the electric field pattern around the metal dome when it is isolated from its surroundings.

Use arrows to show the direction of the electric field.

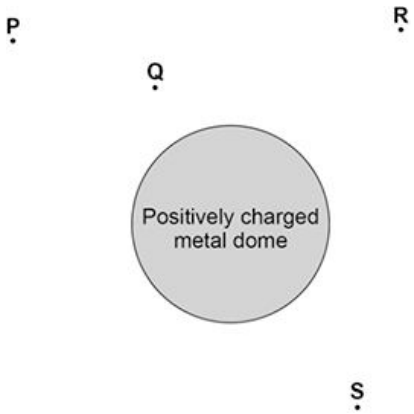
Figure 2

(2)

(c) Another positively charged object is placed in the electric field.

Look at **Figure 3**.

Figure 3



In which position would the object experience the greatest force?

Tick **one** box.

P ☐

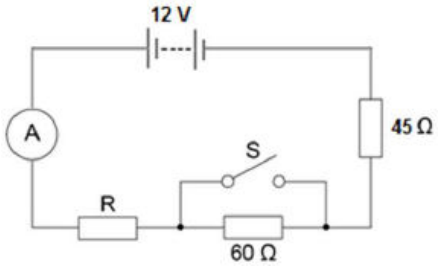
Q ☐

R ☐

S ☐

(1)
(Total 6 marks)

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



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

Calculate the potential difference across the 45 Ω resistor.

.....

.....

Potential difference = ... V

(2)

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

.....

.....

.....

Resistance = ... Ω

(3)

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

.....

.....

.....

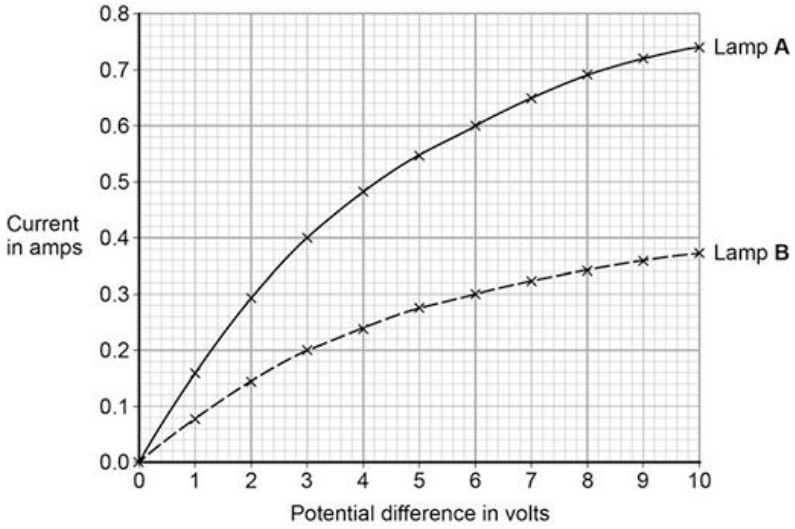
.....

(2)

(Total 7 marks)

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

Her results are shown in the figure below.



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

(3)

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

Explain your answer.

Use the figure above to aid your explanation

.....

.....

.....

.....

(2)

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

Explain how the figure above shows this.

.....

.....

.....

.....

(2)

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

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

Explain your answer.

.....

.....

.....

.....

.....

.....

(3)
(Total 10 marks)

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

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

Figure 1

© Michael Priest

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

Explain why.

.....

.....

.....

.....

.....

.....

.....

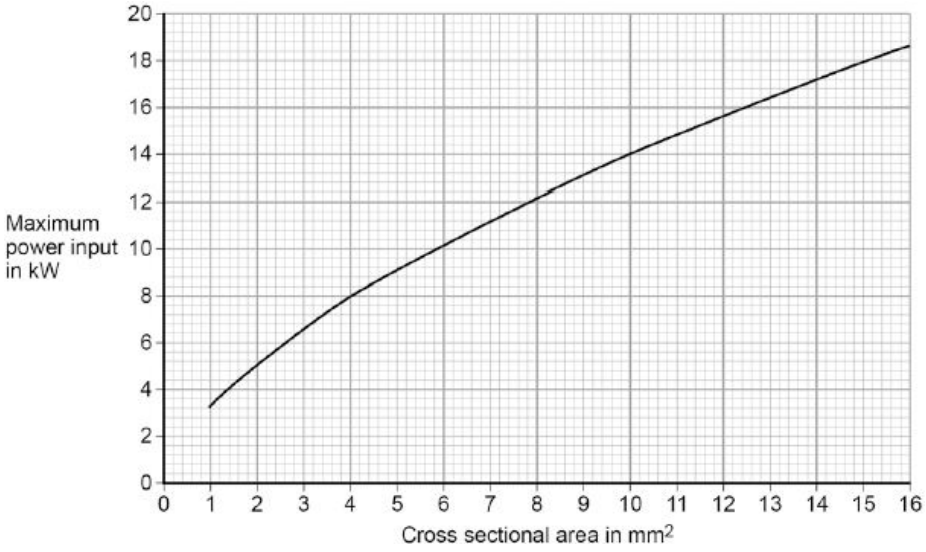
.....

(4)

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

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

Figure 2



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

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

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

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

A is the cross-sectional area of the wire.

.....

.....

Minimum diameter = ... mm

(2)

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

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

Write down any equations you use.

.....

.....

.....

.....

.....

.....

.....

Resistance = ... Ω

(5)
(Total 11 marks)

10 A student finds some information about energy-saving light bulbs.

(a) A 30W light bulb uses 600J of electrical energy in a certain period of time. In that time, it produces 450 J of light energy. The rest of the energy is wasted.

(i) Calculate the energy wasted by the light bulb in this period of time.

.....

Wasted energy = ... J

(1)

(ii) What happens to the energy wasted by the light bulb?

.....

.....

(1)

(iii) Calculate the efficiency of this light bulb.

.....

.....

Efficiency = ...

(2)

(iv) Calculate the period of time, in seconds, during which the 600 J is provided to the 30 W light bulb.

.....

.....

Time = ... s

(2)

(b) A company that makes light bulbs provides information about some of their products.

The table shows some of this information.

	Power in watts	**Lifetime in hours**	**Cost of bulb in £**
Filament bulb	60	1250	2.00
LED bulb	12	50 000	16.00

(i) Suggest why it is important to confirm this information independently.

.....

(1)

(ii) A homeowner is thinking about replacing his filament bulbs with LED bulbs.

A 12 W LED bulb gives the same light output as a 60 W filament bulb.

Suggest reasons why the homeowner is likely to choose LED bulbs.

Use the information given in the table.

.....

.....

.....

.....

(2)

(iii) State **one** factor, other than efficiency, that is important when considering the choice of a bulb for lighting in the home.

.....

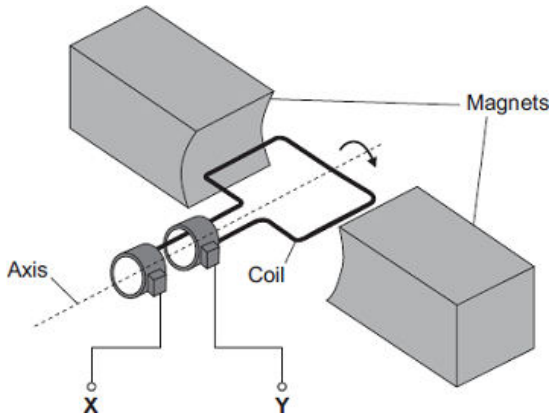
.....

(1)

(Total 10 marks)

11 The diagram shows an a.c. generator.

The coil rotates about the axis shown and cuts through the magnetic field produced by the magnets.



(a) (i) A potential difference is induced between **X** and **Y**.

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

electric	**generator**	**motor**	**transformer**

This effect is called the ..... effect.

(1)

(ii) What do the letters a.c. stand for?

.....

(1)

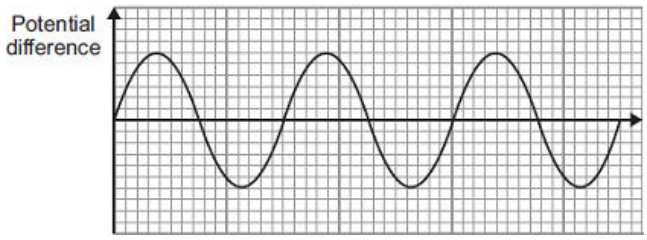
(iii) Name an instrument that could be used to measure the potential difference between **X** and **Y**.

.....

(1)

(b) **Graph 1** shows the output from the a.c. generator.

Graph 1



(i) One of the axes on **Graph 1** has been labelled 'Potential difference'.

What should the other axis be labelled?

.....

(1)

(ii) The direction of the magnetic field is reversed.

On **Graph 1**, draw the output from the a.c. generator if everything else remains the same.

(2)

(c) The number of turns of wire on the coil is increased. This increases the maximum induced potential difference.

State **two** other ways in which the maximum induced potential difference could be increased.

1 .....

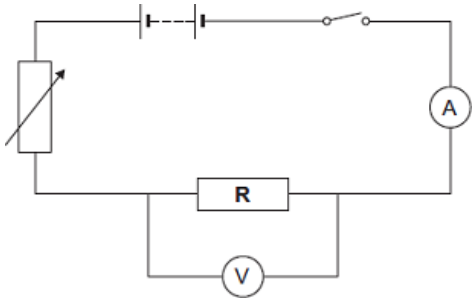
.....

2 .....

.....

(2)
(Total 8 marks)

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



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

.....

.....

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.....

.....

.....

(6)

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

.....

.....

.....

.....

(2)

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

What is the voltmeter reading?

.....

.....

Voltmeter reading = ... V

(2)

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

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

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

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

Give a reason for your answer.

.....

.....

.....

.....

(2)

(b) The diagram shows a fuse.

Describe the action of the fuse in a circuit.

.....

.....

.....

.....

.....

.....

.....

.....

(3)
(Total 15 marks)

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

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

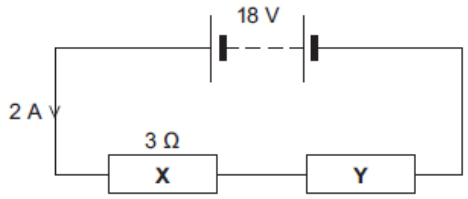
(2)

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

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

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

Figure 1



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

.....

.....

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

(2)

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

.....

.....

.....

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

(2)

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

.....

.....

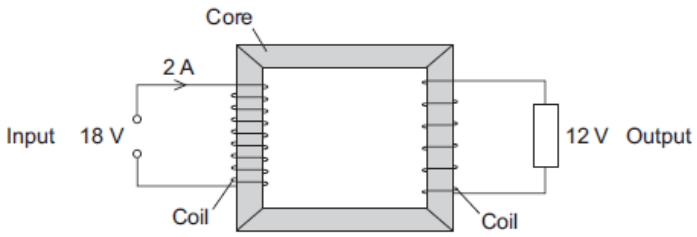
.....

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

(2)

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

Figure 2



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

Explain why.

.....

.....

.....

.....

(2)

(ii) The transformer is 100% efficient.

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

.....

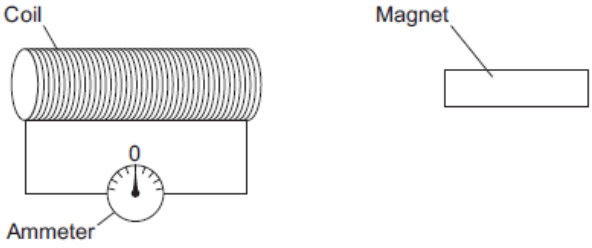
.....

.....

Output current = ... A

(2)
(Total 12 marks)

14 The figure below shows a coil and a magnet. An ammeter is connected to the coil.



The ammeter has a centre zero scale, so that values of current going in either direction through the coil can be measured.

(a) A teacher moves the magnet slowly towards the coil.

Explain why there is a reading on the ammeter.

.....

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.....

.....

(6)

(b) The table below shows some other actions taken by the teacher.

Complete the table to show the effect of each action on the ammeter reading.

Action taken by teacher	**What happens to the ammeter reading?**
Holds the magnet stationary and moves the coil slowly towards the magnet	
Holds the magnet stationary within the coil	
Moves the magnet quickly towards the coil	
Reverses the magnet and moves it slowly towards the coil	

(4)

(c) The magnet moves so that there is a steady reading of 0.05 A on the ammeter for 6 seconds.

Calculate the charge that flows through the coil during the 6 seconds.

Give the unit.

.....

.....

.....

Charge = ...

(3)
(Total 13 marks)

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

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

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

earth	**live**	**neutral**

A fuse is connected in the ..... wire.

(1)

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

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

RCCBs are sometimes preferred to fuses because they ..... .

(1)

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

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

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

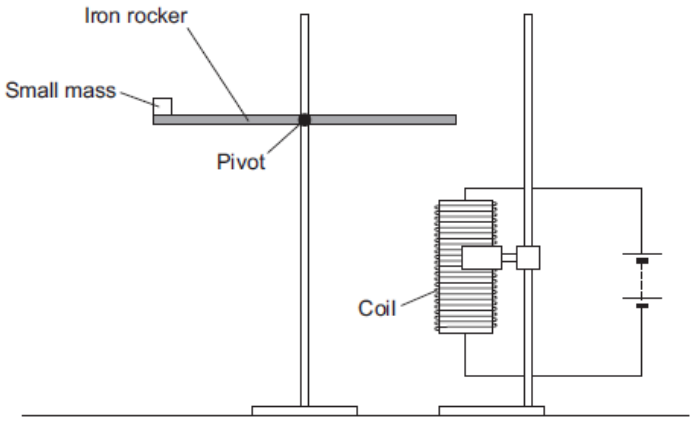
The two wires are the ..... wires.

(1)

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

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

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



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

Some of her results are shown in the table below.

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

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

Give reasons for your answers.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

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

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

Change 1 .....

.....

Change 2 .....

.....

(2)
(Total 9 marks)

16 (a) A company is developing a system which can heat up and melt ice on roads in the winter. This system is called 'energy storage'.

During the summer, the black surface of the road will heat up in the sunshine.

This energy will be stored in a large amount of soil deep under the road surface.
Pipes will run through the soil. In winter, cold water entering the pipes will be warmed and brought to the surface to melt ice.

The system could work well because the road surface is black.

Suggest why.

.....

.....

(1)

(b) (i) What is meant by specific latent heat of fusion?

.....

.....

.....

.....

(2)

(ii) Calculate the amount of energy required to melt 15 kg of ice at 0 °C.

Specific latent heat of fusion of ice = 3.4×10^5 J/kg.

.....

.....

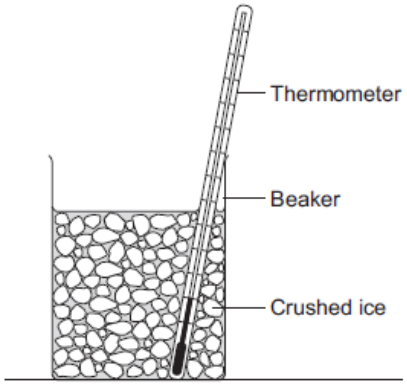
Energy = ... J

(2)

(c) Another way to keep roads clear of ice is to spread salt on them.
When salt is added to ice, the melting point of the ice changes.

A student investigated how the melting point of ice varies with the mass of salt added.

The figure below shows the equipment that she used.



The student added salt to crushed ice and measured the temperature at which the ice melted.

(i) State **one** variable that the student should have controlled.

.....

.....

(1)

(ii) During the investigation the student stirred the crushed ice.

Suggest **two** reasons why.

Tick (✓) **two** boxes.

	Tick (✓)
To raise the melting point of the ice	
To lower the melting point of the ice	
To distribute the salt throughout the ice	
To keep all the ice at the same temperature	
To reduce energy transfer from the surroundings to the ice	

(2)

(iii) The table below shows the data that the student obtained.

Mass of salt added in grams	0	10	20
Melting point of ice in °C	0	-6	-16

Describe the pattern shown in the table.

.....

.....

(1)

(d) Undersoil electrical heating systems are used in greenhouses. This system could also be used under a road.

A cable just below the ground carries an electric current. One greenhouse system has a power output of 0.50 kW.

Calculate the energy transferred in 2 minutes.

.....

.....

.....

Energy transferred = ... J

(3)

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

A local council wants to keep a particular section of a road clear of ice in the winter.

Describe the advantages and disadvantages of keeping the road clear of ice using:

- energy storage
- salt
- undersoil electrical heating.

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Extra space .....

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(6)
(Total 18 marks)

17 Energy can be transferred through some materials by convection.

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

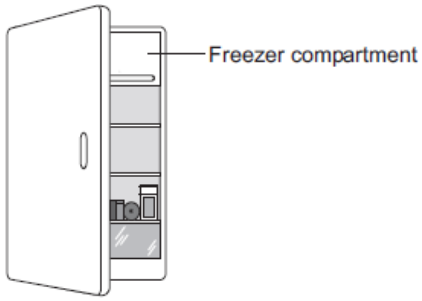
gas	**liquid**	**solid**

Energy **cannot** be transferred by convection through a ..... .

(1)

(b) The figure below shows a fridge with a freezer compartment.

The temperature of the air inside the freezer compartment is –5 °C.



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

Each answer may be used once, more than once or not at all.

decreased	**unchanged**	**increased**

When the air near the freezer compartment is cooled, the energy of the air particles is ..... .

The spaces between the air particles are ..... .

The density of the air is ..... .

(3)

(c) The table below shows some information about three fridges, **A**, **B** and **C**.

The efficiency of each fridge is the same.

Fridge	Volume in litres	Energy used in one year in kWh
A	232	292
B	382	409
C	622	524

(i) Which fridge, **A**, **B** or **C**, would cost the least to use for 1 year? ☐

Give **one** reason for your answer.

.....

.....

(2)

(ii) A householder looks at the data in the table above.

What should she conclude about the pattern linking the volume of the fridge and the energy it uses in one year?

.....

.....

(1)

(iii) The householder could not be certain that her conclusion is correct for all fridges.

Suggest **one** reason why not.

.....

.....

(1)
(Total 8 marks)

18 Electricity can be generated using various energy sources.

(a) Give **one** advantage and **one** disadvantage of using nuclear power stations rather than gas-fired power stations to generate electricity.

Advantage .....

.....

Disadvantage .....

.....

(2)

(b) (i) A single wind turbine has a maximum power output of 2 000 000 W.

The wind turbine operated continuously at maximum power for 6 hours.

Calculate the energy output in kilowatt-hours of the wind turbine.

.....

.....

.....

Energy output = ... kWh

(2)

(ii) Why, on average, do wind turbines operate at maximum power output for only 30% of the time?

.....

.....

(1)

(c) An on-shore wind farm is made up of many individual wind turbines.

They are connected to the National Grid using underground power cables.

Give **one** advantage of using underground power cables rather than overhead power cables.

.....

.....

(1)
(Total 6 marks)

19 (a) Iceland is a country that generates nearly all of its electricity from renewable sources.

In 2013, about 80% of Iceland's electricity was generated using hydroelectric power stations (HEP).

Describe how electricity is generated in a hydroelectric power station. Include the useful energy transfers taking place.

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(4)

(b) The UK produces most of its electricity from fossil fuels.

Many people in the UK leave their televisions in 'stand by' mode when not in use, instead of switching them off.

It is better for the environment if people switch off their televisions, instead of leaving them in 'stand by' mode.

Explain why.

.....

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(3)

(c) A scientist wrote in a newspaper:

'Appliances that do not automatically switch off when they are not being used should be banned.'

Suggest why scientists alone cannot make the decision to ban these appliances.

.....

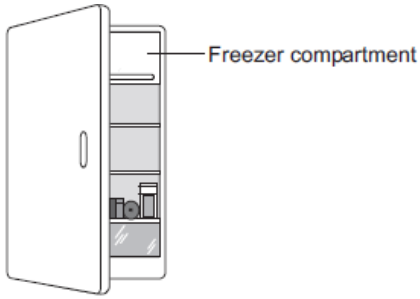
.....

(1)

(Total 8 marks)

20 (a) The figure below shows a fridge with a freezer compartment.

The temperature of the air inside the freezer compartment is –5 °C.



The air inside the fridge forms a convection current when the fridge door is closed.

Explain why.

.....

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(4)

(b) The table below shows information about four fridges.

Fridge	Volume in litres	Energy used in one year in kWh
A	250	300
B	375	480
C	500	630
D	750	750

A householder concludes that the energy used in one year is directly proportional to the volume of the fridge.

Explain why her conclusion is **not** correct.

Use data from the table in your answer.

.....

.....

.....

.....

(2)

(c) New fridges are more efficient than fridges made twenty years ago.

Give **one** advantage and **one** disadvantage of replacing an old fridge with a new fridge.

Ignore the cost of buying a new fridge.

Advantage .....

.....

Disadvantage .....

.....

(2)
(Total 8 marks)

21 **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.

.....

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(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 bulb	Cost to buy	Lifetime in hours	Operating cost over the 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.

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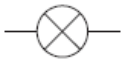
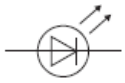
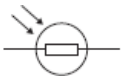
(4)
(Total 12 marks)

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

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

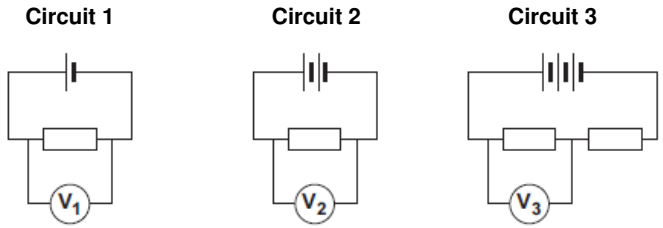
(3)

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

The resistors in the circuits are identical.

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

Figure 1



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

half	twice	the same as

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

(1)

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

.....

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

(1)

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

Draw a ring around the correct answer.

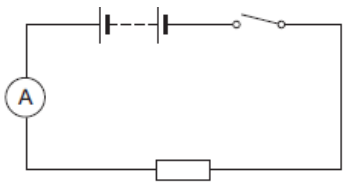
$\mathbf{V_1}$ $\mathbf{V_2}$ $\mathbf{V_3}$

(1)

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

Figure 2 shows the circuit used by the student.

Figure 2



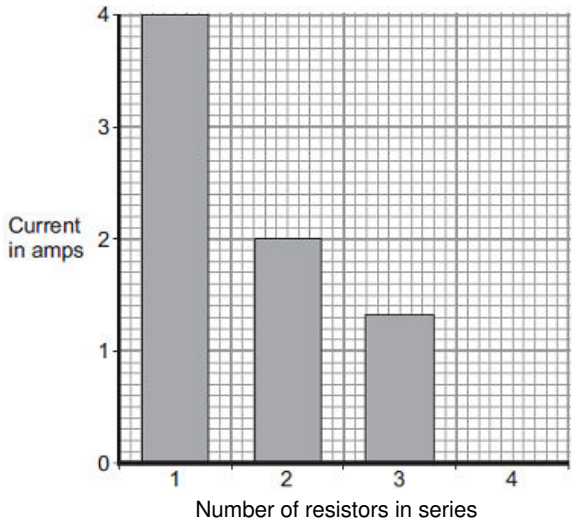
The student started with one resistor and then added more identical resistors to the circuit.

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

The student used a total of 4 resistors.

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

Figure 3



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

Which variable did the student keep the same?

.....

(1)

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

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

(2)

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

.....

.....

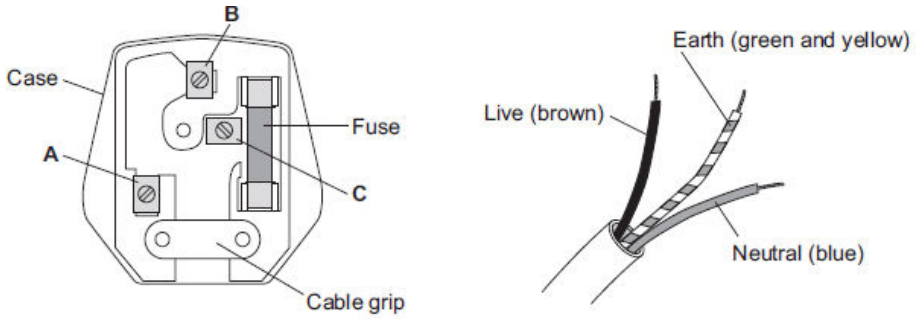
(1)

(Total 10 marks)

23 (a) **Figure 1** shows the inside of a three-pin plug and a length of three-core cable.

The cable is to be connected to the plug.

Figure 1



(i) Complete **Table 1** to show which plug terminal, **A**, **B** or **C**, connects to each of the wires inside the cable.

Table 1

Wire	Plug terminal
Live	
Neutral	
Earth	

(2)

(ii) Name a material that could be used to make the case of the plug.

.....

(1)

(b) **Figure 2** shows an electric drill and an extension lead. The drill is used with the extension lead.

Figure 2

Electric drill Extension lead

(i) The drill is used for 50 seconds.

In this time, 30 000 joules of energy are transferred from the mains electricity supply to the drill.

Calculate the power of the drill.

.....

.....

.....

Power = ... W

(2)

(ii) A second drill is used with the extension lead. The power of this drill is 1200 W.

The instructions for using the extension lead include the following information.

When in use the lead may get hot:

DO NOT go over the maximum power
- lead wound inside the case: 820 watts
- lead fully unwound outside the case: 3100 watts

It would **not** be safe to use this drill with the extension lead if the lead was left wound inside the plastic case.

Explain why.

.....

.....

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.....

.....

(3)

(c) **Table 2** gives information about three different electric drills.

Table 2

Drill	Power input in watts	Power output in watts
X	640	500
Y	710	500
Z	800	500

A person is going to buy **one** of the drills, **X**, **Y** or **Z**. The drills cost the same to buy.

Use only the information in the table to decide which **one** of the drills, **X**, **Y** or **Z**, the person should buy.

Write your answer in the box. ☐

Give a reason for your answer.

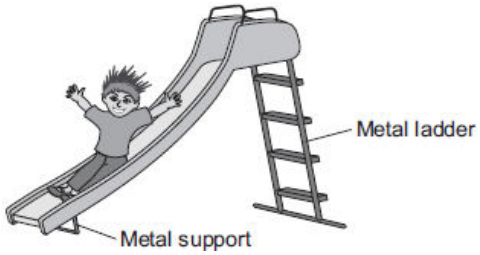
.....

.....

.....

(1)
(Total 9 marks)

24 The figure below shows a slide in a children's playground.



(a) A child of mass 18 kilograms goes down the slide.

The vertical distance from the top to the bottom of the slide is 2.5 metres.

Calculate the decrease in gravitational potential energy of the child sliding from the top to the bottom of the slide.

Gravitational field strength = 10 N / kg

.....

.....

.....

Decrease in gravitational potential energy = ... J

(2)

(b) The slide is made of plastic.

(i) The child becomes electrically charged when he goes down the slide.

Explain why.

.....

.....

.....

.....

(2)

(ii) Going down the slide causes the child's hair to stand on end.

What conclusion about the electrical charge on the child's hair can be made from this observation?

.....

.....

Give a reason for your answer.

.....

.....

(2)

(iii) Why would the child **not** become electrically charged if the slide was made from metal?

.....

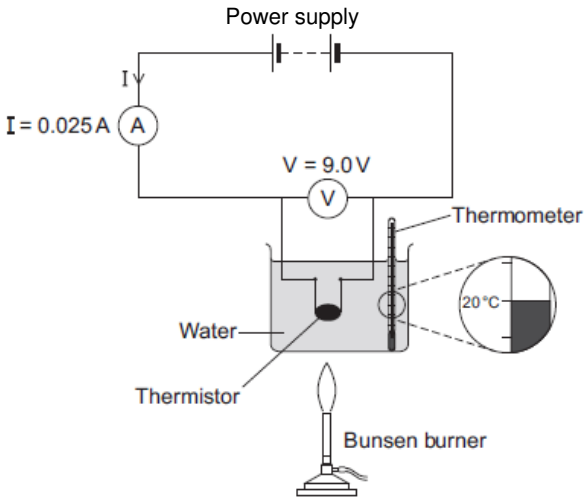
.....

(1)

(Total 7 marks)

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

Figure 1



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

(1)

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

.....

.....

.....

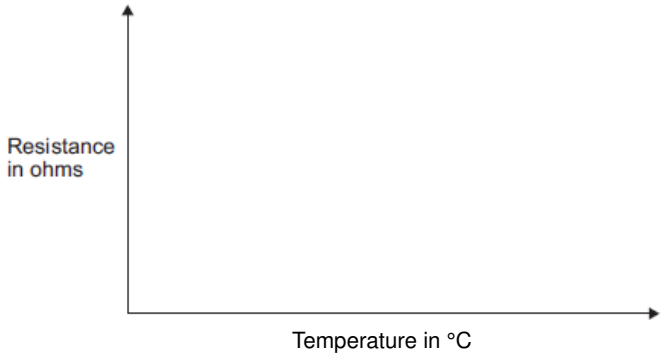
Resistance = ... ohms

(2)

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

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

Figure 2



(1)

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

Tick (✓) **one** box.

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

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

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

(1)

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

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

.....

.....

(1)

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

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

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

Suggest **one** advantage of doing this.

.....

.....

.....

(1)

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

The student starts with the apparatus shown in **Figure 2** but makes three changes to the apparatus.

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

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

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.....

.....

(2)
(Total 9 marks)

26 Solar panels are often seen on the roofs of houses.

(a) Describe the action and purpose of a solar panel.

.....

.....

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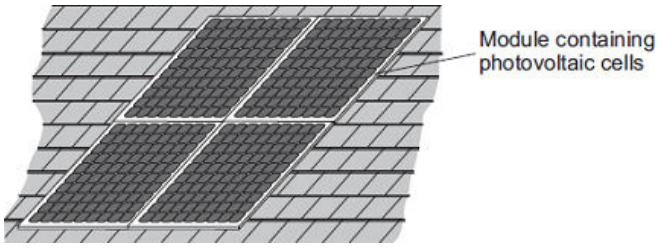
.....

(2)

(b) Photovoltaic cells transfer light energy to electrical energy.

In the UK, some householders have fitted modules containing photovoltaic cells on the roofs of their houses.

Four modules are shown in the diagram.



The electricity company pays the householder for the energy transferred.

The maximum power available from the photovoltaic cells shown in the diagram is 1.4×10^3 W.

How long, in minutes, does it take to transfer 168 kJ of energy?

.....

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.....

..... Time = ... minutes

(3)

(c) When the modules are fitted on a roof, the householder gets an extra electricity meter to measure the amount of energy transferred by the photovoltaic cells.

(i) The diagram shows two readings of this electricity meter taken three months apart. The readings are in kilowatt-hours (kWh).

21 November	0	0	0	4	4
21 February	0	0	1	9	4

Calculate the energy transferred by the photovoltaic cells during this time period.

.....

Energy transferred = ... kWh

(1)

(ii) The electricity company pays 40p for each kWh of energy transferred.

Calculate the money the electricity company would pay the householder.

.....

.....

Money paid = ...

(2)

(iii) The cost of the four modules is £6000.

Calculate the payback time in years for the modules.

.....

.....

Payback time = ... years

(3)

(iv) State an assumption you have made in your calculation in part **(iii)**.

.....

.....

(1)

(d) In the northern hemisphere, the modules should always face south for the maximum transfer of energy.

State **one** other factor that would affect the amount of energy transferred during daylight hours.

.....

.....

(1)

(Total 13 marks)

27 Electrical circuits have resistance.

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

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

decreases.
increases.
stays the same.

(1)

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

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

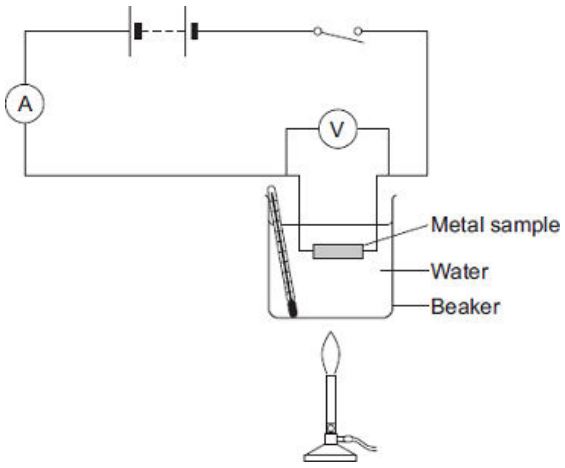
An electrical component which has a resistance that increases as the temperature increases is ..... .

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

(2)

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

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



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

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

Include in your answer:

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

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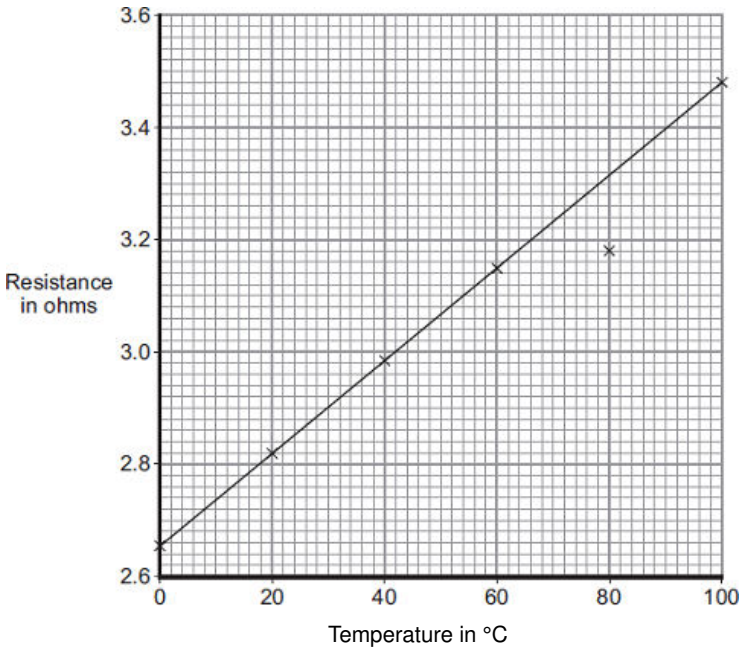
(6)

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

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

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

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



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

(1)

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

(1)

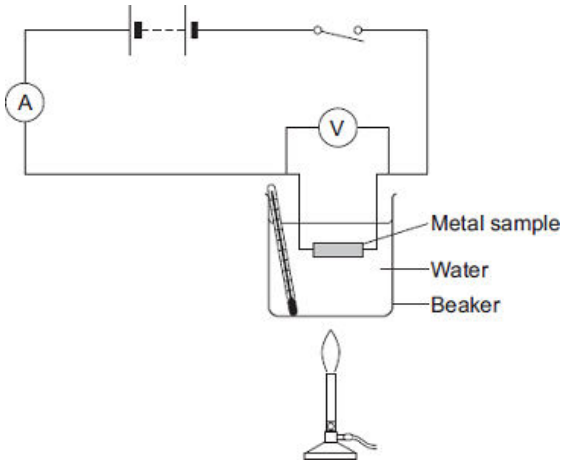
(iii) Suggest a reason for the anomalous result.

.....

.....

(1)

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



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

1 .....

.....

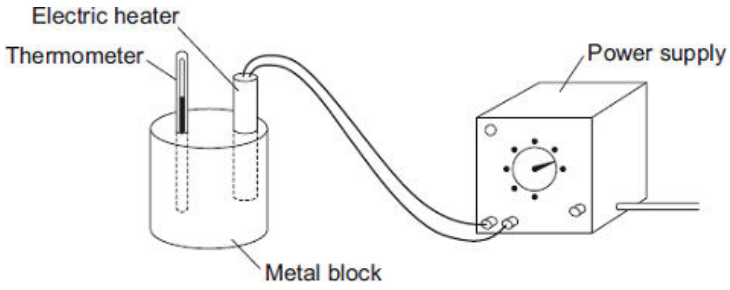
2 .....

.....

(2)

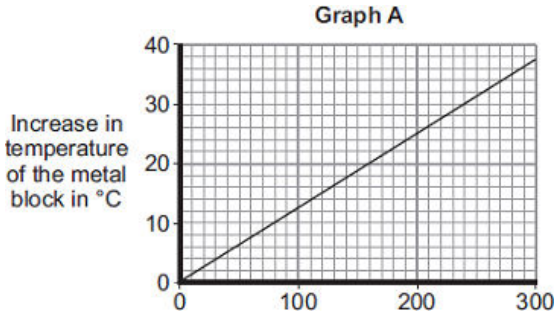
(Total 14 marks)

28 (a) A student used the apparatus drawn below to investigate the heating effect of an electric heater.



(i) Before starting the experiment, the student drew **Graph A**.

Graph A shows how the student expected the temperature of the metal block to change after the heater was switched on.



Describe the pattern shown in **Graph A**.

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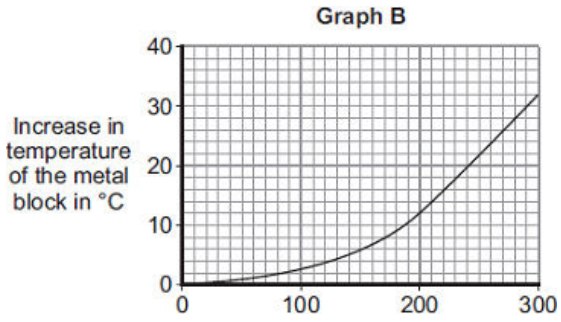
.....

(2)

(ii) The student measured the room temperature. He then switched the heater on and measured the temperature of the metal block every 50 seconds.

The student calculated the increase in temperature of the metal block and plotted **Graph B**.



After 300 seconds, **Graph B** shows the increase in temperature of the metal block is lower than the increase in temperature expected from **Graph A**.

Suggest **one** reason why.

.....

.....

(1)

(iii) The power of the electric heater is 50 watts.

Calculate the energy transferred to the heater from the electricity supply in 300 seconds.

.....

.....

.....

Energy transferred = ... J

(2)

(b) The student uses the same heater to heat blocks of different metals. Each time the heater is switched on for 300 seconds.

Each block of metal has the same mass but a different specific heat capacity.

Metal	Specific heat capacity in J/kg°C
Aluminium	900
Iron	450
Lead	130

Which **one** of the metals will heat up the most?

Draw a ring around the correct answer.

aluminium **iron** **lead**

Give, in terms of the amount of energy needed to heat the metal blocks, a reason for your answer.

.....

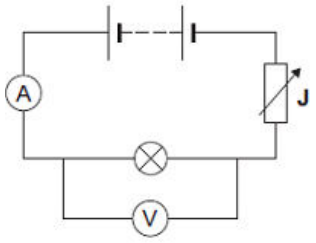
.....

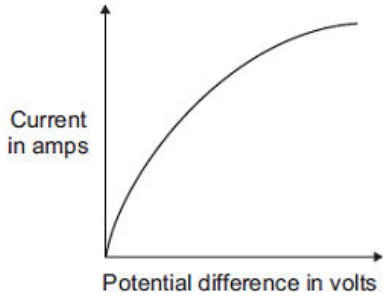
.....

.....

(2)
(Total 7 marks)

29 (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.

.....

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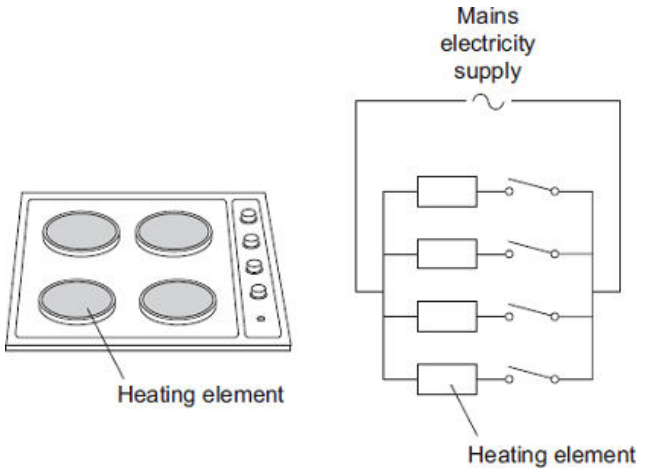
.....

(6)
(Total 11 marks)

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



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

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

Give your answer to 2 significant figures.

.....

.....

.....

Resistance = ... Ω

(3)

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

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

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

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

Why?

.....

.....

.....

.....

(2)

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

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

.....

.....

.....

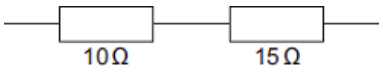
.....

(2)

(Total 7 marks)

31 (a) Electrical circuits often contain resistors.

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



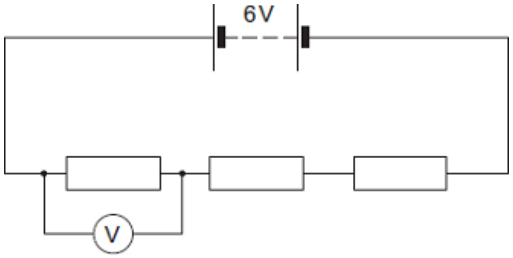
Calculate the total resistance of the **two** resistors.

.....

Total resistance = ... Ω

(1)

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



(i) Calculate the reading on the voltmeter.

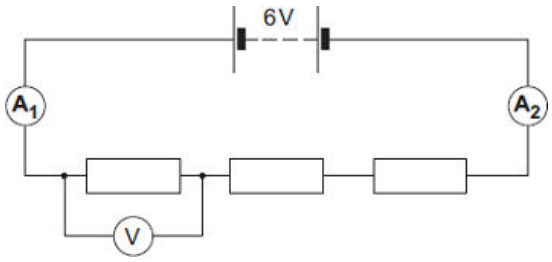
.....

.....

Reading on voltmeter = ... V

(2)

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



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

The reading on ammeter $\mathbf{A_2}$ will be

smaller than
equal to
greater than

the reading on ammeter $\mathbf{A_1}$.

(1)

(Total 4 marks)

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

230 V	**2760 W**
50 Hz	

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

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

.....

(1)

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

.....

(1)

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

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

Choose the unit from the list below.

amps **volts** **watts**

.....

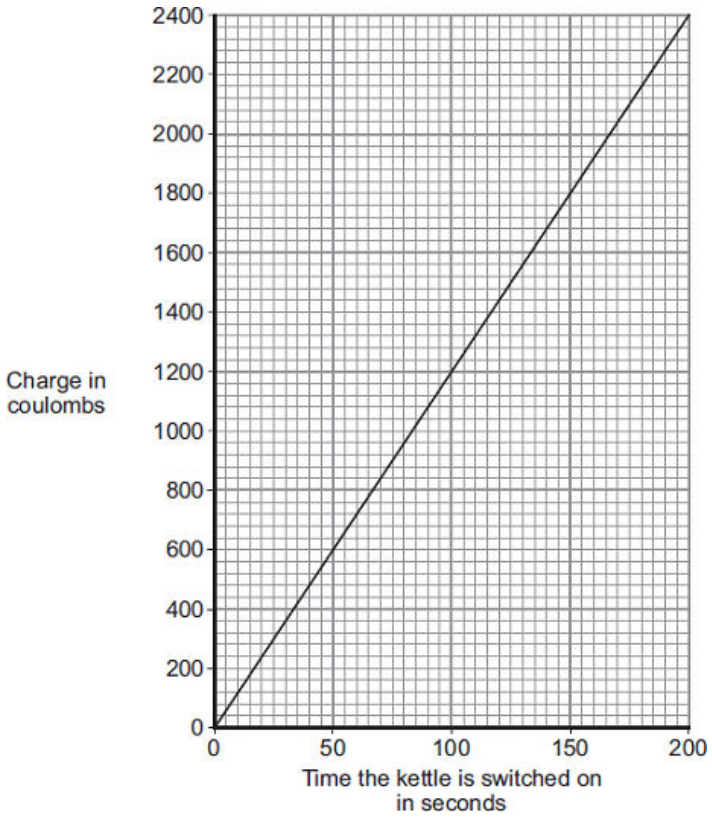
.....

.....

Current = ...

(3)

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



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

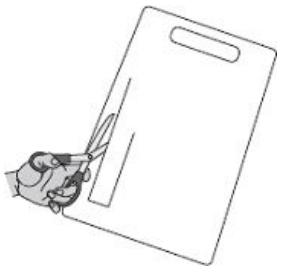
.....

.....

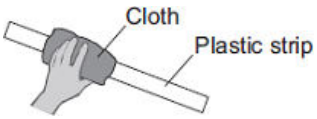
(2)

(Total 7 marks)

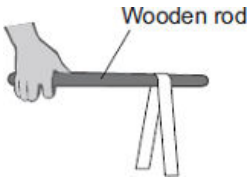
33 (a) A student uses some everyday items to investigate static electricity.



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.

(2)

(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 .....

.....

(2)

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

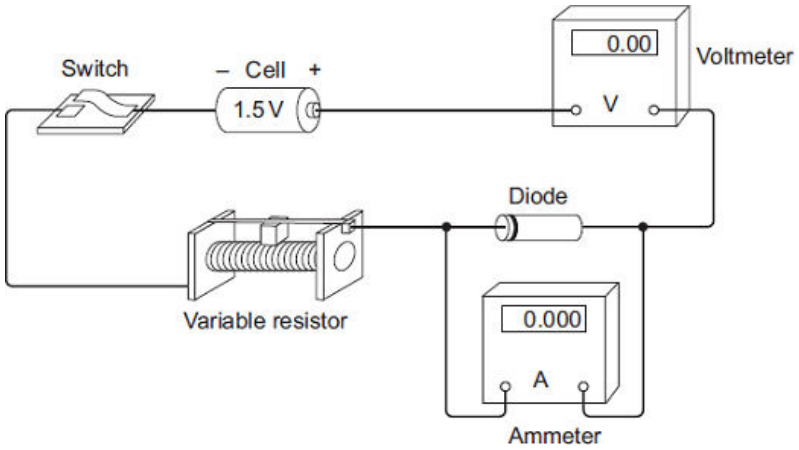
Through which **one** of the following materials would an electrical charge move most easily?

Draw a ring around your answer.

aluminium **glass** **rubber**

(1)
(Total 5 marks)

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



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

Diode	**Variable resistor**

(2)

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

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

1 .....

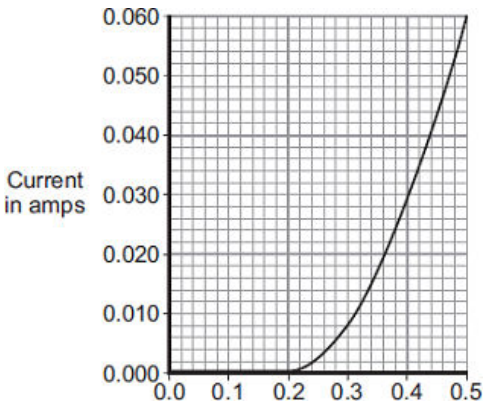
.....

2 .....

.....

(2)

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



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

..... V

(1)

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

.....

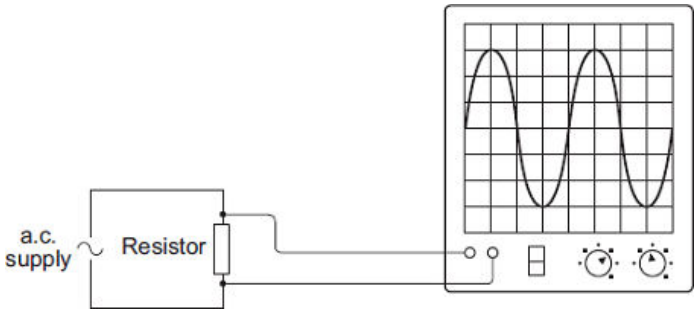
.....

.....

Resistance = ... ohms

(3)

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



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

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

.....

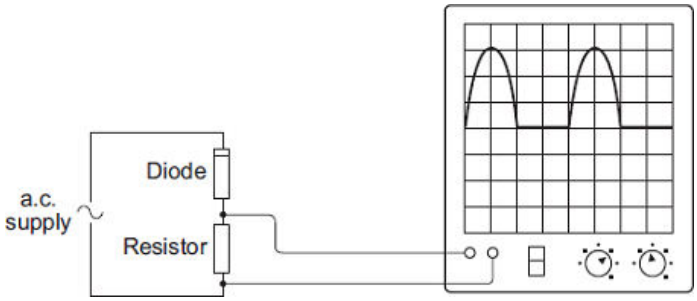
.....

.....

Frequency = ... hertz

(2)

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



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

.....

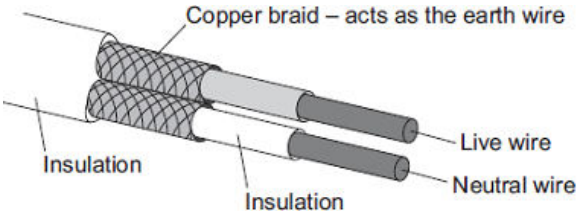
.....

.....

.....

(2)
(Total 12 marks)

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



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

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

.....

(1)

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

.....

.....

.....

.....

(2)

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

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

.....

.....

(1)

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

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

.....

.....

.....

Charge = ...

(3)

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

.....

.....

Energy transferred =..... J

(2)

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

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

.....

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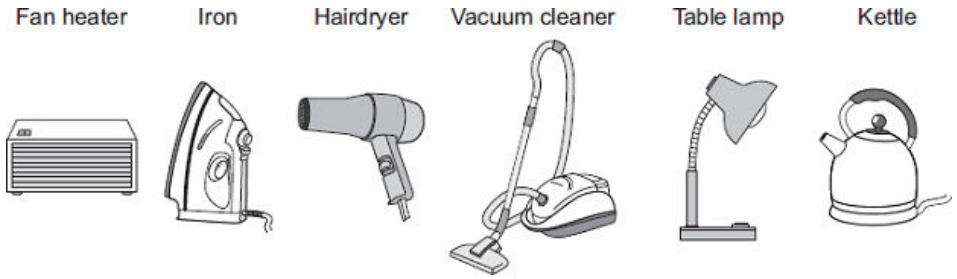
.....

.....

(2)
(Total 11 marks)

36 The pictures show six different household appliances.



(a) Four of the appliances, including the fan heater, are designed to transform electrical energy into heat.

Name the other **three** appliances designed to transform electrical energy into heat.

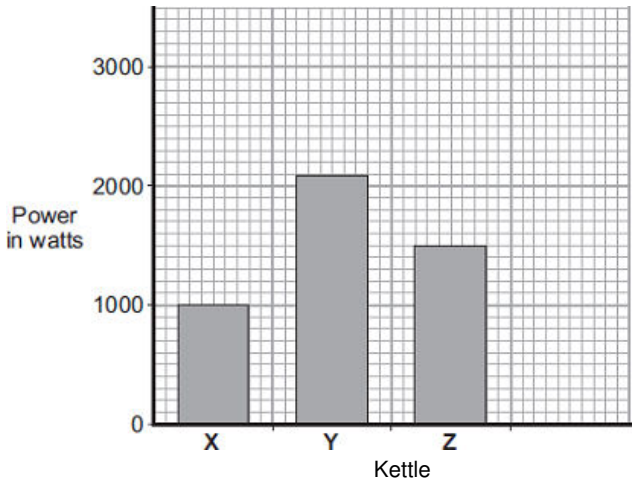
1 .....

2 .....

3 .....

(3)

(b) The bar chart shows the power of three electric kettles, **X**, **Y** and **Z**.



(i) In one week, each kettle is used for a total of 30 minutes.

Which kettle costs the most to use?

Put a tick (✓) next to your answer.

X ☐

Y ☐

Y ☐

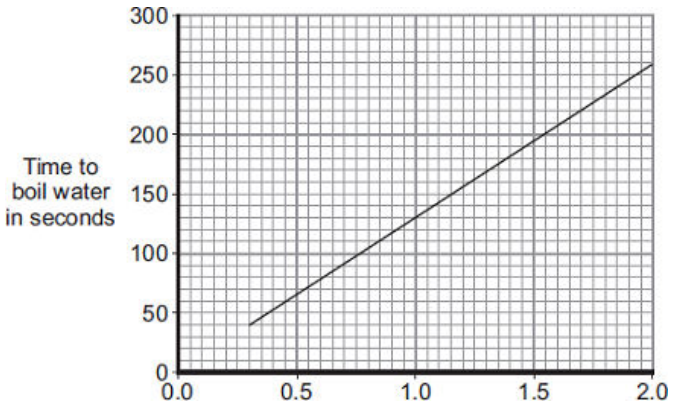
(1)

(ii) A new 'express boil' kettle boils water faster than any other kettle.

Draw a fourth bar on the chart to show the possible power of an 'express boil' kettle.

(1)

(c) The graph shows how the time to boil water in an electric kettle depends on the volume of water in the kettle.



A householder always fills the electric kettle to the top, even when only enough boiling water for one small cup of coffee is wanted.

Explain how the householder is wasting money.

.....

.....

.....

.....

.....

.....

(3)
(Total 8 marks)

37 A householder was out shopping when her electricity meter reading should have been taken. The electricity company estimated the reading and sent the following bill. Unfortunately, the bill was damaged in the post.

AQA electricity

Customer reference: 2634724983
Date sent out: 18 September 2012

Your electricity bill

Present reading: 53600 (e) 13 September
Previous reading: 53490 12 June

Used: 110 kWh

Cost per kWh = 15p (e) = estimated reading
Cost of electricity used =

(a) Use the equation in the box to calculate the cost of the electricity used between 12 June and 13 September.

total cost = number of kilowatt-hours x cost per kilowatt-hour

Show clearly how you work out your answer.

.....

.....

Total cost = ...

(2)

(b) The estimated reading shown on the bill was not very accurate. The correct reading was 53782.

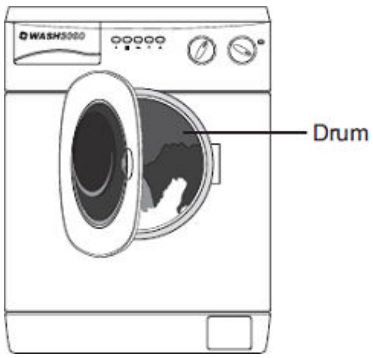
How many kilowatt-hours of electricity had the householder actually used between 12 June and 13 September?

.....

.....

(2)
(Total 4 marks)

38 The picture shows a washing machine. When the door is closed and the machine switched on, an electric motor rotates the drum and washing.



(a) Complete the following sentences.

(i) An electric motor is designed to transform electrical energy into

..... energy.

(1)

(ii) Some of the electrical energy supplied to the motor is wasted as

..... energy and ..... energy.

(1)

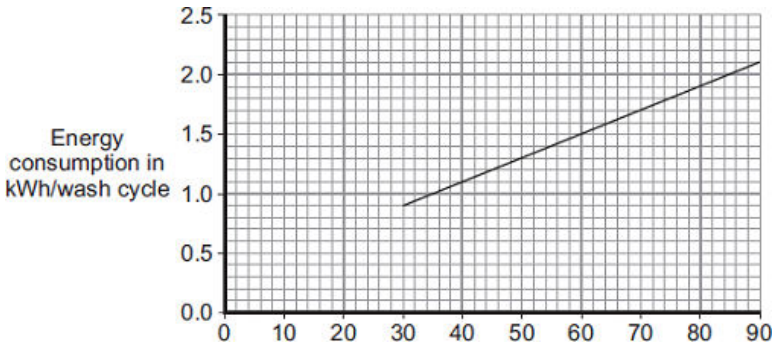
(b) What happens to the energy wasted by the electric motor?

.....

.....

(1)

(c) The graph shows that washing clothes at a lower temperature uses less energy than washing them at a higher temperature. Using less energy will save money.



(i) Electricity costs 15p per kilowatt-hour (kWh).

The temperature setting is turned down from 40 °C to 30 °C.

Use the graph and equation in the box to calculate the money saved each wash cycle.

total cost = number of kilowatt-hours x cost per kilowatt-hour

Show clearly how you work out your answer.

.....

.....

Money saved = ...

(2)

(ii) Reducing the amount of energy used by washing machines could reduce the amount of carbon dioxide emitted into the atmosphere.

Explain why.

.....

.....

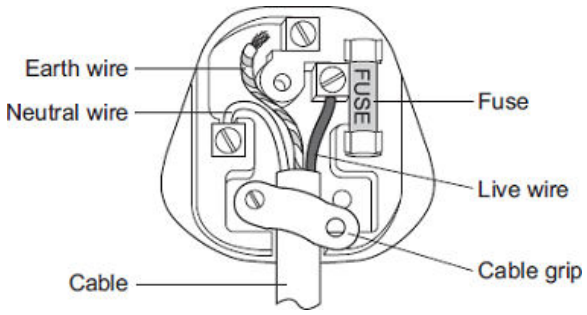
.....

.....

(2)

(Total 7 marks)

39 (a) The diagram shows the inside of an incorrectly wired three-pin plug.



(i) What **two** changes need to be made so that the plug is wired correctly?

1 .....

.....

2 .....

.....

(2)

(ii) The fuse inside a plug is a safety device.

Explain what happens when too much current passes through a fuse.

.....

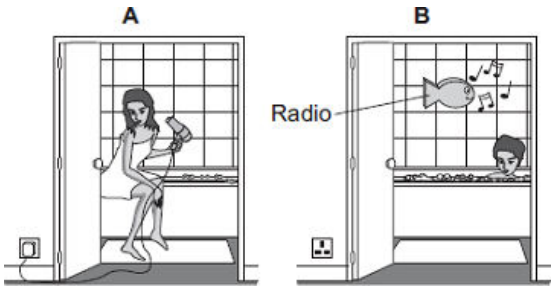
.....

.....

.....

(2)

(b) Each of these pictures shows an electrical appliance being used in a bathroom.



Using the hairdryer in picture **A** is dangerous. However, it is safe to use the battery-operated radio in picture **B**.

Explain why.

.....

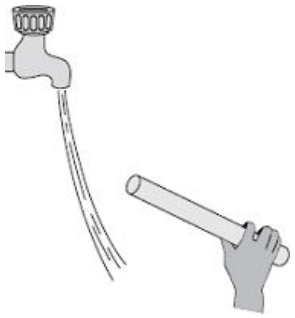
.....

.....

.....

(2)
(Total 6 marks)

40 (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?

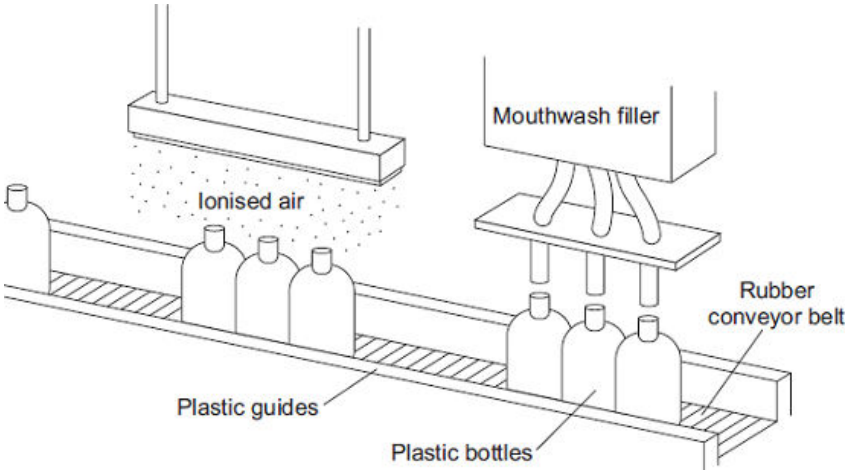
Tick (✓) **one** box.

- 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)

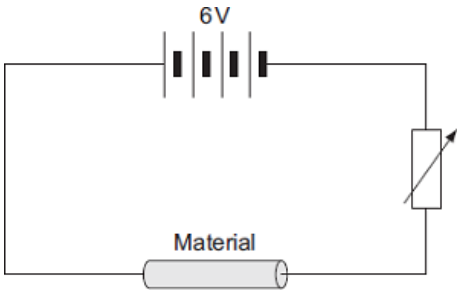
(iii) Earthing the conveyor belt with a conducting wire would not have solved this problem.
Give a reason why.

.....

.....

(1)
(Total 5 marks)

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



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

(2)

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

.....

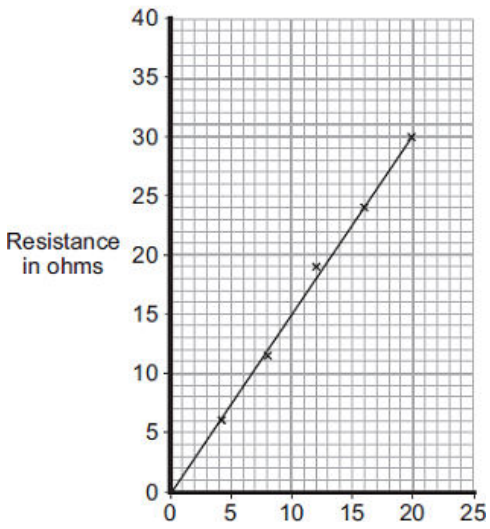
.....

(1)

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

Graph 1 shows how the resistance changes with length.

Graph 1



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

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

Resistance = ... ohms

(1)

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

Show clearly how you work out your answer.

.....

.....

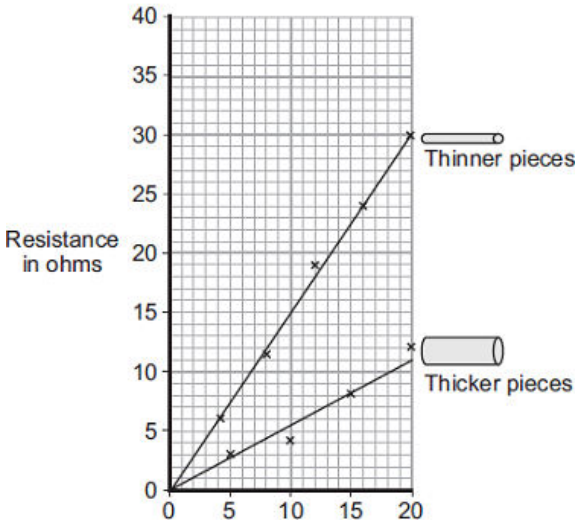
.....

Potential difference = ... volts

(2)

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

Graph 2



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

.....

.....

(1)

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

.....

(1)

(Total 8 marks)

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

.....

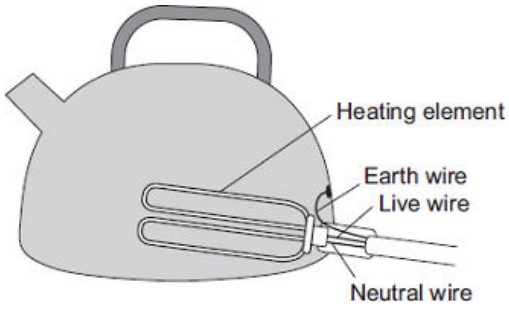
.....

.....

.....

(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.

.....

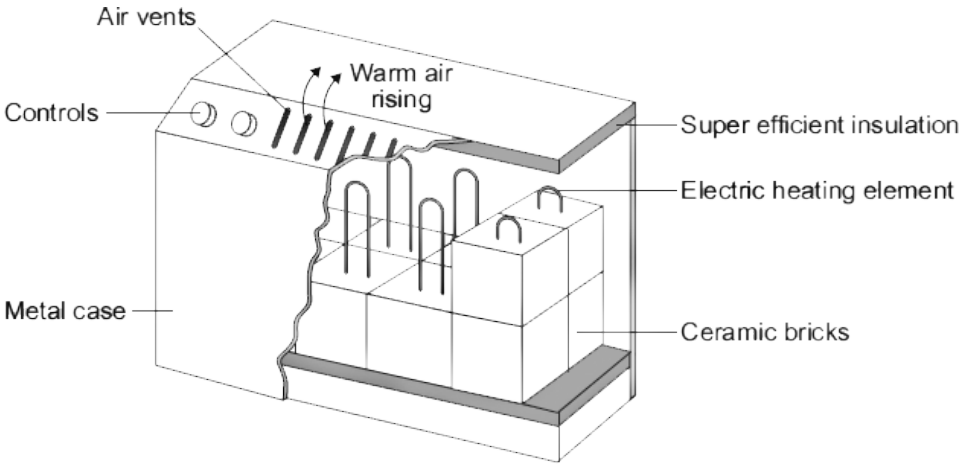
.....

.....

.....

(2)
(Total 4 marks)

43 The diagram shows how one type of electric storage heater is constructed. The heater has ceramic bricks inside. The electric elements heat the ceramic bricks during the night. Later, during the daytime, the ceramic bricks transfer the stored energy to the room.



(a) (i) Complete the following sentences using words from the box.

conduction	**convection**	**evaporation**

Energy is transferred through the metal casing by .....

The warm air rising from the heater transfers energy to the

room by .....

(2)

(ii) The inside of the metal case is insulated.

Which **one** of the following gives the reason why?

Tick (✓) **one** box.

To transfer energy from the ceramic bricks to the room faster ☐

To stop energy from the room transferring into the heater ☐

To keep the ceramic bricks hot for a longer time ☐

(1)

(b) In winter, the electricity supply to a 2.6 kW storage heater is switched on for seven hours each day.

(i) Calculate the energy transferred, in kilowatt-hours, from the electricity supply to the heater in seven hours.

Show clearly how you work out your answer.

.....

.....

Energy transferred = ... kWh

(2)

(ii) The electricity supply to the heater is always switched on between midnight and 7 am. Between these hours, electricity costs 5 p per kilowatt-hour.

Calculate how much it costs to have the heater switched on between midnight and 7 am.

.....

.....

Cost = ... p

(1)

(c) Between 7 am and 8 am, after the electricity supply is switched off, the temperature of the ceramic bricks falls by 25 °C.

Calculate the energy transferred from the ceramic bricks between 7 am and 8 am.

Total mass of ceramic bricks = 120 kg.
Specific heat capacity of the ceramic bricks = 750 J/kg °C.

Show clearly how you work out your answer.

.....

.....

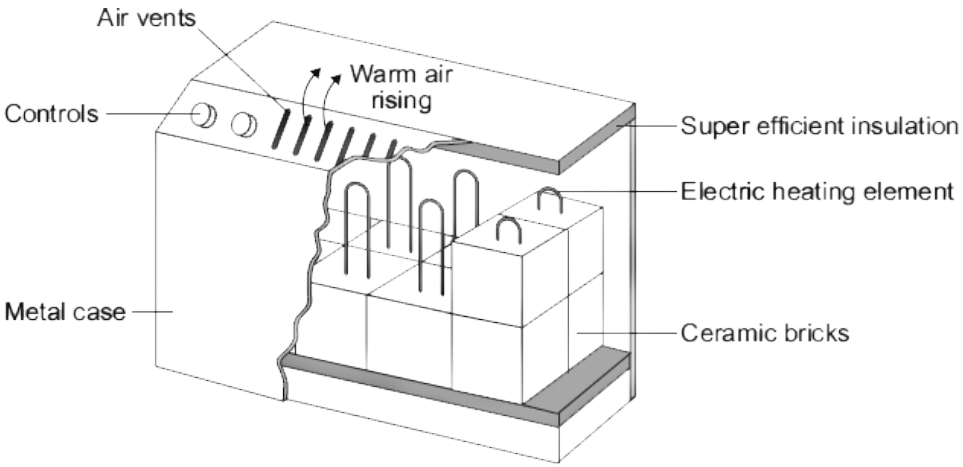
.....

.....

Energy transferred = ... J

(2)
(Total 8 marks)

44 The diagram shows how one type of electric storage heater is constructed. The heater has ceramic bricks inside. The electric elements heat the ceramic bricks during the night. Later, during the daytime, the ceramic bricks transfer the stored energy to the room.



(a) In winter, the electricity supply to a 2.6 kW storage heater is switched on each day between midnight and 7 am. Between these hours, electricity costs 5 p per kilowatt-hour.

Calculate the daily cost of using the storage heater.

Show clearly how you work out your answer.

.....

.....

.....

.....

.....

Cost = ... p

(3)

(b) Homes with electric storage heaters have a separate meter to measure the electricity supplied between midnight and 7 am. Another meter measures the electricity supplied at other times. This electricity supplied at other times costs 15 p per kilowatt-hour.

Electricity companies encourage people to use electricity between midnight and 7 am by selling the electricity at a lower cost.

Suggest why.

.....

.....

(1)

(c) By 7 am, the temperature at the centre of the ceramic bricks is about 800 °C.
The temperature of the outside metal casing is about 80 °C.

The ceramic bricks are surrounded by 'super-efficient' insulation.

Explain why.

.....

.....

.....

.....

(2)

(d) At 7 am, the electricity supply switches off and the temperature of the ceramic bricks starts to fall. The temperature of the bricks falls by 100 °C over the next four hours. During this time, 9 000 000 J of energy are transferred from the bricks.

Calculate the total mass of ceramic bricks inside the heater.

Specific heat capacity of the ceramic bricks = 750 J/kg °C.

Show clearly how you work out your answer.

.....

.....

.....

.....

Mass = ... kg

(2)

(Total 8 marks)

45 The table gives data about two types of low energy bulb.

Type of bulb	Power input in watts	Efficiency	Lifetime in hours	Cost of one bulb
Compact Fluorescent Lamp (CFL)	8	20%	10 000	£3.10
Light Emitting Diode (LED)	5		50 000	£29.85

(a) Both types of bulb produce the same useful power output.

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

Show clearly how you work out your answer.

.....

.....

.....

Useful power output = ... W

(2)

(ii) Calculate the efficiency of the LED bulb.

Show clearly how you work out your answer.

.....

.....

.....

Efficiency = ...

(1)

(b) LED bulbs are expensive. This is because of the large number of individual electronic LED chips needed to produce sufficient light from each bulb.

(i) Use the data in the table to evaluate the cost-effectiveness of an LED bulb compared to a CFL.

.....

.....

.....

.....

(2)

(ii) Scientists are developing brighter and more efficient LED chips than those currently used in LED bulbs.

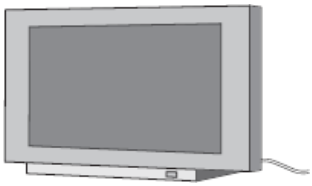
Suggest **one** benefit of developing brighter and more efficient LED chips.

.....

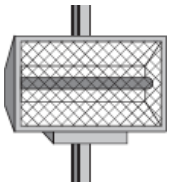
.....

(1)
(Total 6 marks)

46 The data included in the diagrams gives the power of the electrical appliances.



TV
160 W



Radiant heater
1.0 kW

Hairdryer
1100 W

Sandwich toaster
1.1 kW

Food processor
0.4 kW

Table lamp
40 W

(a) (i) Which appliance is designed to transform electrical energy to light and sound?

.....

(1)

(ii) Which **two** appliances transform energy at the same rate?

..... and .....

(1)

(b) During one week, the food processor is used for a total of 3 hours.

(i) Use the equation in the box to calculate the energy transferred, in kilowatt-hours, by the food processor in 3 hours.

energy transferred (kilowatt-hour, kWh)	=	power (kilowatt, kW)	×	time (hour, h)

Show clearly how you work out your answer.

.....

.....

.....

.....

Energy transferred = ... kWh

(2)

(ii) Electricity costs 15 pence per kilowatt-hour.

Use the equation in the box to calculate the cost of using the food processor for 3 hours.

total cost	=	number of kilowatt-hours	×	cost per kilowatt-hour

Show clearly how you work out your answer.

.....

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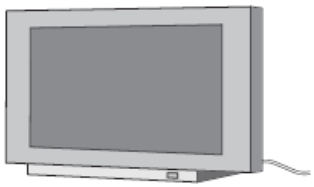
Cost = ... pence

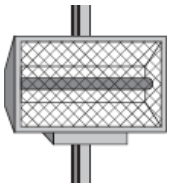
(2)

(Total 6 marks)

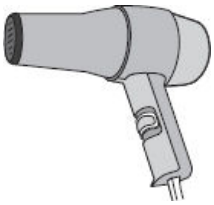
47 The data included in the diagrams gives the power of the electrical appliances.



TV
160 W



Radiant heater
1.0 kW



Hairdryer
1100 W

Sandwich toaster
1.1 kW

Food processor
0.4 kW

Table lamp
40 W

(a) (i) Which of the appliances are designed to transform electrical energy to kinetic energy?

.....

.....

(1)

(ii) Which of the appliances waste energy as heat?

.....

.....

(1)

(b) Leaving the radiant heater switched on is likely to lead to more carbon dioxide being emitted into the atmosphere than leaving the table lamp on for the same length of time.

Explain why.

.....

.....

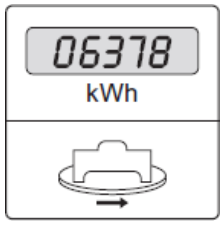
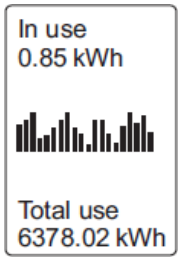
.....

.....

(2)

(c) A homeowner decides to monitor the amount of electrical energy used in his home. He can do this by using the home's electricity meter or by using a separate electronic device.

The table gives some information about each method.

Electricity meter	Electronic device
Records to the nearest kilowatt-hour	Records to the nearest 1/100th kilowatt-hour
Homeowner takes readings at regular intervals	Energy use recorded continuously and stored for one year
	Displays a graph showing energy use over a period of time
	

(i) Complete the following sentence.

The reading given by the electronic device is more ..... than the reading given by the electricity meter.

(1)

(ii) Suggest how data collected and displayed by the electronic device could be useful to the homeowner.

.....

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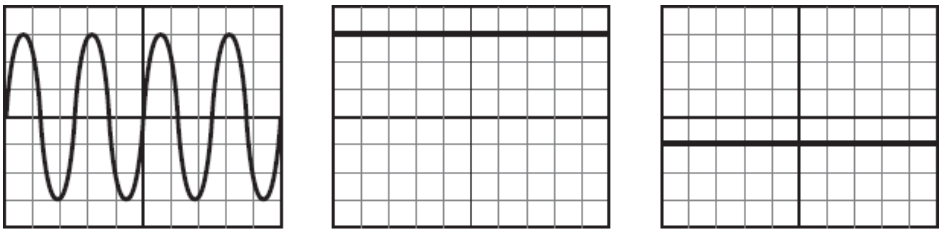
(3)
(Total 8 marks)

48 (a) The diagram shows the traces produced on an oscilloscope when it is connected across different electricity supplies.



Which of the traces could have been produced by the mains electricity supply?

.....

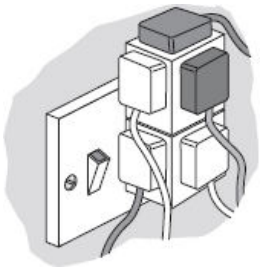
Give a reason for your answer.

.....

.....

(2)

(b) The picture shows two adaptors being used to plug five electrical appliances into the same socket.



Explain why it is dangerous to have all five appliances switched on and working at the same time.

.....

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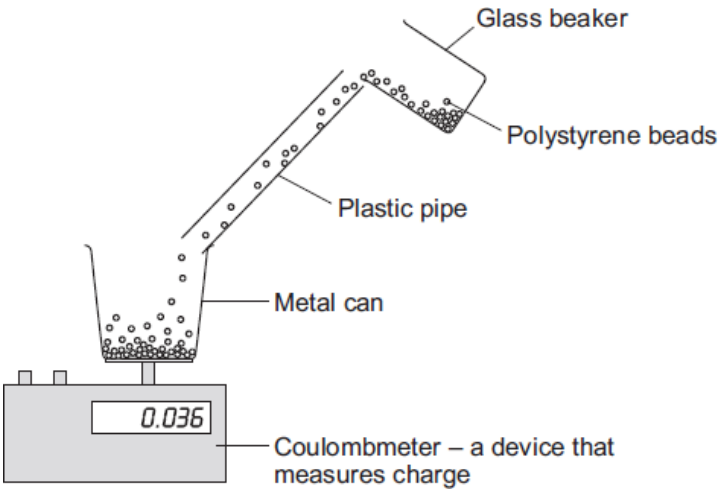
.....

.....

(2)
(Total 4 marks)

49 (a) Fine powders poured through a pipe can become charged. The diagram shows the apparatus used by a student to investigate this effect.



The student poured 75 cm^3 of polystyrene beads down the pipe. The beads fell into a metal can and the charge on them was measured directly using a coulombmeter.

The student repeated this twice more, but each time used 75 cm^3 of beads of a different size.

(i) When they fell through the pipe, the polystyrene beads became negatively charged.

Explain how this happened.

.....

.....

.....

.....

.....

.....

(3)

(ii) Give **one** control variable in the student's investigation.

.....

.....

(1)

(b) The results obtained by the student are shown in the table.

Diameter of polystyrene beads in mm	Charge in microcoulombs
1.0	0.080
2.0	0.044
3.0	0.012

(1 000 000 microcoulombs = 1 coulomb)

(i) Describe the connection between the size of the polystyrene beads and the total charge on the beads.

.....

.....

(1)

(ii) Explain how these results might be different if the student had used a shorter pipe.

.....

.....

.....

.....

(2)

(c) In industry, powders are often pumped through pipes. If the static charge caused a spark, the powder could ignite and cause an explosion.

(i) Is an explosion more likely to happen when pumping very fine powders or when pumping powders that consist of much larger particles?

.....

Give a reason for your answer.

.....

.....

(1)

(ii) Suggest **one** way that the risk of an explosion could be reduced.

.....

.....

(1)

(d) The table gives the minimum ignition energy (MIE) value for a number of fine powders. The MIE is the minimum amount of energy required to cause a fine powder to ignite.

Type of powder	MIE in millijoules
Coal dust	60.00
Aluminium powder	10.00
Cornstarch dust	0.30
Iron powder	0.12

The MIE values for different substances are all measured in the same way and under the same conditions of pressure and temperature.

Why is this important?

.....

.....

(1)
(Total 10 marks)

50 (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.

.....

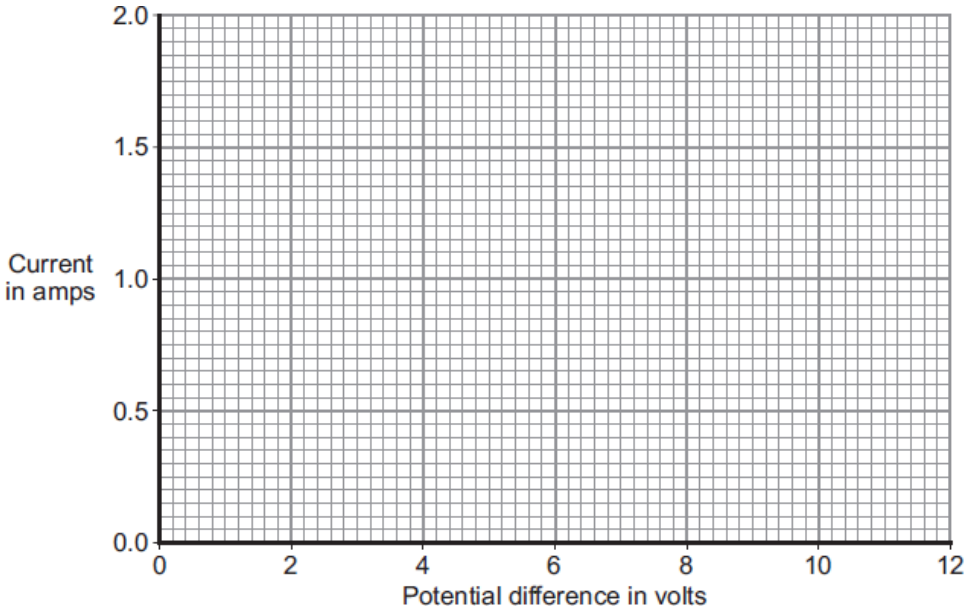
.....

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)

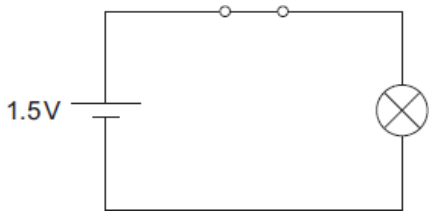
(iii) Why does the resistance of the lamp change when the current through the lamp exceeds 0.8 A?

.....

.....

(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.

.....

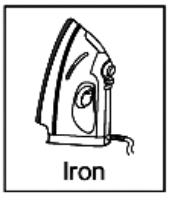
.....

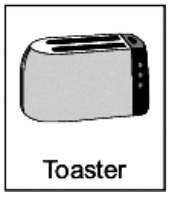
Energy transformed = ... J

(2)

(Total 7 marks)

51 The appliances shown below transfer electrical energy to other types of energy.





(a) The vacuum cleaner is designed to transfer electrical energy to kinetic energy.

Three more of the appliances are also designed to transfer electrical energy to kinetic energy. Which **three**?

Draw a ring around each correct appliance.

3

(b) Which **two** of the following statements are true?

Tick (✓) **two** boxes.

Appliances only transfer part of the energy usefully. ☐

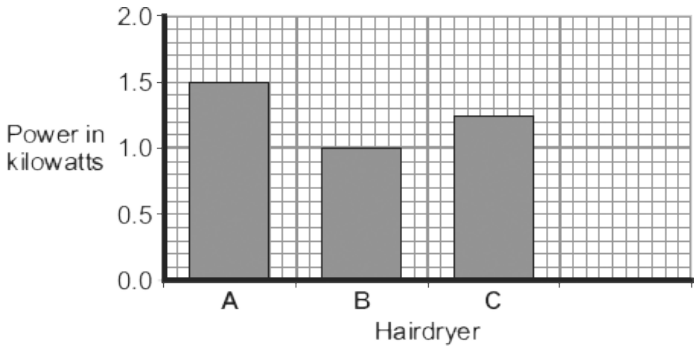
The energy transferred by appliances will be destroyed. ☐

The energy transferred by appliances makes the surroundings warmer. ☐

The energy output from an appliance is bigger than the energy input. ☐

(2)
(Total 5 marks)

52 (a) The bar chart shows the power of three different electric hairdryers.



(i) Which **one** of the hairdryers, **A**, **B** or **C**, would transfer the most energy in 5 minutes?

Write the correct answer in the box. ☐

(1)

(ii) A small 'travel' hairdryer has a power of 500 watts.

Draw a fourth bar on the bar chart to show the power of the 'travel' hairdryer.

(1)

(b) A family shares the same hairdryer.
The hairdryer has a power of 1.2 kW. The hairdryer is used for a total of 2 hours each week.

(i) Calculate how many kilowatt-hours (kWh) of energy the hairdryer transfers in 2 hours.

Show clearly how you work out your answer.

.....

.....

Energy transferred = ... kWh

(2)

(ii) Electricity costs 15 pence per kWh.

Calculate the cost of using the hairdryer for 2 hours.

Show clearly how you work out your answer.

.....

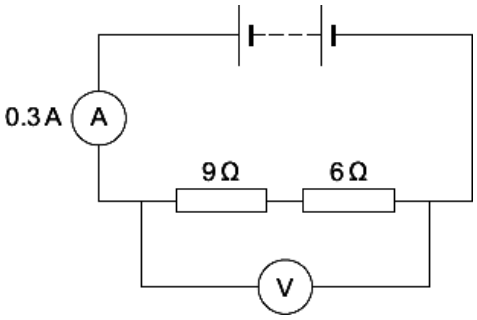
.....

Cost = ... pence

(2)

(Total 6 marks)

53 (a) The diagram shows a simple circuit.



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

.....

Total resistance = ... Ω

(1)

(ii) Calculate the reading on the voltmeter.

Show clearly how you work out your answer.

.....

.....

Voltmeter reading = ... V

(2)

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

Replacing one of the resistors with a resistor of higher value will

decrease
not change
increase

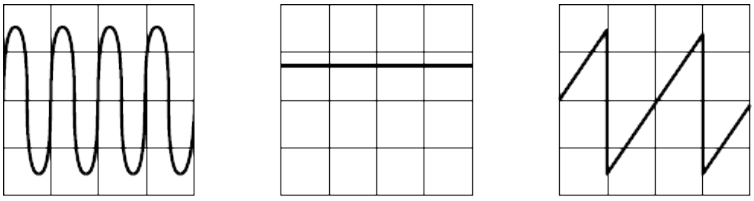
the reading on the ammeter.

(1)

(b) The voltmeter in the circuit is replaced with an oscilloscope.

Which one of the diagrams, **X**, **Y** or **Z**, shows the trace that would be seen on the oscilloscope?

Write your answer, **X**, **Y** or **Z**, in the box.



Diagram

Give a reason for your answer.

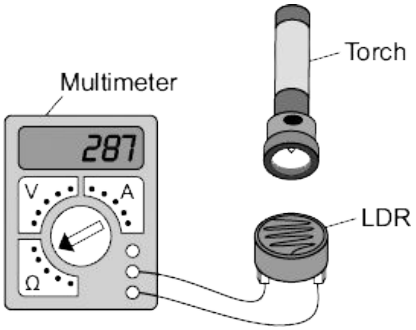
.....

.....

.....

(2)
(Total 6 marks)

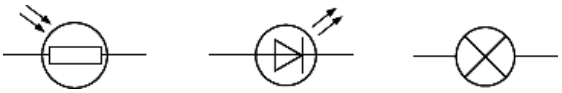
54 A student used the apparatus below to find out how the resistance of a light-dependent resistor (LDR) depends on light intensity.



The resistance of the LDR was measured directly using a multimeter.

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

Draw a ring around your answer.



(1)

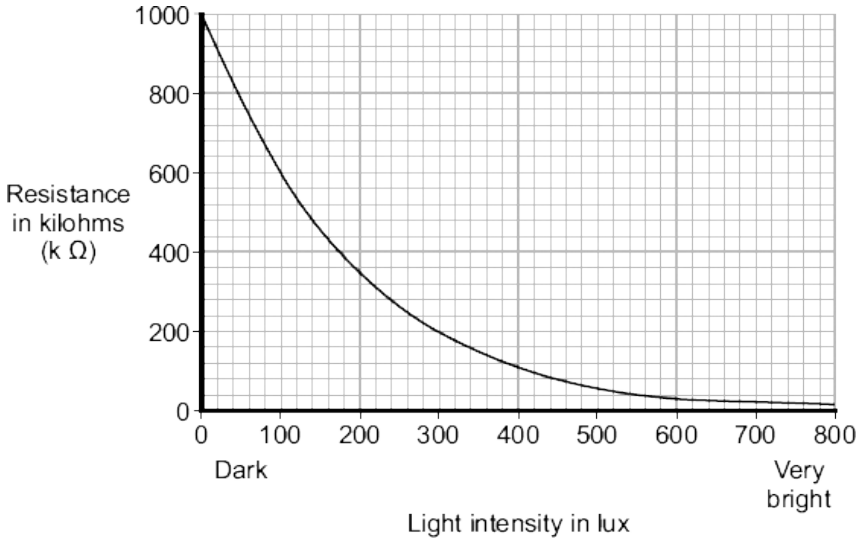
(ii) Name **one** factor that will affect the intensity of the light hitting the LDR.

.....

.....

(1)

(b) The manufacturer of the LDR provides data for the LDR in the form of a graph.



Describe how the resistance of the LDR changes when the light intensity increases from 100 lux to 300 lux.

.....

.....

.....

(2)

(c) The student only obtained three results. These are given in the table.

Light intensity	Resistance in kilohms
Dark	750
Bright	100
Very bright	1

(i) The student could **not** use the results to draw a line graph.
Why not?

.....

.....

(1)

(ii) Do the student's results agree with the data the manufacturer provided?

Draw a ring around your answer. YES NO

Give a reason for your answer.

.....

.....

.....

(1)

(d) Which **one** of the following circuits probably includes a LDR?

Tick (✓) **one** box.

A circuit that automatically switches outside lights on when it gets dark. ☐

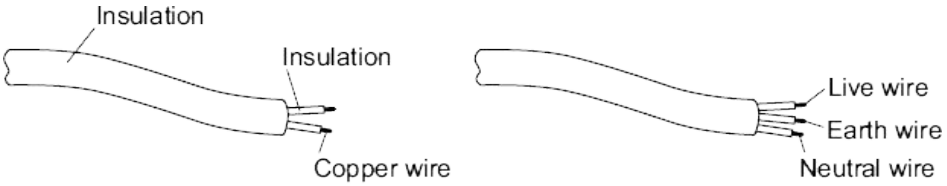
A circuit that automatically switches central heating on and off. ☐

A circuit that automatically turns lights off when no one is in the room. ☐

(1)

(Total 7 marks)

55 (a) The diagram shows a piece of two-core cable and a piece of three-core cable.



(i) Which **one** of the wires inside a three-core cable is missing from a two-core cable?

Draw a ring around your answer.

earth wire **live wire** **neutral wire**

(1)

(ii) Use a word from the box to complete the following sentence.

double	**extra**	**totally**

A pottery table lamp fitted with a two-core cable is safe to use because it is

..... insulated.

(1)

(b) The cables connecting the power sockets in a building contain wires 1.8 mm thick. The maximum current that can safely pass through these wires is 20 amps. A fuse is included in the circuit to protect the wiring.

Explain how a fuse protects the wiring of a circuit.

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(3)
(Total 5 marks)