AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.1.2.1 ENERGY TRANSFERS IN A SYSTEM

SCORE	PERCENTAGE
/144	%

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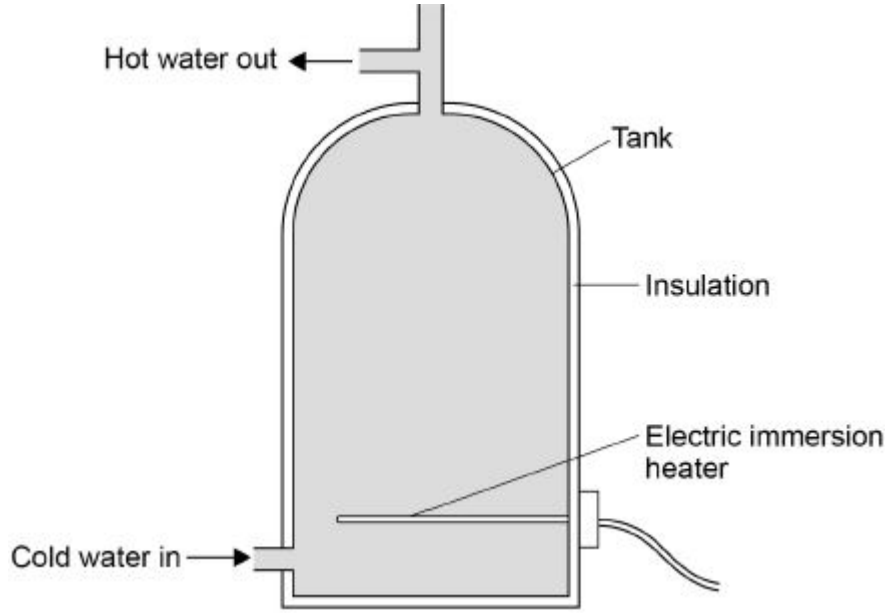
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Q1.

Figure 1 shows a hot water tank made of copper.

Figure 1



(a) Copper has a higher thermal conductivity than most metals.

How does the rate of energy transfer through copper compare with the rate of energy transfer through most metals?

Tick **one** box.

Higher ☐

Lower ☐

The same ☐

(1)

(b) The tank is insulated. When the water is hot, the immersion heater switches off.

Complete the sentences.

Compared to a tank with no insulation, the rate of energy transfer from the water in an insulated tank is _____ .

This means that the water in the insulated tank stays _____ for longer.

(2)

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Figure 2 shows how temperature varies with time for water in a tank heated with an immersion heater.

Figure 3 shows how temperature varies with time for water in a tank heated with a solar panel.

Figure 2

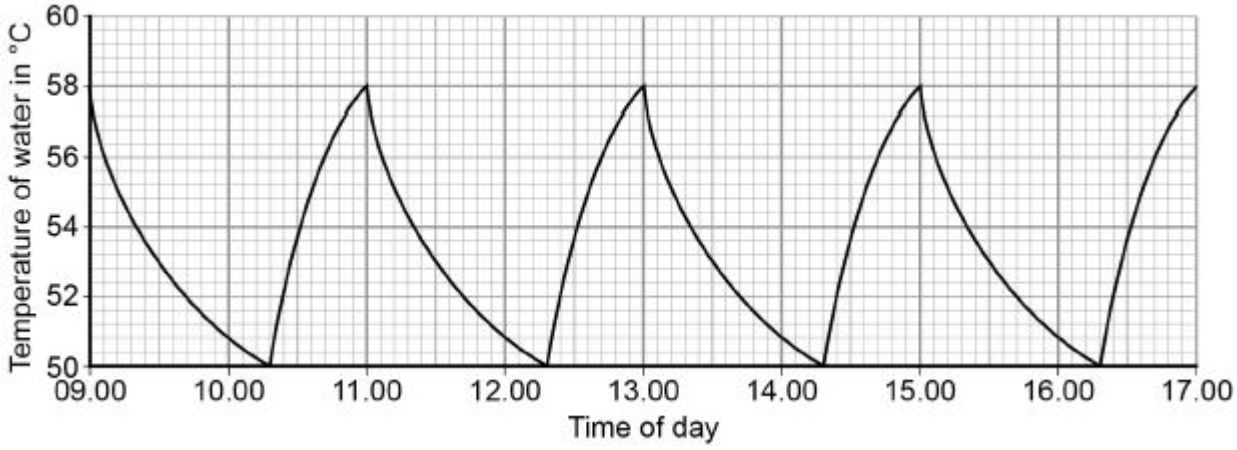
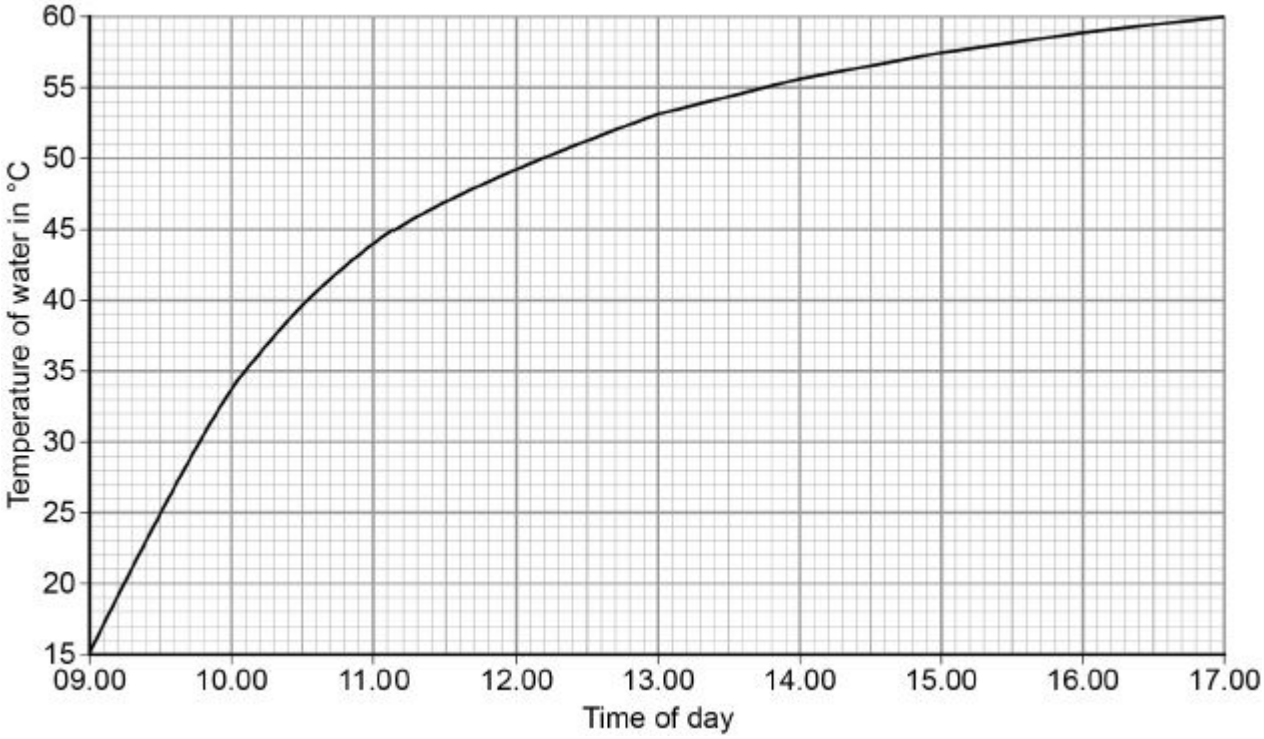


Figure 3



(c) Give **one** advantage and **one** disadvantage of heating the water using solar panels rather than an immersion heater.

Use only information from **Figure 2** and **Figure 3**.

Advantage of solar panels _____

_____

_____

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Disadvantage of solar panels _____

_____

_____

(2)

(d) During one morning, a total of 4 070 000 J of energy is transferred from the electric immersion heater.

4 030 000 J of energy are transferred to the water.

Calculate the proportion of the total energy transferred to the water.

_____

_____

_____

_____

Proportion of total energy = _____

(2)

(e) Write down the equation that links energy transferred, power and time.

_____

(1)

(f) The power output of the immersion heater is 5000 W.

Calculate the time taken for the immersion heater to transfer 4 070 000 J of energy.

Give the unit.

_____

_____

_____

_____

Time = _____ Unit _____

(4)

(Total 12 marks)

Q2.

Figure 1 shows a lift inside a building.

Figure 1

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

Calculate the power output of the motor in the lift.

Use the equation:

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

_____

_____

_____

_____

Power output = _____ W

(2)

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

Tick **two** reasons why.

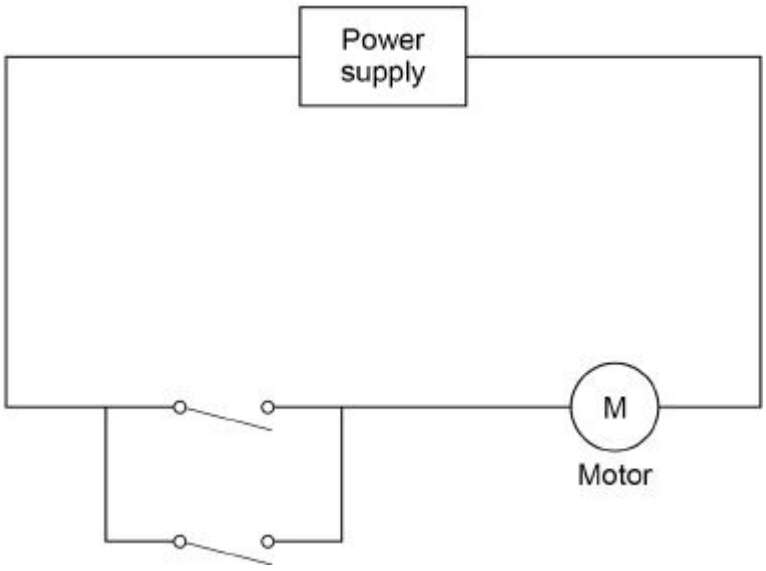
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Energy is transferred in heating the surroundings.	☐
Friction causes energy to be transferred in non-useful ways.	☐
The motor is connected to the mains electricity supply.	☐
The motor is more than 100% efficient.	☐
There are only four people in the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

(2)

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

Figure 2



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

Explain why.

_____

_____

_____

_____

_____

(2)

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

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_____

_____

(1)

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

gravitational field strength = 9.8 N/kg

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

Give your answer to 2 significant figures.

_____

_____

_____

_____

Increase in gravitational potential energy = _____ J

(3)

(Total 10 marks)

Q3.

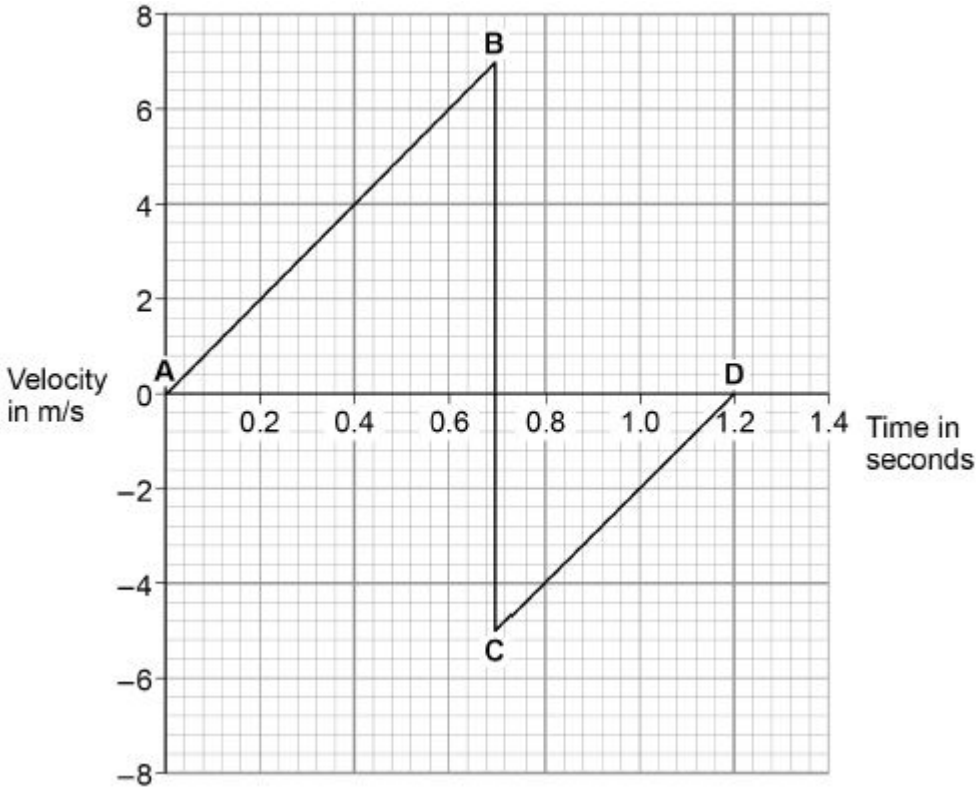
A child drops a ball.

The ball hits the ground and bounces.

The graph below shows the velocity-time graph for the ball from when the ball is dropped until when the ball reaches the top of its first bounce.

Air resistance has been ignored.

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(a) Describe the motion of the ball between points **A** and **B** on the graph above.

_____

_____

_____

_____

(2)

(b) What direction is the ball moving between points **C** and **D** on the graph above?

_____

(1)

(c) The ball and the Earth form a system.

What is meant by 'a system'?

Tick **one** box.

A group of objects that interact. ☐

Objects with big differences in mass. ☐

Objects with gravitational potential energy. ☐

(1)

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(d) When the ball hits the ground, energy is transferred from the ball to the Earth.

Explain how the data in the graph above shows this energy transfer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

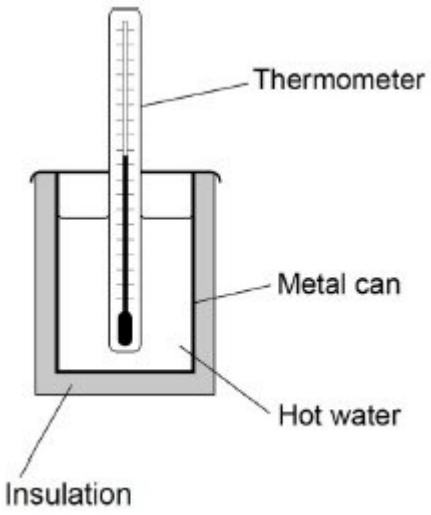
(Total 8 marks)

Q4.

A student investigated the properties of three insulating materials.

Figure 1 shows the apparatus the student used.

Figure 1

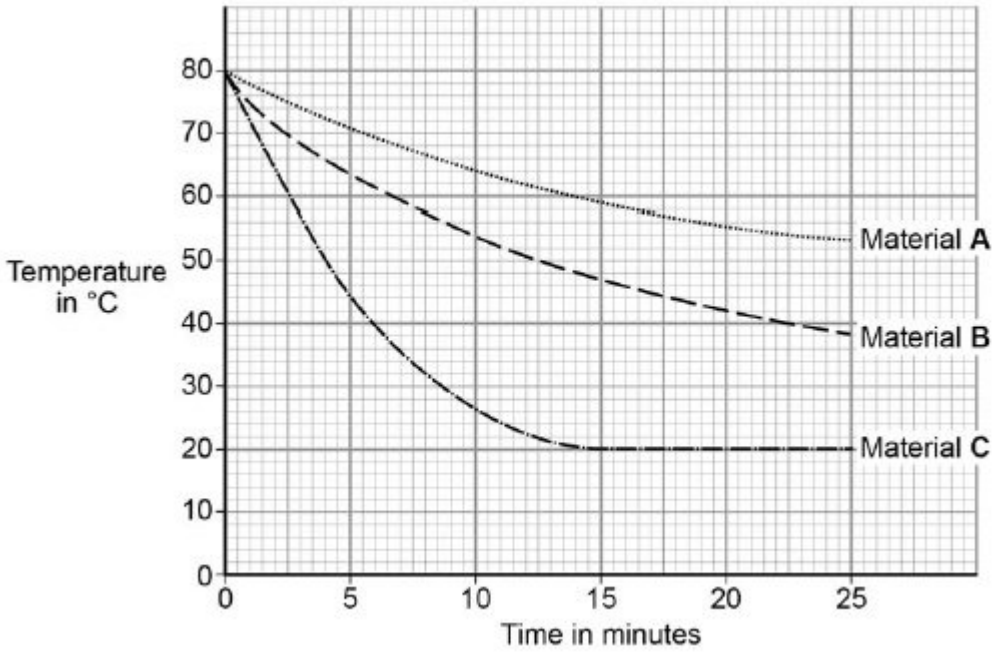


In the investigation, different insulating materials were used to insulate a metal can filled with hot water.

Figure 2 shows how the temperature measured by the thermometer changed over 25 minutes for each of the materials.

Figure 2

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(a) What was the temperature of the room where the student carried out the investigation?

Tick **one** box.

20 °C ☐ 38 °C ☐ 53 °C ☐ 80 °C ☐

(1)

(b) Material C has the highest thermal conductivity.

How does the graph in **Figure 2** show this?

_____

_____

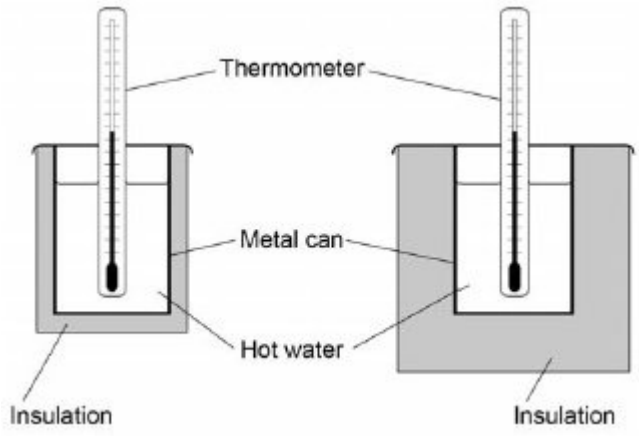
(1)

(c) Another student repeated the investigation using the equipment shown in **Figure 3**.

Figure 1 shows the first set of equipment used.

Figure 1 **Figure 3**

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Suggest how using the equipment in **Figure 3** will have affected the student's results.

_____

_____

_____

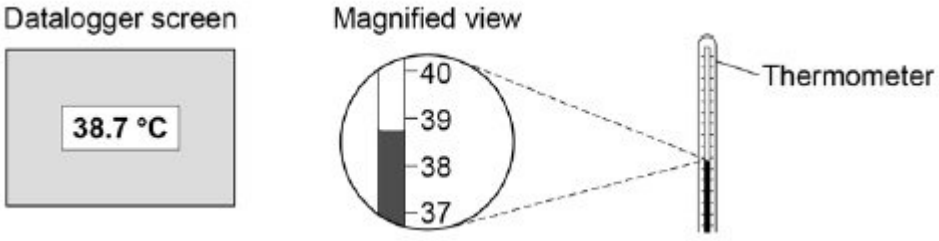
_____

(2)

(d) The students could have used a temperature probe and datalogger instead of a thermometer.

Figure 4 shows the datalogger screen and the thermometer.

Figure 4



Complete the sentences.

Choose the answers from the box.

higher	**lower**	**the same**

Compared to the thermometer, the datalogger and temperature probe have

a resolution that is _____ .

Compared to the thermometer, the chance of misreading the datalogger and

temperature probe is _____ .

(2)

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(e) The table gives information about four types of insulation that could be used in the walls of houses.

Type of insulation	Thermal conductivity in W/m °C
Felt wool	0.070
Mineral wool	0.040
Polyurethane foam	0.030
Rock wool	0.045

Which type of insulation would be most effective in reducing the rate of cooling of a building?

Tick **one** box.

Felt wool ☐

Mineral wool ☐

Polyurethane foam ☐

Rock wool ☐

Give a reason for your answer.

_____

_____

_____

_____

(2)

(Total 8 marks)

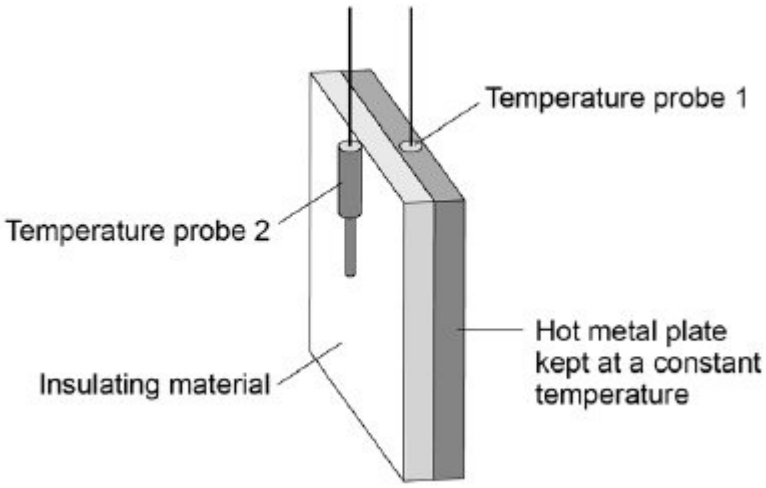
Q5.

A student investigated the properties of three types of insulation.

Figure 1 shows the apparatus the student used.

Figure 1

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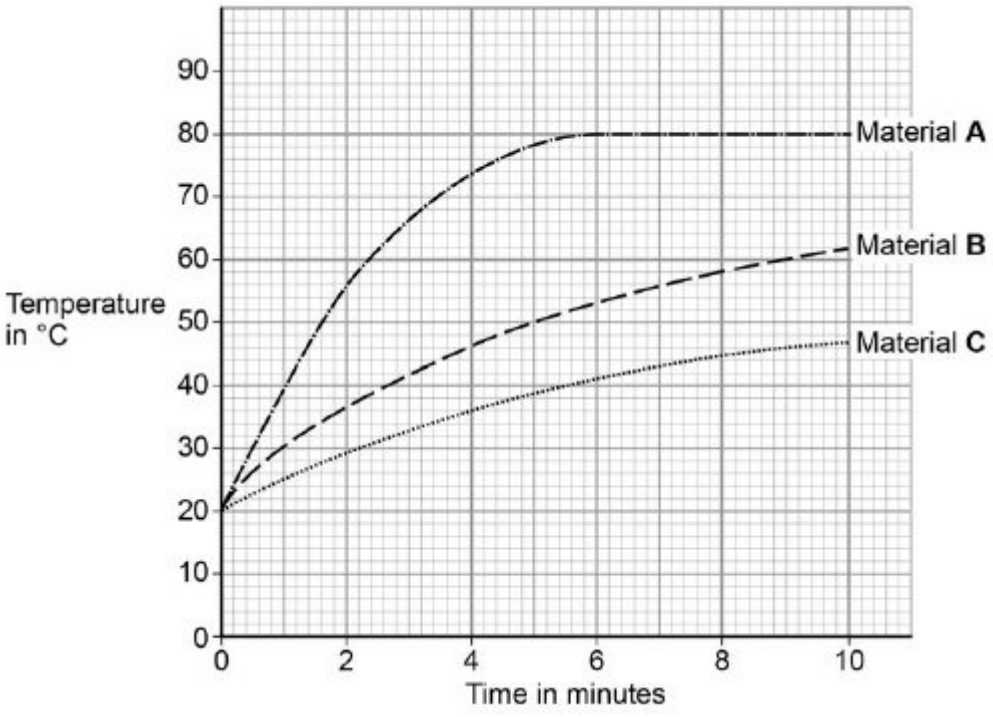
In the investigation different insulating materials were placed in contact with the hot metal plate.

Temperature probes measured the temperature on each side of the material.

The temperature probes were connected to a data logger.

Figure 2 shows how the temperature measured by temperature probe 2 changed over 10 minutes for each of the materials.

Figure 2



(a) What was the temperature of the hot metal plate?

_____ °C

(1)

(b) Which material is the best insulator?

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Tick **one** box.

A ☐ **B** ☐ **C** ☐

Give the reason for your answer.

_____

_____

(2)

(c) Another student repeated the investigation but doubled the thickness for all three insulating materials.

Suggest how using thicker insulation would affect the results of the second student's investigation compared with the first student's results.

_____

_____

_____

_____

_____

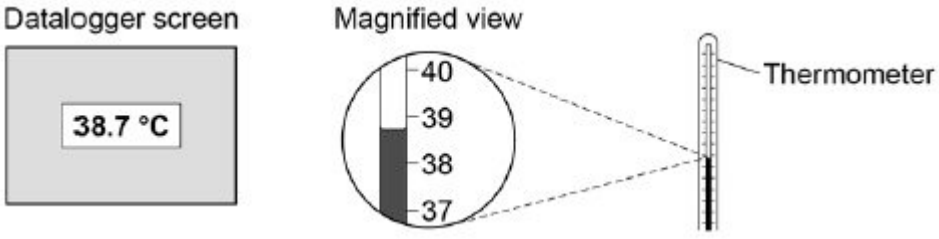
_____

(2)

(d) The students could have used a thermometer instead of temperature probes and a datalogger.

Figure 3 shows the datalogger screen and a thermometer.

Figure 3



Give two advantages of using the datalogger and temperature probes compared to a thermometer.

1. _____

_____

2. _____

_____

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(2)

(e) The table gives information about four types of insulation that could be used for insulating the cavity walls of houses.

Type of insulation	Thermal conductivity in W/m °C
Felt wool	0.070
Mineral wool	0.040
Polyurethane foam	0.030
Rock wool	0.045

Explain which one of the types of insulation in the table would be the best to use for cavity wall insulation.

_____

_____

_____

_____

_____

_____

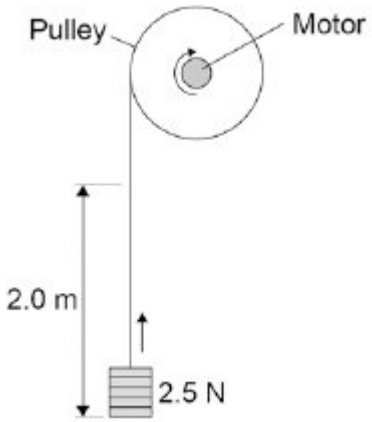
(2)

(Total 9 marks)

Q6.

A student investigated the efficiency of a motor using the equipment in **Figure 1**.

Figure 1



He used the motor to lift a weight of 2.5 N a height of 2.0 m.

He measured the speed at which the weight was lifted and calculated the efficiency of the energy transfer.

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He repeated the experiment to gain two sets of data.

(a) Give **one** variable that the student controlled in his investigation.

_____

(1)

(b) Give **two** reasons for taking repeat readings in an investigation.

1. _____

_____

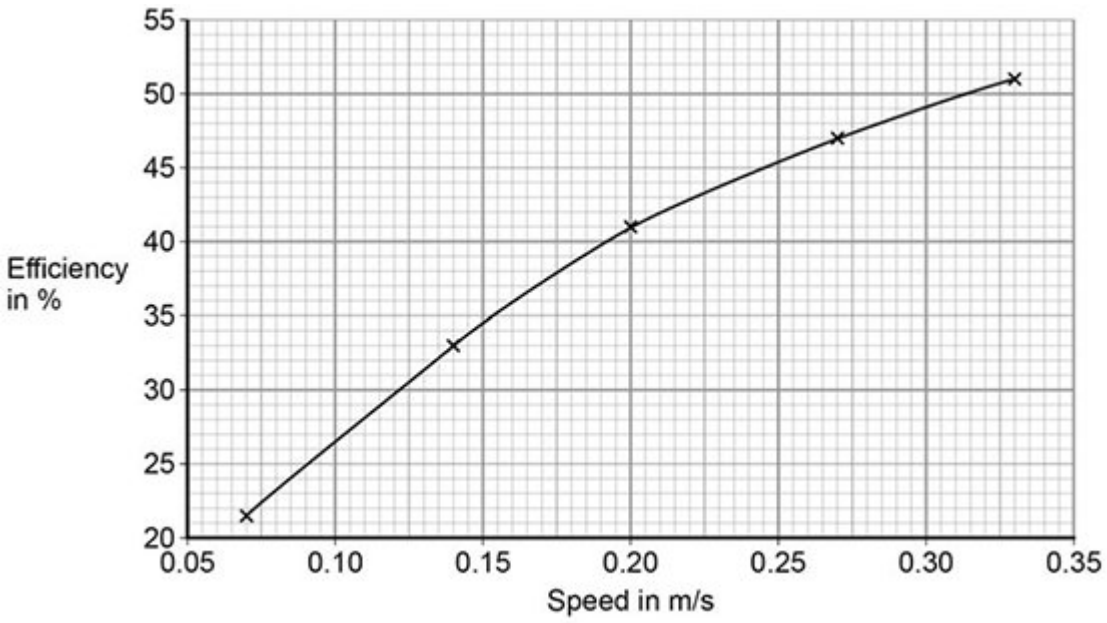
2. _____

_____

(2)

(c) **Figure 2** shows a graph of the student's results.

Figure 2



Give **two** conclusions that could be made from the data in **Figure 2**.

_____

_____

_____

_____

(2)

(d) Give the main way that the motor is likely to waste energy.

_____

_____

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(1)

(e) When the total power input to the motor was 5 W the motor could not lift the 2.5 N weight.

State the efficiency of the motor.

Efficiency = _____ %

(1)

(Total 7 marks)

Q7.

Different energy sources are used to generate electricity.

(a) Use words from the box to match the correct energy source to each of the descriptions given in the table.

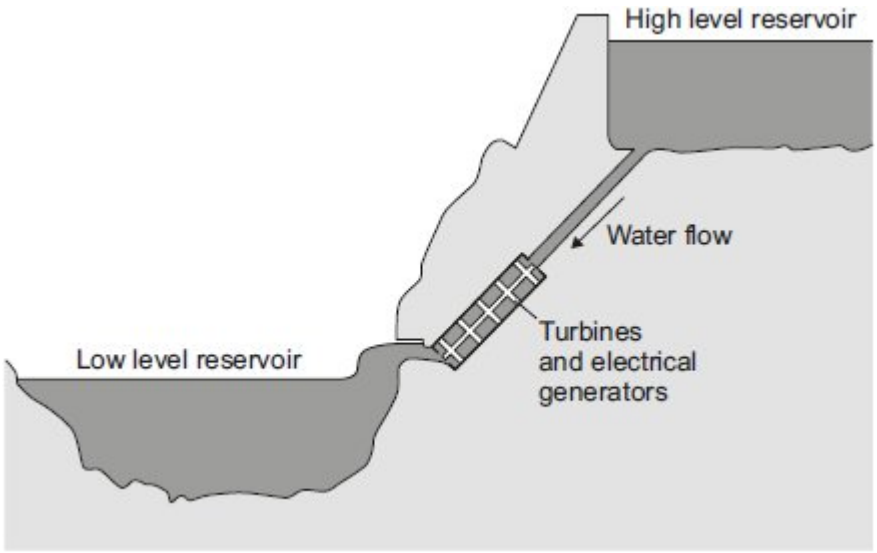
biofuel	coal	geothermal	nuclear	waves

Description	Energy source
Energy from the Earth's core is used to heat water.	
Fission of uranium nuclei is used to heat water.	
Gases from rotting plant material are burned to heat water.	

(3)

(b) Energy can be stored in a pumped storage power station.

The figure shows a pumped storage power station.



When electricity is needed, the water in the high level reservoir is allowed to flow to the low level reservoir. The flowing water generates electricity.

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

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electrical	gravitational potential	kinetic	nuclear	sound

The water in the high level reservoir stores _____ energy.

The flowing water has _____ energy.

The water turns the turbine which is connected to the generator.

The generator produces some _____, this is wasted energy.

(3)

(c) The total power input to a pumped storage power station is 600 MW.

The useful power output is 540 MW.

(i) Calculate the efficiency of this pumped storage power station.

_____

_____

_____

Efficiency = _____

(2)

(ii) Calculate how much power is wasted by the pumped storage power station.

_____

Power = _____ MW

(1)

(iii) How is the temperature of the surroundings affected by the energy wasted by the pumped storage power station?

_____

(1)

(Total 10 marks)

Q8.

The electric kettle shown below is used to boil water.



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(a) After the water has boiled, the temperature of the water decreases by 22 °C.
The mass of water in the kettle is 0.50 kg.
The specific heat capacity of water is 4200 J/kg °C.

Calculate the energy transferred to the surroundings from the water.

_____

_____

_____

Energy = _____ joules

(2)

(b) Why is the total energy input to the kettle higher than the energy used to heat the water?

Tick (✔) **one** box.

	Tick (✔)
Energy is absorbed from the surroundings.	
Energy is used to heat the kettle.	
The kettle is more than 100% efficient.	

(1)

(Total 3 marks)

Q9.

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

A householder wants to reduce her energy bills. She collected information about a number of ways of reducing energy used. The information is shown in the table.

Ways of reducing energy used	**Cost to buy and install in £**	**Money saved per year in £**
Install an energy-efficient boiler	2 000	320
Insulate the loft	400	200
Install double-glazed windows	12 000	120
Install cavity wall insulation	415	145

Use the information in the table to compare the different ways of reducing the energy used. Your answer should include some calculations.

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_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(b) Increasing the amount of insulation in a house affects the total U-value of the house.

(i) What is meant by the term ‘U-value’?

_____

_____

_____

(1)

(ii) How is the U-value affected by increasing the amount of insulation?

_____

(1)

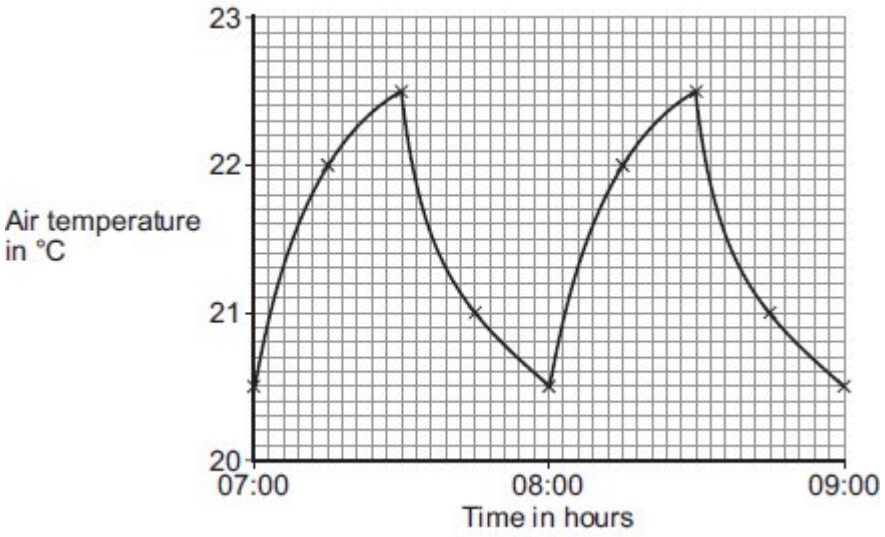
(Total 8 marks)

Q10.

A householder monitored how the air temperature inside his house changed over a 2-hour period. The householder measured the temperature every 15 minutes.

THe graph shows how the temperature changed with time.

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(a) (i) The householder used a digital thermometer to measure the temperature.

What would be an appropriate resolution for the digital thermometer?

Draw a ring around your answer.

0.5 °C **1 °C** **5 °C**

(1)

(ii) The householder's results are shown on the graph above.

Why would it **not** be appropriate to use the results to plot a bar chart?

_____

_____

(1)

(b) The householder's heating is controlled by a thermostat. The thermostat switches the heating on when the temperature decreases below a certain temperature.

(i) At what temperature does the thermostat switch the heating on?

_____ °C

(1)

(ii) Use the graph to determine the number of minutes that the householder's heating was switched on between 07:00 and 09:00.

_____

_____

Time = _____ minutes

(1)

(c) The householder read the following extract from a newspaper article about reducing energy use in the home.

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> . . . decreasing the temperature setting on your thermostat by 1 °C will reduce your heating bill by 10% . . .

On Monday, the householder set his thermostat at 20.0 °C and recorded the energy, in kWh, used to heat his house.

On Tuesday, the householder set his thermostat at 19.0 °C and recorded the energy, in kWh, used to heat his house.

The table shows the results of the householder's investigation.

Thermostat setting in °C	Energy in kWh
20.0	8.0
19.0	7.2

(i) The outside temperature was the same on both days.

Give **one** reason why this was important.

_____

_____

(1)

(ii) Explain how the results shown in the table above support the extract from the newspaper article.

Justify your answer with a calculation.

_____

_____

_____

_____

(2)

(iii) The statement in the extract is **not** valid for all situations.
Suggest why.

_____

_____

_____

_____

(2)

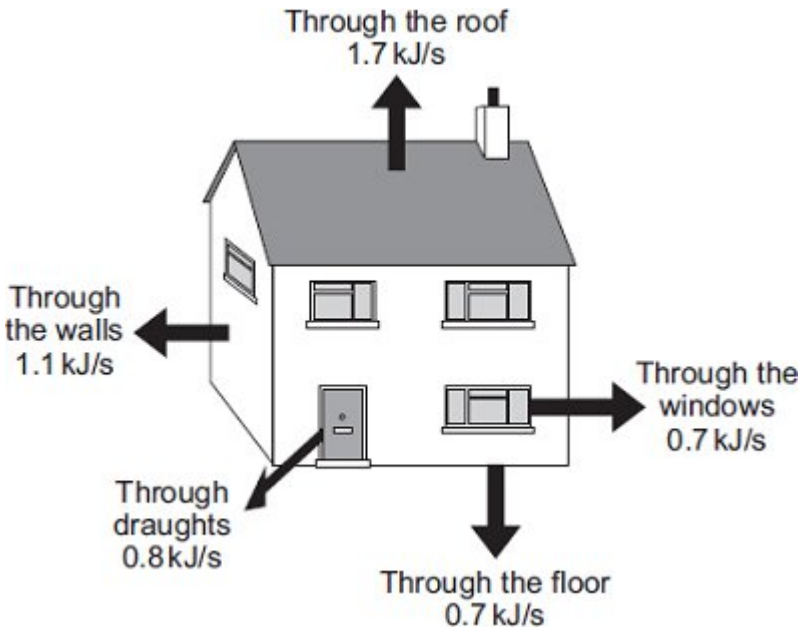
(Total 9 marks)

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Q11.

Diagram 1 shows the energy transferred per second from a badly insulated house on a cold day in winter.

Diagram 1



(a) (i) When the inside of the house is at a constant temperature, the energy transferred from the heating system to the inside of the house equals the energy transferred from the house to the outside.

Calculate, in kilowatts, the power of the heating system used to keep the inside of the house in **Diagram 1** at a constant temperature.

1 kilowatt (kW) = 1 kilojoule per second (kJ/s)

_____

Power of the heating system = _____ kW

(1)

(ii) In the winter, the heating system is switched on for a total of 7 hours each day.

Calculate, in kilowatt-hours, the energy transferred each day from the heating system to the inside of the house.

_____

_____

Energy transferred each day = _____ kWh

(2)

(iii) Energy costs 15 p per kilowatt-hour.

Calculate the cost of heating the house for one day.

_____

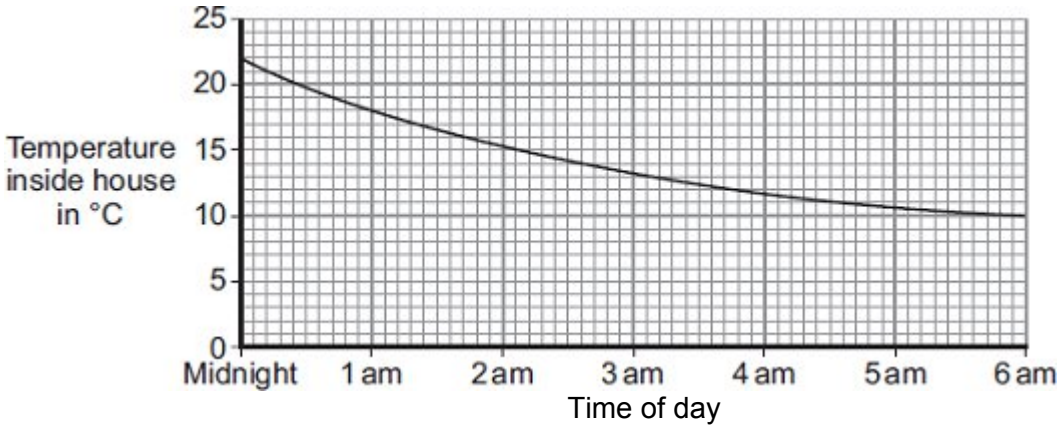
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Cost = _____

(1)

(iv) The heating system is switched off at midnight.

The graph shows how the temperature inside the house changes after the heating system has been switched off.



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

Between midnight and 6 am the rate of energy transfer from

the house

decreases.
decreases then stays constant.
increases.

Give the reason for your answer.

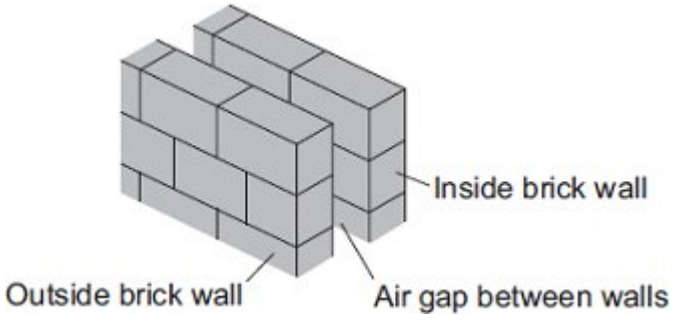
_____

_____

(2)

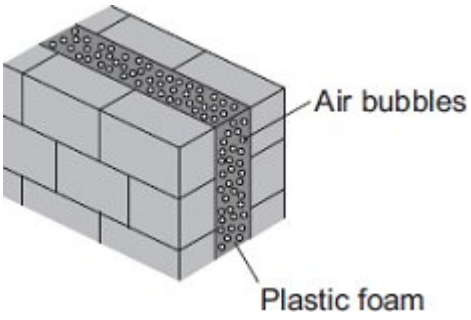
(b) **Diagram 2** shows how the walls of the house are constructed.
Diagram 3 shows how the insulation of the house could be improved by filling the air gap between the two brick walls with plastic foam.

Diagram 2



U-value of the wall = 0.7

Diagram 3



U-value of the wall = 0.3

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The plastic foam reduces energy transfer by convection.

Explain why.

_____

_____

_____

_____

(2)

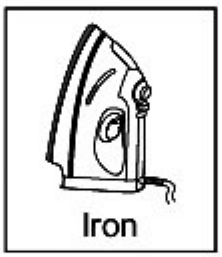
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Q12.

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

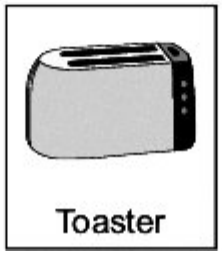














(a) The vacuum cleaner is designed to transfer electrical energy to kinetic energy.

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

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(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. ☐

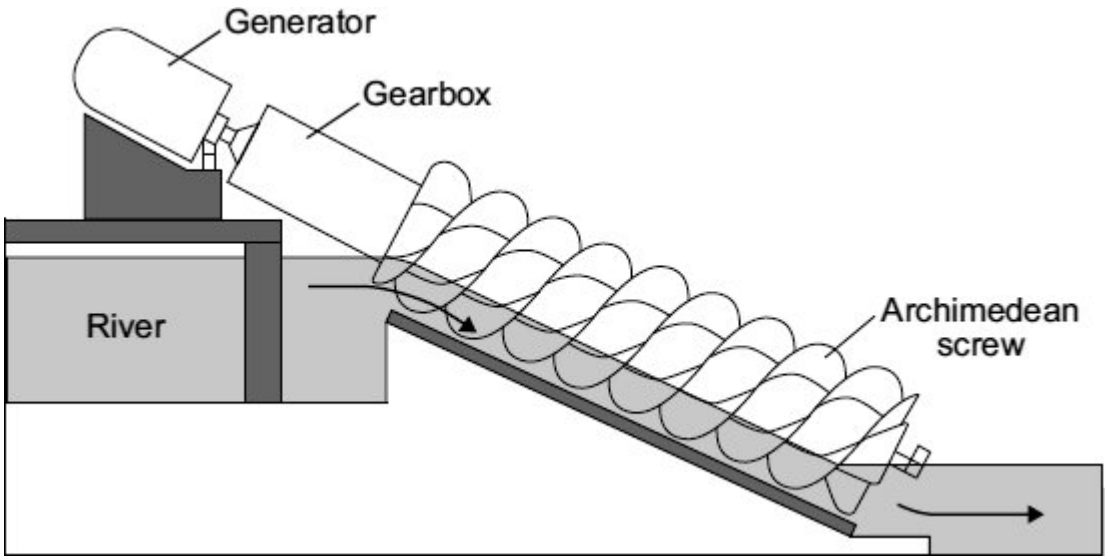
The energy output from an appliance is bigger than the energy input. ☐

(2)

(Total 5 marks)

Q13.

The diagram shows a small-scale, *micro-hydroelectricity* generator which uses the energy of falling river water to generate electricity. The water causes a device, called an Archimedean screw, to rotate.
The Archimedean screw is linked to the generator by a gearbox.



(a) Complete the following sentence by drawing a ring around the correct word in the box.

The gravitational potential energy of the falling water is transformed

into the | chemical / electrical / kinetic | energy of the Archimedean screw.

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(1)

(b) A micro-hydroelectric system generates about 60 kW of electricity, enough for 50 homes. A conventional large-scale hydroelectric power station may generate more than 5 000 000 kW of electricity.

(i) Give **one** advantage of a conventional large-scale hydroelectric power station compared to a micro-hydroelectric system.

_____

_____

(1)

(ii) Which **one** of the following statements gives a **disadvantage** of a conventional large-scale hydroelectric power station compared to a micro–hydroelectric system?

Put a tick (✓) in the box next to your answer.

Energy is wasted as heat and sound. ☐

Large areas of land are flooded. ☐

A constant flow of water is needed. ☐

(1)

(c) The electricity generated by the micro-hydroelectric system is transferred directly to local homes. The electricity generated by a conventional large-scale hydroelectric power station is transferred to homes anywhere in the country through a system of cables and transformers.

(i) What name is given to the system of cables and transformers used to transfer electricity to homes anywhere in the country?

_____

(1)

(ii) Using short cables to transfer electricity to local homes is much more efficient than using very long cables to transfer electricity to homes anywhere in the country.

Why?

_____

_____

(1)

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(d) Nepal is a mountainous country with over 6000 rivers. In Nepal, 9000 kW of electricity are generated using micro-hydroelectric generators.

Suggest **one** reason why in the UK much less electricity is generated using micro-hydroelectric generators, than in Nepal.

_____

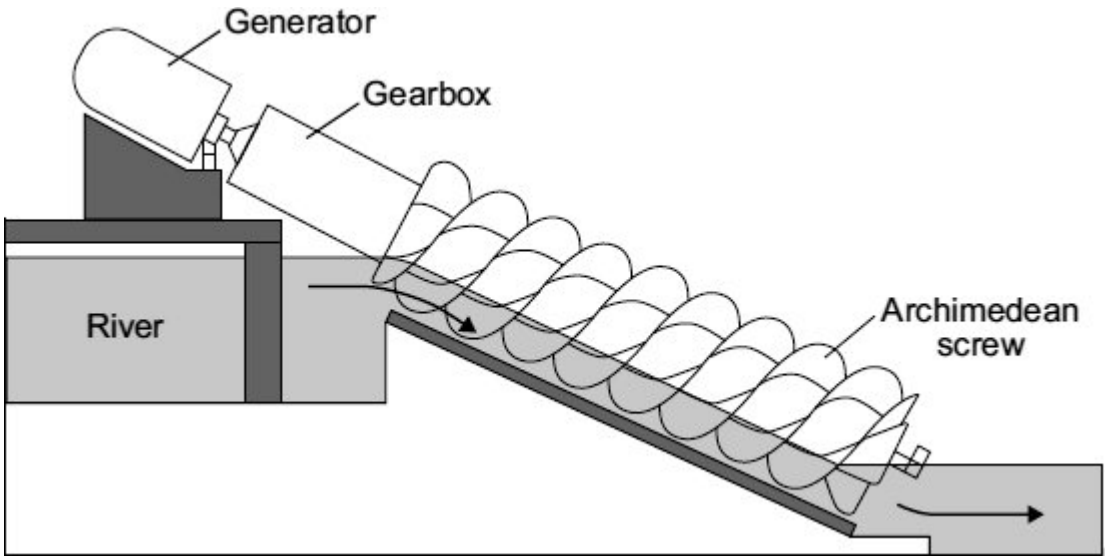
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(1)

(Total 6 marks)

Q14.

The diagram shows a small-scale, *micro-hydroelectricity* generator which uses the energy of falling river water to generate electricity. The water causes a device, called an Archimedean screw, to rotate.
The Archimedean screw is linked to the generator by a gearbox.



(a) Each second, the *micro-hydroelectricity* generator transforms 80 000 joules of gravitational potential energy into 60 000 joules of electrical energy.

(i) Fill in the missing word to complete the energy transformation diagram.

Gravitational potential energy of the falling water	→ _____ energy of the Archimedean screw	→ Electrical energy generated

(1)

(ii) Use the equation in the box to calculate the efficiency of the *micro-hydroelectricity* generator.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

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_____

_____

Efficiency = _____

(2)

(b) The power output from a conventional large-scale hydroelectric power station is 100 000 times more than the power output from a micro-hydroelectric system.

Give **one** disadvantage of a conventional large-scale hydroelectric power station compared to the micro-hydroelectric system.

_____

_____

(1)

(c) The electricity generated by a micro-hydroelectric system is transferred via a transformer directly to local homes. The electricity generated by a conventional large-scale hydroelectric power station is transferred to the National Grid, which distributes the electricity to homes anywhere in the country.

(i) What is the National Grid?

_____

_____

(1)

(ii) Explain why transferring the electricity directly to local homes is more efficient than using the National Grid to distribute the electricity.

_____

_____

_____

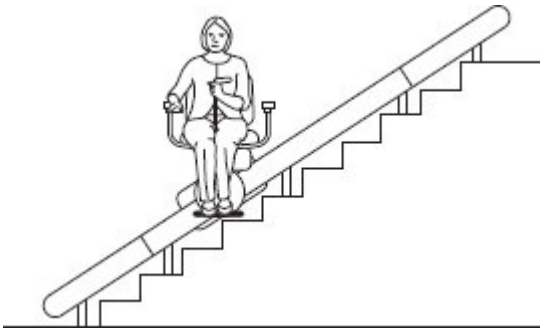
_____

(2)

(Total 7 marks)

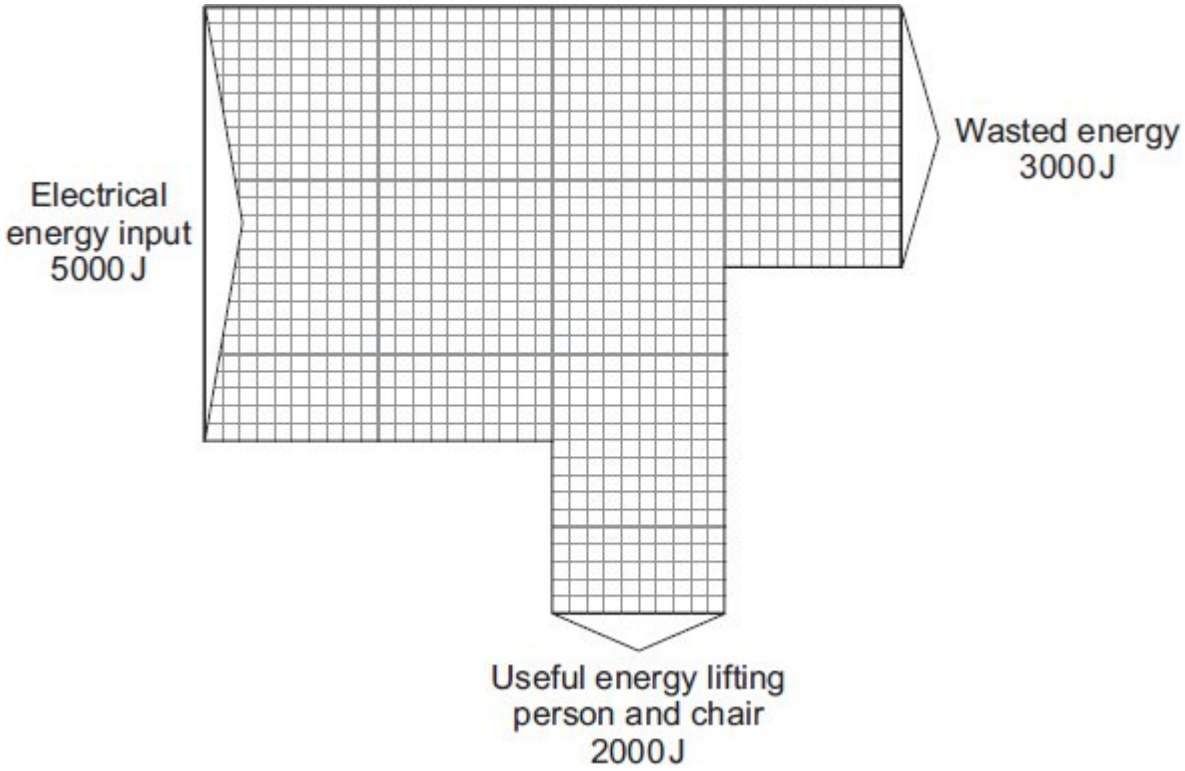
Q15.

A person uses a stairlift to go upstairs. The stairlift is powered by an electric motor.



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The Sankey diagram shows the energy transfers for the electric motor.



(a) Complete the following sentence.

The electric motor wastes energy as _____ energy.

(1)

(b) Use the equation in the box to calculate the efficiency of the electric motor.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

_____

_____

Efficiency = _____

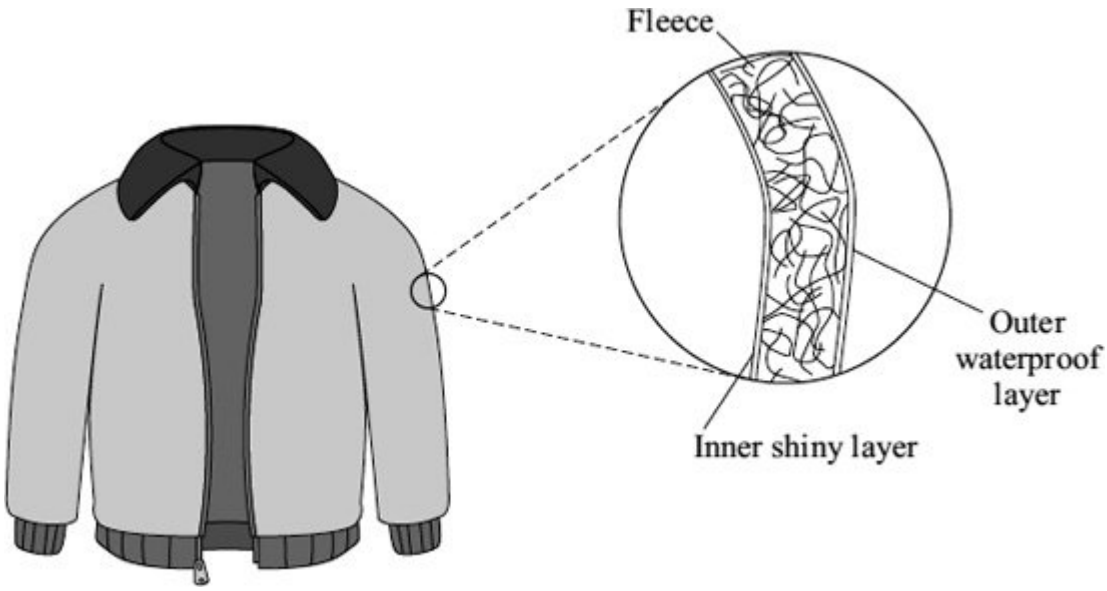
(2)

(Total 3 marks)

Q16.

(a) The diagram shows a ski jacket that has been designed to keep a skier warm.
The jacket is made from layers of different materials.

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(i) The inner layer is shiny to reduce heat transfer.

Which process of heat transfer will it reduce?

_____

(1)

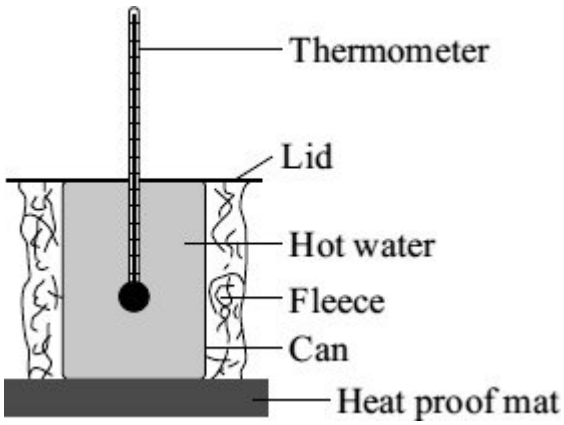
(ii) Why is the layer of fleece good at reducing the transfer of heat from a skier's body?

_____

_____

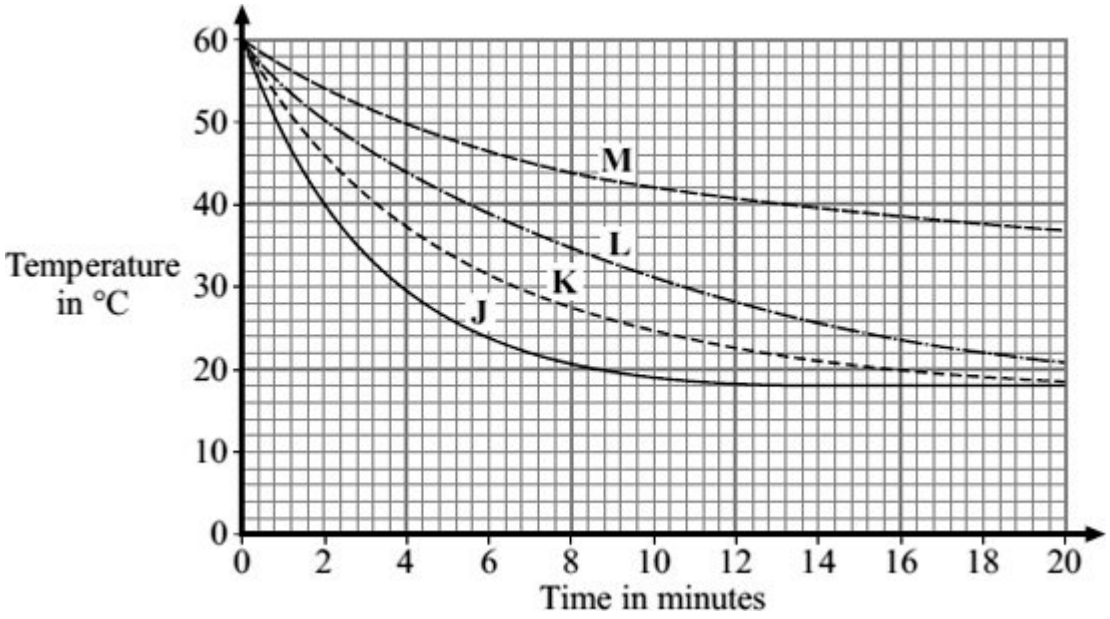
(1)

(b) A student tested four different types of fleece, **J**, **K**, **L** and **M**, to find which would make the warmest jacket. Each type of fleece was wrapped around a can which was then filled with hot water.
The temperature of the water was taken every two minutes for 20 minutes.



The graph shows the student's results.

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(i) In each test, the water cooled faster during the first five minutes than during the last five minutes. Why?

_____

_____

(1)

(ii) To be able to compare the results, it was important to use the same volume of water in each test.

Give **one** other quantity that was the same in each test.

_____

_____

(1)

(iii) Look at the graph line for fleece **K**.

Estimate what the temperature of the water in the can wrapped in fleece **K** would be after 40 minutes.

_____

(1)

(iv) Which type of fleece, **J**, **K**, **L** or **M**, should the student recommend to be used in the ski jacket?

_____

Give a reason for your answer.

_____

_____

_____

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_____

(2)

(Total 7 marks)

Q17.

The picture shows a solar-powered aircraft. The aircraft has no pilot.

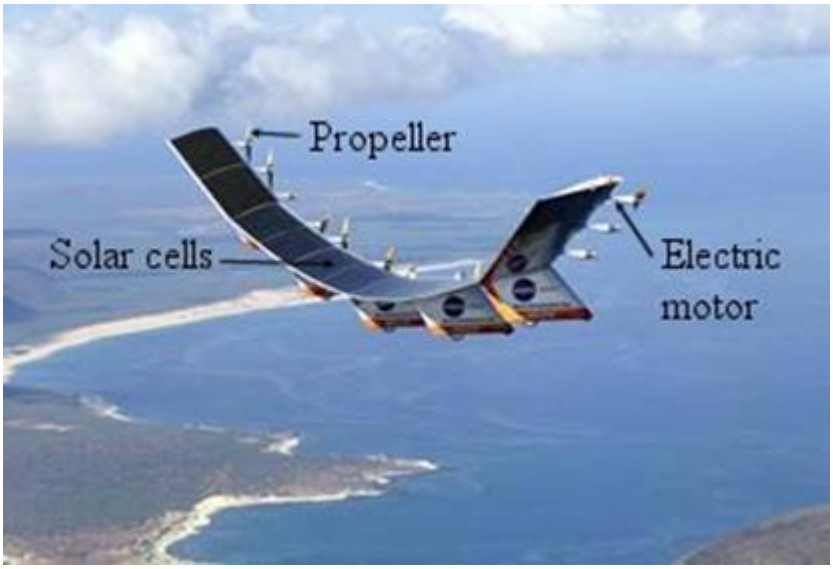


Photo by NASA.

(a) On a summer day, 175 000 joules of energy are supplied to the aircraft's solar cells every second. The useful energy transferred by the solar cells is 35 000 joules every second.

(i) Use the equation in the box to calculate the efficiency of the solar cells.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

_____

_____

Efficiency = _____

(2)

(ii) What happens to the energy that is **not** usefully transferred by the solar cells?

_____

(1)

(b) The aircraft propellers are driven by electric motors. As well as the solar cells, there are fuel cells that provide additional power to the electric motors.

(i) Suggest **one** advantage of the aircraft having fuel cells as well as the solar cells.

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_____

(1)

(ii) Give **one** environmental advantage of using electric motors to drive the aircraft propellers rather than motors that burn a fuel.

_____

_____

(1)

(iii) Eventually, the designers want to produce an unmanned aircraft that can fly at twice the height of a passenger jet for up to six months.

Suggest **one** possible use for an aircraft such as this.

_____

_____

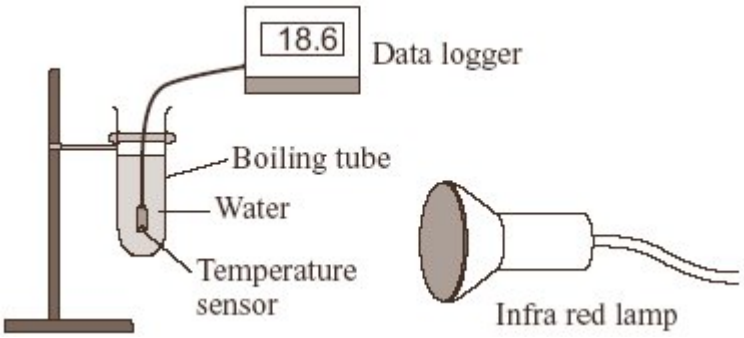
(1)

(Total 6 marks)

Q18.

A student had read about a glacier that had been covered in insulating material. The idea was to slow down the rate at which the glacier melts in the summer.

She investigated this idea using the apparatus shown in the diagram.



(a) These are the steps taken by the student.

- Measure 30 cm^3 of cold water into a boiling tube.
- Place the boiling tube 25 cm from an infra red lamp.
- Record the temperature of the water.
- Switch on the infra red lamp.
- Record the temperature of the water every minute for 5 minutes.
- Repeat with boiling tubes covered in different insulating materials.

(i) Why did she use an infra red lamp?

_____

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(1)

(ii) Name **one** control variable in this investigation.

_____

(1)

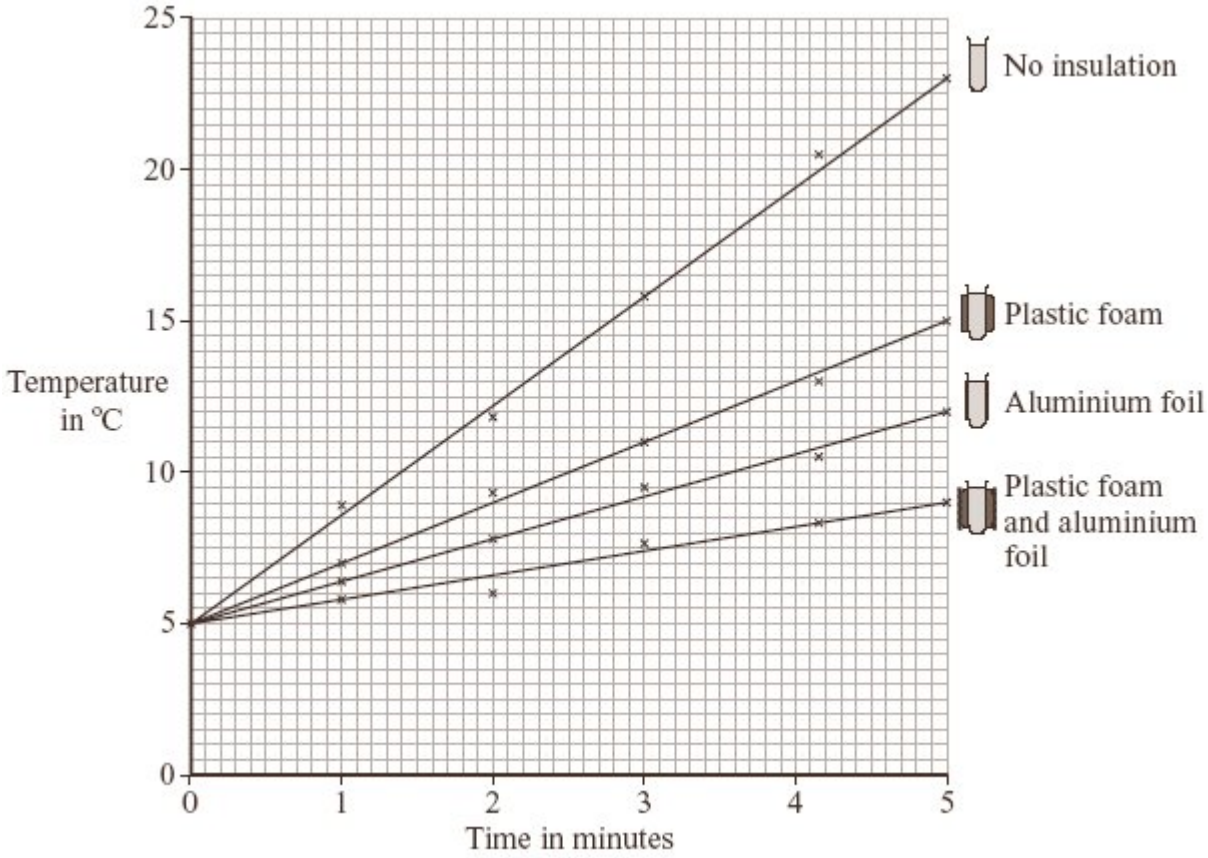
(iii) Give **one** advantage of using a temperature sensor and data logger instead of a glass thermometer to measure temperature.

_____

_____

(1)

(b) The results of the investigation are shown in the graph.



(i) Why did the student use a boiling tube with no insulation?

_____

_____

(1)

(ii) From her results, what should she recommend is used to insulate the glacier?

_____

(1)

(iii) Explain why the insulation recommended by the student will reduce the heat transfer from the Sun to the glacier.

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_____

_____

_____

_____

_____

(2)

(c) Explain, in terms of particles, how heat is transferred through the glass wall of a boiling tube.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q19.

A gas burner is used to heat some water in a pan.



Of the energy released by the burning gas by the time the water starts to boil:

60% has been transferred to the **water**.

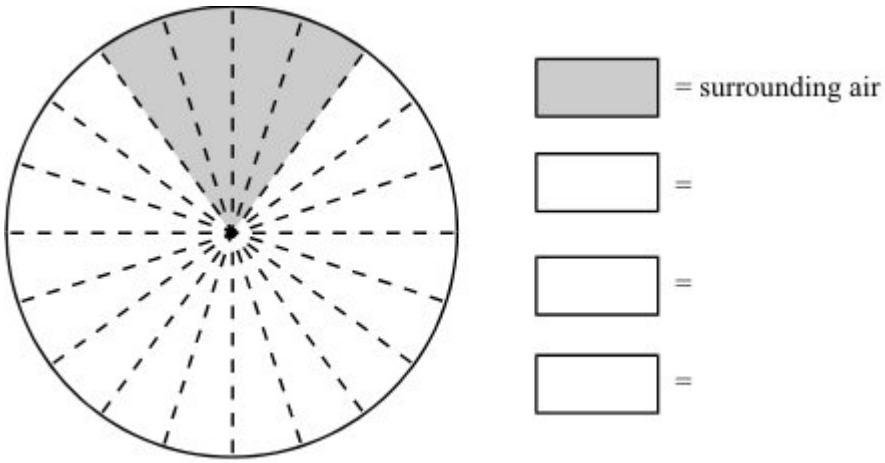
20% has been transferred to the **surrounding air**.

13% has been transferred to the **pan**.

7% has been transferred to the **gas burner** itself.

(a) Use the above information to complete the pie-chart.

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(3)

(b) Some of the energy released by the burning gas is wasted.

(i) What happens to this wasted energy?

_____

_____

(2)

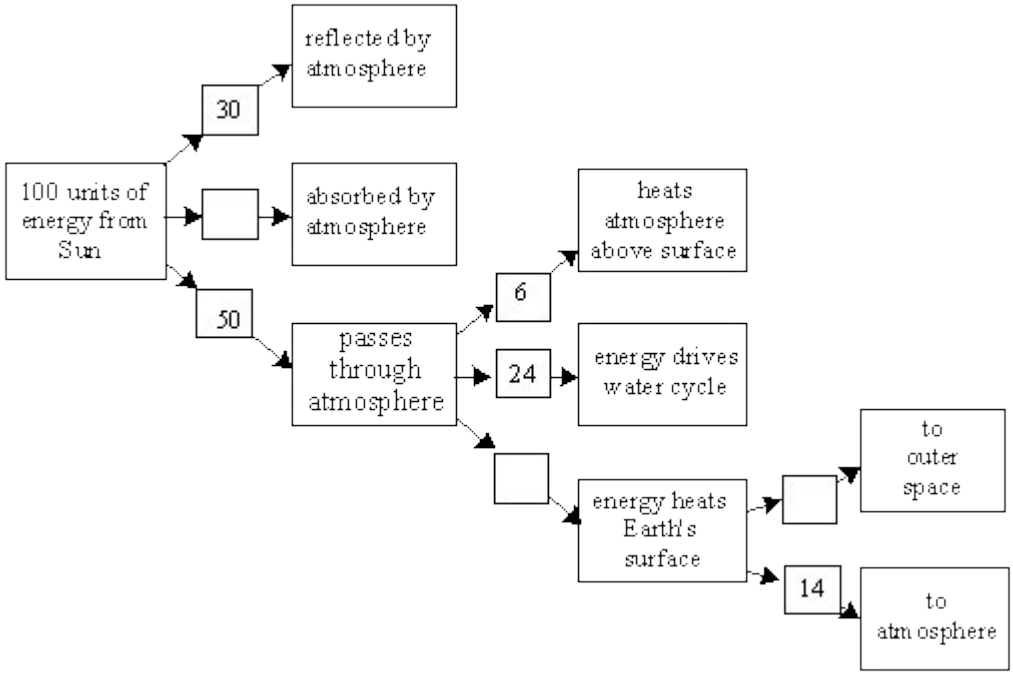
(ii) What percentage (%) of the energy from the gas is wasted? Answer: _____ %

(1)

(Total 6 marks)

Q20.

Complete the boxes on the chart to show what happens to the energy from the Sun.



(Total 3 marks)

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