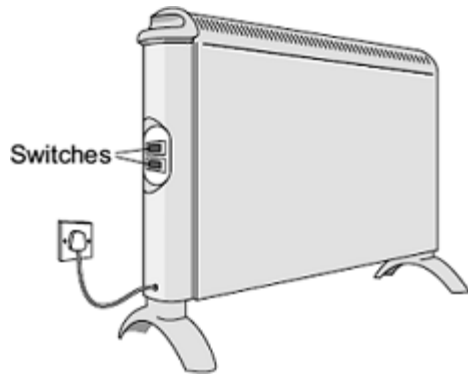**1**

(a)   The diagram shows two switches on a room heater. The heater has three power settings. The power produced by two of the settings is given in the table.

Setting	Power in kW
Low	0.5
Medium	1.5
High	

(i)   When both switches are on, the heater works at the high power setting.

What is the power of the heater when it is switched to the **high** power setting?

....

Power = ... kW

(1)

(ii)   The heater is used on the **medium** power setting. It is switched on for three hours.

Use the equation in the box to work out the energy transferred from the mains to the heater in three hours.

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

Show clearly how you work out your answer.

....

....

Energy transferred = ... kWh

(2)

(iii)   Electricity costs 12 pence per kilowatt-hour.

Use the equation in the box to calculate how much the heater costs to use on **medium** power for three hours.

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

Show clearly how you work out your answer.

....

....

Total cost = ... pence
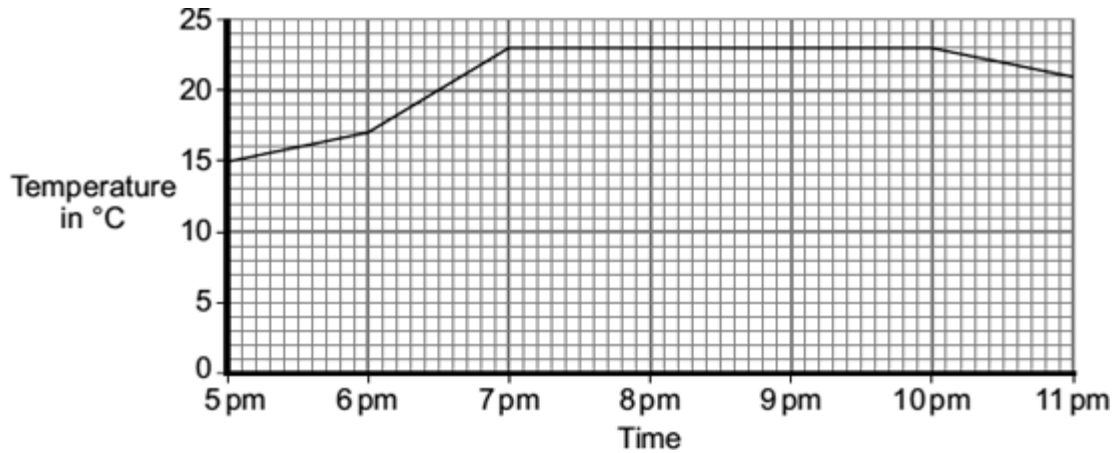
(2)

(b)   The heater is used to warm a room.

The graph shows how the temperature of the room changes from the moment the heater is switched on.

The heater was first used on the medium setting.

(i)   At what time was the heater setting changed to the **high** setting?

....

Give a reason for your answer.

....

....

....

(2)

(ii)   From 7 pm until 10 pm, the temperature of the room is **not** changing.

Which **one** of the following statements gives the reason why the temperature of the room is **not** changing?

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

The room is losing energy slower than the heater supplies energy. ☐

The room is losing energy as fast as the heater supplies energy. ☐

The room is losing energy faster than the heater supplies energy. ☐

(1)
(Total 8 marks)

2   The diagram shows where heat is lost from a house that is **not** insulated.

26% through
the roof

33%
through
the walls

11% through
draughts

12% through
the floor

18% through
the windows
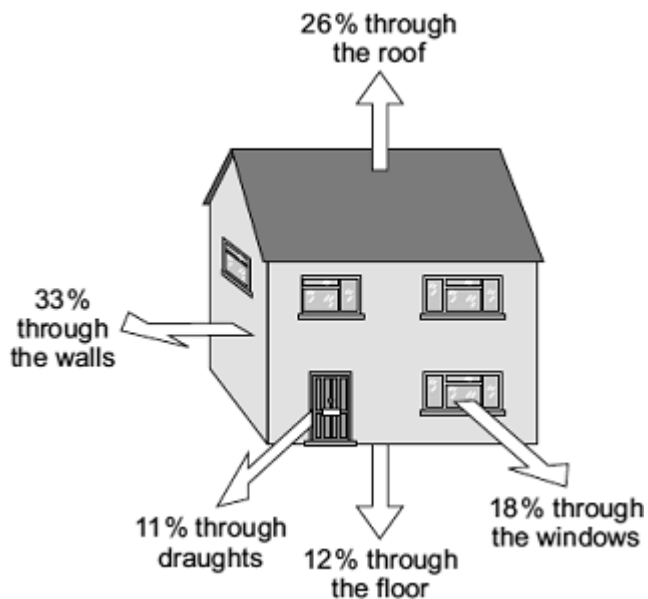
(a)   (i)   Through which part of the house is most heat lost?

....

(1)

(ii)   How can the heat loss through the windows be reduced?

....

....

(1)

(b) A homeowner wants to reduce her energy bills and make her home more energy efficient. The table shows five ways this could be done. The table also shows how much money each way would save the homeowner each year.

	Cost	Money saved each year
Installing loft insulation	£175	£60
Fitting draught-proofing	£45	£20
Installing cavity wall insulation	£300	£80
Adding a hot water tank jacket	£15	£20
Using energy efficient light bulbs	£60	£30

(i) Which **one** of the five ways of reducing energy bills would reduce the yearly energy bill the most?

....

(1)

(ii) This year the homeowner has only got £60 to spend to improve the energy efficiency of her home.

Use the information in the table to explain what the homeowner should spend this money on.

....

....

....

....

(2)
(Total 5 marks)

3 Heat exchangers are devices that are used to transfer heat from one place to another.

The diagram shows a simple heat exchanger used by a student in an investigation.
Heat is transferred from the hot water inside the pipe to the cold water outside the pipe.
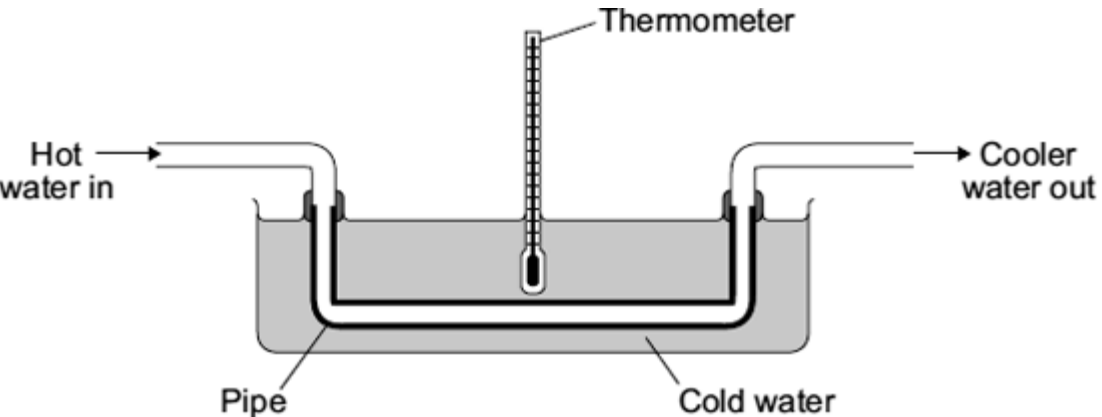
(a) By which process is heat transferred from the hot water inside the pipe to the cold water outside the pipe?

....

(1)

(b) The student wanted to find out if the efficiency of a heat exchanger depends on the material used to make the pipe. The student tested three different materials. For each material, the rate of flow of hot water through the pipe was kept the same.

The results obtained by the student are recorded in the table and displayed in the bar chart.

Material	Temperature of the cold water at the start in °C	Temperature of the cold water after 10 minutes in °C
Copper	20	36
Glass	20	23
Plastic	20	21
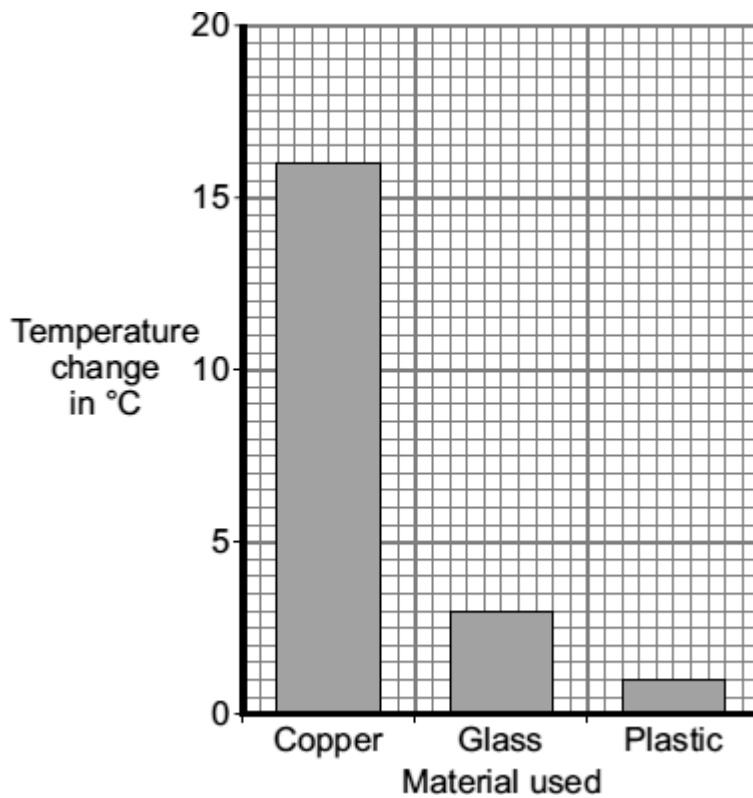
(i) The rate of flow of hot water through the pipe was one of the control variables in the investigation.

Give **one** other control variable in the investigation.

....

(1)

(ii) Why did the student draw a bar chart rather than a line graph?

....

....

(1)

(iii) Which **one** of the three materials made the best heat exchanger?

....

Give a reason for your answer.

....

....

....

(2)

(c) The student finds a picture of a heat exchanger used in an industrial laundry.
The heat exchanger uses hot, dirty water to warm cold, clean water.
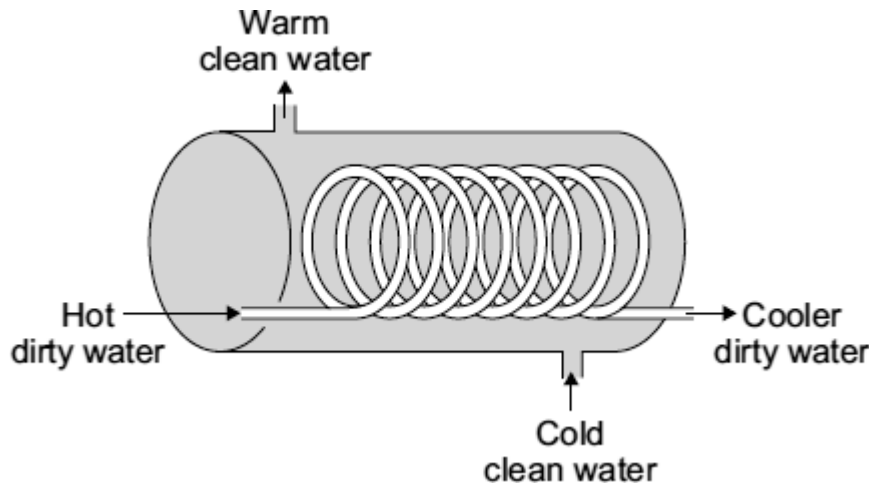
Why does this heat exchanger transfer heat faster than the heat exchanger used by the student in the investigation?

....

....

(1)
(Total 6 marks)

4 (a) The diagram shows two switches on a room heater. The heater has three power settings. The power produced by two of the settings is given in the table.
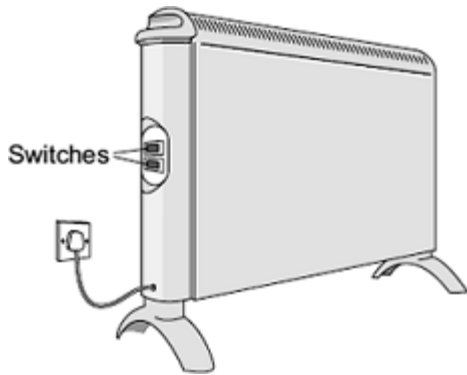
Setting	Power in watts
Low	700
Medium	1400
High	

Switches

(i) When both switches are on, the heater works at the high power setting.

What is the power of the heater, in kilowatts, when it is switched to the **high** power setting?

....

Power = ... kilowatts

(1)

(ii) The heater is used on the **high** power setting. It is switched on for 1½ hours.

Calculate the energy transferred from the mains to the heater in 1½ hours.

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

....

....

....

Energy transferred = ...

(3)

(iii) This type of heater is a very efficient device.

What is meant by a device being very efficient?

....

....

(1)

(b)   The graph shows how the temperature of a room changes during the 1½ hours that the heater is used.
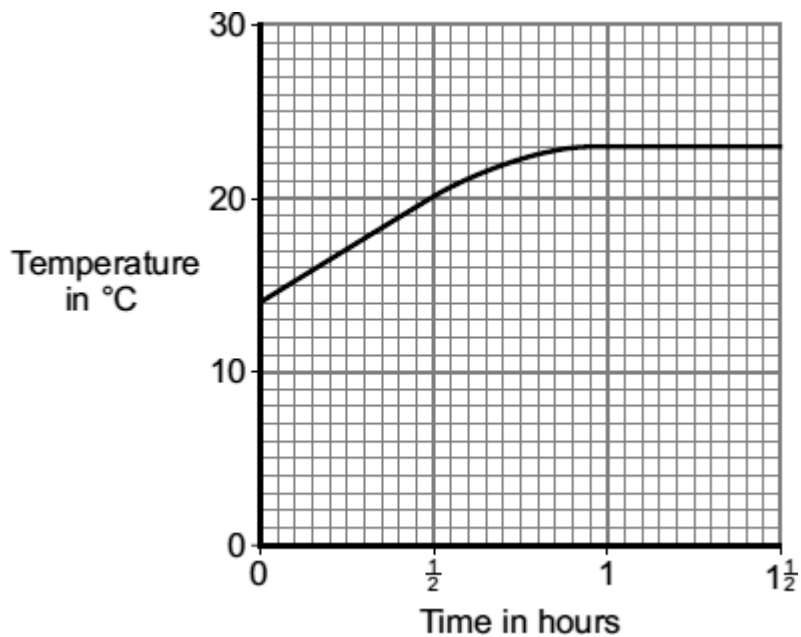
After 1 hour, the temperature of the room has become constant, even though the heater is still switched on.

Explain why.

....

....

....

....

(2)
(Total 7 marks)

5 A vacuum flask is designed to reduce the rate of heat transfer.

- Plastic cap
- Silvered surfaces
- Vacuum
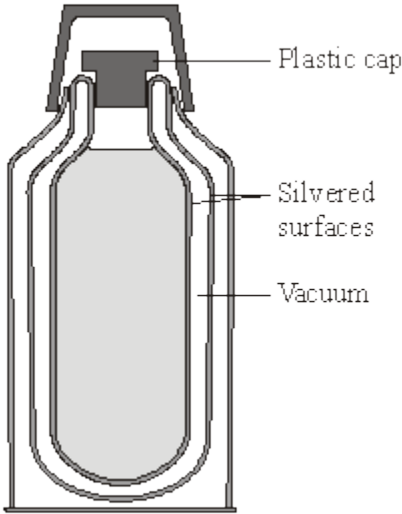
(a) (i) Complete the table to show which methods of heat transfer are reduced by each of the features labelled in the diagram.

The first row has been done for you.

Feature	Conduction	Convection	Radiation
vacuum	*	*	
silveredsurfaces			
plastic cap			

(2)

(ii) Explain why the vacuum between the glass walls of the flask reduces heat transfer by conduction and convection.

....

....

....

....

(2)

(b)   The diagram shows a gas flame patio heater.
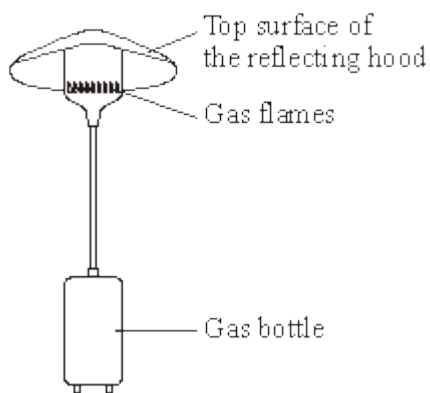
(i)   Explain why the top surface of the reflecting hood should be a light, shiny surface rather than a dark, matt surface.

....

....

....

(2)

(ii)   Most of the chemical energy in the gas is transformed into heat. A **small** amount of chemical energy is transformed into light.

Draw and label a Sankey diagram for the patio heater.

(2)

(iii)   State why the total energy supplied to the patio heater must always equal the total energy transferred by the patio heater.

....

....

(1)
(Total 9 marks)

6 (a) The graph compares how quickly hot water cooled down in two glass beakers with different surface areas.

The volume of water in each beaker was the same.
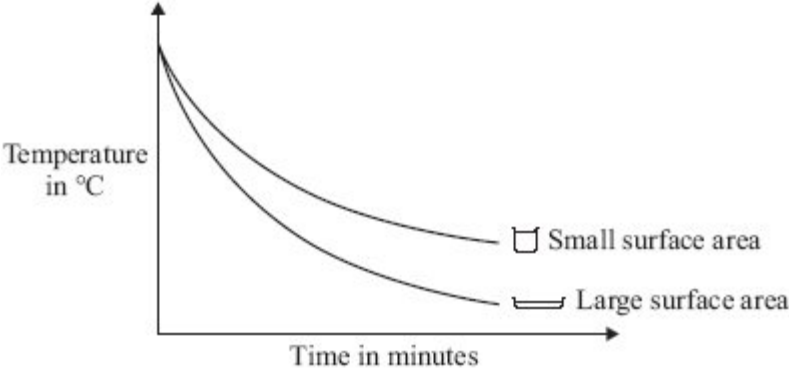
Describe how the surface area of the water affected how fast the water cooled down.

....

....

(1)

(b) Some foxes live in a hot desert environment.

This type of fox has very large ears.

Explain how the size of the fox's ears help it to keep cool in a hot desert.

....

....

....

....

(2)

(c)   Polar bears and reindeer are adapted to live in cold environments.
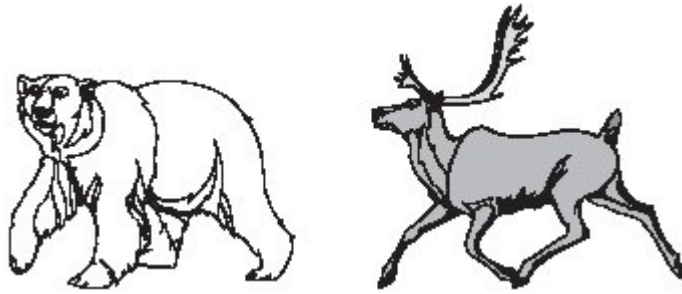
Use the words in the box to complete the following sentences.

conduction   convection   radiation

(i)   The white colour of a polar bear's fur helps to keep the polar bear warm by

reducing the heat lost by ....

(1)

(ii)   The hairs of a reindeer are hollow. The air trapped inside the hairs reduces the

heat lost by ....

(1)
(Total 5 marks)

7   The diagram shows a fridge-freezer.

Fridge

White shiny surface

Freezer

Room temperature 20°C
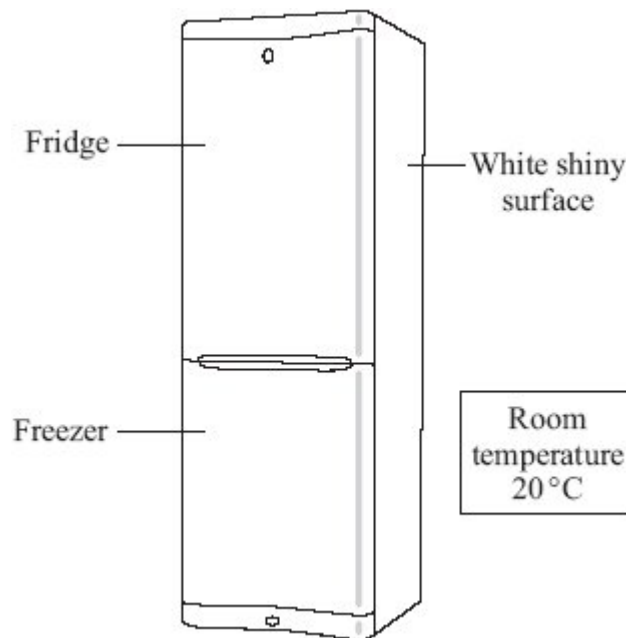
(a) By which method is heat transferred through the walls of the fridge-freezer?

....

(1)

(b) The inside of the fridge is at 4 °C. The inside of the freezer is at –18 °C.

Into which part of the fridge-freezer will the rate of heat transfer be greater?

Draw a ring around your answer.

the fridge   **the freezer**

Give a reason for your answer.

....

....

(1)

(c) The outside surface of the fridge-freezer is white and shiny.

Give **two** reasons why this type of surface is suitable for a fridge-freezer.

1 ....

....

2 ....

....

(2)
(Total 4 marks)

8 (a) In winter, energy is transferred from the warm air inside a house to the air outside.

(i) What effect will the energy transferred from the house have on the air outside?

....

(1)

(ii) What would happen to the energy transfer if the temperature inside the house were reduced? Assume the temperature outside the house does not change.

....

(1)

(b)   To increase energy efficiency, a householder installs a heat exchanger to an outside wall of the house. The heat exchanger uses heat from the air outside to warm the inside of the house. The diagram shows the idea of the heat exchanger.
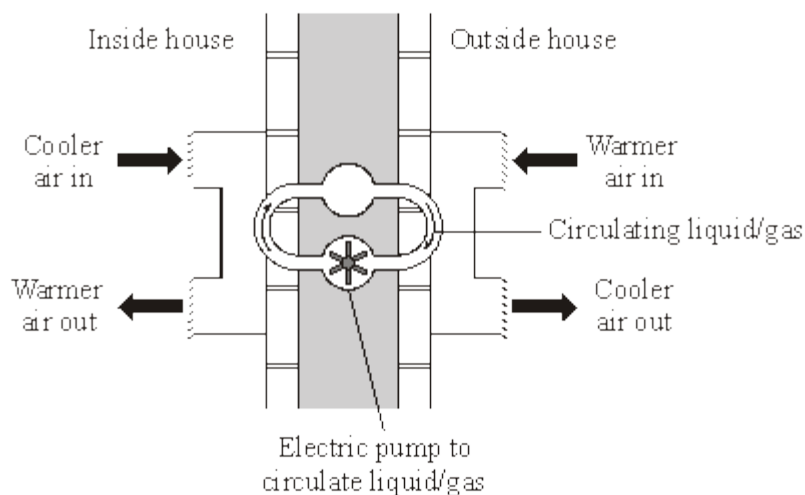
Physics Through Applications edited by J Jardine et el (OUP, 1989), copyright ©
Oxford University Press, reprinted by permission of Oxford University Press.

(i)   Why does the heat exchanger cost money to run?

....

(1)

(ii)   The heat exchanger is cost effective in reducing energy consumption.
       Explain why.

....

....

....

....

(2)
(Total 5 marks)

9 (a) The diagram shows how much heat is lost each second from different parts of an uninsulated house.
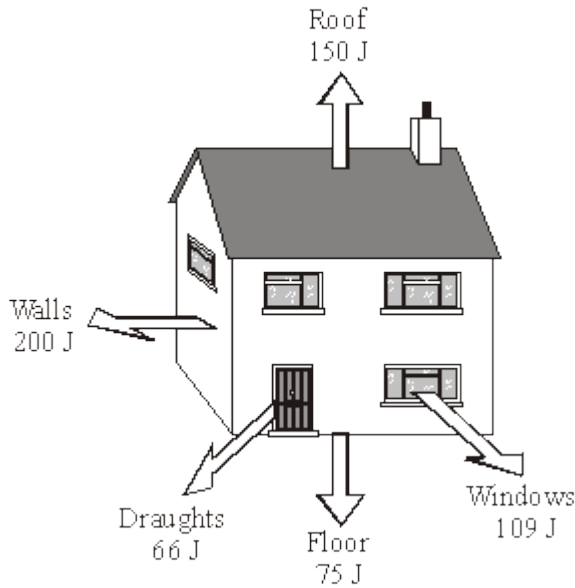
(i) Each year, the house costs £760 to heat.

How much money is being wasted because of heat lost through the roof?

Show clearly how you work out your answer.

....

....

(2)

(ii) Insulating the loft would cut the heat lost through the roof by 50 %.

The loft insulation has a payback time of $1\frac{1}{2}$ years.

How much did the loft insulation cost to buy?

....

Cost of loft insulation = £ ....

(1)

(b) What happens to the wasted energy?

....

....

(1)
(Total 4 marks)

10 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.
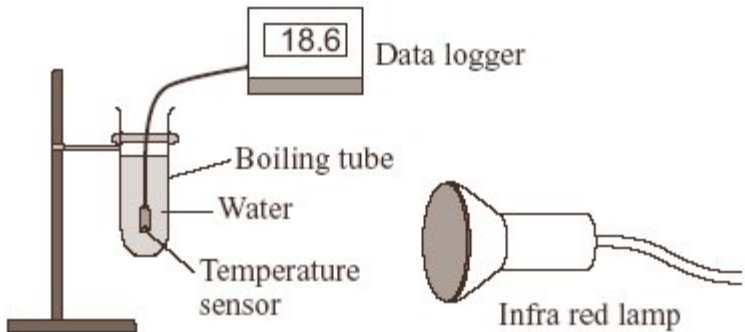
(a)   These are the steps taken by the student.

- 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?

....

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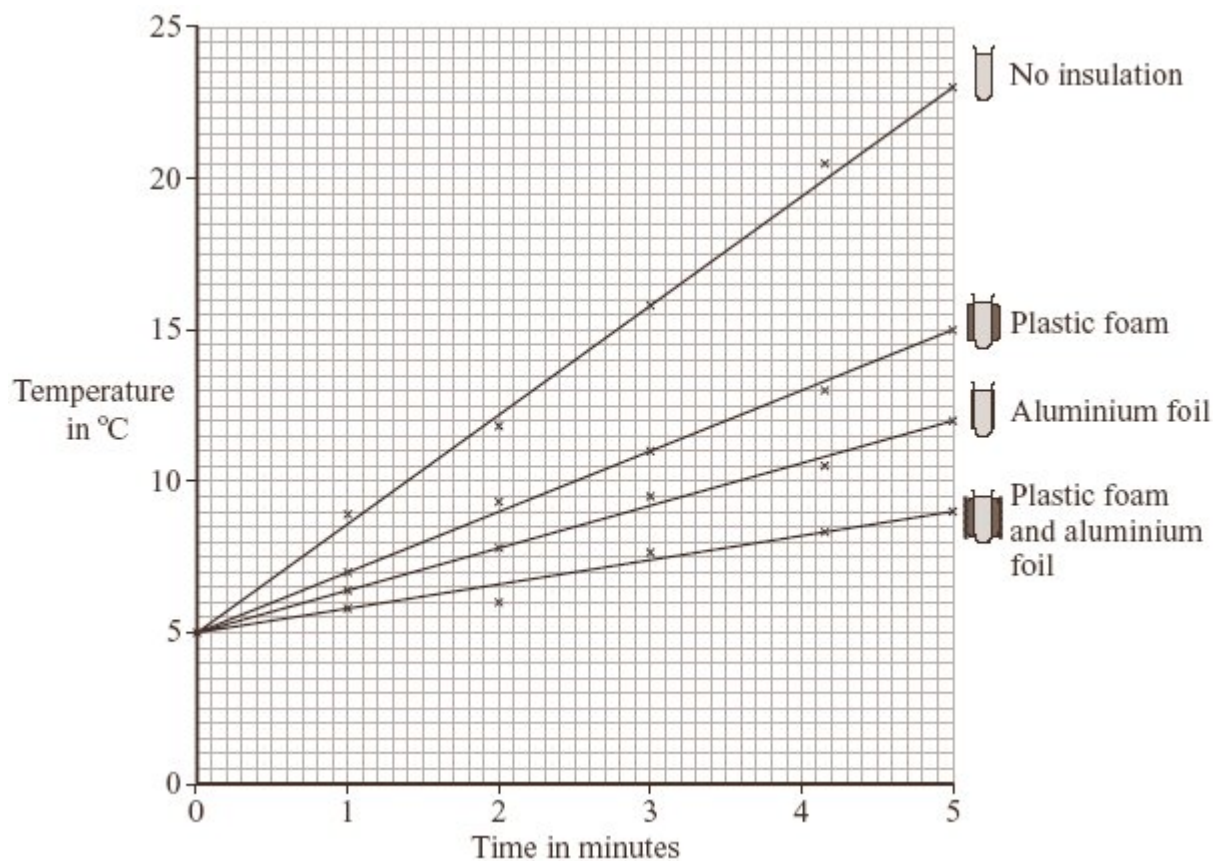
(i)   Why did the student use a boiling tube with no insulation?

        ....

        ....

(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.

        ....

        ....

        ....

        ....

        ....

(2)

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

....

....

....

....

(2)
(Total 9 marks)

11 (a)   The graph shows the temperature inside a flat between 5 pm and 9 pm. The central heating was on at 5 pm.
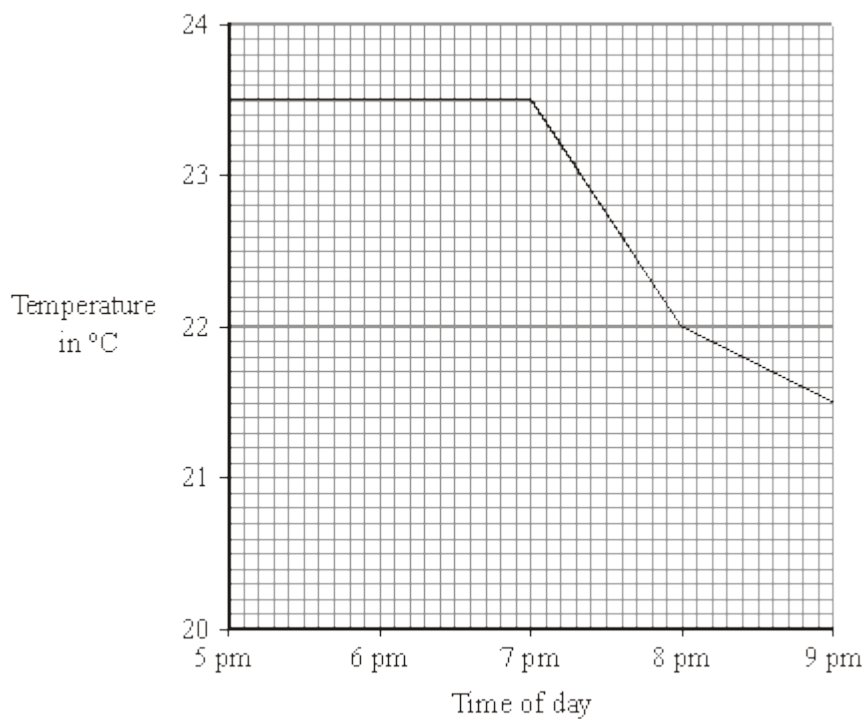
(i)   What time did the central heating switch off?

....

(1)

(ii)   Closing the curtains reduces heat loss from the flat.

What time do you think the curtains were closed?

....

Give a reason for your answer.

....

(2)

(b)   Less heat is lost through double-glazed windows than through single-glazed windows.

Two glass sheets

Trapped air

A double-glazed window
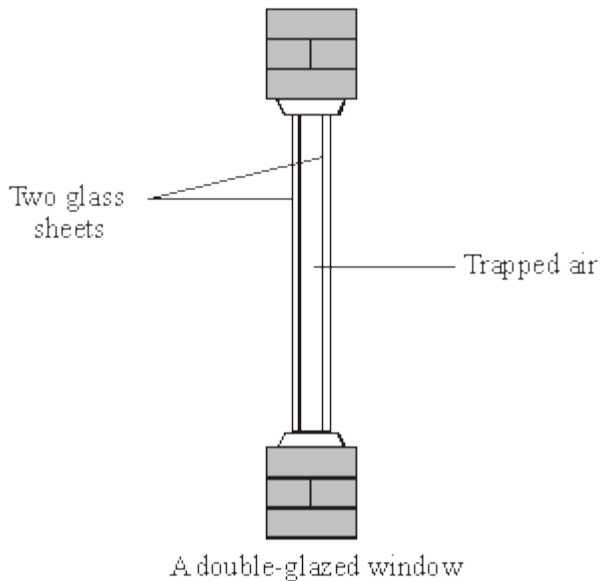
Complete the following sentences by choosing the correct words from the box. Each word may be used once or not at all.

| conduction   conductor   convection   evaporation   insulator   radiation |

Air is a good .... When trapped between two sheets of

glass it reduces heat loss by .... and ....

(3)

(c)   The table gives information about three types of house insulation.

Type of insulation	Cost to install	Money save each year on heating bills	Payback time
Double glazing	£4000	£200	20 years
Loft insulation	£300	£100	3 years
Cavity wallinsulation	£600	£150	

(i) Use the information in the table to calculate the payback time for cavity wall insulation.

....

(1)

(ii) Explain why people often install loft insulation before installing double glazing or cavity wall insulation.

....

....

....

....

(2)
(Total 9 marks)

12 A student was asked to investigate the heat loss from two metal cans, L and M. The cans were identical except for the outside colour.

Temperature sensor — Can L   Can M   Data logger
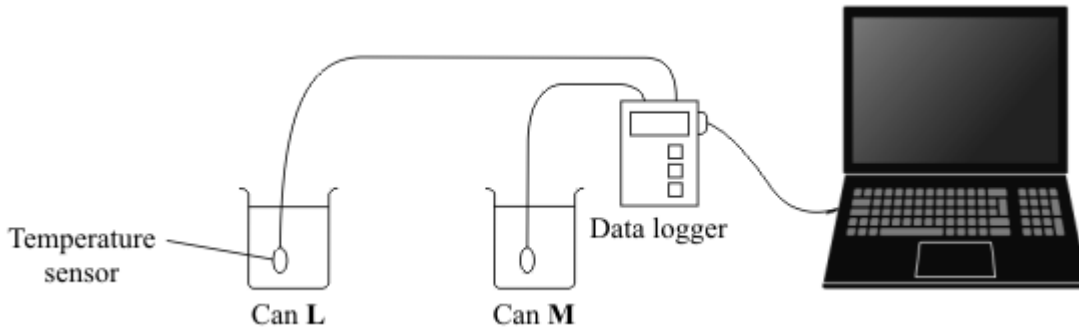
The student filled the two cans with equal volumes of hot water. He then placed the temperature sensors in the water and started the data logger. The computer used the data to draw the graph below.
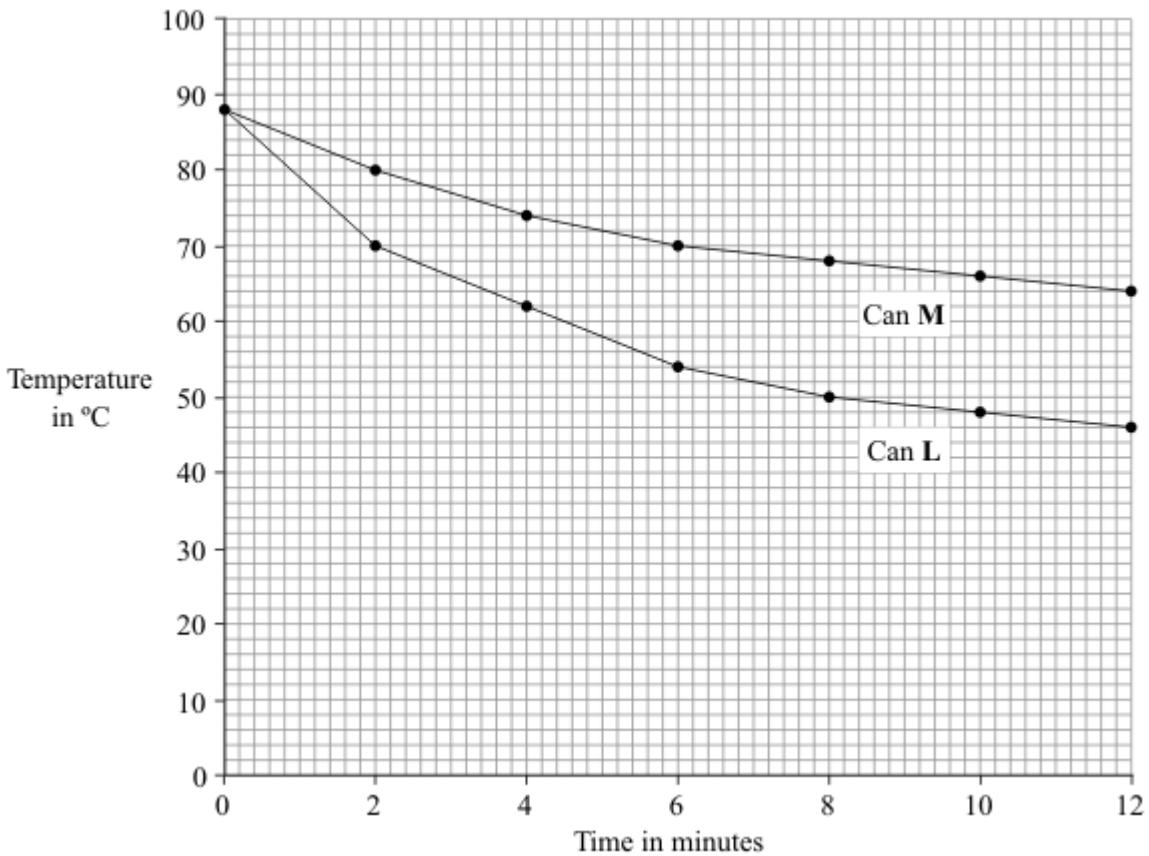
(a) Which **one** of the following is a categoric variable?

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

the outside colour of the cans ☐

the starting temperature of the hot water ☐

the time

☐

the volume of hot water

☐

(1)

(b)   For can **L**, state the temperature drop of the water:

(i)   in the **first** two-minute interval

....

(1)

(ii)   in the **second** two-minute interval.

....

(1)

(c)   In both cans the water cooled faster at the start of the investigation than at the end of the investigation. Why?

....

....

(1)

(d)   One can was black on the outside and the other can was white on the outside.

What colour was can **L**? ....

Explain the reason for your answer.

....

....

....

(3)
(Total 7 marks)

13 (a) The table gives information about some ways of reducing the energy consumption in a house.

Method of reducing energy consumption	Installation cost in £	Annual saving on energy bills in £
Fit a new hot water boiler	1800	200
Fit a solar water heater	2400	100
Fit underfloor heating	600	50
Fit thermostatic radiator valves	75	20

Which way of reducing energy consumption is most cost effective over a 10-year period?

To obtain full marks you must support your answer with calculations.

....

....

....

....

....

....

(3)

(b) Explain why using an energy-efficient light bulb instead of an ordinary light bulb reduces the amount of carbon dioxide emitted into the atmosphere.

....

....

....

....

(2)
(Total 5 marks)

14 The drawing shows water being heated in a metal saucepan.

Hotplate
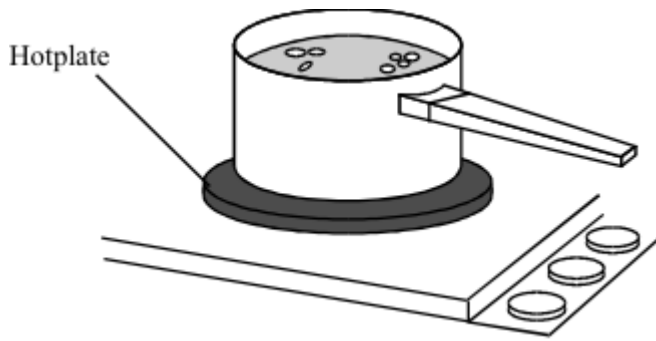
(a) Explain, in terms of the particles in the metal, how heat energy is transferred through the base of the saucepan.

....

....

....

....

(2)

(b) Energy is transferred through the water by convection currents. Explain what happens to cause a convection current in the water. The answer has been started for you.

As heat energy is transferred through the saucepan, the water particles at the bottom

....

....

....

....

....

....

....

....

(3)

(c)   Some energy is transferred from the hotplate to the air by *thermal radiation*. What is meant by *thermal radiation*?

....

....

(1)
(Total 6 marks)

15 (a) The diagram shows the ways in which heat energy can be transferred from an old house.
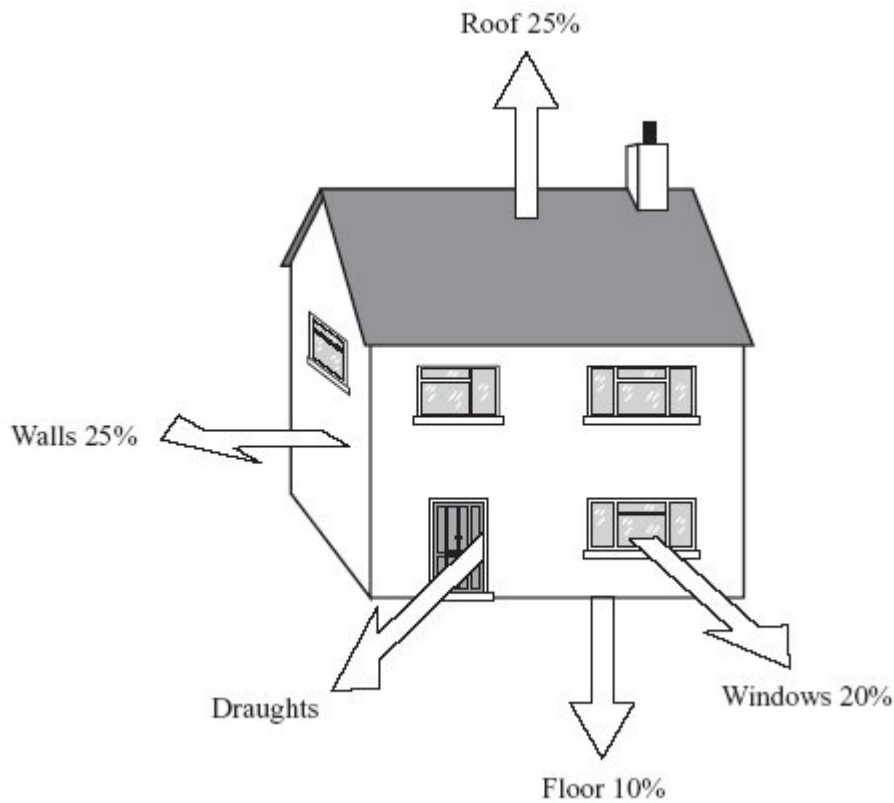
(i)   Calculate the percentage of energy transferred by draughts.

% energy transferred by draughts = ...

(1)

(ii)   Complete the following sentence using **one** of the words from the box.

conduction	convection	radiation

Draughts transfer heat energy by ....

(1)

(iii)   State **one** way of reducing the heat transfer by draughts.

....

(1)

(b)   The diagram shows a section through the walls of a house built in 1930.
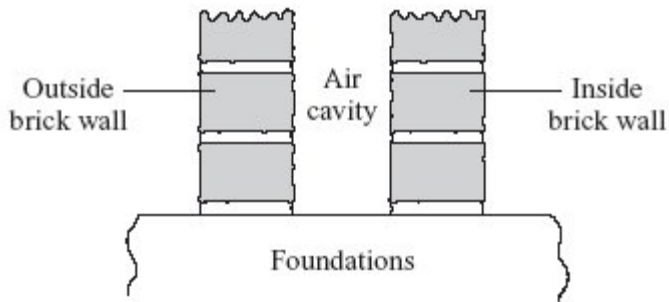
Explain how the air cavity between the two walls reduces the heat transfer from the house.

....

....

....

....

(2)

(c)   The table shows the installation costs and yearly savings on energy bills for different methods of insulating a house.

Method of insulation	Installation costin £	Yearly saving on energy bills in £
Double glazing	4000	65
Loft insulation	240	60
Cavity wall insulation	600	80

(i)   Give **one** reason why loft insulation is often fitted to an old house before double glazing or cavity wall insulation.

....

....

(1)

(ii)   The time it takes for the saving on energy bills to equal the cost of installing the insulation is called the pay-back time.

Calculate the pay-back time for loft insulation.

....

Pay-back time = ... years

(1)
(Total 7 marks)

16   The vacuum flask shown has five features labelled, each one designed to reduce heat transfer.
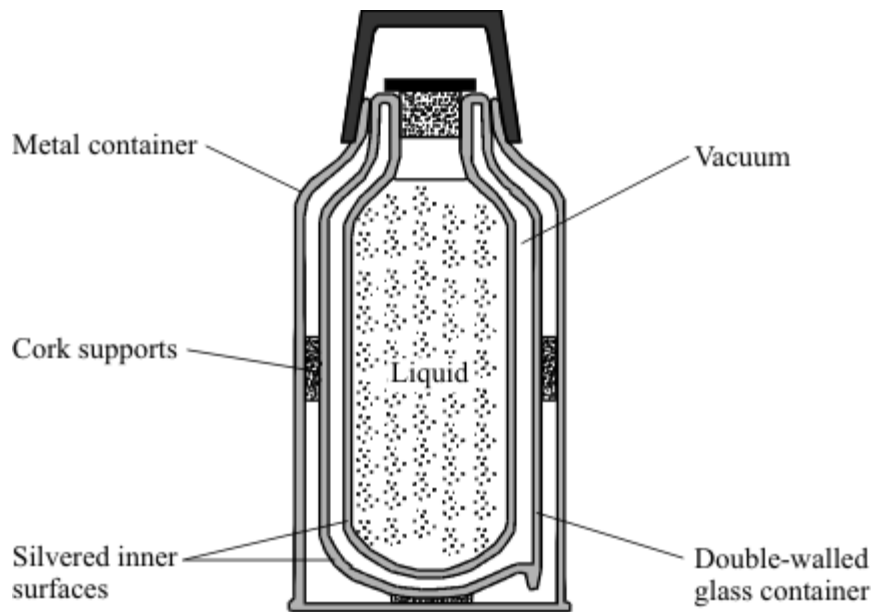
(a)   (i)   Which labelled feature of the vacuum flask reduces heat transfer by both conduction and convection?

....

(1)

(ii) Explain how this feature reduces heat transfer by **both** conduction and convection.

....

....

....

....

....

(2)

(b) (i) Which labelled feature of the vacuum flask reduces beat transfer by radiation?

....

(1)

(ii) Explain how this feature reduces heat transfer by radiation.

....

....

....

....

....

....

(2)
(Total 6 marks)

17 Many people use a sleeping bag when they sleep in a tent. Sleeping bags, designed to keep a person warm, have a fibre filling.

Fibre filling

(i)   Complete the sentence by choosing the correct words from the box.

conduction   convection   radiation

The fibre is designed to reduce heat transfer by .... and

....

(ii)   Explain why the fibre is good at reducing heat loss from a person sleeping in the bag.

....

....

....

....

(Total 3 marks)

18   The diagram shows part of a solar water heater. Water circulating through the solar panel is heated by the Sun.
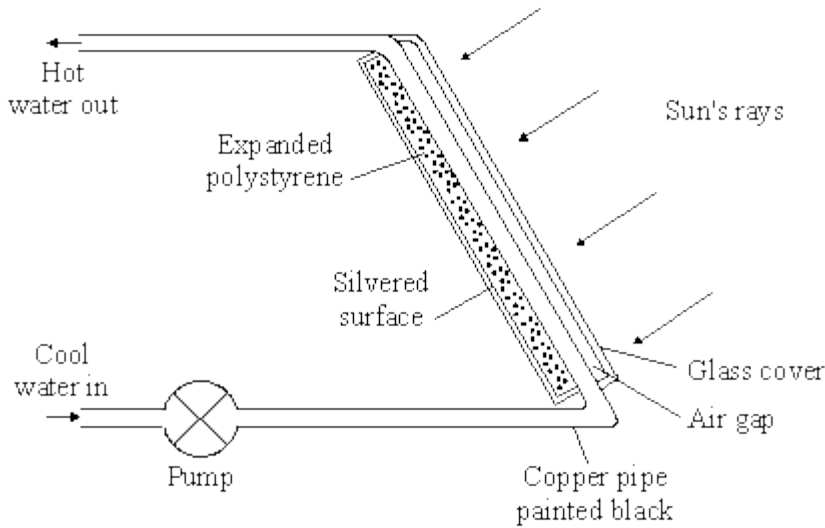
(i)   Complete the following sentence.

Heat energy is transferred from the Sun to the solar panel by

....

(1)

(ii)   The pipe inside the solar panel is black. Why?

....

....

(1)

(iii)   There is a layer of expanded polystyrene behind the black pipe. Why?

....

....

(1)

(iv)   A silvered surface is used at the back of the solar panel. Explain why.

....

....

....

....

(2)
(Total 5 marks)

19 The diagram shows how the metal chimney from a log-burning stove passes through the inside of a house.

(a) Explain how heat is transferred by the process of convection from the inside of the stove to the top of the chimney.

....

....

....

....

....

(2)

(b)   Although the outside of the chimney becomes very hot, there is no insulating material
        around the chimney.

   (i)   Explain, in terms of the particles in a metal, how heat is transferred by conduction
           from the inside to the outside of the metal chimney.

           ....

           ....

           ....

           ....

           ....

                                                                                                              (2)

   (ii)   Suggest **one** advantage of having no insulation around the chimney.

           ....

           ....

                                                                                                              (1)
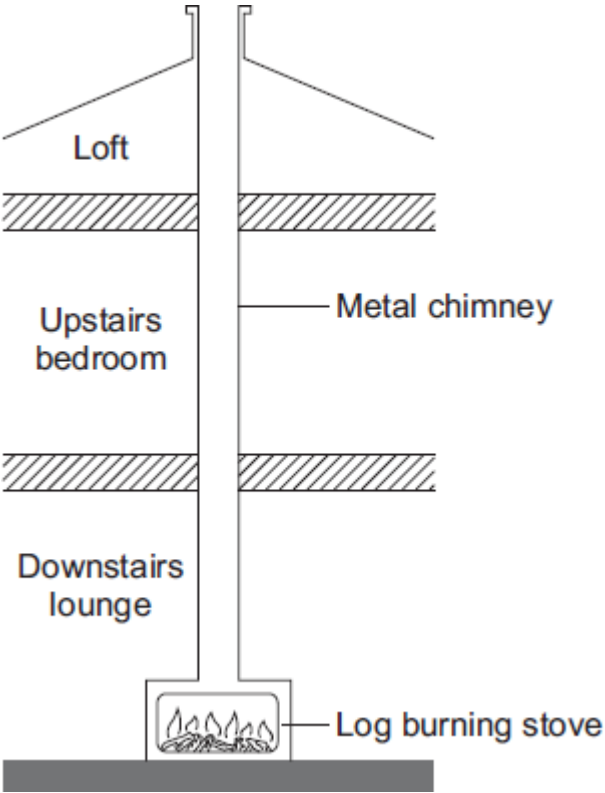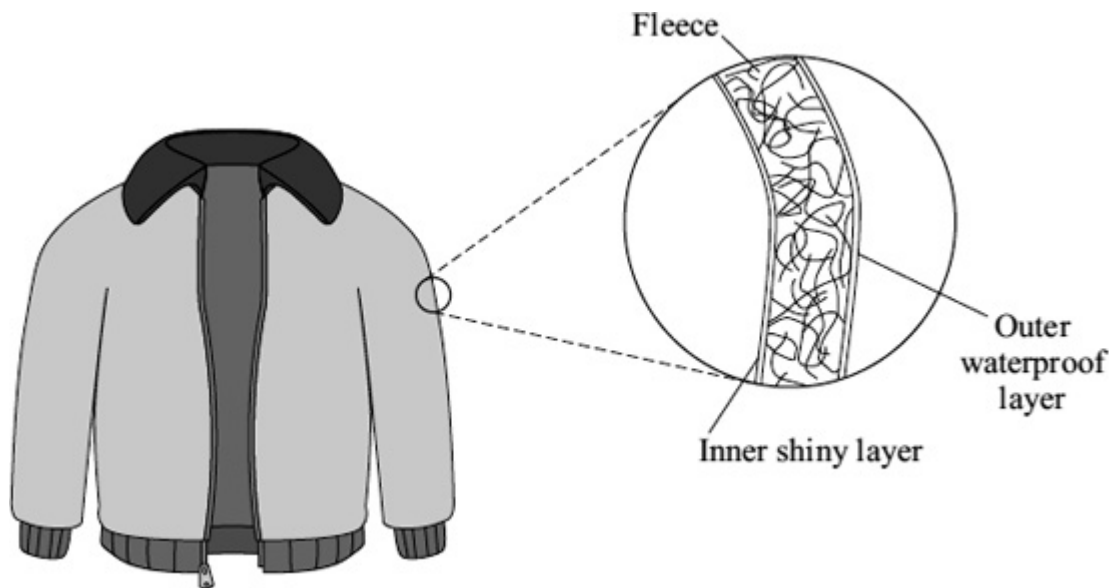   **(Total 5 marks)**

20   (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.

Fleece
Outer waterproof layer
Inner shiny layer

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

           Which process of heat transfer will it reduce?

           ....

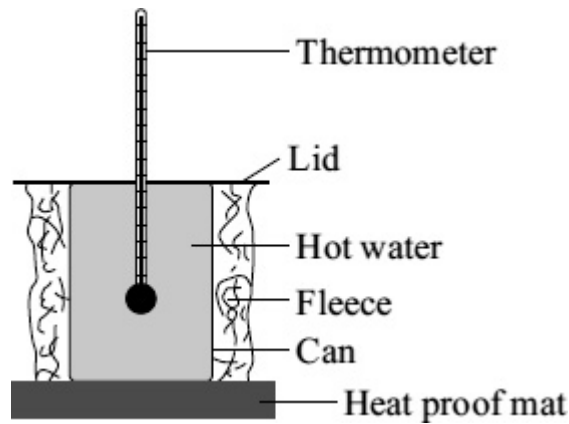   **(1)**

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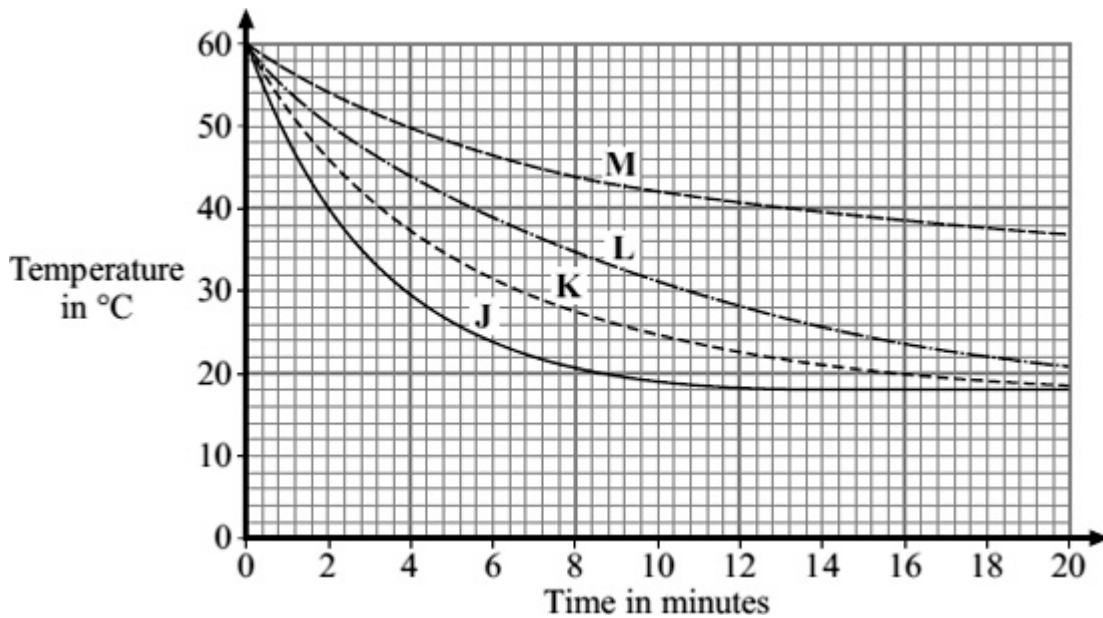
(i)   In each test, the water cooled faster during the first five minutes than during the last five minutes. Why?

....

....

(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.

....

....

....

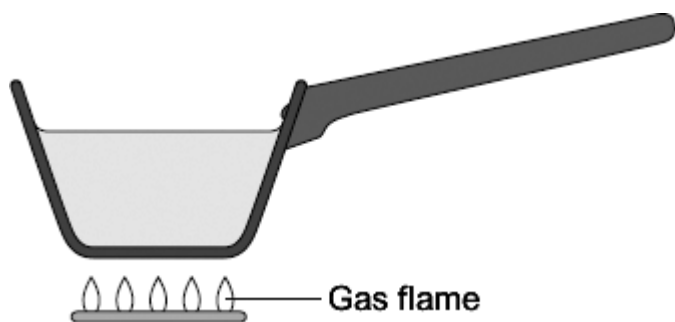...

(2)
(Total 7 marks)

21 The diagram shows a metal pan being used to heat water.

Energy from the gas flame is transferred through the metal pan by conduction.

Explain the process of conduction through metals.

....

....

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....

(4)
(Total 4 marks)

22 A wood burning stove is used to heat a room.

Photograph supplied by iStockphoto/Thinkstock

The fire in the stove uses wood as a fuel. The fire heats the matt black metal case of the stove.

(a) The air next to the stove is warmed by infrared radiation.

How does the design of the stove help to improve the rate of energy transfer by infrared radiation?

....

....

....

....

(2)

(b)   Burning 1 kg of wood transfers 15 MJ of energy to the stove. The stove then transfers 13.5 MJ of energy to the room.

Calculate the efficiency of the stove.

Show clearly how you work out your answer.

....

....

....

Efficiency = ...

(2)

(c)   Some of the energy from the burning wood is wasted as the hot gases leave the chimney and warm the air outside the house.

Name **one** other way energy is wasted by the stove.

....

(1)

(d)   Some people heat their homes using electric heaters. Other people heat their homes using a wood burning stove.

Give **two** environmental advantages of using a wood burning stove to heat a home rather than heaters that use electricity generated from fossil fuels.

1 ....

....

2 ....

....

(2)

(e)   The metal case of the stove gets hot when the fire is lit.

Here is some information about the stove.

Mass of metal case	100 kg
Starting temperature of metal case	20 °C
Final temperature of metal case	70 °C
Specific heat capacity of metal case	510 J/kg °C

Calculate the energy required to raise the temperature of the metal case to 70 °C.

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

....

....

....

....

Energy required = ...

(3)
(Total 10 marks)