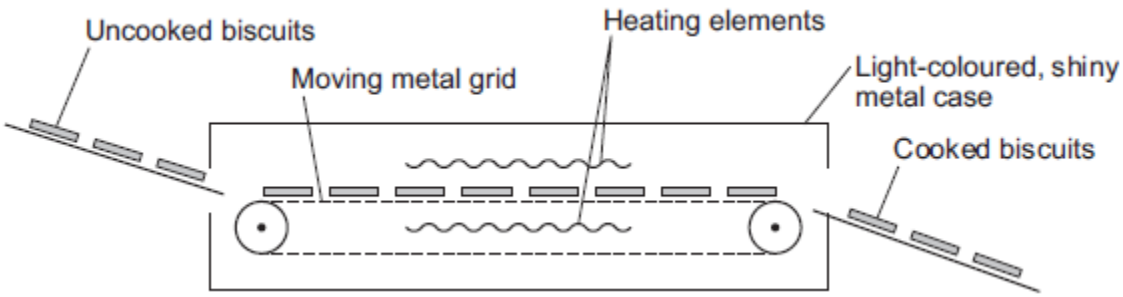
1 **Figure 1** shows one way that biscuit manufacturers cook large quantities of biscuits.

The uncooked biscuits are placed on a moving metal grid.

The biscuits pass between two hot electrical heating elements inside an oven.

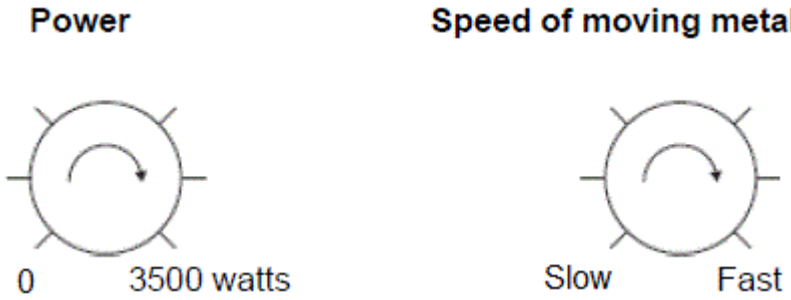
The biscuits turn brown as they cook.

Figure 1



The oven has two control knobs, as shown in **Figure 2**.

Figure 2



(a) Which type of electromagnetic radiation makes the biscuits turn brown?

_____

(1)

(b) Suggest **two** ways of cooking the biscuits in this oven, to make them turn browner.

1. _____

_____

2. _____

_____

(2)

(c) The inside and outside surfaces of the oven are light-coloured and shiny.

Explain why.

_____

_____

_____

_____

_____

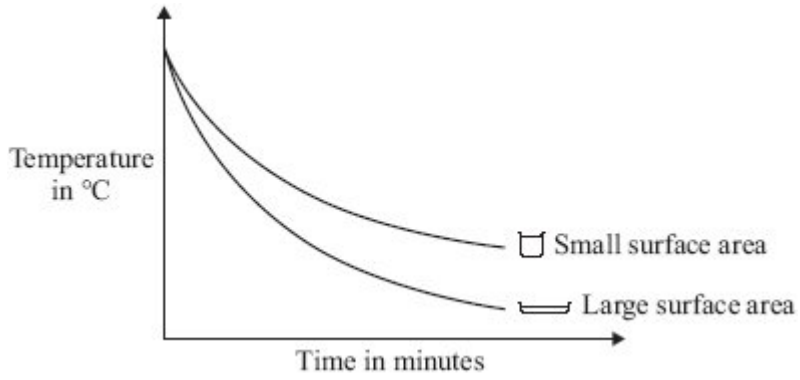
_____

(3)

(Total 6 marks)

2 (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 _____ .

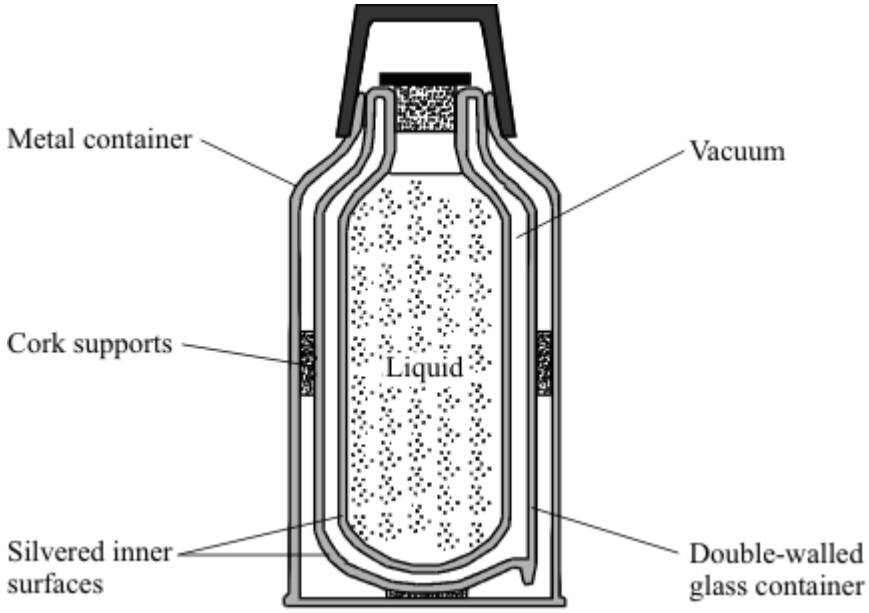
(1)

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

(1)

(Total 5 marks)

3 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.

_____

_____

_____

_____

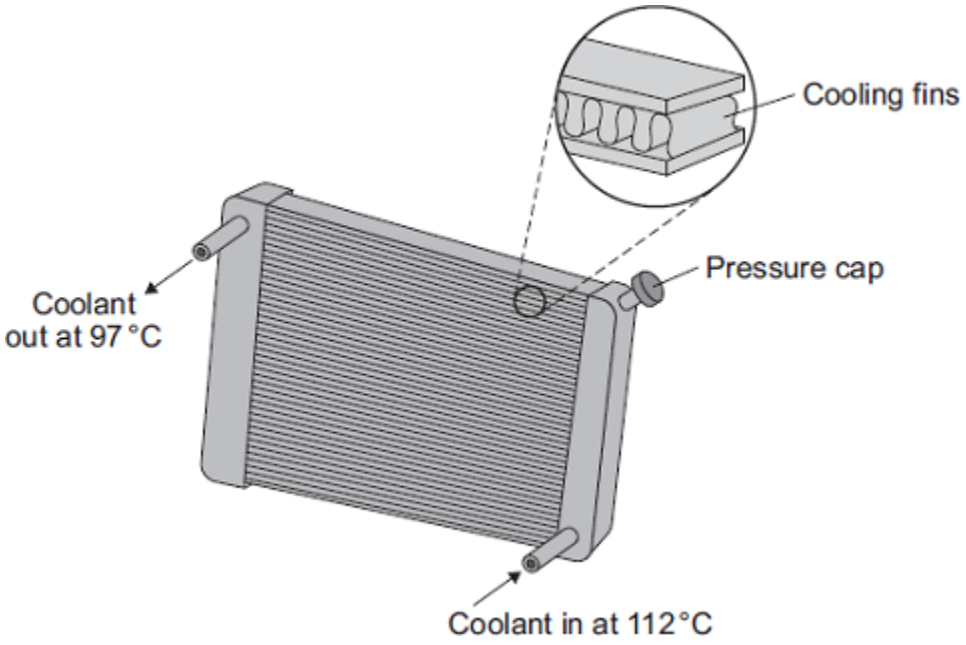
_____

_____

(2)

(Total 6 marks)

4 The diagram shows a car radiator. The radiator is part of the engine cooling system.



Liquid coolant, heated by the car engine, enters the radiator. As the coolant passes through the radiator, the radiator transfers energy to the surroundings and the temperature of the coolant falls.

(a) Why is the radiator painted black?

_____

_____

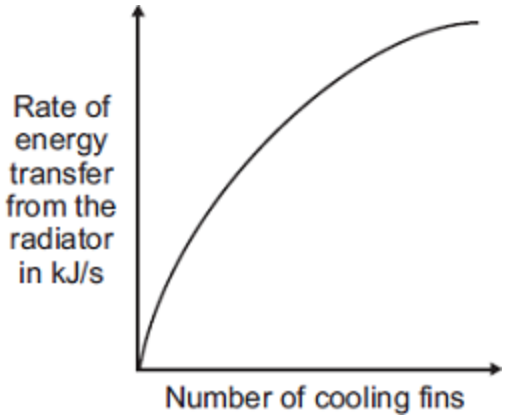
_____

_____

(2)

(b) Different radiators have different numbers of cooling fins along the length of the radiator.

The sketch graph shows how the number of cooling fins affects the rate of energy transfer from the radiator.



The number of cooling fins affects the rate of energy transfer from the radiator.

Explain how.

_____

_____

_____

_____

(2)

(c) When the car engine is working normally, 2 kg of coolant passes through the radiator each second. The temperature of the coolant falls from 112 °C to 97 °C.

Calculate the energy transferred each second from the coolant.

Specific heat capacity of the coolant = 3800 J/kg °C.

_____

_____

_____

_____

Energy transferred each second = _____ J

(3)

(d) On cold days, some of the energy transferred from a hot car engine is used to warm the air inside the car. This is a useful energy transfer.

What effect, if any, does this energy transfer have on the overall efficiency of the car engine?

Draw a ring around the correct answer.

decreases the efficiency	**does not change the efficiency**	**increases the efficiency**

Give a reason for your answer.

_____

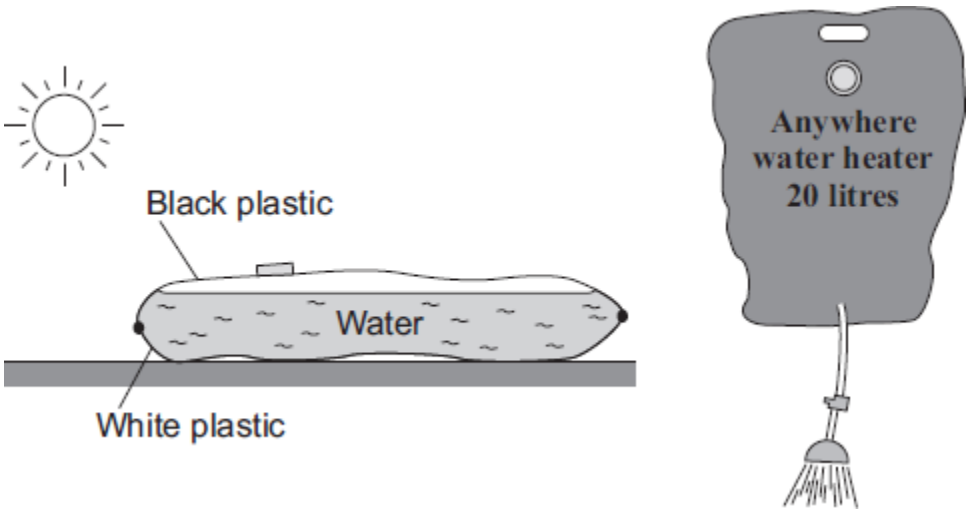
_____

_____

(2)

(Total 9 marks)

5 The diagram shows a simple type of portable shower. The water container is a strong plastic bag that is black on one side and white on the other. To warm the water, the bag is placed on the ground in direct sunlight, with the black side facing the Sun.



(a) (i) Name the process by which heat is transferred from the Sun to the outside of the bag.

_____

(1)

(ii) Explain why the black side of the bag and not the white side should face the Sun.

_____

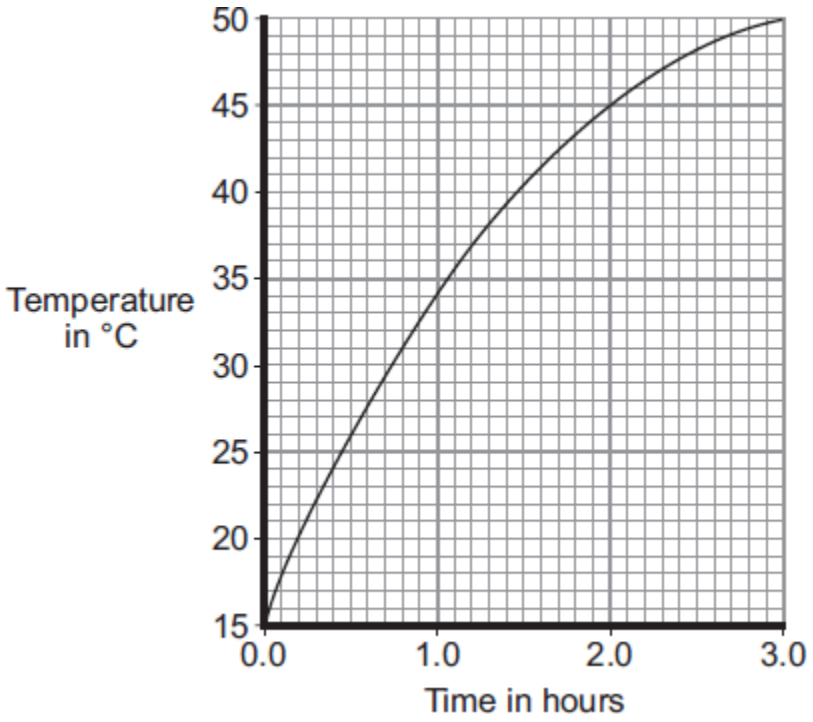
_____

_____

_____

(2)

(b) The graph shows how the temperature of the water inside a full bag increases after the bag is placed outside on a sunny day.



(i) How long does it take for the water to reach 37 °C?

_____

(1)

(ii) Describe how the temperature of the water changes during the three hours.

_____

_____

(1)

(c) A different manufacturer makes the same type of portable shower but uses a bag with a larger surface area. The bag is made from the same coloured plastics and holds the same amount of water.

(i) To compare the efficiency of the two bags at heating water, several variables need to be controlled.

Name **two** variables that need to be controlled.

1. _____

2. _____

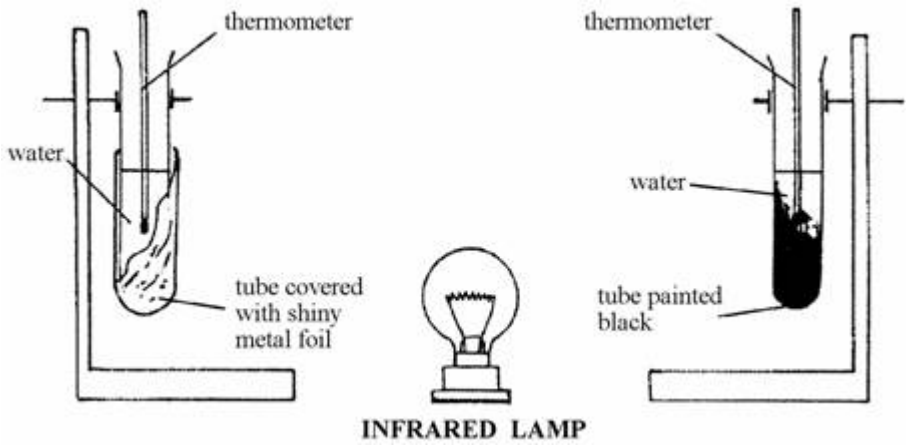
(2)

(ii) The second bag has a larger surface area.
Draw a line on the graph to show how the temperature of the water inside the second bag would change over the first hour.
Assume that the two bags are tested in exactly the same way.

(1)

(Total 8 marks)

6 The diagram shows an experiment to find out what happens to infrared waves when they strike different surfaces.



(a) The water in the black tube gets hotter than the water in the shiny tube.
Choose words from the list to complete the sentences below.

absorbs **conducts** **convects** **radiates** **reflects**

The infrared lamp _____ energy to the tubes of water.

The black surface _____ most of the energy that reaches it.

The shiny surface _____ most of the energy that reaches it.

(3)

(b) Put the sentences A- E below into the correct boxes on the flow diagram so that they tell you how to do the experiment

(You may use just the letters if you want to.)

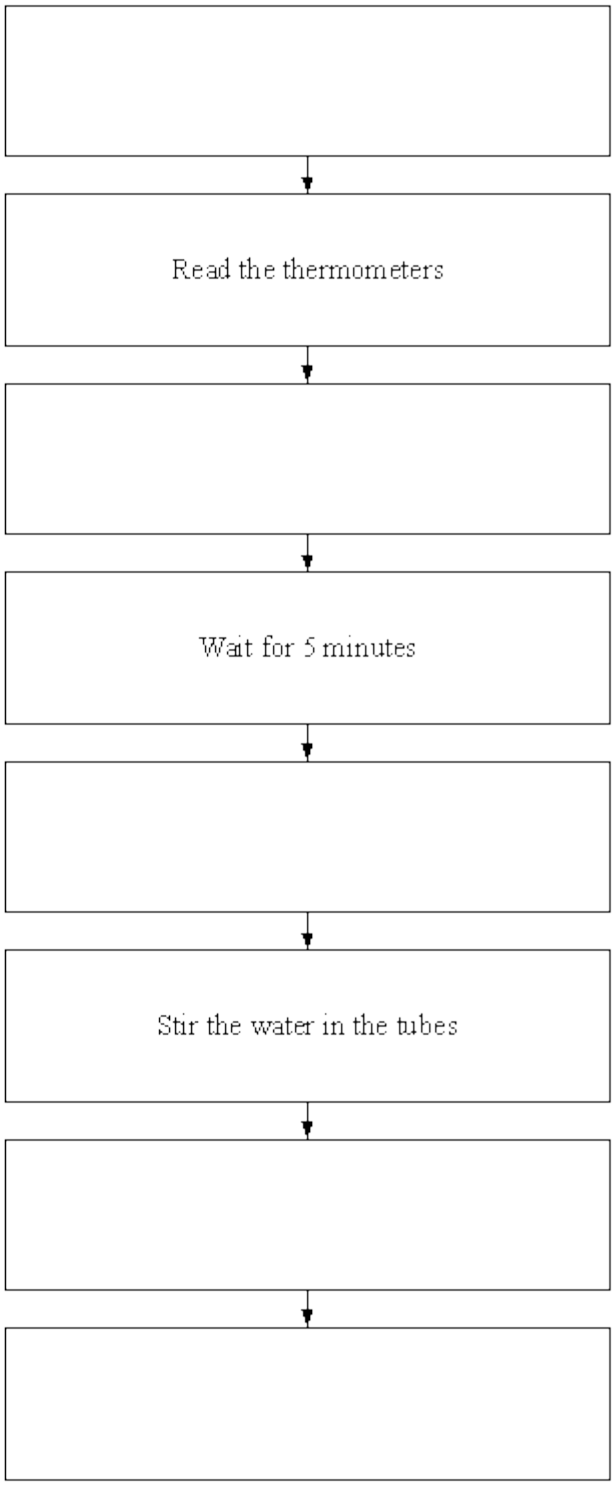
A Switch off the lamp

B Switch on the lamp

C Make sure the lamp is the same distance from both tubes

D Read the thermometers

E Wait for the temperature to stop rising



(5)

(Total 8 marks)

7 (a) Use the words from the box to complete the following sentences.

conduction	**convection**	**radiation**

(i) The transfer of thermal energy (heat) by the movement of hot liquids

is called _____ .

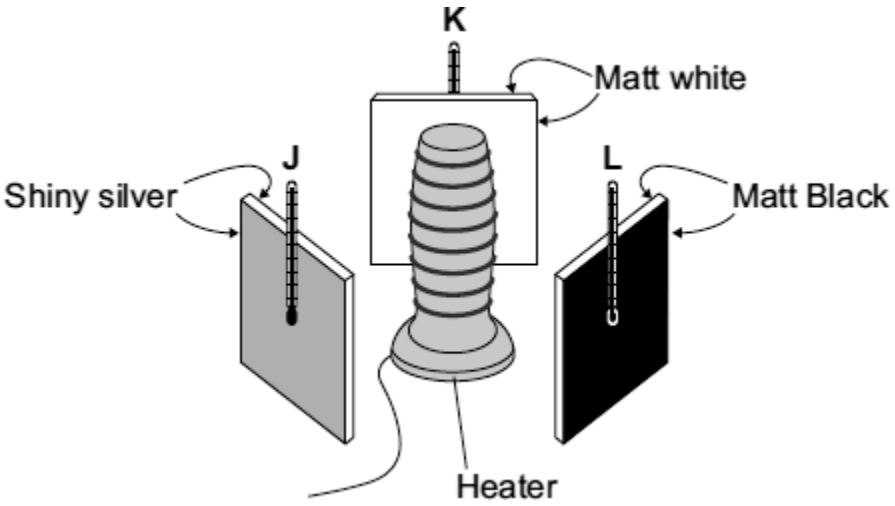
(1)

(ii) The transfer of thermal energy (heat) from one particle to another

is called _____ .

(1)

(b) A student set up the following equipment. The 3 metal plates are the same distance from the heater. The surfaces of each of the 3 metal plates are different colours.



The student switched the heater on for 10 minutes. The thermometers were read before the heater was switched on. The thermometers were read again just after the heaters were switched off.
The readings are shown in the table.

	Temperature before switching on in °C	**Temperature after switching on in °C**
1	19	21
2	19	29
3	19	23

(i) Which set of readings, **1**, **2** or **3**, is most likely to have been taken from the thermometer labelled **L**?

_____

Give a reason for your answer.

_____

_____

(2)

(ii) Which **one** of the following was **not** a control variable in this experiment?

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

the distance between the heater and the metal plates ☐

the power of the heater ☐

the temperature before the heater was switched on ☐

the colour of the metal plates ☐

(1)

(iii) Suggest **one** advantage of using a temperature sensor, data logger and computer, rather than a thermometer to carry out this experiment.

_____

_____

(1)

(c) The picture shows a fire fighter putting out a forest fire. The fire fighter's clothing has thick thermal padding inside and a light coloured, fire proof, shiny layer outside.

(i) What is the main way that heat is transferred through the air from the fire to the fire fighter?

_____

_____

(1)

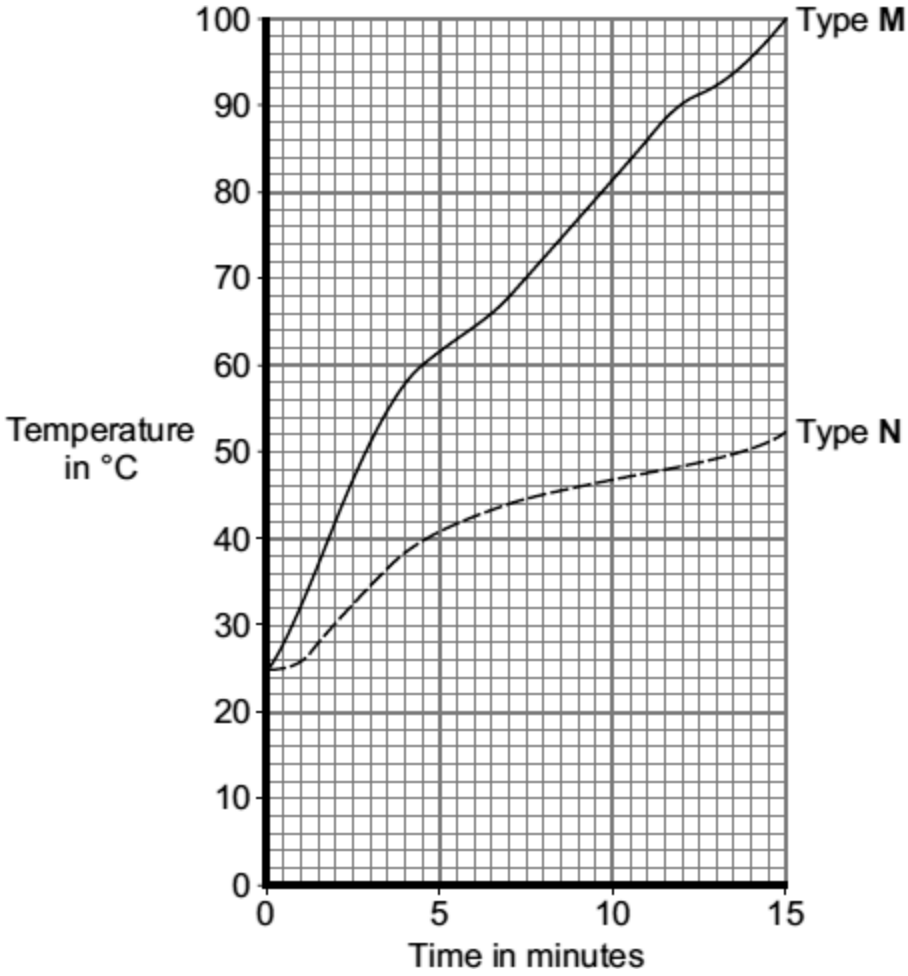
(ii) Why is the outside layer of the clothing shiny?

_____

_____

(1)

(d) The graph shows the result of a laboratory test on two types of thermal padding. Each type of padding was put onto a very hot metal surface and the temperature inside the padding was taken every minute.



Which type of padding, **M** or **N**, would it be best to use inside the fire fighter's clothing?

_____

Give a reason for your answer.

_____

_____

(1)

(Total 9 marks)

8 (a) When an electric kettle is switched on it will take a few minutes to boil the water. Once switched off it will gradually cool down.

(i) When the kettle is switched on the water heats. Explain how all of the water is heated.

_____

_____

(ii) The kettle is now switched off and begins to cool.

(1) Describe how heat energy is transferred **through** the walls of the kettle.

_____

_____

_____

(2) Describe how the heat energy is transferred **from** the walls of the kettle.

_____

_____

_____

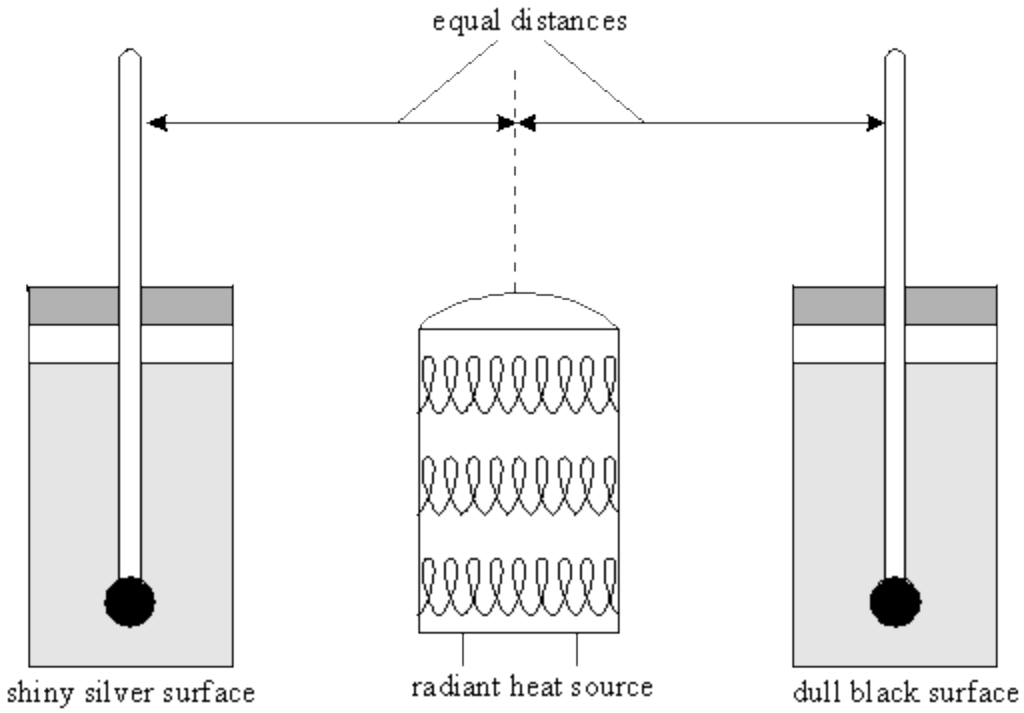
(iii) Describe how heat losses from the surface of a metal kettle may be kept small.

_____

_____

(4)

(b) A shiny metal can and a dull black can are filled with the same amounts of cold water. A radiant heater is placed exactly half way between the cans as shown in the diagram below.



Two thermometers are used to measure the temperature of the water in each can every minute.

(i) Suggest how the temperature of the water in the dull can would be different from the temperature of the water in the shiny can after ten minutes.

_____

_____

(ii) Explain your answer to part (i).

_____

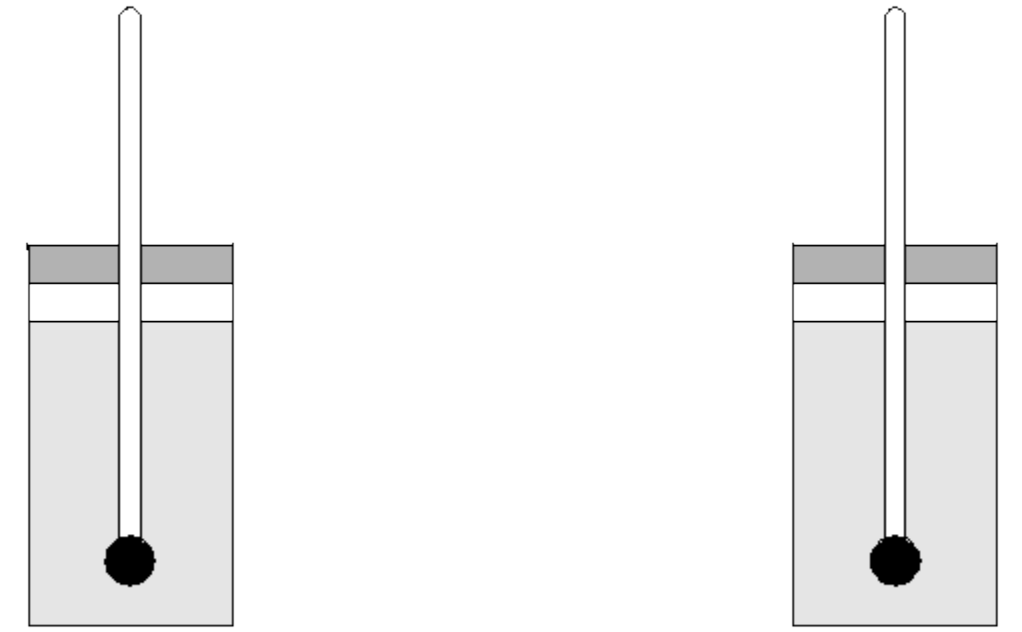
_____

_____

_____

(3)

(c) The radiant heater was removed and both the cans were filled with the same amount of boiling water, as shown in the diagram below.



The temperature was recorded every minute for ten minutes.

(i) Suggest how the temperature of the water in the dull can would be different from the temperature of the water in the shiny can after ten minutes.

_____

_____

(ii) Explain your answer to part (i).

_____

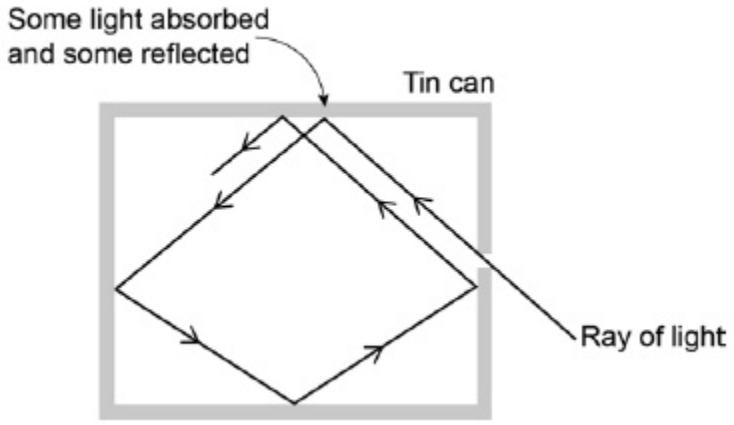
_____

(3)

(Total 10 marks)

9 **Figure 1** shows what happens when a ray of light enters a tin can through a small hole.

Figure 1



(a) Explain why the small hole looks black.

_____

_____

_____

_____

_____

(2)

(b) All objects absorb and emit radiation.

What is meant when an object is described as a perfect black body?

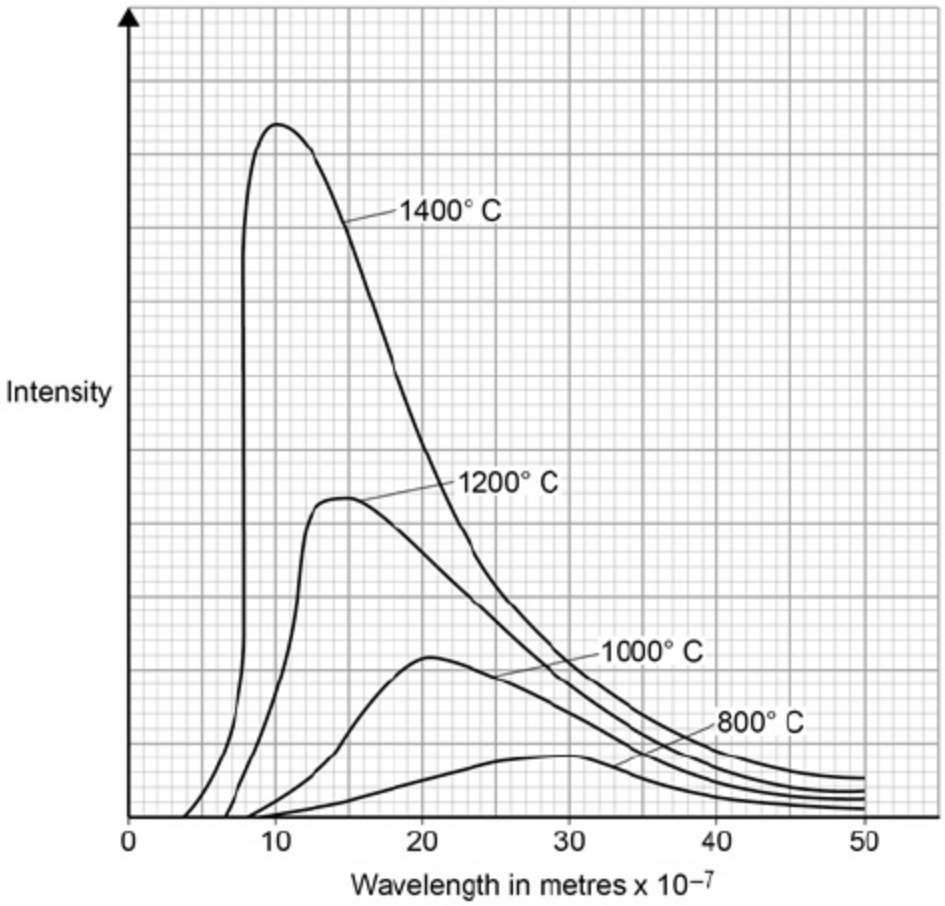
_____

_____

(1)

Figure 2 shows how the intensity of different wavelengths of radiation from a hot object varies with temperature.

Figure 2



(c) What can be concluded from **Figure 2** about how the distribution of the intensity of radiation from an object changes as the temperature of the object increases?

(3)

(d) The wavelength at which the Sun emits the maximum intensity of radiation is approximately $5 \times 10-7$ m

Estimate the surface temperature of the Sun.

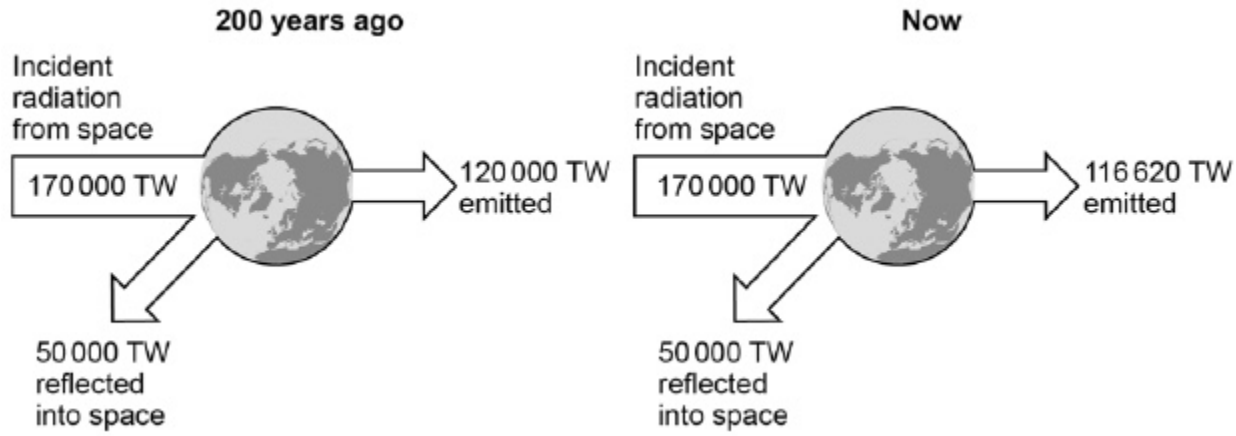
Use **Figure 2**.

_____

(1)

(e) **Figure 3** shows how the balance between the incident radiation from space and the radiation emitted by the Earth into space has changed over the last 200 years.

Figure 3



Explain how the temperature of the Earth and its atmosphere has changed over the last 200 years.

Use the information in **Figure 3**.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

10 All objects emit and absorb infrared radiation.

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

dark matt	dark shiny	light matt	light shiny

The best emitters of infrared radiation have

_____ surfaces.

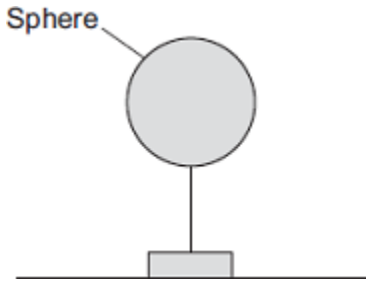
The worst emitters of infrared radiation have

_____ surfaces.

(2)

(b) **Diagram 1** shows a sphere which is at a much higher temperature than its surroundings.

Diagram 1



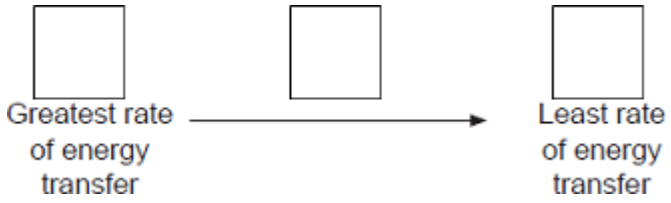
Energy is transferred from the sphere to the surroundings.

The table shows readings for the sphere in three different conditions, **A**, **B** and **C**.

Condition	Temperature of sphere in °C	Temperature of surroundings in °C
A	70	5
B	80	0
C	90	30

In each of the conditions, **A**, **B** and **C**, the sphere transfers energy to the surroundings at a different rate.

Put conditions **A**, **B** and **C** in the correct order.



Give a reason for your answer.

_____

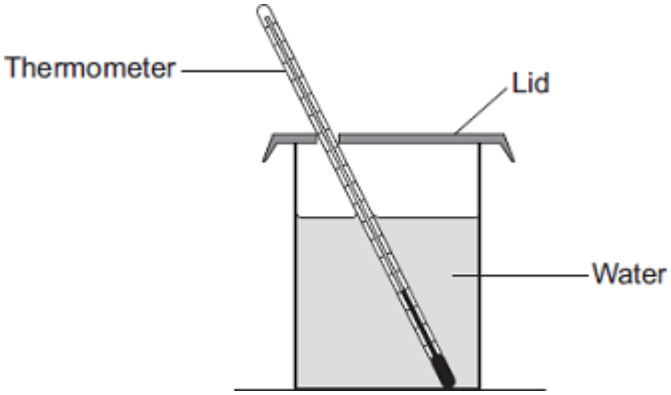
_____

(2)

(c) **Diagram 2** shows a can containing water.

A student investigates how quickly a can of water heats up when it is cooler than room temperature.

Diagram 2



The student has four cans, each made of the same material, with the following outer surfaces.

dark matt **dark shiny** **light matt** **light shiny**

The student times how long it takes the water in each can to reach room temperature.

Each can contains the same mass of water at the same starting temperature.

(i) Which can of water will reach room temperature the quickest?

Give a reason for your answer.

_____

_____

_____

_____

(2)

(ii) Apart from material of the can, mass of water and starting temperature, suggest **three** control variables for the student's investigation.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(d) The photographs show two different foxes.

Fox A

By Algkalv (Own work) [CC-BY-3.0], via Wikimedia Commons

Fox B

© EcoPic/iStock

Which fox is better adapted to survive cold conditions?

Give reasons for your answer.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 12 marks)