



# **GCSE Physics**

## **Black Body Radiation**

### **Question Paper**

**Time available: 55 minutes**

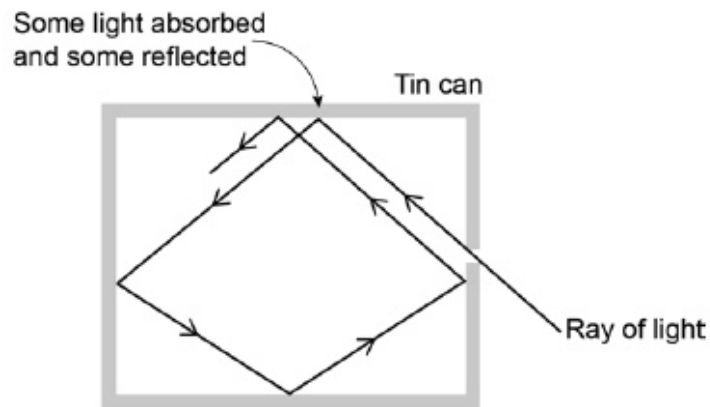
**Marks available: 48 marks**

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1.

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.

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(2)

(b) All objects absorb and emit radiation.

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

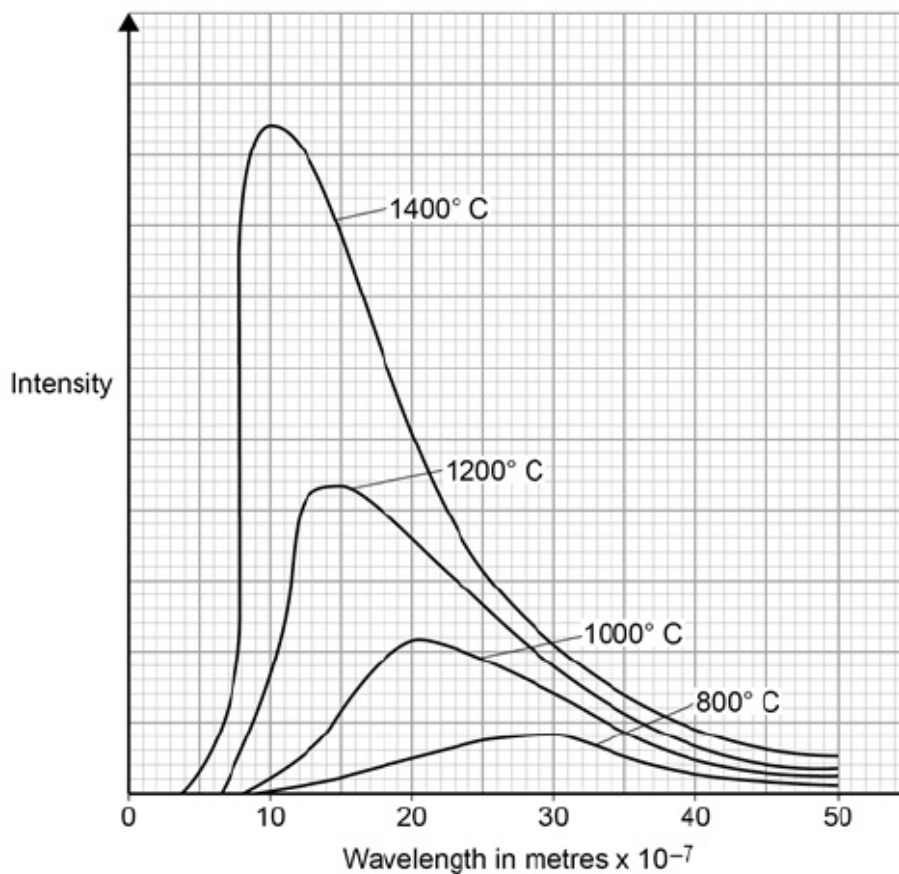
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(1)

**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?

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(3)

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

Estimate the surface temperature of the Sun.

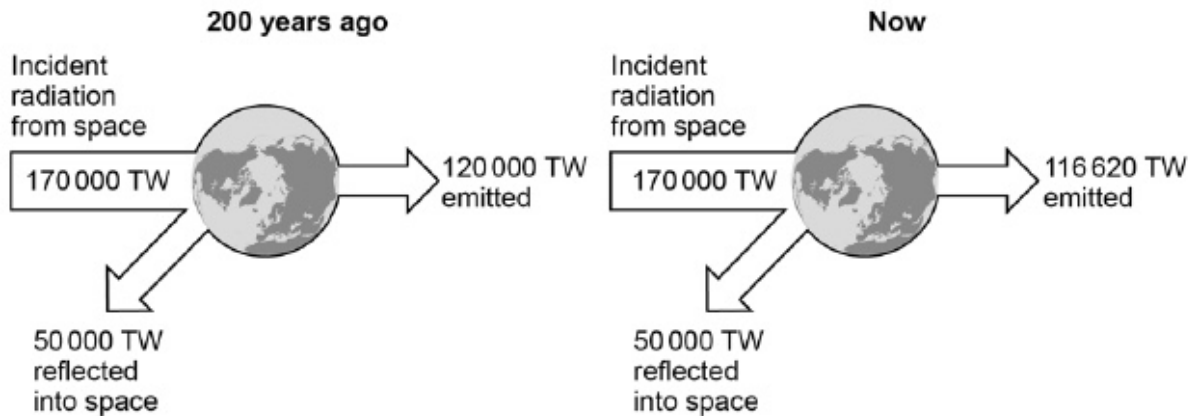
Use **Figure 2**.

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(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**.

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(3)

(Total 10 marks)

2.

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

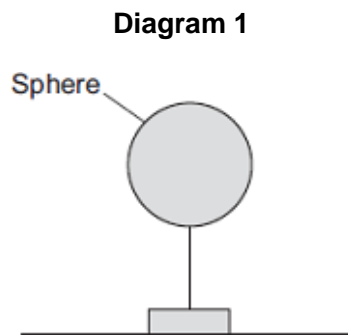
\_\_\_\_\_ surfaces.

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.



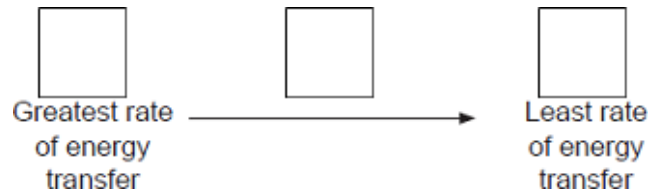
Energy is transferred from the sphere to the surroundings.

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
<b>A</b>	70	5
<b>B</b>	80	0
<b>C</b>	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.

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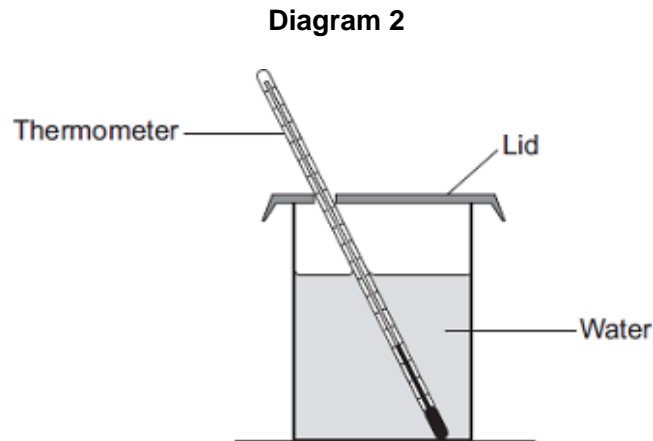


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(2)

(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.



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.

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(2)

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

1. \_\_\_\_\_

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2. \_\_\_\_\_

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3. \_\_\_\_\_

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(3)

(d) The photographs show two different foxes.

**Fox A**



By Algalv (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.

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(3)  
(Total 12 marks)

**3.**

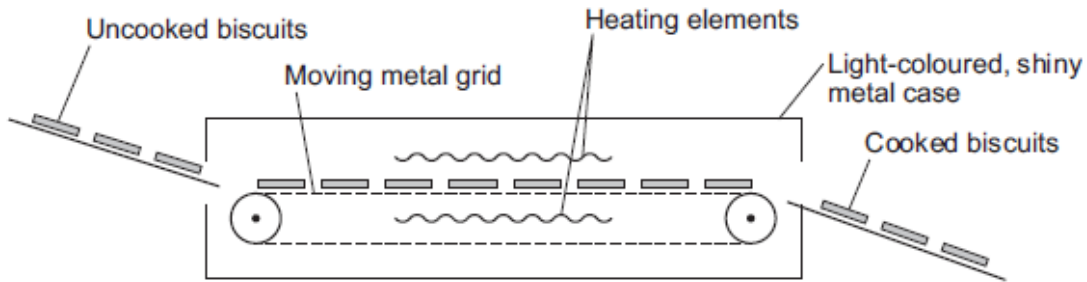
**Figure 1** shows one way that biscuit manufacturers cook large quantities of biscuits.

The uncooked biscuits are placed on a moving metal grid.

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

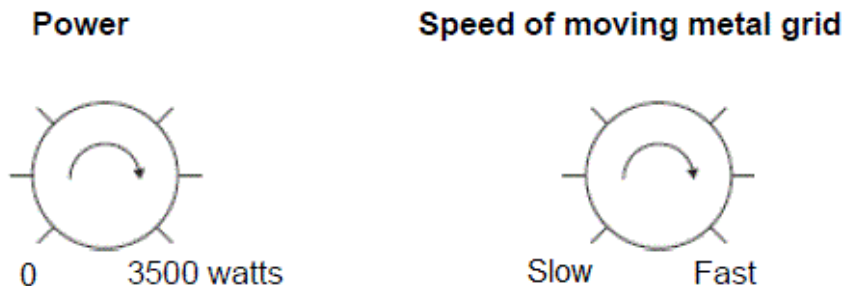
The biscuits turn brown as they cook.

**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?

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(1)

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

1. \_\_\_\_\_

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2. \_\_\_\_\_

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(2)

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

Explain why.

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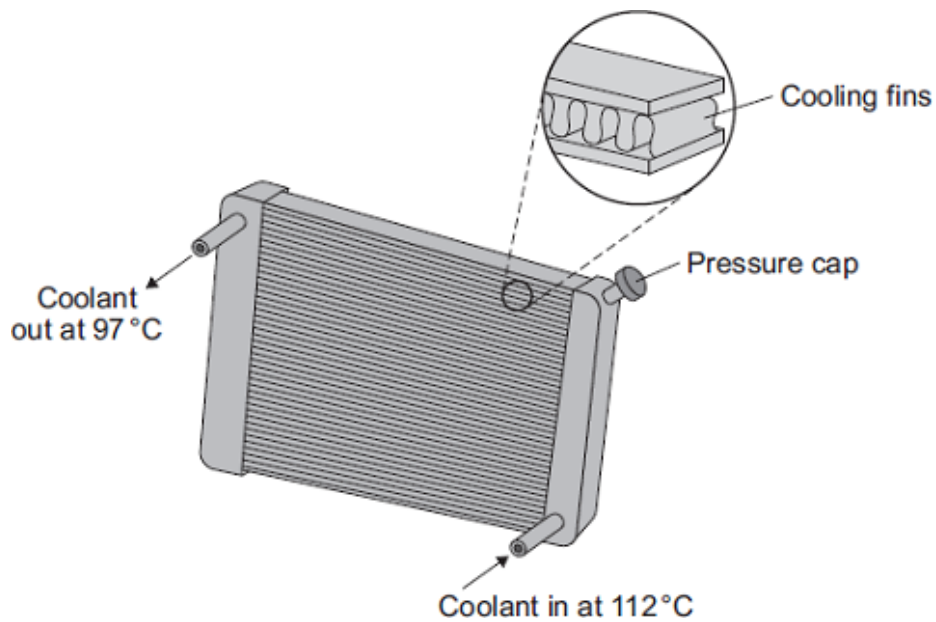
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(3)

(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?

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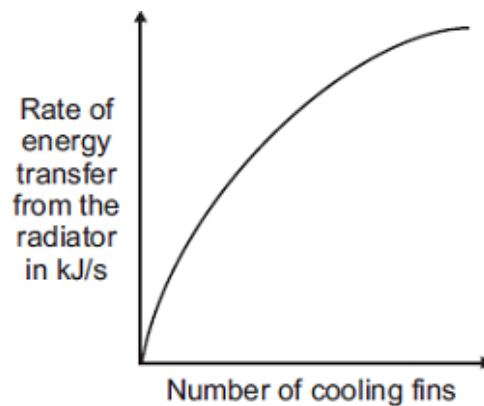


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(2)

(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.

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(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.

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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.

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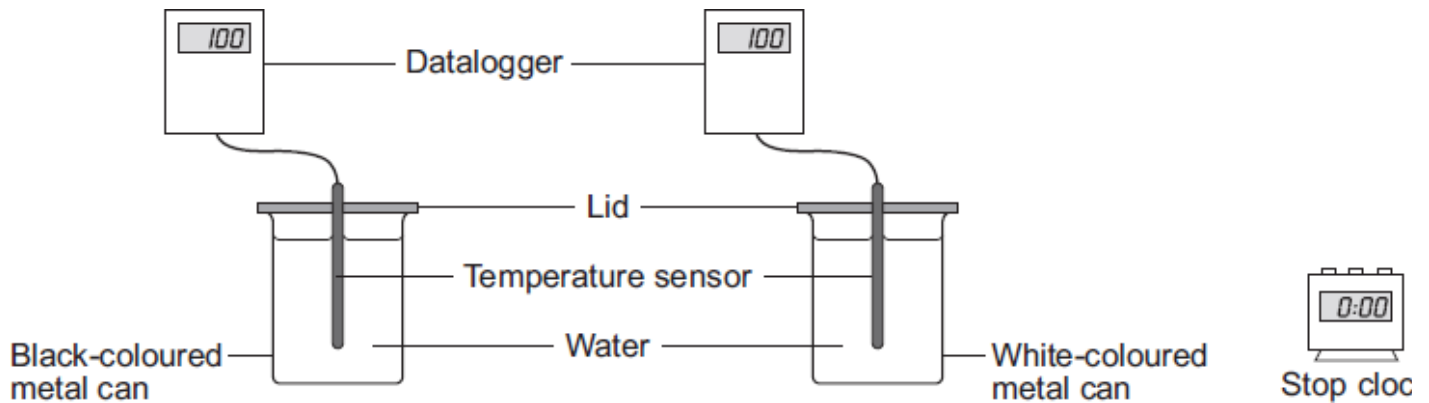
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(2)

(Total 9 marks)

5. The diagram shows the equipment a student used to investigate how the colour of a surface affects how fast it emits (gives out) heat.



An equal volume of boiling water was poured into each metal can. The student then recorded the temperature of the water in each can every minute for ten minutes.

- (a) (i) Which of the following was a control variable in this investigation?

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

The volume of boiling water.

The decrease in temperature of the water.

The outside colour of the metal can.

(1)

- (ii) Give **one** advantage of using a temperature sensor and datalogger rather than a thermometer to measure the temperature of the water.

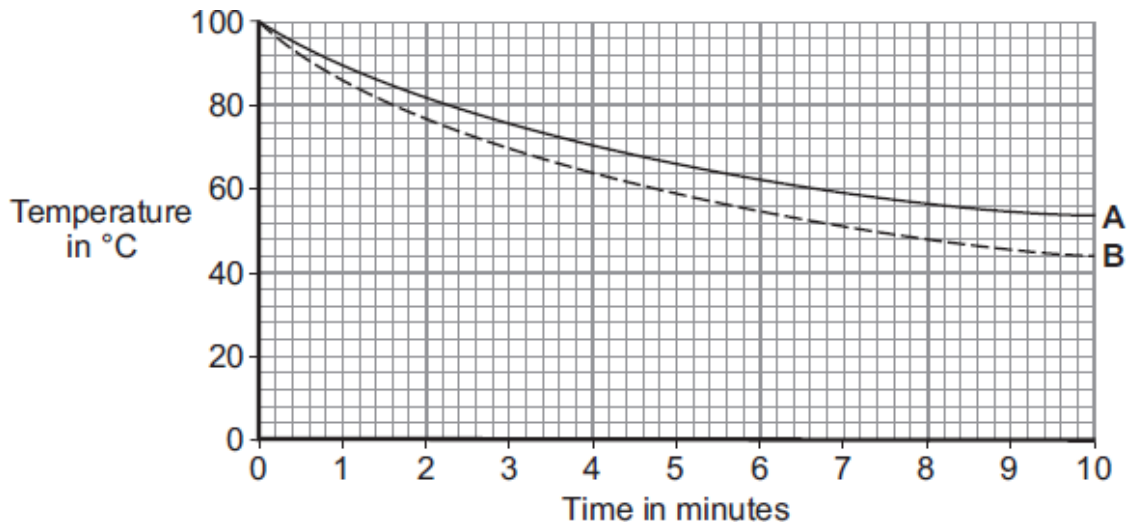
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(1)

(b) The student's results for both cans are plotted on the graph.



Which line, **A** or **B**, shows how the temperature of the water inside the black-coloured metal can changed?

Draw a ring around your answer.     **A**     **B**

Explain the reason for your answer.

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(2)

(c) Some gardeners make soil darker by digging black soot into the soil. Other gardeners use straw to protect plants from the cold.

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

On a warm day, the temperature of darker coloured soil will increase

slower than
as fast as
faster than

 the temperature of lighter coloured soil.

(1)

(ii) Give a reason for your answer to part (c)(i).

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(1)

(iii) The statement in the box is **false**.

Straw keeps plants warm by trapping air.

This is because air is a good conductor.

Change **one** word in the statement to make the statement **true**.

Write down your **new** statement. The answer has been started for you.

This is because air is a \_\_\_\_\_

(1)

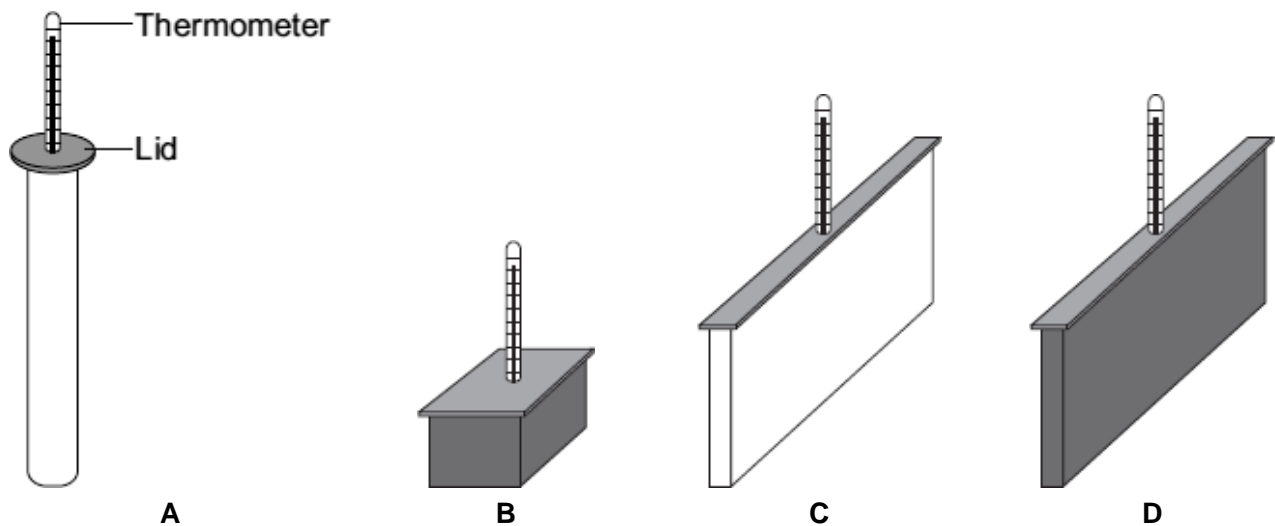
(Total 7 marks)

6.

A student investigated the effect of shape and colour on heat transfer.

The student used metal containers with the same volume but with different shapes and outside colour. The containers were each filled with water at 100 °C.

After 20 minutes the temperature of the water inside each container was measured.



The results from the investigation are given in the table.

Container	Colour	Temperature after 20 minutes in °C	Temperature fall in °C
A	White	86	14
B	Black	86	14
C	White	73	27
D	Black	60	40

- (i) The student uses the results in the table to see if shape has affected heat transfer.

Which containers should the student compare to do this?

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Give a reason for your answer.

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(1)

- (ii) Explain why the temperature of the water in both containers **A** and **B** fell by the same amount.

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(2)

- (iii) A central heating system has several radiators joined together. The hot water goes from the boiler, through each radiator in turn and then back to the boiler for reheating.

Give **one** reason, other than appearance, why it might **not** be a good idea to paint radiators black.

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(1)

(Total 4 marks)