Thermal Properties and Temperature

Question Paper 1

Level	IGCSE
Subject	Physics
ExamBoard	CIE
Topic	Thermal Physics
Sub-Topic	Thermal Properties and Temperature
Paper Type	(Extended) Theory Paper
Booklet	Question Paper 1

Time Allowed: **56 minutes**

Score: **/46**

Percentage: **/100**

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1 **(a)** The source of solar energy is the Sun.

Tick the box next to those resources for which the Sun is also the source of energy.

- ☐ coal
- ☐ geothermal
- ☐ hydroelectric
- ☐ nuclear
- ☐ wind [2]

(b) Fig. 4.1 shows a solar water-heating panel on the roof of a house.

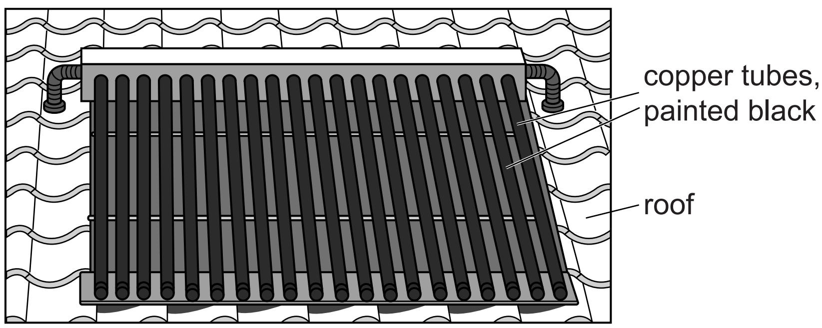

Fig. 4.1

Cold water flows into the copper tubes, which are heated by solar radiation. Hot water flows out of the tubes and is stored in a tank.

(i) Explain why the tubes are made of copper and are painted black.

....

....

....[2]

(ii) In 5.0 s, 0.019 kg of water flows through the tubes. The temperature of the water increases from 20 °C to 72 °C. The specific heat capacity of water is 4200 J / (kg °C).

Calculate the thermal energy gained by the water in 5.0 s.

thermal energy = ...[3]

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(iii) The efficiency of the solar panel is 70%.

Calculate the power of the solar radiation incident on the panel.

power = ...[2]

[Total: 9]

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2 **(a)** State what is meant by the *specific heat capacity* of a substance.

....

....

.... [2]

(b) A student carries out an experiment to find the specific heat capacity of aluminium. He uses an electric heater and a thermometer, inserted into separate holes in an aluminium block.

The following data are obtained.

mass of aluminium block = 2.0 kg
power of heating element = 420 W
time of heating = 95 s
initial temperature of block = 19.5 °C
final temperature of block = 40.5 °C

Calculate the value of the specific heat capacity of aluminium given by this experiment.

specific heat capacity = ... [4]

(c) In the experiment in **(b)**, no attempt is made to prevent loss of thermal energy from the surfaces of the block.

Suggest two actions the student could take to reduce the loss of thermal energy from the surfaces of the block.

1. ....

2. ....

[2]

[Total: 8]

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3 **(a)** Fig. 4.1 shows a device used as a thermocouple thermometer.

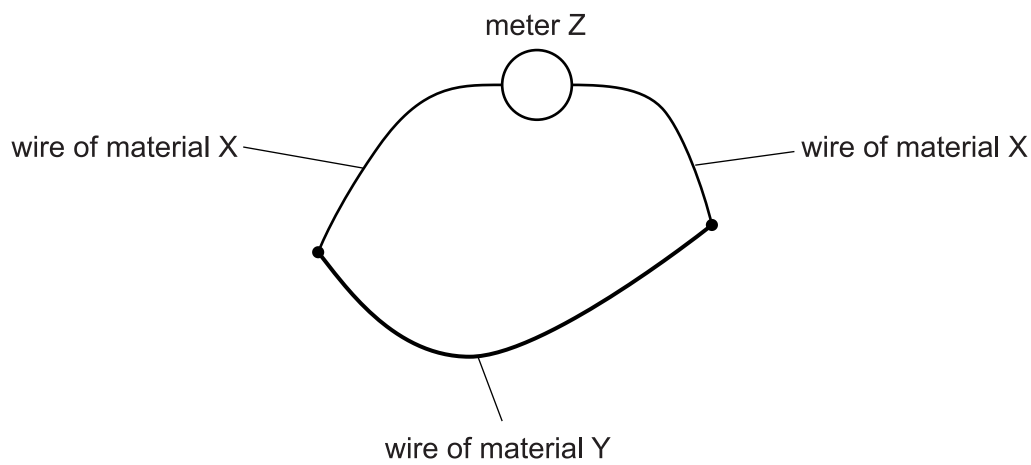

Fig. 4.1

In the table put **three** ticks against the correct statements about the thermocouple thermometer.

Meter Z measures energy.	
Meter Z measures potential difference.	
Meter Z measures power.	
Materials X and Y are different materials.	
Materials X and Y are the same material.	
Materials X and Y are electrical conductors.	
Materials X and Y are electrical insulators.	

[3]

(b) A liquid-in-glass thermometer is replaced by a similar thermometer with a larger bulb. No other change is made.

State and explain the effect on the sensitivity.

....

....

....[2]

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(c) The capillary of a liquid-in-glass thermometer should have a constant diameter.

Fig. 4.2 shows the capillary of a thermometer made with a manufacturing fault.

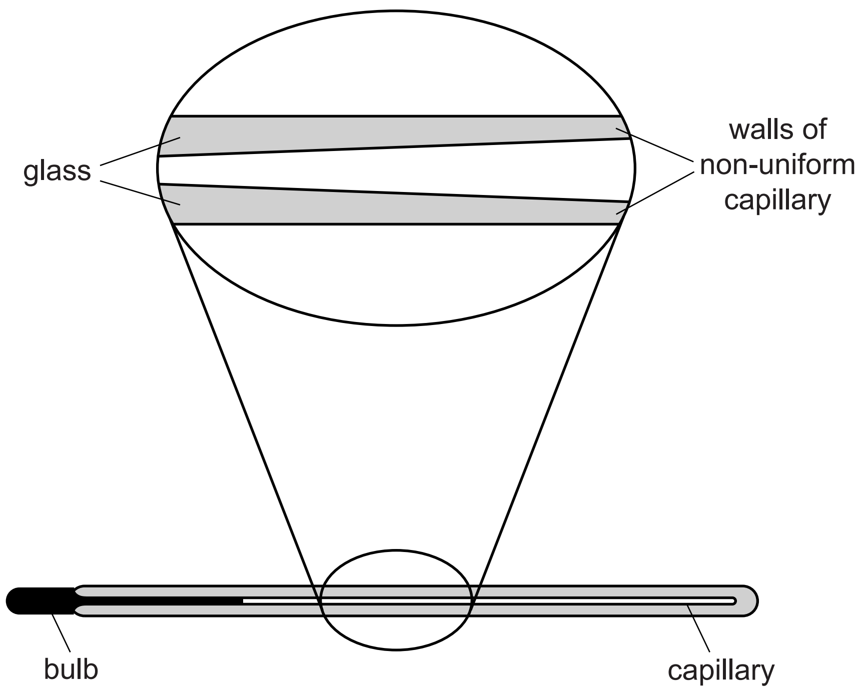

Fig. 4.2 (not to scale)

State and explain the effect of this fault on the linearity of the thermometer.

....

....

....[2]

[Total: 7]

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4 A liquid-in-glass thermometer has a linear scale and a range of 120 °C.

(a) State what is meant by a *linear scale*.

....

....[1]

(b) The highest temperature that this thermometer can measure is 110 °C.

State the lowest temperature that it can measure.

lowest temperature = ...[1]

(c) A second liquid-in-glass thermometer has the same range but it has a greater sensitivity.

Suggest **two** ways in which the second thermometer might differ from the first.

1. ....

2. ....

[2]

(d) A thermometer has a bulb that is painted white and is shiny.

It is placed in boiling water for several minutes. It is then removed from the water and is held in air.

Fig. 4.1 shows how the thermometer reading changes during the next 8 minutes.

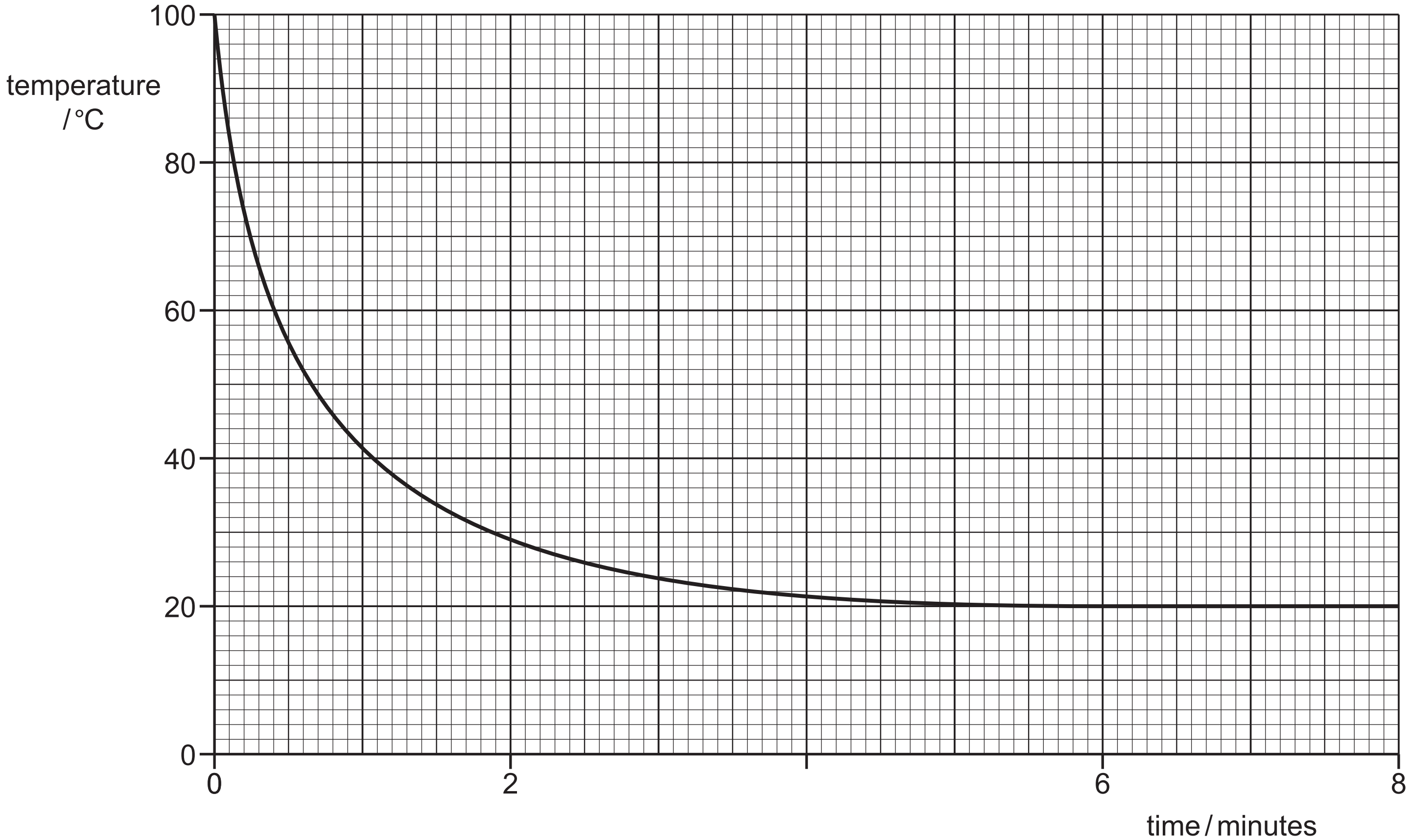

Fig. 4.1

The bulb of this thermometer is now re-painted so that it has a matt, black surface.

The procedure is repeated.

(i) On Fig. 4.1, sketch a second line to suggest how the reading of the re-painted thermometer changes during the 8 minutes. [2]

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(ii) Tick **one** of the boxes to show how painting the bulb black affects the linearity of the scale, the range and the sensitivity of the thermometer.

- [ ] The linearity, the range and the sensitivity all change.
- [ ] Only the linearity and the range change.
- [ ] Only the linearity and the sensitivity change.
- [ ] Only the range and the sensitivity change.
- [ ] Only the linearity changes.
- [ ] Only the range changes.
- [ ] Only the sensitivity changes.
- [ ] None of these properties changes.

[1]

[Total: 7]

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5 **(a)** State what is meant by the *specific latent heat of fusion* (*melting*) of a substance.

....

....[2]

(b) Ice cubes of total mass 70 g, and at 0 °C, are put into a drink of lemonade of mass 300 g.

All the ice melts as 23 500 J of thermal energy transfers from the lemonade to the ice. The final temperature of the drink is 0 °C.

(i) Calculate the specific latent heat of fusion for ice.

specific latent heat of fusion = ...[2]

(ii) The thermal energy that causes the ice to melt is transferred from the lemonade as it cools. The loss of this thermal energy causes the temperature of the 300 g of the lemonade to fall by 19 °C.

Calculate the specific heat capacity of the lemonade.

specific heat capacity = ...[2]

(iii) The melting ice floats on top of the lemonade.

Explain the process by which the lemonade at the bottom of the drink becomes cold.

....

....

....[2]

[Total: 8]

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6 **(a)** An object of mass m and specific heat capacity c is supplied with a quantity of thermal energy Q. The temperature of the object increases by $\Delta\theta$.

Write down an expression for c in terms of Q, m and $\Delta\theta$.

c = ...[1]

(b) Fig. 4.1 shows the heating system of a hot water shower.

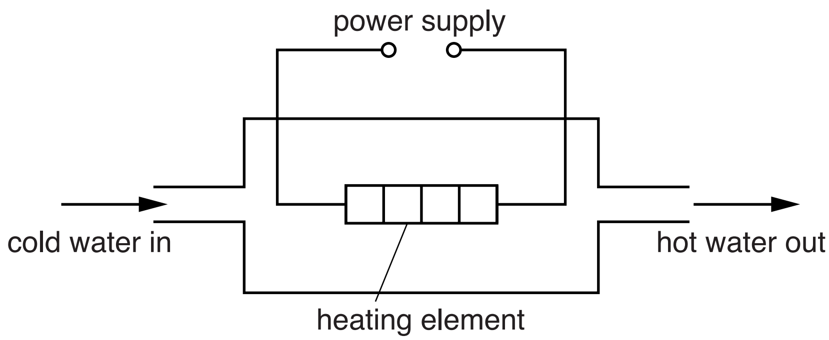

Fig. 4.1

Cold water at 15 °C flows in at the rate of 0.0036 m^3/minute. Hot water flows out at the same rate.

(i) Calculate the mass of water that passes the heating element in one minute. The density of water is 1000 kg/m^3.

mass = ...[2]

(ii) The power of the heating element is 8.5 kW.

Calculate the temperature of the hot water that flows out. The specific heat capacity of water is 4200 J/(kg °C).

temperature = ...[4]

[Total: 7]