Thermal Processes

Question Paper 4

Level	IGCSE
Subject	Physics
Exam Board	CIE
Topic	Thermal Physics
Sub-Topic	Thermal Processes
Paper Type	Alternative to Practical
Booklet	Question Paper 4

Time Allowed: **36 minutes**

Score: **/30**

Percentage: **/100**

1 The IGCSE class is investigating the rate of cooling of water.

Fig. 2.1 shows the apparatus.

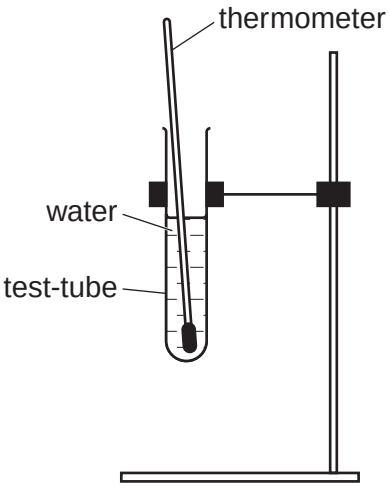


Fig. 2.1

(a) Record room temperature θ_R as shown on the thermometer in Fig. 2.2.

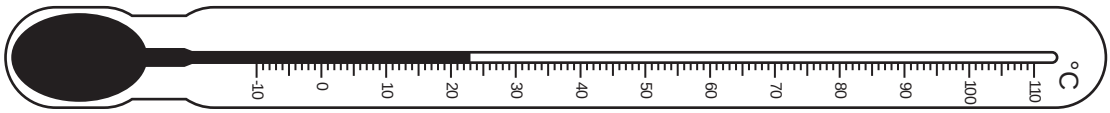


Fig. 2.2

θ_R = ...[1]

(b) A student pours hot water into the test-tube until it is about two thirds full of water and places the thermometer in the water. When the thermometer reading stops rising, she measures the temperature θ of the water and records θ in Table 2.1 at time t = 0. She starts a stopclock and records in the table the time t and the temperature θ of the water every 30 s. She removes the thermometer and pours away the water from the test-tube. She then wraps cotton wool insulation round the test-tube and repeats the procedure.

(i) Complete the time and temperature column headings in the table.

(ii) Complete the time column in the table.

Table 2.1

t /	tube without cotton wool θ /	tube with cotton wool θ /
0	79	80
	65	67
	58	60
	55	57
	53	56
	52	55
	51	54

[2]

(c) State in which experiment the cooling is more rapid. Justify your answer by reference to the readings.

experiment .....

justification .....

.....[2]

(d) If these experiments were to be repeated in order to check the results, it would be important to control the conditions. Suggest two conditions that should be controlled.

1. .....

2. .....[2]

(e) Suggest two alternative insulating materials that could be used in place of cotton wool.

1. .....

2. .....[2]

[Total: 9]

2 The IGCSE class is investigating the cooling of thermometer bulbs under different conditions.

The students are provided with two thermometers **A** and **B**. Thermometer **B** has cotton wool wrapped around the bulb. Fig. 2.1 shows thermometer **A**.

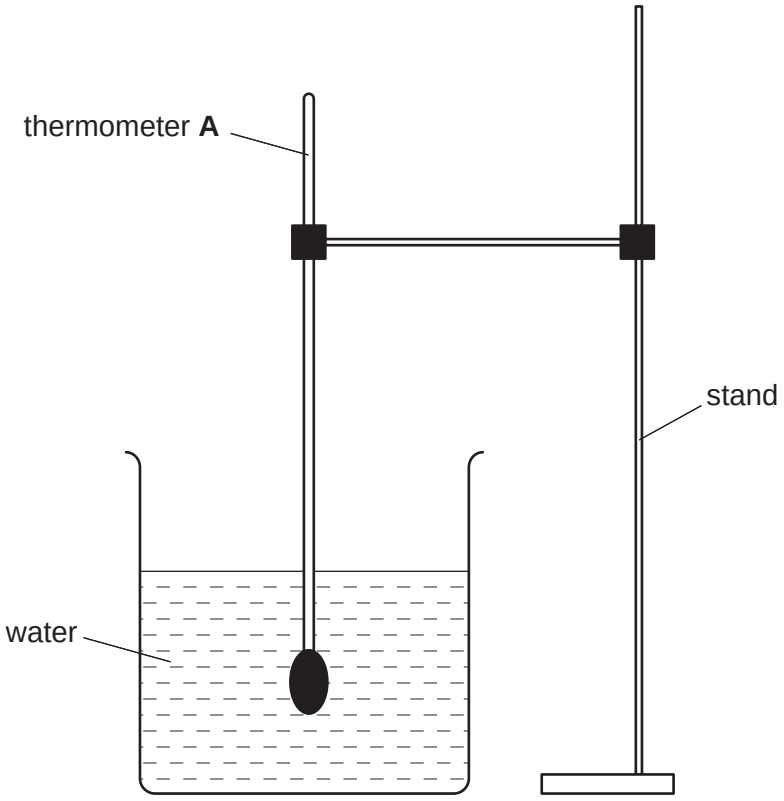
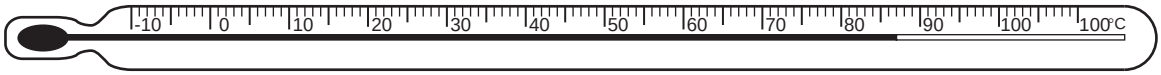


Fig. 2.1

The students measure the temperature θ of the hot water in the beaker. Fig. 2.2 shows the thermometer reading.



thermometer **A**

Fig. 2.2

(a) Record in Table 2.1 at time $t = 0$ s the temperature θ shown in Fig. 2.2.

(b) The students remove the thermometer from the water, starting the stopclock at the same time. Table 2.1 shows the temperature of the thermometer bulb at 30 s intervals. The experiment is repeated using thermometer **B** which has cotton wool wrapped around the thermometer bulb.

Complete Table 2.1 by inserting the appropriate unit in the time and in the temperature column headings.

Table 2.1

	Thermometer **A**	Thermometer **B**
t /	*θ*/	*θ*/
0		81
30	51	72
60	43	58
90	37	49
120	34	43
150	30	38
180	28	34
210	27	31

[2]

(c) Suggest which thermometer cooled more quickly at first. Justify your answer by reference to the readings.

statement .....

justification .....

..... [2]

(d) To make a fair comparison between the rates of cooling of the two thermometer bulbs under different conditions (in this experiment one thermometer bulb is covered with cotton wool), it is important to control other experimental conditions. Suggest two conditions that should be controlled in this experiment.

1. .....

2. ..... [2]

[Total: 6]

3 A student is investigating the transfer of thermal energy.

He uses the apparatus shown in Fig. 1.1.

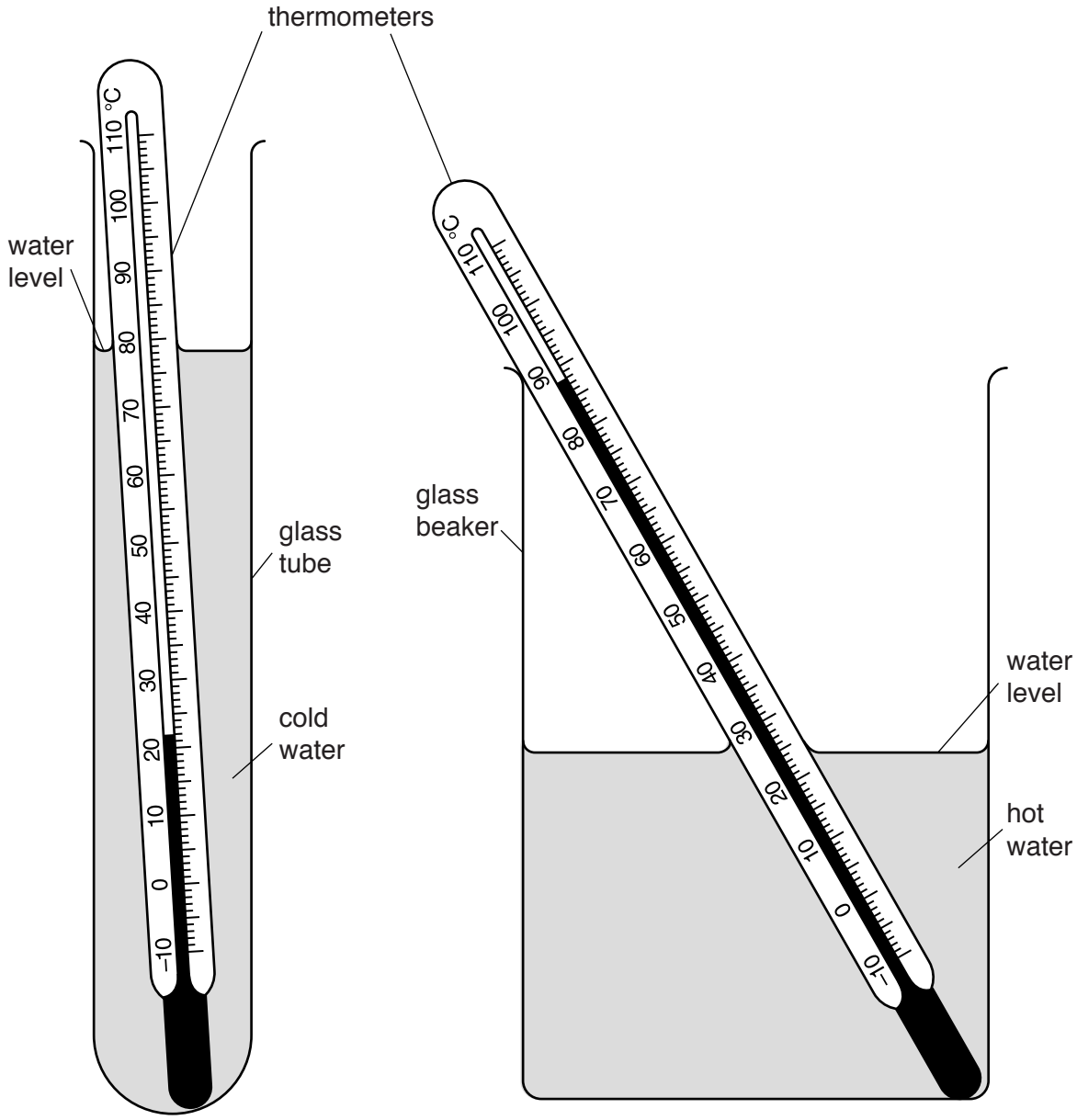


Fig. 1.1

(a) The student pours 50 cm^3 of cold water into the glass tube and 300 cm^3 of hot water into the beaker. The water levels are approximately as shown in Fig. 1.1.

In Table 1.1, record the temperatures θ_C of the cold water and θ_H of the hot water as shown on the thermometers in Fig. 1.1. [1]

Table 1.1

	tube with 50 cm^3 of cold water		tube with 25 cm^3 of cold water	
t/	θ_C/	θ_H/	θ_C/	θ_H/
0			20.0	87.0
30	33.0	82.0	34.0	82.0
60	40.5	79.0	49.0	79.5
90	49.0	78.0	59.5	76.0
120	56.0	76.0	65.5	75.0
150	60.0	75.0	69.5	74.5
180	63.0	74.0	72.0	74.0

(b) The student lowers the glass tube into the beaker of hot water and immediately starts a stopclock.

Table 1.1 shows the readings of the temperature θ_C of the cold water and the temperature θ_H of the hot water at times t = 30 s, 60 s, 90 s, 120 s, 150 s and 180 s.

The student repeats the procedure with the same volume of hot water in the beaker but with 25 cm^3 of cold water in the glass tube. The results are shown in the table.

Complete the column headings in the table. [1]

(c) Write a conclusion stating how the volume of cold water in the tube affects its temperature rise.

.....

.....

.....[1]

(d) Another student wishes to check the conclusion by repeating the experiment with 12.5 cm^3 of cold water.

Suggest two conditions which he should keep the same so that the comparison will be fair.

1. .....

.....

2. .....

.....

[2]

(e) Scientists in an industrial laboratory wish to use this experiment as a model of a heat exchanger, which transfers thermal energy between liquids.

Suggest **two** different improvements to the apparatus which would make the heating of the cold water more efficient.

For your **first** suggestion, explain why it would be an improvement.

suggestion 1 .....

explanation .....

.....

suggestion 2 .....

[3]

[Total: 8]

4 The IGCSE class is investigating the cooling of water.

A student cools some water by four different methods.

Experiment A (cooling with stirring)

(a) The student pours approximately 200 cm^3 of hot water into a beaker.

She measures the temperature θ_1. Fig. 2.1 shows the thermometer.

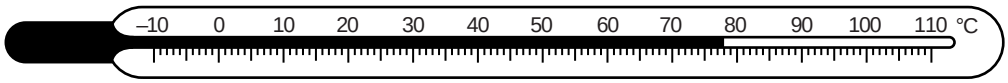


Fig. 2.1

Write down the temperature θ_1 shown on the thermometer in Fig. 2.1.

θ_1 = ...[1]

(b) The student stirs the water for one minute. She then records the temperature θ_2 of the water.

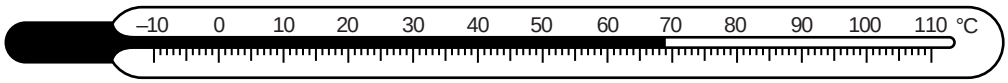


Fig. 2.2

(i) Write down the temperature θ_2 shown on the thermometer in Fig. 2.2.

θ_2 = ...

(ii) Calculate the temperature difference $(\theta_1 - \theta_2)$.

$(\theta_1 - \theta_2)$ = ...
[1]

Experiment B (cooling with pouring)

(c) The student starts again with approximately 200 cm^3 of hot water at the same initial temperature θ_1.

She carefully pours the water from the beaker into another beaker. She pours the water back into the first beaker. She repeats this process four times.

She measures the temperature θ_3 of the water. Fig. 2.3 shows this temperature.

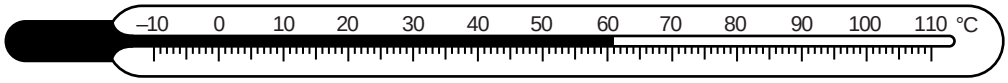


Fig. 2.3

(i) Write down the temperature θ_3 shown on the thermometer in Fig. 2.3.

θ_3 = ...

(ii) Calculate the temperature difference $(\theta_1 - \theta_3)$.

$(\theta_1 - \theta_3)$ = ...
[1]

Experiment C (cooling with a lid) and **Experiment D (cooling without a lid)**

(d) The student pours approximately 200 cm^3 of the hot water into each of two beakers. The initial temperature of the water in each beaker is θ_1.

She places a lid on one of the beakers. She allows both beakers to cool for 5 minutes.

At the end of the cooling period, she calculates the temperature differences.

temperature difference of **C** (with a lid) = 11°C

temperature difference of **D** (without a lid) = 31°C

Rank the experiments **A**, **B**, **C** and **D** in order, with the one that produced the greatest temperature drop first.

greatest temperature drop 1. .....

2. .....

3. .....

smallest temperature drop 4. .....
[1]

(e) If this laboratory investigation is to be repeated many times to check the results, suggest two conditions that should be kept constant in order to provide reliable results.

1. .....

2. .....
[2]

(f) A student complains that the investigation is not a fair comparison.

Suggest one way in which the investigation could be more fair.

.....

.....[1]

[Total: 7]