Thermal Properties and Temperature

Question Paper 5

Level	IGCSE
Subject	Physics
Exam Board	CIE
Topic	Thermal Physics
Sub-Topic	Thermal Properties and Temperature
Paper Type	Alternative to Practical
Booklet	Question Paper 5

Time Allowed: **68 minutes**

Score: **/56**

Percentage: **/100**

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

Fig. 2.1 shows the apparatus.

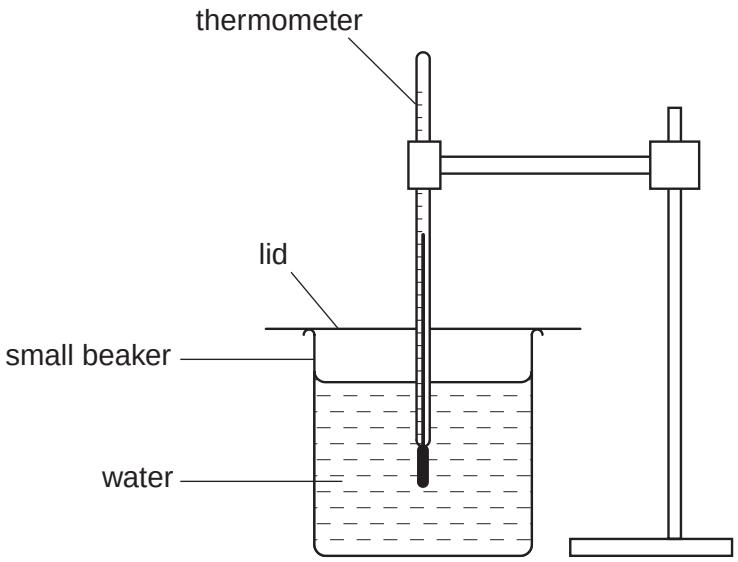


Fig. 2.1

(a) Fig. 2.2 shows a thermometer at room temperature θ_r. Record room temperature θ_r.

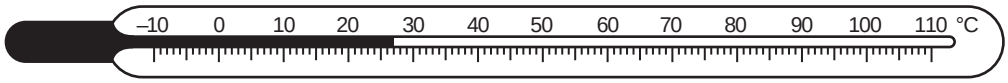


Fig. 2.2

θ_r = ... [1]

(b) A student pours approximately 75 cm^3 of hot water into the small beaker. When the temperature shown on the thermometer stops rising, he records the temperature θ in Table 2.1 at time t = 0 s and immediately starts a stopclock. He records the temperature of the water at 30 s intervals. He then proceeds as follows:

- he empties the water from the beaker;
- he places the empty beaker into a larger beaker;
- he pours fresh hot water into the small beaker;
- he takes a new set of readings, recording them in Table 2.2.

Table 2.1

t/	
0	79
30	79
60	79
90	78
120	77
150	75
180	75

Table 2.2

t/	
0	80
30	80
60	79
90	78
120	77
150	75
180	74

(i) Complete the column headings in both tables.

(ii) State whether the rate of cooling of the water is significantly faster or slower or about the same under the conditions used in Table 2.1 compared with the conditions in Table 2.2. Justify your answer by reference to the readings.

statement .....

justification .....

..... [3]

(c) In order to make this experiment a fair test it is important to control the conditions. Suggest two such conditions that should be controlled.

1. .....

2. ..... [2]

[Total: 6]

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**.

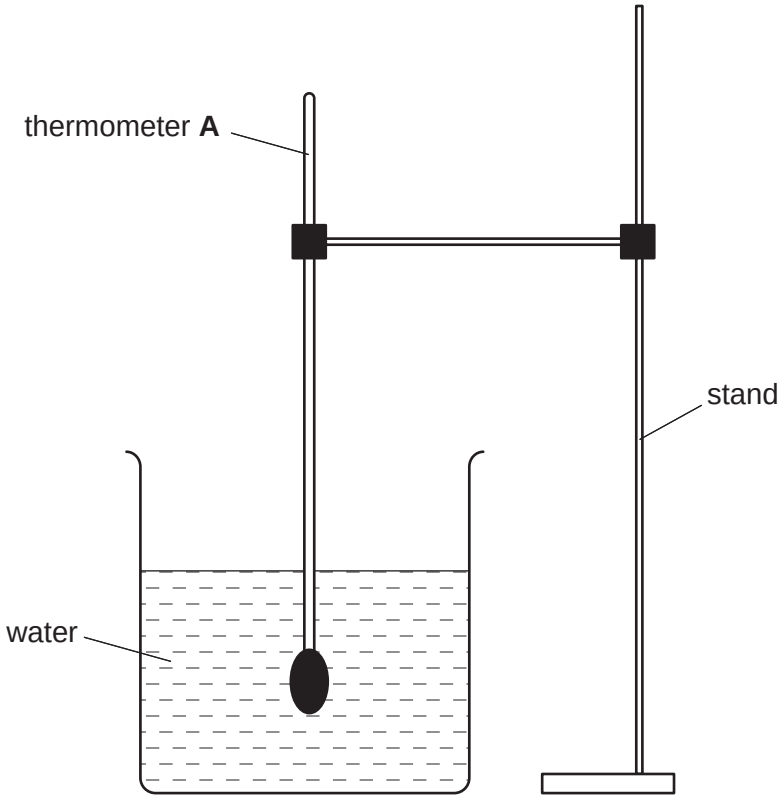
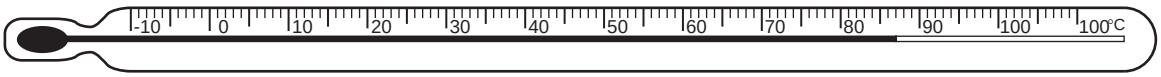


Fig. 2.1

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 An IGCSE student is investigating the cooling of thermometer bulbs under different conditions.

He places a thermometer in a beaker of hot water and records the temperature θ_h of the hot water.

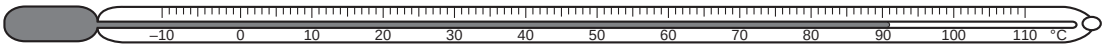


Fig. 2.1

(a) Fig. 2.1 shows the thermometer. Write down the value of θ_h that it shows.

θ_h ..... [1]

He then moves the thermometer until the thermometer bulb is just above the surface of the water (position **A**) and immediately starts a stopclock.

He records the time *t* and the temperature reading θ every 30 s. The readings are shown in Table 2.1.

Table 2.1

	Position A	**Position B**
t /	θ /	θ /
30	65	56
60	58	47
90	54	40
120	52	35
150	50	32
180	48	30

(b) Complete the column headings in the table. [1]

The student replaces the thermometer in the hot water and then moves the thermometer 15 cm away from the beaker to position **B** and immediately starts the stopclock. He records the time *t* and the temperature reading θ every 30 s. The readings are shown in Table 2.1.

(c) State in which position the thermometer bulb cooled more quickly. Justify your answer by reference to the readings.

statement .....

justification .....

..... [1]

(d) To make a fair comparison between the rates of cooling of the thermometer bulbs in the two positions, it is important to control other experimental conditions. Suggest two conditions that should be controlled in this experiment.

1. .....

2. ..... [2]

[Total: 5]

4 The IGCSE class is investigating the change in temperature of hot water as cold water is added to the hot water.

A student measures and records the temperature θ of the hot water before adding any of the cold water available.

He then pours 20 cm^3 of the cold water into the beaker containing the hot water. He measures and records the temperature θ of the mixture of hot and cold water.

He repeats this procedure four times until he has added a total of 100 cm^3 of cold water.

The temperature readings are shown in Table 3.1. V is the volume of cold water added.

Table 3.1

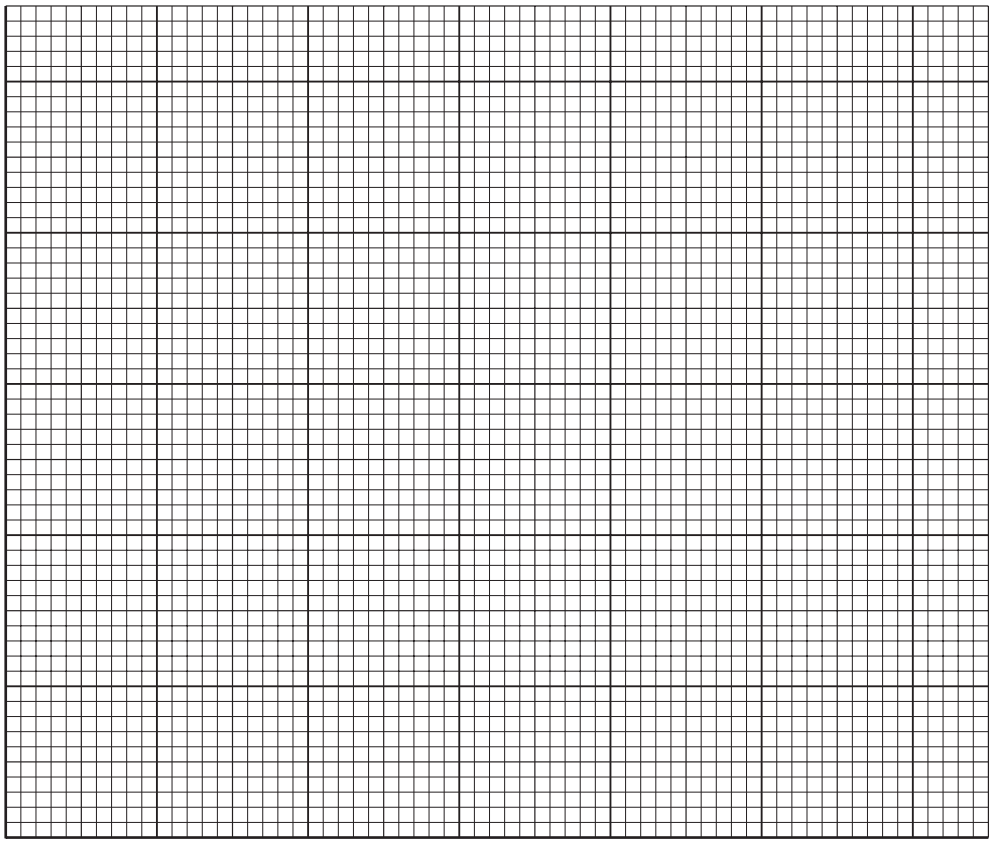
V/	θ/
0	82
	68
	58
	50
	45
	42

(a) (i) Complete the column headings in the table.

(ii) Enter the values for the volume of cold water added.

[2]

(b) Use the data in the table to plot a graph of temperature (*y*-axis) against volume (*x*-axis). Draw the best-fit curve.



[4]

(c) During this experiment, some heat is lost from the hot water to the surroundings. Also, each time the cold water is added, it is added in quite large volumes and at random times.

Suggest two improvements you could make to the procedure to give a graph that more accurately shows the pattern of temperature change of the hot water, due to addition of cold water alone.

1. .....

.....

2. .....

.....[2]

[Total: 8]

5 Some students are comparing the rates of cooling of two thermometer bulbs under wet and dry conditions.

They are using the apparatus shown in Fig. 1.1.

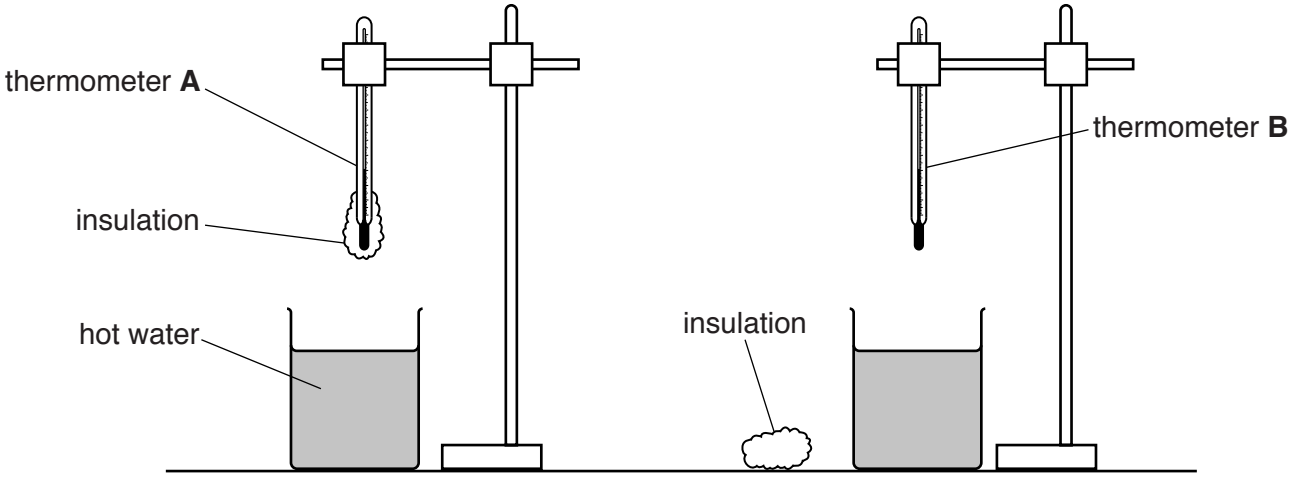


Fig. 1.1

Thermometer **A** has a layer of cotton wool insulation fixed around the bulb.

(a) Record the room temperature θ_R, as shown on the thermometer in Fig. 1.2.

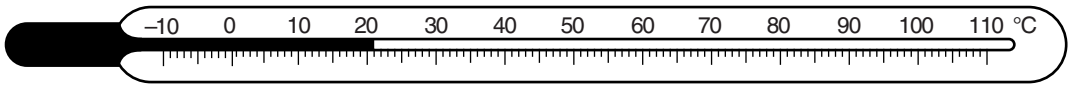


Fig. 1.2

θ_R = ...[1]

(b) • Thermometer **A** is placed into hot water, at 81.0 °C, for two minutes and then removed.

- A student records, in Table 1.1, the temperature θ of the thermometer bulb every 30 s.
- Thermometer **B** is placed into hot water, also at 81.0 °C, for two minutes.
- The student removes thermometer **B** from the water and quickly wraps a layer of dry cotton wool insulation around the bulb.
- He then records the temperature θ of the thermometer bulb every 30 s.

Complete the column headings and time column in Table 1.1.

Table 1.1

	thermometer **A** with wet insulation	thermometer **B** with dry insulation
time /		
0	80.0	77.5
	75.0	70.5
	67.0	64.0
	59.5	59.0
	53.5	54.5
	48.0	50.5
	43.0	47.5

[2]

(c) (i) Write a conclusion to this experiment, stating for which thermometer the cooling is faster. Explain your answer by reference to the results.

.....

.....

.....

.....

.....[2]

(ii) Describe what is unusual about the pattern of cooling for thermometer **A**.

.....

.....

.....[1]

(d) The student first wrapped dry insulation around the bulb of thermometer **B** before starting the timing.

(i) Suggest why he did this.

.....

.....

.....[1]

(ii) Suggest what problem this delay in starting the timing might have caused with the procedure.

.....

.....

.....[1]

(e) Suggest two factors which should be kept constant to ensure that the comparison is fair.

1. .....

.....

2. .....

.....

[2]

[Total: 10]

6 A student is investigating the transfer of thermal energy.

He uses the apparatus shown in Fig. 1.1.

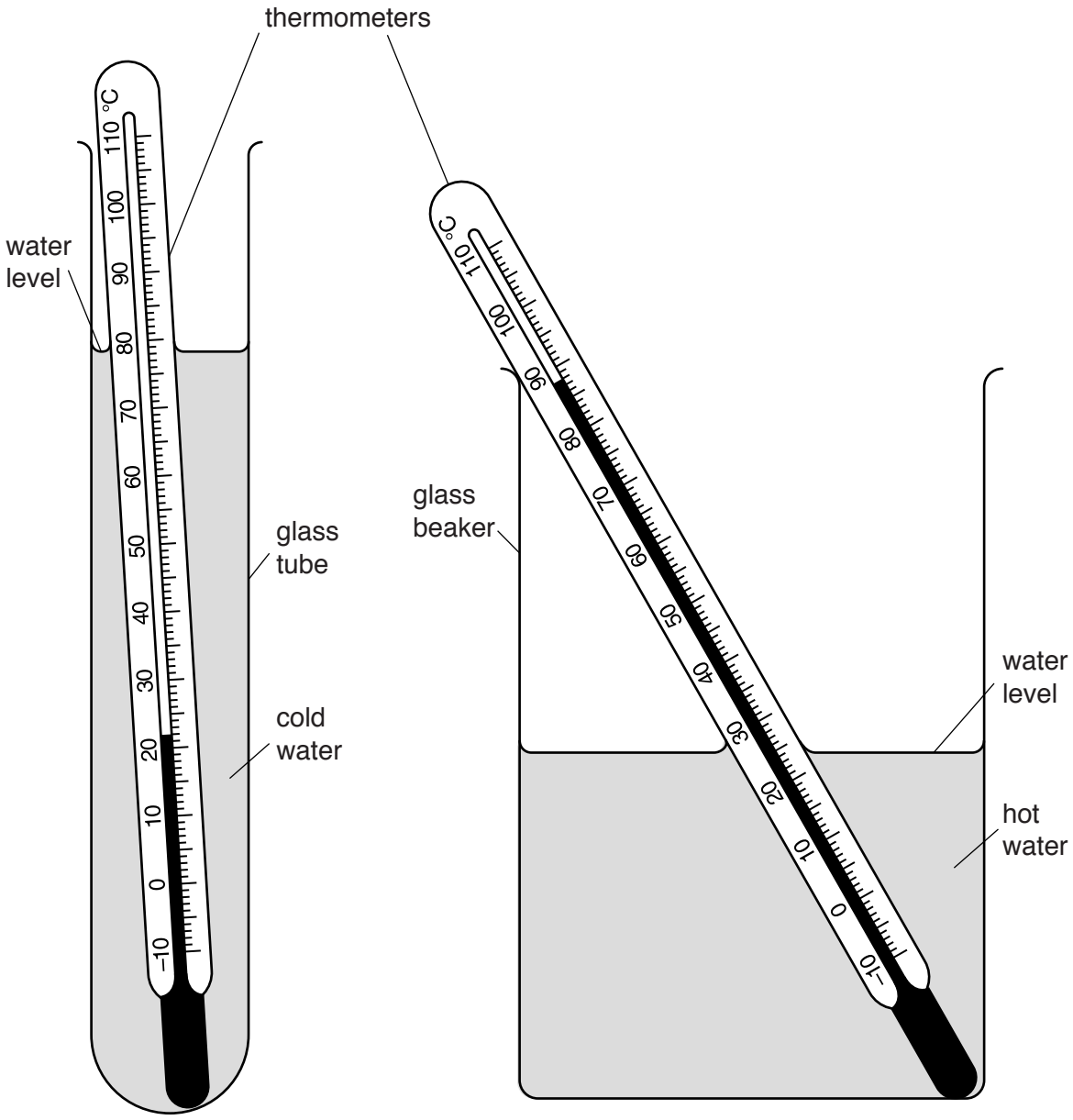


Fig. 1.1

(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]

7 The IGCSE class is investigating the cooling of a thermometer bulb under different conditions.

A student places a thermometer in a beaker of hot water, as shown in Fig. 3.1.

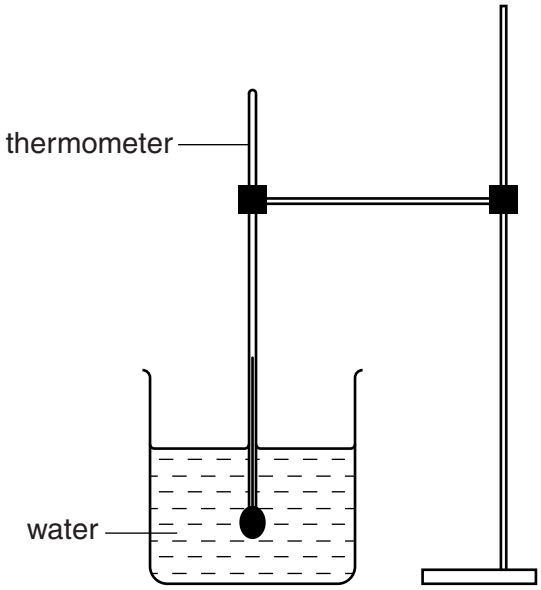


Fig. 3.1

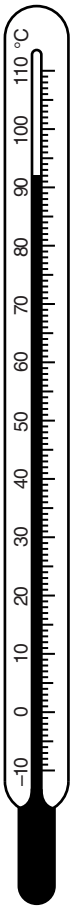


Fig. 3.2

(a) Write down the temperature θ_H of the hot water, as shown on the thermometer in Fig. 3.2.

θ_H ..... [1]

(b) The student removes the thermometer from the beaker of water. He immediately starts a stopclock. He records the temperature θ every 30 s. The readings are shown in Table 3.1.

Table 3.1

	without insulation	with insulation
t/		
30	78	84
60	71	79
90	67	76
120	65	74
150	63	73

He replaces the thermometer in the beaker of hot water and records its temperature.

θ_H ..... 90 °C

He removes the thermometer from the beaker of hot water and places it in a beaker containing only dry cotton wool. The thermometer bulb is completely surrounded by cotton wool. He immediately starts a stopclock, and records the temperature θ every 30 s. The readings are shown in Table 3.1.

(i) Complete the column headings in the table. [1]

(ii) State whether the cotton wool insulation increases, decreases, or has no significant effect on the rate of cooling of the thermometer bulb, compared with the rate of cooling with no insulation. Justify your answer by reference to the results.

statement .....

justification .....

.....

[2]

(c) Suggest two conditions that should be kept constant when this experiment is repeated.

1. .....

.....

2. .....

.....

[2]

[Total: 6]

8 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.

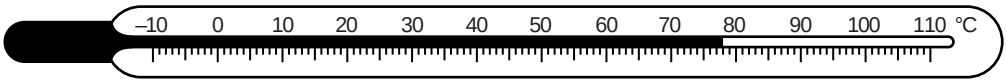


Fig. 2.1

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.

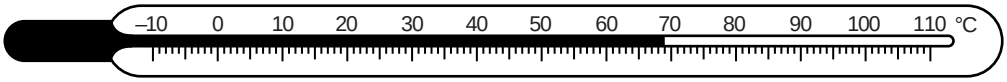


Fig. 2.2

(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.

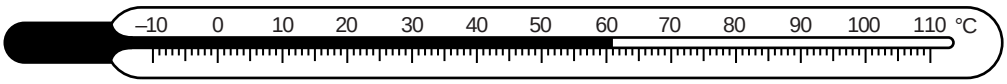


Fig. 2.3

(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]