

Thermal Properties and Temperature

Question Paper 3

Level	IGCSE
Subject	Physics
Exam Board	CIE
Topic	Thermal Physics
Sub-Topic	Thermal Properties and Temperature
Paper Type	Alternative to Practical
Booklet	Question Paper 3

Time Allowed: 62 minutes

Score: /51

Percentage: /100

1 Some IGCSE students are investigating the cooling of water.

Fig. 1.1 shows how the apparatus is set up.

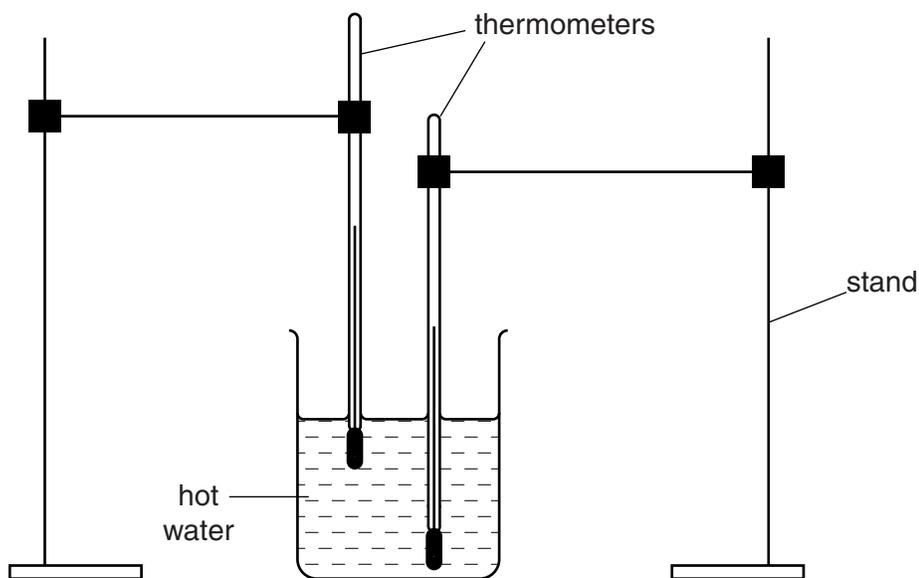


Fig. 1.1

(a) A thermometer is placed on the bench so that room temperature can be measured.

Read and record room temperature θ_R as shown on the thermometer in Fig. 1.2.

$\theta_R = \dots\dots\dots$ [1]

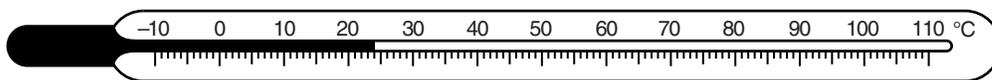


Fig. 1.2

(b) A student pours hot water into the beaker so that the level is as shown in Fig. 1.1.

In Table 1.1, he then records the temperatures θ every minute as the water cools until time $t = 6$ minutes.

Complete the column headings and complete the time column in Table 1.1. [2]

Table 1.1

	thermometer bulb near the bottom of the beaker	thermometer bulb near the surface of the water
$t /$	$\theta /$	$\theta /$
0	82.0	76.0
	79.5	74.0
	77.0	72.0
	75.0	70.0
	73.0	68.0
	70.5	66.0
	69.0	64.5

- (c) State in which position of the thermometer bulb the average rate of cooling is the greater.

Justify your answer by referring to the results.

position

justification

.....

[2]

- (d) What precaution do the results suggest should be taken when measuring the temperature of a liquid?

Explain how the results show that this is a sensible precaution.

precaution

.....

explanation

.....

[2]

- (e) A student in a different school wants to repeat the experiment in order to check the results.

Suggest two experimental conditions which should be kept the same.

1.

.....

2.

.....

[2]

[Total: 9]

2 An IGCSE student is investigating the cooling of a thermometer bulb.

The apparatus used is shown in Figs. 2.1, 2.2 and 2.3.

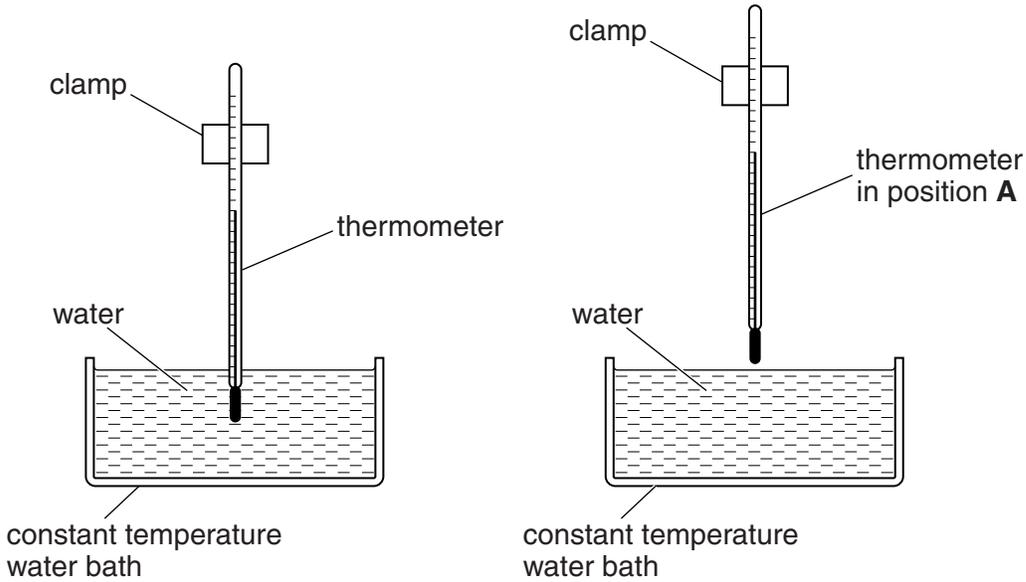


Fig. 2.1

Fig. 2.2

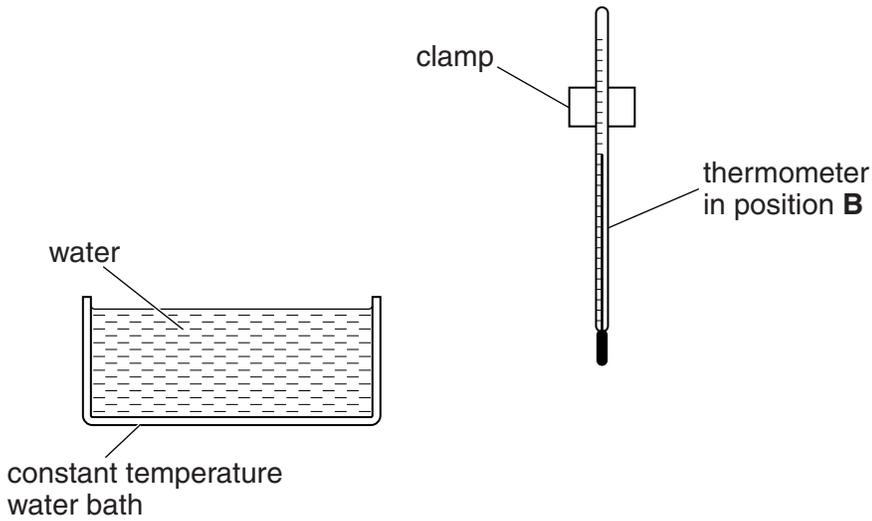


Fig. 2.3

(a) The student places the thermometer in the water bath, as shown in Fig. 2.1.

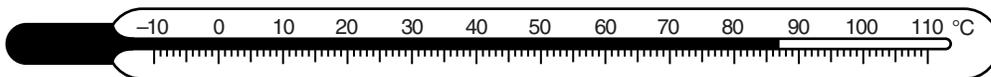


Fig. 2.4

Write down the temperature θ_H of the water bath, shown on the thermometer in Fig. 2.4.

$\theta_H = \dots\dots\dots$ [1]

- (b) The student moves the thermometer until the thermometer bulb is in position **A** above the surface of the water, as shown in Fig. 2.2. She starts a stopclock. She records the time and temperature readings every 30 s.

She replaces the thermometer in the water bath, still at temperature θ_H .

She then moves the thermometer to position **B**, as shown in Fig. 2.3. She records the time and temperature readings every 30 s.

All the readings are shown in Table 2.1.

Table 2.1

	position A	position B
$t/$		
30	79	66
60	74	42
90	70	29
120	66	27
150	61	26
180	56	26

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

- (ii) State in which position, **A** or **B**, the thermometer has the greater rate of cooling in the first 30 s.

position

- (iii) Explain briefly how you reached this conclusion.

.....

 [1]

- (iv) Calculate the temperature difference from 30 s to 180 s for each set of readings.

temperature difference for position **A** =

temperature difference for position **B** =

[1]

- (v) Estimate room temperature θ_R .

$\theta_R = \dots\dots\dots$ [1]

(c) Describe briefly a precaution you would take to make the temperature readings reliable.

.....
..... [1]

(d) A scientist is using this experiment as part of research into convection currents above hot water.

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

1.
2. [2]

[Total: 8]

- 3 Two IGCSE students are investigating the melting of ice cubes in water.

They are dropping ice cubes into hot water at different temperatures and measuring the time taken for the cubes to melt.

This is a page from one student's notebook.

temperature 20°C – time 216 seconds

temperature 40 – time 95 sec

temperature 60°C – time 72 seconds

temperature 30 – time 180

temperature 50 – time 108 seconds

- (a) In the space below, draw a suitable table. Enter the readings in such a way that it is easier to see a pattern from them.

[2]

(b) It appears that one of the readings does not fit the general pattern.

(i) At which temperature does this occur?

temperature [1]

(ii) Suggest what the student might do next with the data to show more clearly that this reading does not fit the general pattern.

Explain how this would help to make it more clear.

suggestion

.....

explanation

.....

[2]

[Total: 5]

4 The IGCSE class is investigating the heating of a thermometer bulb.

The apparatus is shown in Figs. 2.1, 2.2 and 2.3.

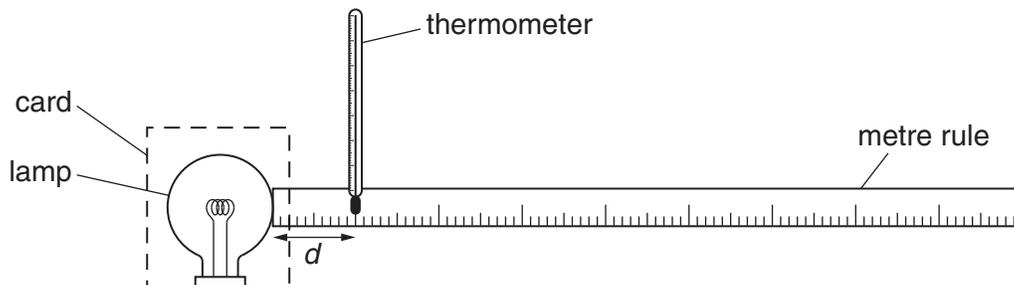


Fig. 2.1

(a) Record the value of room temperature θ_R shown on the thermometer.

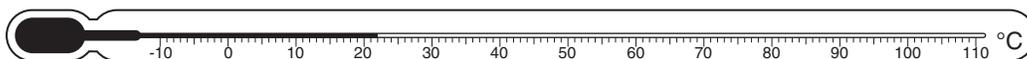


Fig. 2.2

$\theta_R = \dots\dots\dots$ [1]

(b) A student switches on the lamp and places the thermometer so that its bulb is a horizontal distance $d = 100$ mm from the surface of the lamp, as shown in Fig. 2.1. She records the distance d between the thermometer bulb and the surface of the lamp. She also records the temperature θ shown on the thermometer. She repeats the procedure using values of d of 80 mm, 60 mm, 40 mm, 20 mm and 10 mm. The temperature readings are shown in Table 2.1.

- (i) Record the d values in the table.
- (ii) Complete the column headings in the table.

Table 2.1

$d/$	$\theta/$
	52
	56
	61
	67
	75
	86

- (c) The student moves the thermometer away from the lamp and waits for about a minute for the thermometer to cool. She places the thermometer so that its bulb is a vertical distance $d_V = 100\text{ mm}$ from the top surface of the lamp, as shown in Fig. 2.3.

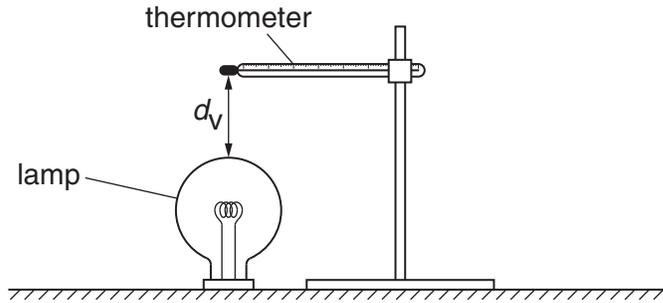


Fig. 2.3

She records the temperature θ_V shown on the thermometer: $\theta_V = 55^\circ\text{C}$.

Calculate the difference between θ_V and the thermometer reading θ_H at a horizontal distance of 100 mm from the lamp. State whether θ_V is higher, lower or the same as θ_H .

temperature difference =

θ_V is [1]

- (d) A student suggests that θ_V will be higher than the thermometer reading θ_H because thermal energy will travel by infra-red radiation and convection to the thermometer bulb above the lamp but by infra-red radiation only when the bulb is to one side of the lamp.

If the experiment were to be repeated in order to investigate this suggestion it would be important to control the conditions. Suggest two such conditions, relevant to this investigation, that should be controlled.

1.

2.

[2]

- (e) Briefly describe a precaution that you would take in this experiment in order to obtain a reliable result.

.....

[1]

[Total: 7]

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

Fig. 2.1 shows the apparatus.

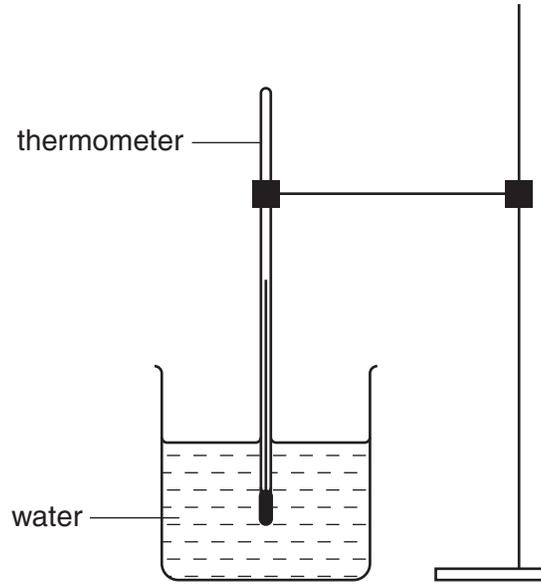
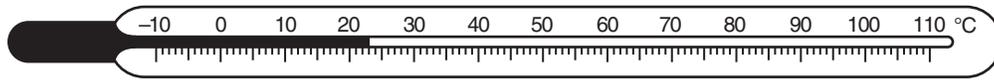


Fig. 2.1

(a) Record the value of room temperature θ_R shown on the thermometer.



$\theta_R = \dots\dots\dots$ [1]

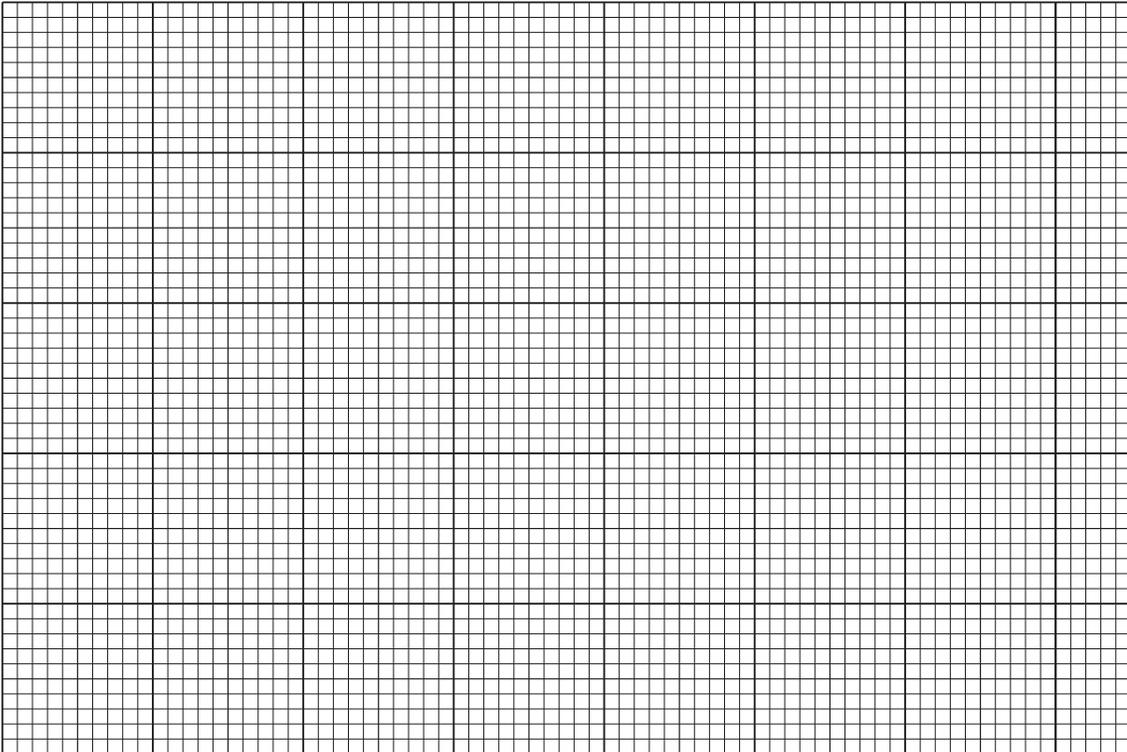
(b) A student pours approximately 200 cm^3 of hot water into the beaker. She measures the temperature θ of the water. She starts a stopclock and records the temperature θ of the water at 30 s intervals up to time $t = 150\text{ s}$. The readings are shown in Table 2.1.

Table 2.1

t/s	$\theta/^\circ\text{C}$
0	86
30	75
60	67
90	61
120	56
150	52

5

Plot a graph of $\theta/^\circ\text{C}$ (y -axis) against t/s (x -axis).



[5]

(c) As you read these words, this experiment is actually being carried out by candidates in many different countries, using identical apparatus.

Suggest two differences in the conditions in the various laboratories that might lead to different graphs.

1.

2.

[2]

[Total: 8]

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

The apparatus is shown in Fig. 2.1.

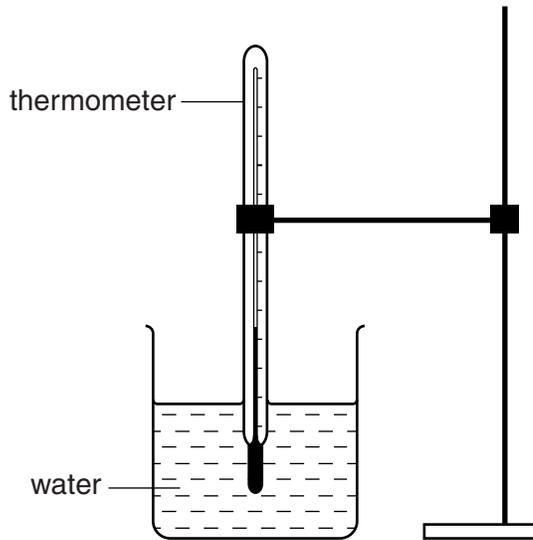


Fig. 2.1



Fig. 2.2

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

$\theta_R = \dots\dots\dots$ [1]

- (b) A student pours 150 cm^3 of hot water into a beaker. She measures the temperature θ of the water at time $t = 0$ and records it in a table.

She starts a stopclock and records the temperature of the water at 30s intervals until she has a total of six values up to time $t = 150\text{ s}$. The readings are shown in Table 2.1.

She repeats the procedure, using 250 cm^3 of hot water.

Table 2.1

	volume of water	
	150 cm^3	250 cm^3
$t/$	$\theta/$	$\theta/$
0	84	85
30	79	79
60	74	75
90	70	72
120	68	70
150	66	68

- (i) Complete the column headings in the table. [1]
- (ii) State whether the rate of cooling is significantly faster, slower, or about the same when using the larger volume of hot water. Justify your answer by reference to the readings.

statement

justification

.....

.....

[2]

- (c) If this experiment were to be repeated in order to check the results, it would be important to control the conditions. Suggest two such conditions that should be controlled.

1.

2.

[2]

[Total: 6]

7 An IGCSE class is investigating the rate of cooling of water.

The apparatus is shown in Fig. 2.1.

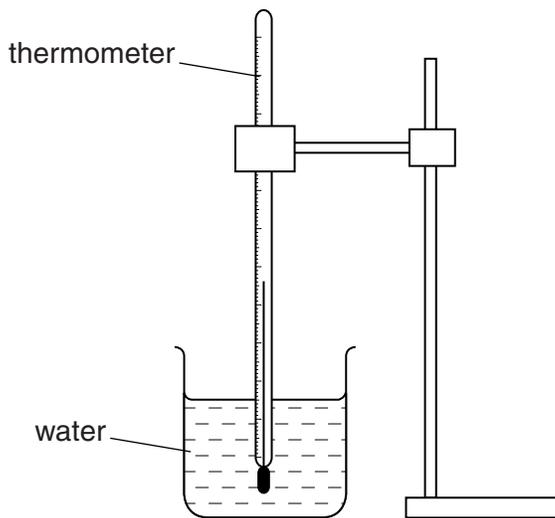


Fig. 2.1



Fig. 2.2

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

$$\theta_R = \dots\dots\dots [2]$$

(b) A student pours 200cm^3 of hot water into a beaker. She records the temperature θ_0 of the water.

$$\theta_0 = \dots\dots\dots 86^\circ\text{C} \dots\dots\dots$$

She starts a stopclock and records the temperature θ_1 of the water at time $t = 100\text{s}$.

$$\theta_1 = \dots\dots\dots 72^\circ\text{C} \dots\dots\dots$$

(i) Calculate the temperature difference θ_A between θ_0 and room temperature θ_R using the equation $\theta_A = (\theta_0 - \theta_R)$.

$$\theta_A = \dots\dots\dots$$

(ii) Calculate the temperature fall θ_H of the hot water using the equation $\theta_H = (\theta_0 - \theta_1)$.

$$\theta_H = \dots\dots\dots$$

- (c) The student empties the beaker. She pours 100 cm^3 of hot water into the beaker, adds 100 cm^3 of cold water to the beaker, and stirs.

She records the temperature θ_2 of the warm water.

$$\theta_2 = \dots\dots\dots 59^\circ\text{C}$$

She starts the stopclock and records the temperature θ_3 of the water at time $t = 100\text{ s}$.

$$\theta_3 = \dots\dots\dots 44^\circ\text{C}$$

- (i) Calculate the temperature difference θ_B between θ_2 and room temperature θ_R using the equation $\theta_B = (\theta_2 - \theta_R)$.

$$\theta_B = \dots\dots\dots$$

- (ii) Calculate the temperature fall θ_W of the warm water using the equation $\theta_W = (\theta_2 - \theta_3)$.

$$\theta_W = \dots\dots\dots$$

[1]

- (d) The student suggests that the rate of temperature change is proportional to the difference between the starting temperature and room temperature. This can be expressed as

$$\frac{\theta_A}{\theta_H} = \frac{\theta_B}{\theta_W}$$

State whether the results support this suggestion and justify your answer with reference to the results.

statement

justification

[2]

- (e) If this experiment were to be repeated in order to check results, it would be important to control the conditions.

Suggest two such conditions that should be controlled.

1.

2.

[2]

[Total: 8]