Thermal Properties and Temperature

Question Paper 4

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

Time Allowed: **59 minutes**

Score: **/49**

Percentage: **/100**

1 The IGCSE class is investigating temperature changes when cold water and hot water are mixed.

(a) A student records the temperature θ_c of 100 cm^3 of cold water and the temperature θ_h of 100 cm^3 of hot water.

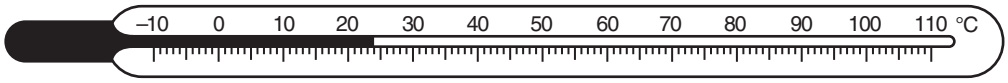


Fig. 2.1

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

θ_c = ... [2]

(b) The hot water is at a temperature θ_h = 86 °C.

Calculate θ_{av}, the average of θ_c and θ_h.

average θ_{av} = ... [1]

(c) The student adds 100 cm^3 of the hot water to the cold water. She records the temperature θ_m of the mixture of hot and cold water, θ_m = 48 °C.

State two precautions (other than repeating the experiment) that the student could take to ensure the reliability of her value of the temperature θ_m.

1. .....

2. .....
[2]

(d) Suggest a practical reason in this experiment for the temperature of the mixture θ_m being different from the average value θ_{av}, even when the student has taken the precautions you suggested in **(c)**.

.....

.....[1]

(e) Suggest a modification to the experiment which should reduce the difference between θ_m and θ_{av}.

.....

.....[1]

(f) The student decides to repeat the experiment to check the readings. Suggest one possible variable that she should keep constant.

.....[1]

[Total: 8]

2 An IGCSE student is investigating temperature changes when hot water and cold water are mixed.

She is provided with a supply of hot water and a supply of cold water.

(a) The temperature θ_c of the cold water is 24 °C.

She pours 100 cm^3 of the hot water into a beaker. Record the temperature θ_h of this water, as shown on the thermometer.

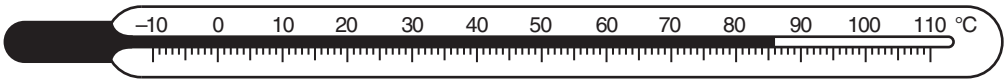


Fig. 2.1

θ_h = ... [1]

(b) She adds 10 cm^3 of the cold water to the beaker of hot water. She briefly stirs the mixture of hot and cold water and records in Table 2.1 the temperature θ_m of the mixture of hot and cold water. She quickly repeats this five times, adding 10 cm^3 of cold water each time, until a total of 60 cm^3 has been added. She records the temperature θ_m of the mixture of hot and cold water at each stage.

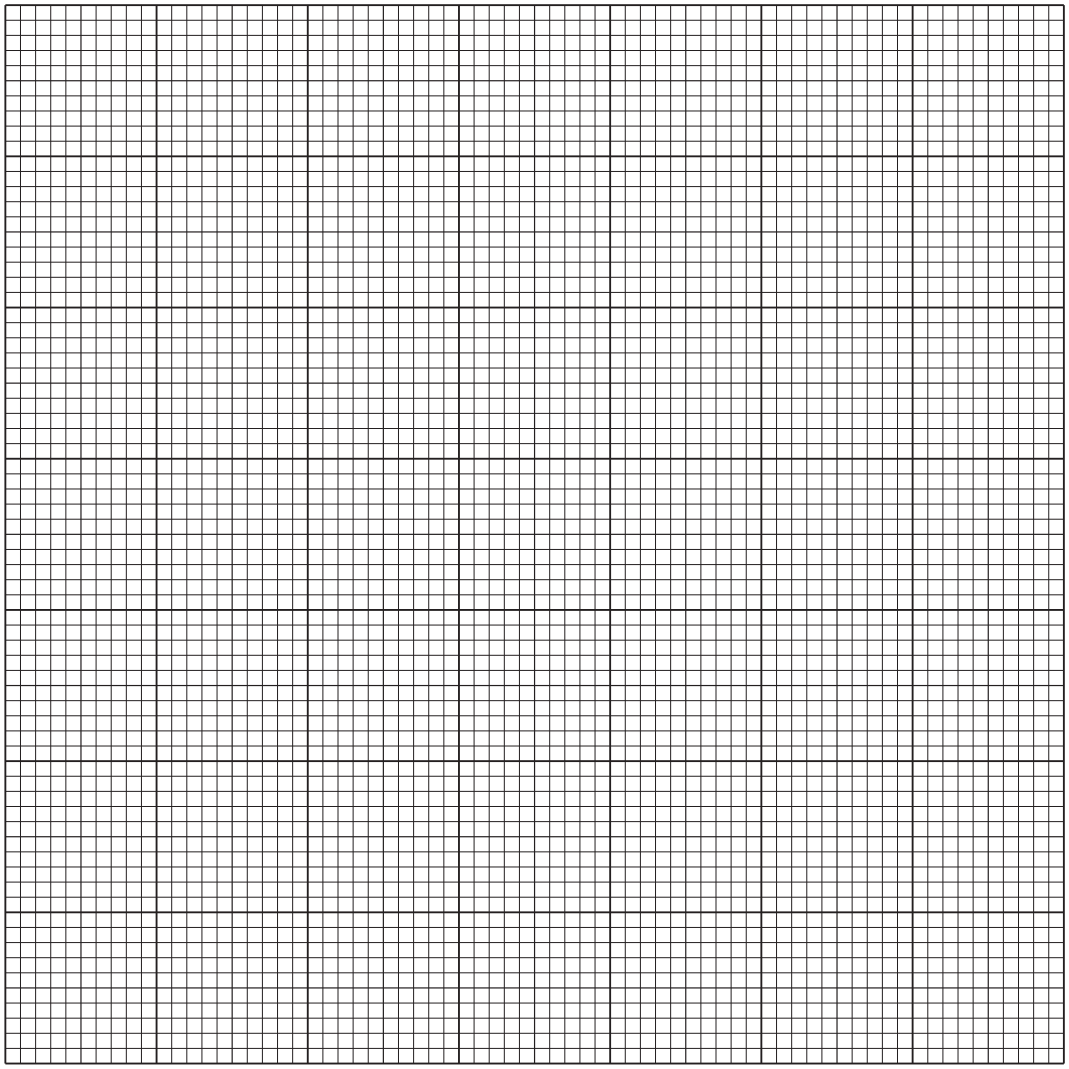
Table 2.1

V/	θ_m/
	78
	74
	68
	63
	61
	59

(i) Complete the volume column in the table, where *V* is the total volume of cold water so far added.

(ii) Complete the column headings in the table. [2]

(c) Plot the graph of temperature θ (y-axis) against volume V (x-axis).



[4]

(d) 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]

(e) Suggest a practical precaution that will enable readings in this experiment to be taken as accurately as possible.

.....

.....[1]

[Total: 10]

3 An IGCSE student is investigating the energy changes that occur when hot water and cold water are mixed.

The student is provided with a supply of hot water and a supply of cold water.

The temperature of the cold water $\theta_c = 23\,°C$.

(a) The temperature of the hot water is shown in Fig. 2.1.

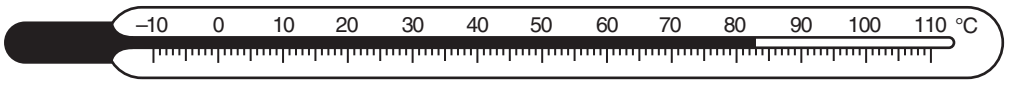


Fig. 2.1

Record the temperature θ_h of this hot water.

θ_h = ... [1]

(b) The student pours 50 cm^3 of the hot water into 50 cm^3 of the cold water. He briefly stirs the mixture and then records the temperature θ_m of the mixture, $\theta_m = 49\,°C$.

(i) Calculate the gain in thermal energy E_c of the cold water using the equation

$$E_c = k(\theta_m - \theta_c),$$

where $k = 210\,J/°C$.

E_c = ...

(ii) Calculate the loss in thermal energy E_h of the hot water using the equation

$$E_h = k(\theta_h - \theta_m),$$

where $k = 210\,J/°C$.

E_h = ...
[2]

(c) The student suggests that all the thermal energy lost by the hot water is gained by the cold. Thus E_c and E_h should be equal.

(i) State whether the experimental results support this suggestion. Justify your statement by reference to the results.

statement .....

justification .....

.....

.....[1]

(ii) Suggest a practical reason in this experiment why E_c might be different from E_h.

.....

.....[1]

(d) Another student is asked to suggest quantities that should be kept constant if this experiment is repeated in order to check the readings. Table 2.1 shows the suggestions.

Place a tick (✓) in the second column of the table next to each correctly suggested quantity.

Table 2.1

suggested quantities	
avoid parallax (line of sight) errors when taking readings	
number of stirs	
room temperature	
starting temperature of hot water	
use a digital thermometer	
use only two or three significant figures for the final answers	

[2]

[Total: 7]

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

The apparatus used is shown in Fig. 2.1.

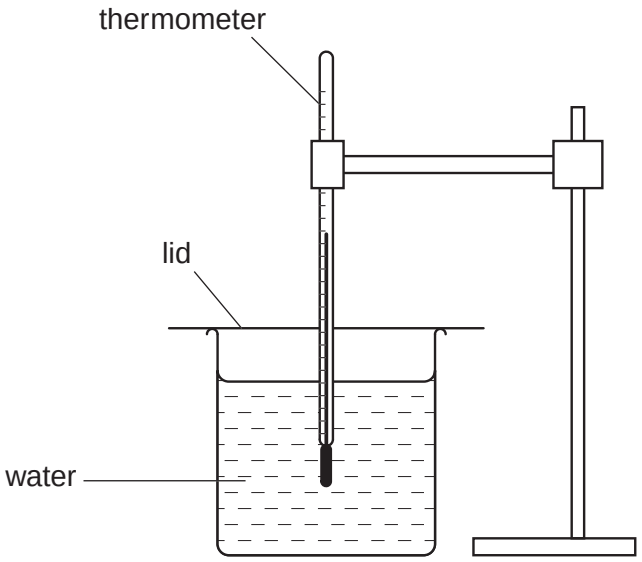
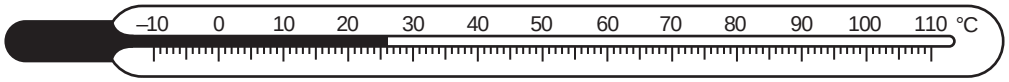


Fig. 2.1

(a) Record the room temperature θ_r shown on the thermometer.



θ_r = ... [1]

(b) For the cooling experiment, a student places the thermometer into hot water as shown in Fig. 2.1. When the temperature shown on the thermometer stops rising, she records the temperature θ at time t = 0 s. She removes the thermometer from the water, immediately starts a stopclock, and records the temperature shown on the thermometer at 30 s intervals. The readings are shown in Table 2.1.

For the heating experiment, the student takes another thermometer and records the temperature θ shown on the thermometer at time t = 0 s. She places the thermometer in the beaker of hot water, immediately starts the stopclock, and records the temperature shown by the thermometer at 10 s intervals. The readings are shown in Table 2.2.

Table 2.1

t/	
0	74
30	60
60	52
90	45
120	39
150	35
180	33

Table 2.2

t/	
0	25
10	69
20	80
30	81
40	81
50	82
60	82

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

(ii) Estimate the time that would be taken in the cooling experiment for the thermometer to cool from the reading at time t = 0 s to room temperature θ_r.

estimated time = ... [1]

(c) State in which table the initial rate of temperature change is the greater. Justify your answer by reference to your readings.

The initial rate of temperature change is greater in Table .....

justification .....

..... [1]

(d) If one of these experiments were to be repeated in order to determine an average temperature for each time, it would be important to control the conditions. Suggest two such conditions that should be controlled.

1. .....

2. ..... [2]

[Total: 6]

5 The IGCSE class is investigating the time taken for ice cubes to melt when placed in water.

Each student is able to use
glass beakers,
a thermometer,
a stopclock,
a measuring cylinder,
an electronic balance,
a supply of ice cubes of different sizes,
a supply of cold water,
a stirrer,
a method of heating the water
and any other common laboratory apparatus that may be useful.

A student decides to investigate the effect of the mass of ice cubes on the time they take to melt in water.

(a) Suggest three possible variables that should be kept constant in this investigation.

1. .....

2. .....

3. .....[3]

(b) In the table below, write the names of three items of apparatus that are necessary in order to take readings in this investigation. In the second column of the table write the quantity that the item measures.

item of apparatus	quantity measured

[3]

[Total: 6]

6 The IGCSE class is investigating the rate of cooling and the rate of heating of a thermometer bulb.

The set-up is shown in Fig. 2.1 and Fig. 2.2.

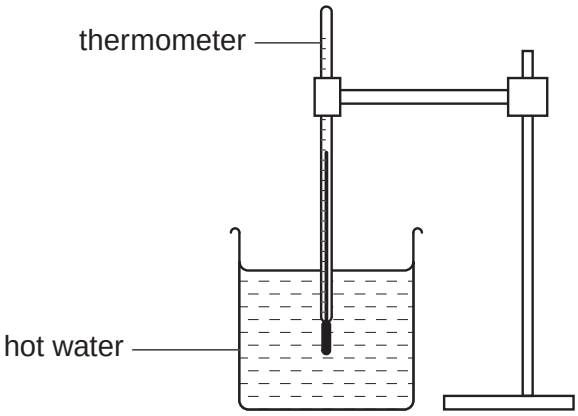


Fig. 2.1

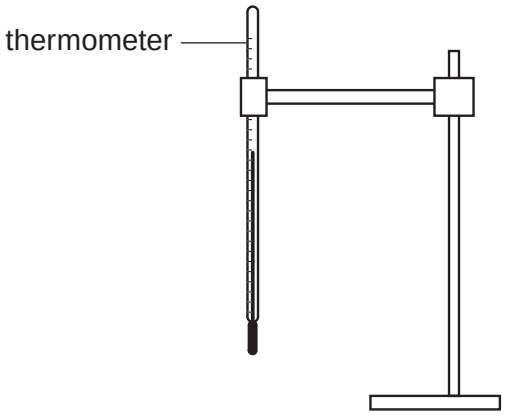


Fig. 2.2

A student places a thermometer in a beaker of hot water. When the reading on the thermometer is steady, she records the temperature reading θ in Table 2.1 at time $t = 0$.

She immediately removes the thermometer from the water and starts a stopclock. As the thermometer cools, she records the thermometer reading every 30 s, as shown in Table 2.1.

At time $t = 210$ s, she records the thermometer reading and immediately puts the thermometer back in the hot water. As the thermometer heats up, she records the time and thermometer reading every 30 s for 180 s, as shown in Table 2.2.

Table 2.1

t /	θ /
0	82
30	74
60	66
90	63
120	57
150	55
180	52

Table 2.2

t /	θ /
210	50
240	66
270	75
300	77
330	78
360	78
390	78

(a) Complete the column headings in both tables. [1]

(b) Calculate the change in the thermometer reading θ_c in the first 90 s whilst the thermometer cools.

θ_c = ... [1]

(c) Suggest a conclusion about the initial rate of cooling of the thermometer bulb compared with the initial rate of heating. Justify your conclusion by reference to Tables 2.1 and 2.2.

conclusion .....

justification .....

.....[2]

(d) When repeating this experiment in order to check the results, it is important to control the conditions. Suggest two such conditions that should be controlled.

1. .....

2. .....[2]

[Total: 6]

7 The IGCSE class is investigating the rate at which salt dissolves in water.

Each student is able to use
- glass beakers,
- a thermometer,
- a stopclock,
- a measuring cylinder,
- an electronic balance,
- a supply of salt,
- a supply of cold water,
- a stirrer,
- a method of heating the water

and any other common laboratory apparatus that may be useful.

A student decides to investigate the effect of temperature on the rate at which salt dissolves in water by observing the time taken for small amounts of salt to dissolve in water at different temperatures.

(a) Suggest three possible variables that should be kept constant in this investigation.

1. .....

2. .....

3. .....[3]

(b) In the table below, write the names of three items of apparatus that are necessary in order to take the readings in this investigation. In the second column of the table write the quantity that the item measures.

item of apparatus	quantity measured

[3]

[Total: 6]