Simple Kinetic Molecular Model of Mater

Question Paper 4

Level	IGCSE
Subject	Physics
Exam Board	CIE
Topic	Thermal Physics
Sub-Topic	Simple Kinetic Molecular Model of Matter
Paper Type	Alternative to Practical
Booklet	Question Paper 4

Time Allowed: 56 minutes

Score: /46

Percentage: /100

1 The IGCSE class is investigating the heating of a thermometer bulb.
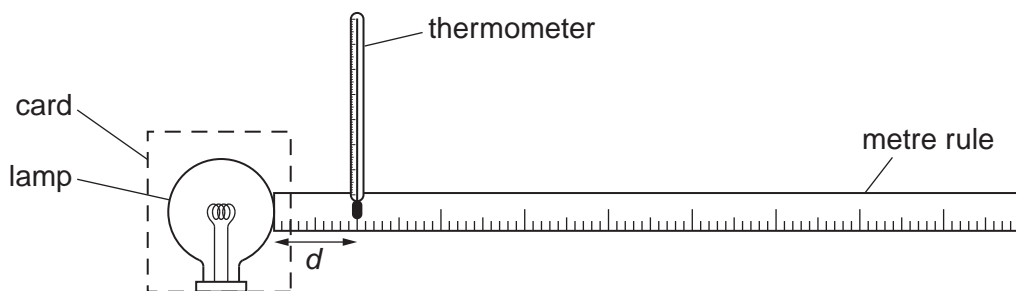
The apparatus is shown in Figs. 2.1, 2.2 and 2.3.

Fig. 2.1

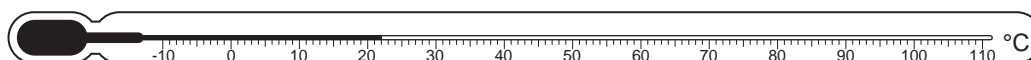**(a)** Record the value of room temperature θ_R shown on the thermometer.

Fig. 2.2

θ_R = ... [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/	θ/
	52
	56
	61
	67
	75
	86

[2]

(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 mm from the top surface of the lamp, as shown in Fig. 2.3.
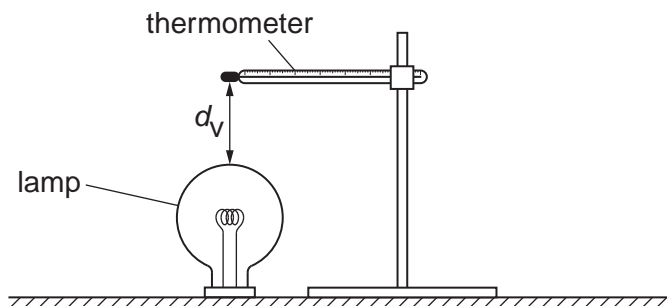

Fig. 2.3

She records the temperature θ_V shown on the thermometer: θ_V = 55 °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]

2   The IGCSE class is investigating the rate of cooling of water.
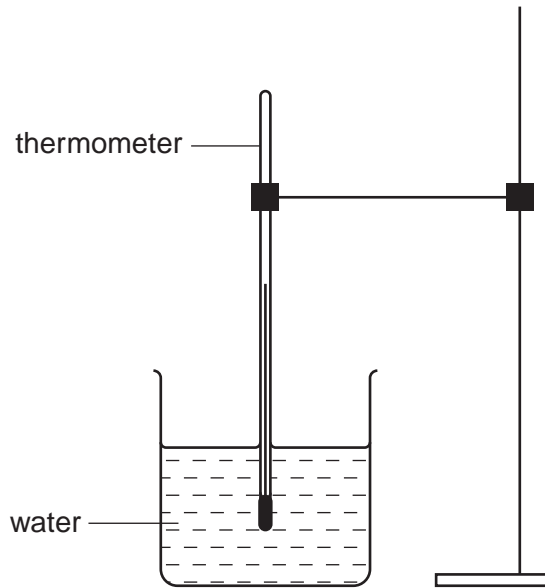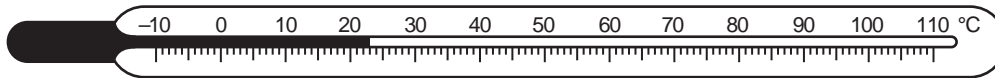
Fig. 2.1 shows the apparatus.

Fig. 2.1

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

θ_R = ...[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 s. The readings are shown in Table 2.1.

Table 2.1

$t/$s	$\theta/$°C
0	86
30	75
60	67
90	61
120	56
150	52

Plot a graph of $\theta/^{\circ}C$ (y-axis) against t/s (x-axis).
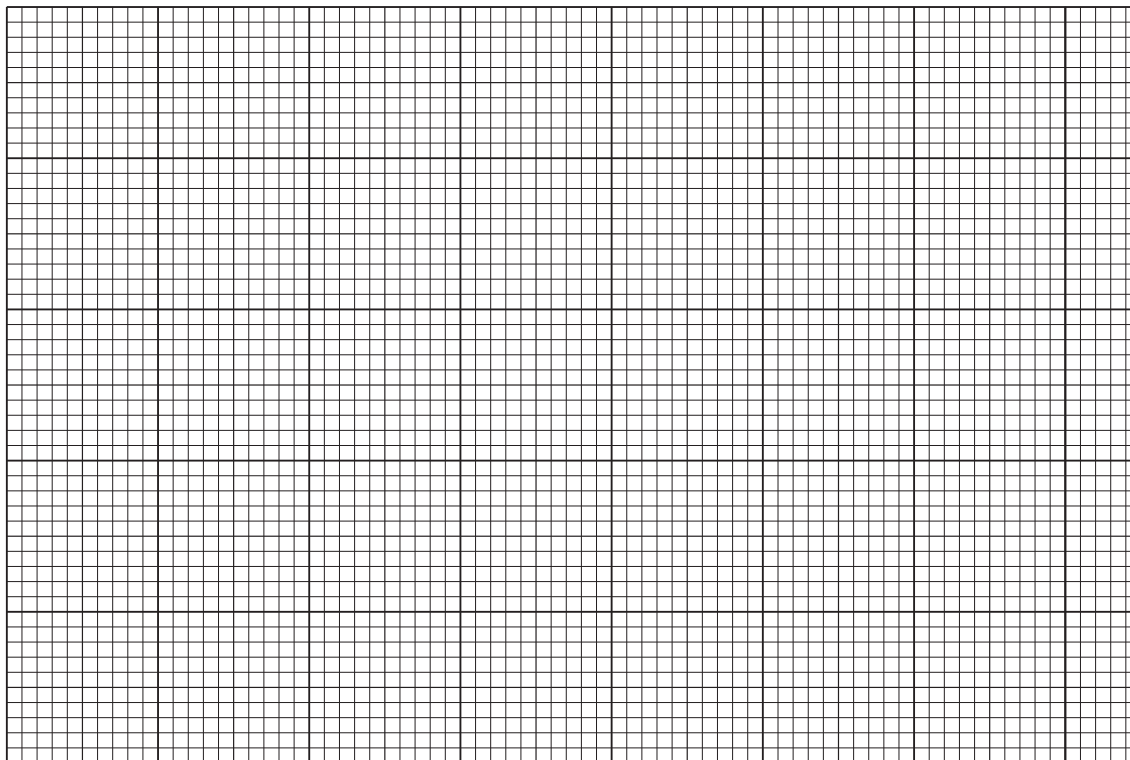
[5]

(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]

3 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.
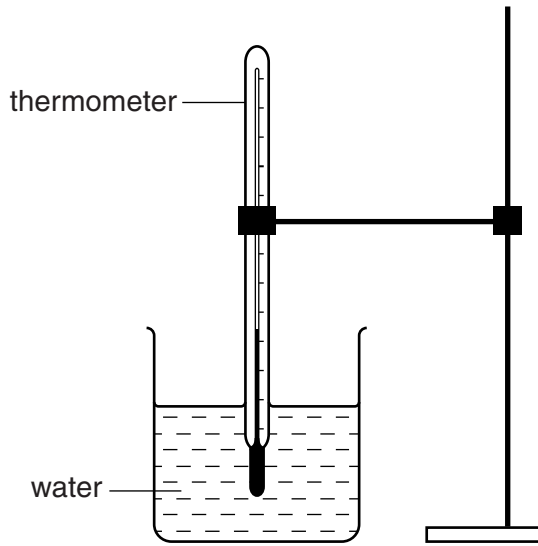
$$\theta_R = \text{..}[1]$$

(b) A student pours 150 cm³ 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 30 s intervals until she has a total of six values up to time $t = 150$ s. The readings are shown in Table 2.1.

She repeats the procedure, using 250 cm³ of hot water.

Table 2.1

	volume of water	
	150 cm³	250 cm³
$t/$	$\theta/$	$\theta/$
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]

4 An IGCSE class is investigating the rate of cooling of water.
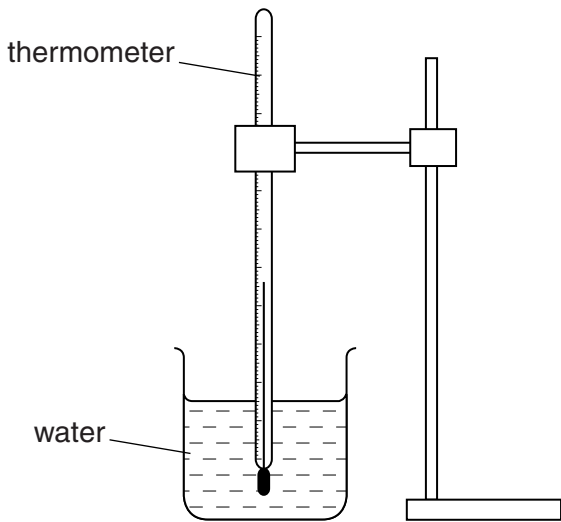
The apparatus is shown in Fig. 2.1.

Fig. 2.1   **Fig. 2.2**

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

θ_R = ...[2]

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

θ_0 = ... 86 °C ....

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

θ_1 = ... 72 °C ....

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

θ_A = ...

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

θ_H = ...
[1]

(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.

$$\theta_2 = \text{.................................} 59\,°C \text{....................................}$$

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

$$\theta_3 = \text{.................................} 44\,°C \text{....................................}$$

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

$$\theta_B = \text{..}$$

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

$$\theta_W = \text{..}$$
$$[1]$$

(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 $\dfrac{\theta_A}{\theta_H} = \dfrac{\theta_B}{\theta_W}$.

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. ....
$$[2]$$

$$[\text{Total: 8}]$$

5 The IGCSE class is investigating the rate of heating and cooling of a thermometer bulb.
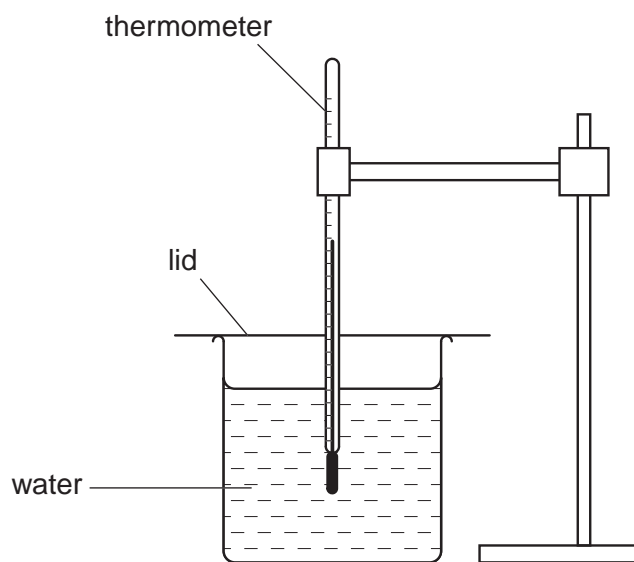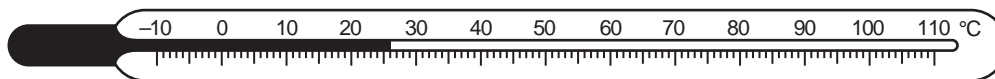
The apparatus used is shown in Fig. 2.1.

Fig. 2.1

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

$$\theta_r = \text{...} \ [1]$$

(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]

6 The IGCSE class is investigating the rate of cooling and the rate of heating of a thermometer bulb.
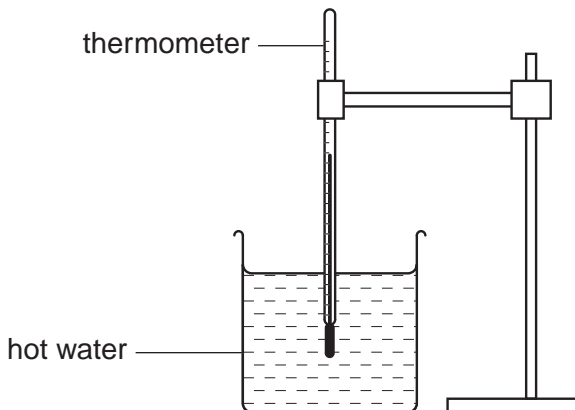
The set-up is shown in Fig. 2.1 and Fig. 2.2.
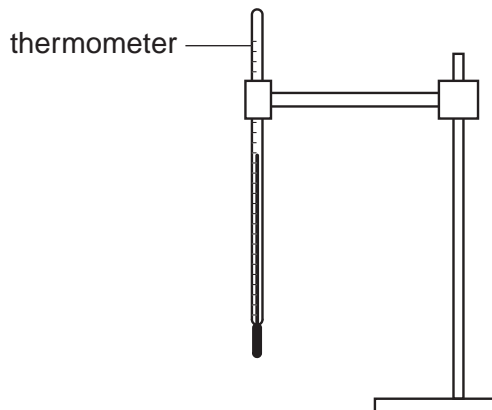

| **Fig. 2.1** | **Fig. 2.2** |

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

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

Table 2.2

$t /$	$\theta /$
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.

$\theta_c =$ ....[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 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.
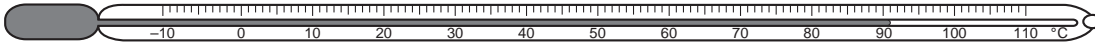

Fig. 2.1

(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
$t/$	$\theta/$	$\theta/$
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]