Simple Kinetic Molecular Model of Mater
Question Paper 3

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 3

Time Allowed: 72   minutes

Score: /60

Percentage: /100

1 A student is investigating the effect of surface area exposed to the air on the rate of cooling of hot water.
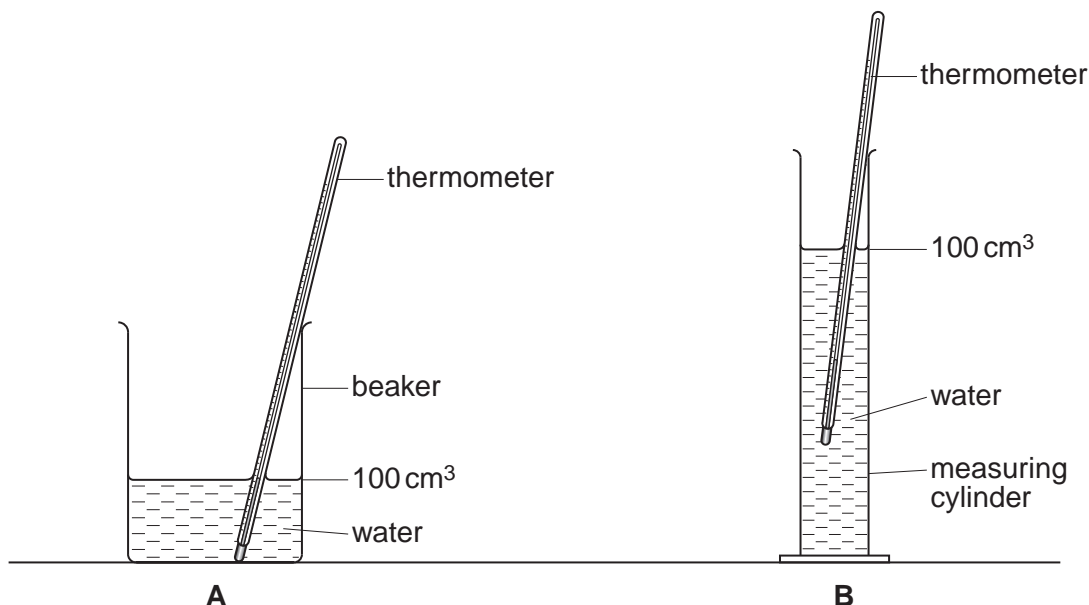

Fig. 3.1

The student is provided with two containers. The beaker is labelled **A** and the measuring cylinder is labelled **B**. Each container contains $100 \, cm^3$ of hot water. He records the temperature of the water at 30 s intervals for a total of four minutes. Table 3.1 shows the readings of time t and temperature θ.

Table 3.1

t/s	container **A** (beaker) θ/°C	container **B** (measuring cylinder) θ/°C
0	85	85
30	76	79
60	68	74
90	63	69
120	59	66
150	56	63
180	54	61
210	52	59
240	51	58

(a) (i) Use the data in Table 3.1 to plot a graph of $\theta/\,°C$ (*y*-axis) against *t*/s (*x*-axis) **for the beaker**. Draw the best-fit curve.

(ii) Use the data for the measuring cylinder to plot another curve on the same graph axes that you used for part **(a)(i)**.

0   20   40   60   80   100   120   140   160   180   200   220   240

t/s
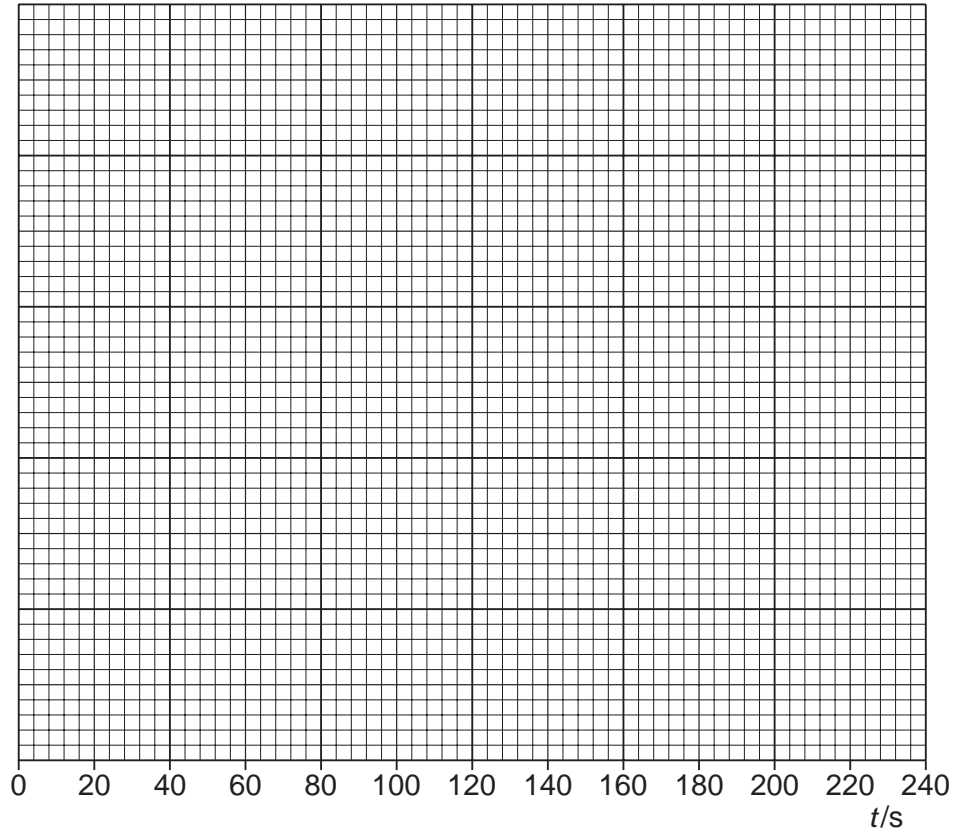
[6]

(b) The experiment is designed to investigate the effect of the surface area exposed to the air on the rate of cooling. State briefly the effect of a larger surface area on the rate of cooling. Justify your answer by reference to your graph.

statement ....

justification ....

....[2]

[Total: 8]

2 A student is investigating the effect of a layer of cotton wool on the cooling of a test-tube of water.
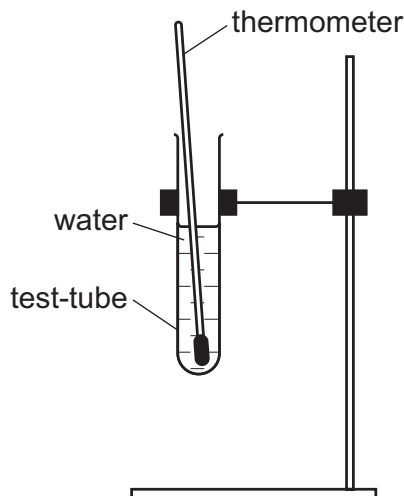
Fig. 2.1 shows the apparatus.

Fig. 2.1

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

Fig. 2.2

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

(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.

She measures the initial temperature θ of the hot water and immediately starts a stopclock.

Suggest one precaution the student takes to make sure that her temperature reading is as accurate as possible.

....

.... [1]

(c) The student records in Table 2.1 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 around the test-tube and repeats the procedure.

Complete the time column and the column headings in Table 2.1.

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

[1]

(d) Write a conclusion to this investigation, stating in which experiment the cooling is more rapid. Explain your answer by reference to the readings and any relevant science.

....

....

....

....

....

....

....

....

.... [3]

(e) Discuss the quality of the results, and suggest **two** improvements to the experiment which would allow a more certain conclusion to be drawn.

quality of results: ....

....

improvements: ....

....

....

....

[3]

(f) This experiment is being carried out by students in many different countries, using identical apparatus.

Suggest **two** differences in the conditions in the various laboratories that might lead to differences in their results.

1. ....

2. ....

[2]

(g) Estimate the volume of water that a test-tube can hold.

volume = ... [1]

[Total: 12]

3 The class is investigating the cooling of water.

Fig. 4.1 shows the apparatus used.
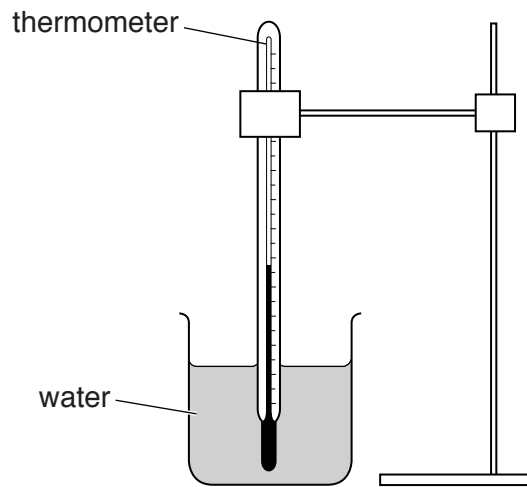
Fig. 4.1

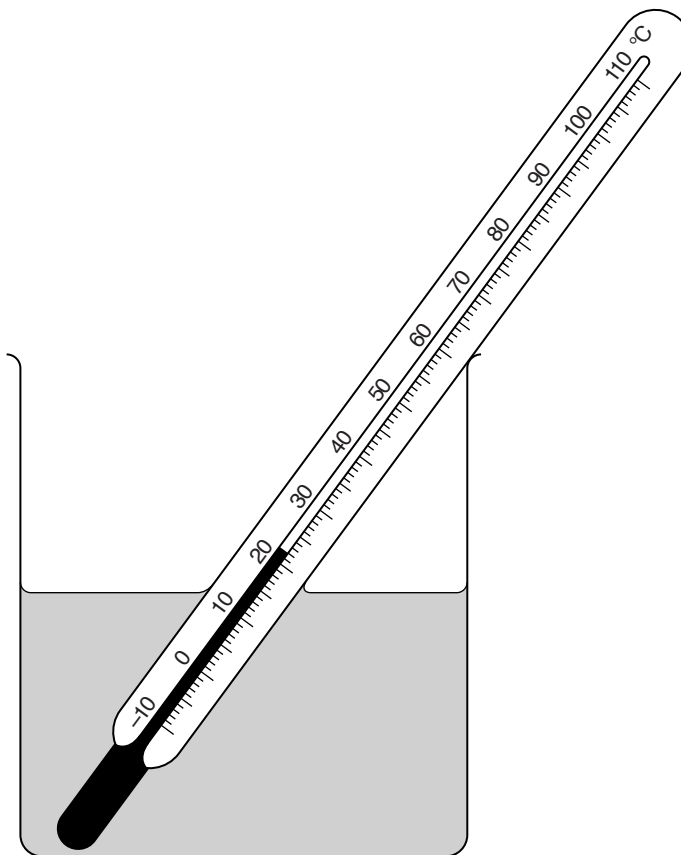**(a)** Record the temperature θ_C of the cold water shown on the thermometer in Fig. 4.2.

Fig. 4.2

$\theta_C =$ ....[1]

(b) A student pours $100\,cm^3$ of hot water into a beaker. He records the temperature θ_H of the hot water in the beaker.

$$\theta_H = \text{.....................} 83\,°C \text{.....................}$$

State one precaution that you would take to ensure that the temperature reading is as reliable as possible.

....

....[1]

(c) The student adds $100\,cm^3$ of cold water to the hot water in the beaker. He records the temperature θ_M of the mixture.

$$\theta_M = \text{.....................} 46\,°C \text{.....................}$$

Calculate the average temperature θ_A of the hot water and the cold water using the equation $\theta_A = \dfrac{(\theta_H + \theta_C)}{2}$.

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

(d) The student carried out this experiment carefully.

He was expecting that the temperature θ_M of the mixture would be the same as the average temperature θ_A of the hot water and the cold water.

Suggest two factors that could cause θ_M and θ_A to be different.

1. ....

....

2. ....

....
[2]

(e) Fig. 4.3 shows a measuring cylinder.

Three students take the volume reading. Their readings are:

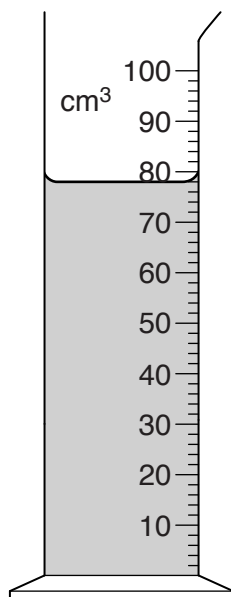- Student 1: 80 cm^3

- Student 2: 79 cm^3

- Student 3: 78 cm^3

Fig. 4.3

(i) State the correct reading.

correct reading = ...

(ii) Explain briefly the mistake made by **one** of the other students.

Student .... is incorrect, because ....

....

[2]

[Total: 7]

4 The IGCSE class is investigating the cooling of water.

A student places a thermometer into a beaker containing $200\,cm^3$ of hot water, as shown in Fig. 2.1.
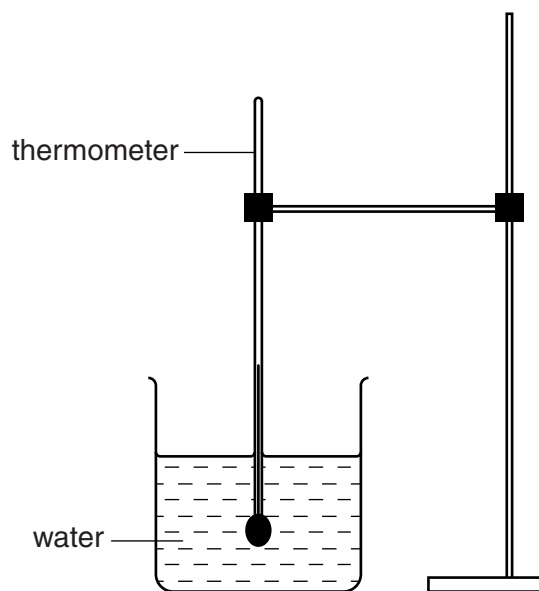
thermometer ⎯

water ⎯

Fig. 2.1

(a) (i) Record the temperature θ_H of the hot water, shown on the thermometer in Fig. 2.2. Write the value in Table 2.1 for time $t = 0\,s$.
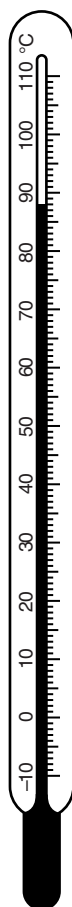
110 °C

Fig. 2.2

(ii) The student leaves the thermometer in the hot water and records the temperature θ every 30 s. The readings are shown in Table 2.1.
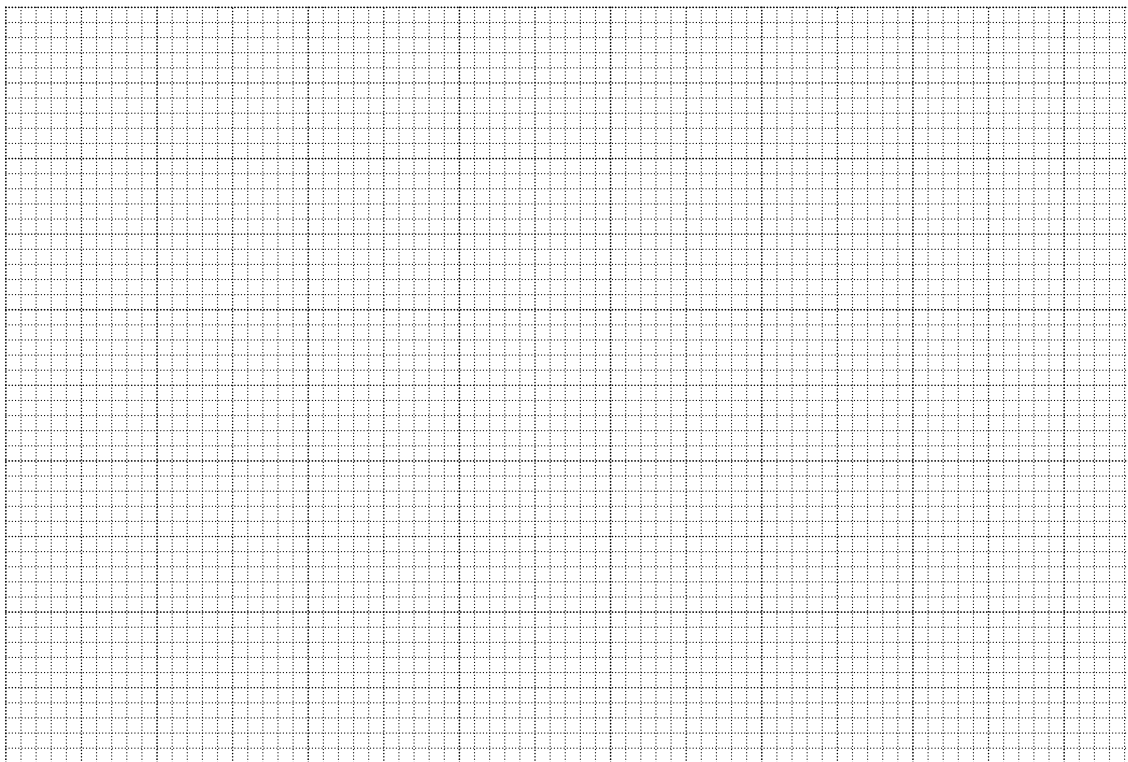
Table 2.1

$t/$	
0	
30	74
60	67
90	63
120	61
150	59

Complete the column headings in the table.

[2]

(b) Plot a graph of $\theta/°C$ (*y*-axis) against *t*/s (*x*-axis).

[5]

(c) (i) Describe briefly the shape of the best-fit graph line that you have drawn.

....

(ii) State what the shape of the graph line tells you about the change, if any, in the rate of cooling of the water during the experiment.

....

....
[2]

(d) Describe briefly how you would read a measuring cylinder to obtain an accurate value for the volume of water. You may draw a diagram.
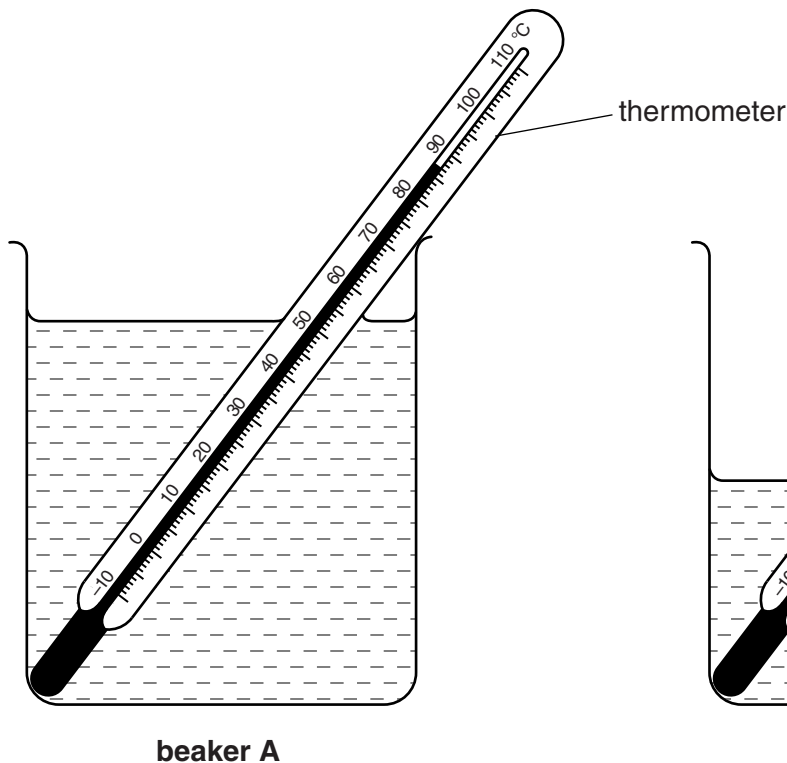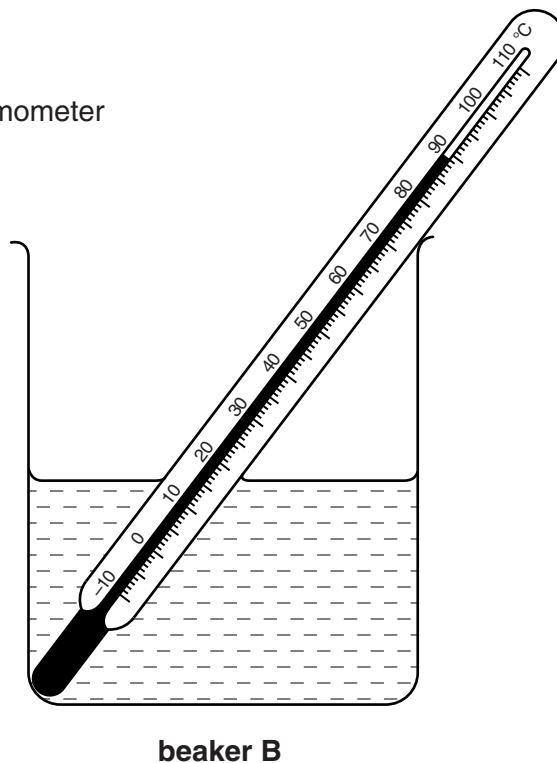
....

....

....

....[1]

[Total: 10]

5 The IGCSE class is investigating the cooling of water.

The apparatus is shown in Figs. 2.1 and 2.2.

beaker A

beaker B

Fig. 2.1 **Fig. 2.2**

(a) Approximately 200 cm³ of hot water is poured into beaker **A** and, after a short while, the thermometer reading rises to the value shown in Fig. 2.1.

Read, and record in the top row of Table 2.1, this temperature θ at time $t = 0$.

(b) Approximately 100 cm³ of hot water is poured into beaker **B**. The thermometer reading rises to the value shown in Fig. 2.2.

Read, and record in the top row of Table 2.1, this temperature θ at time $t = 0$.

(c) The temperatures θ of the thermometer in each experiment at times $t = 30$ s, 60 s, 90 s, 120 s, 150 s and 180 s are shown in Table 2.1.

Complete the column headings and record the values of t in the table.

Table 2.1

	beaker **A** with approximately 200 cm³ of water	beaker **B** with approximately 100 cm³ of water
t /	θ /	θ /
	85.0	86.0
	83.0	83.0
	81.5	80.5
	80.0	78.0
	78.5	75.5
	77.5	74.0

[3]

(d) Describe a similarity in the patterns of temperature change of the two volumes of water, apart from the fact that the temperature of each decreases.

....

....

....[1]

(e) A student suggests that the rate of cooling is less for a larger volume of water than for a smaller volume of water.

State whether the readings support this suggestion. Justify your answer by referring to the readings.

statement ....

justification ....

....

....
[2]

(f) Another IGCSE student wants to repeat the experiment in order to check the results. Suggest two factors that should be kept the same in order for the comparison to be fair.

1. ....

....

2. ....

....
[2]

[Total: 8]

6 The IGCSE class is investigating the cooling of hot water under different conditions.
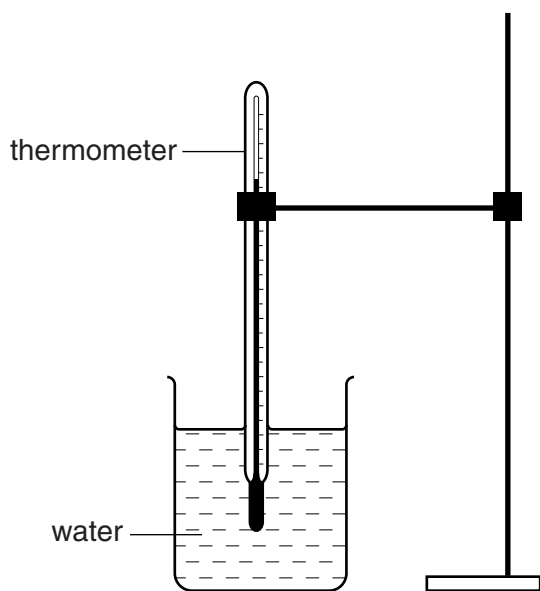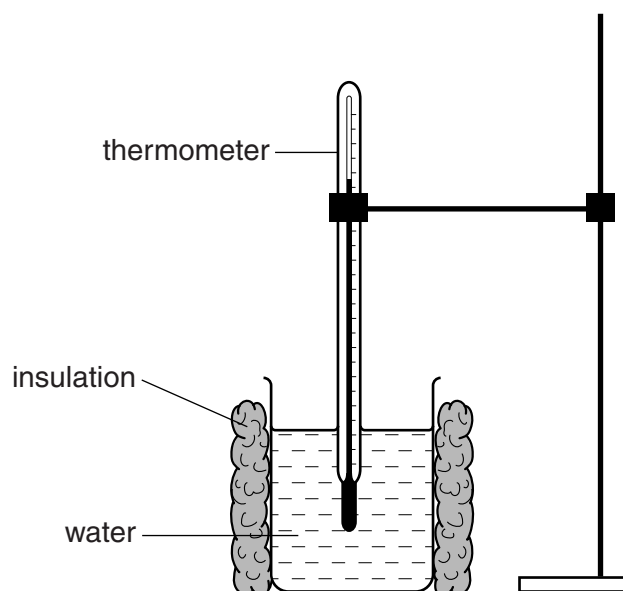
Figs. 2.1 and 2.2 show the apparatus used.

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

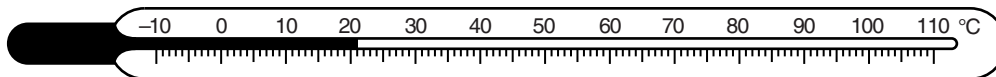**(a)** Record room temperature θ_R as shown on the thermometer in Fig. 2.3.

Fig. 2.3

θ_R = ... [1]

(b) A student pours hot water into the uninsulated beaker shown in Fig. 2.1 until it is about two-thirds full. She measures the temperature and immediately starts a stopclock. She records the temperature every 30 s. She repeats the procedure using the insulated beaker as shown in Fig. 2.2. The readings are shown in Table 2.1.

Table 2.1

t/	without insulation	with insulation
0	80	79
30	77	76
60	74	73
90	72	71
120	70	70
150	69	69

Complete the column headings in the table. [1]

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

statement ....

justification ....

....

....

[2]

(d) The student suggests that a significant cause of loss of thermal energy from the beakers is evaporation.

Suggest how you would reduce the evaporation in this experiment.

....[1]

(e) Suggest one condition that should not be changed when this experiment is repeated.

....[1]

[Total: 6]

7 The IGCSE class is investigating the scale of a thermometer.

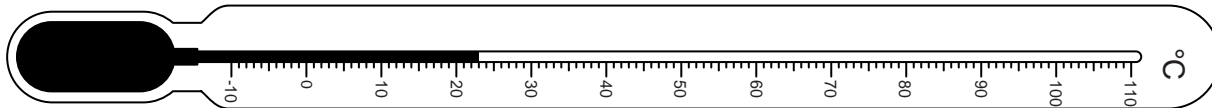**(a)** Record room temperature θ_R as shown on the thermometer in Fig. 2.1.

Fig. 2.1

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

A student pours hot water into a beaker. She measures the temperature θ of the water in the beaker every 30 s. The readings are shown in Table 2.1.

Table 2.1

t/		d/
0	80	
30	74	
60	69	
90	65	
120	63	
150	61	
180	60	

(b) (i) Using Fig. 2.2, measure, and record in the table, the distance d from the end of the thermometer to the position of the liquid in the thermometer at the first temperature reading in the table.
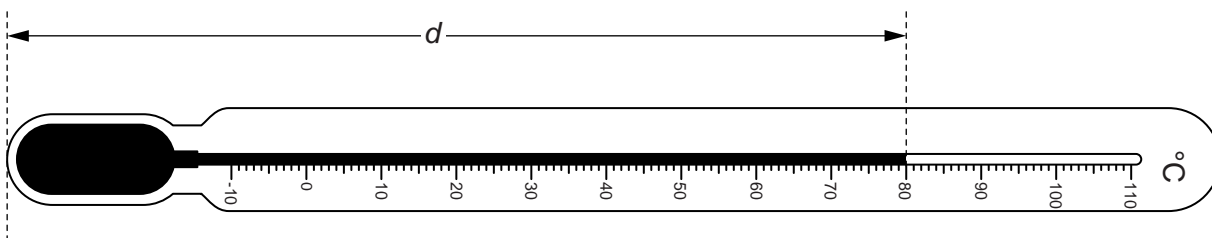
Fig. 2.2

(ii) Repeat the measurement in **(b)(i)** for all the other temperature readings. [2]

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

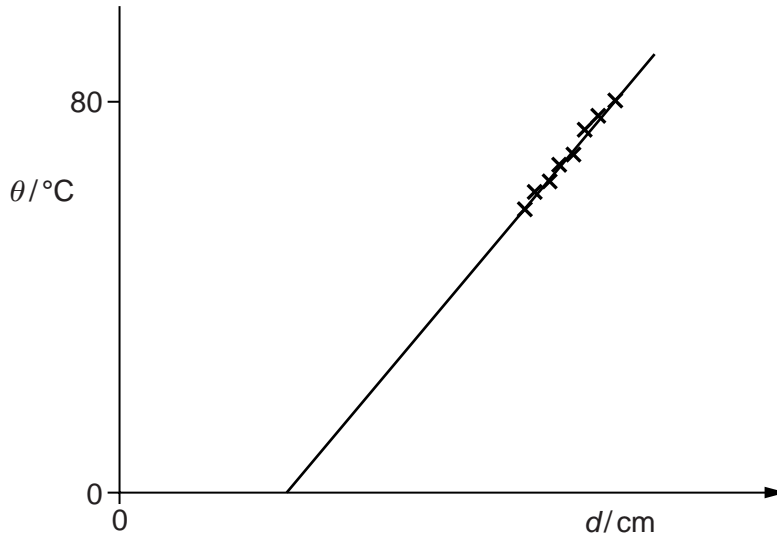**(c)** The student plotted a graph of θ against d. A sketch of the graph obtained is shown in Fig. 2.3.

Fig. 2.3

(i) Explain how the graph line shows that θ is not directly proportional to d.

....

....[1]

(ii) Suggest why, when $\theta = 0\,°C$, the value of d is not zero.

....

....

....

[1]

(d) Determine, as accurately as possible, the distance x between the 1°C marks on the thermometer shown in Fig. 2.2. Show your working.

$x =$ ....[3]

[Total: 9]