Topical Practice

IGCSE PHYSICS

Paper 4

Chapters 8 – 9

EDITION • Volum • STUDENT

CONTENTS

Chapter 8: Thermal Properties and Processes

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.

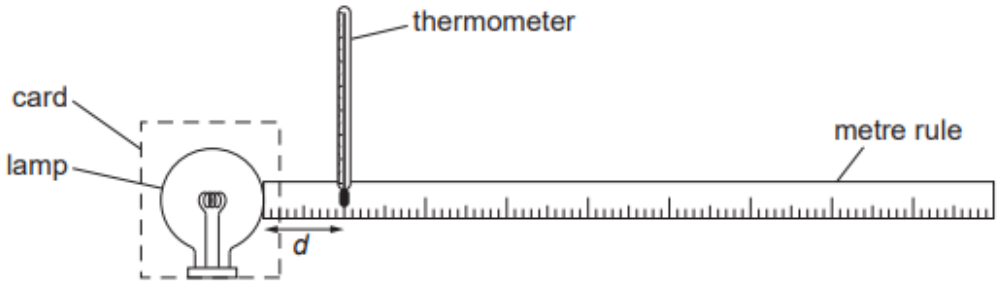


Fig. 2.1

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

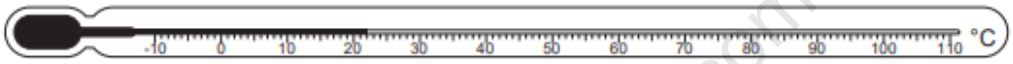


Fig. 2.2

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.

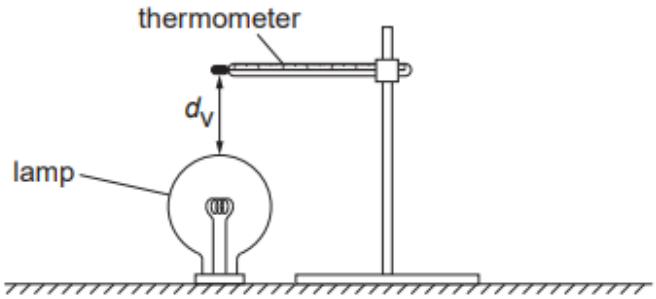


Fig. 2.3

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.

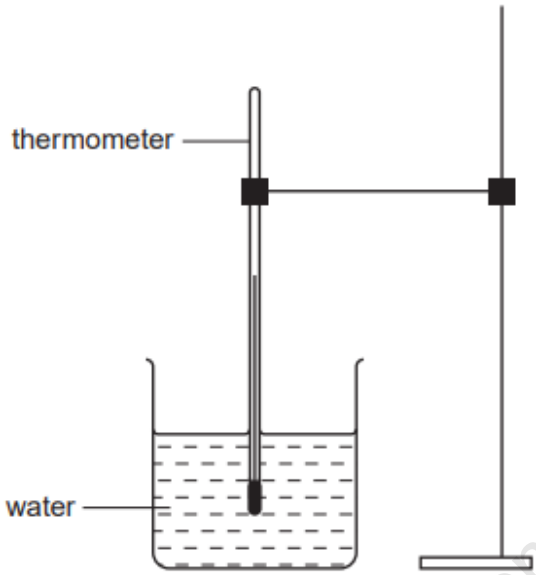
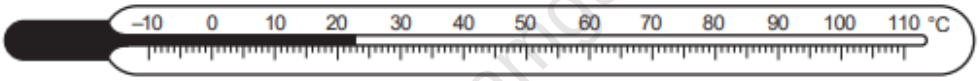


Fig. 2.1

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



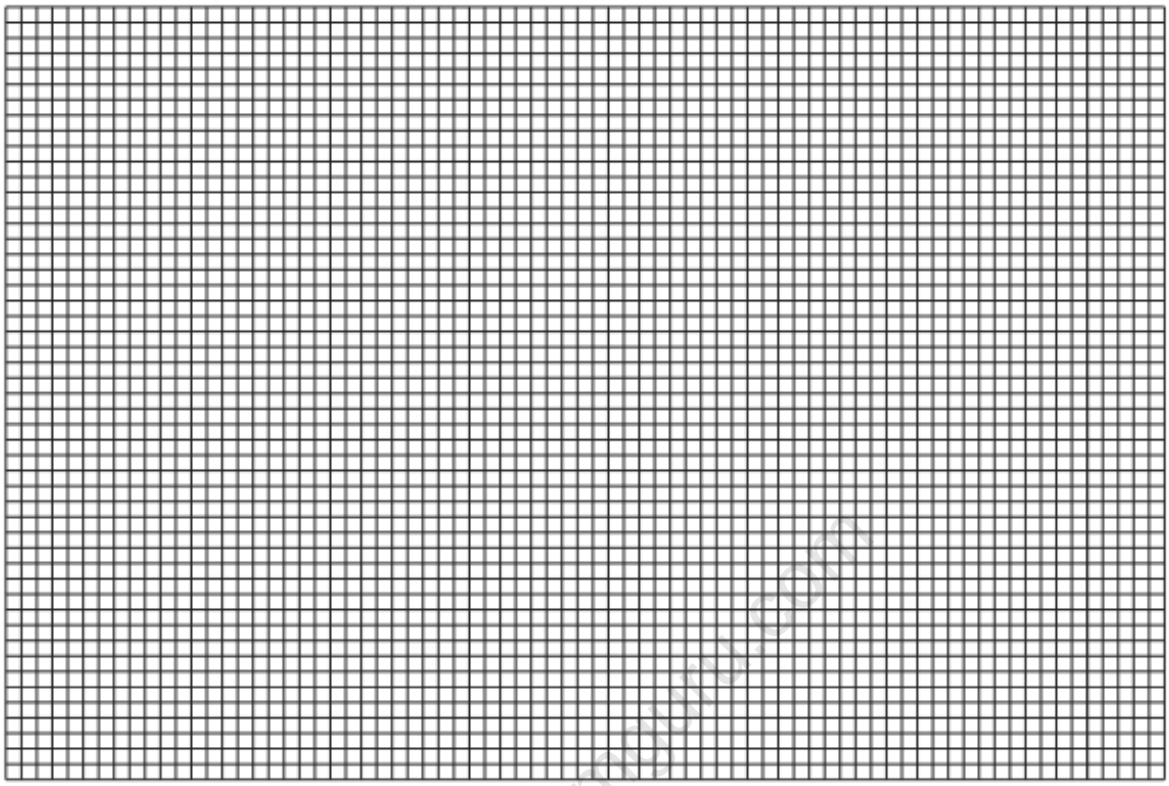
θ_R = ...[1]

(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	θ / °C
0	86
30	75
60	67
90	61
120	56
150	52

Plot a graph of θ/°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.

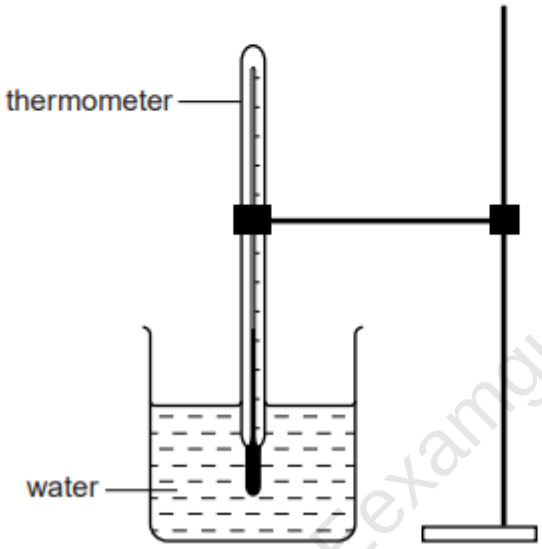


Fig. 2.1

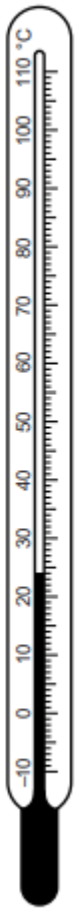


Fig. 2.2

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

θ_R = ...[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 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 cm^3 of hot water.

Table 2.1

	volume of water	
	150 cm^3	250 cm^3
t/	θ/	θ/
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.

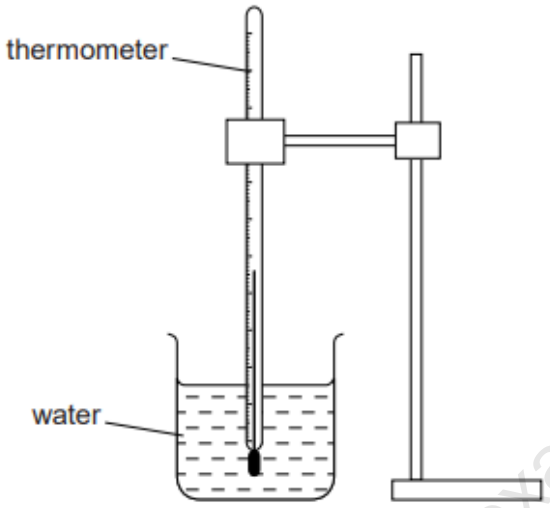


Fig. 2.1

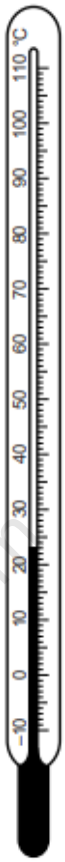


Fig. 2.2

(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.

θ_2 = ... 59 °C .....

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

θ_3 = ... 44 °C .....

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

θ_B = ...

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

θ_W = ...

[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]

5 Some IGCSE students have been asked to investigate how different surfaces absorb thermal radiation.

The apparatus is set up as shown in Fig. 2.1, with a piece of white card in close contact with the thermometer bulb.
The distance between the card and the lamp is 1.0 cm.

Fig. 2.1 shows the reading on the thermometer before the lamp is switched on.

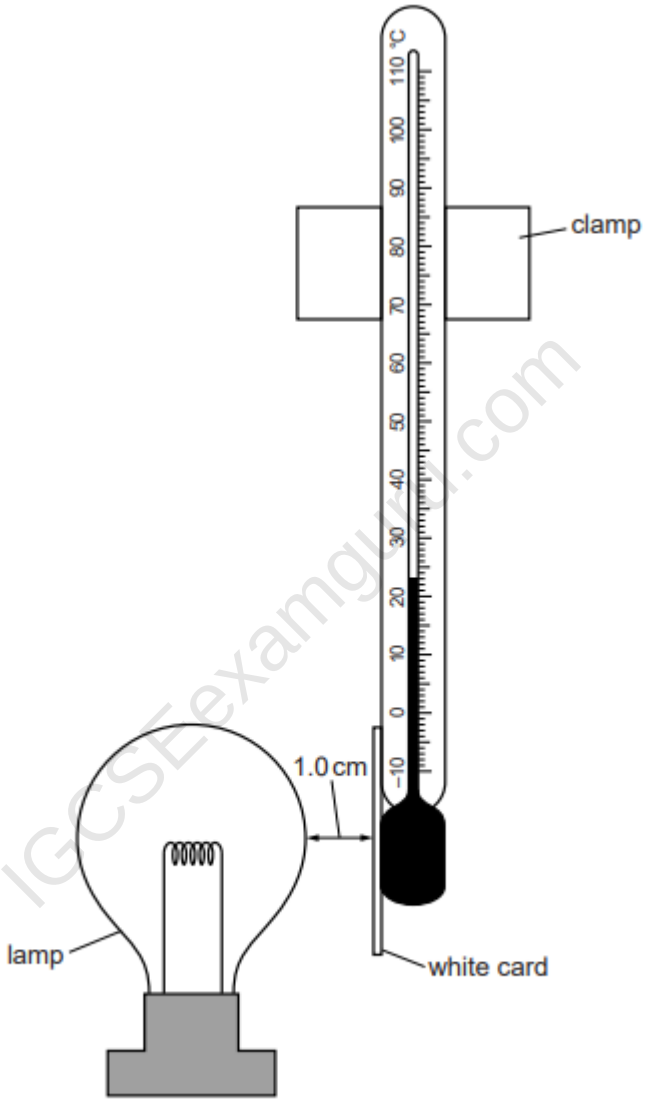


Fig. 2.1

(a) In Table 2.1, record the temperature before the lamp is switched on, as shown in Fig. 2.1.

(b) The lamp is switched on and the temperature recorded every minute.

After 300 s, the lamp is switched off and the white card is replaced with a piece of black card.

The lamp is then switched on for a further 300 s, and the temperature recorded every minute.

Table 2.1 shows the readings obtained during the experiment.

(i) Complete the column headings in the table.

Table 2.1

	white card	black card
t /	*θ* /	*θ* /
0		24
60	25	30
120	28	37
180	30	42
240	32	45
300	33	47

[2]

(ii) Calculate the overall temperature change for each card after 300 s.

white card: temperature change = ...

black card: temperature change = ...

[1]

(iii) Determine which surface, white or black, absorbs thermal radiation more efficiently. State the experimental evidence for your choice.

surface.....

evidence .....

.....

[1]

(iv) A student suggests that the rate of temperature rise will be greater at the beginning of the experiment than towards the end of the experiment.

State whether the results support this. Justify your answer with reference to the data for black card.

statement .....

justification .....

.....

.....

[2]

(c) Another IGCSE student wants to repeat the experiment.

Suggest one precaution which she should take with the apparatus to make the comparison between white and black surfaces a fair one. Explain why not taking this precaution might cause the test to be unfair.

precaution .....

explanation .....

.....

.....

[2]

[Total: 8]

6 Some IGCSE students are investigating the cooling of water.

Fig. 1.1 shows how the apparatus is set up.

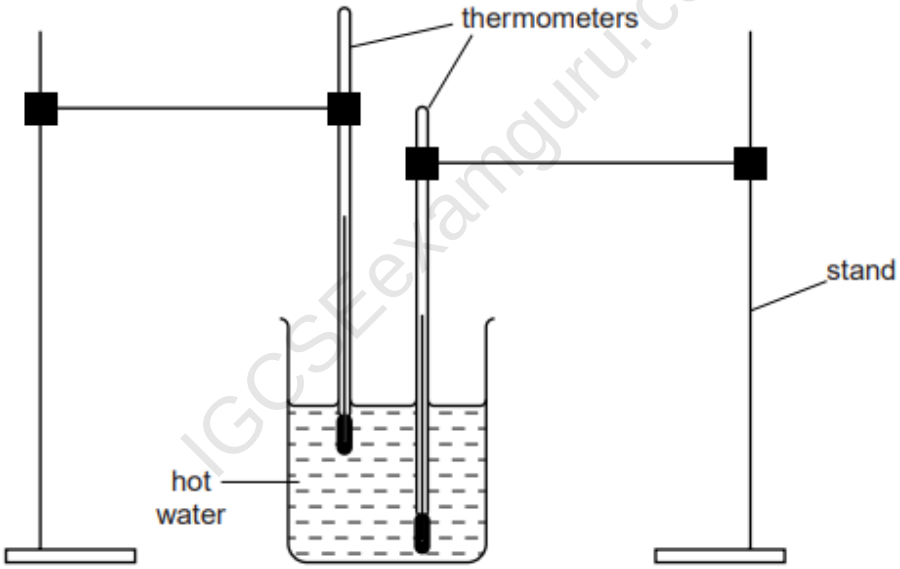


Fig. 1.1

(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.

θ_R = ...[1]

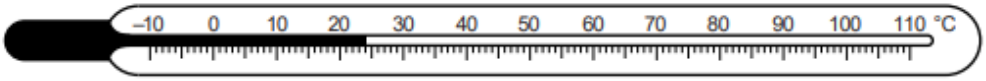


Fig. 1.2

(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 /	θ /	θ /
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]

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.

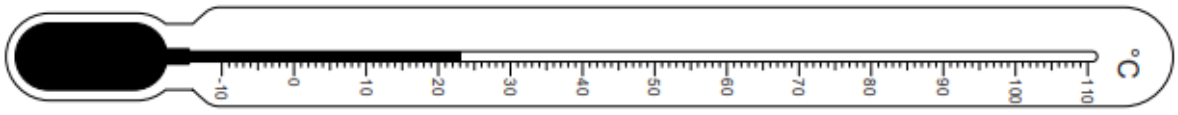


Fig. 2.1

θ_R = ...[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/	*θ*/	*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.

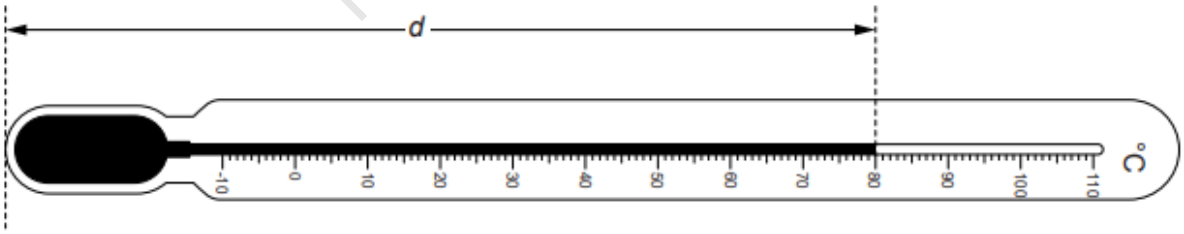


Fig. 2.2

(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.

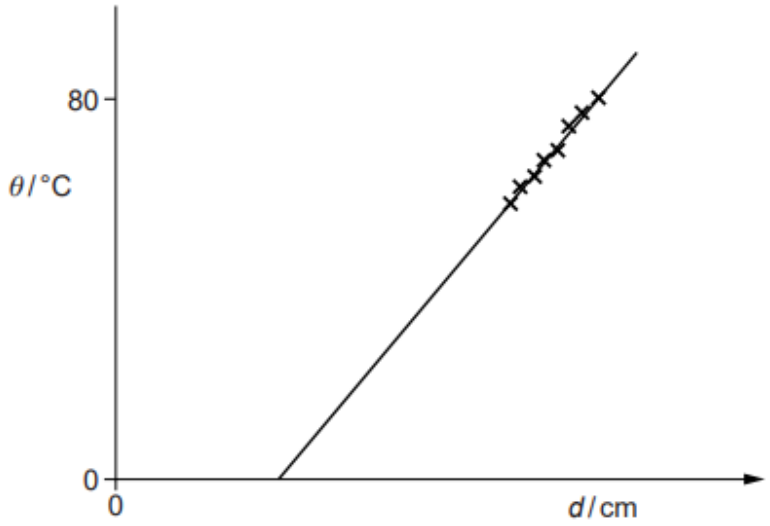


Fig. 2.3

(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]

8 The IGCSE class is investigating the cooling of water.

(a) A student places a thermometer in a beaker of cold water.

Using Fig. 2.1, record the temperature θ_C of the cold water supplied to the student.

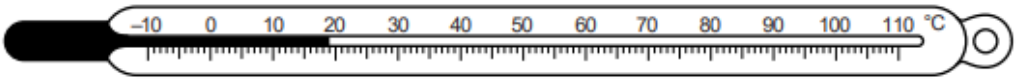


Fig. 2.1

θ_C = ...[1]

(b) The student pours 200 cm^3 of hot water into a beaker. She measures the temperature of the water at 30 s intervals. The readings are shown in Table 2.1.

Table 2.1

t/	*θ*/
0	80
30	75
60	72
90	69
120	67
150	66

Complete the column headings in the table. [1]

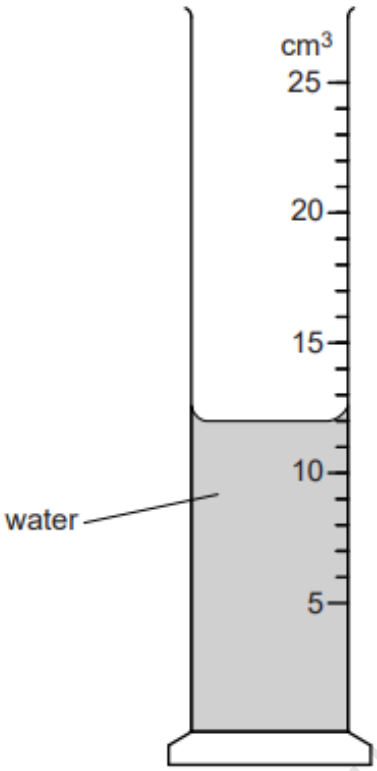
(c) The student empties the beaker and pours another 200 cm^3 of the hot water into the beaker. She measures the temperature θ_H of the water in the beaker.

θ_H = 78 °C

She then empties the cold water from the measuring cylinder shown in Fig. 2.2 into the beaker of hot water. She measures the temperature θ_A of the water in the beaker.

θ_A = 74 °C

Using Fig. 2.2, record the volume V_A of cold water.



(d) Estimate the volume V of cold water that, added to the hot water, would give the same temperature drop as allowing the hot water to cool for 150 s.

Use the evidence from the table and the readings in parts **(b)** and **(c)**. Explain briefly how you arrived at your answer.

.....

.....

.....

V = ...[2]

(e) This laboratory investigation could be used as a small-scale model for a process in a factory. The laboratory investigation would be repeated many times.

Suggest two conditions that should be kept constant in order to provide reliable results.

1. .....

2. .....

[2]

[Total: 7]

9 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.

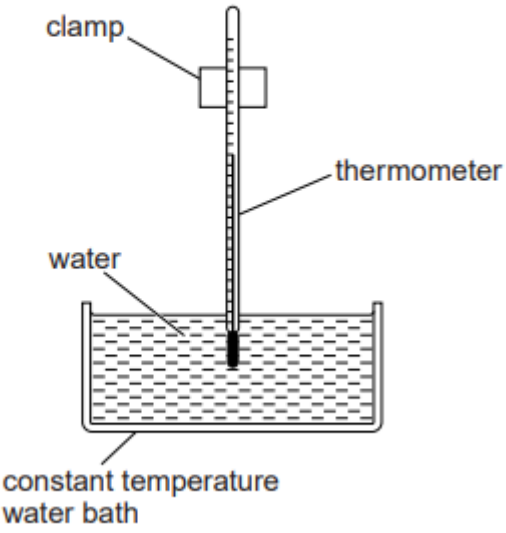


Fig. 2.1

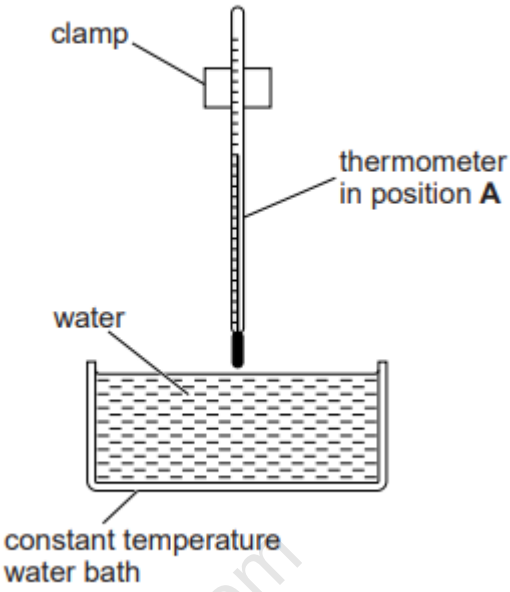


Fig. 2.2

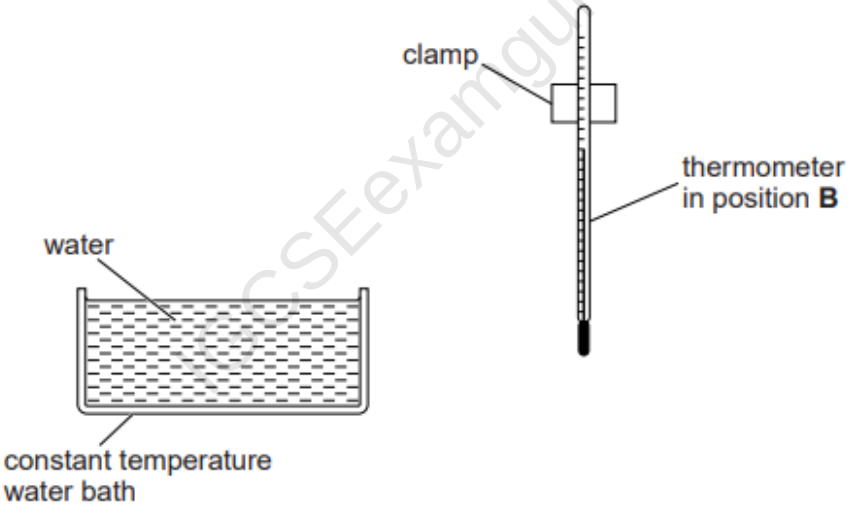


Fig. 2.3

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

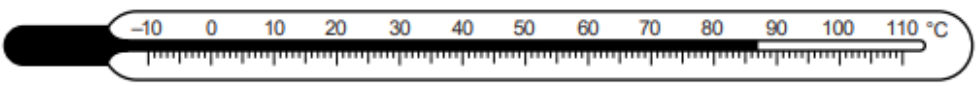


Fig. 2.4

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

θ_H = ... [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/	*θ*/	*θ*/
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.

θ_R = ... [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]

10 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.

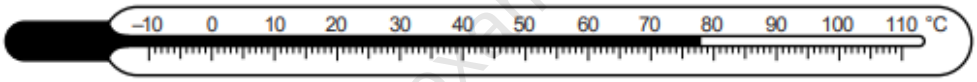


Fig. 2.1

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.

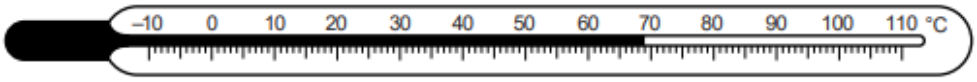


Fig. 2.2

(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.

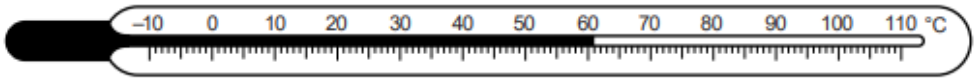


Fig. 2.3

(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]

11 An IGCSE student is investigating methods of preventing loss of thermal energy.

The student is using two beakers labelled **A** and **B**, as shown in Fig. 2.1.

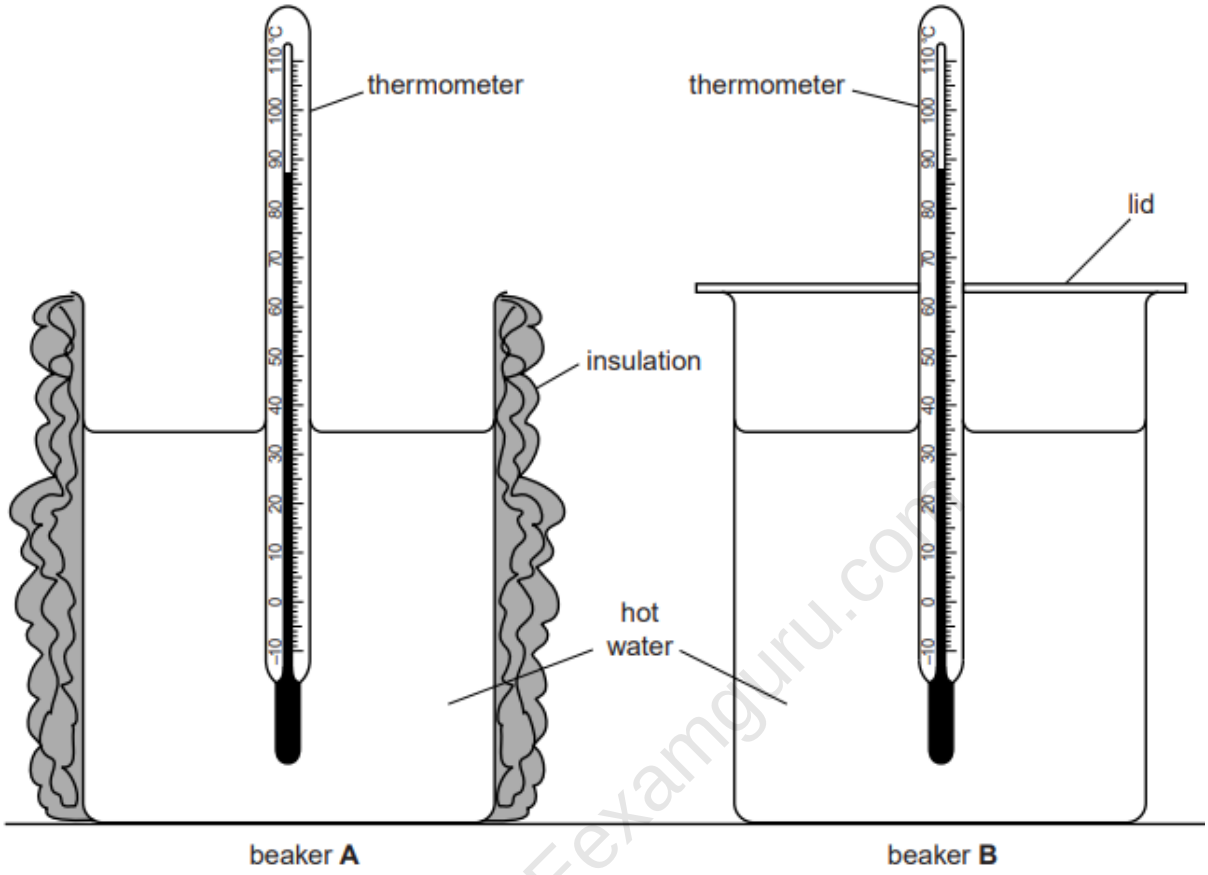


Fig. 2.1

Beaker **A** has a layer of insulation and beaker **B** has a lid but no insulation.

The beakers contain hot water at the start of the experiment. The initial temperatures are as shown in Fig. 2.1.

(a) Read, and record in the first row of Table 2.1, the temperatures of the water in beakers **A** and **B** at time $t = 0$. [1]

(b) The temperatures of the hot water after 30 s, 60 s, 90 s, 120 s, 150 s and 180 s are shown in Table 2.1.

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

[2]

Table 2.1

	beaker **A**	beaker **8**
t/	*θ*/	*θ*/
	85.0	87.0
	83.5	85.5
	82.0	84.5
	81.0	84.0
	79.5	83.0
	78.5	82.5

(c) State from which beaker, if either, the rate of loss of thermal energy is the greater. Justify your answer by referring to the results.

beaker .....

justification .....

.....

.....

[2]

(d) State one condition that should be controlled to ensure that the comparison between beaker **A** and beaker **B** is a fair one.

.....

..... [1]

(e) A student points out that the experiment does not test the effectiveness of insulation in reducing thermal energy loss.

Suggest a change to this experiment which could be made so that the effect of insulation could be investigated. Explain why this change would help.

suggestion .....

.....

explanation .....

.....

.....

[2]

[Total: 8]

12 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]

13 A student carries out an experiment to compare how quickly thermal energy is conducted along rods made from different metals. Each rod is heated at one end with a Bunsen burner flame.

Each rod carries a marker held on the rod with a little wax. When the wax melts, the marker falls.

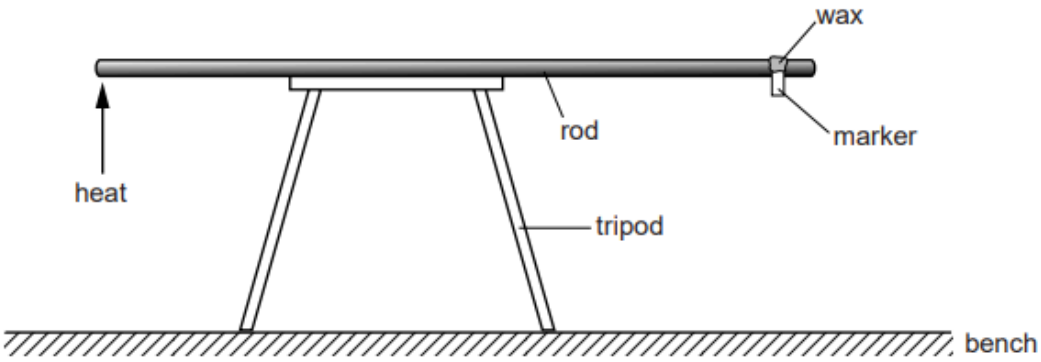


Fig. 2.1

(a) One other piece of equipment is required to compare how quickly thermal energy is conducted. Name this piece of equipment.

.....[1]

(b) Suggest **three** possible variables that the student should keep constant in order to make a fair comparison between the different metals.

1. .....

2. .....

3. .....

[3]

(c) Another student suggests that it would be helpful to measure the temperatures at both ends of the rod. He suggests using a liquid-in-glass thermometer, normally used for measuring the temperature of hot water.

Suggest two reasons why a liquid-in-glass thermometer is **not** suitable.

1. .....

2. .....

[2]

[Total: 6]

14 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.

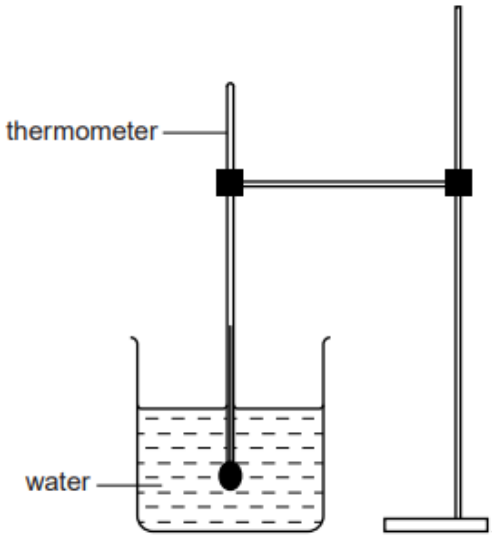


Fig. 2.1

(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.

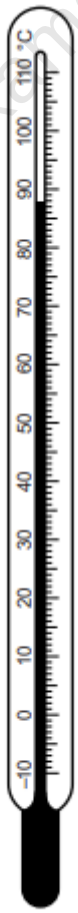


Fig. 2.2

(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.

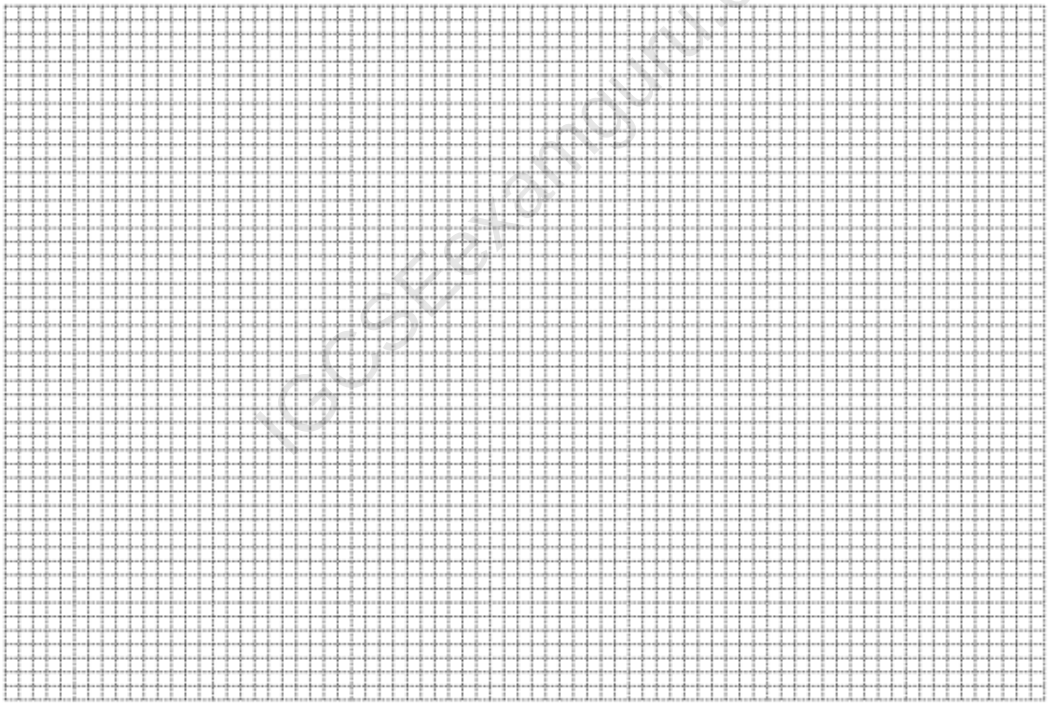
Table 2.1

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

Complete the column headings in the table.

[2]

(b) Plot a graph of θ/°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.

.....

.....

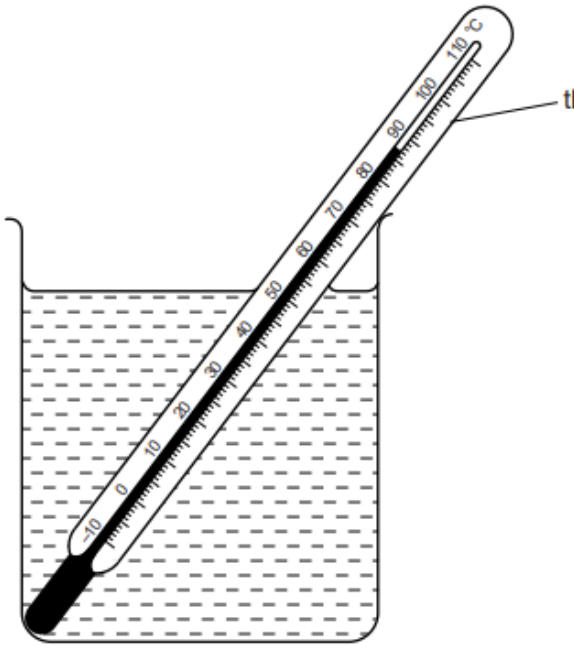
.....

.....[1]

[Total: 10]

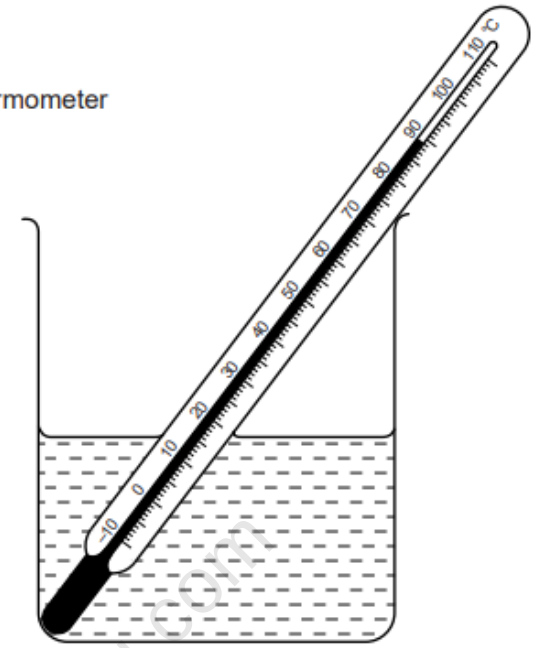
14 The IGCSE class is investigating the cooling of water.

The apparatus is shown in Figs. 2.1 and 2.2.



beaker A

Fig. 2.1



beaker B

Fig. 2.2

(a) Approximately 200 cm^3 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 cm^3 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 cm^3 of water	beaker **B** with approximately 100 cm^3 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]

15 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.

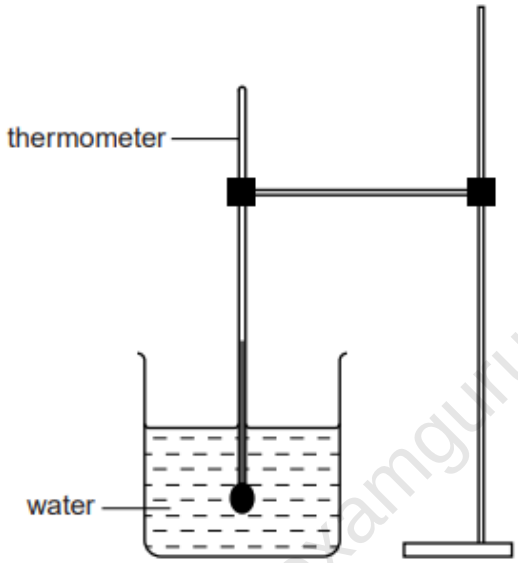


Fig. 3.1

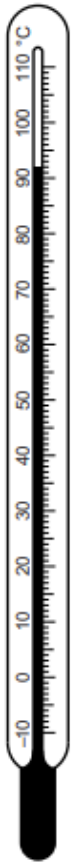


Fig. 3.2

(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/	θ/	θ/
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]

16 The IGCSE class is investigating the cooling of hot water under different conditions.

Figs. 2.1 and 2.2 show the apparatus used.

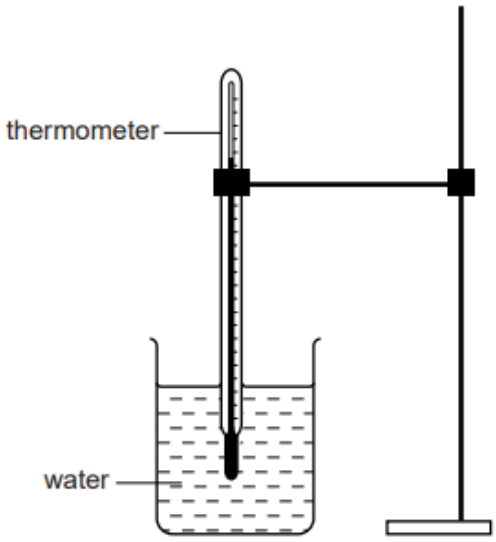


Fig. 2.1

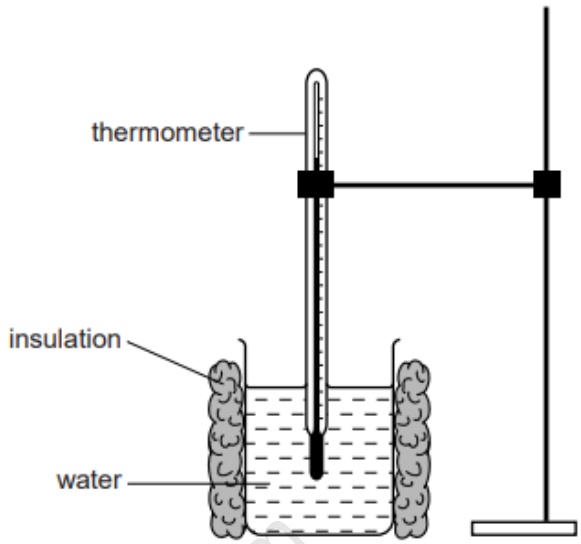


Fig. 2.2

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

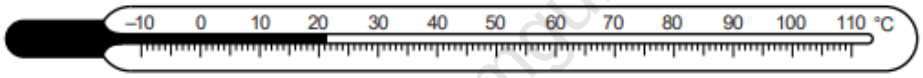


Fig. 2.3

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

	without insulation	with insulation
t/	*θ*/	*θ*/
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]

17 The IGCSE class is investigating the cooling of hot water as cold water is added.

The apparatus is shown in Fig. 2.1.

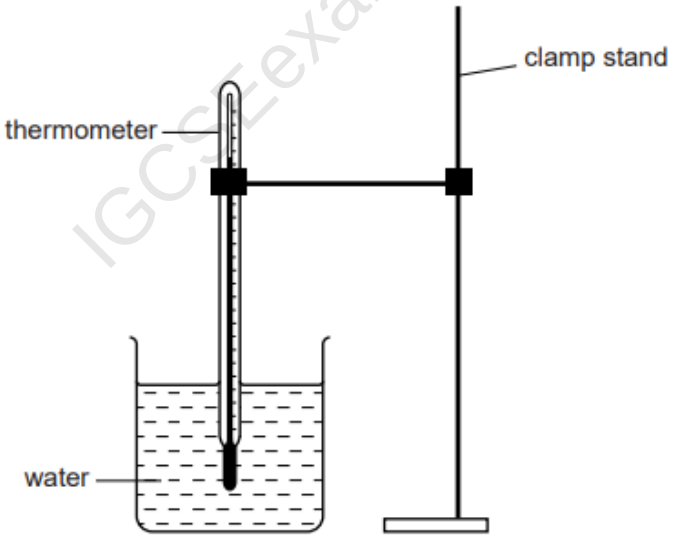


Fig. 2.1

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

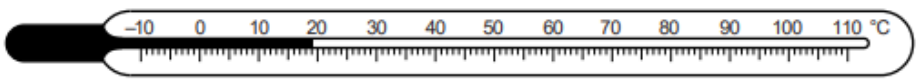


Fig. 2.2

θ_R = ... [1]

(b) A student pours approximately $150\,cm^3$ of hot water into a beaker. She measures the temperature θ of the water in the beaker.

She adds a volume $V = 10\,cm^3$ of water at room temperature to the hot water in the beaker and stirs it briefly. She measures the temperature of the water in the beaker.

She adds a total of $50\,cm^3$ of cold water, $10\,cm^3$ at a time, stirring and measuring the temperature each time. The readings are shown in Table 2.1.

Table 2.1

V/	θ/
0	82
	75
	69
	65
	61
	58

(i) The total volume of cold water added is V.

In Table 2.1, complete the volume V column.

(ii) Complete the column headings in the table.

[2]

(c) Suggest one way you could reduce the loss of thermal energy to the surroundings during the experiment.

.....

..... [1]

(d) The student has a drinks cup, held above a measuring cylinder, as shown in Fig. 2.3. The cup has a small hole in its base.

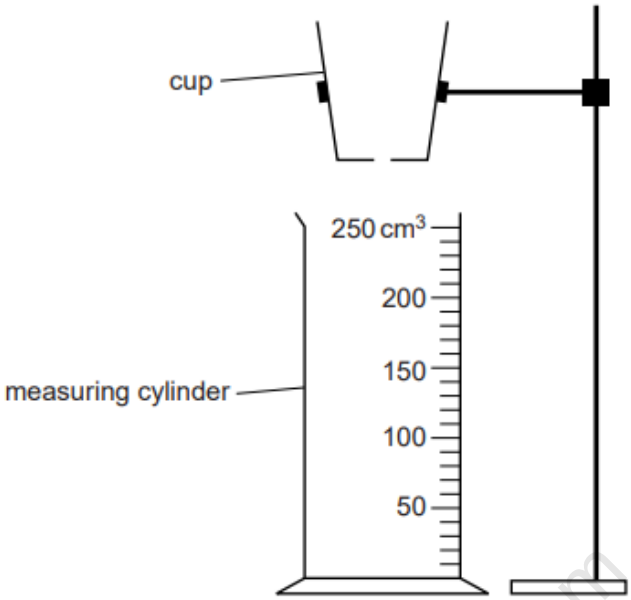


Fig. 2.3

She pours water into the cup until it is about two-thirds full. She measures the time t_1 taken for 50 cm^3 of water to fall into the measuring cylinder. The stopwatch reading is shown in Fig. 2.4.

Fig. 2.4

After setting the stopwatch to zero, she measures the time t_2 taken for the next 50 cm^3 of water to fall into the measuring cylinder. The stopwatch reading is shown in Fig. 2.5.

Fig. 2.5

(i) Calculate the average rate of flow of water R_1 for the first $50\,cm^3$, using the equation $R_1 = \frac{k}{t_1}$, where $k = 50\,cm^3$.

R_1 = ...

(ii) Calculate the average rate of flow of water R_2 for the next $50\,cm^3$, using the equation $R_2 = \frac{k}{t_2}$, where $k = 50\,cm^3$.

R_2 = ...
[2]

(e) A student suggests that the experiment described in part **(b)** would be improved by having a steady flow of cold water added to the hot water.

Suggest one possible disadvantage of using the method described in part **(d)** to produce such a flow of water.

.....

.....
[1]

(f) The experiment described in part **(b)** could be repeated to check the results.

Suggest two conditions that should be kept constant in order to provide a reliable check.

1. .....

2. .....
[2]

[Total: 9]

18 An IGCSE student is investigating how the surface of a container affects the rate at which water cools.

She is using two test-tubes, labelled **A** and **B**, as shown in Fig. 2.1. Test-tube **A** has no covering. Test-tube **B** is covered with foil.

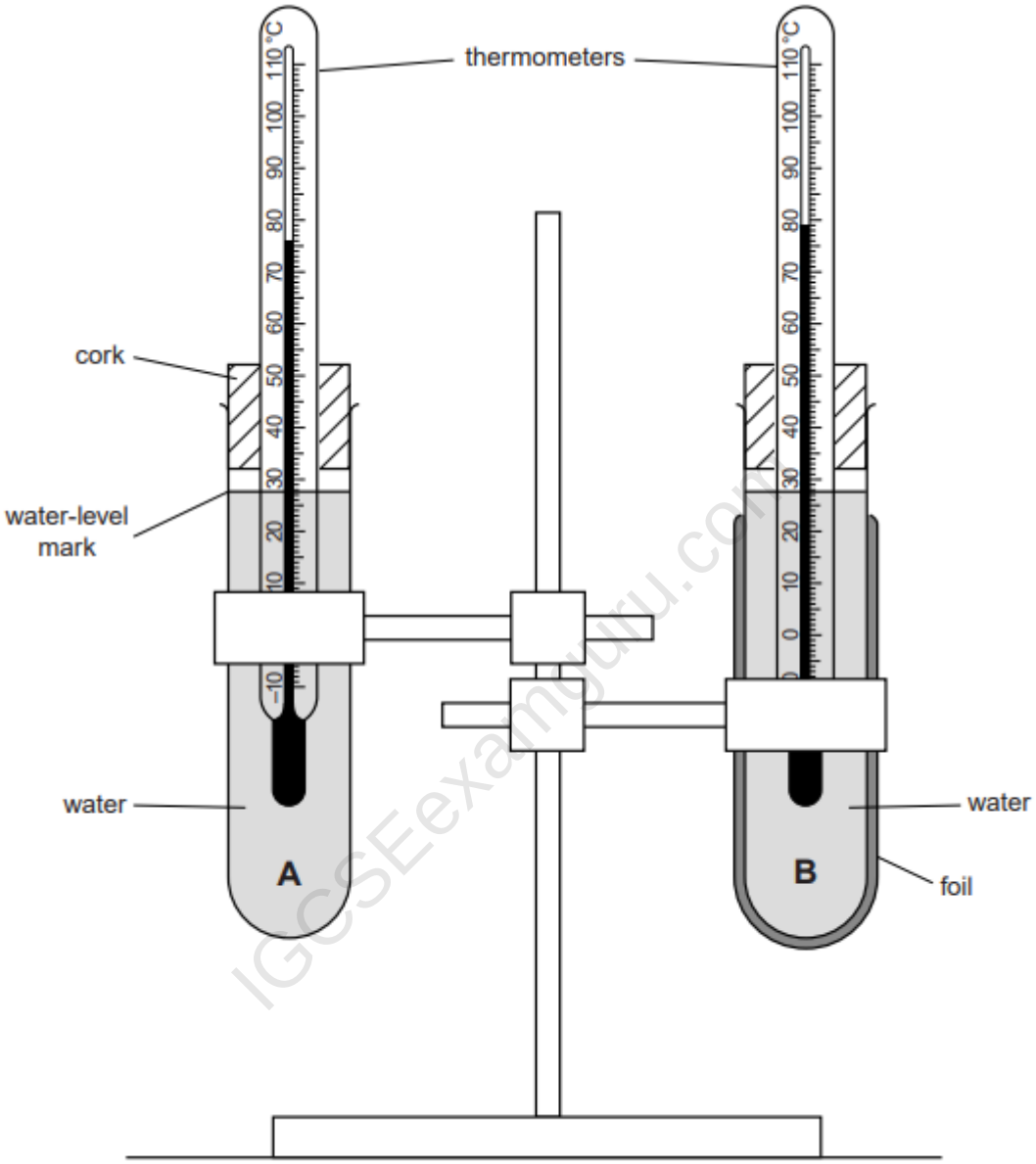


Fig. 2.1

(a) The cork and thermometer are removed from test-tube **A** and hot water is poured into the test-tube up to the marked level. The cork and thermometer are replaced.

(i) The thermometer reading rises to the value shown in Fig. 2.1.

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

(ii) The temperatures θ of the thermometer in test-tube **A** 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 column t values in the table.

Table 2.1

	test-tube **A**	test-tube **B**
t/	θ/	θ/
	71.5	76.0
	67.5	73.0
	64.0	70.5
	60.5	68.5
	58.0	66.5
	56.0	65.0

[3]

(b) The procedure is repeated for test-tube **B**. Fig. 2.1 shows the thermometer reading of test-tube **B** at the start of the experiment.

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

(c) The temperatures θ of the thermometer in test-tube **B** at times t = 30 s, 60 s, 90 s, 120 s, 150 s and 180 s are shown in the table.

State in which test-tube, **A** or **B**, the water cools at the greater rate. Justify your answer by referring to the results.

test-tube .....

justification .....

.....

.....

[2]

(d) Suggest one aspect of the practical procedure which may be a source of unreliability in the experiment.

.....

..... [1]

(e) Another IGCSE student wants to extend the experiment in order to test the effects of other surface materials.

Suggest two factors relating to the apparatus which he should keep the same in order for the tests to be fair.

1. .....

.....

2. .....

.....

[2]

[Total: 8]

19 The class is investigating the cooling of water.

Fig. 2.1 shows some of the apparatus used.

(a) A student measures the initial temperature of hot water in a beaker, as indicated by the thermometer in Fig. 2.1.

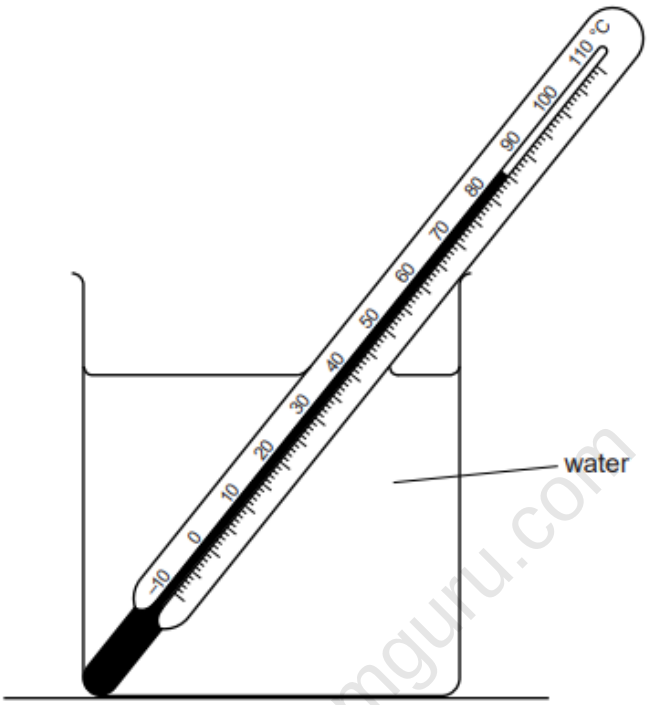


Fig. 2.1

Record this initial temperature in the first row of Table 2.1.

(b) The student allows the water in the beaker to cool and records the temperature at 30 s intervals. The readings are shown in the table.

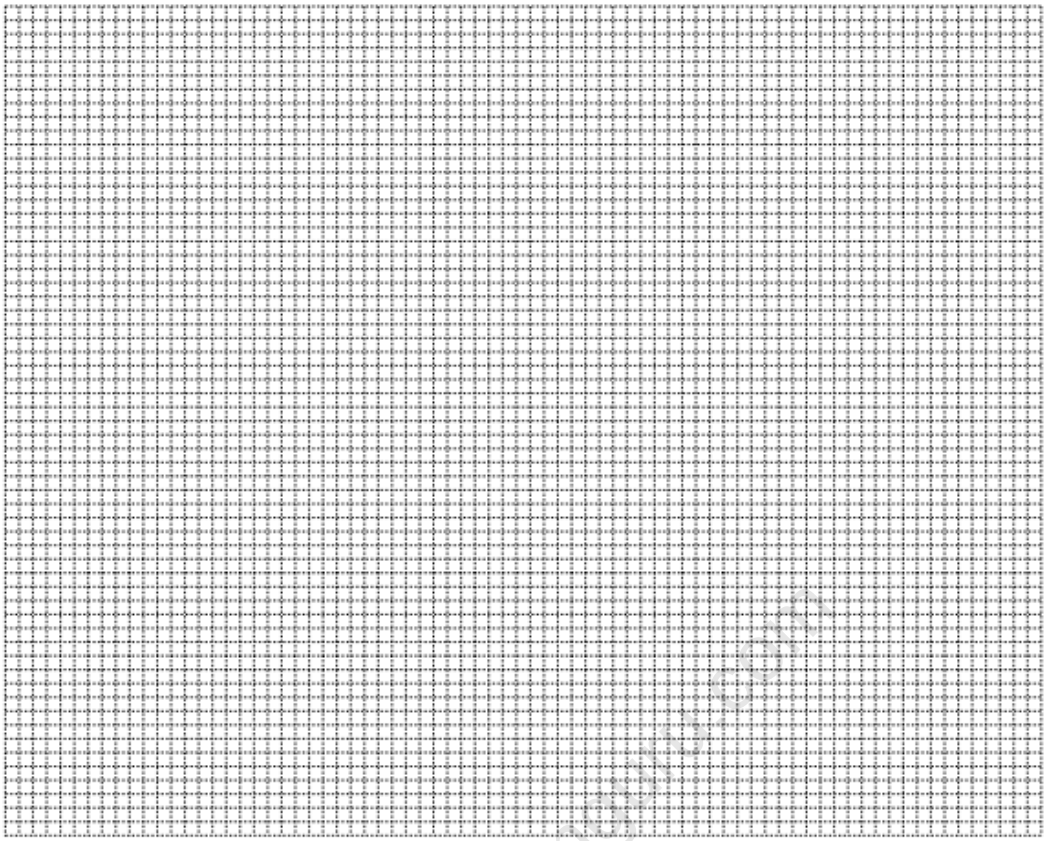
Complete the column headings in the table.

Table 2.1

t/	*θ*/
0	
30	72
60	64
90	60
120	57
150	56

[2]

(c) Plot a graph of θ/°C (y-axis) against t/s (x-axis).



[5]

(d) **(i)** State whether the rate of cooling of the water in the beaker increases, decreases or stays approximately constant during the period of cooling.

The rate of cooling of the water ..... .[1]

(ii) Justify your statement by reference to the graph.

.....

.....

.....[1]

[Total: 9]

20 A student is investigating the transfer of thermal energy.

He uses the apparatus shown in Fig. 1.1.

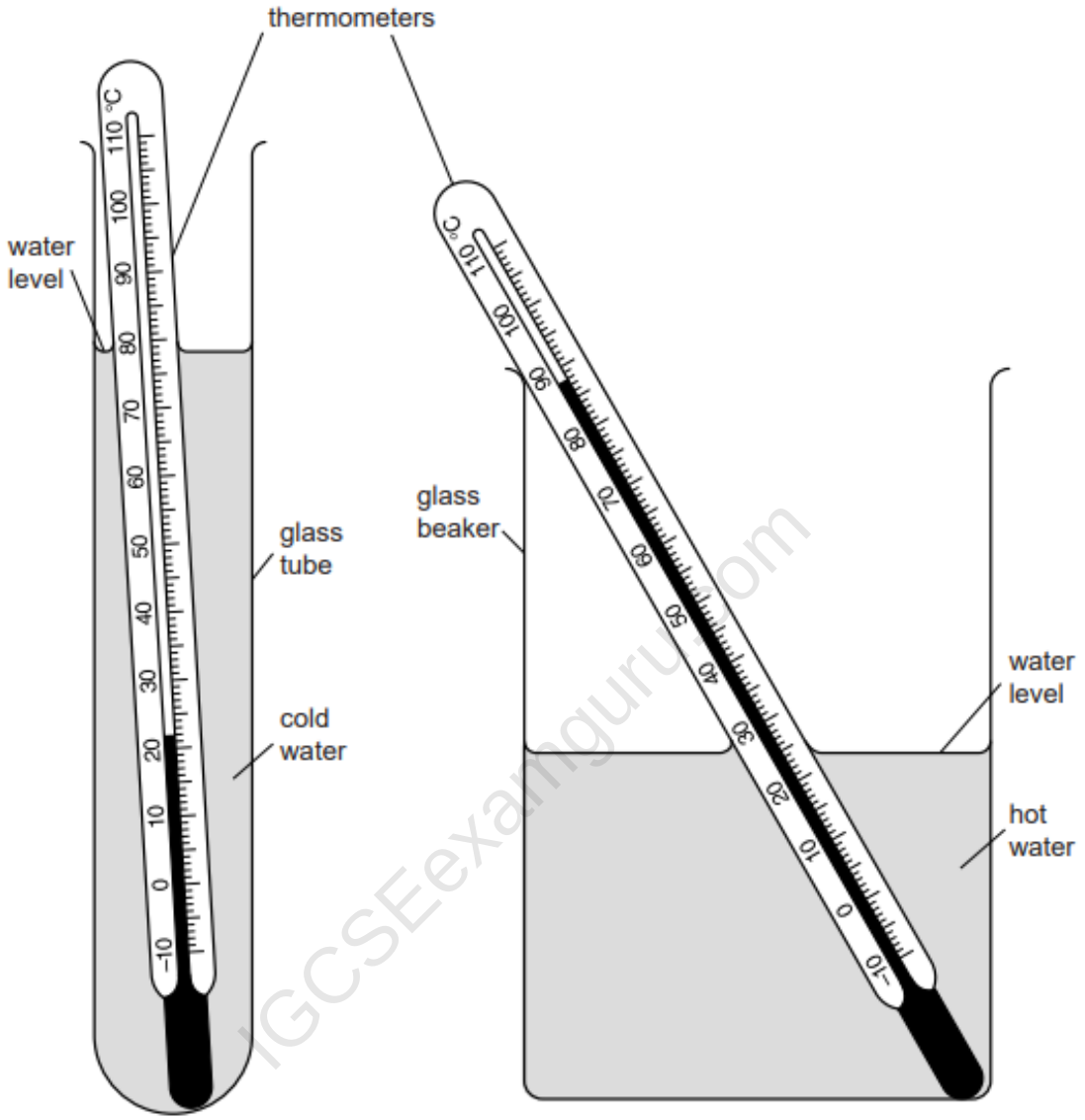


Fig. 1.1

(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]

21 The class is investigating the cooling of a thermometer bulb.

Figs. 2.1 and 2.2 show the apparatus.

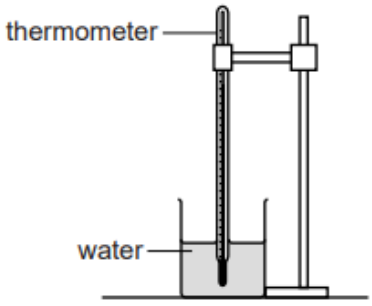


Fig. 2.1

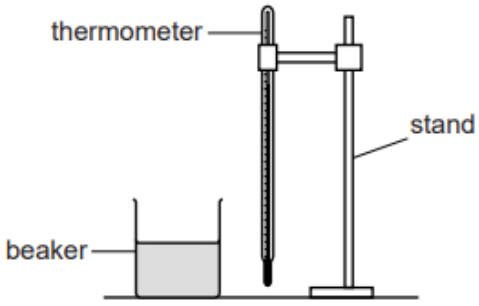


Fig. 2.2

(a) In the space in Table 2.1, record the temperature θ_1 of the hot water as shown on the thermometer in Fig. 2.3.

Fig. 2.3

(b) A student removes the thermometer from the beaker of hot water, as shown in Fig. 2.2. She immediately starts a stopclock, and records the temperature θ_1 every 10 s for 1 minute. The temperature readings are shown in Table 2.1.

Table 2.1

t/	θ_1/	θ_2/
0		33
	72	30
	65	28
	59	27
	53	26
	48	26
	43	25

She then adds 100 cm^3 of cold water to the water in the beaker and repeats the procedure. She records the temperature readings in the θ_2 column of the table.

(i) Complete the column headings in the table.

(ii) Record the time readings in the table.

[2]

(c) **(i)** Using the readings in the θ_1 column of the table, calculate the decrease in temperature $\Delta\theta_1$ in 60 s.

$\Delta\theta_1$ = ...

(ii) Using the readings in the θ_2 column of the table, calculate the decrease in temperature $\Delta\theta_2$ in 60 s.

$\Delta\theta_2$ = ...

(iii) State the reason why $\Delta\theta_2$ is less than $\Delta\theta_1$.

.....

.....

[2]

(d) State a precaution that you would take when reading the thermometer scale in order to obtain reliable readings.

.....[1]

(e) Suggest **one** reason why other students, carrying out this experiment with care, might obtain values of $\Delta\theta_1$ and $\Delta\theta_2$ different from the values in part **(c)**.

.....

.....[1]

[Total: 7]

22 The class is investigating the cooling of water.

Fig. 4.1 shows the apparatus used.

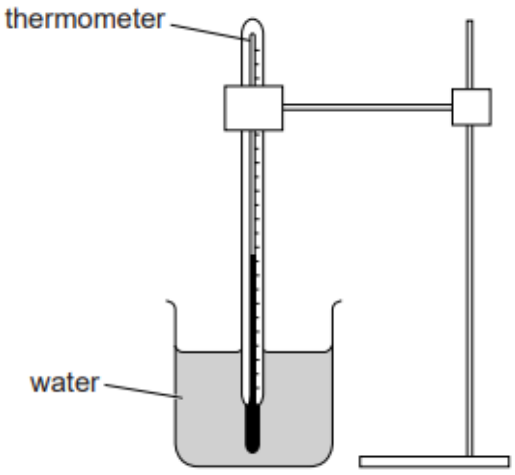


Fig. 4.1

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

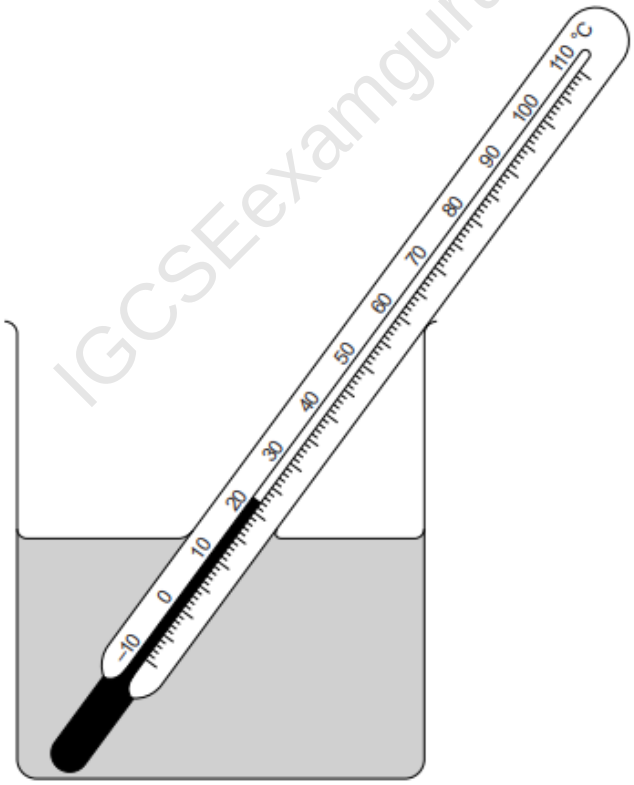


Fig. 4.2

θ_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.

θ_H = 83 °C

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.

θ_M = 46 °C

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

θ_A = ...
[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

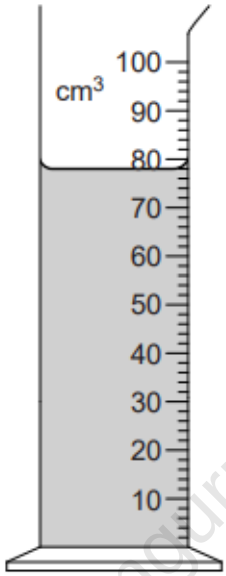


Fig. 4.3

(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]