

2.3 Thermal processes

01. 0625_m20_qp_62 Q: 2

Students are investigating the cooling of hot water in a beaker.

They are using the apparatus shown in Fig. 2.1.

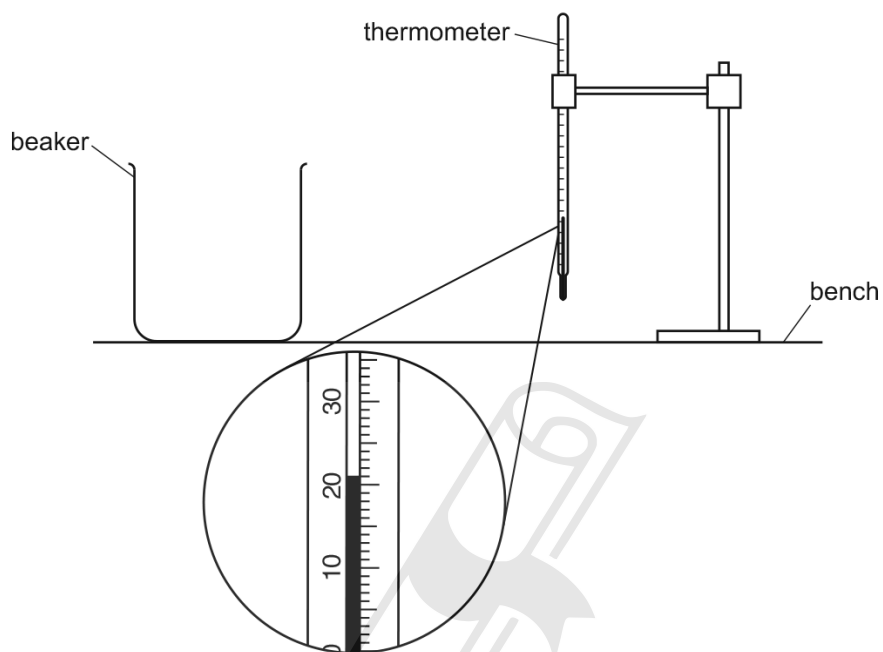


Fig. 2.1

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

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

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- (b) A volume of 150 cm^3 of hot water is poured into the beaker and the initial temperature θ is recorded in Table 2.1.
The temperature of the water is recorded every 30s. The values are shown in Table 2.1.
- (i) Complete the headings in Table 2.1. [1]

Table 2.1

$t/$	$\theta/$
0	95.0
30	89.0
60	83.5
90	79.0
120	75.0
150	71.5
180	68.5
210	66.0
240	64.0
270	62.5

- (ii) Describe **one** precaution that you would take to ensure that the temperature readings in the experiment are as accurate as possible.

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

2.3. THERMAL PROCESSES

- (c) (i) Calculate the average cooling rate x_1 during the first 90s of the experiment. Use the readings from Table 2.1 and the equation

$$x_1 = \frac{\theta_0 - \theta_{90}}{T}$$

where $T = 90\text{s}$ and θ_0 and θ_{90} are the temperatures at $t = 0$ and $t = 90\text{s}$. Include the unit for the cooling rate.

$x_1 = \dots\dots\dots$ [1]

- (ii) Calculate the average cooling rate x_2 during the middle 90s of the experiment. Use the readings from Table 2.1 and the equation

$$x_2 = \frac{\theta_{90} - \theta_{180}}{T}$$

where $T = 90\text{s}$ and θ_{90} and θ_{180} are the temperatures at $t = 90\text{s}$ and $t = 180\text{s}$.

$x_2 = \dots\dots\dots$ [1]

- (iii) Calculate the average cooling rate x_3 during the last 90s of the experiment. Use the readings from Table 2.1 and the equation

$$x_3 = \frac{\theta_{180} - \theta_{270}}{T}$$

where $T = 90\text{s}$ and θ_{180} and θ_{270} are the temperatures at $t = 180\text{s}$ and $t = 270\text{s}$.

$x_3 = \dots\dots\dots$ [1]

- (d) (i) The temperature of the water falls as time passes. Use the results from (c) to describe the pattern of the rate of cooling of the water during the experiment. Justify your answer by reference to the results.

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

- (ii) Give an estimate of the probable final temperature θ_F of the water if left to cool for many hours.

$\theta_F = \dots\dots\dots$ [1]

- (e) (i) A student in another school carries out a similar experiment. She starts with the hot water at a lower initial temperature. Suggest how her cooling rates are likely to compare with those calculated in (c). Use the results to explain your answer.

suggestion

.....

explanation

.....

.....

[2]

- (ii) State **one** variable, other than the initial temperature, which the student should control.

.....

..... [1]

[Total: 11]



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2.3. THERMAL PROCESSES

02. 0625_p20_qp_60 Q: 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.

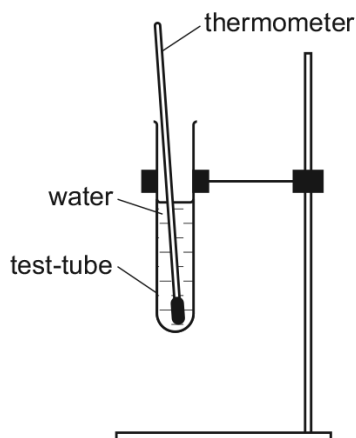


Fig. 2.1

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

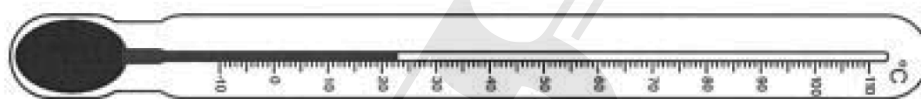


Fig. 2.2

$\theta_R = \dots\dots\dots$ [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.

2.3. THERMAL PROCESSES

- (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]



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03. 0625_s20_qp_61 Q: 4

A student investigates the effect of the colour of the surface of a metal container on the rate of loss of heat from the container. She knows that black surfaces are better radiators of thermal energy than white surfaces and wants to investigate the effect of other colours.

The following apparatus is available:

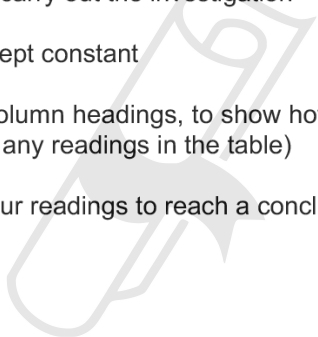
- metal containers each with the outer surface painted a different colour
- a thermometer
- a stop-watch
- a supply of hot water.

She can also use other apparatus and materials that are usually available in a school laboratory.

Plan an experiment to investigate the effect of the colour of the surface of a metal container on the rate of loss of heat from the container.

You should:

- draw a diagram of the apparatus used
- explain briefly how you would carry out the investigation
- state the key variables to be kept constant
- draw a table, or tables, with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- explain how you would use your readings to reach a conclusion.



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04. 0625_m19_qp_62 Q: 2

Students are investigating how the use of a lid or insulation affects the rate of cooling of hot water in a beaker. They use the apparatus shown in Fig. 2.1.

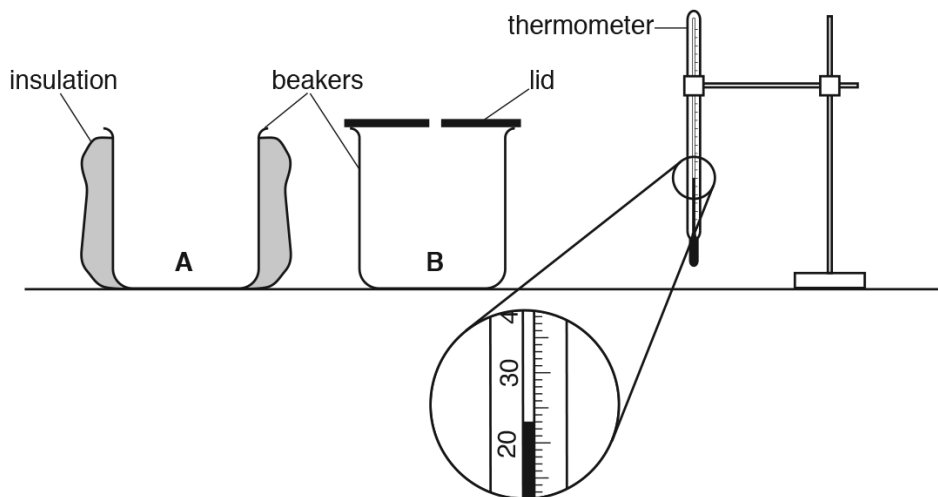


Fig. 2.1

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

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

- (b)
- 100cm³ of hot water is poured into beaker A and the initial temperature θ is recorded in Table 2.1.
 - The temperature θ of the water at times $t = 30\text{ s}, 60\text{ s}, 90\text{ s}, 120\text{ s}, 150\text{ s}$ and 180 s are shown in Table 2.1.
 - This process is repeated for beaker B.

Complete the headings and the time column in Table 2.1. [2]

Table 2.1

	beaker A with insulation	beaker B with a lid
$t/$	$\theta/$	$\theta/$
0	83.0	86.0
	79.0	84.0
	75.5	82.5
	73.0	81.0
	71.0	80.0
	69.5	79.0
	68.5	78.5

2.3. THERMAL PROCESSES

- (c) Write a conclusion stating whether the insulation or the lid is more effective in reducing the cooling rate of the water in the beakers in this experiment.

Justify your answer by reference to the results.

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..... [2]

- (d) One student thinks that the experiment does not show how effective insulation is on its own or how effective a lid is on its own.

Suggest an additional experiment which could be used to show how effective a lid or insulation is.

Explain how the additional results could be used.

additional experiment

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.....
.....

explanation

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.....

[2]



- (e) (i) Calculate x_A , the average cooling rate for beaker **A** over the whole experiment. Use the readings for beaker **A** from Table 2.1 and the equation

$$x_A = \frac{\theta_0 - \theta_{180}}{T}$$

where $T = 180\text{s}$ and θ_0 and θ_{180} are the temperatures at time $t = 0$ and time $t = 180\text{s}$. Include the unit for the cooling rate.

$x_A = \dots\dots\dots$ [2]

- (ii) Students in another school are carrying out this experiment using identical equipment.

State why they should make the initial temperature of the water the same as in this experiment if they are to obtain average cooling rates that are the same as in Table 2.1. Assume that the room temperature is the same in each case.

Use the results from beaker **A** to explain why this factor should be controlled.

statement

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explanation

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[2]

[Total: 11]



2.3. THERMAL PROCESSES

05.0625_s19_qp_61 Q: 3

A student is investigating the rate of cooling of water under different conditions. A greater rate of cooling occurs if there is a greater change in the temperature during the same period of time.

Fig. 3.1 shows some of the apparatus.

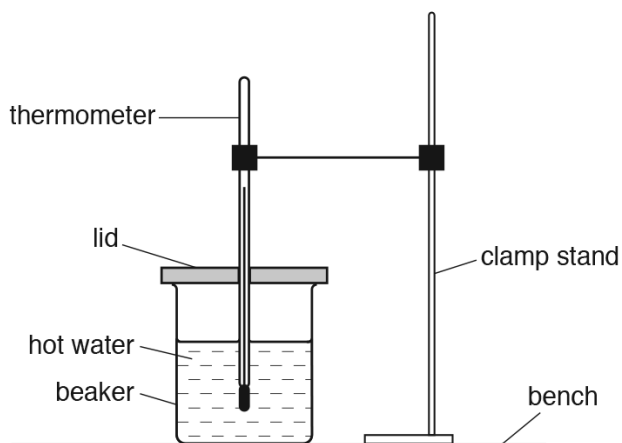


Fig. 3.1

- (a) The thermometer in Fig.3.2 shows the room temperature θ_R at the beginning of the experiment. Record θ_R .

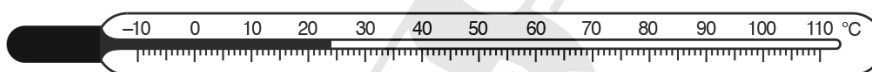


Fig. 3.2

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

- (b) The student pours 200 cm^3 of hot water into the beaker.

She records the temperature θ of the hot water at time $t = 0$. She immediately starts a stopclock.

She continues recording the time and the temperature readings every 30s. The readings are shown in Table 3.1.

Table 3.1

beaker

$t/$	$\theta/$
0	94
30	93
60	92
90	91
120	90
150	89

Table 3.2

can

$t/$	$\theta/$
0	93
30	91
60	90
90	89
120	88
150	87

The student repeats the procedure using a metal can, painted matt black, in place of the beaker.

The readings are shown in Table 3.2.

- (i) Complete the column headings in Table 3.1 and in Table 3.2. [1]
- (ii) Look carefully at the readings in Table 3.1 and in Table 3.2.

Tick the box to show your conclusion from the readings.

- The water in the beaker has a greater rate of cooling than the water in the can.
- The water in the beaker has a smaller rate of cooling than the water in the can.
- There is no significant difference between the rates of cooling of the water in the beaker and the can.

[1]

- (iii) Justify your conclusion by reference to the readings.

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.....

..... [2]

2.3. THERMAL PROCESSES

(c) A student in another school carries out the experiment and reports that the rate of cooling of the water in the can is different from the rate of cooling of the water in the beaker. He plans a change to the experiment to find out whether this difference in the rates of cooling is caused by

- the matt black surface of the can being a better radiator of thermal energy than the shiny surface of the beaker
- the metal of the can being a better conductor of thermal energy than the material of the beaker.

(i) Suggest **two** suitable changes to the apparatus that the student could make.

1.
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2.
.....
[2]

(ii) Suggest **two** variables that should be controlled in order to make the experiment a fair test.

1.
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2.
.....
[2]

(d) State **one** precaution that you would take in order to record accurate temperature readings.

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

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06. 0625_s19_qp_62 Q: 2

A student is investigating the rate of cooling of water under different conditions. A greater rate of cooling occurs if there is a greater change in the temperature during the same period of time.

Fig. 2.1 and Fig. 2.2 show the apparatus used.

Beaker A has a lid. Beaker B is on a mat made of the same material as the lid. The mat and the lid have the same thickness.

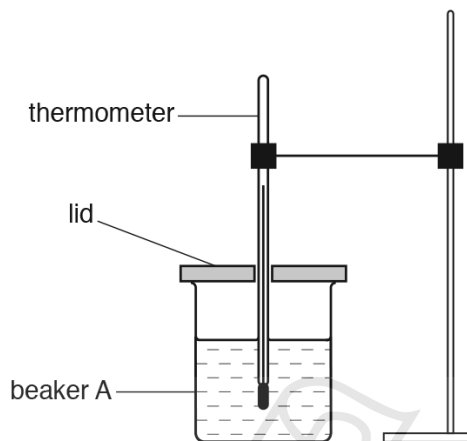


Fig. 2.1

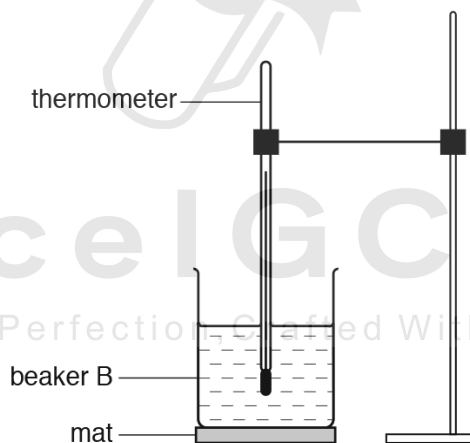


Fig. 2.2

- (a) The thermometer in Fig. 2.3 shows the room temperature θ_R at the beginning of the experiment. Record θ_R .

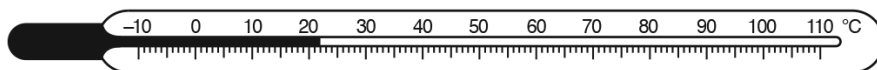


Fig. 2.3

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

2.3. THERMAL PROCESSES

- (b) The student pours 200cm³ of hot water into beaker A. He places the lid on the beaker and places the thermometer in the beaker, as shown in Fig. 2.1.

He records the temperature θ of the hot water at time $t = 0$. He immediately starts the stopclock.

He records the time and temperature readings every 30 s until he has six sets of readings.

He repeats the procedure using beaker B. This beaker is on a mat but has no lid.

All the readings are shown in Table 2.1 and Table 2.2.

Table 2.1

Beaker A, with lid	
$t/$	$\theta/$
0	81
30	80
60	79
90	78
120	77
150	76

Table 2.2

Beaker B, on a mat	
$t/$	$\theta/$
0	83
30	82
60	80
90	79
120	78
150	77

- (i) Complete the column headings in Table 2.1 and in Table 2.2. [1]

- (ii) Look carefully at the readings in Table 2.1 and in Table 2.2.

Tick the box to show your conclusion from the readings.

- The lid reduces the rate of cooling of the water significantly more than the mat reduces the rate of cooling of the water.
- The mat reduces the rate of cooling of the water significantly more than the lid reduces the rate of cooling of the water.
- There is no significant difference between the lid and the mat in reducing the rate of cooling of the water.

[1]

- (iii) Justify your conclusion by reference to the readings.

.....

..... [2]

- (c) A student plans to repeat the experiment using the same apparatus and the same volume of water. Suggest **one** change to the procedure that will decrease the rate of cooling of the water.

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

- (d) State **one** precaution that you must take in order to record accurate temperature readings.

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

- (e) Suggest **two** variables that must be controlled in order to make the experiment a fair test.

1.
.....
2.
..... [2]

- (f) It is important to view a measuring cylinder correctly to obtain an accurate value of the volume of a liquid. Tick the box that gives the best description of how to read a measuring cylinder.

- The line of sight should be along the scale.
 The line of sight should be vertical.
 The line of sight should be at right-angles to the scale.
 The line of sight should be parallel to the scale.

[1]

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[Total: 10]

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2.3. THERMAL PROCESSES

07.0625_s19_qp_63 Q: 2

A student is investigating the transfer of thermal energy between hot water in a beaker and cold water in a glass boiling tube.

He is using the apparatus shown in Fig. 2.1.

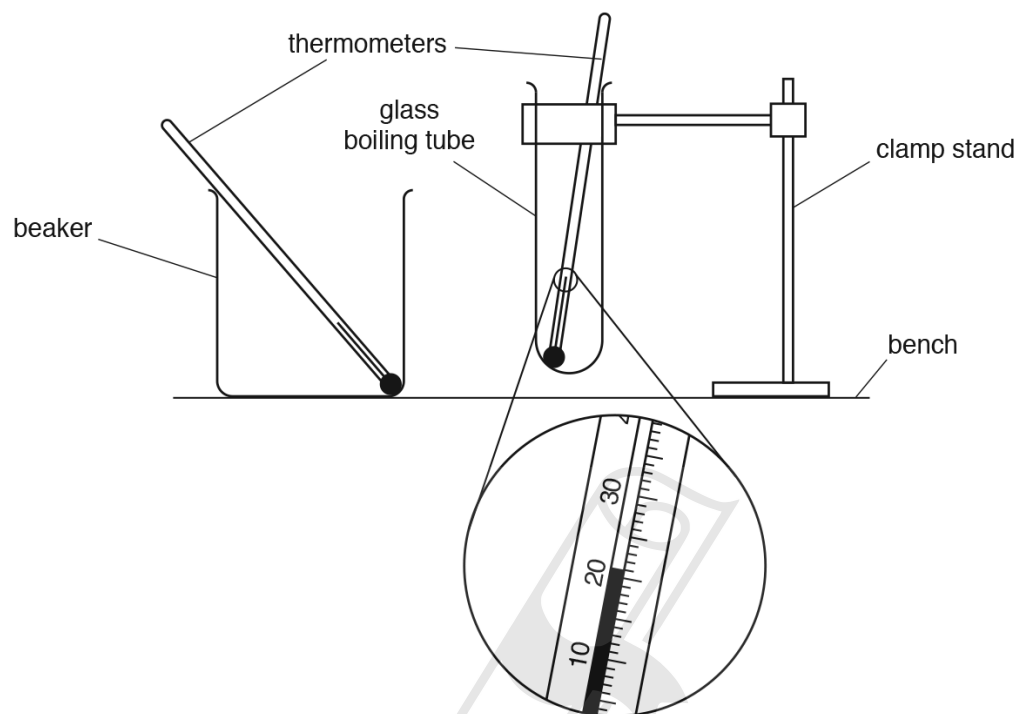


Fig. 2.1

- (a) Record the room temperature θ_R , shown on the thermometer in the boiling tube.

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

- (b) The student pours cold water into the boiling tube and hot water into the beaker. He places the boiling tube into the beaker of hot water. He then records the temperatures θ_C of the water in the boiling tube and the temperatures θ_H of the water in the beaker every 30 s.

His readings are shown in Table 2.1.

- (i) Complete the headings and the time column in Table 2.1. [2]

- (ii) It is difficult to read both thermometers every 30 s. Describe briefly a technique that would ensure the temperature readings are as accurate as possible in the experiment.

.....

 [1]

Table 2.1

	boiling tube	beaker	difference in temperature
$t/$	$\theta_C/$	$\theta_H/$	$(\theta_H - \theta_C)/$
0	19.5	88.5	69.0
	31.0	83.0	52.0
	39.5	80.0	40.5
	47.5	77.5	30.0
	54.0	75.5	21.5
	59.0	74.0	15.0
	63.0	73.0	10.0

- (c) Write a conclusion stating how the difference in temperature between the cold water and the hot water affects the rate of heating of the water in the boiling tube.

Justify your answer by reference to the readings.

.....

 [2]

2.3. THERMAL PROCESSES

- (d) (i) State what you expect the temperature in the boiling tube will be when θ_C stops rising. Justify your answer by reference to the readings.

statement

justification

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[2]

- (ii) State what you predict the temperature θ_H of the water in the beaker will be after a few hours.

$\theta_H =$ [1]

- (e) Suggest **two** changes that could be made to the apparatus or the procedure to ensure that the temperature θ_C of the cold water in the boiling tube rises more quickly.

1.

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2.

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[2]

[Total: 11]

08. 0625_w19_qp_61 Q: 3

A student investigates the cooling of water.

- (a) The thermometer in Fig. 3.1 shows room temperature θ_R at the beginning of the experiment. Record θ_R .

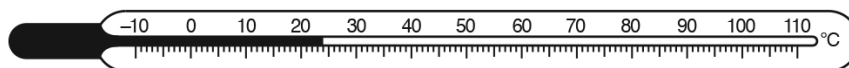


Fig. 3.1

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

- (b) • The student pours 200cm^3 of hot water into a beaker. He places a thermometer in the water.
- He measures the temperature θ of the hot water in the beaker.
 - He immediately starts the stopclock and continues recording the temperature of the water every 60s. The temperature readings are shown in Table 3.1.

Table 3.1

$t/$	$\theta/$
0	95
	89
	85
	81
	78

- (i) Complete the time column in Table 3.1. [1]
- (ii) Complete the column headings in Table 3.1. [1]

- (c) • Calculate the decrease in temperature $\Delta\theta_1$ during the **first** 120s.

$\Delta\theta_1 = \dots\dots\dots$

- Calculate the decrease in temperature $\Delta\theta_2$ during the **last** 120s.

$\Delta\theta_2 = \dots\dots\dots$ [1]

2.3. THERMAL PROCESSES

(d) (i) Tick the box to show your conclusion from the results in (c).

- The average rate of cooling is greater in the first 120s than the average rate of cooling in the last 120s.
- The average rate of cooling is less in the first 120s than the average rate of cooling in the last 120s.
- The average rate of cooling is the same in the first 120s as the last 120s.

[1]

(ii) Justify your conclusion in (d)(i) by reference to the results.

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

(e) Suggest **two** ways in which the student could reduce the rate of loss of thermal energy from the beaker in this type of experiment.

- 1
- 2

[2]

(f) Draw a diagram of a measuring cylinder being used to determine the volume of water. Show clearly the water level and draw, with a ruler, a straight line showing the line of sight required to obtain an accurate reading of the volume of water.

[2]

[Total: 11]



09. 0625_w19_qp_62 Q: 4

A student investigates the time taken for ice cubes in a container to melt using different insulating materials on the container.

The following apparatus is available:

- a copper container
- a variety of insulating materials that can be wrapped round the copper container
- a thermometer
- a stopwatch
- a supply of ice cubes

The student can also use other apparatus and materials that are usually available in a school laboratory.

Plan an experiment to investigate the time taken for ice cubes to melt using different insulating materials.

In your plan, you should:

- draw a diagram of the apparatus used
- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table, or tables, with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- explain how you would use your readings to reach a conclusion.



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10. 0625_w19_qp_63 Q: 4

A student is investigating ways of slowing the rate of cooling of hot liquids in a container. The student knows that a lid will reduce the rate of cooling. He wants to find out if the thickness of the lid makes any difference to the rate of cooling.

Plan an experiment which will enable him to compare the effects of lids of different thicknesses.

In your plan, you should:

- list the apparatus needed
- explain briefly how you would carry out the investigation, including the measurements to be taken
- state any key variables that would need to be kept the same
- draw a suitable table or tables, with column headings, to show how the readings would be displayed (you are **not** required to enter any readings in the table)
- explain how you would use your readings to reach a conclusion.

You may draw a diagram if it helps to explain your plan.



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11. 0625_m18_qp_62 Q: 2

Some students are investigating how the volume of water affects the rate at which water in a beaker cools.

They are using the apparatus shown in Fig. 2.1.

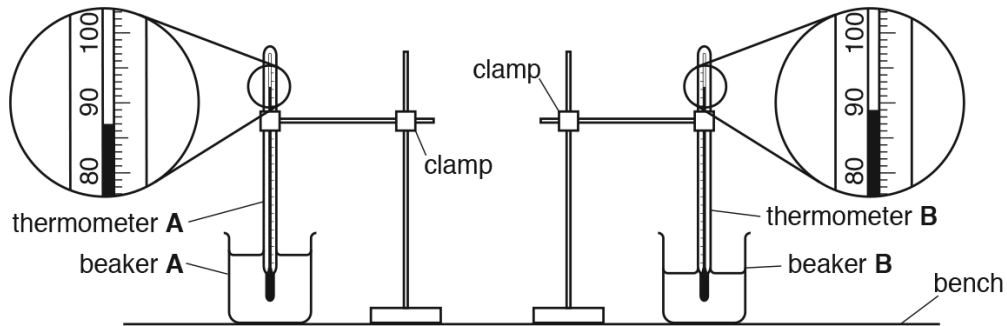


Fig. 2.1

- (a) (i) 200 cm³ of hot water is poured into beaker A and the initial temperature rises to the value shown on thermometer A in Fig. 2.1.

In the first row of Table 2.1, record this temperature θ_A for time $t = 0$.

100 cm³ of hot water is poured into beaker B. The temperature rises to the value shown on thermometer B in Fig. 2.1.

In the first row of the table, record this temperature θ_B for time $t = 0$.

[1]

- (ii) The temperatures θ_A and θ_B of the water in each experiment at times $t = 30\text{ s}$, 60 s , 90 s , 120 s , 150 s and 180 s are shown in the table.

Complete the headings and the time column in the table.

[2]

Table 2.1

	beaker A with 200 cm ³ of water	beaker B with 100 cm ³ of water
$t/$	$\theta_A/$	$\theta_B/$
0		
	85.0	86.0
	83.0	83.0
	81.5	80.5
	80.0	78.0
	78.5	76.0
	77.5	74.5

2.3. THERMAL PROCESSES

- (b) Describe one precaution which should be taken to ensure that the temperature readings in the experiment are as accurate as possible.

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[1]

- (c) Write a conclusion stating how the volume of water in the beaker affects the rate of cooling of the water. Justify your answer by reference to the results.

.....

[2]

- (d) (i) Using the results for 100cm³ of water, calculate the average rate of cooling x_1 for the **first** 90s of the experiment. Use the readings from the table and the equation

$$x_1 = \frac{\theta_0 - \theta_{90}}{t},$$

where $t = 90$ s and θ_0 and θ_{90} are the temperatures at time 0 and at time 90s. Include the unit for the rate of cooling.

$x_1 =$ [1]

- (ii) Using the results for 100cm³ of water, calculate the average rate of cooling x_2 in the **last** 90s of the experiment. Use the readings from the table and the equation

$$x_2 = \frac{\theta_{90} - \theta_{180}}{t},$$

where $t = 90$ s and θ_{90} and θ_{180} are the temperatures at time 90s and at time 180s. Include the unit for the rate of cooling.

$x_2 =$ [1]

- (e) A student suggests that it is important that the experiments with the two volumes of water should have the same starting temperatures.

State whether your values for x_1 and x_2 support this suggestion. Justify your statement with reference to your results.

statement

justification

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[1]

- (f) Another student plans to investigate whether more thermal energy is lost from the water surface than from the sides of the beakers.

Describe an experiment that could be done to investigate this.

You may draw a diagram to help your description.

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

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[Total: 11]

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2.3. THERMAL PROCESSES

12. 0625_s18_qp_61 Q:4

A student is investigating the effect of double-walled insulation on the rate of cooling of hot water in a copper container. The student places the copper container inside a larger metal container. He is investigating the effect of the size of the air gap between the copper container and larger metal containers.

Plan an experiment to investigate the effect of the size of the air gap between the copper container and larger metal containers on the rate of cooling of hot water.

The following apparatus is available:

- a copper container
- a number of metal containers of different diameters (all larger than the copper container)
- a thermometer
- a stopwatch
- a measuring cylinder
- a supply of hot water.

You can also use other apparatus and materials that are usually available in a school laboratory.

In your plan, you should:

- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table, or tables, with column headings, to show how you would display your readings (you are not required to enter any readings in the table)
- explain how you would use your readings to reach a conclusion.

You may draw a diagram if it helps your explanation.



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2.3. THERMAL PROCESSES

13. 0625_s18_qp_62 Q: 2

A student is investigating the cooling of water.

Fig. 2.1 shows the apparatus used.

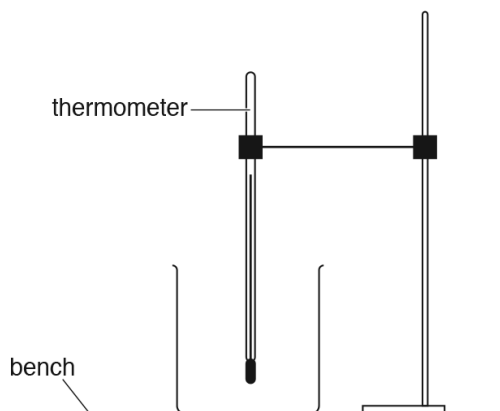


Fig. 2.1

- (a) The thermometer in Fig. 2.2 shows room temperature θ_R at the beginning of the experiment. Record θ_R .

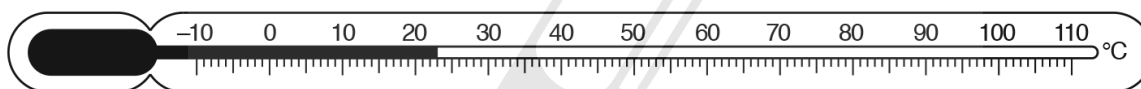


Fig. 2.2

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

- (b) The student pours 200 cm^3 of hot water into the beaker.

He records the temperature θ_H of the hot water at time $t = 0$ and immediately starts a stopclock.

He continues recording the temperature readings every 30s. The readings are shown in Table 2.1.

- (i) Explain why the student should wait a few seconds after placing the thermometer in the hot water before taking the first temperature reading.

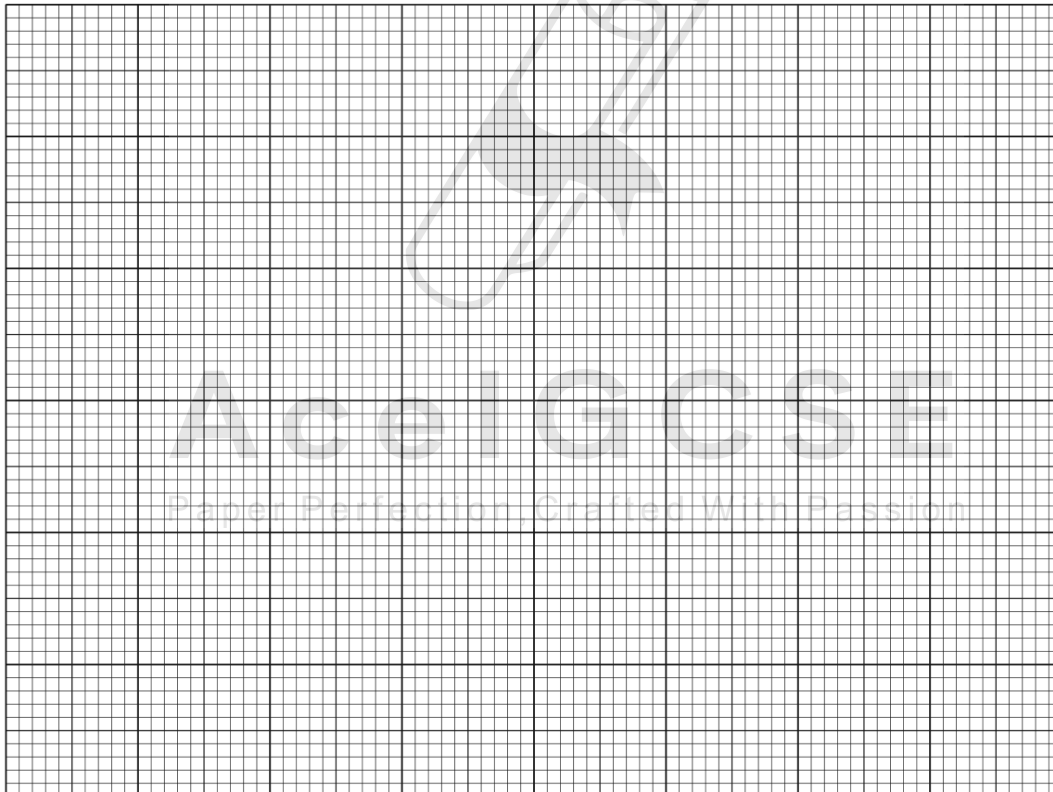
.....
 [1]

- (ii) Complete the column headings in Table 2.1. [1]
- (iii) Complete the time column in Table 2.1. [1]

Table 2.1

$t/$	$\theta/$
0	70
	60
	52
	49
	46
	43

- (iv) Plot a graph of $\theta/^\circ\text{C}$ (y -axis) against t/s (x -axis). You do **not** need to start the y -axis at the origin (0,0) but the value of room temperature θ_R must be marked on the y -axis.



[4]

2.3. THERMAL PROCESSES

(c) Draw a horizontal line across the graph grid to indicate the value of room temperature θ_R , as shown by the thermometer in Fig. 2.2. [1]

(d) State **two** precautions that you would take in order to obtain accurate readings in this experiment.

- 1.
.....
 - 2.
.....
- [2]

(e) A student plans to repeat the experiment using the same thermometer and the same volume of water.

Suggest **two** changes to the apparatus or the procedure that would **increase** the rate of cooling of the water.

- 1.
.....
 - 2.
.....
- [2]

[Total: 13]



14. 0625_s18_qp_63 Q: 1

A student is investigating how partly covering the surface of the water in a beaker affects the rate at which the water cools.

The apparatus used is shown in Fig. 1.1.

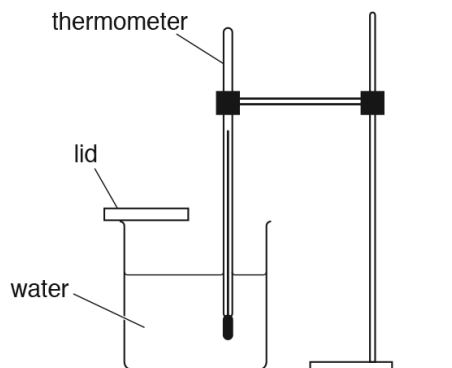


Fig. 1.1

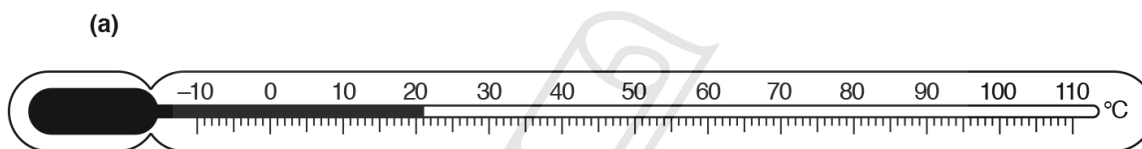


Fig. 1.2

Record the room temperature θ_R , shown on the thermometer in Fig. 1.2.

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

- (b) The student pours 100 cm^3 of hot water into a beaker. She places lid **A** on the beaker. This leaves half of the water surface uncovered, as shown in Fig. 1.3. She records the temperature of the water in the beaker and immediately starts a stopclock. She records the temperature θ of the water every 30 s. Her readings are shown in Table 1.1. She repeats the procedure using lid **B**. This leaves a quarter of the water surface uncovered, as shown in Fig. 1.4.

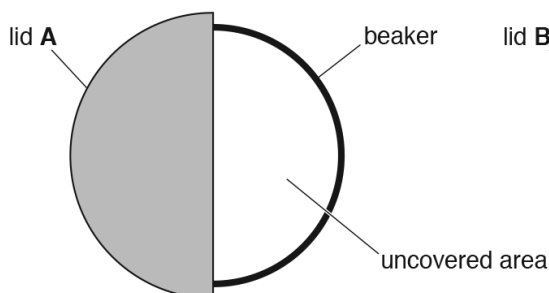


Fig. 1.3

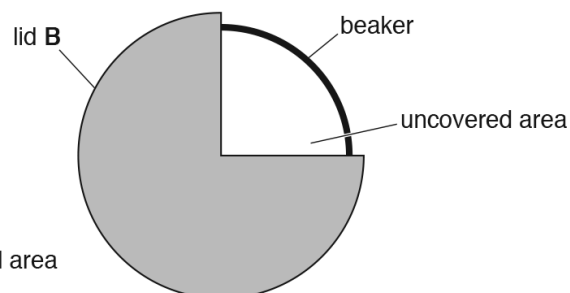


Fig. 1.4

2.3. THERMAL PROCESSES

Complete the headings and the time t column in Table 1.1.

[2]

Table 1.1

	beaker with lid A	beaker with lid B
$t/$	$\theta/$	$\theta/$
0	80.0	81.0
	77.0	79.0
	74.5	77.5
	72.5	76.0
	70.5	75.0
	69.0	74.0
	68.0	73.5

- (c) Describe a precaution that should be taken to ensure that the temperature readings are as accurate as possible in the experiment.

.....
 [1]

- (d) (i) Write a conclusion to this experiment, stating for which lid the rate of cooling is greater. Explain your answer by reference to the results.

.....

 [2]

- (ii) Suggest a change to the **apparatus** that could produce a greater difference between the rates of cooling for lid **A** and lid **B**.

Explain why the change might produce a greater difference.

change

.....

explanation

..... [2]

- (e) A student suggests that the rate of cooling is directly proportional to the percentage of the uncovered surface area. He wants to draw a graph of cooling rate against the percentage of uncovered area to investigate this.

Describe how his graph line will show whether the rate of cooling and the percentage of uncovered surface area are directly proportional.

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

- (f) Students in other countries carry out the same experiment.

Suggest **one** factor that they should keep the same if they are to obtain similar readings.

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

[Total: 11]



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2.3. THERMAL PROCESSES

16. 0625_w18_qp_63 Q: 4

A student is investigating the conduction of thermal energy by metals.

Plan an experiment to compare the rates at which different metals conduct thermal energy.

The apparatus available includes:

- strips of different metals, shaped as shown in Fig. 4.1
- a test-tube in a clamp stand
- a beaker
- a supply of cold water
- a supply of hot water.

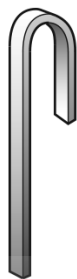


Fig. 4.1

The shorter section of each strip of metal can fit inside a test-tube.

Write a plan for the experiment.

You should:

- list any additional apparatus needed
- draw a labelled diagram of how the apparatus will be arranged
- explain briefly how you will carry out the experiment
- explain how the metals will be compared
- state the precautions which should be taken to obtain reliable results.

2.3. THERMAL PROCESSES

17.0625_m17_qp_62 Q: 1

Some students are investigating how the surrounding temperature affects the rate at which water cools.

They are using the apparatus shown in Fig. 1.1.

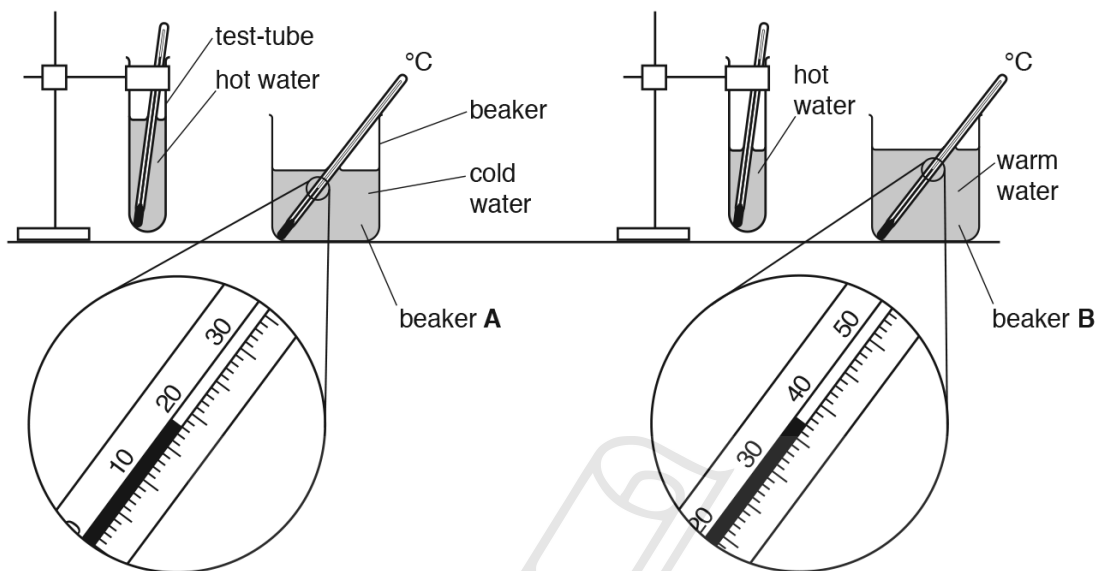


Fig. 1.1

(a) Using Fig. 1.1

- record the temperature θ_A of the cold water in beaker A,

$\theta_A = \dots\dots\dots$

- record the temperature θ_B of the warm water in beaker B.

$\theta_B = \dots\dots\dots$

[1]

- (b) The test-tubes of hot water are placed into beakers **A** and **B**.

The students record the temperatures θ of the water in the test-tubes every 30s. Their readings are shown in Table 1.1.

Complete the units and the time column in Table 1.1.

Table 1.1

time	tube in beaker A with cold water	tube in beaker B with warm water
$t/$	$\theta/$	$\theta/$
0	80.5	81.0
	52.5	64.5
	42.0	55.0
	36.0	50.5
	32.5	48.0
	30.5	46.5
	29.0	45.5

[2]

- (c) Describe **two** precautions that you would take, before reading the thermometer, to ensure that the temperature readings are as accurate as possible in the experiment.

1.
.....

2.
.....

[2]

- (d) Write a conclusion stating how increasing the temperature of the surrounding water affects the rate of cooling of the water in the test-tube.

Justify your answer by reference to the results in Table 1.1.

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

2.3. THERMAL PROCESSES

- (e) Suggest **one** change to the experiment shown in Fig. 1.1 to ensure that the comparison of the effect of surrounding temperature on cooling is a fair test.

Explain why the change is an improvement.

change

.....

explanation

.....

[2]

- (f) The students use a measuring cylinder to measure 200 cm³ of cold water.

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



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.....[2]

[Total: 11]

18. 0625_s17_qp_61 Q: 3

The class is investigating the cooling of water.

Fig. 3.1 shows the apparatus.

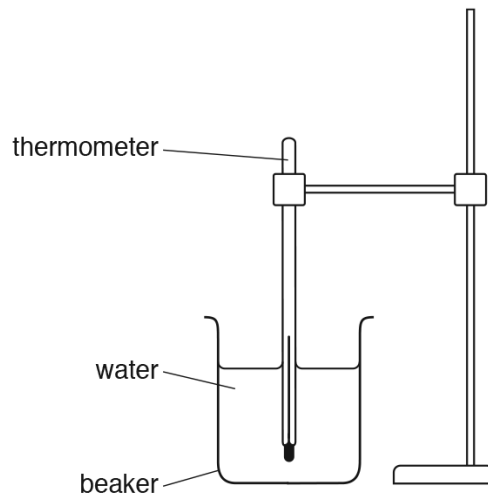


Fig. 3.1

- (a) The thermometer in Fig. 3.2 shows the room temperature θ_R at the beginning of the experiment.

Record θ_R .

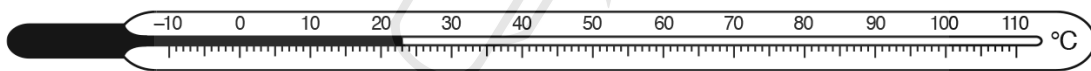


Fig. 3.2

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

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2.3. THERMAL PROCESSES

- (b)
- A student pours 200 cm³ of hot water into the beaker.
 - She measures the temperature θ of the hot water in the beaker.
 - She immediately starts a stopclock.
 - After 180 s, she measures the temperature θ of the hot water.
 - After 360 s, she measures the temperature θ of the hot water again.

The readings are shown in Table 3.1.

Table 3.1

t/s	$\theta/^\circ\text{C}$
0	85
180	74
360	66

- (i)
- Calculate the temperature fall $\Delta\theta_1$ during the first 180 s.

$\Delta\theta_1 = \dots\dots\dots$

- Calculate the temperature fall $\Delta\theta_2$ during the next 180 s.

$\Delta\theta_2 = \dots\dots\dots$ [1]

- (ii) Suggest why $\Delta\theta_1$ is different from $\Delta\theta_2$.

.....
 [1]

- (c) Another student plans to investigate the factors affecting the difference between the values of $\Delta\theta_1$ and $\Delta\theta_2$.

Suggest **two** changes that he could make to the procedure to obtain a larger value of this difference.

1.
 2.
- [2]

- (d) The volume of water used in this experiment is measured using a measuring cylinder. Fig. 3.3 shows a measuring cylinder.

A, B, C and D are four possible lines of sight that could be used to read the volume of the water.

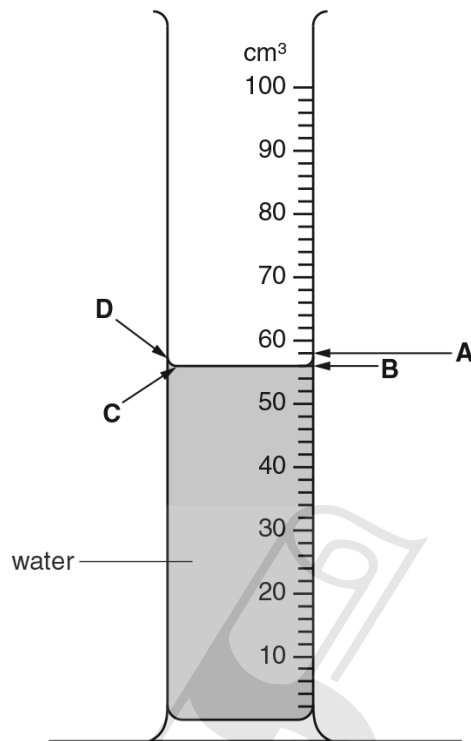


Fig. 3.3

Give **two** reasons why **B** should be used to obtain the most accurate reading.

1.
2.

[2]

[Total: 7]

2.3. THERMAL PROCESSES

19. 0625_s17_qp_62 Q: 5

A student is investigating the effect of draughts (moving air) on the rate of cooling of hot water.

The following apparatus is available to the student:

an electric fan with four speed settings
a supply of hot water
thermometer
250 cm³ beaker
250 cm³ measuring cylinder
stopwatch
clamp, boss and stand.

Plan an experiment to investigate the effect of draughts on the rate of cooling of hot water.

You should:

- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table, or tables, with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- explain how you would use your readings to reach a conclusion.

You may draw a diagram if it helps your explanation.

2.3. THERMAL PROCESSES

20. 0625_s17_qp_63 Q: 4

Plan an experiment to investigate how increasing the number of layers of insulation affects the rate of cooling of hot water in a beaker.

Write a plan for the experiment, including:

- the apparatus needed
- what you would measure
- the variables you would keep the same to ensure the comparison is a fair test
- instructions for carrying out the experiment
- how you would present your results
- how you would use your readings to reach a conclusion.

You may draw a diagram if it helps to explain your plan.



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2.3. THERMAL PROCESSES

21. 0625_w17_qp_62 Q: 2

A student is investigating the cooling of water.

- (a) The thermometer in Fig. 2.1 shows room temperature θ_R at the beginning of the experiment. Record θ_R .

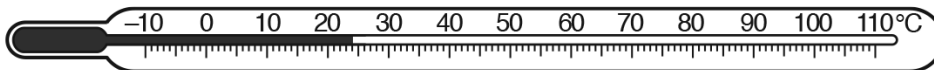


Fig. 2.1

$\theta_R = \dots\dots\dots$ °C [1]

- (b) The student pours 50 cm³ of hot water into a beaker.

He measures the temperature θ_H of the hot water.

$\theta_H = \dots\dots\dots 86$ °C

He adds 50 cm³ of cold water to the beaker. He stirs the water briefly.

He measures the new temperature θ_M of the water in the beaker.

$\theta_M = \dots\dots\dots 52$ °C

Calculate the temperature fall θ_F using the equation $\theta_F = (\theta_H - \theta_M)$.

$\theta_F = \dots\dots\dots$ [1]

- (c) He repeats the procedure in (b) using 100 cm³ of hot water and 100 cm³ of cold water.

$\theta_H = \dots\dots\dots 84$ °C

$\theta_M = \dots\dots\dots 54$ °C

Calculate the temperature fall θ_F using the equation $\theta_F = (\theta_H - \theta_M)$.

$\theta_F = \dots\dots\dots$ [1]

- (d) Suggest **one** reason for stirring the water before reading θ_M .

.....
 [1]

- (e) A student states that the temperature fall θ_F should be the same each time because the proportions of hot and cold water are the same.

Suggest **one** reason why θ_F could be significantly different in (b) and (c).

.....

 [1]

- (f) Suggest an improvement to the apparatus to make it more likely that θ_F would be the same each time.

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

- (g) Suggest a condition, not included in your answer to (f), that you would control to make it more likely that θ_F would be the same each time.

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

- (h) The student uses a measuring cylinder to measure the volume of water he uses. Draw a measuring cylinder about half-full of water. Show clearly on your diagram the line-of-sight required for obtaining a correct reading for the volume of water.



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[3]

[Total: 10]

2.3. THERMAL PROCESSES

22. 0625_w17_qp_63 Q: 1

Some students are investigating how the use of a lid affects the rate of cooling of water in a beaker.

They are using the apparatus shown in Fig. 1.1.

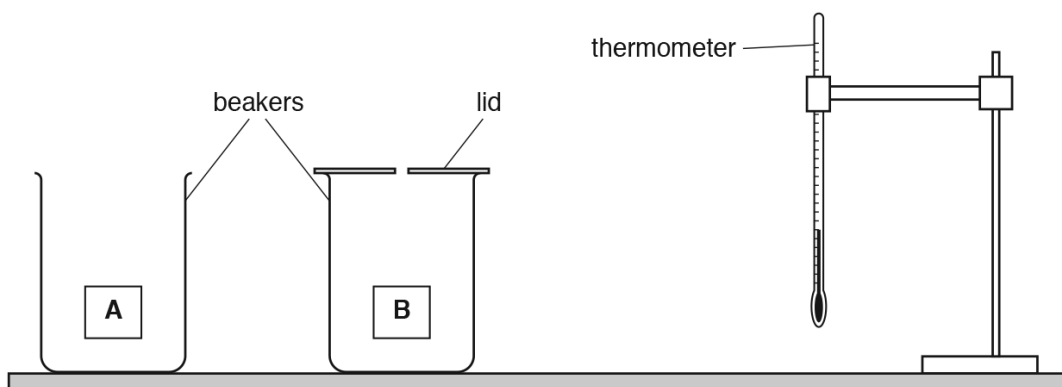


Fig. 1.1

- A student pours 100 cm^3 of hot water into beaker **A**.
- He records the temperature of the water in beaker **A** and immediately starts a stopclock.
- The student records the temperature θ of the water every 30s. His readings are shown in Table 1.1.
- The student repeats the procedure for beaker **B** using 75 cm^3 of hot water.

(a) Complete the headings and the time column in Table 1.1.

[2]

Table 1.1

	beaker A without a lid	beaker B with a lid
<i>t</i> /	<i>θ</i> /	<i>θ</i> /
	80.0	81.0
	77.0	79.0
	74.5	77.5
	72.5	76.0
	70.5	75.0
	69.0	74.0
	68.0	73.5

(b) Describe **two** precautions which should be taken to ensure that the temperature readings are as accurate as possible in the experiment.

1

.....

2

.....

[2]

(c) (i) Write a conclusion, stating how the use of the lid affects the rate of cooling of the water. Justify your answer by reference to the results.

.....

.....

.....

.....[2]

(ii) Suggest **one** change to the apparatus or procedure to make the comparison a fairer test. Explain why the change makes the test fairer.

change

.....

explanation

.....

.....[2]

(iii) The temperature of the water in each beaker decreases.

Describe **one** other similarity in the pattern of cooling in beakers **A** and **B**.

.....

.....[1]



2.3. THERMAL PROCESSES

(d)

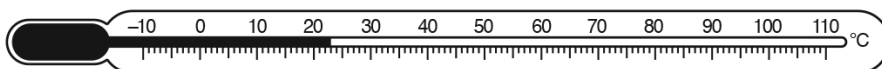


Fig. 1.2

(i) Record the room temperature θ_R , shown on the thermometer in Fig. 1.2.

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

(ii) Another student is carrying out the same experiment in a room with a room temperature that is much higher than θ_R .

Suggest whether this might affect the cooling of the water in beaker **A** in her experiment. Briefly explain your answer.

suggestion

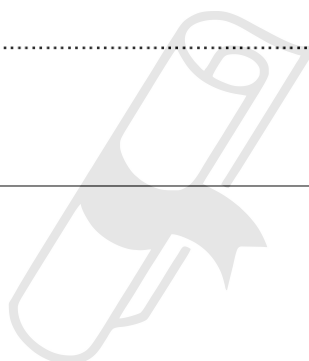
explanation

.....

.....

[1]

[Total: 11]



23. 0625_m16_qp_62 Q: 4

A student suggests that the area of the water surface will affect the rate of cooling of hot water in a container.

Plan an experiment to investigate the relationship between surface area and rate of cooling.

Write a plan for the experiment, including:

- the apparatus needed
- how you will obtain a range of surface areas
- instructions for carrying out the experiment
- the measurements you will take
- the precautions you will take to ensure that the results are as reliable as possible
- the graph you will plot from your results – you should sketch the axes, with appropriate labels.

A diagram is not required but you may draw one if it helps to explain your plan.



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24. 0625_p16_qp_60 Q: 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.

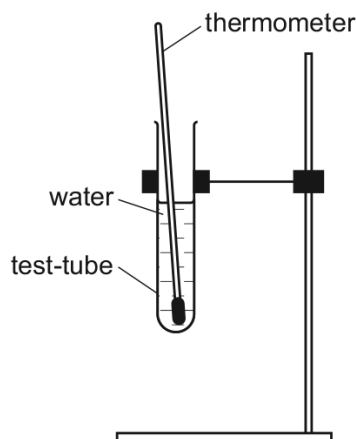


Fig. 2.1

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

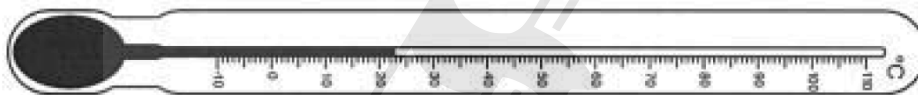


Fig. 2.2

$\theta_R = \dots\dots\dots$ [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 30s. 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.

- (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]

25. 0625_s16_qp_61 Q: 4

A student is investigating the effect of insulation on the rate of cooling of hot water in a 250 cm³ container.

The student can choose from the following apparatus:

- thermometer
- 250 cm³ glass beaker
- 250 cm³ plastic beaker
- 250 cm³ copper can
- 250 cm³ measuring cylinder
- three different insulating materials
- clamp, boss and stand
- stopwatch.

Plan an experiment to investigate the effectiveness of the three insulating materials.

You should

- explain briefly how you would carry out the investigation,
- state the key variables that you would control,
- draw a table, or tables, with column headings, to show how you would display your readings. You are not required to enter any readings in the table,
- explain how you would use your readings to reach a conclusion.

A diagram is not required but you may draw a diagram if it helps your explanation.

26. 0625_s16_qp_62 Q: 5

A student is investigating the cooling of water.

Some of the apparatus is shown in Fig. 5.1.

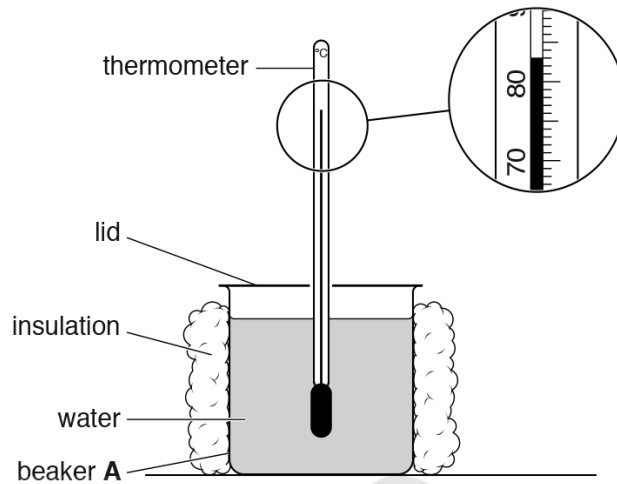


Fig. 5.1

- (a) The student pours 200 cm^3 of hot water into a 250 cm^3 insulated beaker labelled **A**. He covers the top of the beaker with a lid.

The student takes a temperature reading every 30 s as the water cools. The readings are shown in Table 5.1.

- (i) Complete the column headings in the table. [1]
- (ii) The starting temperature θ of the hot water in beaker **A** is shown on Fig. 5.1.

Record this temperature in the table at time $t = 0\text{ s}$. [1]

Table 5.1

	beaker A insulation and lid	beaker B insulation, no lid	beaker C lid, no insulation
$t/$	$\theta/$	$\theta/$	$\theta/$
0		85	78
30	80	79	74
60	77	74	71
90	75	70	68
120	73	67	66
150	71	64	64

2.3. THERMAL PROCESSES

- (b) The student repeats the procedure using a 250 cm³ beaker labelled **B**. This beaker is insulated but has no lid.

He repeats the procedure again using a 250 cm³ beaker labelled **C**. This beaker has a lid but no insulation.

All the readings are shown in Table 5.1.

- (i) Tick the statement that best describes the results of the investigation.

- Removing the lid speeds up the rate of cooling significantly more than removing the insulation.
- Removing the insulation speeds up the rate of cooling significantly more than removing the lid.
- There is no significant difference between removing the lid and removing the insulation.

[1]

- (ii) Justify your answer by reference to the readings.

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

- (c) State two of the conditions that should be kept the same in this experiment in order for the comparison to be fair.

1.
.....
2.
.....

[2]

- (d) Suggest a suitable material for the lid. Give a reason for your choice of material.

material
reason
.....

[2]

- (e) Describe briefly how a measuring cylinder is read in order to obtain a reliable value for the volume of water. You may draw a diagram.

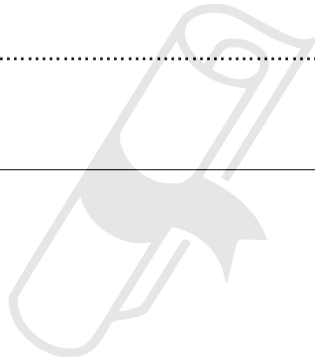
.....

.....

.....

.....[2]

[Total: 10]



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2.3. THERMAL PROCESSES

27. 0625_s16_qp_63 Q: 1

Some students are comparing the rates of cooling of two thermometer bulbs under wet and dry conditions.

They are using the apparatus shown in Fig. 1.1.

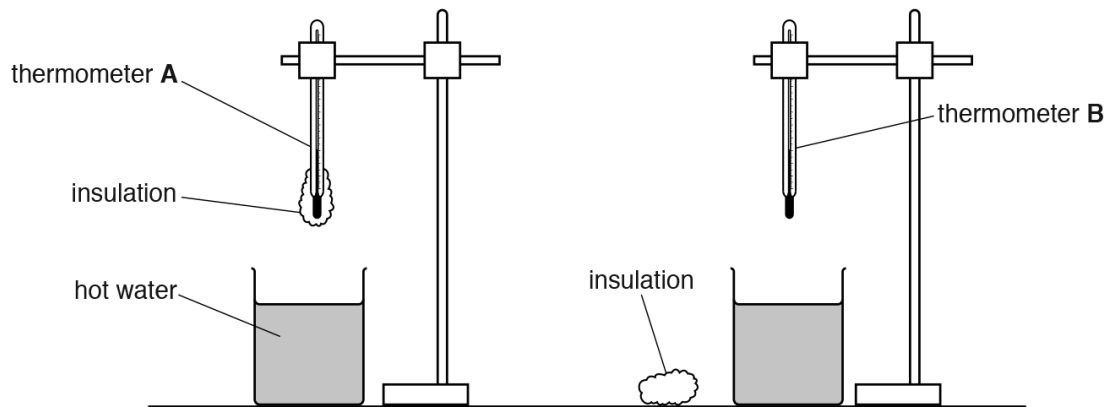


Fig. 1.1

Thermometer **A** has a layer of cotton wool insulation fixed around the bulb.

(a) Record the room temperature θ_R , as shown on the thermometer in Fig. 1.2.

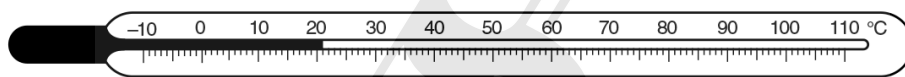


Fig. 1.2

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

- (b) • Thermometer **A** is placed into hot water, at 81.0°C, for two minutes and then removed.
- A student records, in Table 1.1, the temperature θ of the thermometer bulb every 30s.
- Thermometer **B** is placed into hot water, also at 81.0°C, for two minutes.
- The student removes thermometer **B** from the water and quickly wraps a layer of dry cotton wool insulation around the bulb.
- He then records the temperature θ of the thermometer bulb every 30s.

Complete the column headings and time column in Table 1.1.

Table 1.1

	thermometer A with wet insulation	thermometer B with dry insulation
time/	$\theta/$	$\theta/$
0	80.0	77.5
	75.0	70.5
	67.0	64.0
	59.5	59.0
	53.5	54.5
	48.0	50.5
	43.0	47.5

[2]

- (c) (i) Write a conclusion to this experiment, stating for which thermometer the cooling is faster. Explain your answer by reference to the results.

.....

[2]

- (ii) Describe what is unusual about the pattern of cooling for thermometer **A**.

.....

[1]

2.3. THERMAL PROCESSES

(d) The student first wrapped dry insulation around the bulb of thermometer **B** before starting the timing.

(i) Suggest why he did this.

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

(ii) Suggest what problem this delay in starting the timing might have caused with the procedure.

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

(e) Suggest two factors which should be kept constant to ensure that the comparison is fair.

1.
.....
2.
.....
.....[2]

[Total: 10]

28. 0625_w16_qp_61 Q: 2

A student is investigating the cooling of water.

(a) She pours 100 cm³ of hot water into a beaker.

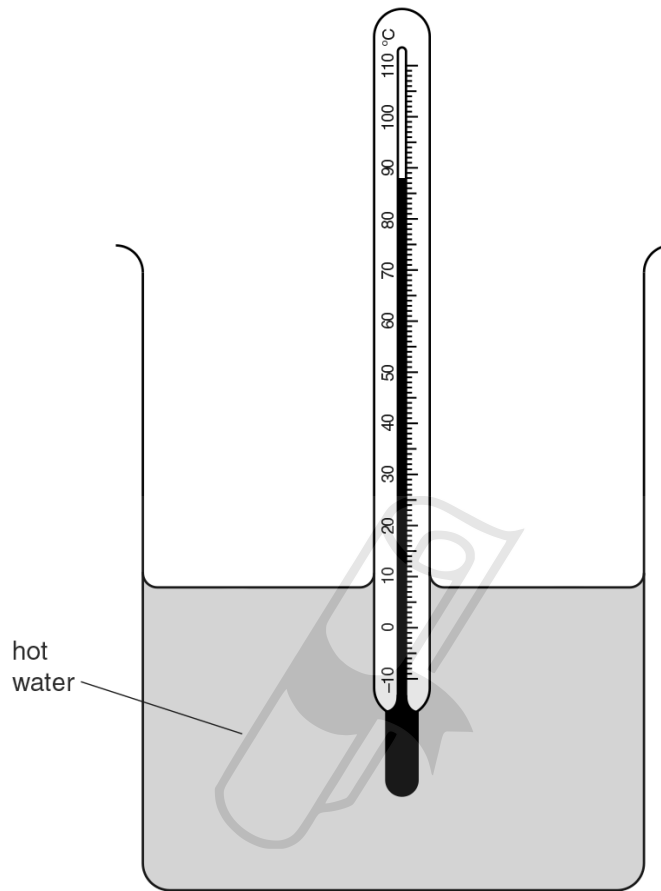


Fig. 2.1

(i) Record the temperature θ_H of the hot water, as shown in Fig. 2.1.

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

(ii) The student measures the temperature θ_C of an equal volume of cold water.

$\theta_C = \dots\dots\dots 19^\circ\text{C} \dots\dots\dots$

Calculate the average temperature θ_{AV} using the equation $\theta_{AV} = \frac{\theta_H + \theta_C}{2}$.

$\theta_{AV} = \dots\dots\dots$ [1]

2.3. THERMAL PROCESSES

- (b) The student adds the cold water to the hot water. She records the temperature θ_M of the mixture.

$$\theta_M = \dots\dots\dots 46^\circ\text{C} \dots\dots\dots$$

State **one** precaution that you would take to ensure that the temperature readings are as reliable as possible.

.....
[1]

- (c) The student is provided with:

- a lid, with a hole for the thermometer
- some insulating material
- two elastic bands.

In the space below, draw a labelled diagram to show how you would use these items to reduce the loss of thermal energy when the procedure is repeated.

- (d) Using the improvements shown in your diagram, the student repeats the procedure and obtains these readings.

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

$$\theta_C = \dots\dots\dots 20^\circ\text{C} \dots\dots\dots$$

$$\theta_{AV} = \dots\dots\dots 53^\circ\text{C} \dots\dots\dots$$

$$\theta_M = \dots\dots\dots 49^\circ\text{C} \dots\dots\dots$$

Comment on whether the improvements made to the apparatus have significantly changed the value of the temperature θ_M . Use the results to justify your answer.

.....

[1]

- (e) Suggest **two** conditions that should be kept constant for all parts, (a) to (d), of this experiment.

1.
 2.
- [2]

[Total: 8]

29. 0625_w16_qp_62 Q: 4

A student is investigating whether using a lid reduces the time taken to heat a beaker of water to boiling point.

The student has the following apparatus available:

thermometer
250 cm³ glass beaker
250 cm³ measuring cylinder
heatproof mat
lid to fit the beaker
clamp, boss and stand.

Plan an experiment to investigate whether using a lid reduces the heating time.

You should

- list the additional apparatus that you would require
- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table, with column headings, to show how you would display your readings; you are not required to enter any readings in the table
- explain how you would use your readings to reach a conclusion.

A diagram is not required but you may draw a diagram if it helps your explanation.

30. 0625_w16_qp_63 Q: 1

Some students are investigating how the surface area of water exposed to the air affects the rate at which the water cools.

They are using the apparatus shown in Fig. 1.1. Beaker **B** is bigger than beaker **A**.

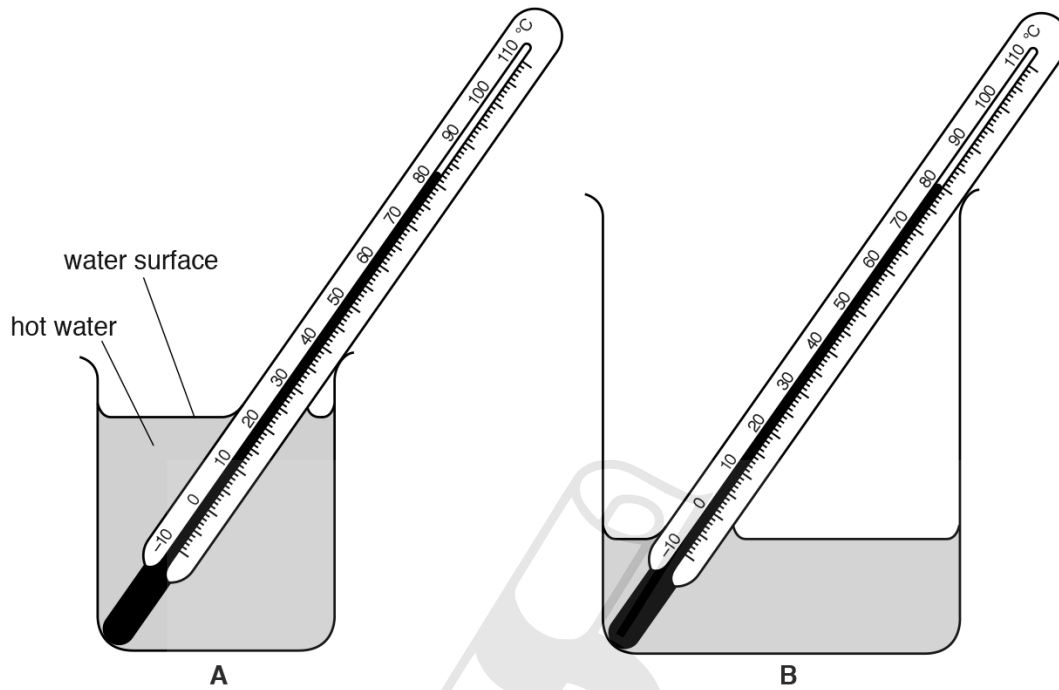


Fig. 1.1

- (a) The students pour 75 cm^3 of hot water into beaker **A** and 75 cm^3 of hot water into beaker **B**. They immediately start a stopclock.
- (i) Record, in the first row of Table 1.1, the initial temperatures θ of the water in beaker **A** and in beaker **B**, as shown in Fig. 1.1. [1]
- (ii) The students record the temperatures θ of the water every 30s. Their readings are shown in Table 1.1.

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

Table 1.1

	beaker A	beaker B
$t/$	$\theta/$	$\theta/$
0		
	80.0	76.0
	78.0	73.5
	76.5	71.0
	75.0	68.5
	73.5	66.5
	72.5	65.0

(b) Describe two precautions which should be taken, when using this apparatus, to ensure that the temperature readings are as reliable as possible in the experiment.

1.

.....

2.

.....

[2]

(c) (i) Write a conclusion, stating how increasing the surface area of the hot water affects the rate of cooling of the water. Justify your answer by reference to the results.

.....

.....

.....

.....

[2]

- (ii) Suggest a change to the apparatus to make the comparison of the effect of surface area on cooling a fairer test.

Explain why the change is an improvement and state the likely effect on the recorded temperatures.

change

.....

explanation

.....

effect on temperatures

.....

[3]

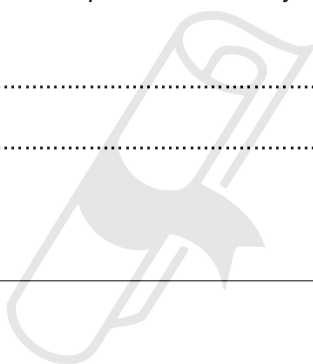
- (d) Students in other classrooms are carrying out the same experiment.

Suggest a factor that they should keep the same if they are all to obtain similar temperature readings.

.....

.....[1]

[Total: 11]



2.3. THERMAL PROCESSES

31. 0625_m15_qp_62 Q: 2

The class is investigating whether the insulation around a container affects the rate at which water cools.

Two test-tubes are set up as shown in Fig. 2.1.

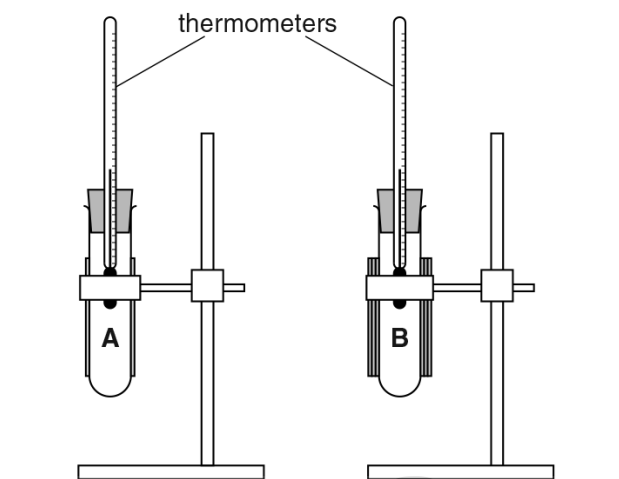


Fig. 2.1

Test-tube **A** has one layer of insulation. Test-tube **B** has three layers of insulation. This is indicated by the cross-sections of the test-tubes shown in Fig. 2.2.

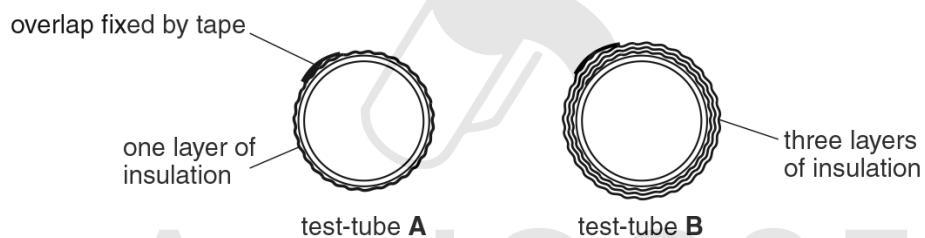


Fig. 2.2

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- (a) The students pour hot water into each test-tube, up to the level of the top of the insulation.

They record, in Table 2.1, the temperatures θ of the water in each test-tube and immediately start a stopclock. They also record the temperatures θ at times $t = 30\text{ s}$, 60 s , 90 s , 120 s , 150 s and 180 s .

Complete the table.

Table 2.1

	test-tube A (1 layer)	test-tube B (3 layers)
$t/$	$\theta/$	$\theta/$
	71.0	75.5
	68.5	73.5
	66.0	71.0
	64.0	69.5
	62.0	67.5
	60.5	66.0
	58.5	64.5

[2]

- (b) From the results in the table, state how increasing the number of layers of insulation affects the rate at which water cools. Justify your answer by referring to the results.

statement

.....

justification

.....

.....

.....

[2]

- (c) State two ways in which the temperature readings in this experiment could be made as reliable as possible.

1.

.....

2.

.....

[2]

2.3. THERMAL PROCESSES

(d) Suggest two improvements to the apparatus or procedures which will ensure that the investigation into the effect of insulation on the rate of cooling is more reliable.

1.

.....

2.

.....

[2]

[Total: 8]



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32. 0625_m15_qp_62 Q: 5

Two students are investigating thermal energy transfer.

They are using the apparatus shown in Fig. 5.1.

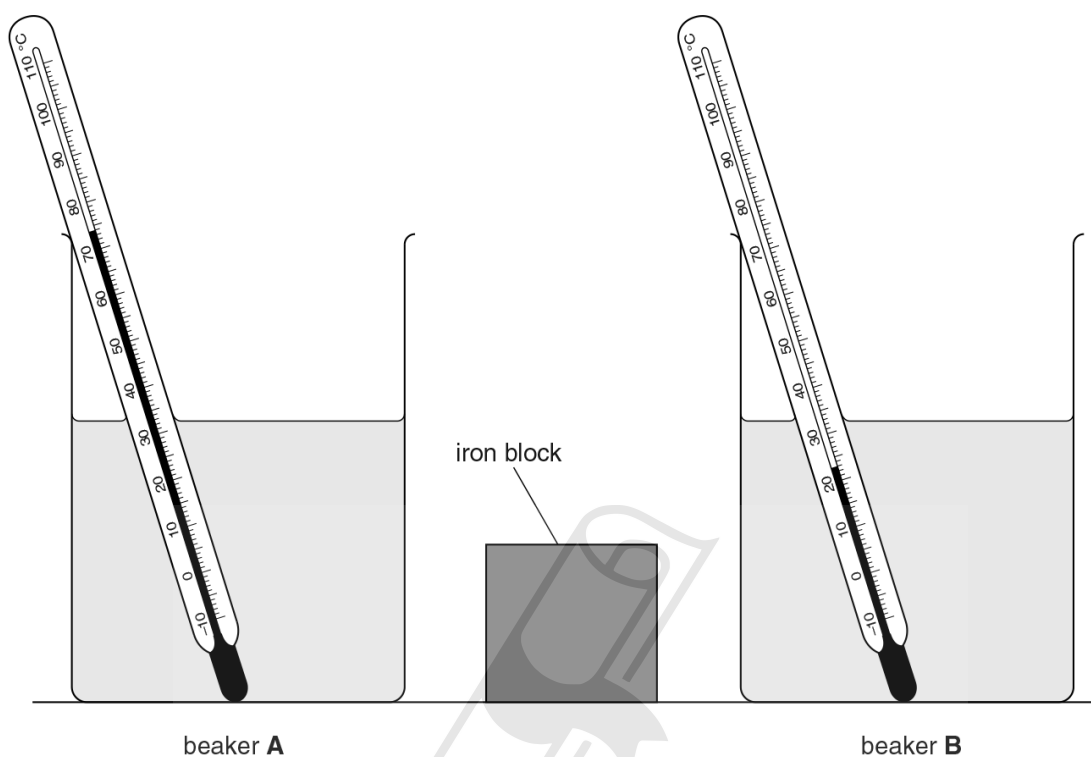


Fig. 5.1

Beaker **A** contains hot water and beaker **B** contains cold water at room temperature.

- (a) Record the temperature θ_H of the hot water and the temperature θ_C of the cold water as shown on the thermometers in Fig. 5.1.

$\theta_H =$

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$\theta_C =$

[1]

- (b) Using metal tongs, one of the students places the iron block in the hot water in beaker **A** for 30 seconds.

He then removes the block and places it in the cold water in beaker **B**.

The other student then measures the temperature of the water in beaker **B** and finds that it has risen to 35 °C. Their teacher suggests that this value is lower than expected.

2.3. THERMAL PROCESSES

- (i) The students suggest that, immediately before the iron block was put into the cold water, the temperature of the iron block was not the same as θ_H .

Suggest one reason for this and a possible improvement to the experiment which could make the temperature of the block nearer to θ_H .

reason

.....
.....

improvement

.....
.....

[2]

- (ii) The students also think that, when the block cooled in the water, not all of the thermal energy lost by the block raised the temperature of the water.

Suggest one reason for this and a possible improvement to the experiment which would reduce thermal losses.

reason

.....
.....

improvement

.....
.....

[2]

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Paper Perfection, Crafted With Passion [Total: 5]

33. 0625_s15_qp_61 Q: 2

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.

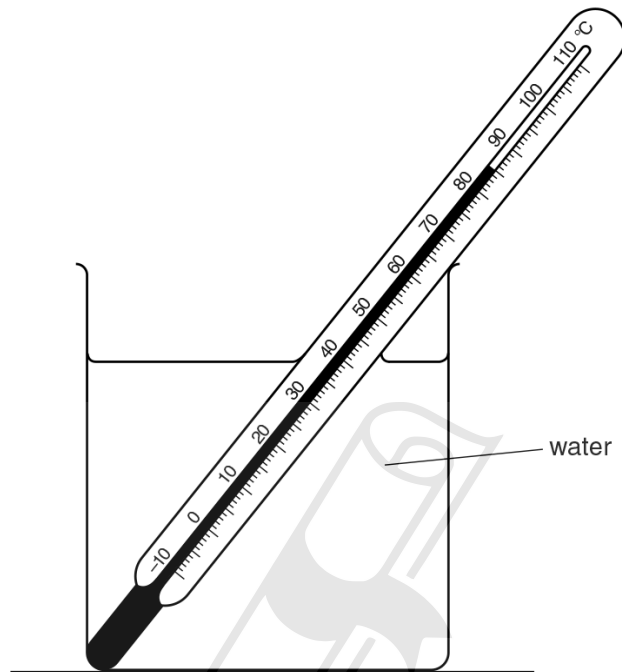


Fig. 2.1

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.

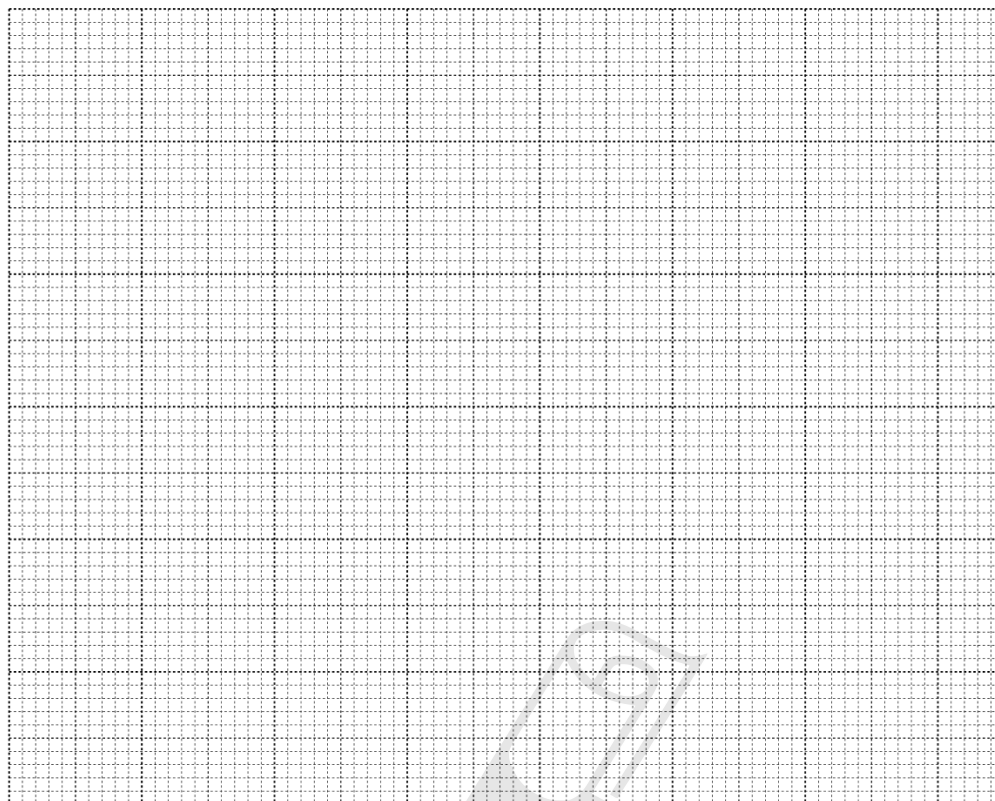
Table 2.1

$t/$	$\theta/$
0	
30	72
60	64
90	60
120	57
150	56

[2]

2.3. THERMAL PROCESSES

(c) Plot a graph of $\theta/^\circ\text{C}$ (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]

34. 0625_s15_qp_62 Q: 2

The class is investigating the cooling of water.

- (a) A student pours 100cm^3 of hot water into a beaker. He places a thermometer in the water. Fig. 2.1 shows the thermometer.

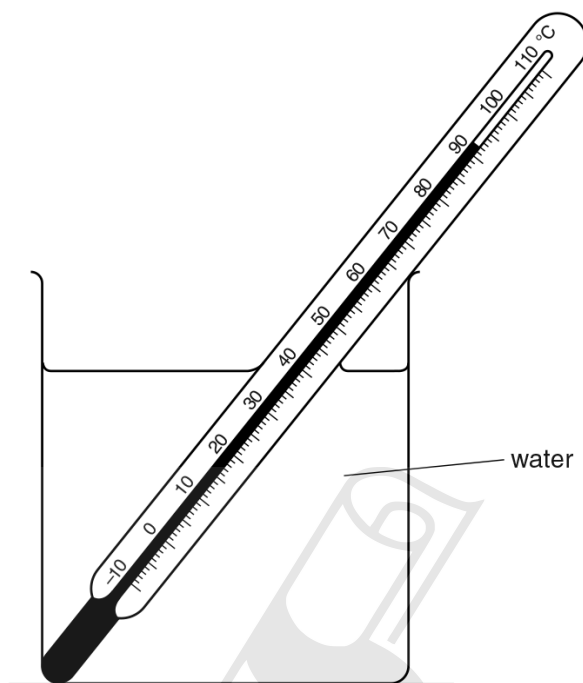


Fig. 2.1

- (i) Record the temperature θ_H of the hot water as shown on the thermometer in Fig. 2.1.

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

- (ii) State one precaution that you would take to ensure that the temperature reading for the hot water is as reliable as possible.

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 [1]

- (b) The student adds 50cm^3 of cold water to the hot water. He records the temperature θ_1 .

$\theta_1 = \dots\dots\dots 71^\circ\text{C} \dots\dots\dots$

Calculate the decrease in temperature θ_A using the equation $\theta_A = (\theta_H - \theta_1)$.

$\theta_A = \dots\dots\dots [1]$

2.3. THERMAL PROCESSES

- (c) The student adds a further 100cm³ of cold water to the water in the beaker. He records the temperature θ_2 .

$\theta_2 = \dots\dots\dots 57^\circ\text{C} \dots\dots\dots$

Calculate the decrease in temperature θ_B using the equation $\theta_B = (\theta_1 - \theta_2)$.

$\theta_B = \dots\dots\dots$ [1]

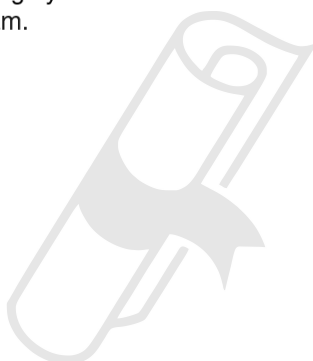
- (d) Suggest two factors, other than the volume and temperature of the cold water added, that affect the decrease in temperature of the hot water.

1.
.....

2.
.....

[2]

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



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.....
.....
.....

[2]

[Total: 8]

35. 0625_s15_qp_63 Q: 2

A student is studying the cooling of water.

She is using the apparatus shown in Fig. 2.1.

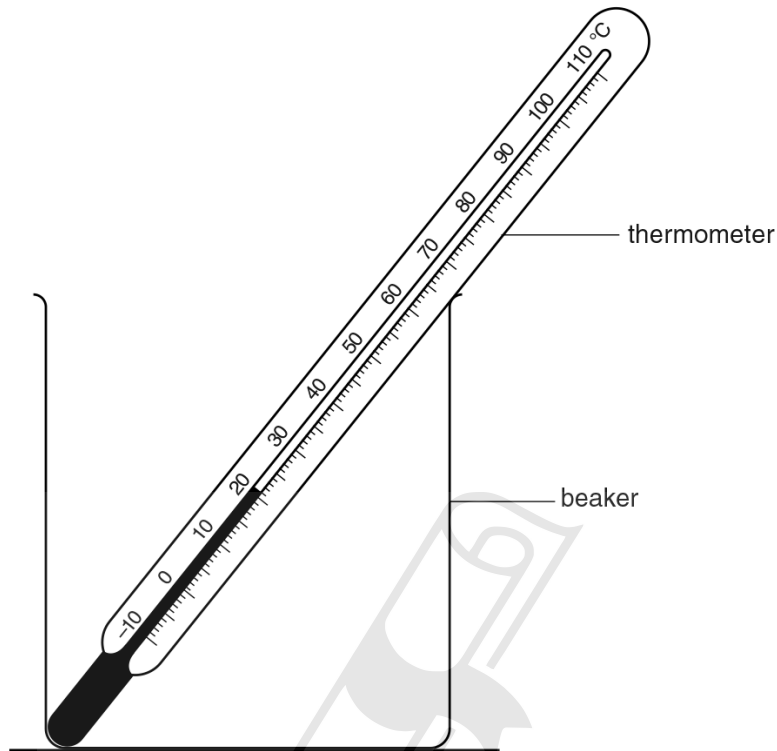


Fig. 2.1

(a) Record the room temperature θ_R as indicated by the thermometer in Fig. 2.1.

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

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2.3. THERMAL PROCESSES

(b) The student pours approximately 100 cm³ of hot water into the beaker.

She reads the thermometer at the start of the experiment and again at times $t = 30\text{ s}$, 60 s , 90 s , 120 s , 150 s , 180 s , 210 s , 240 s and 270 s .

Her readings of the temperature θ are shown in Table 2.1.

Complete the table.

Table 2.1

t/s	$\theta/^\circ\text{C}$
0	85.0
	82.0
	80.0
	77.5
	75.5
	74.0
	72.0
	70.5
	69.0
	67.5

[1]

(c) (i) Calculate the average cooling rate x_1 for the first 90 s of the experiment. Use the readings from the table and the equation $x_1 = \frac{(\theta_0 - \theta_{90})}{T}$, where $T = 90\text{ s}$ and θ_0 and θ_{90} are the temperatures at 0 s and 90 s. Give the unit for the cooling rate.

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Paper Perfection, Crafted With Passion.....[2]

- (ii) Calculate the average cooling rate x_2 in the next 90 s of the experiment. Use the readings from the table and the equation $x_2 = \frac{(\theta_{90} - \theta_{180})}{T}$, where $T = 90$ s and θ_{90} and θ_{180} are the temperatures at 90 s and 180 s.

$x_2 = \dots\dots\dots$

- (iii) Calculate the average cooling rate x_3 in the last 90 s of the experiment. Use the readings from the table and the equation $x_3 = \frac{(\theta_{180} - \theta_{270})}{T}$, where $T = 90$ s and θ_{180} and θ_{270} are the temperatures at 180 s and 270 s.

$x_3 = \dots\dots\dots$ [1]

- (d) Use your results from (c) to predict the average cooling rate x_4 for the next 90 s, if the experiment had been carried on for a longer time. Justify your prediction by reference to your results.

prediction for $x_4 = \dots\dots\dots$
 justification $\dots\dots\dots$
 $\dots\dots\dots$
 $\dots\dots\dots$ [2]

- (e) State two precautions that you would take in this experiment to ensure that the temperature readings are as reliable as possible.

1. $\dots\dots\dots$
 $\dots\dots\dots$
 2. $\dots\dots\dots$
 $\dots\dots\dots$ [2]

[Total: 9]

2.3. THERMAL PROCESSES

36. 0625_w15_qp_61 Q: 4

The class is investigating the cooling of water.

Fig. 4.1 shows the apparatus used.

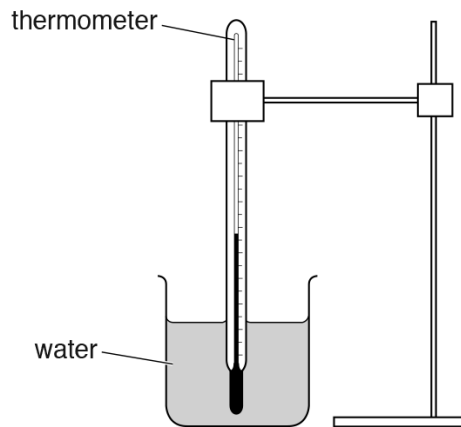


Fig. 4.1

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

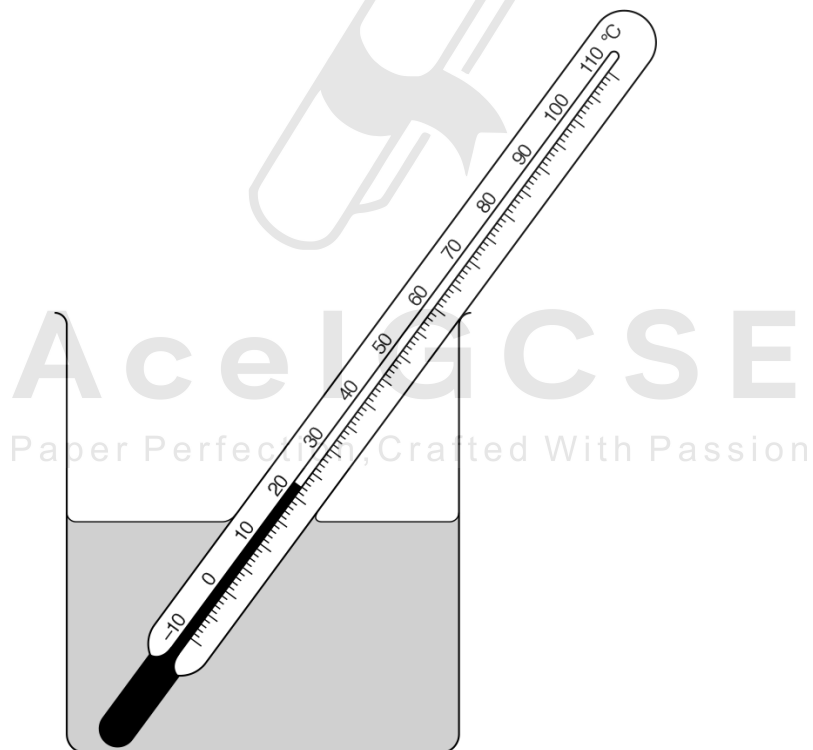


Fig. 4.2

$\theta_C = \dots\dots\dots$ [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.

$$\theta_H = \dots\dots\dots 83^\circ\text{C}$$

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.

$$\theta_M = \dots\dots\dots 46^\circ\text{C}$$

Calculate the average temperature θ_A of the hot water and the cold water using the equation

$$\theta_A = \frac{(\theta_H + \theta_C)}{2}.$$

$$\theta_A = \dots\dots\dots [1]$$

- (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]

2.3. THERMAL PROCESSES

(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

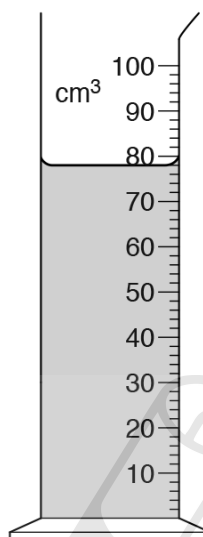


Fig. 4.3

(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]

37. 0625_w15_qp_62 Q: 2

The class is investigating the cooling of a thermometer bulb.

Figs. 2.1 and 2.2 show the apparatus.

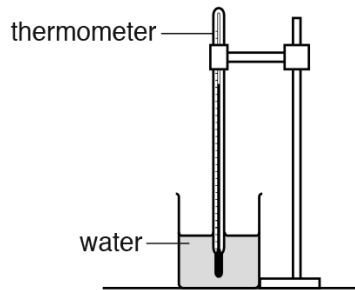


Fig. 2.1

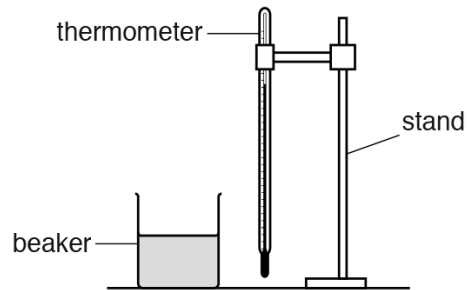


Fig. 2.2

- (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.

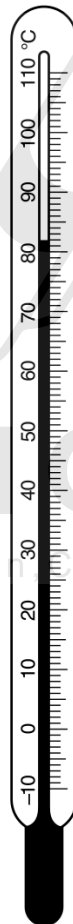


Fig. 2.3

[1]

2.3. THERMAL PROCESSES

- (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 10s for 1 minute. The temperature readings are shown in Table 2.1.

Table 2.1

$t/$	$\theta_1/$	$\theta_2/$
0		33
	72	30
	65	28
	59	27
	53	26
	48	26
	43	25

She then adds 100 cm³ 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 60s.

$\Delta\theta_1 = \dots\dots\dots$

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

$\Delta\theta_2 = \dots\dots\dots$

- (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]



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2.3. THERMAL PROCESSES

38. 0625_w15_qp_63 Q: 1

A student is investigating the transfer of thermal energy.

He uses the apparatus shown in Fig. 1.1.

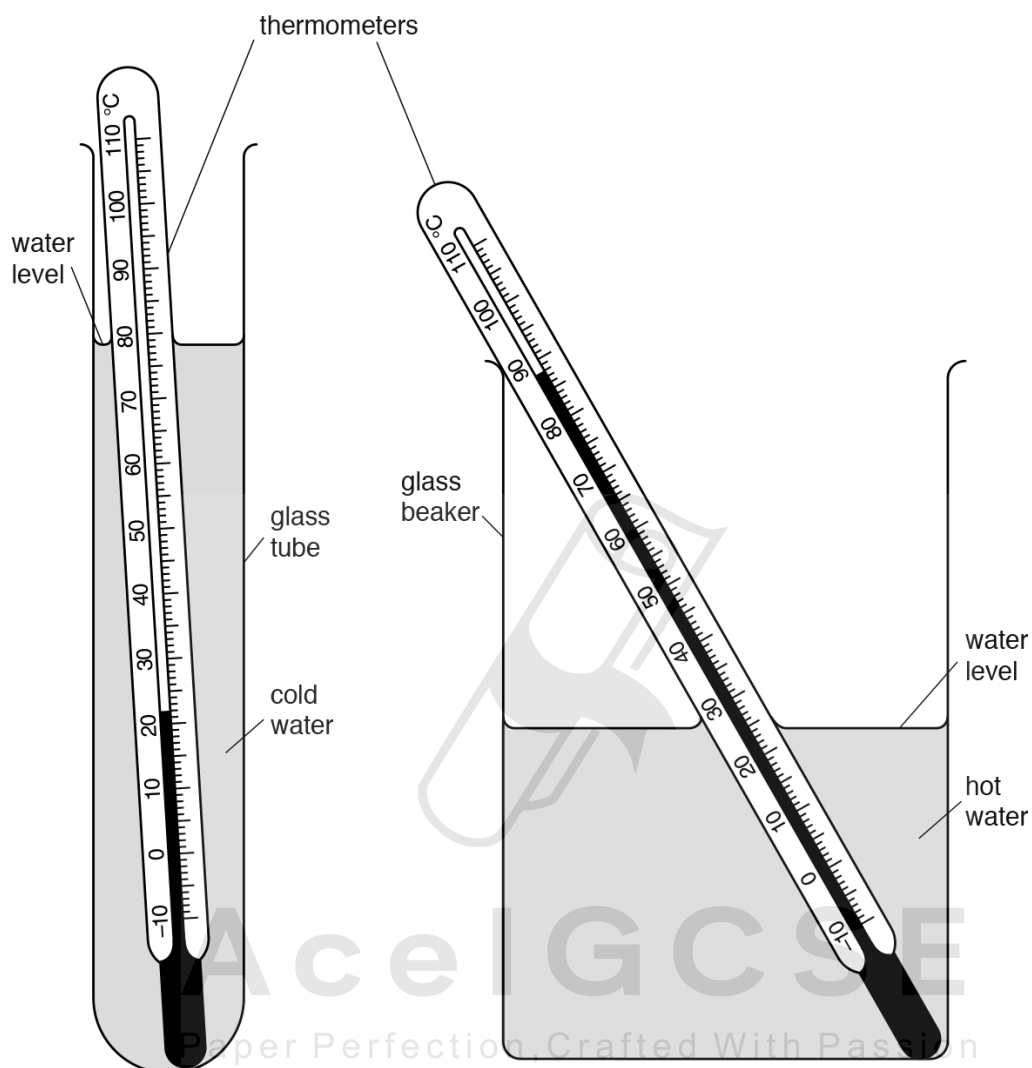


Fig. 1.1

- (a) The student pours 50 cm³ of cold water into the glass tube and 300 cm³ 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

$t/$	tube with 50 cm ³ of cold water		tube with 25 cm ³ of cold water	
	$\theta_C/$	$\theta_H/$	$\theta_C/$	$\theta_H/$
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 $t = 30\text{ s}, 60\text{ s}, 90\text{ s}, 120\text{ s}, 150\text{ s}$ 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]

2.3. THERMAL PROCESSES

- (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]



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39. 0625_s14_qp_61 Q: 2

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.

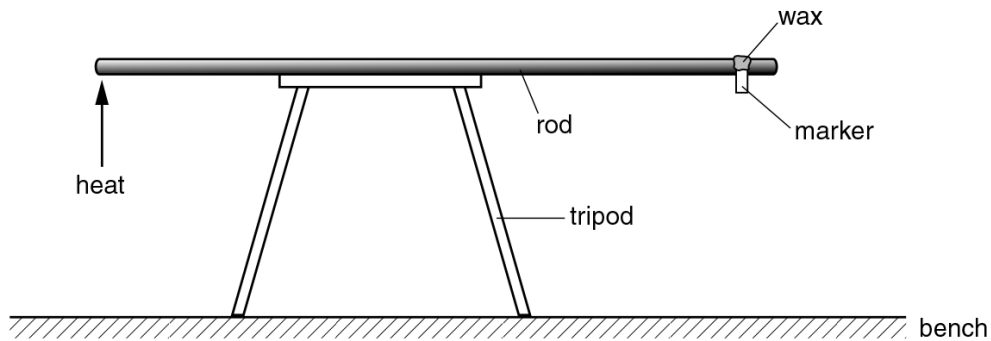


Fig. 2.1

- (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]

2.3. THERMAL PROCESSES

40. 0625_s14_qp_61 Q: 3

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.

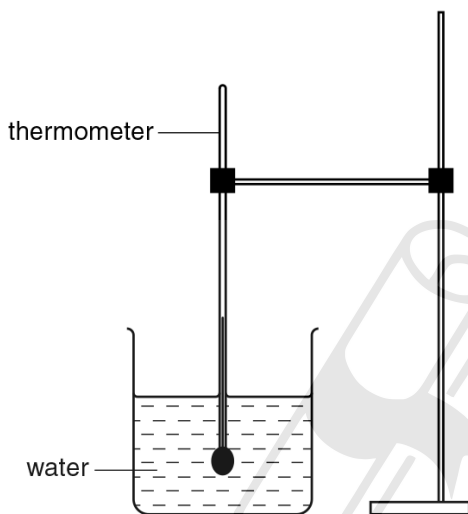


Fig. 3.1

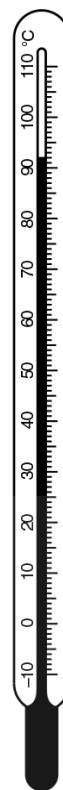


Fig. 3.2

- (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
$t/$	$\theta/$	$\theta/$
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.

$$\theta_H \dots\dots\dots 90^\circ\text{C}$$

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]

2.3. THERMAL PROCESSES

41. 0625_s14_qp_62 Q: 2

The IGCSE class is investigating the cooling of water.

A student places a thermometer into a beaker containing 200 cm³ of hot water, as shown in Fig. 2.1.

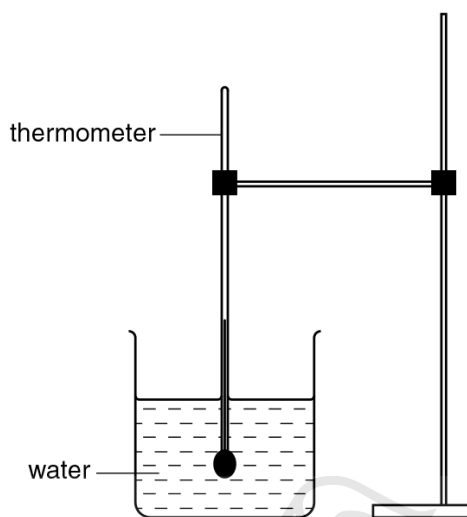


Fig. 2.1

- (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.

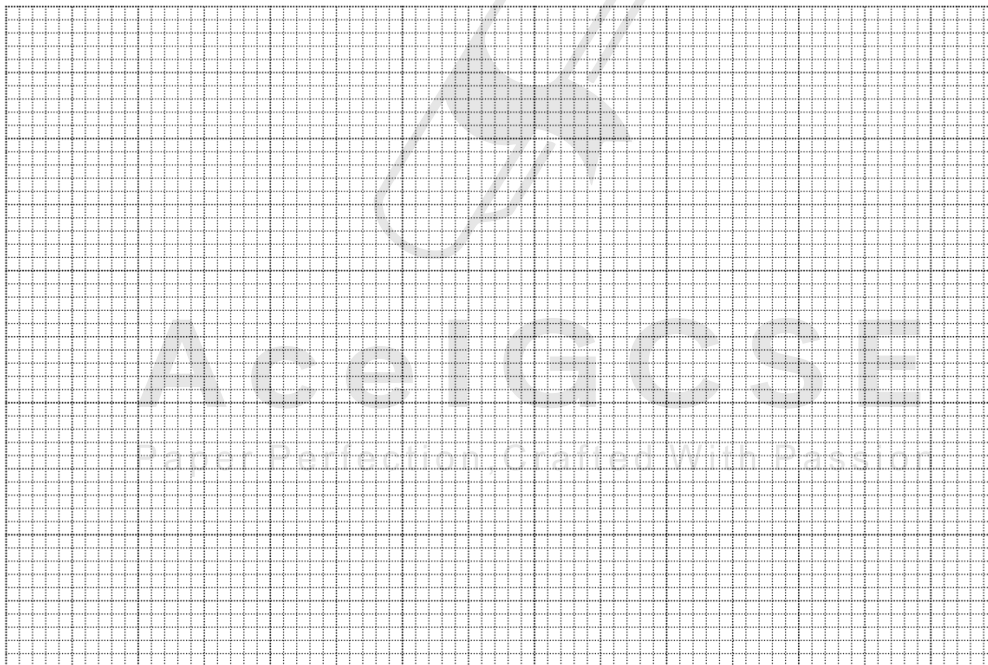
Table 2.1

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

Complete the column headings in the table.

[2]

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



[5]

2.3. THERMAL PROCESSES

(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.



.....

.....

.....

.....

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[1]

Paper Perfection, Crafted With Passion [Total: 10]

42. 0625_s14_qp_63 Q: 2

The IGCSE class is investigating the cooling of water.

The apparatus is shown in Figs. 2.1 and 2.2.

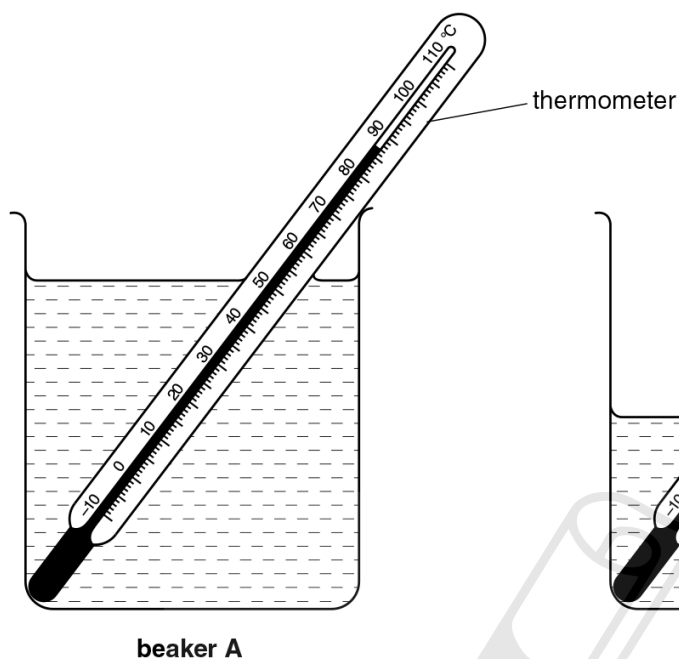


Fig. 2.1

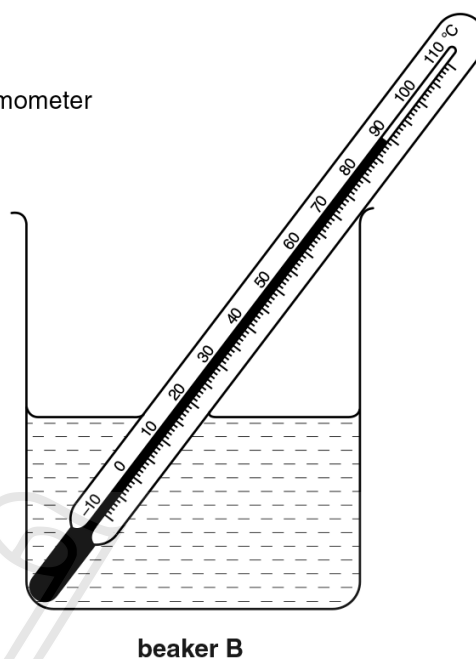


Fig. 2.2

- (a) Approximately 200cm^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 100cm^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 $t = 30\text{ s}$, 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
<i>t</i> /	<i>θ</i> /	<i>θ</i> /
	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

.....
 Paper Perfection, Crafted With Passion

[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]

43. 0625_w14_qp_61 Q: 2

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

Figs. 2.1 and 2.2 show the apparatus used.

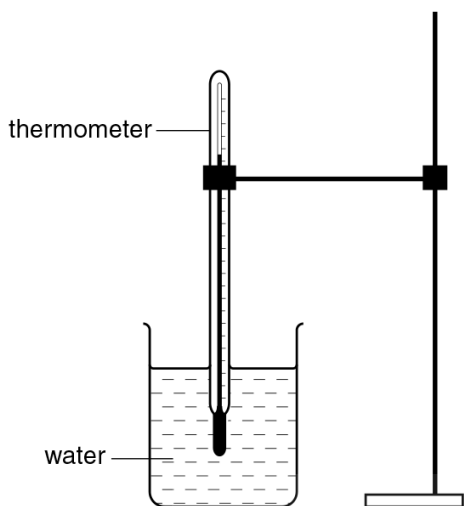


Fig. 2.1

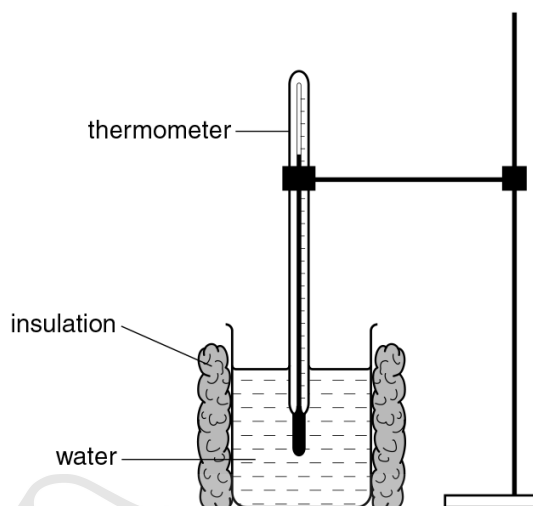


Fig. 2.2

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

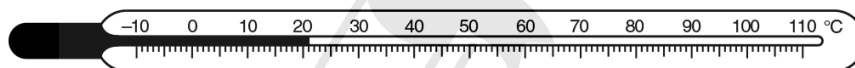


Fig. 2.3

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

- (b) A student pours hot water into the un-insulated 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.

Paper Perfection Gifted With Passion **Table 2.1**

	without insulation	with insulation
$t/$	$\theta/$	$\theta/$
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]

2.3. THERMAL PROCESSES

- (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.

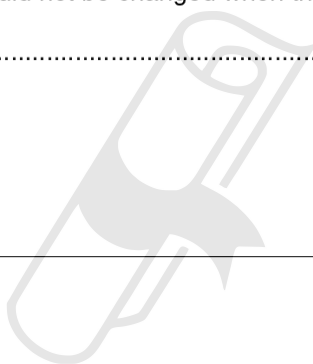
Suggest how you would reduce the evaporation in this experiment.

.....[1]

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

.....[1]

[Total: 6]



44. 0625_w14_qp_62 Q: 2

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

The apparatus is shown in Fig. 2.1.

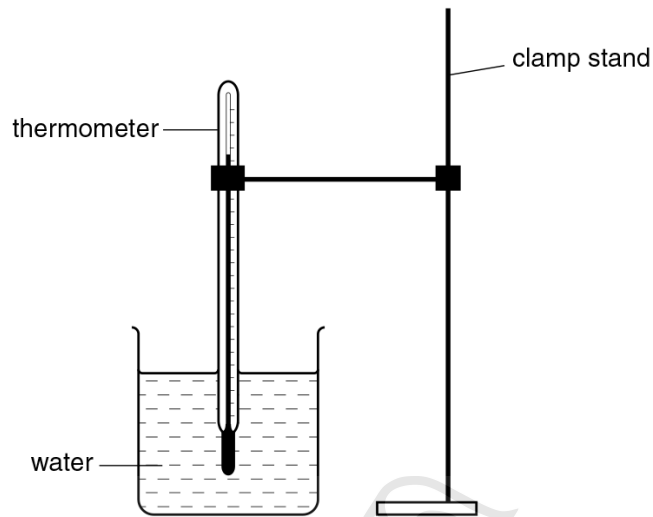


Fig. 2.1

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

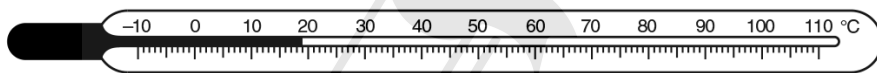


Fig. 2.2

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

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2.3. THERMAL PROCESSES

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

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

Table 2.1

$V/$	$\theta/$
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.

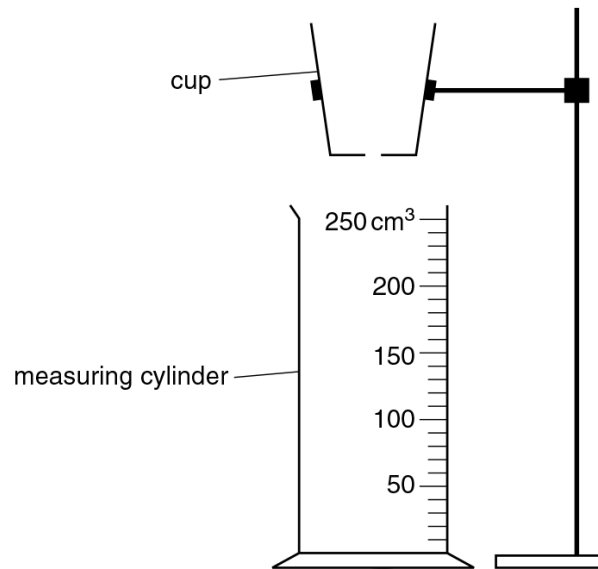


Fig. 2.3

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

2.3. THERMAL PROCESSES

- (i) Calculate the average rate of flow of water R_1 for the first 50 cm^3 , using the equation

$$R_1 = \frac{k}{t_1}, \text{ where } k = 50 \text{ cm}^3.$$

$$R_1 = \dots\dots\dots$$

- (ii) Calculate the average rate of flow of water R_2 for the next 50 cm^3 , using the equation

$$R_2 = \frac{k}{t_2}, \text{ where } k = 50 \text{ cm}^3.$$

$$R_2 = \dots\dots\dots [2]$$

- (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]

45. 0625_w14_qp_63 Q: 2

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.

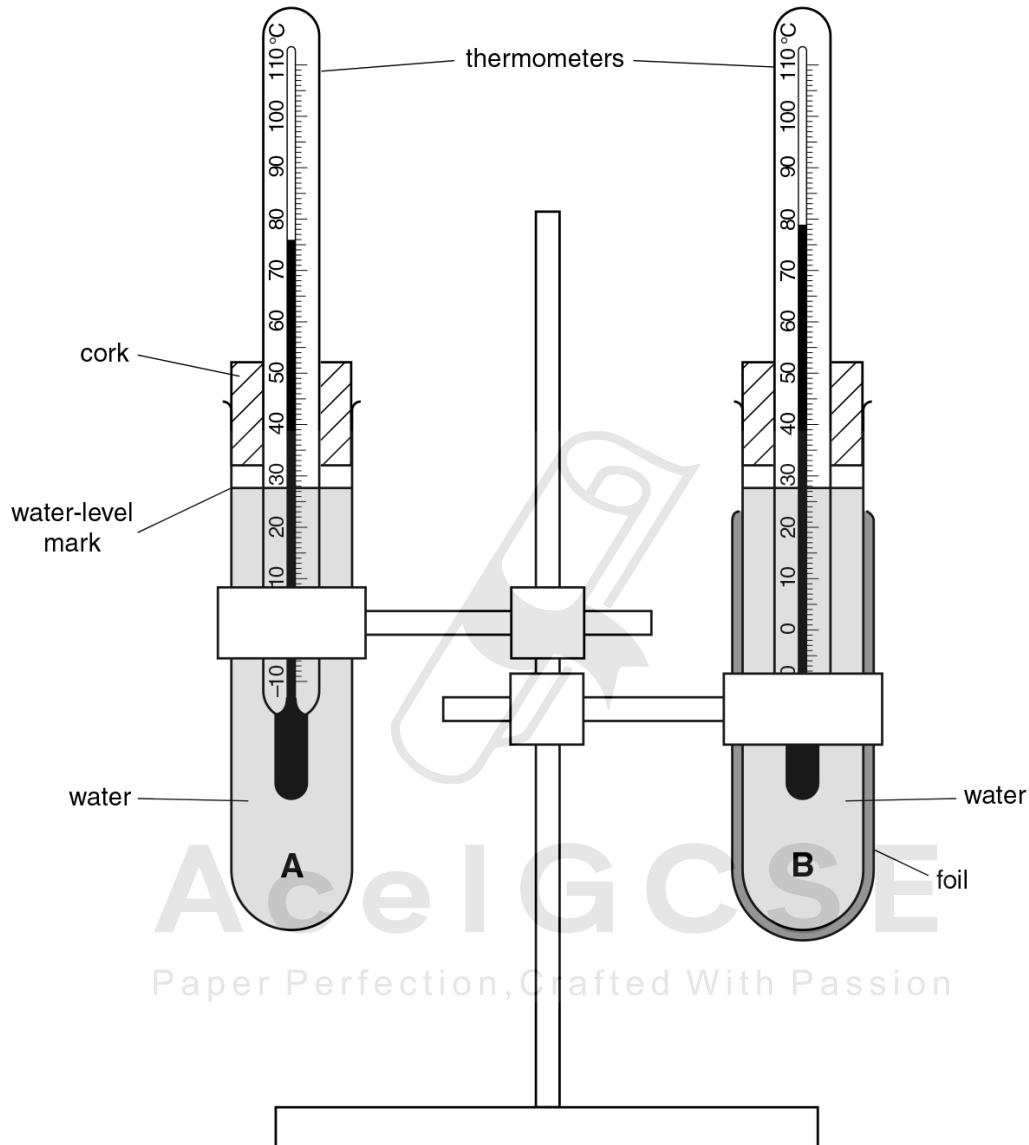


Fig. 2.1

- (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.

2.3. THERMAL PROCESSES

- (ii) The temperatures θ of the thermometer in test-tube **A** at times $t = 30\text{s}$, 60s , 90s , 120s , 150s and 180s 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
$t/$	$\theta/$	$\theta/$
	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 $t = 0\text{s}$.

- (c) The temperatures θ of the thermometer in test-tube **B** at times $t = 30\text{s}$, 60s , 90s , 120s , 150s and 180s 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]



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46. 0625_s13_qp_62 Q: 2

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.

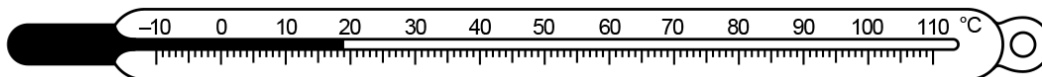


Fig. 2.1

$\theta_C = \dots\dots\dots [1]$

- (b) The student pours 200 cm³ 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

<i>t</i> /	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 cm³ of the hot water into the beaker. She measures the temperature θ_H of the water in the beaker.

$\theta_H = \dots\dots\dots 78^\circ\text{C} \dots\dots\dots$

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.

$\theta_A = \dots\dots\dots 74^\circ\text{C} \dots\dots\dots$

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

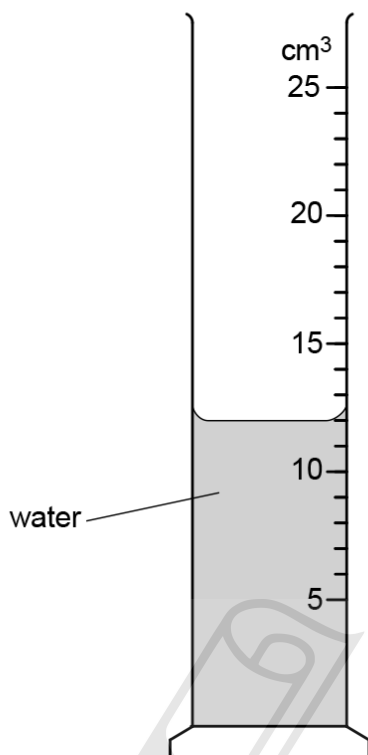


Fig. 2.2

$V_A = \dots\dots\dots$ [1]

- (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 150s.

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

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.....

.....

.....

$V = \dots\dots\dots$ [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]

47.0625_s13_qp_63 Q:1

Some IGCSE students are investigating the cooling of water.

Fig. 1.1 shows how the apparatus is set up.

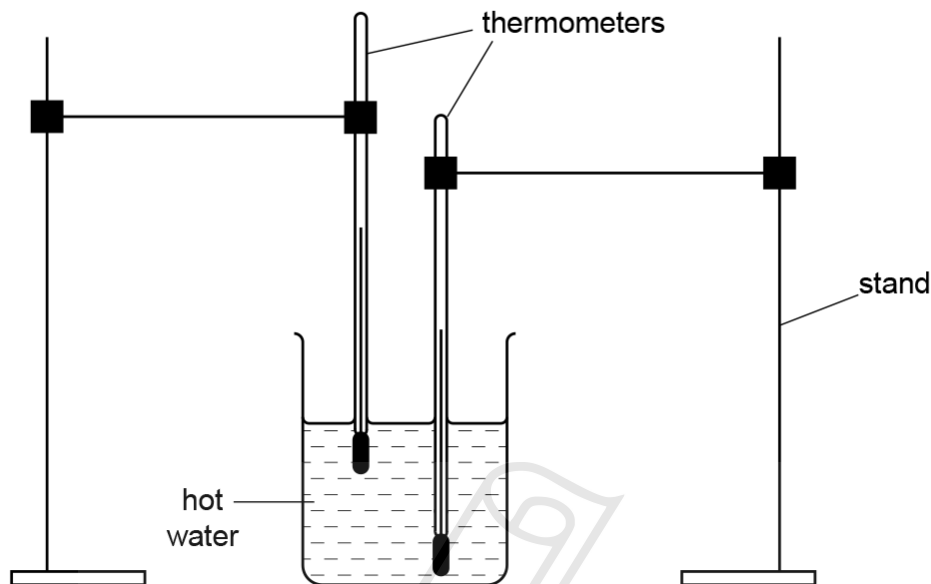


Fig. 1.1

- (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]

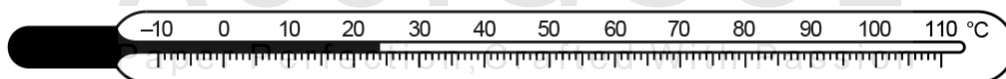


Fig. 1.2

- (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]

2.3. THERMAL PROCESSES

- (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]



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48. 0625_w13_qp_61 Q: 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.

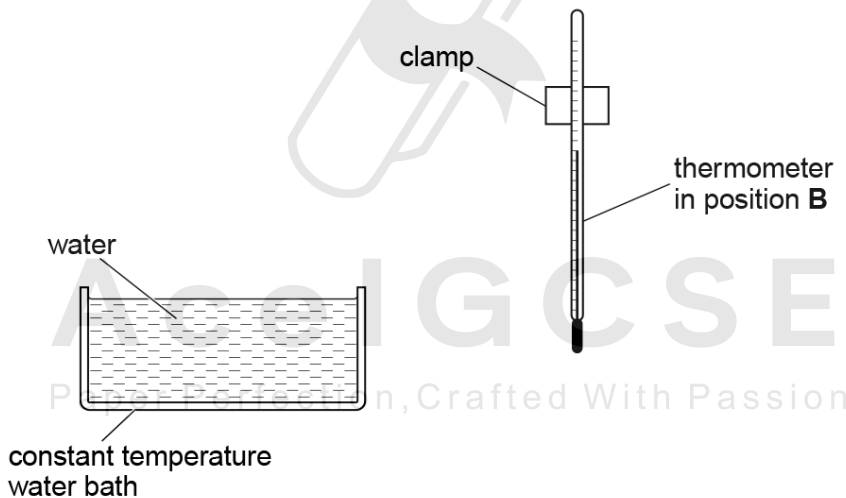
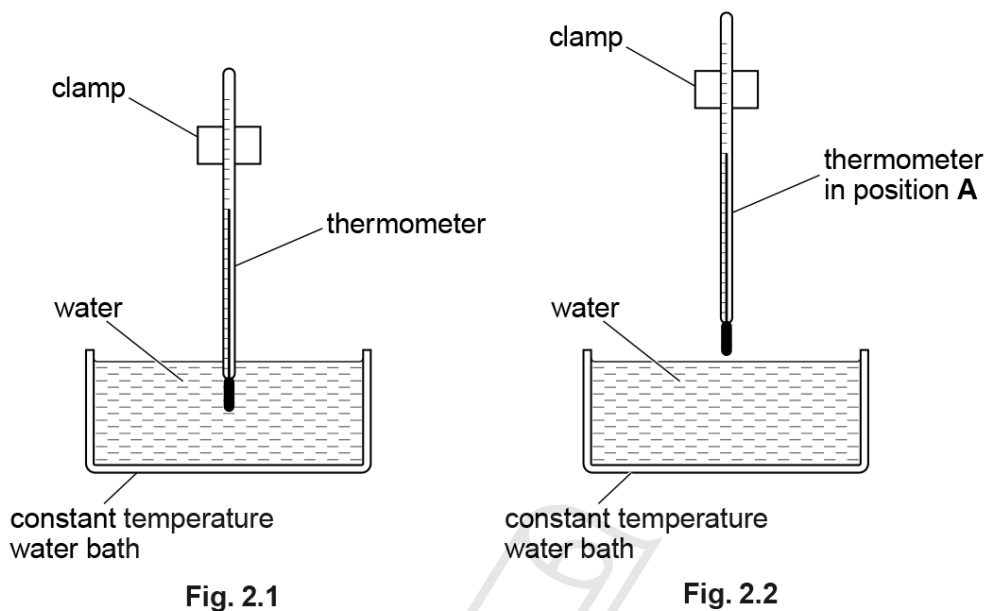


Fig. 2.3

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

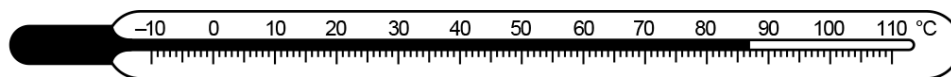


Fig. 2.4

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



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49. 0625_w13_qp_62 Q: 2

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 cm³ of hot water into a beaker.

She measures the temperature θ_1 . Fig. 2.1 shows the thermometer.

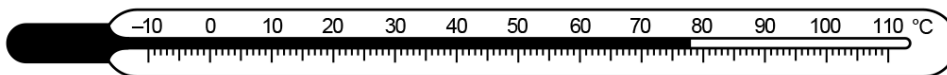


Fig. 2.1

Write down the temperature θ_1 shown on the thermometer in Fig. 2.1.

$\theta_1 = \dots\dots\dots$ [1]

(b) The student stirs the water for one minute. She then records the temperature θ_2 of the water.

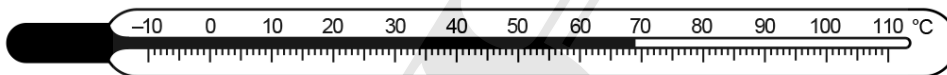


Fig. 2.2

(i) Write down the temperature θ_2 shown on the thermometer in Fig. 2.2.

$\theta_2 = \dots\dots\dots$

(ii) Calculate the temperature difference ($\theta_1 - \theta_2$).

$(\theta_1 - \theta_2) = \dots\dots\dots$ [1]

Experiment B (cooling with pouring)

(c) The student starts again with approximately 200 cm³ 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.

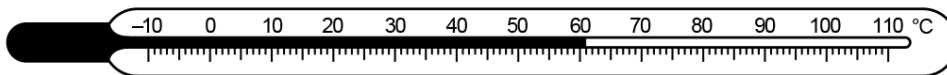


Fig. 2.3

(i) Write down the temperature θ_3 shown on the thermometer in Fig. 2.3.

$\theta_3 =$

(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 cm³ 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]

50.0625_w13_qp_63 Q: 2

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.

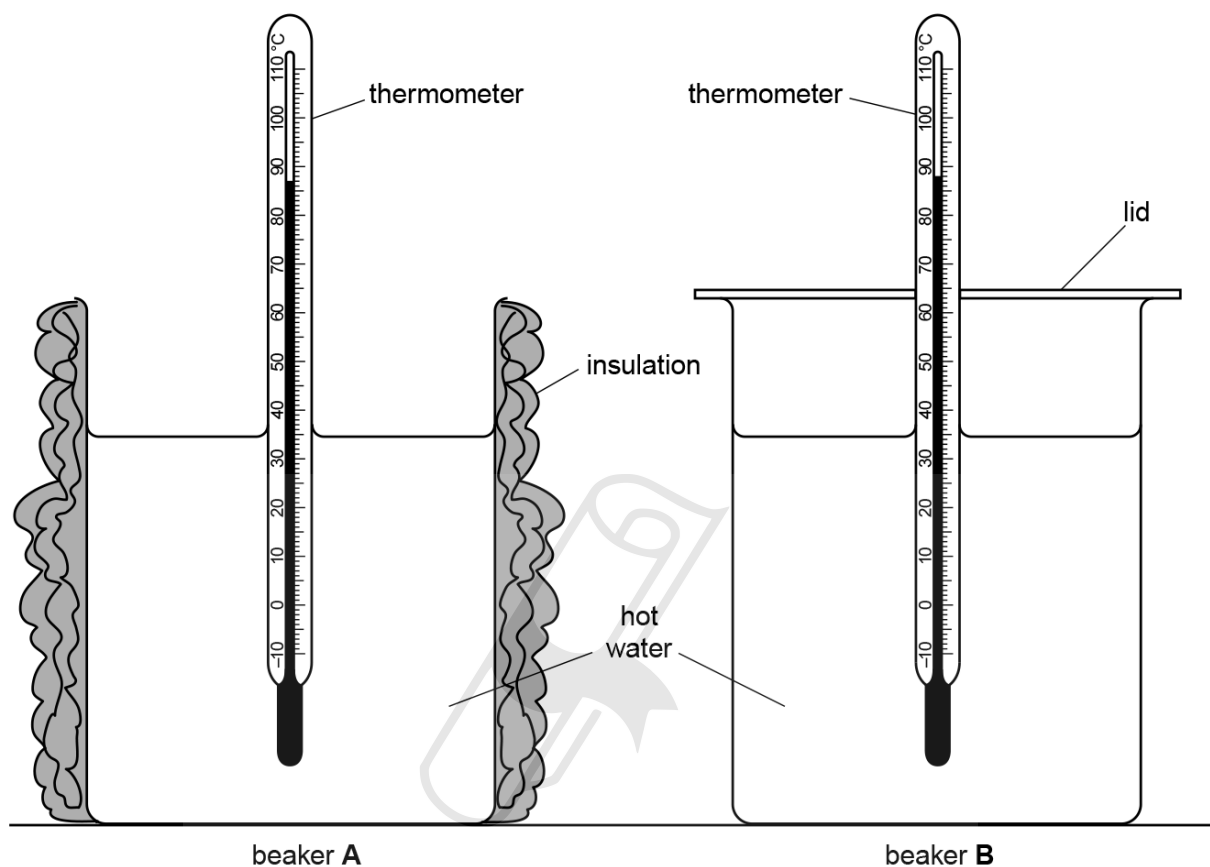


Fig. 2.1

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 B
<i>t/</i>	<i>θ/</i>	<i>θ/</i>
	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]



51. 0625_s12_qp_61 Q: 2

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

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

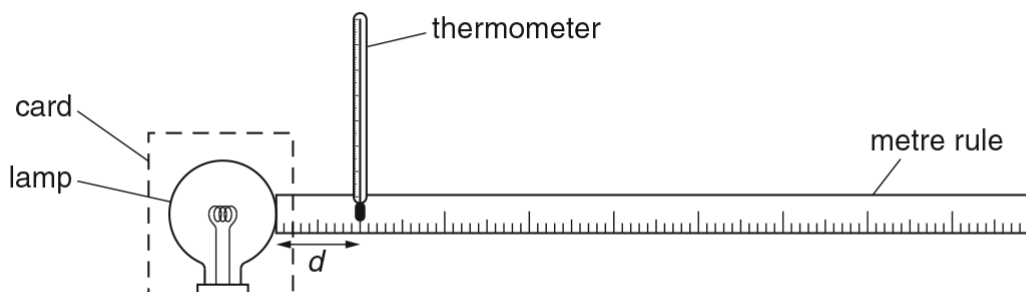


Fig. 2.1

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

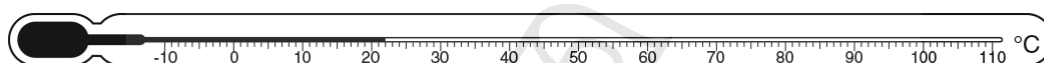


Fig. 2.2

$\theta_R = \dots\dots\dots$ [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

[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 $d_V = 100\text{ mm}$ from the top surface of the lamp, as shown in Fig. 2.3.

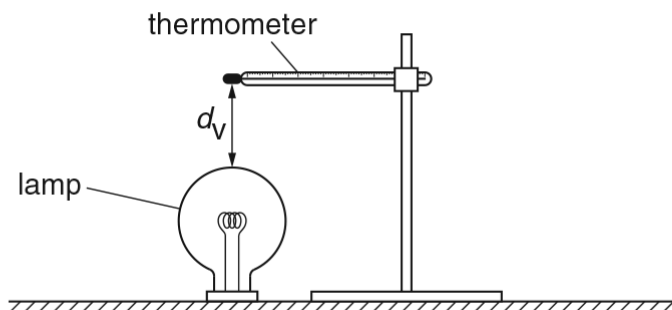


Fig. 2.3

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]

52. 0625_s12_qp_62 Q: 2

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

Fig. 2.1 shows the apparatus.

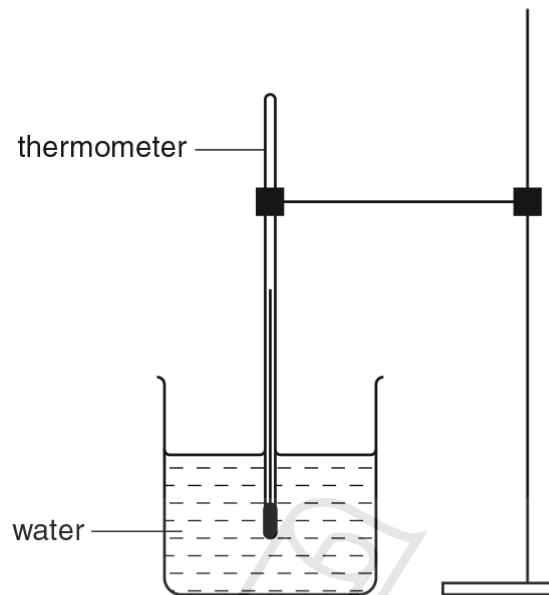
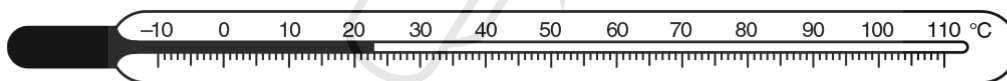


Fig. 2.1

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



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

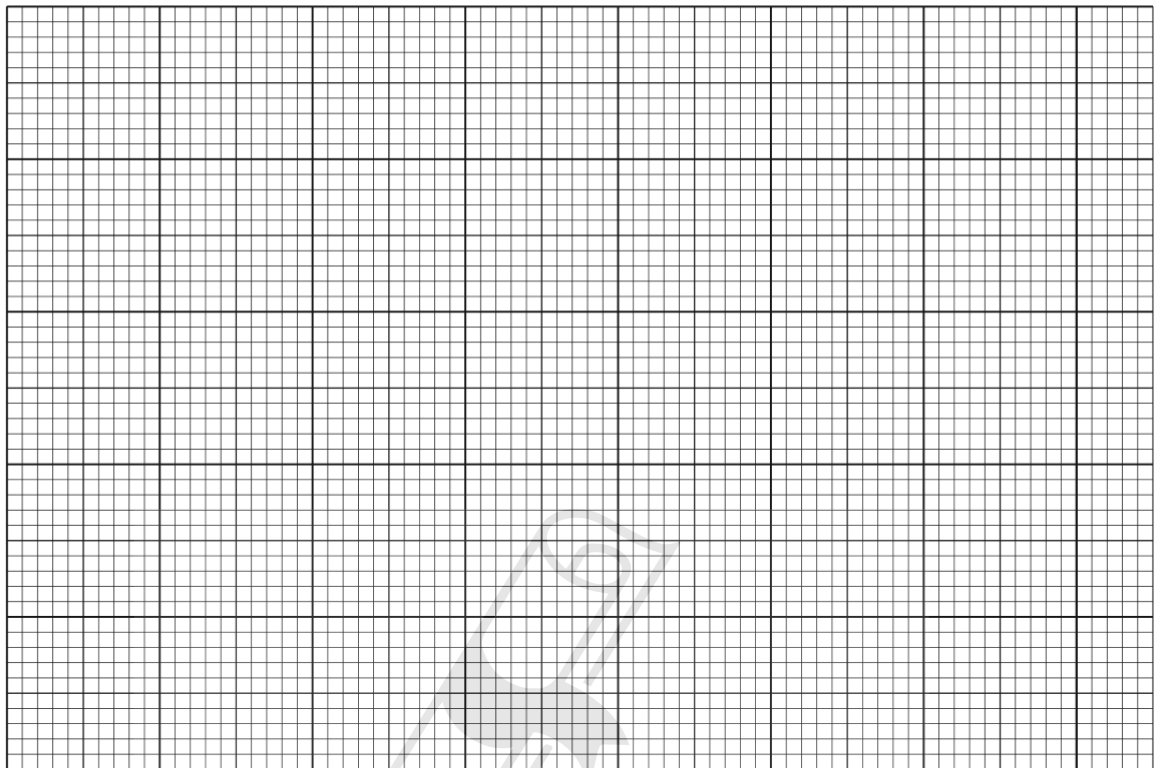
- (b) A student pours approximately 200 cm^3 of hot water into the beaker. She measures the temperature θ of the water. She starts a stopclock and records the temperature θ of the water at 30s intervals up to time $t = 150\text{ s}$. The readings are shown in Table 2.1.

Table 2.1

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

2.3. THERMAL PROCESSES

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]

53. 0625_s12_qp_63 Q: 2

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

Fig. 2.1 shows the apparatus.

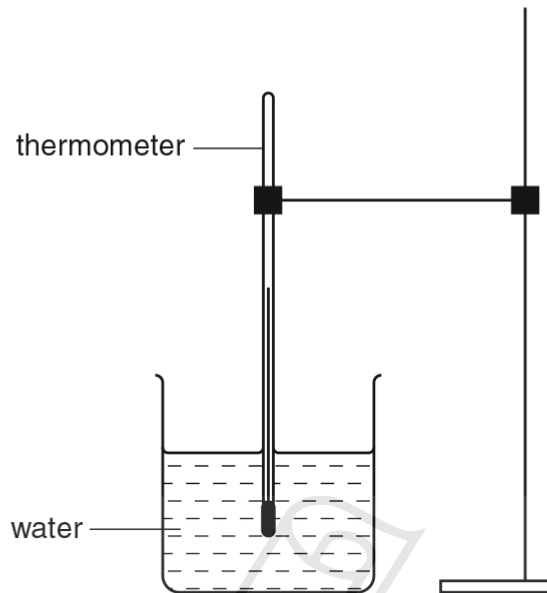
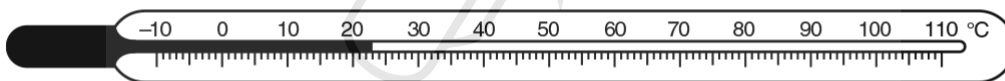


Fig. 2.1

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



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

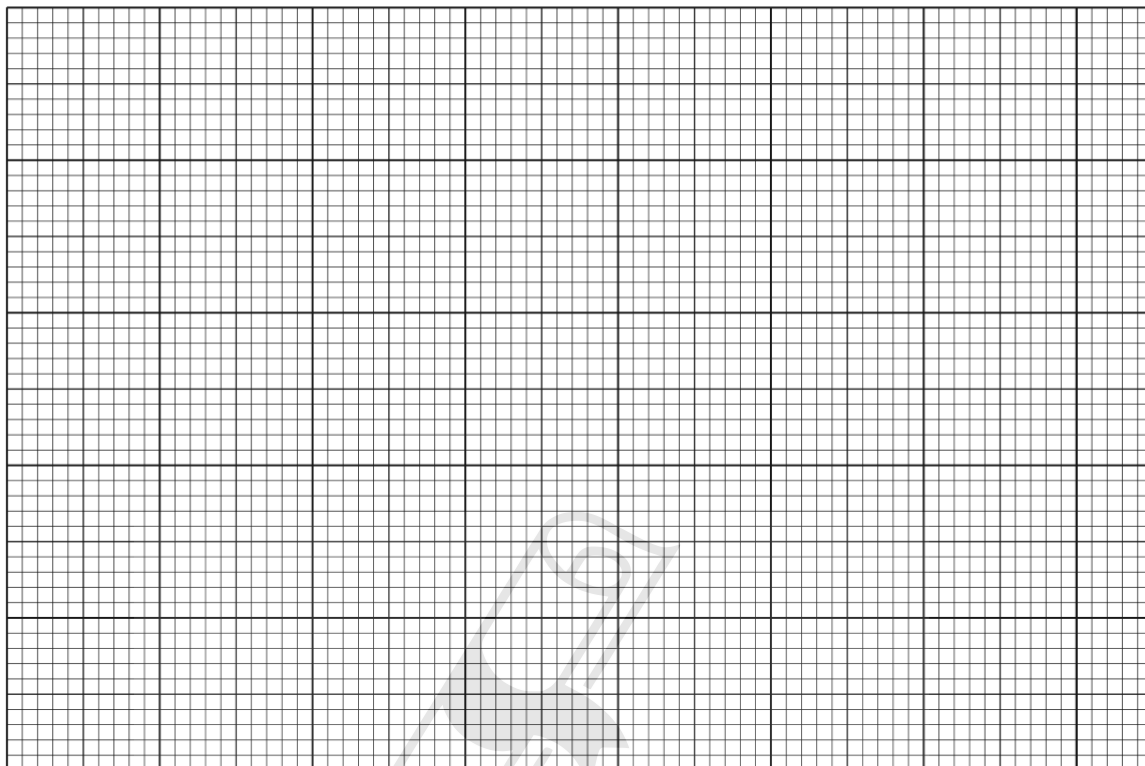
- (b) A student pours approximately 200 cm^3 of hot water into the beaker. She measures the temperature θ of the water. She starts a stopclock and records the temperature θ of the water at 30s intervals up to time $t = 150\text{ s}$. The readings are shown in Table 2.1.

Table 2.1

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

2.3. THERMAL PROCESSES

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]

54. 0625_w12_qp_61 Q: 2

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

The apparatus is shown in Fig. 2.1.

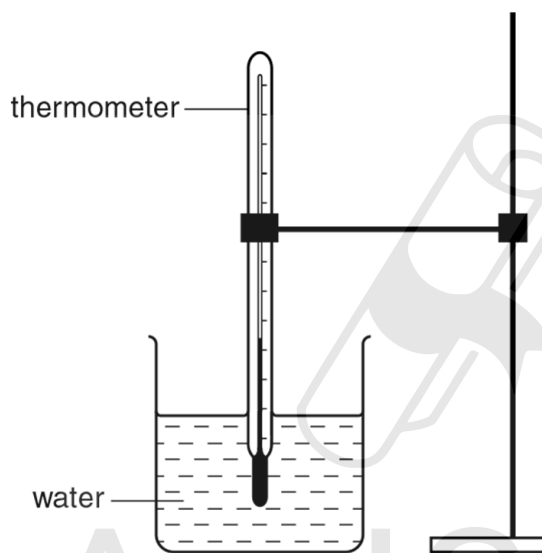


Fig. 2.1



Fig. 2.2

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

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

2.3. THERMAL PROCESSES

- (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 30s 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 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]

55. 0625_w12_qp_62 Q: 2

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

The apparatus is shown in Fig. 2.1.

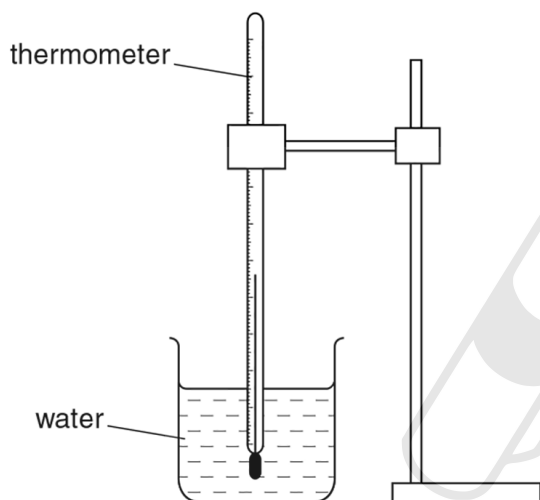


Fig. 2.1



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 200 cm^3 of hot water into a beaker. She records the temperature θ_0 of the water.

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

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

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

- (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 $\theta_H = (\theta_0 - \theta_1)$.

$\theta_H = \dots\dots\dots$

[1]

2.3. THERMAL PROCESSES

- (c) The student empties the beaker. She pours 100 cm³ of hot water into the beaker, adds 100 cm³ 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 $t = 100$ 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.

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statement $\dots\dots\dots$

justification $\dots\dots\dots$

$\dots\dots\dots$ [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. $\dots\dots\dots$

2. $\dots\dots\dots$

[2]

[Total: 8]

56. 0625_w12_qp_63 Q: 2

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.

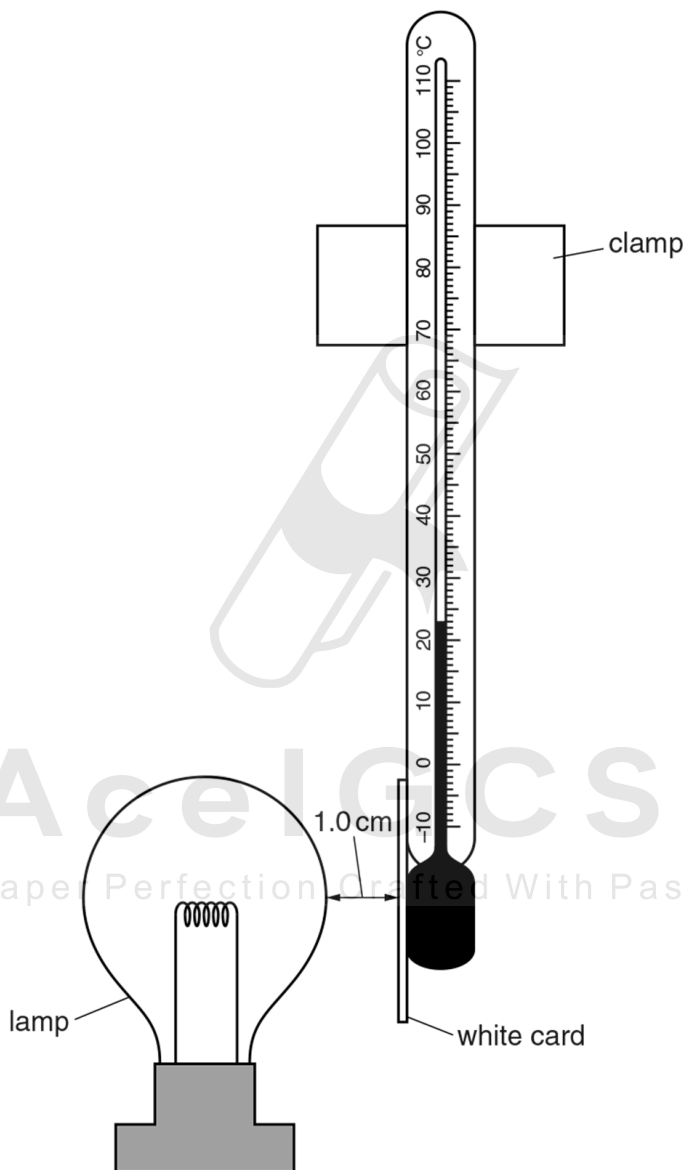


Fig. 2.1

- (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.

2.3. THERMAL PROCESSES

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
$t/$	$\theta/$	$\theta/$
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 300s.

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]



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01. 0625_m20_MS_62 Q: 2

(a)	$\theta_R = 21$ (°C)	1
(b)(i)	s, °C both correct in heading	1
(b)(ii)	suitable precaution e.g.: line of sight perpendicular to scale wait until reading stops rising (at start) stir before reading keep thermometer at same depth	1
(c)(i)	$x_1 = 0.18$	1
(c)(ii)	unit °C / s, seen in (c) and not contradicted	1
(c)(iii)	$x_3 = 0.07$ <u>and</u> $x_2 = 0.12$	1
(d)(i)	cooling rate decreases (over time) <u>and justified by comparative values</u> of cooling rate over suitable periods of time	1
(d)(ii)	$\theta_F = \theta_R$	1
(e)(i)	suggestion matching results	1
	explanation matching suggestion: EITHER: SUGGESTION: smaller cooling rates (at equivalent times) EXPLANATION: reference to cooling rate being smaller at <u>lower temperatures and values stated</u> OR SUGGESTION: smaller difference(s) in cooling rates (between equivalent times) EXPLANATION: clear reference to $(x_2 - x_3)$ being smaller than $(x_1 - x_2)$	1
(e)(ii)	suitable control: (same) volume of water, (same) material of beaker, (same) duration of experiment, (same) room temp / named appropriate environmental condition	1

02. 0625_p20_MS_60 Q: 2

- (a) 23 (°C) [1]
- (b) any one from:
wait for thermometer reading to stop rising
eye level with top of (mercury) thread owtte
stir water [max 1]
- (c) s, °C, °C, words or symbols AND
30, 60, 90, 120, 150, 180 [1]
- (d) uninsulated (owtte) OR no significant difference [1]
justified by reference to temperature differences and time [1]
relevant science, consistent with readings and conclusion
(e.g. therefore cotton wool is a good/not a good insulator OR most cooling is due to
convection or radiation etc.) [1]

(e) quality poor due to small temperature differences [1]

- any two improvements from:
 increase initial temperature of water
 ensure initial temperatures are identical
 use a lid
 stir to eliminate differences between top and bottom of the water
 use thicker insulation
 use more sensitive thermometer or datalogger

[max 2]

(f) any two from:
 laboratory temperature
 draughts/open windows
 accept temperature of hot water source

[max 2]

(g) 5–50 cm³ [1]

03. 0625_s20_MS_61 Q: 4

MP1	Diagram to show container and thermometer	1
MP2	Hot water in a container. Record initial temperature and take temperature at intervals as it cools	1
MP3	Repeat with at least three other colours	1
Any two from: MP4 Same starting temperature Same room temperature MP5 Use of a lid At least three named colours Same thickness of paint		2
MP6	Table with clear columns for temperature and /or time (to match method), with appropriate units	1
MP7	Conclusion: Greatest temperature drop shows best radiator (or reverse argument)	1

04. 0625_m19_MS_62 Q: 2

(a)	$\theta_r = 23$ (°C)	1
(b)	s, °C, °C all correct	1
	30, 60, 90, 120, 150, 180	1
(c)	lid is more effective	1
	correct mention of comparative temperature change over 180 s, supporting conclusion	1
(d)	additional experiment with both insulation and lid / neither insulation nor lid	1
	compare result of (previous) experiment with additional / only one factor changed in (each) comparison	1
(e)(i)	$x_A = 0.081$	1
	°C / s	1
(e)(ii)	cooling more rapid at higher temperatures	1
	comparison of temperature difference over first 30 s and last 30 s supporting statement	1

05. 0625_s19_MS_61 Q: 3

(a)	24 (°C)	1
(b)(i)	s, °C seen and not contradicted	1
(b)(ii)	Third box ticked to match readings	1
	Pairs of readings 94(°C), 89(°C) and 93 (°C), 87 (°C) quoted. OR differences 5(°C) and 6(°C) quoted	1
	Difference is only 1(°C) OR difference is small. owtte	1
(c)(i)	Use a black painted beaker (and black painted can)	1
	Use a shiny can (and unpainted beaker)	1
(c)(ii)	Any two from: Room temperature Volume of water Same starting temperature (of water)	2
(d)	Perpendicular viewing of the thermometer OR stirring OR thermometer not touching beaker.	1

06. 0625_s19_MS_62 Q: 2

(a)	22(.0) (°C)	1
(b)(i)	s, °C seen in both tables	1
(b)(ii)	third box ticked to match readings	1
(b)(iii)	quoting temperatures from the table in the same time	1
(c)	any one from: higher room temperature lower <u>starting</u> /initial temperature insulation	1
(d)	perpendicular viewing of thermometer/view (reading) at eye level/stir the water/thermometer not touching the sides of the beaker/wait for the temperature to stop <u>rising</u> (initially)	1
(e)	any two from: room temperature/stated environmental condition <u>starting</u> /initial temperature of the (hot) <u>water</u> volume/mass/amount of water same beaker total time for experiment	2
(f)	third box ticked	1

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07. 0625_s19_MS_63 Q: 2

(a)	21 (°C)	1
(b)(i)	s, °C, °C, °C all correct	1
	30, 60, 90, 120, 150, 180	1
(b)(ii)	any one from: <ul style="list-style-type: none"> place stop-clock <u>and</u> thermometers so seen easily keep eyes at level to thermometer scales use an audible 30 s alarm read temperatures alternately every 15 s use of data logger 	1
(c)	greater temperature difference causes greater (rate of) heating	1
	comparison of temperature changes during same period in first half and in second half of experiment	1
(d)(i)	within range 64 to 72 (°C) inclusive	1
	justification with reference to hot and cold water trends	1
(d)(ii)	21 (°C) / room temperature	1
(e)	any two from: <ul style="list-style-type: none"> thinner walls on tube metal tube bung/lid on tube insulate sides of beaker/lid on beaker higher <u>initial</u> hot water temperature lower <u>initial</u> cold water temperature increase volume of hot water decrease volume of cold water stirring 	2

08. 0625_w19_MS_61 Q: 3

(a)	24 (°C)	1
(b)(i)	Times 60, 120, 180, 240, 300	1
(b)(ii)	Units s and °C	1
(c)	10, 7	1
(d)(i)	Correct box ticked to match readings	1
(d)(ii)	Justification to match (i), quoting figures	1
	Reference to same time	1
(e)	Two from: <ul style="list-style-type: none"> Insulate Lid Lower starting temperature Higher room temperature Smaller volume of water Smaller surface area 	2
(f)	Clearly shown perpendicular line of sight	1
	Clearly shown bottom of meniscus	1

09. 0625_w19_MS_62 Q: 4

MP1 method diagram: container, ice (cubes, thermometer and insulation)	1
MP2 ice (in container), measure time (for all the ice) to melt	1
MP3 repeat with different insulators	1
MP4 control variables (total) mass / volume of ice cubes	1
MP5 any one from: thickness / amount of insulation room temperature / other environmental condition size / shape / surface area of ice cubes initial temperature (of ice cubes)	1
MP6 table table with headings of (named) insulator and time with correct units	1
MP7 conclusion (use the table to) compare the insulator with the time taken for the ice cubes to melt	1

10. 0625_w19_MS_63 Q: 4

MP1 Apparatus beaker <u>and</u> (material for) lid <u>and</u> thermometer <u>and</u> stop clock (or alternative)	1
MP2 Method pour (hot) water into container measure temperature of (hot) water over period of time	1
MP3 Method repeat for different thicknesses of lid	1
MP4 & MP5 Control variables any two from: <input type="checkbox"/> same <u>initial/starting</u> temperature of water ; <input type="checkbox"/> same volume of water ; <input type="checkbox"/> same size / material / thickness of beaker ; <input type="checkbox"/> same material for lid ; <input type="checkbox"/> same time for measuring temperature change / same temperature difference for measuring time taken <input type="checkbox"/> same room temperature / other environmental condition	2
MP6 Table suitable column headings and <u>units</u>	1
MP7 Analysis any one from: <input type="checkbox"/> comparison of temperature decrease / rates of cooling with <u>thickness</u> / different <u>lids</u> <input type="checkbox"/> draw a suitable graph with axes stated	1

11. 0625_m18_MS_62 Q: 2

(a)(i)	θ for beaker A = 87(.0)(°C) <u>and</u> θ for beaker B = 89(.0)(°C)	1
(a)(ii)	s, °C, °C all correct	1
	30, 60, 90, 120, 150, 180	1
(b)	one precaution e.g.: read at 90° (to scale) / perpendicularly, stir (before reading) / wait until reading stops rising(at start)	1
(c)	conclusion matching results	1
	justification matching conclusion with <u>correct</u> mention of comparative temperature change <u>over 0 to 180 s</u>	1
(d)(i)	unit °C / s	1
(d)(ii)	$x_1 = 0.094$ / ecf <u>and</u> $x_2 = 0.067$	1
(e)	statement matching results <u>with</u> results used in explanation and reference to different (starting) temperatures for x_1 and x_2	1
(f)	experiment with lid <u>and</u> no insulation	1
	experiment with insulation <u>and</u> no lid	1

12. 0625_s18_MS_61 Q: 4

	Method to include: (Hot) water in copper can, time taken for temperature to drop	1
	Correct use of at least 3 larger outer containers, separately	1
	Some indication that size of air gap is measured	1
	Any two from: Use of something to cover air gap Use of lid on copper can Same starting temperature Same room temperature Same volume of hot water Use of 'control' with no outer container Inner container standing on an insulator Uniform air gap all round	2
	Table with clear columns for temperature and/or time (to match method) and air-gap, with appropriate units	1
	Conclusion: Least temperature drop OR longest time for temperature to drop shows lowest cooling rate OR best insulation OR plot temperature against time and least gradient shows lowest cooling rate (ora)	1

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13. 0625_s18_MS_62 Q: 2

(a)	$\theta_R = 23(.0) (^{\circ}\text{C})$	1
(b)(i)	ensure thermometer / bulb / alcohol / mercury has reached the temperature of the water	1
(b)(ii)	s / seconds, $^{\circ}\text{C}$	1
(b)(iii)	t values 30, 60, 90, 120, 150	1
(b)(iv)	graph:	
	axes correctly labelled and right way round	1
	suitable scales (scales must start below θ_R)	1
	all plots correct to $\frac{1}{2}$ small square	1
	good line judgement, thin, continuous line	1
(c)	horizontal line at θ_R correctly positioned	1
(d)	any two from: perpendicular viewing of thermometer stir (before taking temperature reading) don't let the thermometer (bulb) touch the sides / bottom of beaker wait for thermometer to reach θ_{MAX} before reading	2
(e)	any two from: higher starting temperature / use hotter water use of metal can instead of beaker / metal bench lower room temperature / cold water bath use of a fan container with a greater surface area / larger beaker	2

14. 0625_s18_MS_63 Q: 1

(a)	21(.0) ($^{\circ}\text{C}$)	1
(b)	s, $^{\circ}\text{C}$, $^{\circ}\text{C}$ all correct	1
	30, 60, 90, 120, 150, 180	1
(c)	appropriate precaution e.g. avoidance of parallax (only if explained) / wait until reading stops rising (at start)	1
(d)(i)	beaker with lid A (has a greater rate of cooling)	1
	correct mention of comparative temperature change over 0 to 180 s	1
(d)(ii)	any suitable change to apparatus relating to comparison e.g. insulate sides / stand on mat use plastic beaker thicker lid use of fan use wider beaker	1
	matching explanation e.g. thermal energy only escapes from surface less transfer of thermal energy by sides / bottom less conduction through lid larger surface area (for evaporation to occur)	1
(e)	straight line	1
	through the origin	1
(f)	any appropriate factor e.g. volume of water initial temperature of water (same) lids type / material / size of beaker room temperature / appropriate environmental factor	

15. 0625_w18_MS_62 Q: 4

method:		1
MP1 measure room / starting temperature		
MP2 measure time to raise water temperature to boiling point		1
MP3 repeat with the other two containers		1
control variables:		2
MP4 any two from: same starting temperature / same room temperature same volume / mass / amount of water		
MP5 keep Bunsen burner flame constant / keep the distance from the flame to the bottom of the beaker constant		
table:		1
MP6 table to show container and heating time		
conclusion:		1
MP7 comparison of heating times and suitable comment made		

16. 0625_m17_MS_62 Q: 1

(a)	$\theta_A = 18$ and $\theta_B = 37$ ($^{\circ}\text{C}$)	1
(b)	units all correct (symbols or words)	1
	t values all present (30, 60, 90, 120, 150 and 180)	1
(c)	any 2 appropriate precautions: stir before reading, keep thermometer at same level, set eye to same level as / perpendicular / right angles to scale, wait until reading stops rising (at start), position clock so that thermometer and clock can be easily seen	2
(d)	conclusion matching results	1
	correct mention of comparative temperature change over 180 s	1
(e)	any suitable improvement to apparatus or procedure relating to comparison, e.g.: <ul style="list-style-type: none"> • measure water into test-tube / beaker, • use same volume of water in test-tube / beaker, • use same starting temperatures in tubes, • ensure all water in tube below level of water in beaker, • use insulation / lid on beaker 	1
	matching explanation, e.g.: <ul style="list-style-type: none"> • ensure same amount of water being used each time, • cooling rates different / owtte at different volumes / temps, • all water in tube has same surrounding temperature, • keeps water in beaker at (more) constant temperature 	1
(f)	reading taken perpendicular to scale	1
	at bottom of meniscus	1
Total:		11

17. 0625_s17_MS_61 Q: 3

(a)	23 with unit °C	1
(b)(i)	11 AND 8	1
(b)(ii)	Starting temperature closer to room temperature in the second case (or further from room temperature in the first case)	1
(c)	Two from: Increase draught (over surface of water) Increase temperature of hot water Increase surface area of water Longer time intervals Decrease room temperature Decrease volume of water Use metal can instead of glass beaker Stirring	2
(d)	Any 2 from: Uses bottom of meniscus Perpendicular (to reading) That is where the scale markings are, owtte	2
Total:		7

18. 0625_s17_MS_62 Q: 5

	method to include:	
MP1	measurements of temperature of hot water over a period of time/measurement of temperature at start and end of a specified cooling time /measurement of time for a specified temperature drop	1
MP2	repeat using variety of fan speeds (blowing air over water surface)	1
MP3 MP4	two from: room temperature initial/starting temperature of hot water volume/mass/amount of (hot) water distance of beaker to fan for each speed setting time of cooling (for a fixed temperature drop) temperature drop (for a fixed time) same beaker size/material	2
MP5	table with columns for fan speed, time and temperature with units in the table headings (not the body of the table) for time and temperature, but fan speed units not required	1
MP6	compare readings <u>to find out which fan speed</u> produces the greatest temperature drop / takes least time or plot a graph of temperature against time	1
MP7	in the same time / for same temperature drop or steepest gradient gives the fastest rate of cooling	1
Total:		7

19. 0625_s17_MS_63 Q: 4

4 MP1	apparatus beaker <u>with</u> insulation <u>and</u> thermometer <u>and</u> stopclock (or alternative) mentioned	1
MP2	method pour <u>hot</u> water into container measure temperature of hot water over period of time	1
MP3	repeat for additional layers	1
MP4	results: suitable table / graph / cooling curve	1
MP5	control variables any pair from: same initial temperature, same volume of water, same size/material/thickness of beaker, same thickness of each layer,	1
MP6 MP7	additional points any 2 from: how cooling rate calculated/how to compare cooling curves, read thermometer perpendicularly, thermometer at same depth (for repeat) thermometer not touching beaker, stir before reading thermometer, use of lid, minimum of 5 different thicknesses of insulation, repeat experiment with different sized beakers/different amount of water, sensible amount of water (50 cm ³ to 500 cm ³)	2
	Total:	7

20. 0625_w17_MS_62 Q: 2

(a)	24 (°C)	1
(b)	34 (°C)	1
(c)	30 (°C) AND °C seen once in 2(a), 2(b) or 2(c)	1
(d)	to make sure that the temperature is the same throughout / to allow the water to mix and reach its final temperature faster	1
(e)	heat loss (to surroundings) / time delays in transferring the water / did not wait for thermometer readings to stabilise / (initial) temperatures of the (cold / hot) <u>water</u> not the same	1
(f)	insulation	1
(g)	same starting temperature (of hot / cold water) / same room temperature	1
(h)	recognisable measuring cylinder	1
	perpendicular viewing	1
	to bottom of meniscus	1

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21. 0625_w17_MS_63 Q: 1

(a)	units ALL correct (symbols or words)	1
	t values all present (0, 30, 60, 90, 120, 150 and 180)	1
(b)	two appropriate precautions, e.g.: avoidance of parallax(only if explained), wait until reading stops rising at start, ensure thermometer not touching beaker	2
(c)(i)	conclusion matching results	1
	correct mention of comparative <u>temperature change</u> over 180 s	1
(c)(ii)	any suitable improvement relating to comparison: e.g. same volume of water, same initial temperature, insulate sides, use plastic beaker, stand on mat, use a thicker / more insulated lid,	1
	<u>matching</u> explanation: e.g. lid only factor changed, cooling more rapid for higher temperatures, cooling different for different volumes, thermal energy only escapes from surface, less transfer of thermal energy by sides, effect of lid more marked	1
(c)(iii)	any appropriate similarity: e.g. both cool more rapidly at the start	1
(d)(i)	23 (°C)	1
(d)(ii)	any suitable suggestion with a valid explanation greater temperature at end as cannot fall below room temperature, lower rate of cooling as temperature difference between water and room is smaller	1

22. 0625_m16_MS_62 Q: 4

apparatus: [1]
(set of) different sized beakers/containers, thermometer and stop clock/watch

method: [1]
pour hot water into container (and allow to cool)
and measure temperature and time

repeat for a second container with a different surface area [1]

precautions: [2]
any two from:
same volume of hot water
same initial hot water temperature
same room temperature or other environmental condition

graph: [1]
temperature change/rate of cooling against surface area,
temperature against time,
time to cool between fixed temperatures against surface area

additional point: [1]
any one from:

- at least 5 different surface areas,
- sensible range of container sizes given,
- sensible amount of water stated,
- use of lagging/insulating material for container walls,
- same type of container
- how surface area may be calculated

[Total: 7]

23. 0625_p16_MS_60 Q: 2

(a) 23 (°C) [1]

(b) any one from: [max 1]
wait for thermometer reading to stop rising
eye level with top of (mercury) thread owtte
stir water

(c) s, °C, °C, words or symbols AND [1]
30, 60, 90, 120, 150, 180

(d) uninsulated (owtte) OR no significant difference [1]
justified by reference to temperature differences and time [1]
relevant science, consistent with readings and conclusion
(e.g. therefore cotton wool is a good/not a good insulator OR most cooling is due to
convection or radiation etc.) [1]

(e) quality poor due to small temperature differences [1]

any two improvements from:
 increase initial temperature of water
 ensure initial temperatures are identical
 use a lid
 stir to eliminate differences between top and bottom of the water
 use thicker insulation
 use more sensitive thermometer or datalogger

[max 2]

(f) any two from:
 laboratory temperature
 draughts/open windows
 accept temperature of hot water source

[max 2]

(g) 5–50 cm³ [1]

24. 0625_s16_MS_61 Q: 4

MP1	Uses same container throughout	1
MP2	Hot water in container (any) <u>and</u> takes temperatures at intervals or at start and after a fixed time OR Hot water in container (any) <u>and</u> takes time for a fixed temperature fall.	1
MP3	Repeats with different insulators (all three used)	1
MP 4&5	Any two from: Constant room temperature Same starting temperatures (clearly stated) Same volumes of hot water (clearly stated) Same thickness/amount of insulator Use container without insulation Use of a lid Insulates bottom of container Uses the copper can only	2
MP6	Table or tables as appropriate to method: Temperatures with unit °C and time with unit s (or min) <u>and</u> different insulators shown	1
MP7	Use of readings: graph of temperature against time	1
	OR compare results and comment that longest time to cool = best insulator or smallest drop in temperature in fixed time = best insulator (or reverse arguments)	
		Total 7

25. 0625_s16_MS_62 Q: 5

(a)(i)	s, °C, °C, °C	1
(a)(ii)	83(°C)	1
(b)(i)	First box/sentence indicated	1
(b)(ii)	Clear reference to <u>readings</u> with examples of <u>temperature differences</u>	1
(c)	Any two from: <ul style="list-style-type: none"> Room temperature (or suitable reference to draughts or similar) Starting temperature (of water) Density of packing/amount/type of insulation Thickness of lids/identical lids 	max 2
(d)	Card or any suitable insulating material Should be a good insulator/poor conductor	1 1
(e)	Perpendicular viewing/view at right angles/eye level Reading to bottom of meniscus	1 1
		Total: 10

26. 0625_s16_MS_63 Q: 1

(a)	$\theta_R = 21(^{\circ}\text{C})$	1
(b)	s, °C , °C	1
	time values correct 30, 60, 90, 120, 150, 180	1
(c)(i)	'thermometer A cools more rapidly' and 'greater overall temperature change'	1
	reference to 'in the same time'	1
(c)(ii)	rate increases then decreases OR cooling is less in first 30 s than in subsequent 30 s periods	1
(d)(i)	makes comparison fair/only one factor changed	1
(d)(ii)	causes start temperature to be lower	1
(e)	any two appropriate factors: e.g. start temperature, room temperature, draughts, humidity, amount of insulation, type of thermometer	2
		Total: 10

27. 0625_w16_MS_61 Q: 2

(a)(i)	88 (°C)	1
(a)(ii)	$\theta_{AV} = 53.5$ (°C)	1
(b)	Perpendicular viewing of scale OR stirring OR wait until temperature stops rising, OR avoid delay (between adding water and taking temperature) Allow thermometer not touching beaker, owtte	1
(c)	Correct diagram with lid drawn Insulation placed round beaker	1 1
(d)	Statement and justification to match results. A number or numbers must be seen. Comment must include yes or no or 'too close to call'; owtte	1
(e)	Two from: Room temperature (or other environmental condition) Temperature of cold water Temperature of hot water Volumes of water Size/shape/material/surface area of beaker	2
	Total:	8

28. 0625_w16_MS_62 Q: 4

clock/stopwatch <u>and</u> source of heat	1
heat to boiling with <u>and</u> without lid	1
measure time taken to reach boiling point/boil	1
same volume / mass / amount of water	1
same starting temperature	1
suitable table with column headings <u>and</u> units (seconds or minutes)	1
conclusion drawn	1
	Total:
	7

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(a)(i)	$\theta = 82(.0), 80(.0)$	1
(a)(ii)	units all correct (symbols or words) t values all present (30, 60, 90, 120, 150 and 180)	1 1
(b)	any 2 appropriate precautions: e.g. viewing perp. to thermometer scale (to avoid parallax) stir before reading keep thermometer at same level / not touching beaker walls wait until reading stops rising at the start	2
(c)(i)	Conclusion <u>and</u> explicit quoting of figures from the table which relate to the <i>whole</i> 180 s period (eg 15.0 and 9.5 °C, or 5.5 °C more) statement that B cools more <u>quickly</u> / its <u>temperature</u> drops <u>faster</u> / its temperature falls more <u>in the same time</u>	1 1
(c)(ii)	any suitable improvement to apparatus relating to comparison: e.g. insulate sides, use plastic beaker, stand on mat matching explanation: e.g. thermal energy only escapes from surface, surface area only variable changed, less transfer of thermal energy / heat by sides appropriate effect on values of θ . e.g. all higher	1 1 1
(d)	any appropriate factor: e.g. volume of water, initial temperature of water, similar ratio of surface areas, type / material / size of beaker, room temperature	1
	Total	11

30. 0625_m15_MS_62 Q: 2

- (a) units correct, accept symbols or words [1]
 t values correct: 0, 30, 60, 90, 120, 150, 180 [1]
- (b) statement matching results with comparison of temperature changes over whole available range OR for 120 s from 71 °C [1]
 justification with mention of 'in the same time' owtte [1]
- (c) two precautions relating to temperature measurement, e.g. [2]
- thermometer at same depth
 - read thermometer with reading at eye level/90° to scale/explain parallax
 - wait until thermometer has stopped rising (at the start)
- (d) two improvements to apparatus or procedure, e.g. [2]
- insulation all way up side of test-tube/covering bottom of test-tube
 - start taking measurements at same temperature/same initial temp. of water
 - same volume of water/use measuring cylinder for water
 - plot cooling curves
 - use metal/thinner glass test-tubes
 - more layers of insulation
 - make sure insulation is dry
 - avoid overlapping insulation
 - use same tube/same tube thickness in each experiment

[Total: 8]

31. 0625_m15_MS_62 Q: 5

(a) $\theta_H = 74$ AND $\theta_C = 23(^{\circ}\text{C})$ [1]

(b) (i) suitable reason, e.g. [1]

- temperature not able to reach max θ_H (in 30s)
- temperature dropped on transfer
- conduction/transfer to metal tongs

matching improvement, e.g. [1]

- leave block in hot water longer
- transfer more quickly
- use insulated tongs/cotton round block

(ii) suitable reason, e.g. [1]

- some (thermal) energy transferred to beaker,
- some (thermal) energy transferred to surroundings,
- evaporation/convection (into atmosphere)

matching improvement, e.g. [1]

- use a less conducting material for beaker/owtte
- insulate beaker
- allow for beaker in any calculation
- lid on beaker

[Total: 5]

32. 0625_s15_MS_61 Q: 2

(a) 85 (recorded in table) [1]

(b) s, $^{\circ}\text{C}$ [1]

(c) Graph: [1]

- axes correctly labelled, right way round and with units [1]
- suitable scales, plots occupying at least half grid in both directions [1]
- all plots correct to within $\frac{1}{2}$ small square [1]
- good best-fit line judgement [1]
- single, thin, continuous line [1]

(d) (i) decreases owtte, no ecf [1]

(ii) statement justified by reference to the graph [1]

[Total: 9]

33. 0625_s15_MS_62 Q: 2

- (a) (i) $\theta_H = 92(^{\circ}\text{C})$ [1]
- (ii) any one from:
- wait for thermometer reading to stop rising
 - perpendicular viewing of scale
 - stirring
 - thermometer bulb in middle of water/not touching beaker
- [1]
- (b) $\theta_A = 21(^{\circ}\text{C})$ allow ecf from (i) [1]
- (c) $\theta_B = 14$, correct unit seen, $^{\circ}\text{C}$ or deg C NOT C° or $^{\circ}\text{C}$, and not contradicted [1]
- (d) any two from:
- room temperature/other environmental statement
 - initial hot water temperature
 - heat loss to surroundings /evaporation/conduction through sides of beaker
 - time delays in adding water
- [max.2]
- (e) perpendicular viewing/eye level with meniscus [1]
 reading to bottom of meniscus [1]
- [Total: 8]**

34. 0625_s15_MS_63 Q: 2

- (a) $21(^{\circ}\text{C})$ [1]
- (b) t values correct: 30, 60, 90, 120, 150, 180, 210, 240, 270 [1]
- (c) $x_1 = 0.083$ [1]
 $^{\circ}\text{C/s}$ [1]
 $x_2 = 0.061$ AND $x_3 = 0.05(0)$ [1]
- (d) prediction less than x_3 [1]
 justification with specific mention of (average) cooling rate decreasing with time/temperature [1]

- (e) any two precautions relating to temperature measurement e.g: [2]
- stir before reading
 - keep thermometer at same depth
 - read thermometer 90° to scale/with reading at eye level
 - wait until thermometer has stopped rising (at the start)
 - thermometer in middle of water/not touching beaker

[Total: 9]

35. 0625_w15_MS_61 Q: 4

(a) $\theta_c = 22^\circ\text{C}$ [1]

(b) view thermometer at right angles OR stirring OR wait for reading to stop rising OR thermometer (bulb) not touching sides/bottom of beaker owtte [1]

(c) $\theta_A = 52.5^\circ\text{C}$ OR e.c.f. [1]

(d) any two from:

- heat loss to surroundings/beaker OR heat loss/drop in temperature by evaporation
- delays in taking readings
- reference to uncertainty in volume measurements

 [2]

(e) (i) $78\text{ (cm}^3\text{)}$ [1]

(ii) EITHER:
Student 1 (80) – read to top of meniscus OR scale not read at right angles
OR Student 2 (79) – divisions are every $2\text{(cm}^3\text{)}$ not $1\text{(cm}^3\text{)}$
OR Student 2 (79) – scale not read at right angles [1]

[Total: 7]

36. 0625_w15_MS_62 Q: 2

(a) $\theta_1 = 82$ ($^{\circ}\text{C}$) [1]

(b) (i) s, $^{\circ}\text{C}$, $^{\circ}\text{C}$ [1]

(ii) 10, 20, 30, 40, 50, 60 [1]

(c)(i)(ii) $\Delta\theta_1 = 39$ ($^{\circ}\text{C}$) AND $\Delta\theta_2 = 8$ ($^{\circ}\text{C}$) [1]

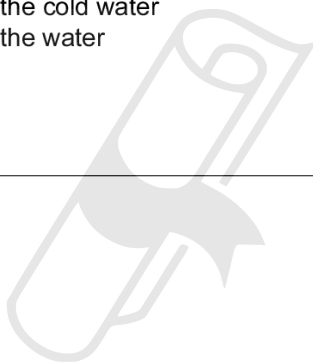
(iii) temperature θ_2 at time $t = 0$ less than θ_1 [1]

(d) view thermometer at right angles [1]

(e) any one from:

- room temperature/other environmental factor
- volume/mass/quantity/amount of hot water
- initial temperature of the hot water
- initial temperature of the cold water
- initial temperature of the water

[1]

[Total: 7]

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37. 0625_w15_MS_63 Q: 1

(a) 22(.0) AND 88(.0) [1]

(b) units correct and consistent (symbols or words) [1]

(c) conclusion which matches the temperature changes [1]

(d) any two from: [2]

- volume/level of hot water
- initial temperature of hot water
- initial temperature of cold water
- same type of boiling tube
- room temperature/draughts/appropriate environmental condition

(e) any two improvements relating to apparatus: [2]

- lid on beaker
- insulation on beaker
- lid/cotton wool in boiling tube
- thinner/metal walls on tube
- all cold water in boiling tube below hot water level
- greater contact area of tube
- use of water bath

explanation matching first improvement, including: [1]

- reduces loss of thermal energy from beaker
- reduces loss of thermal energy from boiling tube
- better thermal conduction
- not affected by variation in hot water temperature

[Total: 8]

38. 0625_s14_MS_61 Q: 2

(a) stopwatch/stopclock [1]

(b) any three from:

- length of rod
- diameter/thickness/area (of cross-section) of rod
- amount of wax/type of wax
- weight/size/mass of marker
- position for the markers
- (Bunsen) flame/(rate of) heating
- position of Bunsen/flame
- position of rod on tripod

[max 3]

(c) temperature too high
or thermometer only measures up to about 100 °C
or small range

[1]

thermometer/bulb can't make proper contact

[1]

[Total: 6]

39. 0625_s14_MS_61 Q: 3

(a) $\theta_H = 92$ (°C) [1]

(b) (i) table: s, °C, °C [1]

(ii) decreases [1]

justified by reference to results, giving numbers referring to temperature drops [1]

(c) any two from:

- room temperature/air conditioning/draughts/environmental conditions
- starting temperature (of thermometer)/temperature of (hot) water
- density of packing/amount of cotton wool/dryness of cotton wool

[max 2]

[Total: 6]

40. 0625_s14_MS_62 Q: 2

- (a) (i) 88 (°C) [1]
- (ii) s, °C [1]
- (b) axes correctly labelled with quantity and unit [1]
- suitable scales on both axes, occupying more than half the grid [1]
- all plots correct to $\frac{1}{2}$ small square [1]
- good line judgement, not through all points [1]
- thin, continuous line and neat plots (penalise large 'blobs') [1]
- (c) (i) statement to match candidate's graph line (expect curve) [1]
- (ii) statement to match candidate's graph line (expect (rate) decreases) [1]
- (d) description or diagram to show one from: [1]
- perpendicular line of sight
 - reading to bottom of meniscus
- [Total: 10]

41. 0625_s14_MS_63 Q: 2

- (a)(b) 87 and 89, both correct answer only [1]
- (c) units correct in symbols or words, s, °C, °C [1]
- t values correct 0, 30, 60, 90, 120, 150, 180 [1]
- (d) appropriate pattern which fully matches results
e.g. rate of temperature drop greater at start than at end
NOT stated pattern which partly matches results [1]
- (e) statement matching temperature changes
(expect 'Yes' but accept 'No' or 'no significant difference' if ecf) [1]
- justification referring to results and involving comparative change in temperature
with specific mention of in the same time [1]

- (f) any two from:
- room temperature/external temperature (but not outside temperature)/ environmental factor such as draughts/sunshine
 - initial water temperature/start temperature
 - same amount of stirring/wait same time before reading
 - keep thermometer at same depth
 - same size/thickness/material/surface area of beaker
 - same volumes of water

[2]

[Total: 8]

42. 0625_w14_MS_61 Q: 2

- (a) 21(°C) [1]
- (b) table: s, °C, °C [1]
- (c) no significant effect, justified by some reference to results [1]
- wording that communicates the idea that the temperatures are the same within the limits of experimental accuracy OR almost the same rate [1]
- (d) lid/cover/smaller cross-sectional area [1]
- (e) any one from:
 room temperature (or equivalent environmental condition)
 initial water temperature
 volume of water
 same/dry insulation [1]

[Total: 6]

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43. 0625_w14_MS_62 Q: 2

- (a) 19 (°C) cao [1]
- (b) table:
cm³, °C [1]
NOT C°, centigrade

correct V values 10, 20, 30, 40, 50 [1]
- (c) lid/insulation/polystyrene cup/minimal time delay [1]
- (d) $R_1 = 2.00$ $R_2 = 1.4(3)$ [1]
note: do not give the mark if using incorrect stopwatch reading e.g. 35.5 rather than 35.05

cm³/s [1]
- (e) rate/flow is not constant [1]
- (f) any two from:
room temperature/air conditioning
initial/hot water temperature
volume/quantity/amount of hot water
cold water temperature
intervals/time between adding volumes of water [2]
ignore draughts/humidity/pressure

[Total: 9]

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44. 0625_w14_MS_63 Q: 2

- (a) θ for **A** 76 ($^{\circ}\text{C}$) and for **B** 79 ($^{\circ}\text{C}$) [1]
- (b) units all correct [1]
 t values correct 0, 30, 60, 90, 120, 150, 180 [1]
- (c) statement matching temperature changes with justification referring to results and involving correct comparative change in temperature [1]
 justification has specific mention of temperature change in the same time owtte [1]
- (d) appropriate source of inaccuracy associated with procedure e.g. any one from:
 • water levels not the same
 • thermometer scales not read at 90°
 • initial temperatures different
 • not able to stir water
 • not waiting for temperature to stabilise initially / waiting time not long enough [1]
- (e) any two factors relating to apparatus from:
 • keep thermometer at same depth
 • same size/thickness/material of test-tube / same test-tube
 • same water levels/volume/quantity/amount of water
 • same thickness/surface area of surface material [2]

[Total: 8]

45. 0625_s13_MS_62 Q: 2

- (a) $\theta_c = 19$ ($^{\circ}\text{C}$) [1]
- (b) s, $^{\circ}\text{C}$, symbols or words [1]
- (c) 12 cm^3 (unit needed) [1]
- (d) 40–50 (cm^3), (expect 42 cm^3 e.c.f. (c)) [1]
 estimate given to nearest 1 cm^3 only and sensible method [1]
- (e) two from:
 room / surrounding temperature / other environmental condition
initial hot water temperature
initial cold water temperature
 volume / mass / amount of hot water
 time delay on adding cold water / same time for cooling [2]

[Total: 7]

46. 0625_s13_MS_63 Q: 1

- (a) 24(°C) [1]
- (b) units all correct (symbols or words) [1]
times 1, 2, 3, 4, 5, 6 (allow seconds if compatible with heading) [1]
- (c) thermometer near bottom/no significant difference
and justification matching statement (words or figures) with mention/implication of temperature change [1]
in same time [1]
- (d) appropriate precaution: [1]
e.g. stir before reading / keep thermometer at same depth [1]
matching explanation:
e.g. ensure temperature is the same throughout / temperature different at different depths [1]
- (e) appropriate precautions relating to comparison
any two of:
same size/thickness/surface area of beaker
same volume of water
same initial temperature (of water)
same room temperature / appropriate environmental condition [2]

[Total: 9]

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47. 0625_w13_MS_61 Q: 2

- (a) 87 (°C) [1]
- (b) (i) s, °C, °C [1]
- (ii)(iii) **B** and greater temperature difference
OR numbers quoted, *must see* 21 and 8 or 24 and 5 [1]
- (iv) **A** 23(°C) and **B** 40(°C) [1]
- (v) 20 – 26 (°C) [1]
- (c) EITHER viewing thermometer at right angles
OR reference to being ready on time [1]
- (d) any two from:
room temperature
water / starting temperature
distance of thermometer bulb from water surface
relevant reference to draughts / fans / air conditioning [2]
- [Total: 8]**

48. 0625_w13_MS_62 Q: 2

- (a) 78 °C c.a.o. unit needed [1]
- (b)(c) both thermometer readings correct 69, 61 [1]
correct differences 9, 17 allow e.c.f. [1]
- (d) order matches results (expect D, B, C, A) allow e.c.f. [1]
- (e) any two from:
room temperature (or other environmental condition)
initial (hot) water / starting temperature (accept initial temperature)
volume / mass / amount / level of (hot) water
same type / thickness / material / size / volume of beaker
time delays during operations [2]
- (f) same time of cooling for each experiment [1]
- [Total: 7]**

- (a) **A = 87(°C) and B = 88(°C)** [1]
- (b) units correct (symbols or words) [1]
times correct (0, 30, 60, 90, 120, 150, 180) [1]
- (c) statement matching temperature changes (accept 'no significant difference' if justified) [1]
and justification matching statement (comparison of temperature changes) [1]
including specific mention of temperature change in same time
- (d) appropriate condition relating to comparison
i.e. any one from:
same size/thickness of beaker
same volume of water
same initial temperature
same room temperature / appropriate environmental condition
same time for cooling [1]
- (e) any sensible alteration e.g.
put lid on/cover top of **A**
extra experiment without insulation or lid / take lid off **B** [1]
matching explanation e.g.
most thermal energy loss by convection or o.w.t.t.e.
have only changed one factor or o.w.t.t.e. [1]

[Total: 8]

50. 0625_s12_MS_61 Q: 2

- (a) $\theta_R = 22(^{\circ}\text{C})$ [1]
- (b) Table: [1]
 mm, $^{\circ}\text{C}$ [1]
 Correct d values 100, 80, 60, 40, 20, 10 [1]
- (c) Temperature difference = $3(^{\circ}\text{C})$, higher [1]
- (d) Draughts [1]
 Room temperature/humidity [1]
- (e) One from: [1]
 Relevant avoidance of parallax explained, in using rule or thermometer
 Waiting time between readings
 Wait for steady thermometer reading
 Allow lamp to cool/warm up
 Repeats and average [1]

[Total: 7]

51. 0625_s12_MS_62 Q: 2

- (a) 23°C need unit for the mark [1]
- (b) Axes correctly labelled with quantity and unit [1]
 Suitable scales [1]
 All plots correct to $\frac{1}{2}$ small square [1]
 Good line judgement [1]
 Thin, continuous line [1]
- (c) Two from: Paper Perfection, Crafted With Passion
 Room temperature/humidity/sun through window/air conditioning
 Draughts
 Initial water temperature [2]

[Total: 8]

52. 0625_s12_MS_63 Q: 2

- (a) 23 °C need unit for the mark [1]
- (b) Axes correctly labelled with quantity and unit [1]
Suitable scales [1]
All plots correct to ½ small square [1]
Good line judgement [1]
Thin, continuous line [1]
- (c) Two from:
Room temperature/humidity/sun through window/air conditioning
Draughts
Initial water temperature [2]

[Total: 8]

53. 0625_w12_MS_61 Q: 2

- (a) $\theta_R = 24(^{\circ}\text{C})$ [1]
- (b) (i) Table:
s, °C, °C [1]
- (ii) About the same [1]
Justified with reference to numbers in table [1]
- (c) Any two from:
Volumes of water
Room temperature/draughts
Same beaker
Initial water temperature [2]

[Total: 6]


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54. 0625_w12_MS_62 Q: 2

- (a) $\theta_R = 23$ [1]
 $^{\circ}\text{C}$ [1]
- (b) (i) $\theta_A = 63$ and (ii) $\theta_H = 14$ (unit not required) ecf θ_R from **2(a)** [1]
- (c) (i) $\theta_B = 36$ and (ii) $\theta_W = 15$ (unit not required) ecf θ_R from **2(a)** [1]
- (d) Ratios calculated 4.5 and 2.4 ecf **2(b)** and **2(c)** [1]
 Expect NO and ratios too different/not close enough (owtte), matching statement ecf wrong values from **2(b)** and **2(c)** [1]
- (e) Any two from:
 Room temperature/draughts/humidity/air conditioning (i.e. environmental factor)
 Initial (water) temperature (cold or hot)
 Amount of stirring
 Time interval
 Mass/volume/amount of water/water level
 Size/surface area/material of beaker [2]

[Total: 8]

55. 0625_w12_MS_63 Q: 2

- (a) 23 seen in correct place in table [1]
- (b) (i) Units all correct (symbols or words) [1]
 (ii) 10°C (or ecf from **2(a)**) and 23°C [1]
 (iii) Statement matching temperature changes (expect 'black') with supporting comparative comment [1]
 (iv) Statement matching results (expect 'Yes') [1]
Figures from table matching correct statement [1]
and time interval mentioned at least once [1]

- (c) Any one from:
 same (type of) lamp/same brightness
 same distance/height
 same (type of) thermometer
 same area of card
 same thickness of card
 good contact between card and thermometer (owtte)
 same start temperature/allow thermometer to cool
 allow lamp to cool

[1]

Appropriate matching explanation:
 power output may not be the same (owtte)
 different intensity of radiation (owtte)
 respond differently/different heat capacity
 different surface area to absorb radiant heat (owtte)
 different rate of conduction (owtte)
 rate of rise different at different temperatures
 heating starts at different times

[1]

[Total: 8]

56. Not applicable



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