Thermal Processes

Question Paper 1

Level	IGCSE
Subject	Physics
Exam Board	CIE
Topic	Thermal Physics
Sub-Topic	Thermal Processes
Paper Type	Alternative to Practical
Booklet	Question Paper 1

Time Allowed: **57 minutes**

Score: **/47**

Percentage: **/100**

1 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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.....[7]

[Total: 7]

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.

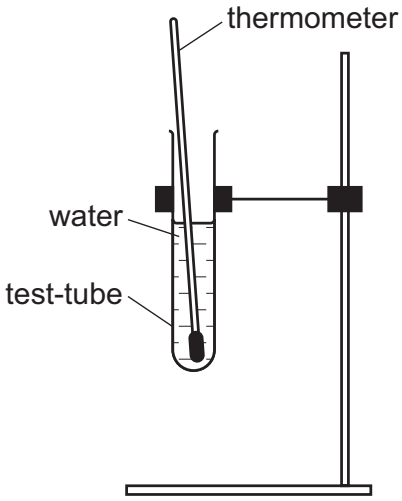

Fig. 2.1

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

Fig. 2.2

θ_R = ... [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.

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..... [1]

(c) The student records in Table 2.1 the time *t* and the temperature θ of the water every 30 s. She removes the thermometer and pours away the water from the test-tube.

She then wraps cotton wool insulation around the test-tube and repeats the procedure.

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

Table 2.1

t /	tube without cotton wool θ /	tube with cotton wool θ /
0	79	80
	65	67
	58	60
	55	57
	53	56
	52	55
	51	54

[1]

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

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..... [3]

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

quality of results: .....

.....

improvements: .....

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.....

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[3]

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

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

1. .....

2. .....

[2]

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

volume = ... [1]

[Total: 12]

3 The class is investigating 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.

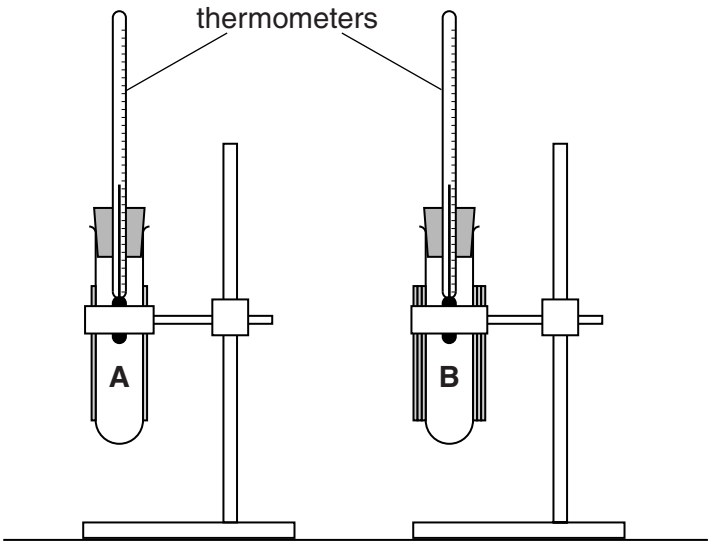

Fig. 2.1

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.

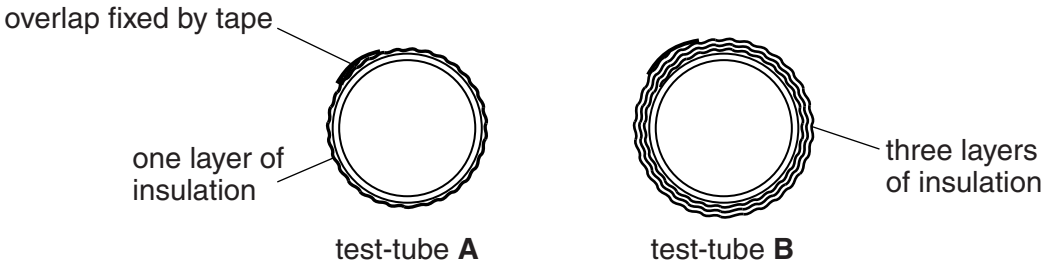

Fig. 2.2

(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 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/		
	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 .....

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justification .....

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[2]

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

1. .....

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2. .....

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[2]

(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. .....

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2. .....

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[2]

[Total: 8]

4 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.

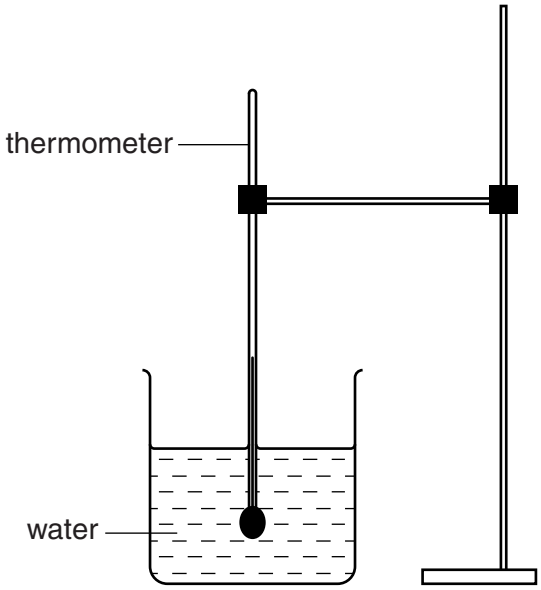

Fig. 3.1

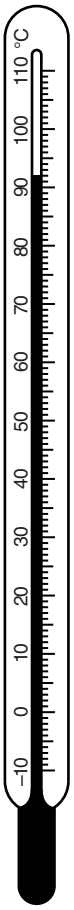

Fig. 3.2

(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/		
30	78	84
60	71	79
90	67	76
120	65	74
150	63	73

He replaces the thermometer in the beaker of hot water and records its temperature.

θ_H ..... 90 °C .....

He removes the thermometer from the beaker of hot water and places it in a beaker containing only dry cotton wool. The thermometer bulb is completely surrounded by cotton wool. He immediately starts a stopclock, and records the temperature θ every 30 s. The readings are shown in Table 3.1.

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

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

statement .....

justification .....

.....

[2]

(c) Suggest two conditions that should be kept constant when this experiment is repeated.

1. .....

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2. .....

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[2]

[Total: 6]

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

Figs. 2.1 and 2.2 show the apparatus used.

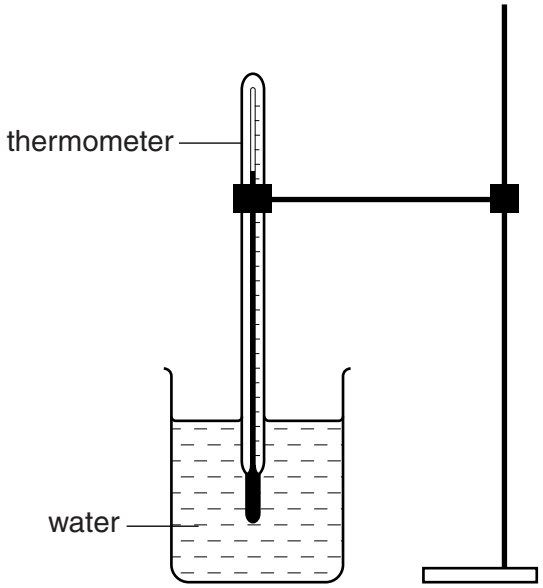

Fig. 2.1

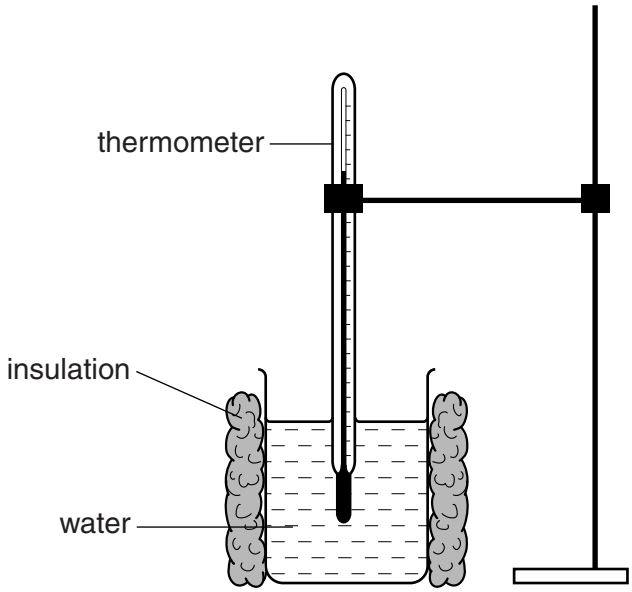

Fig. 2.2

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

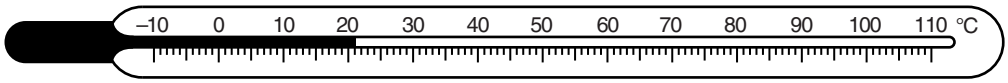

Fig. 2.3

θ_R = ... [1]

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

Table 2.1

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

Complete the column headings in the table. [1]

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

statement .....

justification .....

.....

.....

[2]

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

Suggest how you would reduce the evaporation in this experiment.

.....[1]

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

.....[1]

[Total: 6]

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

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

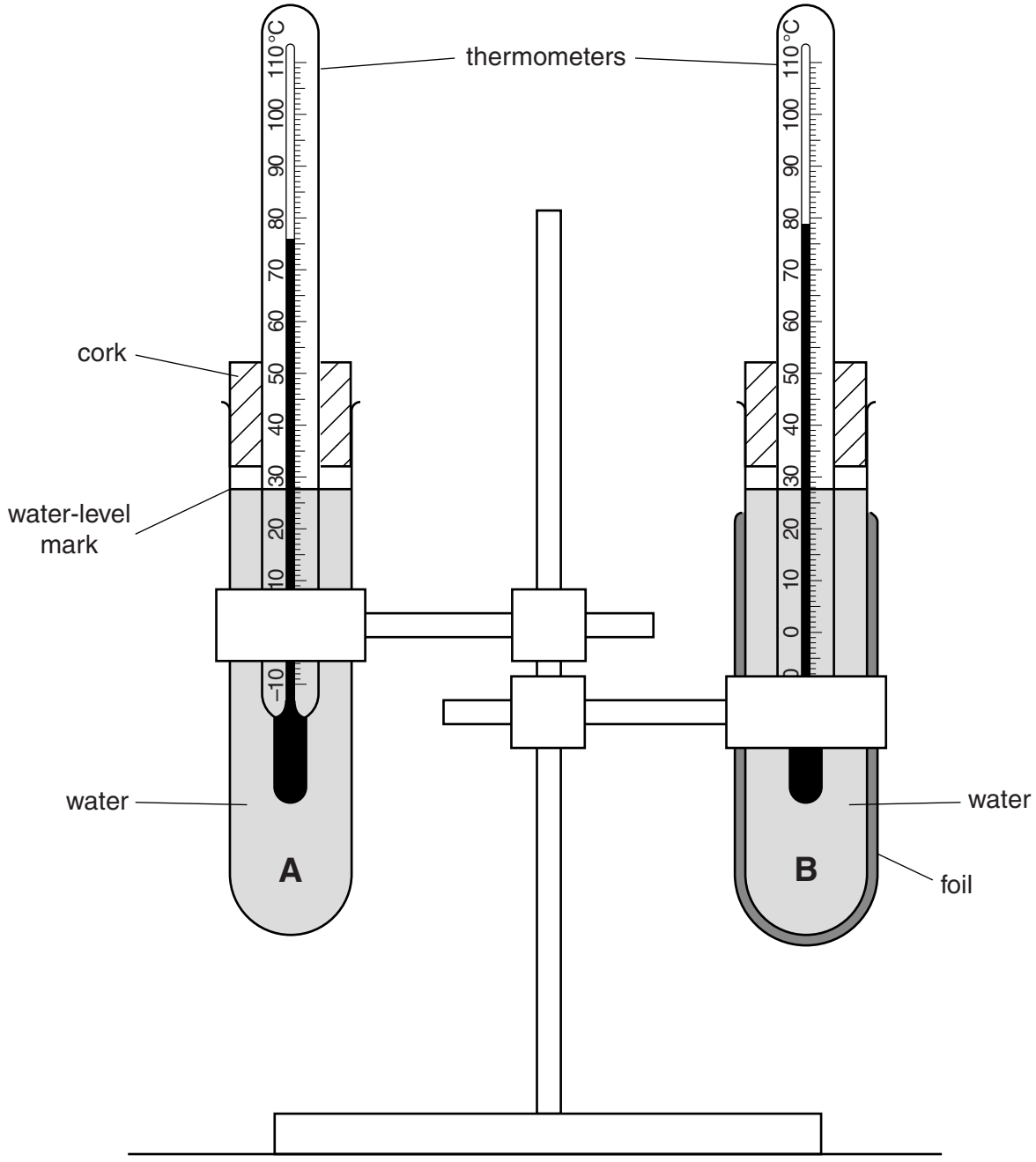

Fig. 2.1

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

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

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

(ii) The temperatures θ of the thermometer in test-tube **A** at times $t = 30\,s$, $60\,s$, $90\,s$, $120\,s$, $150\,s$ and $180\,s$ are shown in Table 2.1.

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

Table 2.1

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

[3]

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

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

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

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

test-tube .....

justification .....

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[2]

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

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..... [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. .....

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2. .....

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[2]

[Total: 8]