Cambridge Assessment International Education

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3: Energy – Topic questions

Paper 6

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2016	June	61
5	2016	March	62
1	2016	November	63

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

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4 A student is investigating the effect of insulation on the rate of cooling of hot water in a 250 cm^3 container.

The student can choose from the following apparatus:

thermometer
250 cm^3 glass beaker
250 cm^3 plastic beaker
250 cm^3 copper can
250 cm^3 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.

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.... [7]

[Total: 7]

1 A student is investigating the transfer of thermal energy.

He uses the apparatus shown in Fig. 1.1.

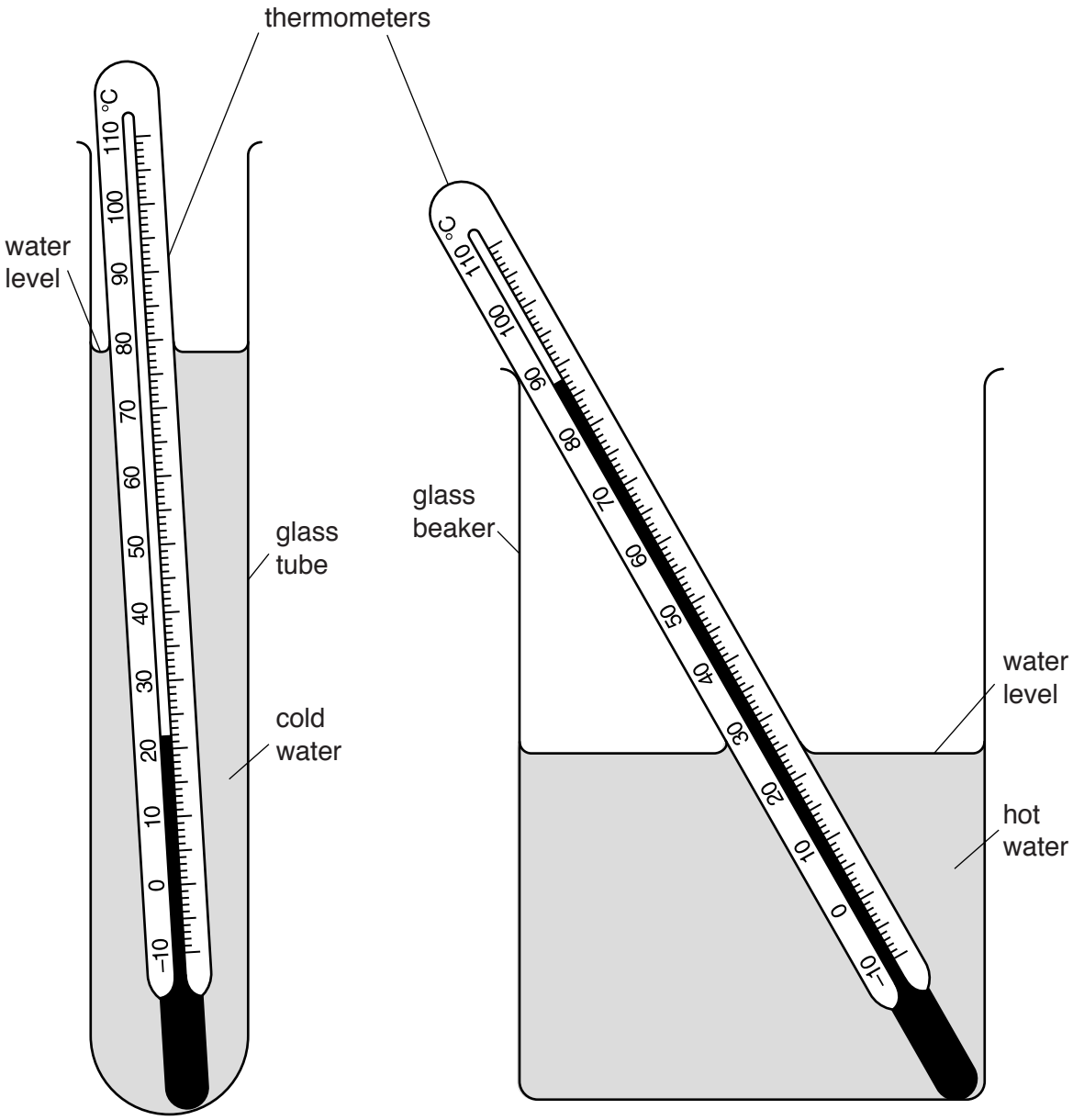

Fig. 1.1

(a) The student pours 50 cm^3 of cold water into the glass tube and 300 cm^3 of hot water into the beaker. The water levels are approximately as shown in Fig. 1.1.

In Table 1.1, record the temperatures θ_C of the cold water and θ_H of the hot water as shown on the thermometers in Fig. 1.1. [1]

Table 1.1

	tube with 50 cm^3 of cold water		tube with 25 cm^3 of cold water	
t/	θ_C/	θ_H/	θ_C/	θ_H/
0			20.0	87.0
30	33.0	82.0	34.0	82.0
60	40.5	79.0	49.0	79.5
90	49.0	78.0	59.5	76.0
120	56.0	76.0	65.5	75.0
150	60.0	75.0	69.5	74.5
180	63.0	74.0	72.0	74.0

(b) The student lowers the glass tube into the beaker of hot water and immediately starts a stopclock.

Table 1.1 shows the readings of the temperature θ_C of the cold water and the temperature θ_H of the hot water at times t = 30 s, 60 s, 90 s, 120 s, 150 s and 180 s.

The student repeats the procedure with the same volume of hot water in the beaker but with 25 cm^3 of cold water in the glass tube. The results are shown in the table.

Complete the column headings in the table. [1]

(c) Write a conclusion stating how the volume of cold water in the tube affects its temperature rise.

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

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2. .....

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[2]

(e) Scientists in an industrial laboratory wish to use this experiment as a model of a heat exchanger, which transfers thermal energy between liquids.

Suggest **two** different improvements to the apparatus which would make the heating of the cold water more efficient.

For your **first** suggestion, explain why it would be an improvement.

suggestion 1 .....

explanation .....

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suggestion 2 .....

[3]

[Total: 8]

5 Two students are investigating thermal energy transfer.

They are using the apparatus shown in Fig. 5.1.

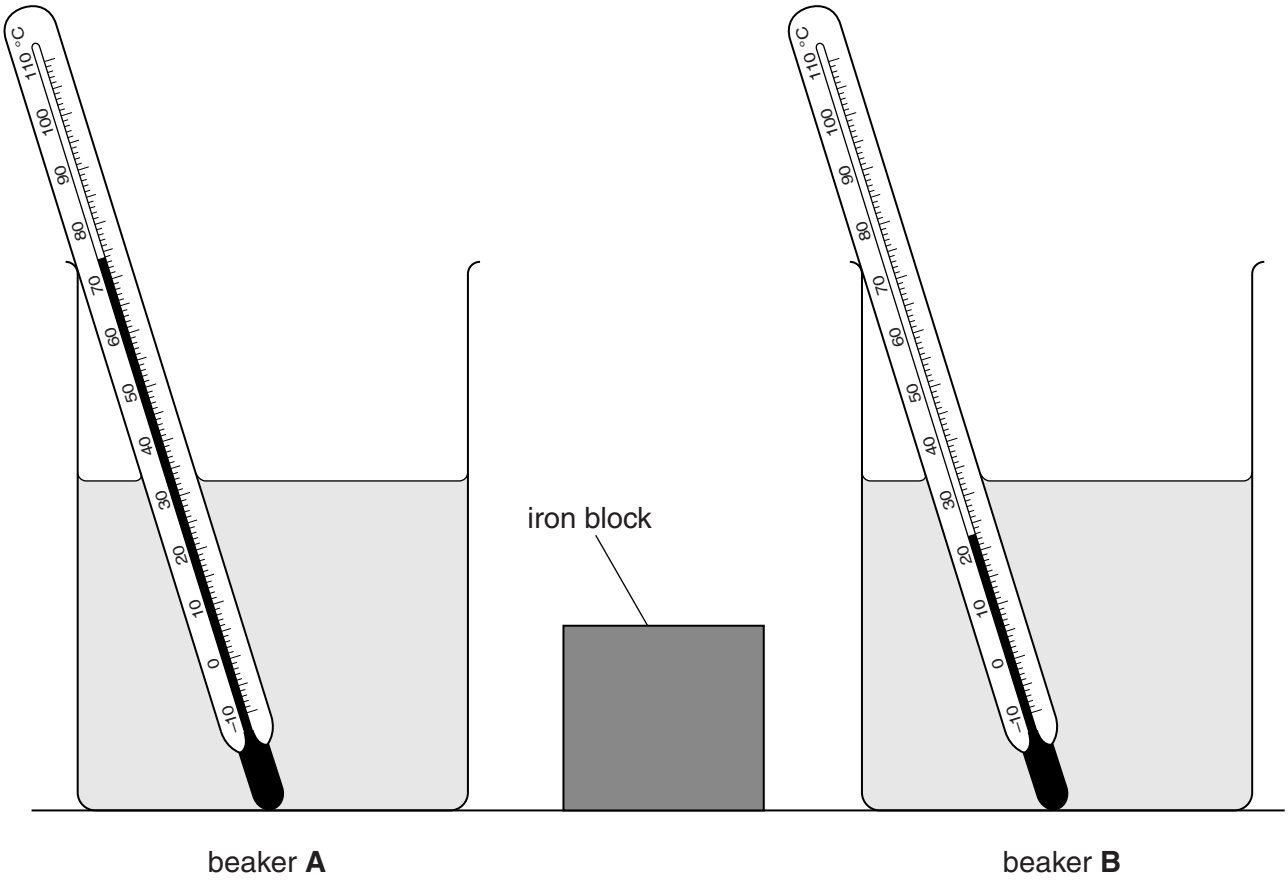

Fig. 5.1

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.

θ_H = ...

θ_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.

(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 .....

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improvement .....

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[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 .....

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improvement .....

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[2]

[Total: 5]

Question	Answer		Mark
4	**MP1**	Uses same container throughout	1
	MP2	Hot water in container (any) and takes temperatures at intervals or at start and after a fixed time	1
		OR Hot water in container (any) and takes time for a fixed temperature fall.	
	MP3	Repeats with different insulators (all three used)	1
	MP4&5	Any two from:	1
		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	
	MP6	Table or tables as appropriate to method: Temperatures with unit °C and time with unit s (or min) and different	1
		insulators shown	
	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

Question	Answer	Mark
1 (a)	22(.0) AND 88(.0)	1
1 (b)	units correct and consistent (symbols or words)	1
1 (c)	conclusion which matches the temperature changes	1
1 (d)	any two from: • 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	2
1 (e)	any two improvements relating to apparatus: • lid on beaker / in boiling tube • insulation on beaker • 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: • reduces loss of thermal energy from beaker / boiling tube • better thermal conduction • not affected by variation in hot water temperature	2 1
		Total: 8
5 (a)	θ_H = 74 AND θ_C 23(°C)	1
1 (b) (i)	suitable reason, e.g. • temperature not able to reach max θ_H (in 30s) • temperature dropped on transfer • conduction/transfer to metal tongs matching improvement, e.g. • leave block in hot water for longer • transfer more quickly • use insulated tongs/cotton round block	1 1
1 (b) (ii)	suitable reason, e.g. • some (thermal) energy transferred to beaker • some (thermal) energy transferred to surroundings • evaporation/convection (into atmosphere) matching improvement, .g. • use a less conducting material for beaker owtte • insulate beaker • allow for beaker in any calculation • lid on beaker	1 1
		Total: 5

Notes about the mark scheme are available separately.