Thermal insulation

Physics required practical | AQA GCSE Physics 8463 only (not Combined Science) | 14 questions, 35 marks

GCSE science required practicals

This practical online

Name: _____ **Date:** _____ **Score:** _____ / 35

Aim: To find out how the thickness of an insulating layer, and the type of material, affects how quickly a beaker of hot water cools.

Equipment: Several identical 250 cm^3 beakers; Kettle to supply hot water; Measuring cylinder (250 cm^3); Thermometer (a digital one reading to 0.1 °C is best); Stopwatch; Sheets of newspaper (or other insulating materials such as bubble wrap, cotton wool, felt); Elastic bands or tape; Card lids with a hole for the thermometer; Heatproof mat.

Results

Priya put 200 cm^3 of hot water into each of six beakers wrapped in different numbers of layers of newspaper. She started timing when each beaker was at 80.0 °C and read the temperature again 10 minutes later.

Number of layers of newspaper	Temperature at start in °C	Temperature after 10 minutes in °C	Temperature drop in °C
0	80.0	61.6	18.4
1	80.0	66.0	14.0
2	80.0	68.7	11.3
3	80.0	67.4	12.6
4	80.0	71.6	8.4
5	80.0	72.2	7.8

Questions

1 In Priya's experiment, what was:

a. the independent variable

b. the dependent variable?

(2 marks)

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2 Priya used 200 cm^3 of water in every beaker. Explain why it was important to keep the volume of water the same.

(2 marks)

3 Every beaker had the same card lid on it. Explain why.

(2 marks)

4 Give one hazard in Priya's experiment and one way she can reduce the risk.

(2 marks)

5 Describe the pattern in Priya's results.

(2 marks)

6 One result does not fit the pattern.

a. Which result is anomalous?

b. Suggest one thing that could have gone wrong to cause it.

(2 marks)

7 Calculate the mean rate of cooling of the water in the beaker with no layers, in °C per minute.

(2 marks)

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8 The beaker with no layers held 200 g of water. The specific heat capacity of water is 4200 J/kg °C.

The change in thermal energy is given by $\Delta E = mc\Delta\theta$, where m is the mass in kg, c is the specific heat capacity and $\Delta\theta$ is the temperature change in °C.

Calculate the energy transferred from the water to the surroundings in 10 minutes. Give your answer to 3 significant figures. Show your working.

(3 marks)

9 The water in the beaker with no layers lost 15 456 J of energy in 10 minutes.

Calculate the mean rate at which energy was transferred from the water, in watts. Give your answer to 2 significant figures. Show your working.

(3 marks)

10 Calculate the percentage decrease in the temperature drop when the number of layers goes from 0 to 5. Give your answer to 2 significant figures.

(2 marks)

11 **Higher tier**

Explain why wrapping the beaker in newspaper slows down the cooling, and suggest why adding a fifth layer made much less difference than adding the first layer.

(3 marks)

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12 Tomasz did the same experiment using a liquid-in-glass thermometer marked every 1 °C. Suggest why Priya's digital thermometer, which reads to 0.1 °C, is a better choice for this investigation.

(2 marks)

13 **Higher tier**

Kwame says Priya did not need to wait for each beaker to cool to exactly 80.0 °C before starting the stopwatch. Explain why he is wrong.

(2 marks)

14 Plan an investigation to find out which of four materials (bubble wrap, cotton wool, felt and fleece fabric) is the best thermal insulator.

(6 marks)

End of questions | Total 35 marks | The answers sheet has the full method as revision notes.

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