Thermal insulation

Name _____ Class _____ Date _____

Insulation reduces the rate of energy transfer by heating. In this practical you compare how well different materials insulate, and test a factor such as thickness.

KEY IDEAS

- The higher the thermal conductivity of a material, the higher the rate of energy transfer by conduction across it.
- The rate of cooling of a building depends on the thickness and the thermal conductivity of its walls.
- In the practical, the **best insulator** gives the **smallest temperature drop** in a fixed time.

Section A · Recall

Grade 4–5

1 State what is meant by a thermal insulator. [1]

A material with a low thermal conductivity, which reduces the rate of energy transfer by heating.

2 Give two ways a house can be insulated to reduce energy transfer. [2]

Loft insulation / cavity wall insulation / double glazing / thicker walls

Draught excluders / carpets

Section B · The practical

Grade 5–6

3 A student wraps a beaker of hot water in different materials and measures the temperature after 10 minutes.

Material	Start temperature (°C)	Temperature after 10 min (°C)	Temperature drop (°C)
No material (control)	80	62	**18**
Cotton wool	80	72	**8**
Bubble wrap	80	70	**10**
Newspaper	80	68	**12**

a Complete the temperature drop column. [2]

b Name the independent variable and the dependent variable. [2]

Independent: type of material

Dependent: temperature drop (over 10 minutes)

c Give two control variables. [2]

Starting temperature of the water; volume of water

Same beaker / same thickness of material / same time / lid on each

d Which material is the best insulator? Explain how you know. [2]

Cotton wool,

because it had the smallest temperature drop in the same time.

e Suggest why the results should be shown on a bar chart, not a line graph. [1]

The independent variable (type of material) is categoric.

Section C · Stretch

Grade 7+

4 Explain why the water must start at the same temperature for each material. [2]

The rate of cooling depends on the temperature difference with the surroundings;

hotter water cools faster, so a different start temperature would not be a fair test.

5 The student then tests 1, 2, 3 and 4 layers of newspaper. Predict the results and suggest the shape of a graph of temperature drop against number of layers. [3]

More layers → smaller temperature drop (thicker insulation).

The temperature drop decreases as layers increase,

but each extra layer makes less difference, so the graph curves and levels off.

Exam-style question

AQA style

6 A student wants to find out which material would be best for insulating a hot water tank.

a Describe a method the student could use. Include how to make it a fair test. [6]

Put a fixed volume of hot water (e.g. 80 cm^3) into a beaker inside a larger beaker, packed with the first material.

Add a lid with a hole for the thermometer; wait until the water is at the starting temperature (e.g. 80 °C).

Start a stopwatch; record the temperature every 3 minutes for 15 minutes (or after a fixed time).

Repeat with each material, keeping the volume, starting temperature, beakers, thickness and time the same.

Calculate the temperature drop for each; repeat and calculate means.

The material with the smallest temperature drop is the best insulator. Hazard: hot water can scald, so take care.

b Suggest one way to improve the accuracy of the temperature readings. [1]

Use a digital thermometer or temperature probe and data logger (higher resolution, no reading errors).

Total: _____ / 24

How confident am I?	Not yet	Nearly	Got it
I can describe the thermal insulation practical	☐	☐	☐
I can identify variables and explain why they must be controlled	☐	☐	☐
I can link insulation to thermal conductivity and thickness	☐	☐	☐