


Learning Objectives -

- Measure the rate of cooling of a beaker of hot water that is insulated with different materials.
- Use your results to plot cooling curves to determine which is the best thermal insulator.

Method:

- Put the small beaker **inside** the larger beaker.
- Use the **kettle** to boil water. Put **80 cm³** of this hot water into the small beaker.
- Use a piece of **cardboard** as a lid for the large beaker - there must be a **hole** for the thermometer.
- Put the **thermometer** through the hole in the cardboard lid so that its bulb is in the hot water.
- Record** the **temperature** of the water and start the **stopwatch**.
- Record the temperature of the water every **3 minutes** for **15 minutes**.
- Record your results in a table.
- Repeat steps 1-6 using **different materials** each time to **fill the space** between the small and large beaker.

Make sure you use the **same volume of water** each time.

 You might find it easier to set up your beakers at the start.

REQUIRED PRACTICAL 2 THERMAL INSULATION P1 - DIFFERENT MATERIALS

Time (mins)	Material used for insulation			
	No insulation	Bubblewrap	Cottonwool	Newspaper
	Temperature (°C)			
0				
3				
6				
9				
12				
15				
Change in temperature (°C)				

Random errors

- Some **heat will dissipate** into the surroundings
 - Make sure the hole in cardboard is as small as possible.
- Errors** in **measurements** from thermometer
 - Use a joulemeter to calculate energy directly
- Human error** of temperature reading
 - Take repeated readings and obtain a mean.
 - Read values at eye level.

Independent variable

- type of material

Dependent variable

- temperature, T (°C)

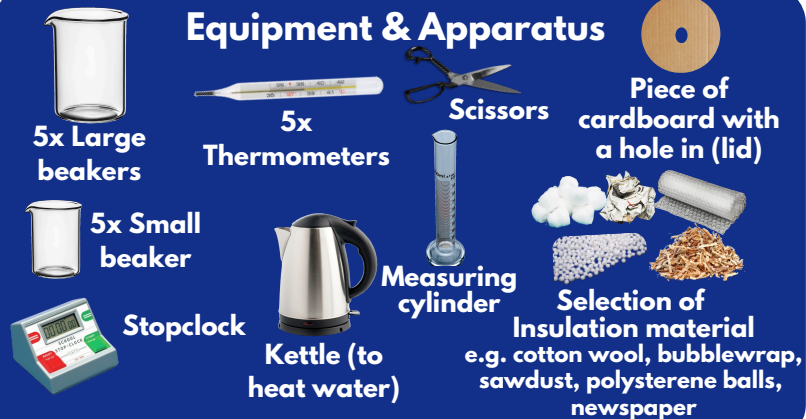
Control variables -

volume of water, temperature at the start, thickness of each material

Systematic errors

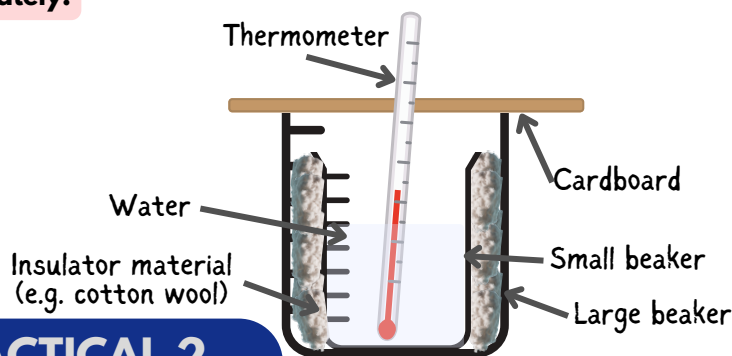
- If the **starting temperature** of the water is **different** for each material, this will affect the rate of heat loss - work in **pairs to coordinate** the starting of the stopwatch and point at which the temperature gets to the starting point used in the control.
- Make sure only the top of the beaker is covered so **energy is transferred** through the **glass**.
- A thermometer has a resolution of 1°C, a **data logger** connected to a **digital thermometer** would get more accurate readings.

Equipment & Apparatus

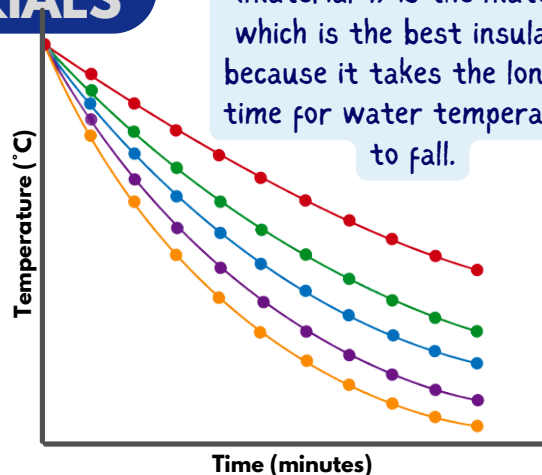


Safety:

- Do not touch the beakers when **hot** - if skin is scalded, run area under cold water for at least five - ten minutes.
- Keep the beakers on the **heatproof mat** and allow time for equipment to cool before deconstructing.
- Wear **eye protection** around hot water.
- If there is cracked or **broken glass**, inform a **supervisor** immediately.



The shallowest curve (material 1) is the material which is the best insulator because it takes the longest time for water temperature to fall.



- Material 1 ● Material 3 ● Material 4
- Material 2 ● Material 5

Temperature fall is quicker at higher temperatures than lower temperatures
- When water temperature is high, there is a greater temperature difference between it and room temperature, so there is a higher rate of energy transfer.

Exam Style Questions - Thermal Insulation P1

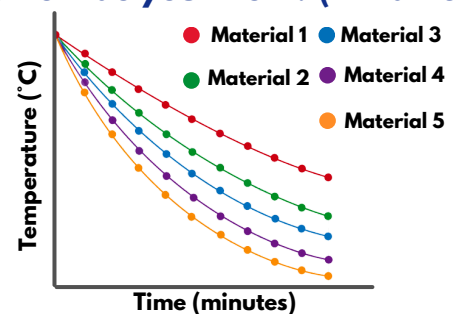
1. What is the independent variable in this experiment? (1 mark)

2. Why is a lid with a hole used during the experiment? (1 mark)

3. Describe how you would compare the effectiveness of five insulating materials using this setup. (3 marks)

4. A student finds that the temperature of the water drops fastest with newspaper and slowest with bubble wrap. What conclusion can they make about the effectiveness of these two materials? (2 marks)

5. Look at the graph. Which line shows the best insulator and how do you know? (2 marks)



6. Explain why it is important to use the same starting temperature of water in each beaker. (2 marks)

7. The student notices the thermometer readings vary slightly each time they insert it. Suggest one reason why this happens and how it could be reduced. (2 marks)

8. A student finds that the temperature of the water drops quickly in the first 3 minutes, then more slowly afterwards. Explain why this happens using ideas about temperature difference and energy transfer. (3 marks)

Exam Style Questions - Thermal Insulation P1

1. What is the independent variable in this experiment? (1 mark)

Mark One - Type of insulating material

2. Why is a lid with a hole used during the experiment? (1 mark)

Mark One - To reduce heat loss while still allowing the thermometer to be inserted

3. Describe how you would compare the effectiveness of five insulating materials using this setup. (3 marks)

Mark One - Use the same volume and temperature of hot water in each beaker

Mark Two - Wrap each beaker in a different insulating material

Mark Three - Record the temperature every 3 minutes for 15 minutes and compare the results

4. A student finds that the temperature of the water drops fastest with newspaper and slowest with bubble wrap. What conclusion can they make about the effectiveness of these two materials? (2 marks)

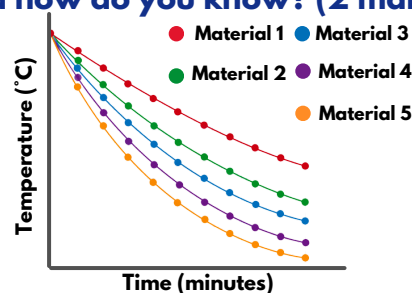
Mark One - Bubble wrap is a better insulator

Mark Two - Because it slows down energy transfer more than newspaper

5. Look at the graph. Which line shows the best insulator and how do you know? (2 marks)

Mark One - The line with the shallowest gradient (temperature drops slowest)

Mark Two - Because the temperature stays highest for longest



6. Explain why it is important to use the same starting temperature of water in each beaker. (2 marks)

Mark One - So the results are comparable

Mark Two - Different starting temperatures could affect the rate of cooling

7. The student notices the thermometer readings vary slightly each time they insert it. Suggest one reason why this happens and how it could be reduced. (2 marks)

Mark One - The thermometer may not be in the same position each time

Mark Two - Use a fixed lid or clamp to keep the thermometer in place

8. A student finds that the temperature of the water drops quickly in the first 3 minutes, then more slowly afterwards. Explain why this happens using ideas about temperature difference and energy transfer. (3 marks)

Mark One - At the start, the temperature difference between the water and surroundings is greatest

Mark Two - This causes faster energy transfer to the surroundings

Mark Three - As the water cools, the temperature difference decreases, so heat is lost more slowly