
Thermal insulation

Investigate the effectiveness of different materials as thermal insulators and the factors that may affect the thermal insulation properties of a material.

In this practical you will:

- 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
- measure the rate of cooling of a beaker of hot water that is insulated with different thicknesses of the same material
- use your results to plot cooling curves to determine the effect of changing the thickness of the insulator.

Activity 1: Comparing the effectiveness of different materials as thermal insulators

Apparatus

- a large beaker
- a small beaker
- a thermometer
- a kettle to heat water
- a piece of cardboard with hole in as a lid
- scissors
- a stopclock
- a selection of insulating materials.

Method

1. Put the small beaker inside the larger beaker.
2. Use the kettle to boil water. Put 80 cm³ of this hot water into the small beaker.
3. Use a piece of cardboard as a lid for the large beaker. The cardboard must have a hole for the thermometer.
4. Put the thermometer through the hole in the cardboard lid so that its bulb is in the hot water.
5. Record the temperature of the water and start the stopwatch.
6. Record the temperature of the water every 3 minutes for 15 minutes.

7. Record your results in a table like this one:

Time mins	Material used for insulation			
	No insulation			
	Temperature °C			
0				
3				
6				
9				
12				
15				
Change in temperature °C				

8. 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.

Analysis of results

- Use your results to plot a graph to show the cooling curve for each material.
- Use your graph to determine which material is the best insulator.
- Why do you think this material was a particularly good insulator?

Activity 2: How thickness of material affects the thermal insulation

Apparatus

- a 100 cm³ beaker
- a thermometer
- a kettle to heat water
- a piece of cardboard with hole in as a lid
- scissors
- stopwatch
- insulating material
- rubber bands.

Method

1. Wrap **two layers** of insulating material around the beaker, holding it in place with a rubber band. Do not add insulating material to the bottom of the beaker.
2. Put 80 cm³ of hot water into the beaker.
3. Add a lid to the beaker.
4. Insert the thermometer through the hole in the lid so that its bulb is in the hot water.
5. Record the temperature of the water and start the stopwatch.
6. Record the temperature of the water every 3 minutes for 15 minutes.
7. Record your results in a table like this one. You can use the '**no insulation**' results from activity 1 for '**0 layers**' in this results table to save time.

Time mins	Material used for insulation			
	0 layers of newspaper	2 layers of newspaper	4 layers of newspaper	6 layers of newspaper
	Temperature °C			
0				
3				
6				
9				
12				
15				
Change in temperature °C				

8. Repeat steps 2–6 **adding 2 more layers of insulation each time.**

Analysis of results

Use your results to plot a graph to show the cooling curve for each different numbers of layers of insulation.

Use your graph to state the relationship between the numbers of layers of insulation and the overall change in temperature over the 15 minutes period.

Using the principles from both investigations, explain how these are applied in home construction to build energy efficient houses.