About thermal properties

Hot 'n' cold

Sometimes we want to keep things hot, other times we want to keep things cold. It's all about heat energy being transferred. Whichever your need, **thermal properties** are the key. One of these is thermal **conductivity**. It's the rate at which heat flows through a cross-sectional area of a material.

When heating a solid, its particles vibrate more quickly, converting **heat energy** into **kinetic energy**. The particles collide with neighbouring particles, passing on the energy. Metals are good conductors of heat and non-metals are poor conductors. This is easily shown when you hold a piece of wood over a flame. The wood may catch fire, but the end you're holding doesn't heat up. If you did the same with a piece of metal (don't try this at home, or anywhere else for that matter!), the heat would travel along the metal, eventually burning your hand. And it wouldn't catch fire - but that's a different property to thermal conductivity.

When choosing suitable materials for an engineered product, thermal conductivity is often important. For example, you don't want a handle on a frying pan to get hot when you're cooking eggs. But you do want the actual pan to conduct heat, or the eggs would stay cold.

There are other thermal properties worth knowing about, too. **Melting temperatures** are important. Again, you wouldn't want a frying pan to melt when it's on the hob. And **expansion** needs to be considered for some applications. Metals expand when heated, and contract again when cooled. Non-metals also expand, but not as much.

Last but not least, it's important to know if your materials will burst into flames when heated. This is a real problem in the home - old sofas, for example, burn extremely strongly in air. House fires are often started, or made much worse, when such furniture catches fire.

The Comparative Test supplied here is for comparing heat energy transfer through a range of materials. It's difficult to determine absolute measurements for thermal conductivity. Many British Standards use a method called 'Hot Box'. It's capable of great accuracy, but it's also a slow and painstaking method.

CT 0003:2003 Methods of testing thermal properties -

Part 1: Comparing heat energy transfer through a range of materials

COMPARATIVE TEST CT 0003-1:2003

Methods of testing thermal properties -

Part 1: Comparing heat energy transfer through a range of materials

1 Scope

This Comparative Test can be used to compare the rate of heat energy transfer through a range of materials.

2 Principle

When one end of a solid is heated, the vibrating particles at the hot end effect neighbouring particles, making them vibrate more. This happens quickly in a solid with high thermal conductivity. Heating one end of a material and timing how long it takes for the other end to heat up is a measure of the ease with which the material conducts heat.

3 Apparatus

- 400 cm^3 glass beaker
- watch glass
- thermistor connected to a multimeter set to read resistance
- stop clock
- two wooden blocks, approximately 50 mm x 50 mm, and the same width as the thermistor
- heat supply to boil water (either a kettle or a Bunsen burner, tripod and 400 cm^3 beaker)
- draught-proof, insulated container large enough to fit apparatus (see figure 1). Insulated container should have two small holes near the bottom, large enough to just fit the multimeter leads through.
- cotton wool

4 Test specimens

Test specimens should be 90 mm x 90 mm, with a thickness of 5 mm (see figure 1)

At least three specimens should be tested.

5 Procedure

- Set up apparatus as shown in figure 2
- Boil approximately 250 cm^3 water
- Pour 200 cm^3 of boiling water into the 400 cm^3 beaker, using the beaker's graduation to measure the water. Cover with a watch glass
- Replace the lid of the draught-proof box and immediately start the stop clock and record the reading on the multimeter
- Take multimeter readings (resistance, in ohms) every 30 seconds for five minutes.

6 Expression of Results

Copy and complete table 1.

Plot a graph of *average resistance* (in ohms) against *time* (in minutes).

NOTE: when testing different materials, use the same graph, to allow for easy comparison. Materials that produce a steep curve can transfer heat energy more easily.

7 Test Report

Your test report should include:

(a) Reference to this Comparative Test

(b) A copy of the table 1

(c) A copy of the graph.

figure 1

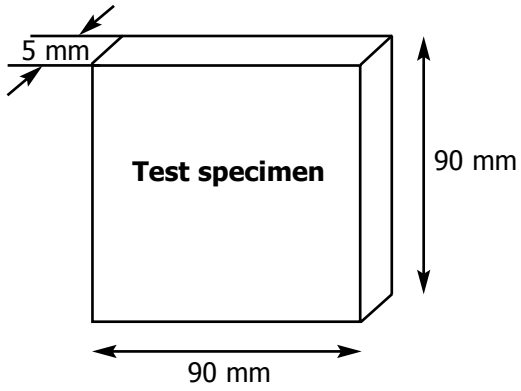

figure 2

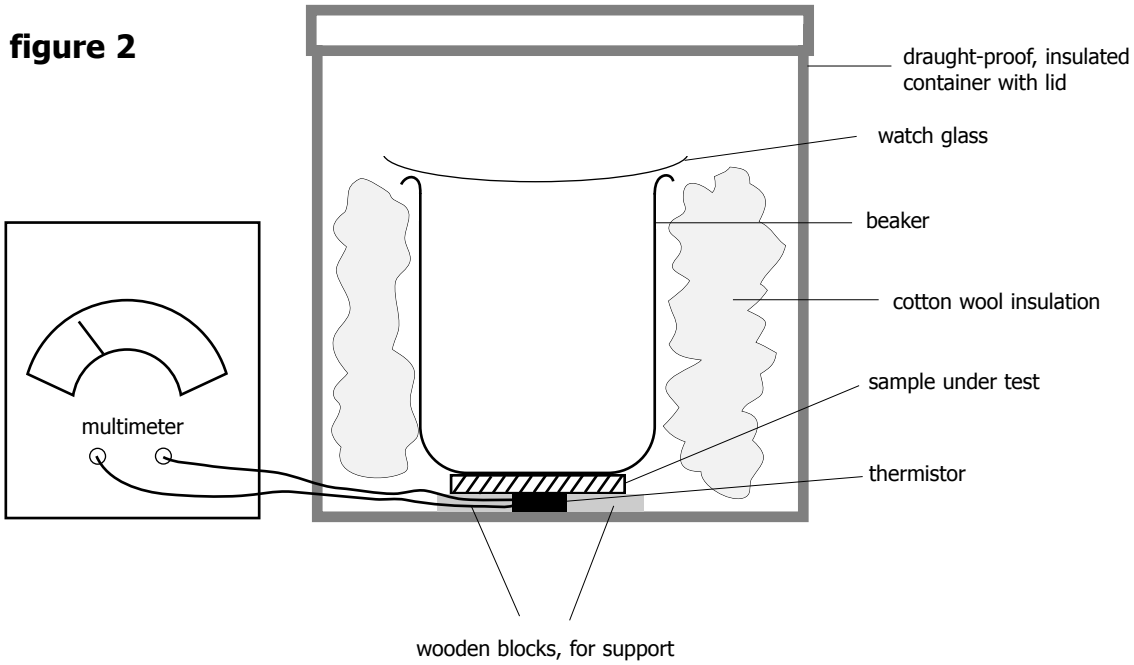

table 1

	Material =			
	Test specimen			
	One	**Two**	**Three**	
Time / mins	Resistance / Ohms	Resistance / Ohms	Resistance / Ohms	**Average resistance / Ohms**
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				
4.0				
4.5				
5.0				