Resistivity and Superconductivity

Resistance

The resistance of a wire is caused by free electrons colliding with the positive ions that make up the structure of the metal. The resistance depends upon several factors:

Length, l **Length increases – resistance increases**

The longer the piece of wire the more collisions the electrons will have.

Area, A **Area increases – resistance decreases**

The wider the piece of wire the more gaps there are between the ions.

Temperature **Temperature increases – resistance increases**

As temperature increases the ions are given more energy and vibrate more, the electrons are more likely to collide with the ions.

Material

The structure of any two metals is similar but not the same, some metal ions are closer together, others have bigger ions.

Resistivity, ρ

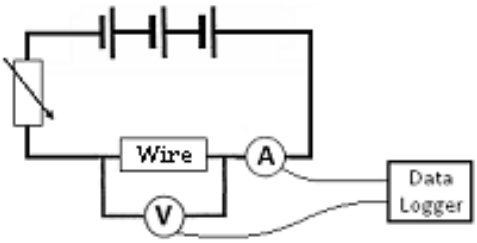
The resistance of a material can be calculate using $\boxed{R = \rho \frac{l}{A}}$ where ρ is the resistivity of the material.

Resistivity is a factor that accounts for the structure of the metal and the temperature. Each metal has its own value of resisitivity for each temperature. For example, the resistivity of copper is 1.7×10^{-8} Ωm and carbon is 3×10^{-5} Ωm at room temperature. When both are heated to 100°C their resistivities increase.

Resistivity is measured in Ohm metres , Ωm

Measuring Resistivity

In order to measure resistivity of a wire we need to measure the length, cross-sectional area (using Area = πr^2) and resistance. Remember, to measure the resistance we need to measure values of current and potential difference using the set up shown on the right



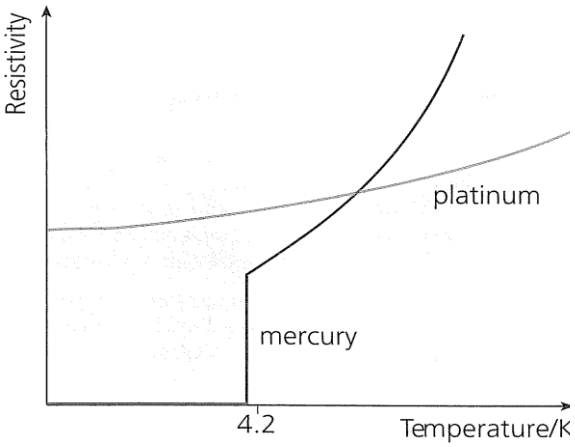
We then rearrange the equation to $\boxed{\rho = \frac{RA}{l}}$ and substitute values in

Superconductivity

The resistivity (and so resistance) of metals increases with the temperature. The reverse is also true that, lowering the temperature lowers the resistivity.

When certain metals are cooled below a *critical temperature* their resistivity drops to zero. The metal now has zero resistance and allows massive currents to flow without losing any energy as heat. These metals are called superconductors. When a superconductor is heated above it's critical temperature it loses its superconductivity and behaves like other metals.

The highest recorded temperature to date is –196°C, large amounts of energy are required to cool the metal to below this temperature.



Uses of Superconductors

High-power electromagnets

Power cables

Magnetic Resonance Imaging (MRI) scanners