Resistance and Resistivity

- $R \propto \rho$ ← resistivity

$$R = \frac{\rho l}{A}$$

$$\rho = \frac{RA}{l}$$

$$= \frac{\Omega m^{\cancel{2}}}{m}$$

$$= \Omega m$$

Difference between resistance and resistivity

- The resistance is the ratio of the length and cross-section area of the conductor, whereas the resistivity of the material is the ratio of the product of the resistance and area to the length of the conductor.
- The resistance is the property of the material which obstructs the flow of current, whereas the resistivity gives the resistance of the material which has fixed dimension.

How do superconductors work?

- If you cool some materials down to below a critical temperature called the "transitional temperature", their resistivity disappears entirely and they become a superconductor.
- Without any resistance, none of the electrical energy is turned into heat, so none of it is wasted.

Why are superconductors so rare?

- Most conductors, e.g. metals, have critical temperatures below 10 kelvin (-263°C).
- Getting things cold is expensive & tricky.

Heating effect of currents (Why does resistance increase when temperature increases?)

- The p.d over a conductor accelerates the free electrons giving them greater kinetic energy.
- As electrons move through the lattice, they collide with ions.
- This increases the vibrational kinetic energy of the lattice ions, making them heat up.
- Collisions with free electrons therefore are more frequent.
- Hence resistance increases as temperature increases.

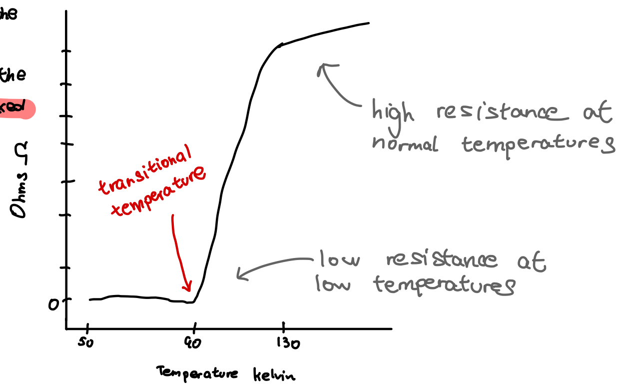
What is resistivity?

- This is a measure of how much a particular material resists current flow. It depends on the structure of the material as well on environmental factors such as temperature and light intensity.

$$\rho = \frac{RA}{L}$$

resistance/ Ω (R); cross-section area / m^2 (A); resistivity/ Ωm (ρ); length /m (L)

Superconducting



- Superconducting means using electricity with high currents without the heating effect of current, hence more energy can be used since less heat energy is loss.
- This is done by cooling down the wires as close to absolute zero K as possible.

Uses of superconductors

Superconducting wires can be used to make:

- Power cables that transmit electricity without any loss of power.
- Strong electromagnets that have lots of applications (e.g medicine, Maglev trains)
- Electronic circuits that work really fast with minimal energy loss (as there is no resistance to slow the current down)

Semiconductors

→ Semiconductors are a group of materials that aren't as good at conducting electricity as metals, because they have far fewer charge carriers (electrons) available

- If energy is supplied to a semiconductor (such as by an increase in temperature), more charge carriers can be released and the resistivity of the material decreases.

↓ hence

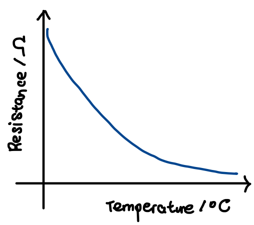
- They make excellent sensors for detecting changes in their environment.

↳ examples include: thermistors, diodes and LDRs. (Light dependent resistors)

Thermistors are a type of semiconductor

→ A thermistor is a component with a resistance that depends on its temperature.

- For NTC thermistors "Negative Temperature Coefficient", the resistance decreases as the temperature goes up.



NTC thermistor

How do NTC thermistors work?

- Warming the thermistor gives more electrons enough energy to escape from their atoms. This means that there are more charge carriers available, so the resistance is lower.