GCE Physics Unit 2.2 Resistance

Potential difference:

Potential difference is the **energy** transferred from electrical energy to another form for **each unit of charge** that passes. It is measured in colts where, $1V = 1JC^{-1}$

Ohm's Law:

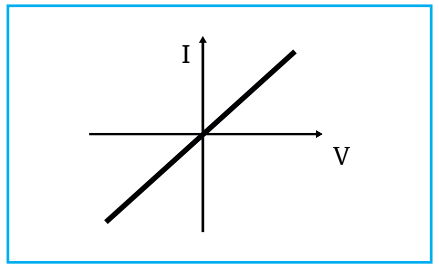
Ohm's law states that the **potential difference** across a component is **directly proportional** to the **current** through it, **under constant physical conditions**.

This can be expressed using the equation $V=IR$
Where R is the resistance in Ohms (Ω).

I-V graphs:

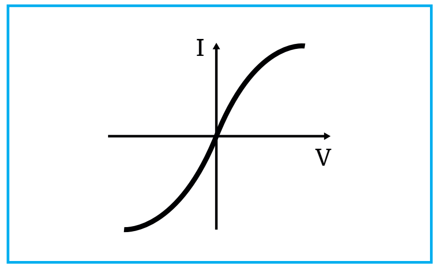
Investigating Ohm's law with different components will give you these graphs. It is important to remember the shape of each graph.

Resistor or wire
(At a constant temperature)



Constant resistance = obeys Ohms law

Filament lamp



Resistance increases at higher voltages

Doesn't obey Ohms law because the temperature of the lamp changes.

The resistance of each component at any point on the graph can be calculated using the gradient of the curve.

$$gradient = \frac{1}{R}$$

Resistance:

Resistance is caused by **collisions** between the free **electrons and the ions** in the conductor. These collisions cause some **energy to transfer** from the electrons to the ions in the form of heat energy.

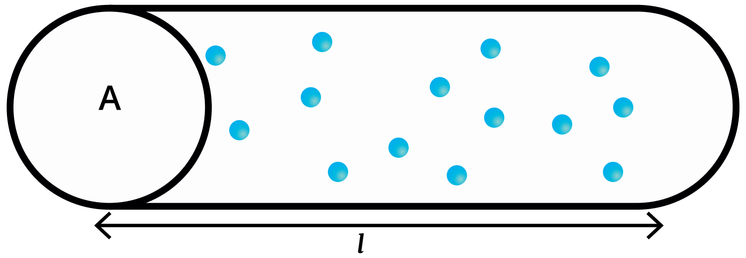
Power:

Electrical power can be calculated using the following equations:

$$P = IV = I^2R = \frac{V^2}{R}$$

Power is the energy transferred per second in Js^{-1} or Watts (W).

Resistivity:



The resistance of a wire is determined by these factors; the length (l), the cross-sectional area (A) and the resistivity of the material (ρ). The resistivity is measured in Ωm and is a constant for each different material.

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

The resistance can be calculated using this equation

Remember:

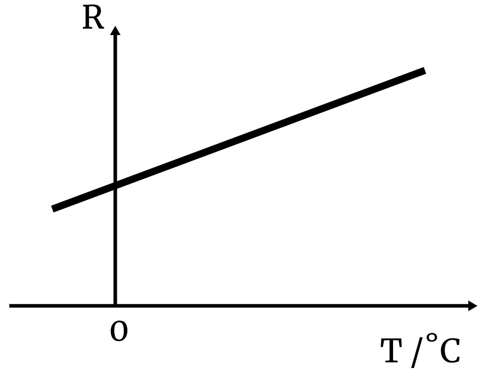
Calculate the area correctly, if it has a circular cross section, use the equation $A = \pi\frac{d^2}{4}$

Be consistent with units, convert to meters before calculating to ensure the area is in m^2.

Effect of Temperature:

As temperature increases, resistance increases linearly.

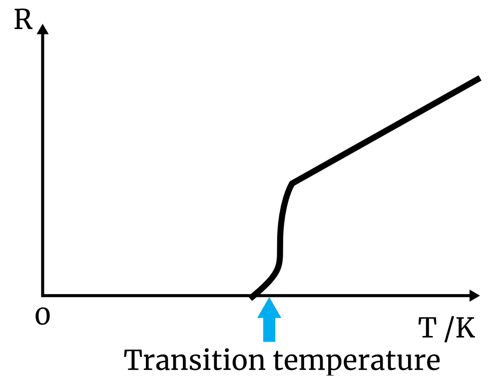
This heat energy causes the **ions to vibrate more** and therefore will cause more **frequent collisions** between the ions and electrons, increasing the resistance.



Superconductivity:

If you were to cool a metal, the resistance would decrease and following a linear pattern would reach 0Ω at -273°C or 0K. For most metals this is not the case.

When cooled the metal will reach its **transition temperature**, where its **resistance drops quickly to 0Ω**. This is superconductivity. For some metals this temperature is a few degrees above 0K, but for others **liquid nitrogen** can be used to cool the material enough to be superconducting. This is very useful in MRI scanners or particle accelerators as **very high currents can flow without any losses due to the heating effect of resistance**.



V = potential difference in V   I = current in A   R = resistance in Ohms (Ω)   P = power in W ρ = resistivity in Ωm