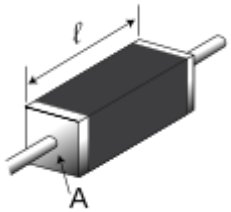
Resistance

- Materials restricts the flow of charge (I) when a voltage (V) is applied over the material.
- The current I is proportional to the applied voltage V. Ohm's law is:

$$V = RI$$

Georg Simon Ohm (1787–1854)



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

where ρ is called resistivity

- Resistivity (ρ) varies many order of magnitude for different materials.
(Course IH1611 Semiconductor Devices explains why resitsivity is so different for different materials.)

Material	Resistivity, ρ ($\Omega \cdot$ m)	Co
Conductors		
Silver	1.59×10^{-8}	
Copper	1.68×10^{-8}	
Gold	2.44×10^{-8}	
Aluminum	2.65×10^{-8}	
Tungsten	5.6×10^{-8}	
Iron	9.71×10^{-8}	
Platinum	10.6×10^{-8}	
Mercury	98×10^{-8}	
Nichrome (Ni, Fe, Cr alloy)	100×10^{-8}	
Semiconductors‡		
Carbon (graphite)	$(3–60) \times 10^{-5}$	
Germanium	$(1–500) \times 10^{-3}$	
Silicon	0.1 – 60	
Insulators		
Glass	$10^{9}–10^{12}$	
Hard rubber	$10^{13}–10^{15}$	

‡ Values depend strongly on the presence of even slight amounts of impurities.

Power

- Power (electric) is the rate at which electric energy is converted into another energy form, e.g. heat or light

- The energy transformed in a device comes from the potential energy converted when a charge moves through a potential difference $E_{pot}=QV$ *(see video on electric potential energy and voltage).*

$$P = \frac{energy\ transformed}{time} = \frac{QV}{t} = IV$$

$$\boxed{P = VI}$$

James Watt (1736–1819)

The unit of power is: $[V][A] = \left[\frac{J}{C}\frac{C}{s}\right] = \left[\frac{J}{s}\right] = [W]$ which is named watt (W)