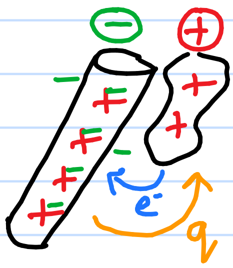
Current and charge

electrons $q_e = -1.60\times10^{-19}\,C = -e$

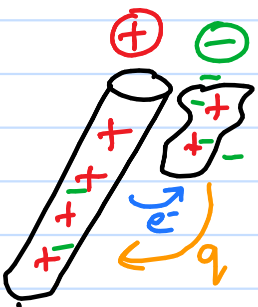
protons $q_p = 1.60\times10^{-19}\,C = e$

Current $I = \dfrac{\Delta Q}{\Delta t} = \dfrac{dQ}{dt} \longrightarrow \int I(t)\,dt = Q$

Rate of flow of charge = current



Amber or polythene

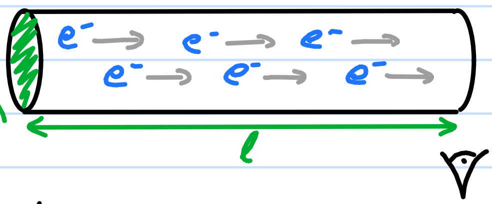


glass or polycarbonate

- Like charges
- unlike charges attract

$\boxed{\text{Current flows in opposite direction to electrons}}$

Drift velocity



Cross sectional area A

n = electron density = $10^{29}\,m^{-3}$
N = number of electrons
V = volume = Al
I = current

$$I = \frac{Q}{t} = \frac{Ne}{t} = \frac{nVe}{t} = \frac{nAle}{t} = nAve$$

$$\text{drift velocity } v = \frac{I}{nAe} = \frac{4I}{\pi n d^2 e}$$

$\left(A = \frac{1}{4}\pi d^2 \text{ for a cylinder}\right)$

For a typical circuit $I = 0.50A$, $n = 10^{29}\,m^{-3}$, $d = 1.0\,mm$
$e = 1.60\times10^{-19}\,C$

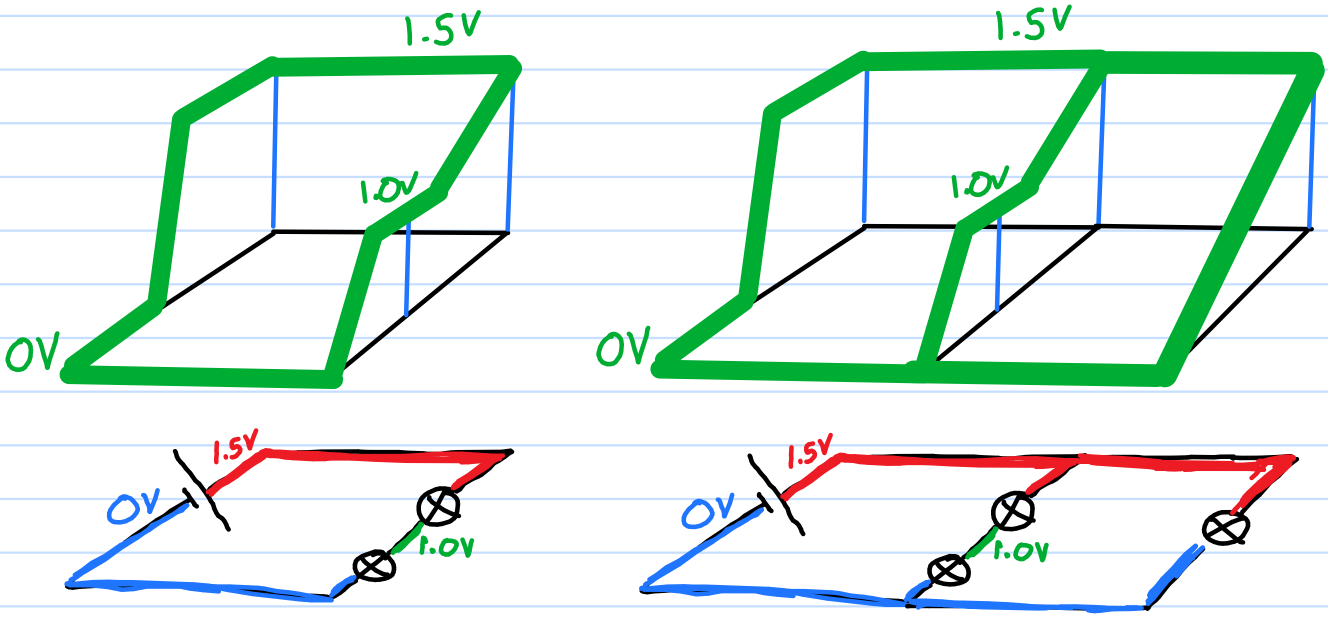
$$v = \frac{4\times0.50}{\pi\times10^{29}\times(1.0\times10^{-3})^2\times1.60\times10^{-19}} = 4.0\times10^{-5}\,ms^{-1}$$
$$= 4.0\times10^{-2}\,mm\,s^{-1}$$
$$= 40\,\mu m\,s^{-1}$$

- Conductors – charge can easily flow
- insulators – charge cannot easily flow

- semiconductors – more current under certain circumstances.

Potential difference and power

potential difference = voltage $= \frac{W}{Q}$



Power

$P = \frac{W}{t}$ $\quad W = QV \quad Q = It$

$W = IVt$

$P = \frac{IV\cancel{t}}{\cancel{t}} = IV$

Resistance

$R = \frac{V}{I}$ measured in ohms Ω

Prefixes

nano	micro	milli	kilo	mega	giga
n	μ	m	k	M	G
10^{-9}	10^{-6}	10^{-3}	10^{3}	10^{6}	10^{9}

$V = IR$ is not Ohm's law; Ohm's law is that, for Ohmic components, R does not depend on I (i.e. is constant) at a given temperature. $V \propto I$ at constant temperature

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Resistivity

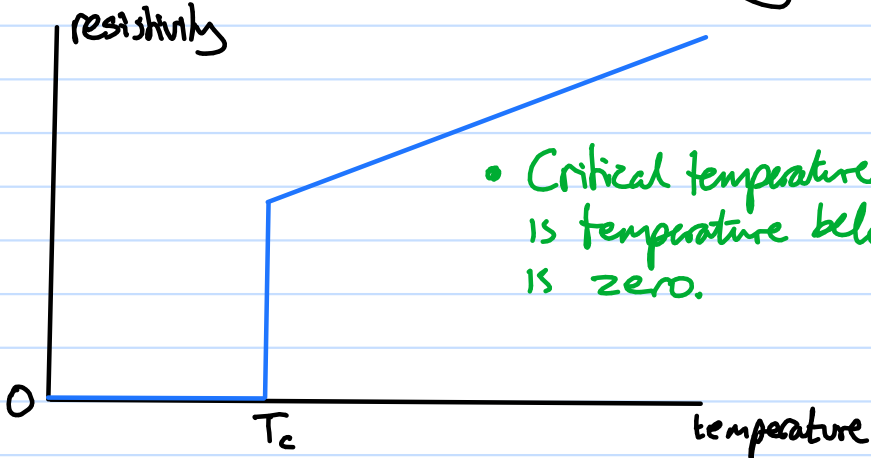
the longer the wire, the greater the resistance
the thinner the wire, the greater the resistance } $R \propto \frac{L}{A}$ ← length, cross sectional area

$R = \rho \frac{L}{A}$ ← resistivity

$\rho = \frac{RA}{\ell}$ units: $\frac{\Omega m^{\cancel{2}}}{\cancel{m}} = \Omega m$

Superconductivity

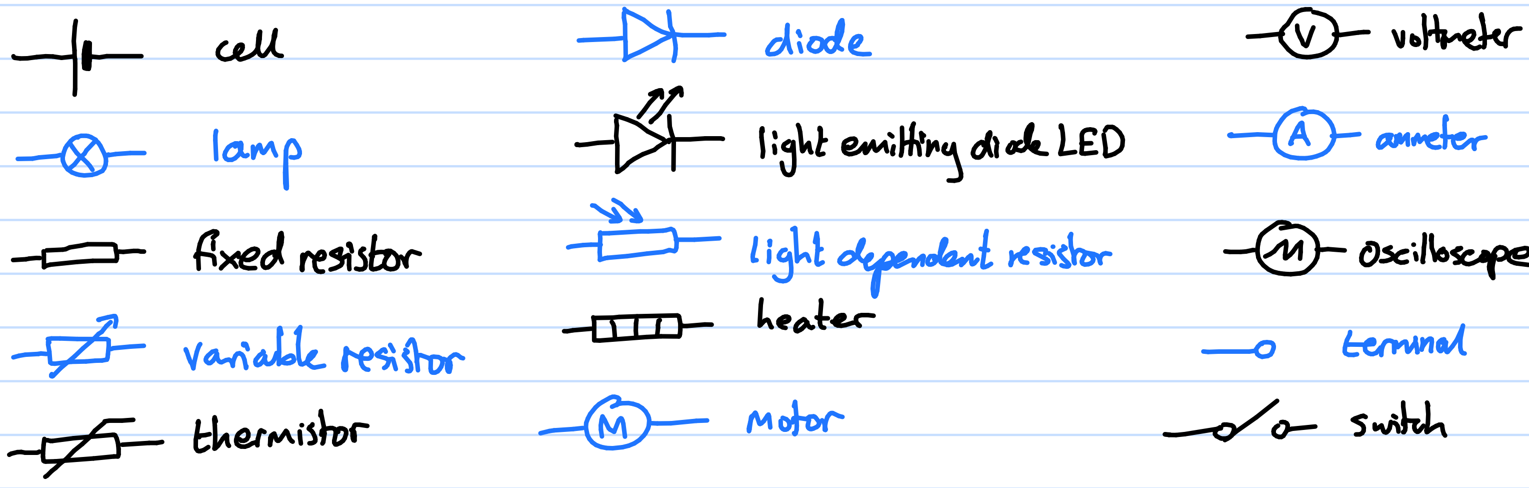
As temperature of metal reduced, resistivity reduces



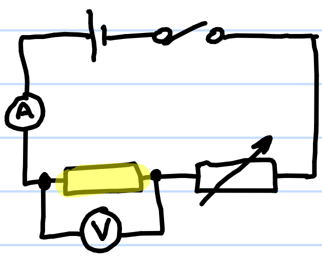
critical temperature

- Critical temperature of superconductor is temperature below which resistivity is zero.

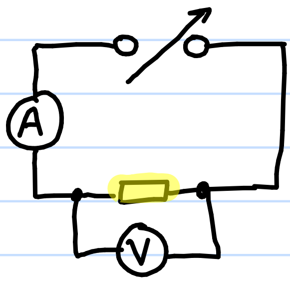
Components and their characteristics



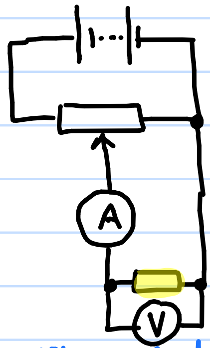
Measuring component characteristics



using variable resistor

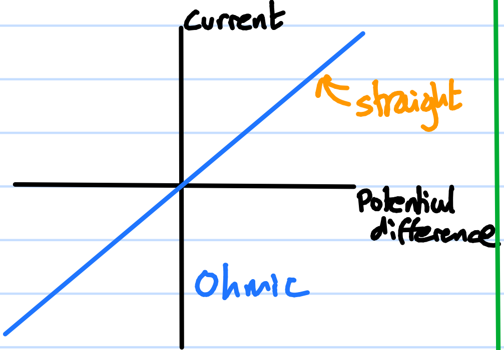


using variable power supply

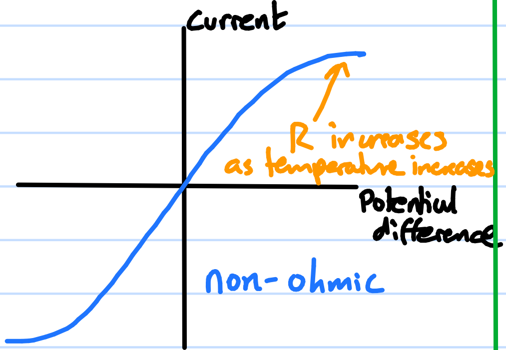


using potentiometer

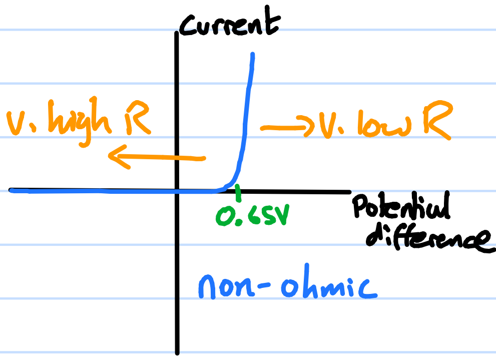
For a fixed resistor:



For a filament lamp:



For a diode:



Resistance and temperature