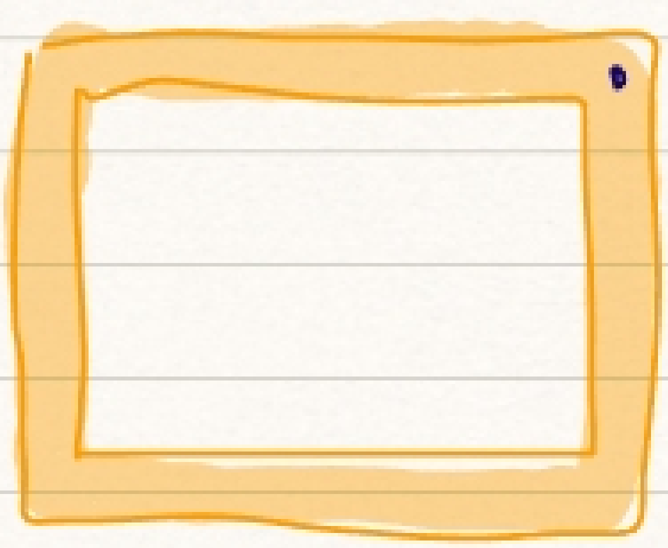
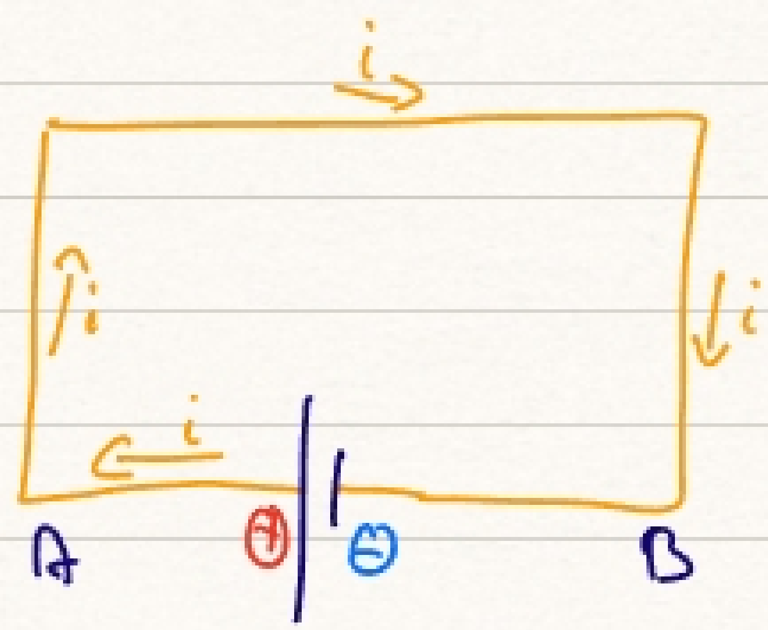
Current and Resistance

Electric Current



If all points inside a conductor are on the same potential the free electrons move at random directions and thus there is no net transport.

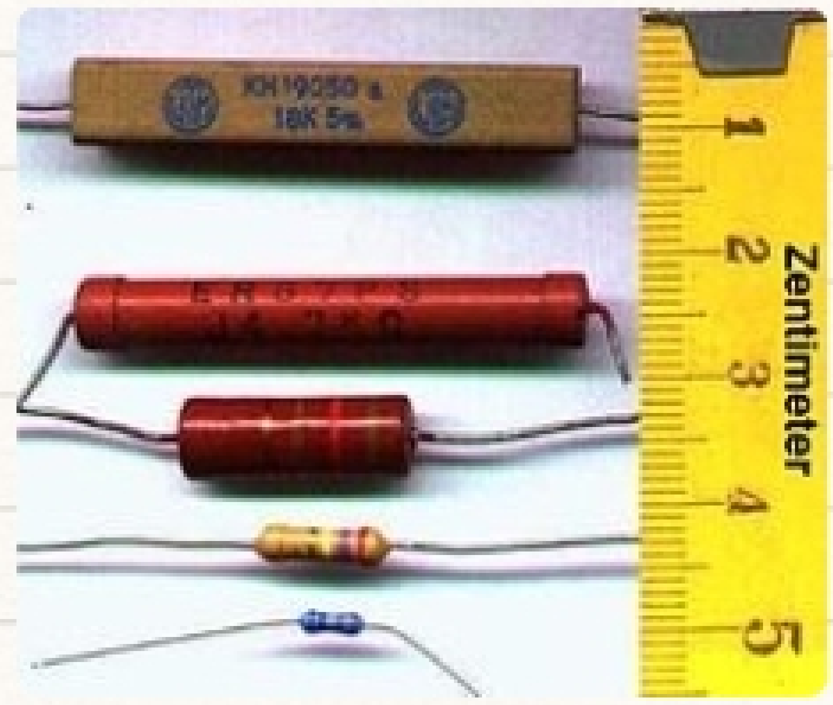


However, if we make a break in the conductor and insert a battery two points A, B are now on different potentials V_A, V_B which relates to the voltage of the battery $V = V_A - V_B$

Now the free electrons inside the conductor move in the same direction and there is a net flow of electric charge which we define as

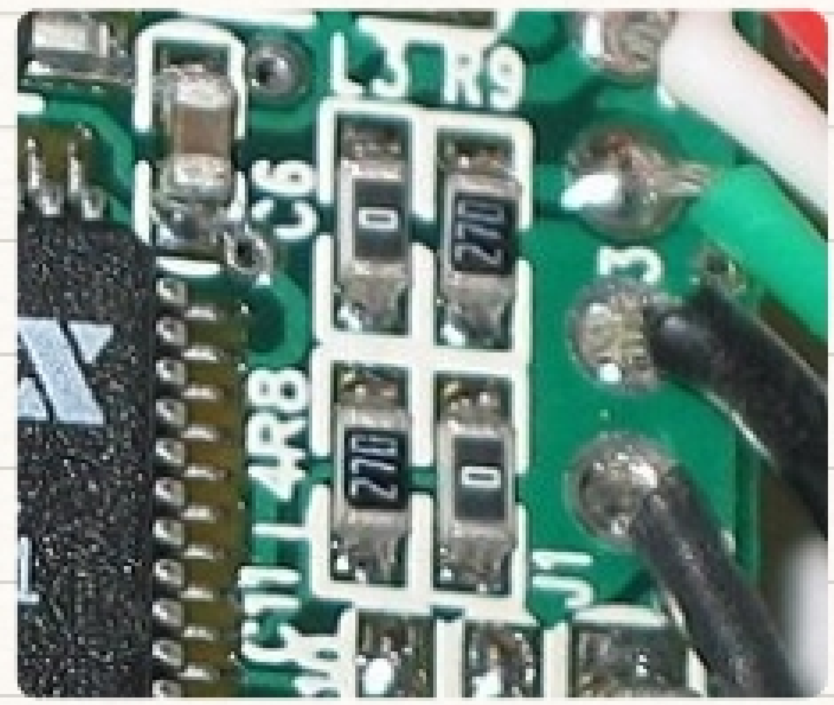
<u>Electric current</u>

The electric current



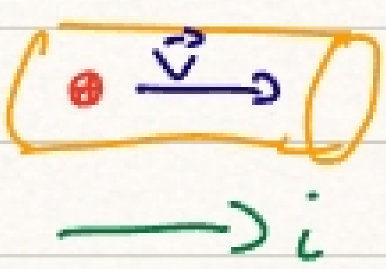
$$i = \frac{dq}{dt}$$

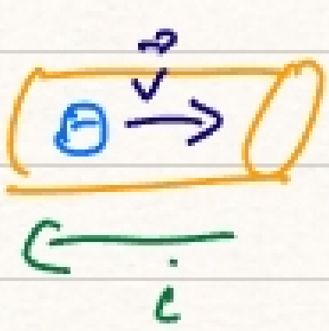
Current: rate at which charges flow



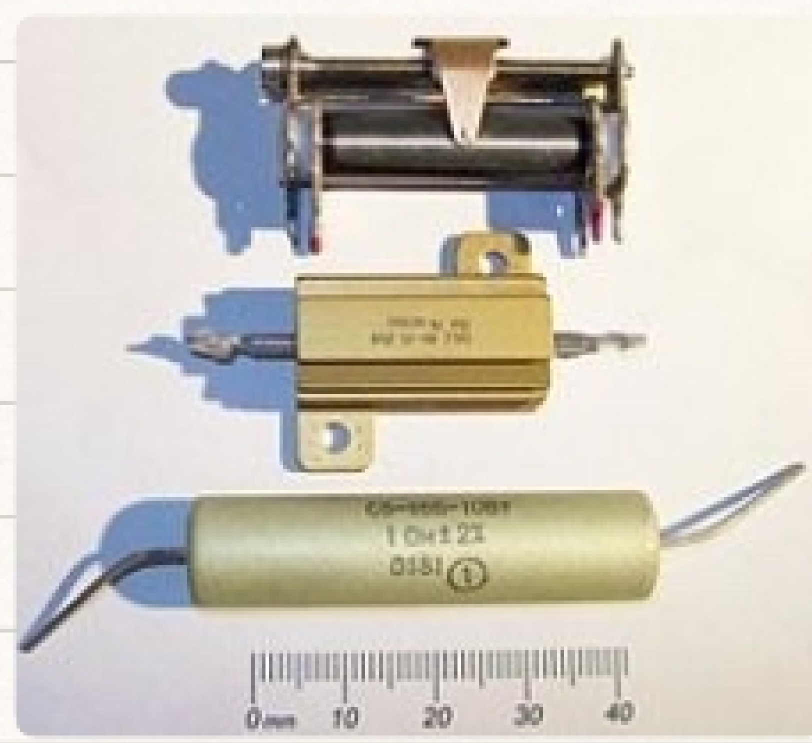
SI Unit: $\frac{C}{s}$ [A] Ampere

Current direction:





An electric current has the same direction as the charge velocity
The sign is defined as follows:



1. If the current is due to the motion of positive charges the current is parallel to the charge velocity $\vec{v}$
2. If the current is due to the motion of negative charges the current is antiparallel to the charge velocity $\vec{v}$

Current density

Current density is a vector that is defined as

$$J = \frac{i}{A} \quad \text{Units} \left[\frac{A}{m^2}\right]$$

The direction of $\vec{J}$ is the same as that of the current

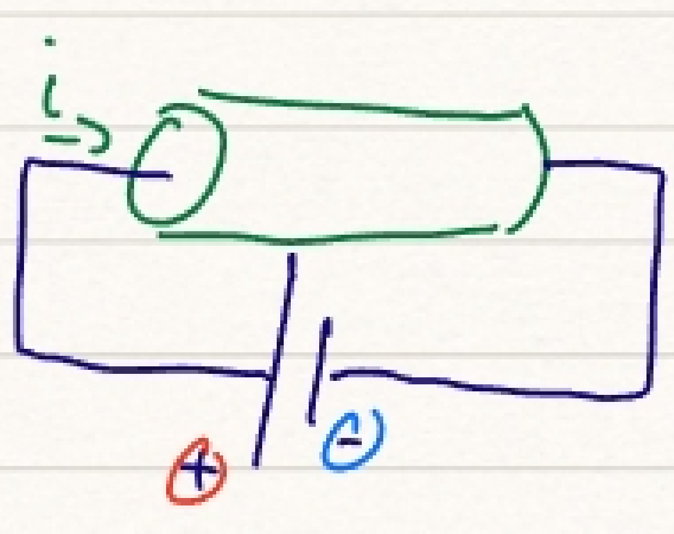
The current through a conductor of cross-sectional area A is give by

$$i = JA$$

if the current desity is constant

If $\vec{J}$ is not constant then $i = \int \vec{J} \cdot d\vec{A}$

Resistance



We apply a voltage across a conductor
A current i will flow through the conductor