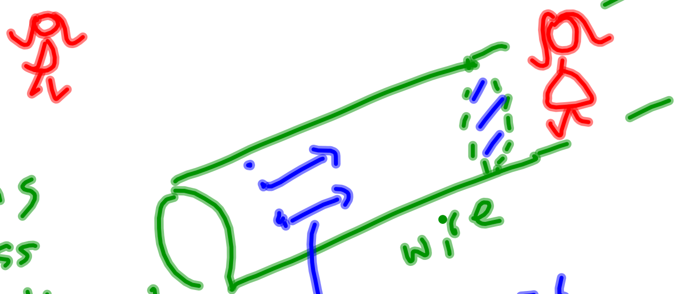
The electric current

- so far the charges were in static equilibrium
- now — controlled motion of charges - currents

- imagine counts electrons that pass through a cross section



$v_d \sim 10^{-4}$ m/s electrons

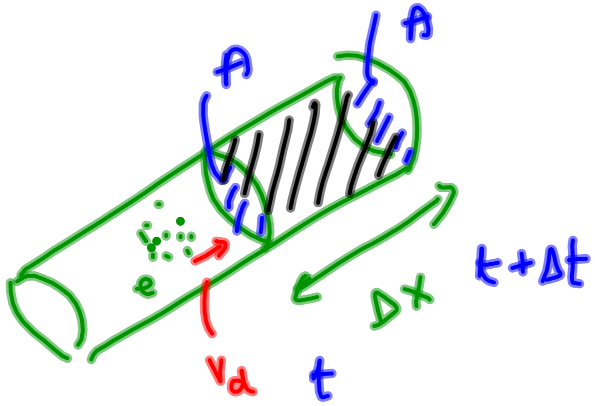
The charges that move in a conductor are called charge carriers.

Electrons are charge carriers.

Definition: i_e is electron current of a number of electrons per second that pass through a crossection of a wire. $[s^{-1}]$

$$N_e = i_e \Delta t$$

number of electrons N_e that  counted during Δt time



increasing v_d (drift speed) will increase N_e & therefore i_e

the sea of electrons move forward the distance

$\Delta x = v_d \Delta t$ /// throug the volume $V = A\Delta x$

If the number density of electrons is n_e per m^3 than $N_e = n_e V = n_e A \Delta x \Rightarrow$

table in the book

$$N_e = n_e A \Delta x = n_e A v_d \Delta t$$

$$i_e = \frac{N_e}{\Delta t} = \frac{n_e A v_d \Delta t}{\Delta t} = n_e A v_d$$

$i_e \nearrow$ if $n_e \uparrow$ more of electrons

$v_d \uparrow$ go faster

$A \uparrow$ size increases

$$\Delta x = v_d \, \Delta t$$

if you want to discharge a capacitor & $v_d \sim 10^{-4}$, $\Delta x = 0.2\,m$

how long will it take us

$$\Delta t = \frac{\Delta x}{v_d} = \frac{1}{2}\,h$$

this doesn't happen in reality

- what we overlooked is that wire is already full of electrons

A nonuniform distribution of surface charges along a wire creates a net electric field inside the wire that points from the more positive end toward the more negative end.

This is the internal field $\vec{E}$ that pushes the electric current through the wire

$i_e = n_e A v_d \,|\, \cdot q$

$$\boxed{I = \frac{\Delta Q}{\Delta t}}$$

net rate of charge crossing an area in time Δt

$I = n_e A v_d q$

$[C/s] = [A]$ ampere

for steady current $I = \frac{\Delta Q}{\Delta t}$

instantaneous current $I = \frac{dQ}{dt}$

Note: current in direction where + flows (historical reasons)

Ex A 1.8 mm diameter copper wire carries 15 A to a household appliance. Find the magnitude of the electric field in the wire.

$I = 15\,A$ $r = 0.9\,mm$

$2r = 1.8\,mm$

$$E = \frac{I\rho}{A} = \frac{15A \cdot 1.68 ?}{\pi \cdot r^2} = 95\,mV/m$$

ρ resistivity $\rho = 1/\sigma$

σ how easily the charges can move in a material