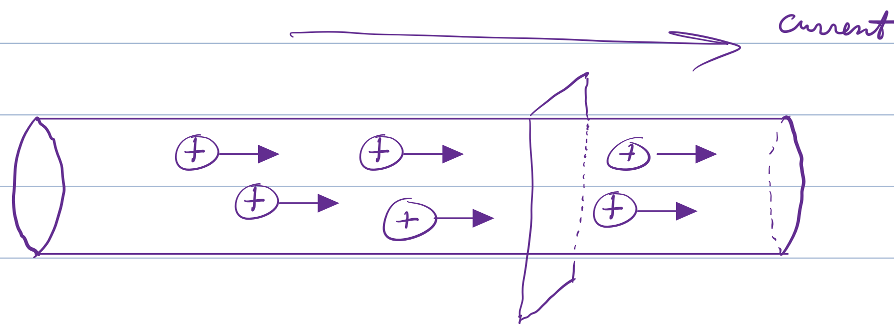
Chapter 22: Current and Resistance

## 22.1 A Model of Current & 22.2 Defining and Describing Current

We now consider systems out of equilibrium.
What happens to charge carriers if you apply an electric field? They tend to move.
e.g. consider a wire




Count how many charges $\Delta Q$ pass through this surface in a time $\Delta t$

Define current $I \equiv \dfrac{\Delta Q}{\Delta t}$

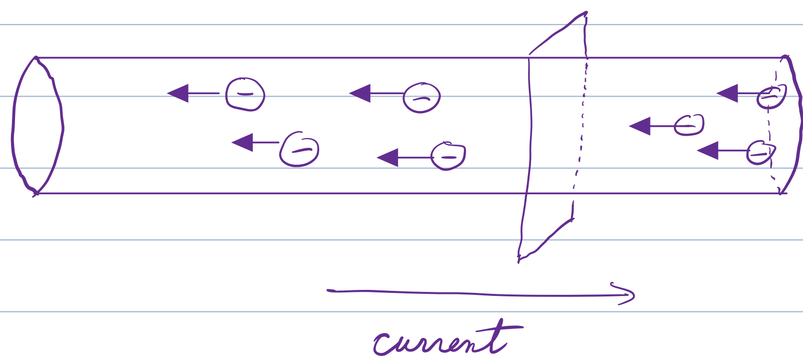
Units: $\dfrac{\text{Coulombs}}{\text{second}} \equiv$ Amperes = Amps = A.

Common units: $1\,mA = 10^{-3}\,A$.
Household circuits $\lesssim 20\,A$ or $30\,A$.

Some complications

1) It's often electrons that move

But ⊖ charges moving left ⟺
⊕ charges moving right




Conventional current: as if + charges were moving. In an ionic solution you could have both types of charges moving.

2) Moving charges encounter resistance.
(imperfections, impurities in the medium)

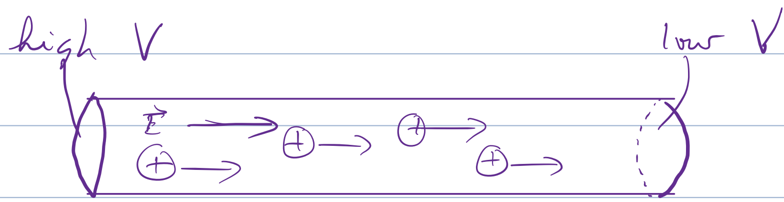
If $\vec{E} = 0$, this resistance brings charges to a rest.

$\therefore$ to keep them moving, need to apply a force via $\vec{E}$.

Basic question: how much current flows?

Microscopic view — next time.

Macroscopic View - Ohm's Law
(This week's lab)




apply a potential difference $\Delta V$. How much current flows?

For some materials:

$$I = \left(\frac{1}{R}\right) \Delta V \qquad \text{Ohm's Law}$$

R = Resistance (Low resistance ⇒ large current; High resistance ⇒ small current)

More voltage ⇒ more current.

For other materials, I still depends on $\Delta V$, but it is not linear.
Exploring I vs. $\Delta V$ is the subject of this week's lab.

Units:

$$\underbrace{\Delta V}_{\text{Volts}} = \underbrace{I}_{\text{Amps}} \cdot \underbrace{R}_{\text{Ohms}} \qquad \text{Ohm's Law}$$

$$\text{Ohm} = \frac{\text{Volt}}{\text{Amp}} = \Omega$$

common multiples: $1\,k\Omega = 10^3\,\Omega$

$1\,M\Omega = 10^6\,\Omega$

Typical lab values

$I \sim 10^{-3} A = 1\,mA$

$R \sim 10^3 \Omega = 1\,k\Omega$

$V \sim I \cdot R \sim 1\,V$