 Phys 2426 2016-09-13 Lec 6

So far: Electrostatics - charges didn't move.

Electric Current - Flow of charge

How do we measure flow?

$$\text{Flow Rate} = \frac{\text{Amount of stuff}}{\text{Time interval}}$$

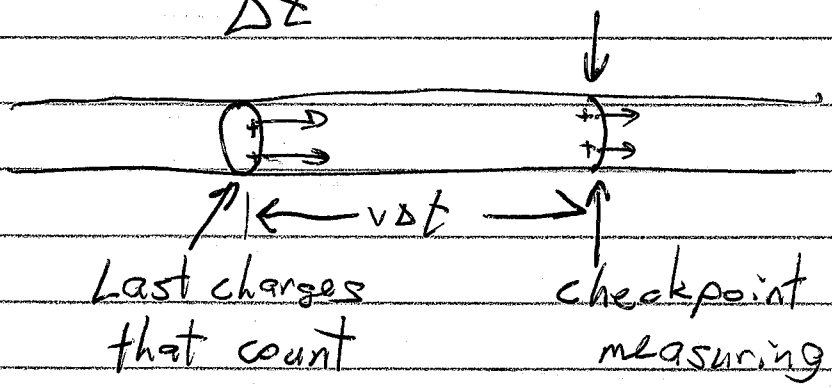
$$\text{Current} = I = \frac{\text{Charge}}{\text{Time}} = \frac{\Delta Q}{\Delta t}$$

Need 2 things to have current:

- Motivation
- Mechanism, ie a pathway

How Fast do the charges move?

$$I = \frac{\text{Charge}}{\Delta t}$$



Run timer for Δt

Last charges travel $l = v\Delta t$

How ~~many~~ much charges ~~are~~ is in that length of wire?

$$Q = \rho(Vol) = \rho l A$$

So the current is: $I = \frac{\Delta Q}{\Delta t} = \rho v A$

Density $\left[\frac{C}{m^3}\right]$ Speed $\left[\frac{m}{s}\right]$ Area $[m^2]$

Ex: Copper 10^{28} electrons $/m^3$

$\rho = (10^{28})(1.6\times10^{-19}\ C)/m^3 = 1.6\times10^{9}\ C/m^3$

$A = 3.1\times10^{-6}\ m^2$ (1 mm radius)

$I = 1.0\ A$

$v = \frac{I}{\rho A} = -0.0002\ m/s = -0.2\ mm/s$

How much is a lot of current?

Cell Phone	~0.1 – 1.0 A
Vacuum Cleaner	5.0 A
Light Bulb	0.1 – 10.0 A
House	200 A
Electric Shock	1.0 mA

Voltage acts like pressure, motivating current to flow.

$$I = \frac{V}{R}$$

I ← Current; V ← Voltage; R ← Resistance

$$V = IR$$

Also need a circuit.

- Current flows in loops.
- "Dead Ends" would cause huge static charges to build up, so the current gets shut down.
- Once a circuit is completed, all charges move instantly.

Important DC Relationships

$$V = IR$$

$$P = IV$$

$$\text{Power} = \frac{\text{Energy}}{\text{Time}} = \left(\frac{\text{Charge}}{\text{Time}}\right)\left(\frac{\text{Energy}}{\text{Charge}}\right)$$

Ex: $V = 3.0\,V$ $R = 15\,\Omega$

$$I = \frac{V}{R} = \frac{3.0\,V}{15\,\Omega} = 0.2\,A$$

$$P = IV = (0.2\,A)(3.0\,V) = 0.6\,W$$

Ex: (6 W) Light Bulb designed for (120 V). $I = ?$ $R = ?$

$P = VI$ $\qquad$ $V = IR$

$$I = \frac{6}{120} = 0.05\,A \qquad R = \frac{120}{0.05} = 2400\,\Omega$$

Ex: $P = 10\,W$ $\qquad$ $R = 20\,\Omega$

$$P = I^2R \qquad I = \sqrt{\frac{P}{R}} = 0.707\,A$$

$$V = \frac{P}{I} = \frac{10}{0.707} = 14.1\,V$$

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Thermal Coefficient
Relates temp change to fractional change in resistance.

$$\frac{\Delta R}{R} = \alpha \Delta T$$

Easy to interpret

ΔT → Temp Change
α → Thermal Coeff

Usu: $\Delta T = T - T_0$
$\Delta R = R - R_0$

$$\frac{R - R_0}{R} = \alpha (T - T_0)$$

$$R = R_0 (1 + \alpha (T - T_0))$$

Solved for R