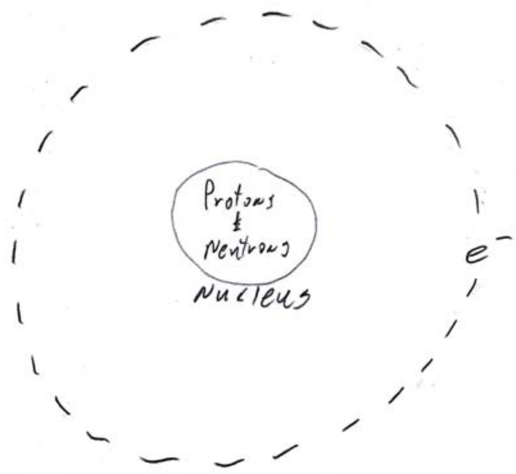
College Prep Physics II – Video Lecture Notes – Chapter 19
Video Lecture #1
Introduction to Conventional Current and Direct Current & Example Problem

Current, I: The movement of charges. The rate at which charges pass by a point in a wire.

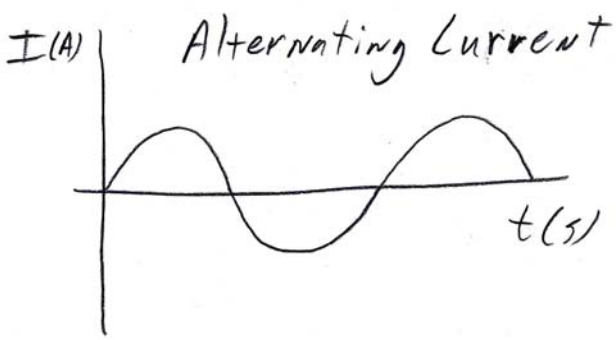
Bohr Model of the Atom: Protons and Neutrons in the nucleus with electrons in orbital shells. Electrons are much easier to remove from the atom; therefore it is generally electrons that flow in wires.

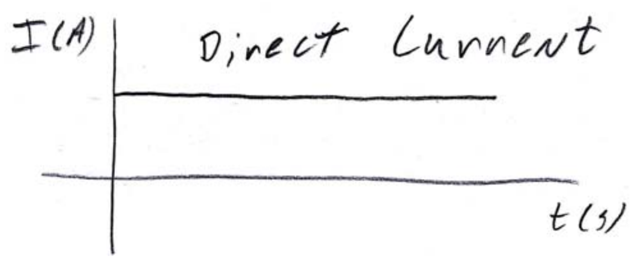


$$I = \frac{\Delta Q}{\Delta t} \Rightarrow \frac{Coulombs}{second} = \frac{C}{s} \Rightarrow Amperes, Amps, A$$

(Base SI Dimension)

Conventional Current: The direction that positive charges <u>would</u> flow. The reality is that negative charges flow in a negative direction.





Alternating Current, AC: Direction and magnitude of the current changes. Has a frequency like a sine or cosine wave. Less power loss over distance.

Direct Current, DC: Direction and magnitude of the current is constant. Large power loss over distance.

Many electronic devices have an AC/DC power converter to convert the alternating current that comes to your house to direct current. That is what the "brick" attached to your electronic devices is for.

Example Problem: A charge of 13.0 mC passes through a cross-section of wire in 4.5 seconds. (a) What is the current on the wire? (b) How many electrons pass through the wire in this time?

$\Delta Q = 13.0mC \times \frac{1C}{1000mC} = 0.013C$; $\Delta t = 4.5s$; a) I = ? b) # of electrons = ?

a) $I = \frac{\Delta Q}{\Delta t} = \frac{0.013}{4.5} = 0.002\overline{8}\,A \approx \boxed{0.0029A = 2.9mA}$

b) $Q = ne \Rightarrow n = \frac{Q}{e} = \frac{0.013}{1.6 \times 10^{-19}} = 8.125 \times 10^{16} e^- \approx \boxed{8.1 \times 10^{16} e^-}$

$n \approx 81 \times 10^{15} e^- = 81 Pe^- = 81{,}000{,}000{,}000{,}000{,}000\, e^-$ (That is a lot of electrons, eh?)

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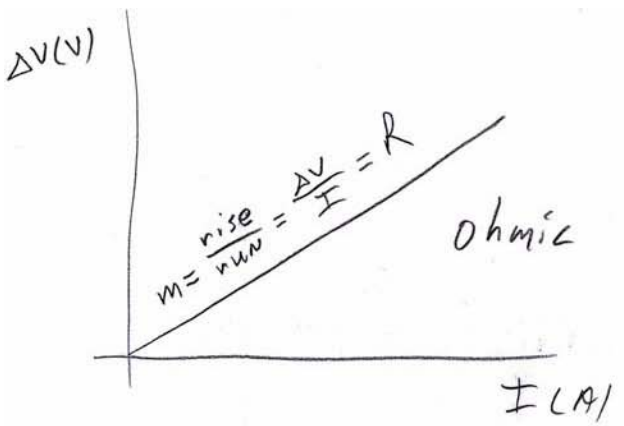
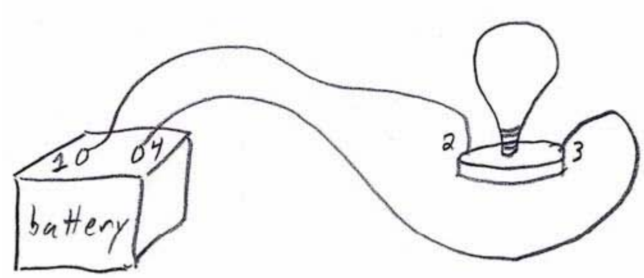
Video Lecture #2
Defining Resistance, Ohmic vs. Non-Ohmic, Electrical Power

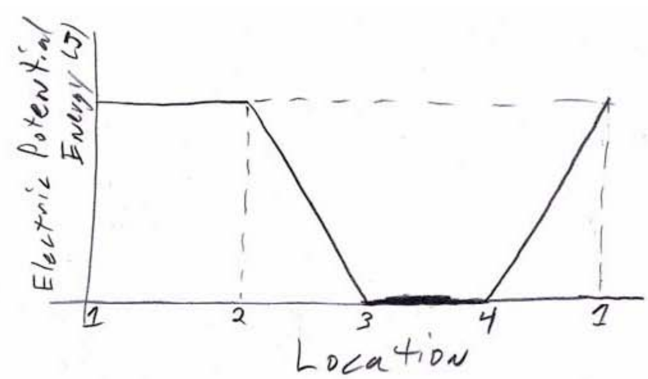
Resistance, R, is the resistance to current flow. $R = \frac{\Delta V}{I} \Rightarrow \boxed{\Delta V = IR}$ (Ohm's Law)

$R = \frac{\Delta V}{I} \Rightarrow \frac{Volts}{Amps} = \Omega$ or Ohms (Capital Omega, an upside down horse shoe, it's unlucky.)



Materials that follow Ohm's Law are called Ohmic. If they don't they are Non-Ohmic.
We will consider all resistors to be Ohmic, unless otherwise stated.





Electric Power: The rate at which electrical potential energy is being converted to heat, light and sound.

From 1-2 and 3-4 the charges are moving along the wire and we consider wires to have zero resistance unless otherwise stated.
From 2-3 the electric potential energy of the electrons is converted to heat, light and sound.
From 4-1 the electrons are being given electric potential energy by the battery.

Derivation of Electric Power Equation:

$$P = \frac{W}{t} = \frac{\Delta PE_{electric}}{t} \Rightarrow \frac{J}{s} = Watts \ \ \& \ \ \Delta V = \frac{\Delta PE_{ele}}{q} \Rightarrow \Delta PE_{ele} = q\Delta V$$

Therefore: $P = \frac{\Delta PE_{electric}}{t} = \frac{q\Delta V}{t} = \left(\frac{q}{t}\right)\Delta V = I\Delta V \ \ \& \ \ \Delta V = IR$

Gives: $P = I\Delta V = I(IR) = I^2 R \ \ \& \ \ \Delta V = IR \Rightarrow I = \frac{\Delta V}{R}$

Gives: $P = I^2 R = \left(\frac{\Delta V}{R}\right)^2 R = \frac{\Delta V^2 R}{R^2} = \frac{\Delta V^2}{R}$ Therefore: $\boxed{P = I\Delta V = I^2 R = \frac{\Delta V^2}{R}}$

College Prep Physics II – Video Lecture Notes – Chapter 19
Video Lecture #3
Finding the cost to power light bulbs and Defining Kilowatt Hour

$0.12

Example Problem: 3 Light Bulbs; P_f = 15 watts; P_i = 60 watts; ΔV = 120 V; $\frac{\$0.12}{kW \cdot hr}$

$\frac{3hr}{day}$ (Bulbs are powered for this much time)

(yes, there are 24 hours in a day, however, the light bulbs are not on 24 hours each day.)

(A standard household circuit in the United States has a potential difference of 120 V.)

$$\Delta P = P_f - P_i = 15 - 65 = -50\,watts \Rightarrow \|\Delta P\| = 50\,watts$$

$$\Delta V = IR \Rightarrow R = \frac{\Delta V}{I} = \frac{120}{I} = ?????$$ (we don't know the current.)

$$P = \frac{\Delta V^2}{R} \Rightarrow R = \frac{\Delta V^2}{P} = \frac{120^2}{15} = \boxed{960\Omega}$$

Power saved by three bulbs: $P_{saved} = 3 \times 50 = 150\,watts \times \frac{1kW}{1000watts} = 0.15kW$

$$0.15kW \times \frac{3hr}{day} = \frac{0.45kW \cdot hr}{day} \Rightarrow \left(\frac{0.45kW \cdot hr}{day}\right)\left(\frac{\$0.12}{kW \cdot hr}\right)\left(\frac{365.242days}{1year}\right) = \frac{\$19.723}{year}$$

$$\$108 \times \frac{1year}{\$19.723} = 5.4758 \approx \boxed{5.5\,years}$$

What is a KiloWatt Hour?

$$(kW \cdot hr)\left(\frac{1000W}{1kW}\right)\left(\frac{3600s}{1hr}\right) = 3{,}600{,}000W \cdot s = 3{,}600{,}000\frac{J}{s} \cdot s = 3{,}600{,}000s = 3.6MJ$$

$1kW \cdot hr = 3.6MJ$ (you will not be given this as a conversion, you must derive it, every time.)