Potential difference and electric current

Once again, consider the atom

- Atoms contain positively charged protons and negatively charged electrons.

- Our 'general' view is of a nucleus with electrons in shells

  - This model is excellent for explaining chemical reactions, however, the physical structure can be better presented.
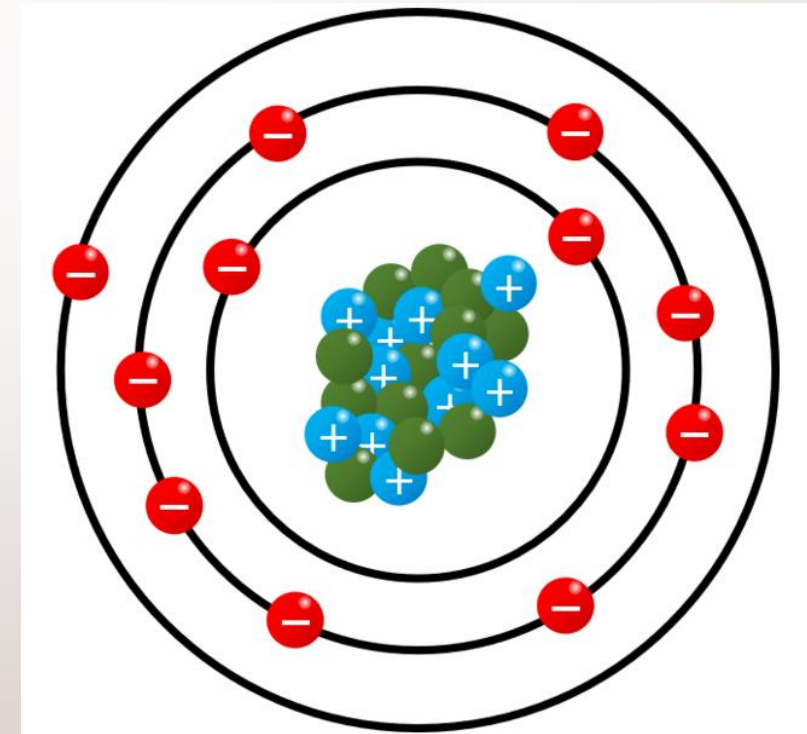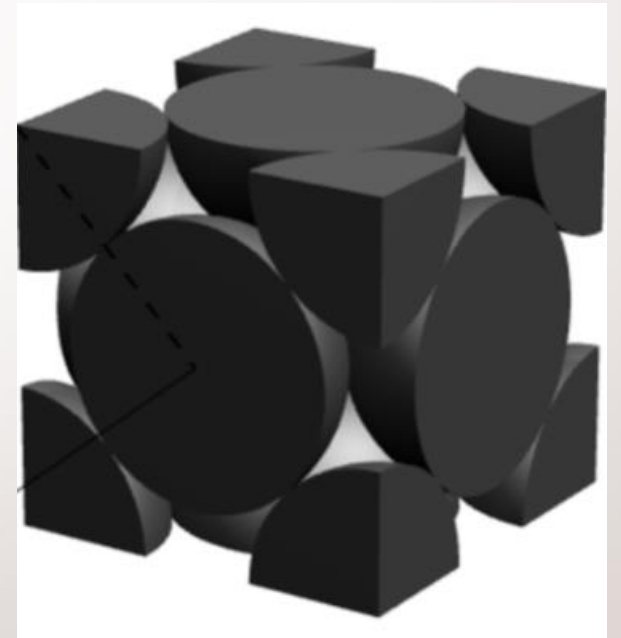
Image courtesy Plazmi

How does charge move?

- Metals like copper are 'conductors'
    - They conduct electricity
    - That is, they let electrons move
    - Their structure is like a lattice with evenly spaced atomic nuclei and some free moving electrons
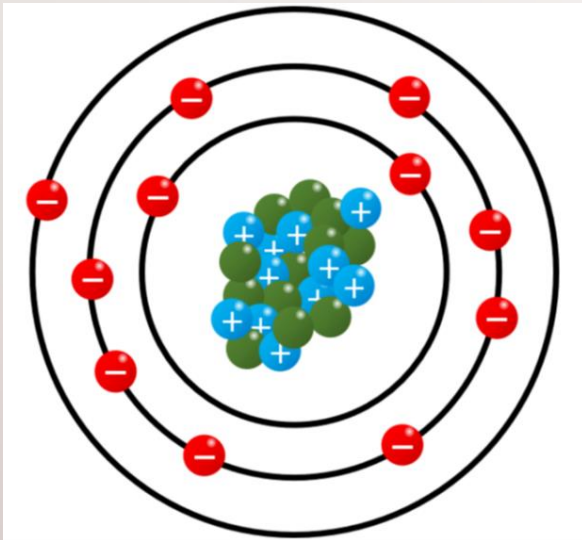
Whilst we have you ...

- A more accurate view of the atom is of a nucleus with "clouds" of electrons around it.

- The 'cloud' indicates the probability that the electron will be found in that position

- Dark sections are high probability, light, low probability

Image courtesy Geek3

Because …

Electrons, being negatively charged, repel each other, so they don't sit neatly in shells. They sit as far away from each other as possible.

# What has all that got to do with charge?

- 'Free' electrons can move

- 'Bound' electrons can move slightly

- This allows for:

  - Current flow – electrons moving

  - Static charge – build up of electrons in one area

So we can say ...

- Objects become charged when electrons are transferred from one object to another or redistributed on one object
  - Add electrons – increase in negative charge
  - Remove electrons – increase in positive charge

Big concept

- The concept of positively and negatively charged items is not quite right ….

  - It is just "more" positive or "more" negative

  - An electron sitting between two plates, one with 1000 'extra' electrons and one with 1100 extra electrons will be attracted to the one with less electrons. The electron 'sees' it as 'more positive'
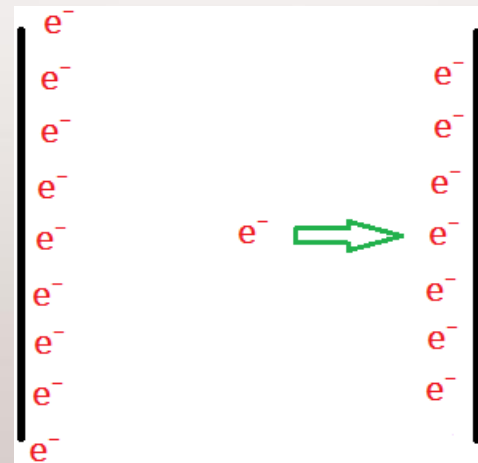
Attraction and repulsion

- Two like charges exert repulsive forces on each other, whereas two opposite charges exert attractive forces on each other.

- Coulomb wrote an equation about it

$$F = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r^2}$$

$\frac{1}{4\pi\varepsilon_0}$ is a constant - $9.00 \times 10^9 Nm^2 C^{-2}$

$q_1 \quad and \quad q_2$ are the two charges

r is the distance between the charges

Because …

- Charges (or charged particles) are either attracted to each other, or repelled from each other and never 'happy to hang around', it takes energy to work against this force

  - Energy is required to separate positive and negative charges.

This allows batteries to provide energy

- Batteries have positive and negative ends

- The positive end will attract electrons

  - Opposite charges attract

- So … if a circuit (path for current to flow), exists, then electrons will flow from the negative to the positive end of the circuit
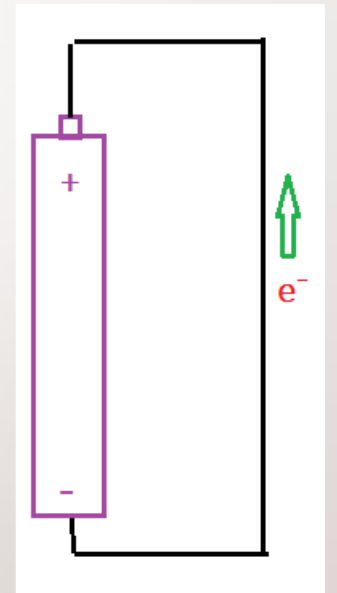
But "hang on" you cry ….

- We all **KNOW**, current flows from positive to negative, DON'T WE?

- Well – "Benjamin Franklin" (the guy who supposedly flew kites in thunderstorms

- Long before we even knew what an electron was, he 'discovered' current, named positive and negative, and defined current as flowing from positive to negative

- Thus, we still say

   "Conventional current flows from positive to negative"

History time

- [Great Minds: Benjamin Franklin: Founding Nerd, SciShow](#)

- [What Does An Atom REALLY Look Like?, Science Asylum](#)

Voltage

- Voltage, electric potential difference, electric pressure or electric tension is the difference in electric potential between two points

Definition of Voltage and Current, ElectroBOOM

Quick look at an electric circuit

We get far deeper into circuits later but let's have a quick look at one now. Do not be afraid, they are fairly simple.

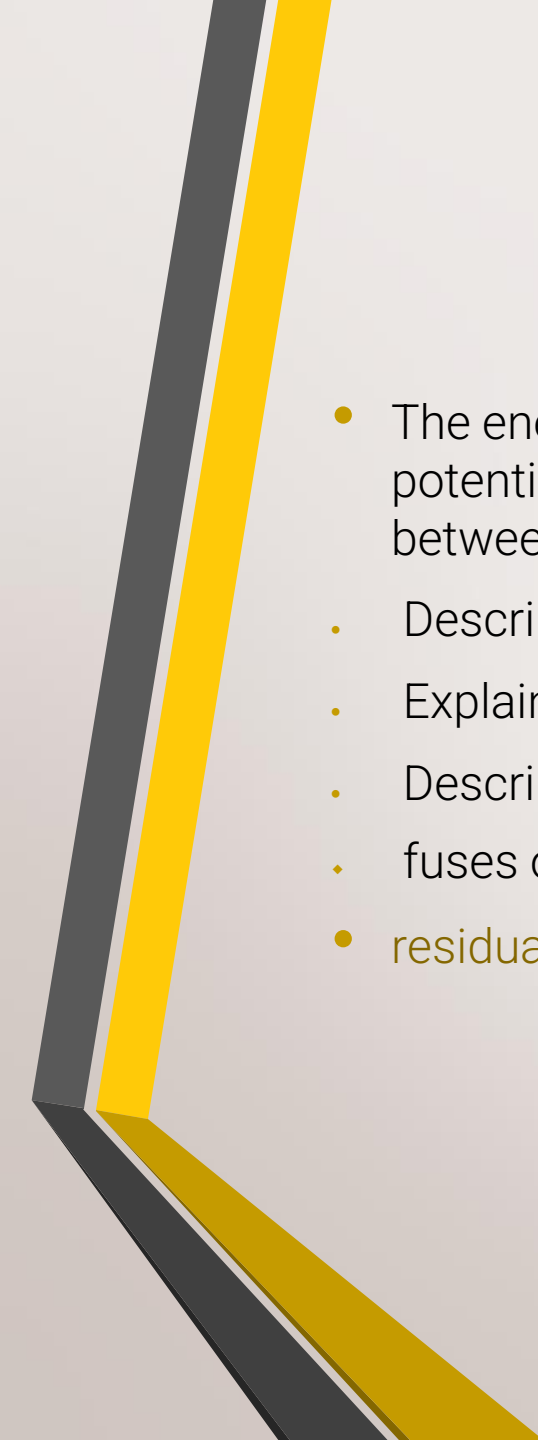[How to Read a Schematic](#)

Final part of today's videofest

- Having spoken about voltage and current. How do we measure them?

[Voltmeters and Ammeters, Khan Academy](#)

Unfinished track ahead

- The energy available to charges moving in an electrical circuit is measured using electric potential difference (voltage). This is defined as the change in potential energy per unit charge between two defined points in the circuit and is measured using a voltmeter.

  - Describe how a voltmeter is used in an electric circuit.

  - Explain the purpose of measuring potential difference in electric circuit.

  - Describe how electrical safety is increased through the use of:

  - fuses or circuit breakers

- residual current devices.

- Electric current is carried by discrete charge carriers. Charge is conserved at all points in an electrical circuit.

- •Distinguish between electron current and conventional current.

- Electric current is the rate of flow of charge.

- •Solve problems involving .

- $I = \frac{q}{t}$

- An ammeter is used to measure the electric current at a point in a circuit. It is placed in series with the electrical component through which the current is to be measured.