Electric Current

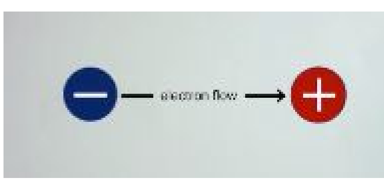
One fine day, when Aristotle was just sitting around in Athens thinking about nothingness, he realized

that there wasn't any. He naturally pondered that. He mused that nature seemed to love balance and good order, and would do whatever needed to be done to resolve chaos and fill voids. He decided to discover a new law of physics, that would explain the absence of nothingness, and excitedly proclaimed 'Horror Vacui!' — meaning 'Nature abhors a vacuum'.

In our previous conversations, we learned that the outer shell electrons of some atoms are very loosely bound to the nucleus, and can become disassociated from it, giving rise to charge.

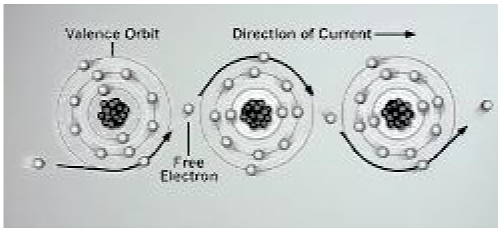
Atoms should be in balance, charge-wise. Otherwise, where there is a deficiency of electrons, the atom has a net positive charge, because the positive charges of its protons are not balanced by a like number of negatively charged electrons. In the same manner, where there happens to be an excess of outer shell electrons, such that the total number of orbital electrons exceeds the number of protons in the nucleus, the atom will have a net negative charge.

If a suitable conduit is provided between two differently charged bodies, electrons will flow from the body having the greater concentration of negative charge, to the body with the lesser concentration,



until balance is achieved.

These so-called 'free electrons' are never actually freely disassociated from an atom. Instead of floating around freely through space, they move in a daisy-chain manner, from the outer shell of one atom into the outer shell of the next —



sort of like a weave the ring move in square dancing! This movement of electrons, from areas of greater (-) to lesser concentration (+), is what constitutes electric current.

The unit of measure of electric current is the ampere.

Yes there was a guy by that name; André-Marie Ampère, a self-taught Frenchman who spent a lot of time studying electromagnetism.

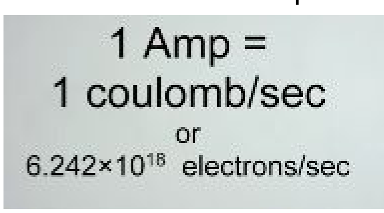
Electrons are so small, and the charge on each one so minute, that it takes great numbers of them to be of any practical consequence as electric current.

The ampere is defined as about 6.3-million-million-million electrons passing a given point per second.

The number is actually 6.242 times 10 to the 18th power, which is also defined as one coulomb.

(There's that name again.)

So, in other words, one ampere ('amp' for short) is equal to one coulomb per second. As a way to visualize what one amp looks like, the current flowing through a 60-watt incandescent light bulb is about a half amp.



Your vacuum cleaner probably runs on about 12-amps.

The imbalance of charge that produces current flow is called a difference of potential, or electromotive force (EMF). Course we can create charge and balances by rubbing a balloon on our hair, or flying a kite during a thunderstorm.

But, so what! The phenomenon of electric current was interesting, but not considered very useful, until someone came up with a way to maintain a difference in potential long enough to sustain a current that would provide some useful function.

Luckily, in 1800, someone did — an Italian this time, named Alessandro Volta.

His invention, the “Voltaic Pile”, (do I hear someone snickering?)
was the forerunner to today’s chemical batteries.
By way of thanks, the unit of electromotive force was named the volt.
Electrons move more freely through some materials, than through others. Materials that are readily conducive to current flow are called conductors. Materials that are highly resistant to it are called insulators.

There are no perfect conductors. All the materials that are resistant to current flow to some extent, and that characteristic is called resistivity.
The opposite of that, of course, is called conductivity. The conductivity or resistivity of a material depends on its atomic structure. Materials whose atoms have loosely bound electrons in their outer shell are good conductors

(high conductivity.)
Conversely, materials made up of atoms with few, if any, “free electrons” … meaning that all the orbital electrons are very tightly bound to the nucleus … are good insulators (high resistivity.)

Silver has the lowest resistivity of any conductive material, and is therefore the best conductor. Next in line are copper, gold, aluminum, tungsten, zinc, iron, platinum, steel and tin.

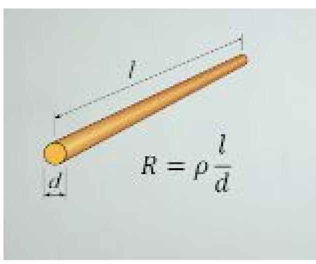
Since silver is an expensive precious metal, copper wins out as our conductor of choice. Glass and porcelain are probably the best insulators

with rubber and various kinds of plastics also in common use. An ideal conductor would be one that has absolutely no resistance to current flow, just as the resistivity of an ideal insulator would be infinite.

Such things do not exist.

All conductors exhibit some resistance to current flow, and even the best insulators have 'leakage' characteristics. The conductance or resistance of a particular conductor or insulator therefore has a dimensional aspect.

Conductors, which are typically copper wires, have resistance, and that resistance is directly proportional to their length, and inversely proportional to their cross-sectional area.



The longer the run, the higher the overall resistance;

the larger the wire, the lower the resistance.

The same is basically true for insulators,

which is why you can see stacks of large porcelain insulators on high-power electric lines. So summarizing ... we've talked about electric current, what causes it, and the meaning of the term amperes, or “amps”. We’ve seen that differences in charge produce an electromotive force, more commonly known as voltage, and referred to as volts.

We found that materials differ when it comes to their ability to pass electric current.
Some (mainly metals) are good conductors while others (such as glass, porcelain or plastics) make good insulators.

Between those extremes, are certain materials that become very useful because they are neither really good conductors, nor good insulators.
We'll talk about those next, and we'll see how such materials are formed into what is probably the simplest, but most useful component in electronics ...the lowly, unsophisticated resistor..