Interactive Problem Set 14, SP212 Spring 2013

Topic: 26.1 - 26.4 Current and Resistance

IPS 14.1 (PROOF) Consider the following expression for current in terms of what is going on at a very "zoomed in" level,

$$i = nAev_d.$$

Here is an explanation for each of the terms on the right,

- n is the number density of the conduction electrons (number / m^3).
- A is the cross sectional area of the current carrying wire.
- e is the fundamental charge.
- v_d is the drift velocity of the electrons. It turns out the conduction electrons are moving quite fast in random directions, v_d is the very small part of motion of the electrons that is the systematic collection march of electrons down the wire in the direction of the current.

During steady flow of charge, we could think $i = \Delta q/\Delta t$ and $v_d = \Delta x/\Delta t$. *Using these ideas and with the help of a careful sketch, convince yourself the above "zoomed in" equation makes sense.*

NOTE: In many sophisticated treatments the key quantity of interest is not the current i but rather the current density J which is the current per cross sectional area where the flow of charge is passing directly through the cross section,

$$J = \frac{i}{A} = nev_d$$

IPS 14.2 A long thin section of wire has a resistance of 22.0 Ω. Suppose a second resistor is constructed with the same kind of material but it's length is twice and it's radius is half that of the original resistor.

- What is the resistance of this second resistor?
- If I construct a simple circuit with the original resistor and a 5.00 V battery, what is the current through the circuit?
- If I construct a simple circuit with the second resistor and a 5.00 V battery, what is the current through the circuit?
- For this simple circuit, how many conduction electrons pass through a checkpoint in the circuit over one minute?

Prep for next class: WPC Chapter 26.