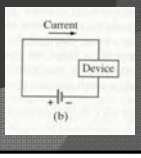
4 – ELECTRIC CIRCUITS

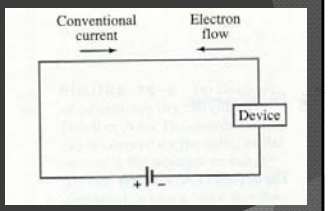
Voltage Source Schematic

- Notice the longer line of the battery notation on the schematic is + while the shorter line is negative.
- it takes more ink to write a + than a –
- it takes more ink to write the longer line



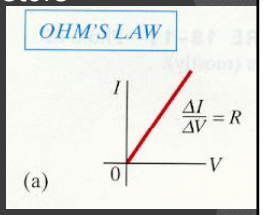
Conventional Current

- It would be a while before anyone knew about electrons.
- When the rules of this game were being set, everyone assumed positive charge flowed in a circuit.
- Electron current tracks the path of the electron flow and it is *opposite to* conventional current.



Ohm's Law: Resistance and Resistors

- To produce an electric current in a circuit, a difference in potential is required.
- Georg Simon Ohm (1787-1854) determined I is proportional to V
- This is also affected by resistance of a wire or other device to the flow of current and it varies inversely with current so
- I = V/R
- R is measured in ohms, Ω



Ohm's Law

$V = IR$

Resistance

- All electric devices offer resistance to the flow of current.
- The resistance of the filaments in light bulbs and the heating coils of electric heaters and stoves result in their becoming HOT.

Resistors

- Resistors can be used to control the amount of current.
- The range of resistors is less than 1 ohm to millions of ohms.
- Wire-wound resistors consist of a coil of fine wire and composition resistors are usually made of the semiconductor carbon.

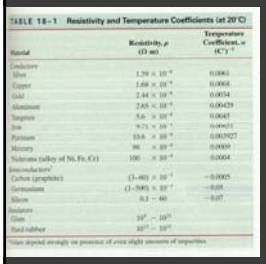
Resistors

Resistor Color Code

Color	Number	Multiplier	Tolerance (%)
Black	0	1	
Brown	1	10^1	
Red	2	10^2	
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Gold		10^{-1}	5%
Silver		10^{-2}	10%
No color			20%

FIGURE 18–12 The resistance value of a given resistor is written on the exterior, or may be given as a color code, as shown above and in the table: the first two colors represent the first two digits in the value of the resistance, the third color represents the power of ten that it must be multiplied by, and the fourth is the manufactured tolerance. For example, a resistor whose four colors are red, green, orange, and silver has a resistance of 25,000 Ω (25 kΩ), give or take 10 percent.

Resistivity



- **Resistivity**–The resistance of a metal wire is directly proportional to its length, L, and inversely proportional to the cross-sectional area, A.
- Where rho,ρ, is a resistivity and depends on the material used.
- $R = \rho \frac{L}{A}$

Electric Power

- Electric heaters, stoves, toasters and hair dryers convert electrical energy into thermal energy.
- In an incandescent light bulb the tiny wire filament becomes so hot it glows.
- Only a few percent of the energy is transformed into visible light, 90% is converted into thermal energy.
- Collisions between the electrons and the atoms of the metal conductor cause the heat to be produced.
- The KE of the electron is transferred to the metal's atom and increases its KE which raises the temperature.

Electric Power

- $Power = \frac{\text{energy transferred}}{\text{Time}} = \frac{QV}{t}$
- $P = IV = I^2R = V^2 / R$