# Ohm's Law & Power

#### Electric Current - I

- Electric current (I) = the flow of electric charge
  - e- carry the charge through the circuit because they are free to move throughout the atomic network
- Electric current is measured in units of amperes (A)
  - 1 ampere = the flow of 1 coulomb of charge per second



$$I = current [A]$$
  

$$q = charge [C]$$
  

$$t = time [s]$$

#### Electric Potential (Voltage) - V

- Charge flows when there is a **potential difference** 
  - When the ends of an electric conductor are at different electric potentials, charge flows from one end to the other
  - The flow of charge will continue until both ends reach a common potential



#### FIGURE 34.1

 a. Water flows from higher pressure to lower pressure.
 The flow will cease when the difference in pressure ceases.
 b. Water continues to flow because a difference in pressure is maintained with the pump.

# Current (I) vs. Voltage (V)

- Charges flow when there is a potential difference (V)
- A voltage source provides a potential difference
  - Ex: batteries, generators
- Charges flow through a circuit because of an applied voltage across the circuit
- Voltage (V) causes current (I)

If you increase the potential difference (voltage) in a circuit, will the current... (a) increase or (b) decrease?

### Resistance (R)

- The current also depends on the resistance that the conductor offers to the flow of charge—the <u>electric resistance (R)</u>
- Resistance is measured in units of <u>ohms (Ω)</u>
  - Resistance (R) of a wire depends on:
    - Conductivity of the material used in the wire
      - Better conductors have less resistance
    - Thickness of the wire
      - Thick wires have less resistance than thin wires.
    - Length of the wire
      - Longer wires have more resistance than short wires
    - Temperature
      - For most conductors, increased temperature means increased resistance

Why will an electric drill operating on a very long extension cord not rotate as fast as one operated on a short cord?

#### So...What do we know?

How is current (I) related to voltage (V)?

How is current (I) related to resistance (R)?

Combining these findings...



**Ex 1:** How much voltage is required to make 2 amperes flow through a resistance of 8 ohms?

**Ex 2:** If the voltage impressed across a circuit is constant but the resistance doubles, what change occurs in the current?

#### Electric Power

- <u>Electric power (P)</u> = the rate at which electrical energy is converted into another form such as mechanical energy, heat, or light
  - Measured in Watts (W)

$$P = VI$$
  $P = I^2 R$  P = Power [W]

**Ex:** Calculate the power supplied to an electric blanket that carries 1.20 A when connected to a 120-V outlet.

# Ohm's Law and Electric Shock

- The damaging effects of electric shock are the result of current passing through the body
- Body's resistance = 100 ohms if you're soaked with salt water to about 500,000 ohms if your skin is very dry

Table 34.1	ffect of Various Electric Currents on the Body
Current (amperes)	Effect
0.001	Can be felt
0.005	Painful
0.010	Involuntary muscle contractions (spasms)
0.015	Loss of muscle control
0.070	If through the heart, serious disruption; probably fatal if current lasts for more than 1 second



FIGURE 34.7 Handling a wet hair dryer can be like sticking your fingers into a live socket.

# Why don't birds get fried?



- Every part of the bird's body is at the same high potential as the wire, so the bird feels no effects
- For the bird to receive a shock, there must be a difference in potential between one part of its body and another part

Jane falls from a bridge and manages to grab onto a high-voltage power line, halting her fall. Will she be ok??

As long as Jane touches nothing else of different potential, she will receive no shock at all. Even if the wire is thousands of volts above ground potential and even if she hangs by it with two hands, no charge will flow from one hand to the other. If, however, you reach over with one hand and grab onto a wire of different potential, ZAP!!