March 15, 2013 Physics 132 Prof. E. F. Redish

- **<u>Theme Music:</u> Benny Goodman**
  AC/DC Current
- **<u>Cartoon:</u> Bob Thaves**
  Frank & Ernest

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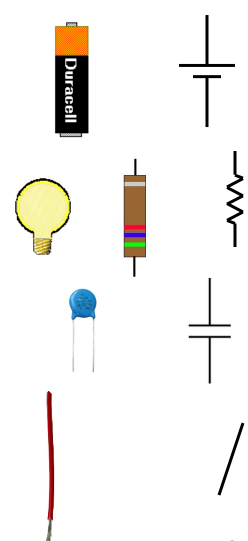
Electric circuit elements

- <u>*Batteries*</u> —devices that maintain a constant electrical pressure difference across their terminals (like a water pump that raises water to a certain height).
- <u>*Resistances*</u> —devices that have significant drag and oppose current. Pressure will drop across them.
- <u>*Capacitors*</u> – devices that can maintain a separation of charge if there is a potential difference maintained across the,
- <u>*Wires*</u> — have very little resistance. We can ignore the drag in them (mostly – as long as there are other resistances present).



Foothold ideas: Kirchhoff's principles

1. ***Flow rule***: The total amount of current flowing into any volume in an electrical network equals the amount flowing out.
2. ***Ohm's law***: in a resistor, $\Delta V = IR$
3. ***Loop rule***: Following around any loop in an electrical network the potential has to come back to the same value (sum of drops = sum of rises).

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Very useful heuristic

- The Constant Potential Corollary (CPC)
  - Along any part of a circuit with 0 resistance, then $\Delta V = 0$, i.e., the voltage is constant since in any circuit element

$$\Delta V = IR$$

$$R = 0 \Rightarrow \Delta V = 0$$

$$(\text{even if } I \neq 0)$$

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Electric Power

- The rate at which electric energy is depleted from a battery or dissipated (into heat or light) in a resistor is

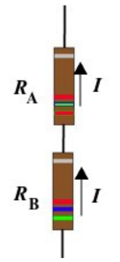
$$Power = I\Delta V$$

Units

- Current (I) **Ampere** = Coulomb/sec
- Voltage (V) **Volt** = Joule/Coulomb
- E-Field (E) Newton/Coulomb = Volt/meter
- Resistance (R) **Ohm** = Volt/Ampere
- Capacitance (C) **Farad** = Volt/Coulomb
- Power (P) **Watt** = Joule/sec

Series and parallel

- Series
  - Same current flows through both devices

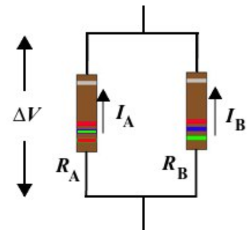


$$I = \frac{\Delta V_A}{R_A} = \frac{\Delta V_B}{R_B}$$

$$\frac{\Delta V_A}{\Delta V_B} = \frac{R_A}{R_B}$$

$$\Delta V = \Delta V_A + \Delta V_B$$
$$= I(R_A + R_B)$$

- Parallel
  - Same voltage drop across both devices



$$\Delta V = I_A R_A = I_B R_B$$

$$\frac{I_A}{I_B} = \frac{R_B}{R_A}$$

$$I = I_A + I_B$$
$$= \Delta V\left(\frac{1}{R_A} + \frac{1}{R_B}\right)$$

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