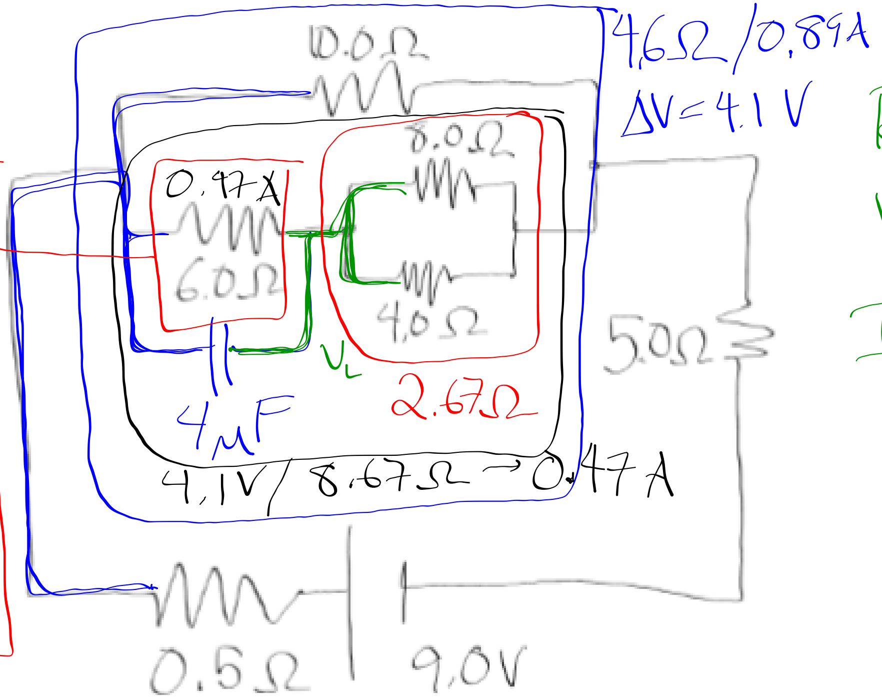
2. Suppose a 4.0 μF capacitor were placed across the 6.0 Ohm resistor in the circuit below. Calculate the charge on the capacitor in its steady state (after the capacitor is fully charged). **[11.4 μC]**

$Q = CV$ 2.88 V

$Q = (4e{-}6)(2.88)V_H$

$\boxed{Q = 1.15e{-}5\,C}$



$R_T = 10.1\,\Omega$

$V_T = 9\,V$

$I_T = \frac{9}{10.1} = 0.89\,A$

$$V = IR$$

ΔV between two points = current travelling between points × equivalent resistance

---

$$Q = CV$$

Charge on a capacitor = capacitance of that capacitor × ΔV across capacitor

3. A heart pacemaker is designed to operate at 70 beats/min using a 7.0 μF capacitor. What value of resistance should be used if the pacemaker is to fire when the voltage reaches 63% of maximum? [1.22e5 Ohms]

$63\% = 1\ \tau$

$\frac{70 \text{ beats}}{\text{min}}$

$\tau = RC$

$\frac{1 \cancel{\text{min}}}{70 \text{ beats}} \cdot \frac{60 s}{\cancel{\text{min}}} = 0.86\ s$

$0.86 s = R(7e{-6}\ F)$

$R = 122{,}449\ \Omega$

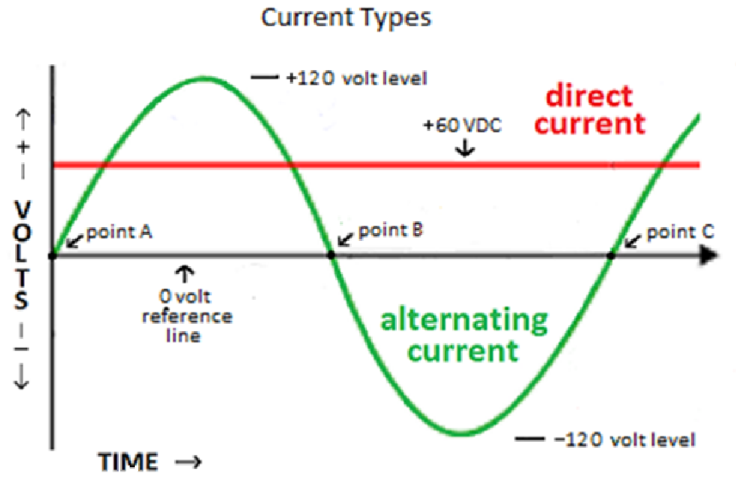
Alternating Current (AC):

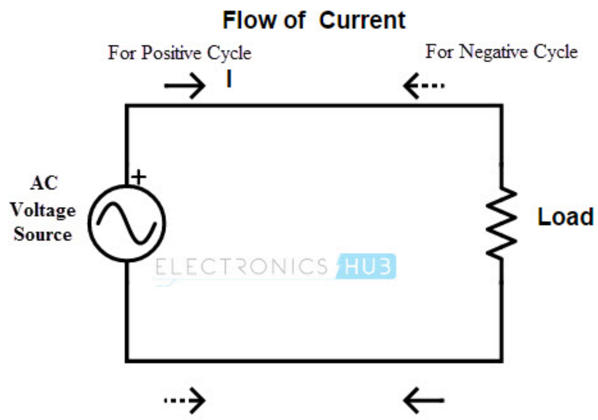
- Voltage at one terminal of the source is constantly changing - ranges from zero to a positive voltage, back to zero, to a negative voltage, in a sine wave.

- Creates an ever-changing "push-pull" which creates a back-and-forth current

- Current can still do stuff! And often it's the same or close to DC current.

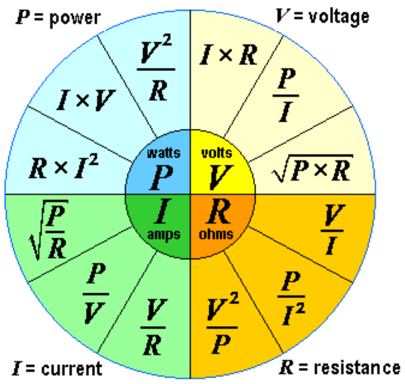
- Why? Easier power transmission; relatively easy to change to DC if needed

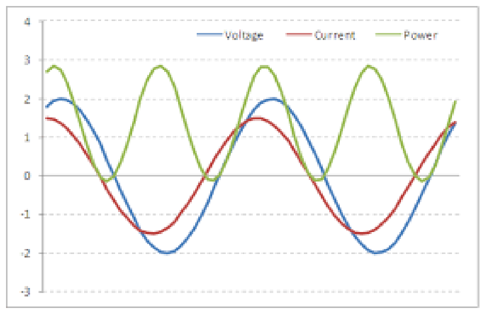




Electrical Power:

- Power measures work done per time
- Unit is Watts (Joules/Sec)
- In a circuit, P = IV
- If there is resistance, P = I^2R or V^2/R (Ohm's Law)
- In a standardized system (like US power grid) V is always the same so P and I are somewhat interchangeable





Example 1:

- A circuit uses 14.9 W of power and generates an overall current of 6 A. What is the voltage driving the circuit? $V = 2.48\,V$

- If there is a 0.321 Ohm resistor in the circuit, how much power is dissipated (as heat) through the resistor? $R = 0.321\,\Omega$

  $P = I^2 R = 11.6\,W$

  $\cancel{P = V^2/R}$

- What do you suppose happens to the rest of the power used by the circuit?

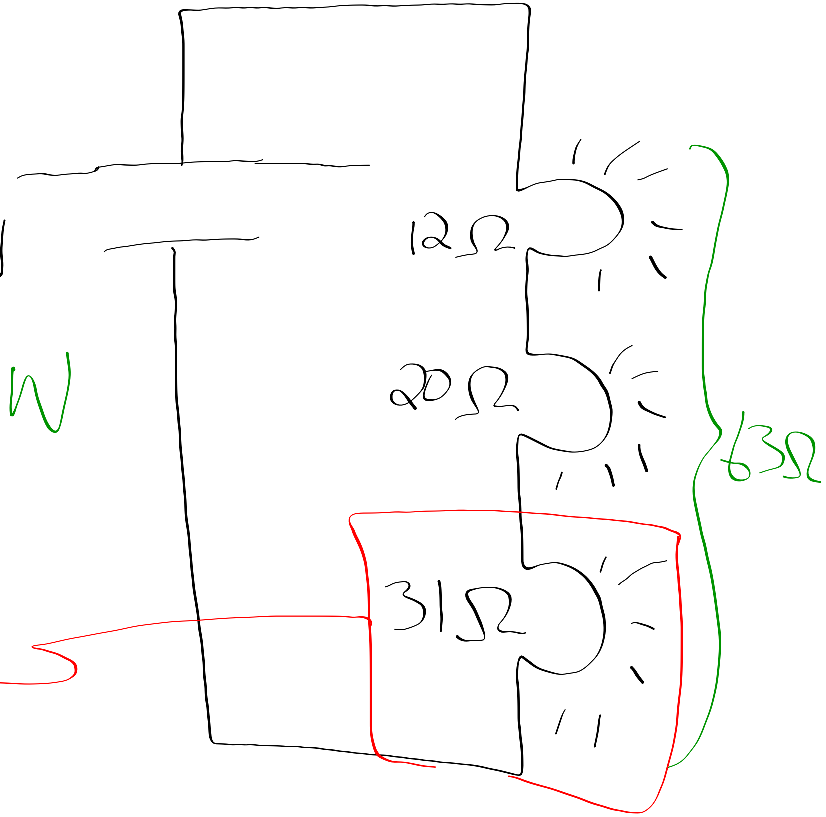
  $3.3\,W \Longrightarrow$ heat, work, light, sound . . .

Example 2:

- How much power is used by this circuit? How much is dissipated across each bulb? $P = \frac{V^2}{R} = 2.29\ W$

- Which light bulb will burn the brightest, and why?

Waste the most but also use the most electricity productively



Example 3:

$P = I \cdot V$

- How much power is used by this circuit with the switch open?
- How much power is used by this circuit with the switch closed?
- Why do these values make sense intuitively?

OPEN: $R_T = 10 + 13 + 12 = 35\,\Omega$

$P = V^2/R = 9^2/35 = 2.3\,W$

CLOSED: $R_T = 10 + \frac{1}{\frac{1}{25} + \frac{1}{4}} = 13.4\,\Omega$

$P = V^2/R = 9^2/13.4 = 6\,W$