HW 2 - Work on it!
   - Use "Ask Your Teacher"

Want to transfer energy quickly.
Usual phone charger = 5.0 V.

Rate of Energy Flow = \( P = I \cdot V \)

For small wires, \( I = 2.0 \text{ A max.} \)
\( P = (5 \text{ V}) (2 \text{ A}) = 10 \text{ W} \)

Qualcomm Quick Charge
\( V = 5 \text{ V}, 9 \text{ V}, 12 \text{ V} \)

Then \( P = (12 \text{ V}) (2 \text{ A}) = 24 \text{ W} \)
Circuit Analysis Principles

* Const. Charge
* Const. Energy per charge

Cons. Charge

Must account for all current. What goes in must come out.
Current flows through components.

\[ I_{in} = 0.5\, A \quad I_{out} \]

We know \( I_{out} = 0.5\, A \)

At a junction, current “splits”.

\[ I_1 = 5\, A \quad I_3 \]

\[ I_2 = 2\, A \]

\[ I_1 = I_2 + I_3 \]

In general: \( \sum I_{in} = \sum I_{out} \)
Cons. Energy per charge

When a charge completes any loop, its total energy gain must equal its total energy loss.

For any loop: \[ \Sigma V_{\text{gain}} - \Sigma V_{\text{loss}} = 0 \]
\[ \Sigma \Delta V = 0 \]

\[ E = 12 \text{V} \]
\[ R = 3 \Omega \]

My loop: start at lower left, go CW.

Battery \( V_{\text{gain}} = 12 \text{V} \) \( \Delta V = +12 \text{V} \)

Resistor \( V_{\text{loss}} = IR \) \( \Delta V = -IR \)

\[ 12 \text{V} - IR = 0 \]
\[ 12 \text{V} = I \times 3 \Omega \]
\[ I = 4 \text{A} \]

Loop eqn says \( V_{\text{batt}} = V_R \)
Series Circuit - current passes thru one component after another.

\[ E = 12V \]
\[ R_1 = 1 \Omega \]
\[ R_2 = 2 \Omega \]

Charge: There is only one current.
\[ I_{\text{batt}} = I_1 = I_2 = I \]

Voltage: Loop from lower-left, CW

Batt:
\[ V_{\text{gain}} = 12V \]
\[ R_1 : \quad V_{\text{loss}} = I \times (1\Omega) \]
\[ R_2 : \quad V_{\text{loss}} = I \times (2\Omega) \]

\[ (12V) - I(1\Omega) - I(2\Omega) = 0 \]
\[ (12V) - I(1\Omega + 2\Omega) < 0 \]
\[ (12V) = I \times (1\Omega + 2\Omega) \]
\[ V = I \times R \]

Series: \[ R_{\text{eq}} = R_1 + R_2 + \cdots \]
Parallel Circuit - current has options

\[ I_B = I_4 + I_{12} \]

Current: At top junction

- \( I_{\text{batt}} \) is inward
- \( I_4 \) is outward
- \( I_{12} \) is outward

\[ I_B = I_4 + I_{12} \]

Voltage: Can follow different loops

- Batt - \( R_{12} \)
  \[ 12V - I_{12} R_{12} = 0 \]
  \[ I_{12} = \frac{12V}{12\Omega} = 1A \]

- Batt - \( R_4 \)
  \[ 12V - I_4 R_4 = 0 \]
  \[ I_4 = \frac{12V}{4\Omega} = 3A \]

\[ I_B = 3A + 1A = 4A \]

Batt "sees": \( \varepsilon = 12V \quad I = 4A \quad R_{\text{eq}} = 3\Omega \)

\( R_4 \) "sees": \( R_4 = 4\Omega \quad I = 3A \quad V_4 = 12V \)

\( R_{12} \) "sees": \( R_{12} = 12V \)
Current
\[ I_{\text{Series}} = I_1 = I_2 = I_3 = \ldots \]
\[ I_{\text{Parallel}} = I_1 + I_2 + \ldots \]

Voltage
\[ V_{\text{Series}} = V_1 + V_2 + \ldots \]
\[ V_{\text{Parallel}} = V_1 = V_2 = \ldots \]

Resistance
\[ R_{\text{Series}} = R_1 + R_2 + \ldots \]
\[ R_{\text{Parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \]

Power
\[ P_{\text{Series}} = P_1 + P_2 + \ldots \]
\[ P_{\text{Parallel}} = P_1 + P_2 + \ldots \]

For any circuit:
\[ \sum P_{\text{gen}} = \sum P_{\text{used}} \]
Method 1:

\[ I_B = I_4 + I_{12} \]

\[ (12\,\text{V}) - 0.5I_B - 12I_{12} = 0 \]

\[ (12\,\text{V}) - 0.5I_B - 4I_4 = 0 \]

Method 2: