UF | UNIVERSITY of FLORIDA

Pre-Health Post-Baccalaureate Program

PHY2054 Study Guide & Practice Problems

Date:

10/5 - 10/9

Topics Covered:

Circuits

Kirchhoff's Laws

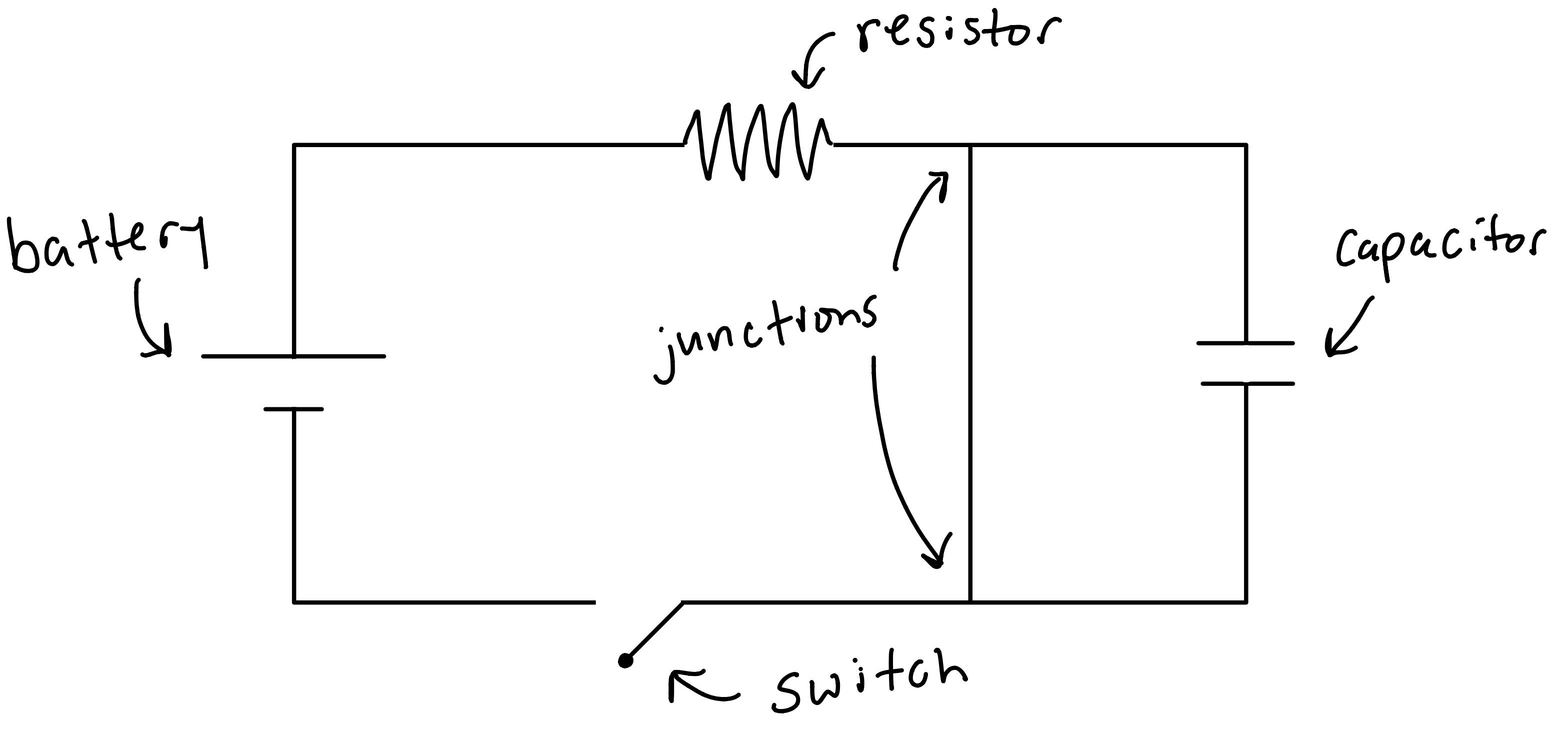
Series Resistors

Parallel Resistors

Created by Isaac Loy

Circuits

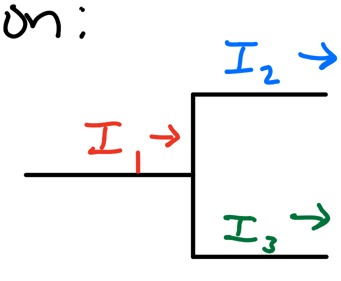
- Let's take everything from last week and apply it - circuit diagrams represent the physics behind what is happening in a closed loop of wire connected to:
    - A source of voltage / emf / potential difference (battery)
    - Resistors (light bulbs)
    - Capacitors
    - Switches



Kirchhoff's Laws

- These laws will help us gain a conceptual understanding of circuits, as well as be necessary to solve math-based problems.

- The Junction Law tells us that the sum of the currents entering a junction (see diagram on previous page) must equal the sum of the currents exiting the junction:



$$\sum I_{in} = \sum I_{out}$$

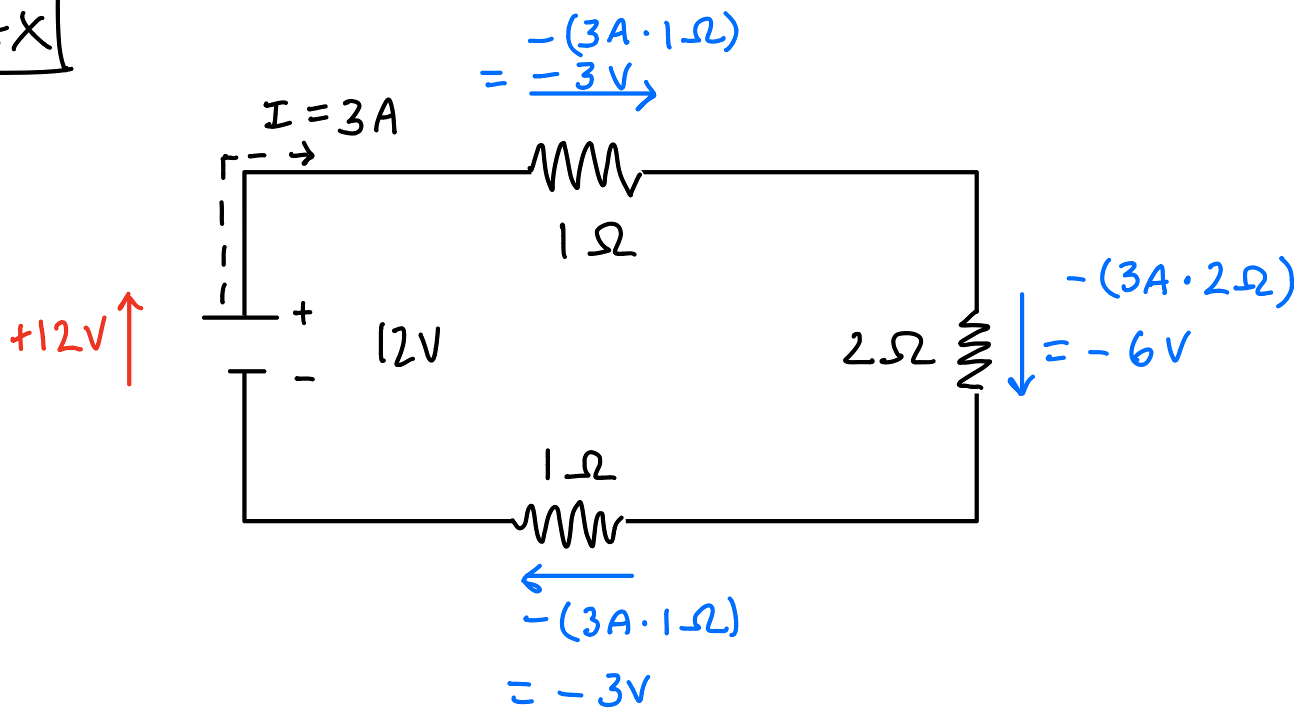
$$I_1 = I_2 + I_3$$

- The Loop Law tells us that the change in voltage around the entire loop equals zero:

$$\Delta V_{loop} = \sum V_{loop} = 0$$

- Another way of thinking about this is to consider that the increase in voltage across the battery is equal to the loss of voltage across all resistors. The voltage increase across the battery equals the voltage/emf of the battery, and the voltage loss across a resistor equals current · resistance ($V=IR$)

Ex



Voltage gained across battery = +12 V

voltage lost across resistors = −3V − 6V − 3V = −12 V

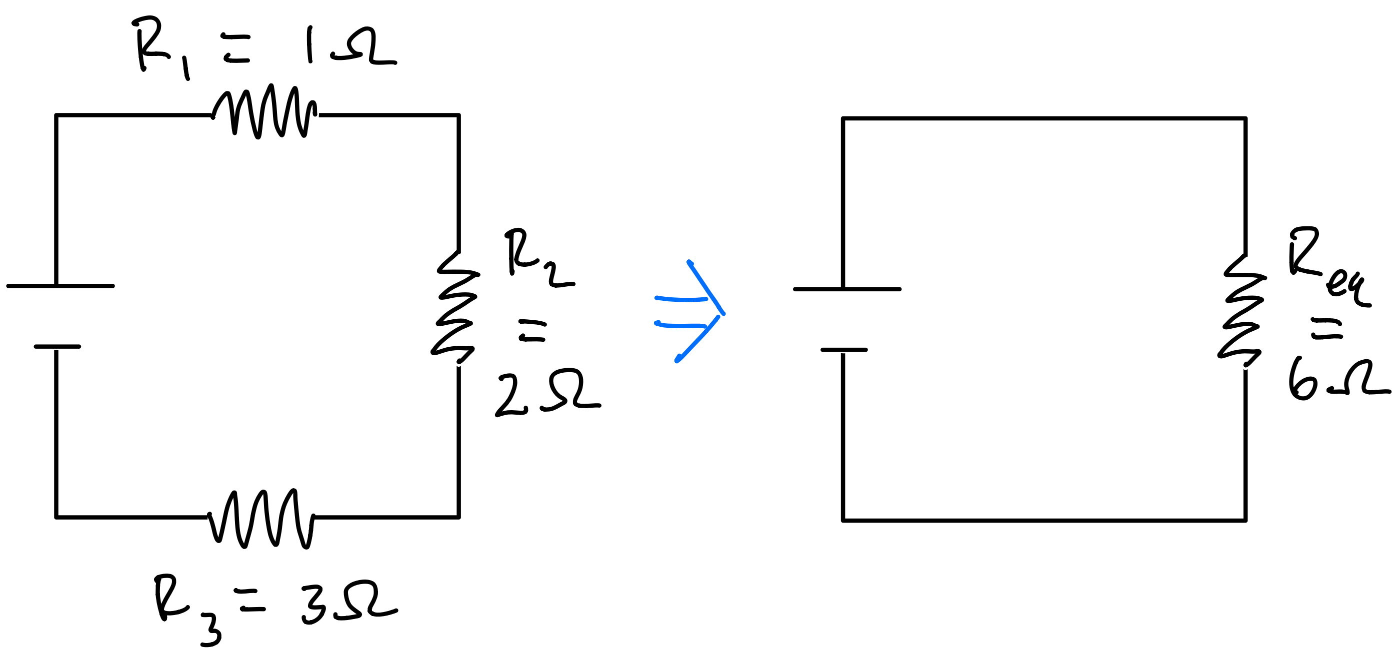
$$\sum V_{loop} = +12V - 12V = 0$$

Series Resistors

- Resistors are "in series" when they exist on the same loop without junctions

- We can simplify circuit diagrams with resistors in series by adding and combining to get equivalent resistance (shown below):

$$R_{eq} = R_1 + R_2 + R_3 + \ldots + R_N$$



- The current across resistors in series is the same:

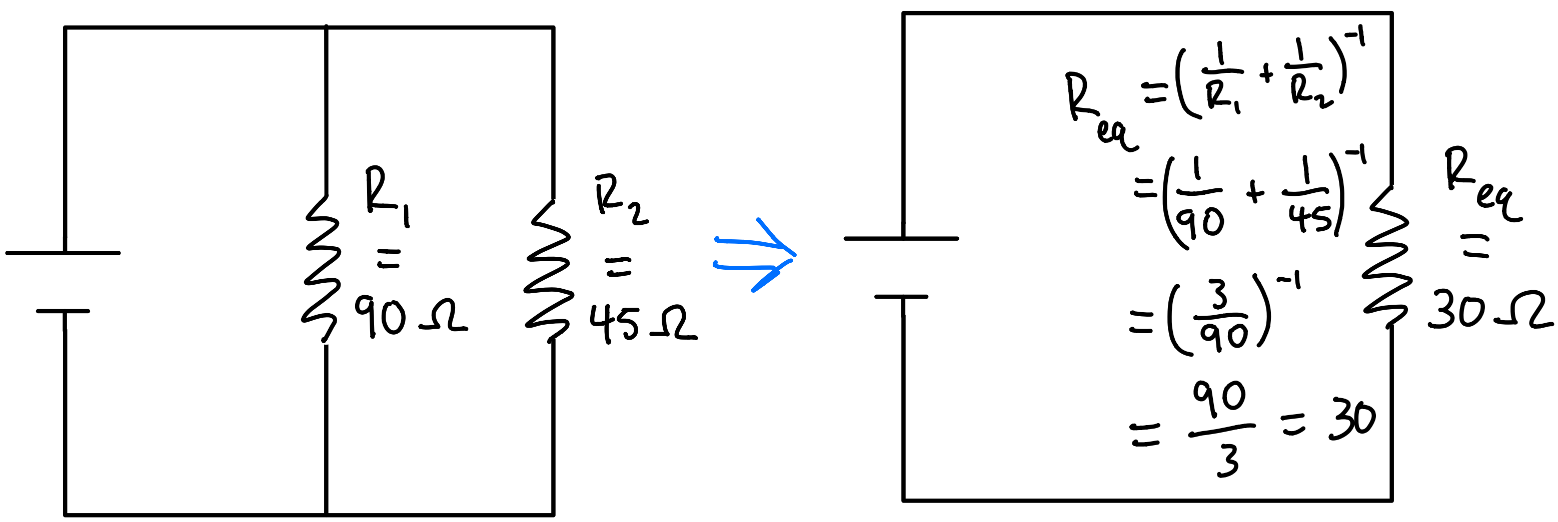
$$V = I R_{eq}$$

$$\Rightarrow I = \frac{V}{R_{eq}} = \frac{V}{R_1 + R_2 + \ldots + R_N}$$

Parallel Resistors

- Resistors are "in parallel" when they are on different branches of a junction point
- We can again simplify to find the equivalent resistance, but it is a little more complicated than before:

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_N} \right)^{-1}$$



- Because of the junction, the current across each resistor in parallel is different (recall Kirchhoff's Junction Law)
- However, upon finding equivalent resistance, the current across the equivalen resistor equals the current exiting and entering the battery (shown below):