Physics
Ms. Brunsting

Kirchhoff's Rules

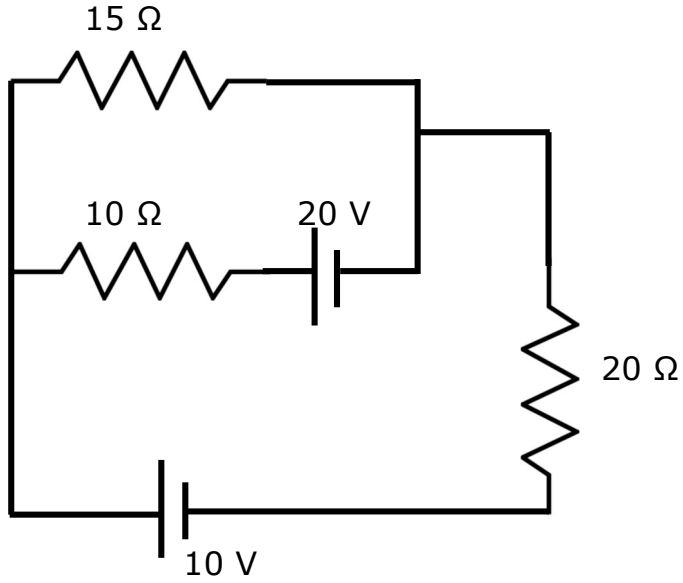
First Rule (Loop Rule)
The change in potential around a closed loop is always equal to zero.

Second Rule (Junction Rule)
The sum of the currents entering a junction must equal the sum of the currents leaving a junction.

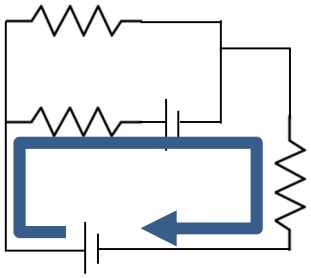
Conventions When Tracing a Loop:

1. Resistors:
    - If you go across a resistor in the **same directi**on as the current, the potential **decreases** by $I \cdot R$.
    - If you go across a resistor in the **opposite directi**on as the current, the potential **increases** by $I \cdot R$.
2. Batteries:
    - If you encounter the **positive** side of the battery first, the potential **decreases** by the battery's voltage.
    - If you encounter the **negative** side of the battery first, the potential **increases** by the battery's voltage.

Example: Determine the current that flows through each resistor.

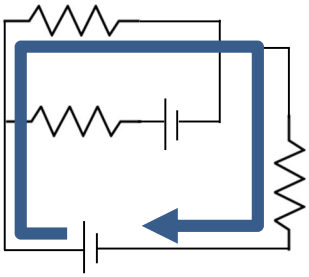


1. Use the First Rule around both loops.



Lower loop: $10\ V - I_2\ (10\ \Omega) - 20\ V - I_1\ (20\ \Omega) = 0$

Upper loop: $10\ V - I_3\ (15\ \Omega) - I_1\ (20\ \Omega) = 0$



2. The sum of the currents on the two branches equals the total current.

$$I_1 = I_2 + I_3$$

3. Rearrange the equations get the Is and numbers in columns.

$$\begin{aligned} -I_1\ (20\ \Omega) - I_2\ (10\ \Omega) + I_3\ (0) &= 10\ V \\ -I_1\ (20\ \Omega) - I_2\ (0\ ) - I_3\ (15\ \Omega) &= -10\ V \\ I_1 - I_2 - I_3 &= 0 \end{aligned}$$

4. Enter the equations into matrices and solve.

$$[A] = \begin{bmatrix} -20 & -10 & 0 \\ -20 & 0 & -15 \\ 1 & -1 & -1 \end{bmatrix} \qquad [B] = \begin{bmatrix} -10 \\ -10 \\ 0 \end{bmatrix}$$

Solution:

$I_1 = -0.0769\ A$
$I_2 = -0.8462\ A$
$I_3 = 0.7692$

Currents 1 and 2 are negative which means the current goes in the opposite direction than the one initially chosen.