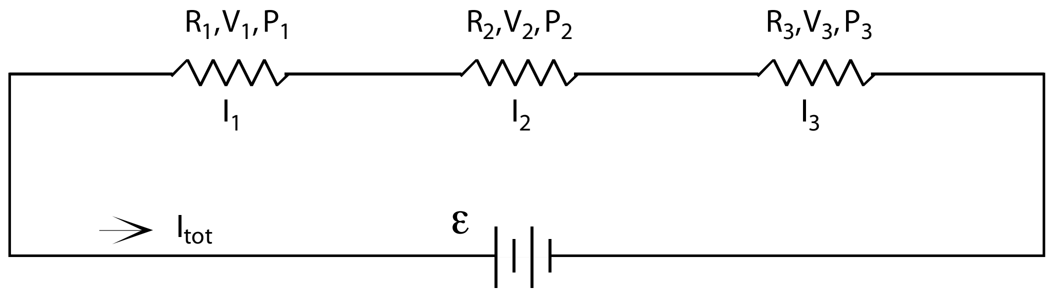
# PhyzExamples: Series Circuits




In ALL circuits...

$$I_{tot} = \frac{\varepsilon}{R_{eq}}$$

OHM'S LAW
The total current in the circuit is equal to the emf of the voltage source (battery) divided by the equivalent resistance of the circuit.

$$P_{tot} = I_{tot}\varepsilon$$

JOULE'S LAW
The total power developed in the circuit is equal to the product of the total current and the emf of the voltage source.

$$P_{tot} = P_1 + P_2 + P_3 + \cdots$$

POWER SUM
The total power in the circuit is equal to sum of the power values of each of the resistors.

In SERIES circuits...

$$I_{tot} = I_1 = I_2 = I_3 = \cdots$$

SERIES CURRENT
The current in a series circuit is the same in all elements of the circuit.

$$\varepsilon = V_1 + V_2 + V_3 + \cdots$$

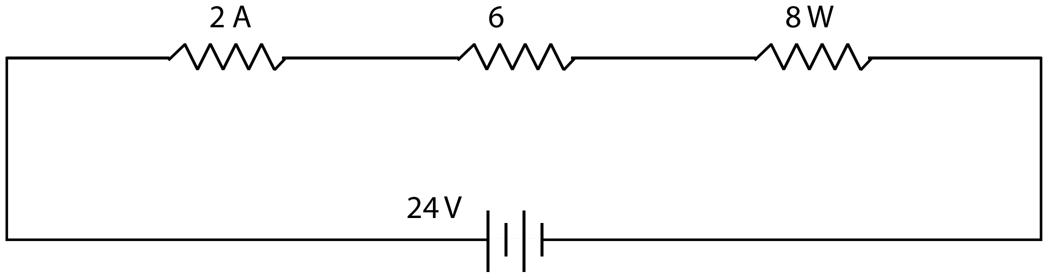
SERIES VOLTAGE
The voltage in a series circuit is divided among the resistors. The potential of the battery is equal to the sum of the potentials across each resistor.

$$R_{eq} = R_1 + R_2 + R_3 + \cdots$$

SERIES EQUIVALENT RESISTANCE
The equivalent resistance of a series circuit is equal to the sum of the resistance values of each resistor.

In ANY resistor $R_n$...

$V_n = I_n R_n$ $\quad$ $P_n = I_n V_n$ $\quad$ $P_n = V_n^2/R_n$ $\quad$ $P_n = I_n^2 R_n$




Given this information, what can be determined about the circuit? EVERYTHING!!!

1. Since the total potential in the circuit is 24 V and the current in the circuit is 2 A, the equivalent resistance in the circuit is

$R_{eq} = \varepsilon/I = 24\text{ V} / 2\text{ A} = 12\ \Omega$

2. Since $R_2 = 6\ \Omega$ and $I = 2$ A, the potential across $R_2$ is

$V_2 = IR_2 = 2\text{ A} \cdot 6\ \Omega = 12\text{ V}$

3. The power dissipated in $R_2$ is

$P_2 = I^2R_2 = (2\text{ A})^2 \cdot 6\ \Omega = 24\text{ W}$

4. Since the power dissipated in $R_3$ is 8 W, the potential drop across $R_3$ is

$V_3 = P_3/I = 8\text{ W} / 2\text{ A} = 4\text{ V}$

5. And the resistance of $R_3$ is

$R_3 = P/I^2 = 8\text{ W} / (2\text{ A})^2 = 2\ \Omega$

6. Since the equivalent resistance is 12 Ω, $R_2$ is 6 Ω, and $R_3$ is 2 Ω,

$R_1 = R_{eq} - R_2 - R_3 = 12\ \Omega - 6\ \Omega - 2\ \Omega = 4\ \Omega$

7. The potential drop across $R_1$ is

$V_1 = \varepsilon - V_2 - V_3 = 24\text{ V} - 12\text{ V} - 4\text{ V} = 8\text{ V}$ or $V_1 = IR_1 = 2\text{ A} \cdot 4\ \Omega = 8\text{ V}$

8. And so the power dissipated in $R_1$ is

$P_1 = I^2R_1 = (2\text{ A})^2 \cdot 4\ \Omega = 16\text{ W}$

9. So the total power dissipated in the circuit is

$P_{tot} = P_1 + P_2 + P_3 = 16\text{ W} + 24\text{ W} + 8\text{ W} = 48\text{ W}$ or $P_{tot} = I\varepsilon = 2\text{ A} \cdot 24\text{ V} = 48\text{ W}$