ATL SKILL ()
Q1
DEFINITIONS
GLOBAL CONTEXT ()
KEY CONCEPT ()
RELATED CONCEPT ()
SOLUTION
FORMATIVE ASSESSMENT
Q2
SUMMATIVE ASSESSMENT
Q3

Series & Parallel Circuits

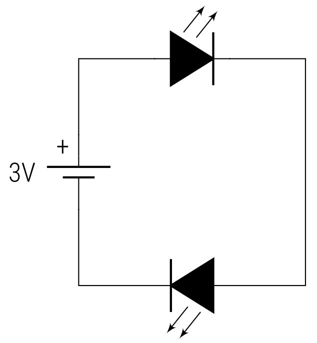
Before You Begin

Technical Background

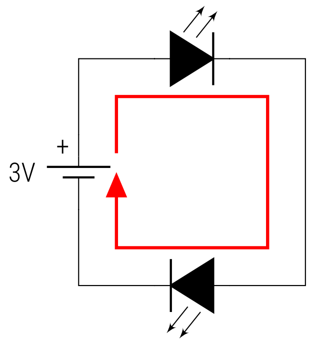
So far, all of the circuits we have built have revolved around a single "loop" of electric current. These simple circuits are called *series circuits*.

This lesson focuses on the difference between building a circuit in *series* and *parallel*, as defined below.

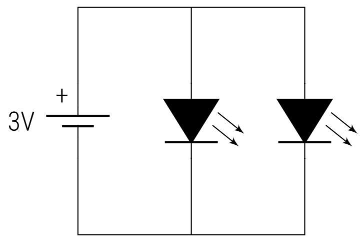
Series Circuits



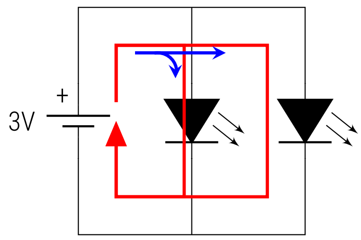
In a simple series circuit such as the one given here, electrical energy passes through one component before entering the next.



Parallel Circuits



In parallel circuits, electrical energy splits along multiple paths. This allows voltage to remain the same across all components, while dividing current.

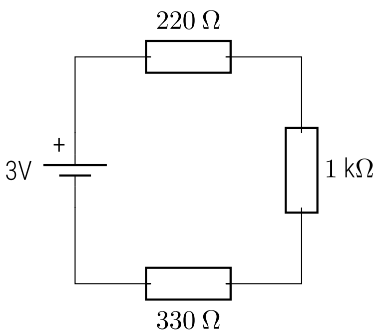


Resistors in Series

Because resistors are used to restrict the flow of electricity, or *current*, they behave differenty in series circuits versus parallel circuits.

In series circuits, the *total resistance* in the circuit is calculated as the sum of each resistor.

Example



$$
\begin{aligned}
R_{\text{total}} &= R_1 + R_2 + R_3 \\
&= 220 + 1000 + 330 \\
&= 1550\,\Omega
\end{aligned}
$$

Calculating Total Resistance in a Series Circuit

The above example yields the following formula:

$$R_{\text{total}} = R_1 + R_2 + \cdots + R_n$$

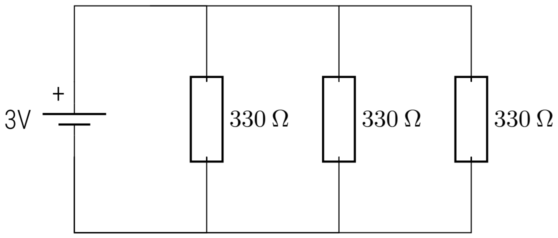
This is a very simple formula, but can be applied in a variety of ways to create circuits with various target resistances.

Resistors in Parallel

Because parallel circuits *divide current*, it becomes a bit harder to determine total resistance in the type of circuits seen below.

Example #1

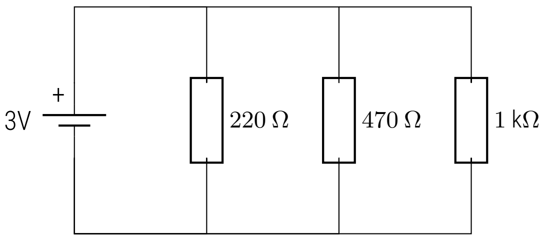
Rarely, all resistors in the circuit will have the same value as in this first example. In that case, all you need to do is divide the resistor value by the number of parallel paths in the circuit.



$$\text{R}_{\text{total}} = \frac{\text{R}}{3} = \frac{330}{3} = 110\,\Omega$$

Example #2

The result is less obvious for more complex parallel circuits. To understand what is going on, let's make a small chart of values for the current passing through each resistor. Remember: in a parallel circuit such as this one the voltage across all components remains the same. Keep in mind that *Ohm's Law* gives us a formula for current: $I = \frac{V}{R}$.



	R$_1$	**R$_2$**	**R$_3$**
V	3	3	3
R	220	470	1000
I	$\frac{3}{220} \approx 0.0136$	$\frac{3}{470} \approx 0.0064$	$\frac{3}{1000} = 0.0030$

From the above table, we can see that the *total current* in the circuit is approximately 0.023 amps (23 mA). Once again using *Ohm's Law* $\left(R = \frac{V}{I}\right)$ gives us a *total resistance* of: $R = \frac{3}{0.023} \approx 130.435\,\Omega$.

Calculating Total Resistance of a Parallel Circuit

The above work can be summarized by the following formula:

$$\text{R}_{\text{total}} = \frac{1}{\frac{1}{\text{R}_1} + \frac{1}{\text{R}_2} + \cdots + \frac{1}{\text{R}_n}}$$

Although it looks complicated, the end result of this formula is identical to making a chart of values similar to what we did previously.

ATL SKILL (Communication Skills)

...use and interpret a range of discipline-specific terms and symbols...

Q4 Apply the formula above to calculate the total resistance of a parallel circuit using the given resistor values ($220\,\Omega$, $470\,\Omega$, and $1000\,\Omega$).

...make inferences and draw conclusions...

Q5 Explain why using the formula did *not* yield the exact same value as in our example.

Developing Technical Skills

Reflections