

Source: [KBhPHYS201IntroToElectrostaticsLN](#)

## 1 | Resistance and Current

Resistance roughly measures how much pressure against current — electron flow there is in a conductor.

### Current

Use the variable  $I$ , a unit  $\frac{C}{s}$ , *Amps*, to measure current. This also equals  $\frac{\Delta V}{Resistance}$ . Big resistance, little current. Current is measured in a unit  $\frac{C}{s}$ , which intuitively makes sense — Current/second is kind of like metres<sup>3</sup>/second — it measures, roughly, the “amount of flow”/second.

Definition 1 · **Current**  $I$  A value measured in unit  $\frac{C}{s}$ , a.k.a. *Amps* that measures electron flow

### Resistance

So, let's figure out resistance.

We know that...  $V = \frac{J}{C}$ , per [KBhPHYS201Voltage](#), and we also know that resistance would equal a unit  $\frac{V_s}{C}$  given that  $I = \frac{C}{s} = \frac{\Delta V}{Resistance}$ . Plugging in the definition of voltage, we get that resistance is measured in  $\frac{Js}{C^2}$ . We call this unit Ohms, or  $\Omega$ .

Definition 2 · **Resistance**  $\Omega$  A value measured in  $\frac{Js}{C^2}$  that measures the resistance to current

### Calculating resistance

- So, let's think. With a wire of length  $L$  and with a wire of area  $A$ , if we increase  $L$ , the resistance in the wire would increase; if we increase area  $A$ , the resistance in the wire would decrease.
- $Resistance = \frac{L}{A} * ResistivityOfMaterial$  with units  $\frac{m}{m^2}(\Omega \times m)$ .

and, indeed, resistivity of materials are measured in  $\Omega \times m$ , which also makes sense intuitively.

### Resistors in Different configurations

#### Series

If you have two resistors...

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With the first having a resistance of  $A\Omega$  and the second  $B\Omega$ .

The total resistance would simply be  $(A + B)\Omega$ .

- Same as equivalent of “electricity!” go through the first then the second

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**Parallel**

Smaller area |---||---| Bigger area |===||===|

$$R_2 = R_1 \times \frac{A_1}{A_2}$$

$$R_{eq} = R_1 \times \frac{A_1}{A_1 + A_2}$$

$$\frac{1}{R_{eq}} = \frac{A_1 + A_2}{A_1 R_1}$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{A_2}{A_1 R_1}$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Resistance equation for series :pointup:

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Calculate resistance

**Calculating Current in a Circuit.**

Traditional Kirkob's Laws approach

A circuit!

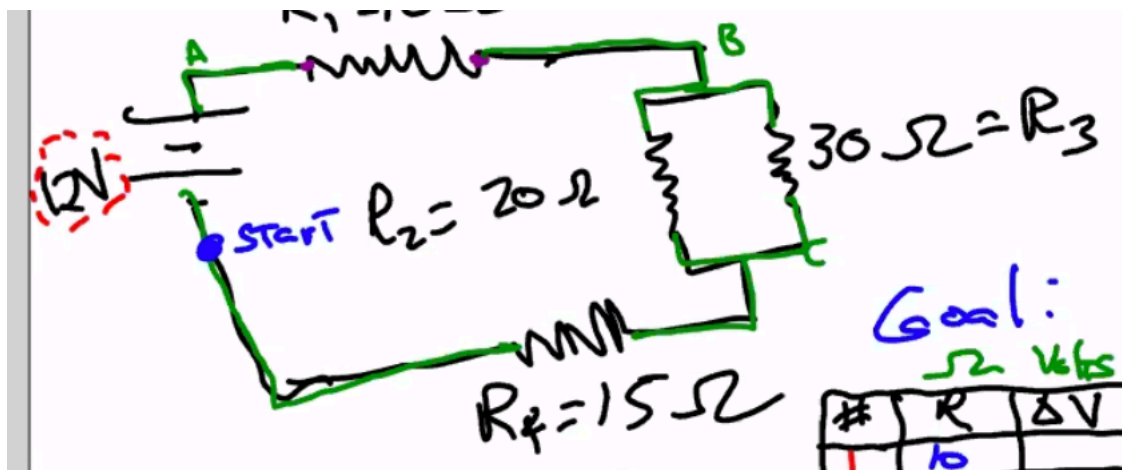


Figure 1: Screen Shot 2020-09-14 at 10.38.44 AM.png

**Kirkab's First Law** Sum of voltage in any closed loop should add up to 0

As in, the sum of all voltage changes from Start => Start will add up to 0.

**Kirbob's Second law** Net current flowing into a node is 0

With a current  $i_0$ , when it flows into a junction like B, the current  $i_0$  splits into  $i_2$  and  $i_3$

So, to calculate the resistance and current at every point o

START at start

- +12

- $-I_1 * 10$  (per  $I = \frac{\Delta V}{\text{resistance}}$ )
- $-I_2 * 20$
- $-I_1 * 15$
- $= 0$

$I_1 - I_2 - I_3 = 0$ , per Kirerbab's Second Law.

**Through a resistor, the Current does NOT change, the Voltage drops.**

### "Combine Resistors" Method

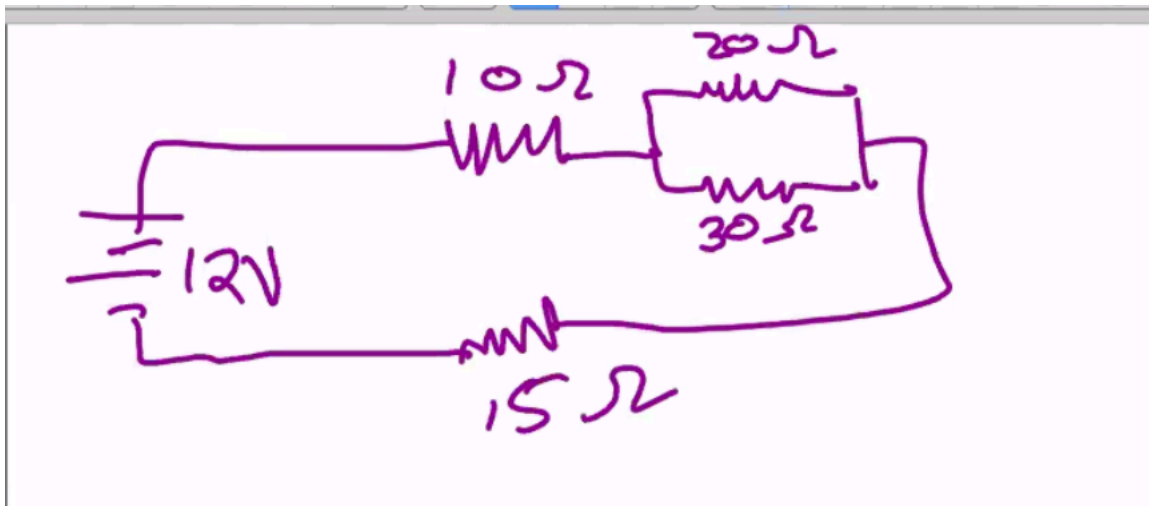
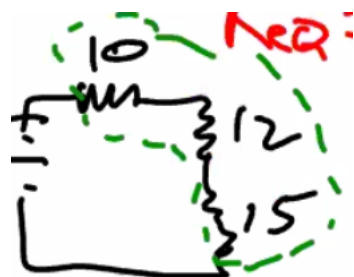


Figure 2: Screen Shot 2020-09-14 at 11.02.45 AM.png

**Parallel Resistors as Single Resistors** Per the previous resistors rules, that  $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$ , we could treat the  $20\Omega$  and  $30\Omega$  in parallel as a single resistor of  $12\Omega$ .

Now the circuit becomes even simpler:



### #### Sequence Resistors as Single Resistors

Per the sequence resistors rules, that total resistance is  $(A + B)\Omega$ , we could combine these three resistors as a  $37\Omega$  resistor.