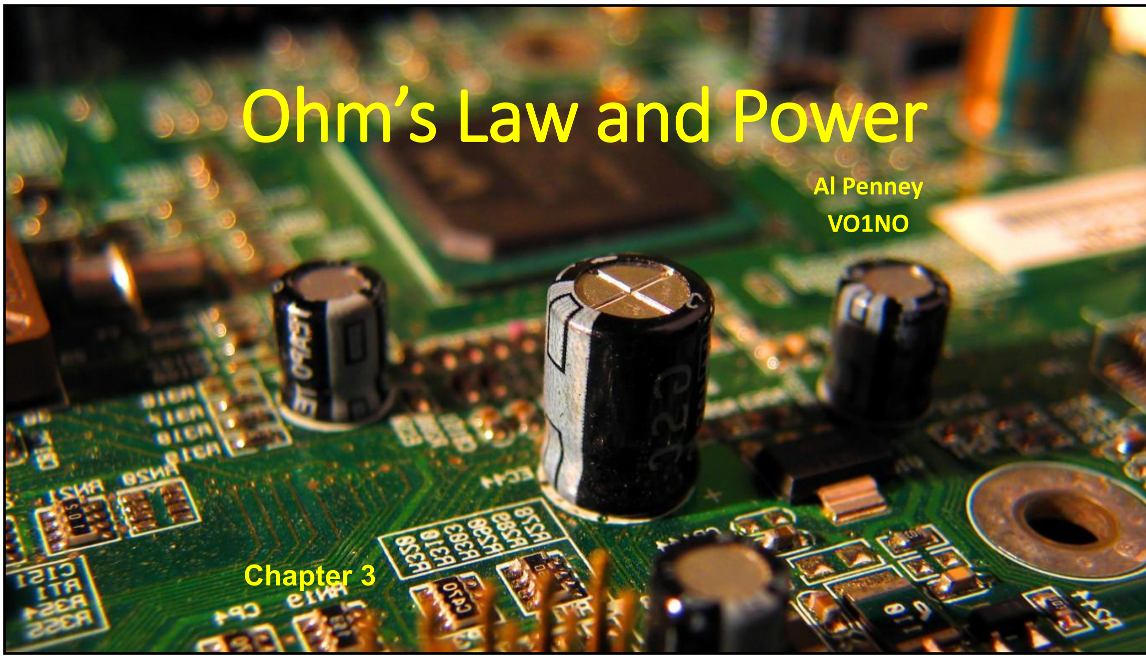
Ohm's Law and Power
Al Penney
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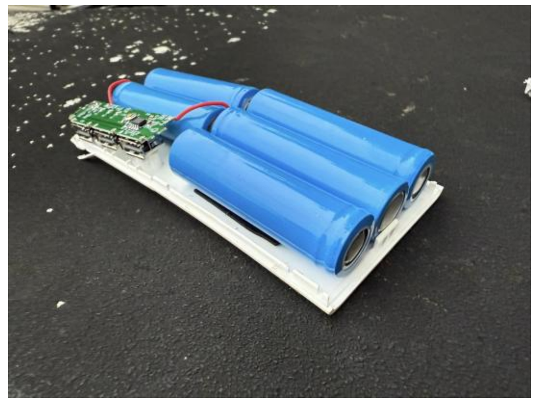
Chapter 3

Beware Cheap Battery Packs!



Objective

- Define Ohm’s law;
- Make simple calculations using Ohm’s law; and
- Understand the concept of power and the formula for its calculation.

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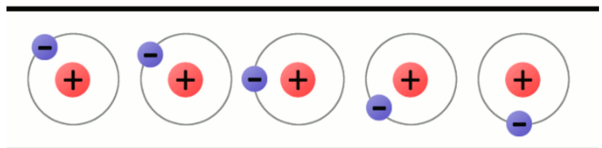
Electric Current



- Electric current is the **flow of electron**s through a conductor.
- Current (I) is measured in **Amperes** (A).
- E.g.: I = 5 A (Current equals 5 Amperes).

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Voltage

- Voltage is the **force** must be applied to make electrons move.
- Think of it as the "pressure" that pushes electrons through a conductor.
- Also known as **Electromotive Force (EMF)** and **Potential Difference**.
- Voltage (V) is measured in **Volts**.
- Symbol is "E" e.g.: E = 5V

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Resistance

- The **Opposition** to the flow of current.
- Unit of resistance is the **Ohm**.
- Symbol is the Greek letter Omega: Ω
- Abbreviation for resistance is "R": e.g.: R = 5 Ω

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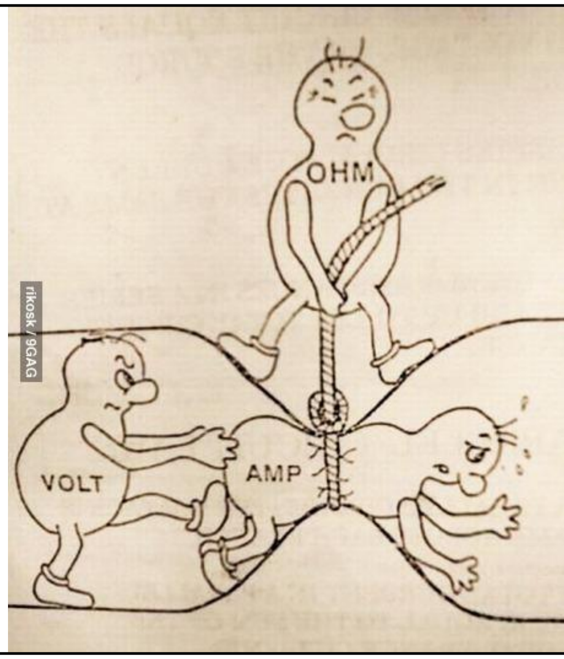
The **electrical resistance** of an object is a measure of its opposition to the flow of electric current. The inverse quantity is **electrical conductance**, and is the ease with which an electric current passes. Electrical resistance shares some conceptual parallels with the notion of mechanical friction. The SI unit of electrical resistance is the ohm (Ω), while electrical conductance is measured in siemens (S).

The resistance of an object depends in large part on the material it is made of—objects made of electrical insulators like rubber tend to have very high resistance and low conductivity, while objects made of electrical conductors like metals tend to have very low resistance and high conductivity. This material dependence is quantified by resistivity or conductivity. However, resistance and conductance are extensive rather than bulk properties, meaning that they also depend on the size and shape of an object. For example, a wire's resistance is higher if it is long and thin, and lower if it is short and thick. All objects show some resistance, except for superconductors, which have a resistance of zero.



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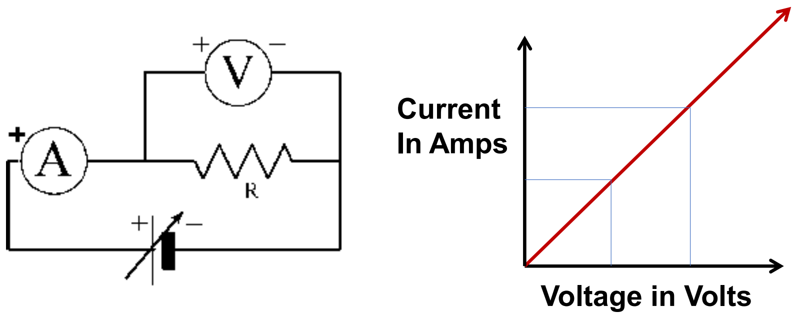
Voltage and Current



As Voltage is increased, Current also increases.

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Ohm's law states that the current through a conductor between two points is directly proportional to the potential difference across the two points. Introducing the constant of proportionality, the resistance, one arrives at the usual mathematical equation that describes this relationship:

E = I x R

where *I* is the current through the conductor in units of amperes, *V* is the potential difference measured *across* the conductor in units of volts, and *R* is the resistance of the conductor in units of ohms. More specifically, Ohm's law states that the *R* in this relation is constant, independent of the current.
The law was named after the German physicist Georg Ohm, who, in a treatise published in 1827, described measurements of applied voltage and current through simple electrical circuits containing various lengths of wire. He presented a slightly more complex equation than the one above to explain his experimental results. The above equation is the modern form of Ohm's law.

Georg Simon Ohm (16 March 1789 – 6 July 1854) was a German physicist and mathematician. As a school teacher, Ohm began his research with the new electrochemical cell, invented by Italian scientist Alessandro Volta. Using equipment of his own creation, Ohm found that there is a direct proportionality between the potential difference (voltage) applied across a conductor and the resultant electric current. This relationship is known as Ohm's law, and the ohm, the standard unit of electrical resistance, is named after him.

Ohm's law, that electric current is proportional to a potential difference, was first discovered by Henry Cavendish, but Cavendish did not publish his electrical discoveries in his lifetime and they did not become known until 1879, long after Ohm had independently made the discovery and published himself. Thus the law came to bear the name of Ohm.

Ohm's Law

- Relationship between Voltage, Current and Resistance can be expressed mathematically as:

$$E = I \times R$$

Where:

E is measured in Volts;

I is measured in Amps; and

R is measured in Ohms.

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Ohm's Law

The equation can be re-written to determine any of the 3 variables if the other two are known:

$$I = E / R$$

And

$$R = E / I$$

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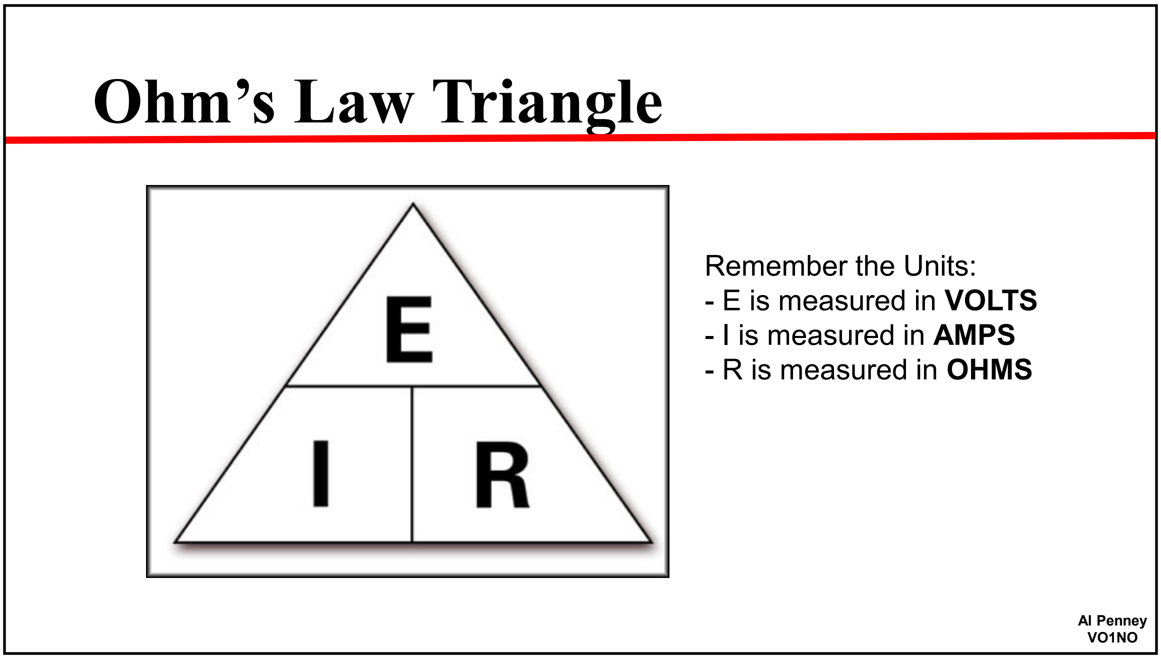
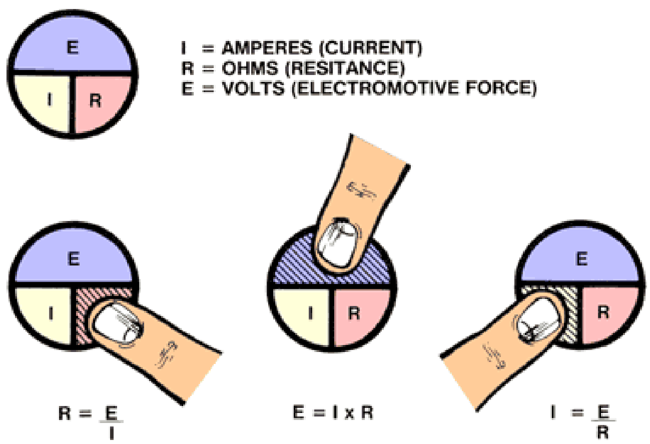


To help remember the formula it is possible to use a triangle with one side horizontal and the peak at the top like a pyramid. This is sometimes known as the Ohm's law triangle.
In the top corner of the Ohms law triangle is the letter E, in the left hand corner, the letter I, and in the right hand bottom corner, R.

To use the triangle cover up the unknown quantity and then and then calculate it from the other two. If they are in line they are multiplied, but if one is on top of the other then they should be divided. In other words if current has to be calculated the voltage is divided by the resistance i.e. E/R and so forth.

Ohm's Law Triangle (Okay – Circle!)



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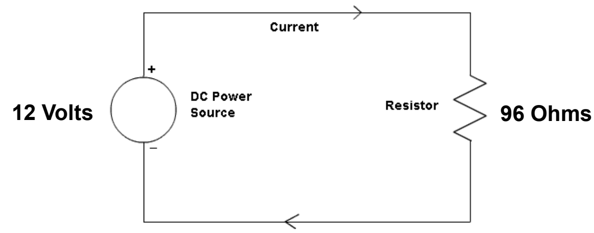
Ohm's Law Problem #1

What is the current?



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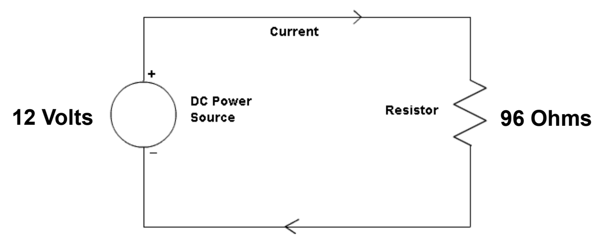
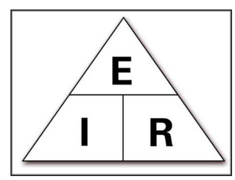
Ohm’s Law Problem #1

What is the current?



Consult the Ohms Law Triangle:



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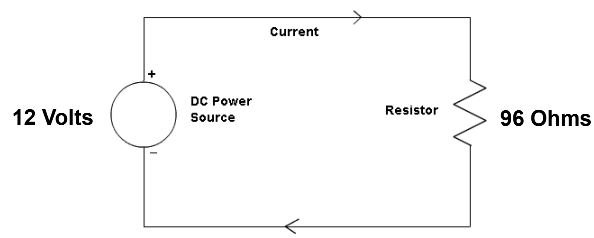
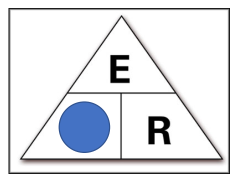
Ohm’s Law Problem #1

What is the current?



Consult the Ohms Law Triangle:



I = E / R

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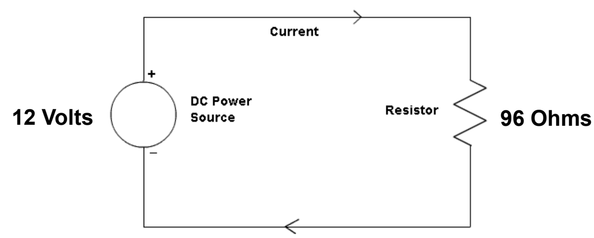
Ohm's Law Problem #1

What is the current?



I = E / R

I = 12 Volts / 96 Ohms

I =

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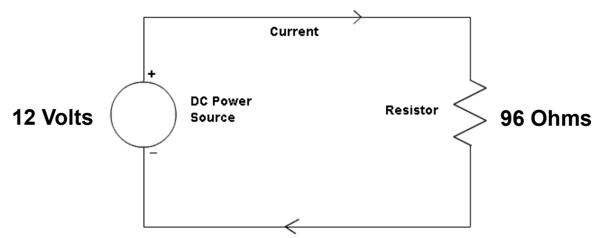
Ohm’s Law Problem #1

What is the current?



I = E / R
I = 12 Volts / 96 Ohms
I = 0.125 Amps

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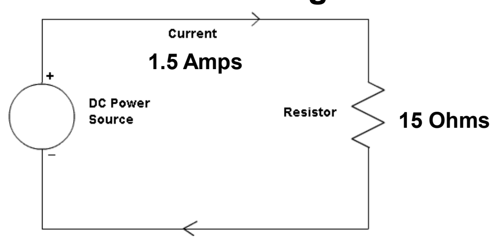
Ohm's Law Problem #2

What is the voltage?



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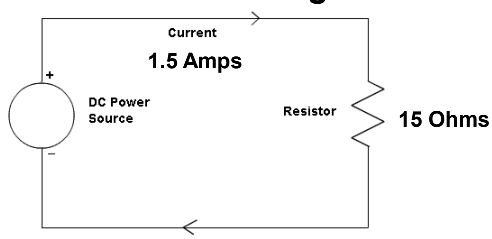
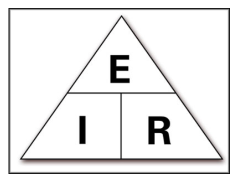
Ohm’s Law Problem #2

What is the voltage?



Consult the Ohms Law Triangle:



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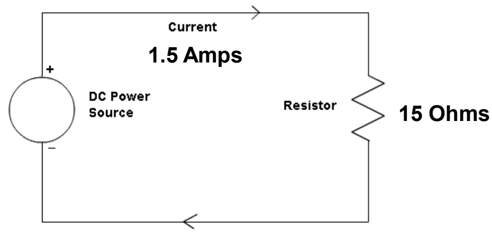
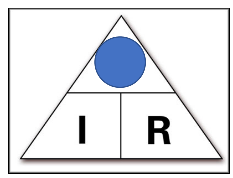
Ohm’s Law Problem #2

What is the voltage?



Consult the Ohms Law Triangle:



E = I x R

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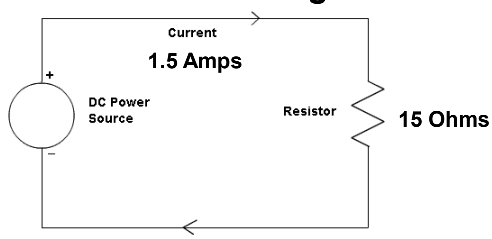
Ohm's Law Problem #2

What is the voltage?



E = I x R

= 1.5 Amps x 15 Ohms

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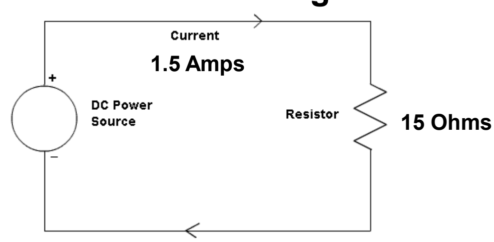
Ohm’s Law Problem #2

What is the voltage?



E = I x R
= 1.5 Amps x 15 Ohms
= 22.5 Volts

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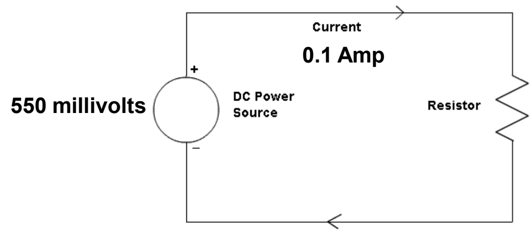
Ohm's Law Problem #3

What is the resistance?



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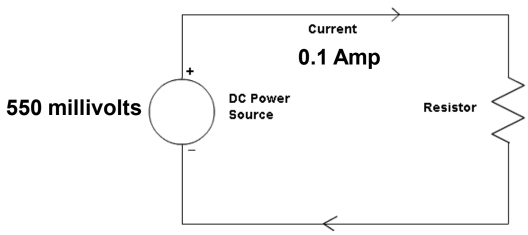
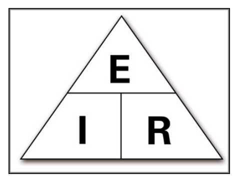
Ohm's Law Problem #3

What is the resistance?



Consult the Ohms Law Triangle:



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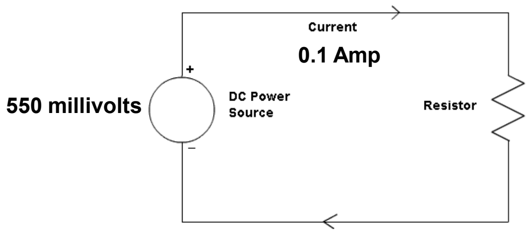
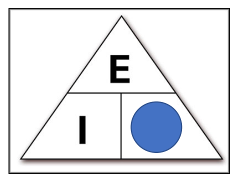
Ohm’s Law Problem #3

What is the resistance?



Consult the Ohms Law Triangle:



$R = E / I$

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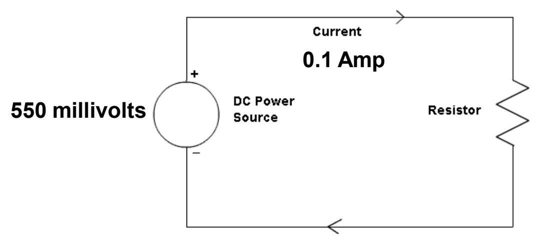
Ohm’s Law Problem #3

What is the resistance?



R = E / I

= 550 millivolts / 0.1 Amp

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Ohm's Law Problem #3

- **REMEMBER the UNITS!**
  - 550 **millivolts** = 550 / 1000 volts = 0.55 **volts**

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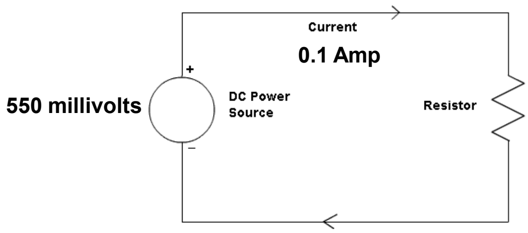
Ohm's Law Problem #3

What is the resistance?



R = E / I
= 550 millivolts / 0.1 Amp
= 0.55 Volts / 0.1 Amp

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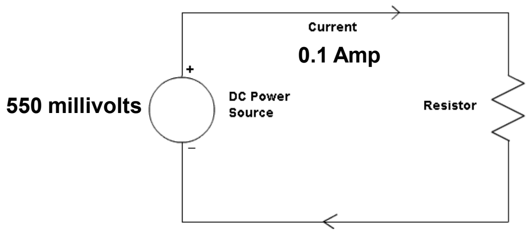
Ohm’s Law Problem #3

What is the resistance?



R = E / I
= 550 millivolts / 0.1 Amp
= 0.55 Volts / 0.1 Amp
= 5.5 Ohms

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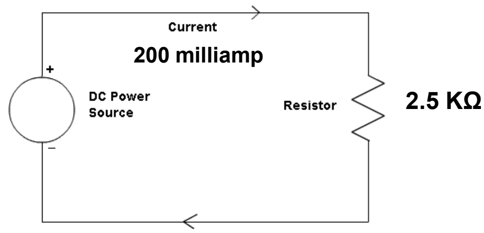
Ohm's Law Problem #4

What is the voltage?



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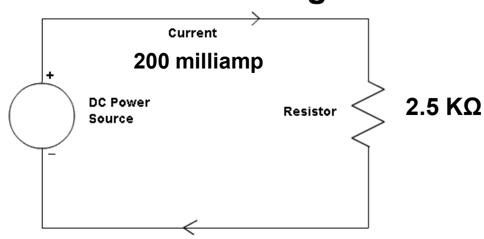
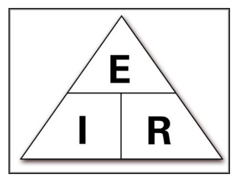
Ohm’s Law Problem #4

What is the voltage?



Consult the Ohms Law Triangle:



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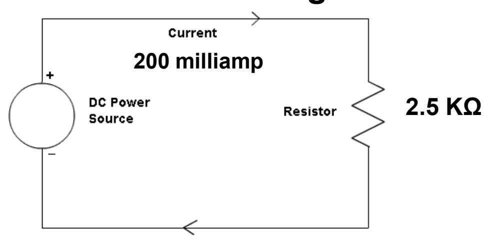
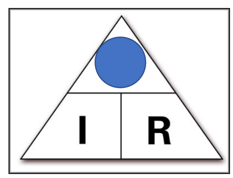
Ohm’s Law Problem #4

What is the voltage?



Consult the Ohms Law Triangle:



E = I x R

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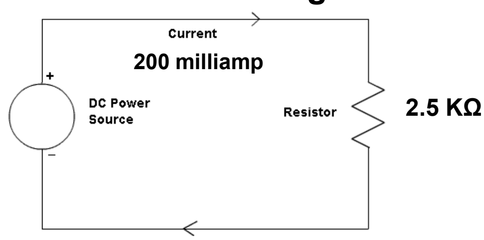
Ohm's Law Problem #4

What is the voltage?



E = I x R
= 200 milliamps x 2.5 Kilo Ohms

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Ohm’s Law Problem #4

- **REMEMBER the UNITS!**
  - 200 **milliamps** = 200 / 1000 Amps = 0.2 Amps
  - 2.5 **Kilo Ohms =** 2.5 x 1000 Ohms = 2500 Ohms

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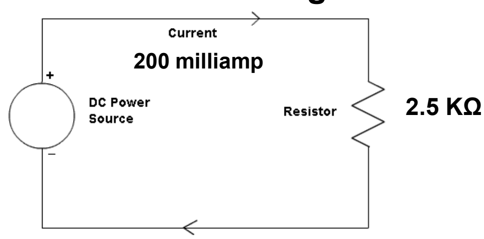
Ohm's Law Problem #4

What is the voltage?



E = I x R
= 200 milliamps x 2.5 Kilo Ohms
= 0.2 Amps x 2500 Ohms

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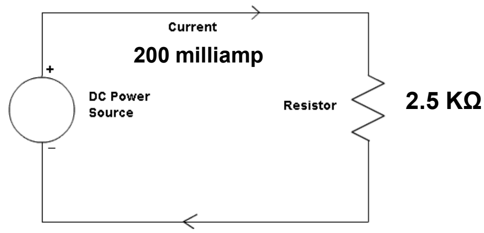
Ohm's Law Problem #4

What is the voltage?



E = I x R
= 200 milliamps x 2.5 Kilo Ohms
= 0.2 Amps x 2500 Ohms
= 500 Volts

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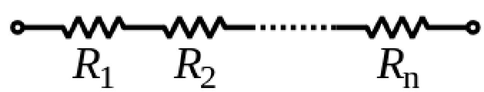
Resistors in Series

- When resistors are in **SERIES**, the total resistance is the **SUM** of the individual resistances.



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

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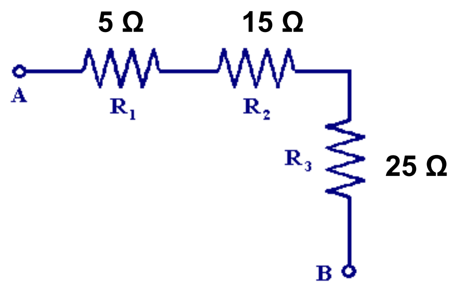
Resistors in Series



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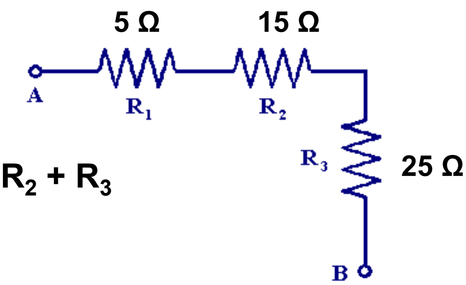
Resistors in Series



$R_{Total} = R_1 + R_2 + R_3$

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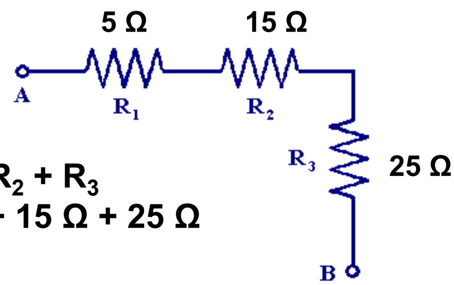
Resistors in Series



$R_{Total} = R_1 + R_2 + R_3$

$R_{Total} = 5\ \Omega + 15\ \Omega + 25\ \Omega$

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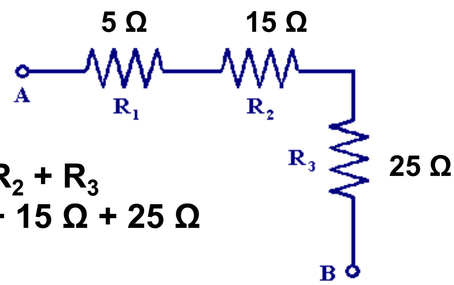
Resistors in Series



$R_{Total} = R_1 + R_2 + R_3$
$R_{Total} = 5\ \Omega + 15\ \Omega + 25\ \Omega$
$R_{Total} = 45\ \Omega$

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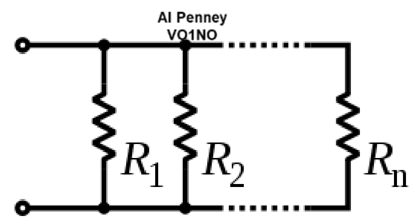
Resistors in Parallel

- When resistors are in Parallel, the total resistance is given by the following equation:

  $1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3 + ... + 1/R_N$



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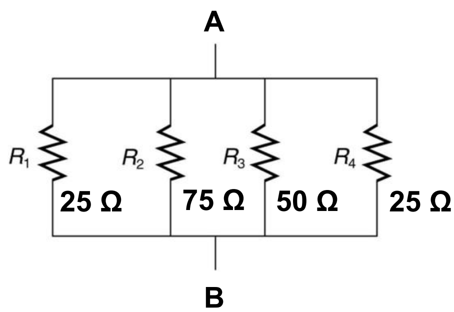
Resistors in Parallel



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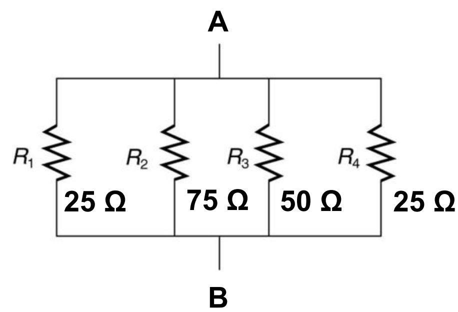
Resistors in Parallel



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3 + 1/R_4$

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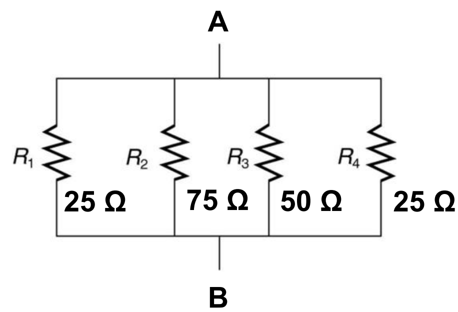
Resistors in Parallel



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3 + 1/R_4$

$1/R_{Total} = 1/25 + 1/75 + 1/50 + 1/25$

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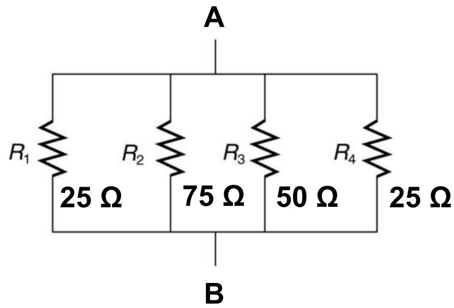
Resistors in Parallel



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3 + 1/R_4$

$1/R_{Total} = 1/25 + 1/75 + 1/50 + 1/25 = 6/150 + 2/150 + 3/150 + 6/150$

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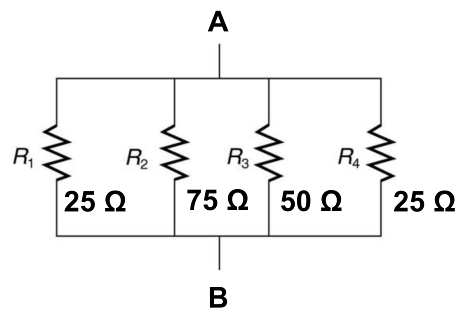
Resistors in Parallel



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3 + 1/R_4$

$1/R_{Total} = 1/25 + 1/75 + 1/50 + 1/25 = 6/150 + 2/150 + 3/150 + 6/150$

$1/R_{Total} = 17/150\ \Omega$

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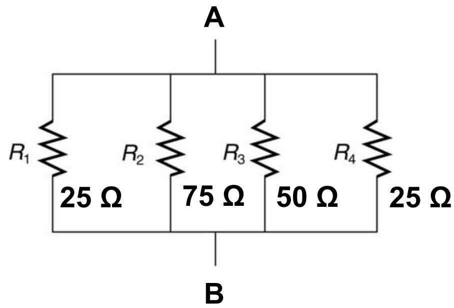
Resistors in Parallel



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3 + 1/R_4$

$1/R_{Total} = 1/25 + 1/75 + 1/50 + 1/25 = 6/150 + 2/150 + 3/150 + 6/150$

$1/R_{Total} = 17/150\ \Omega$

$R_{Total} = 150/17\ \Omega = 8.82\ \Omega$

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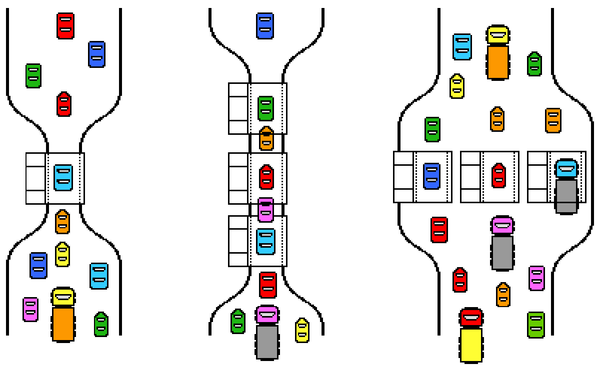
Influencing the Flow Rate on a Tollway



A Single Resistor

Three Resistors Placed in Series

Three Resistors Placed in Parallel

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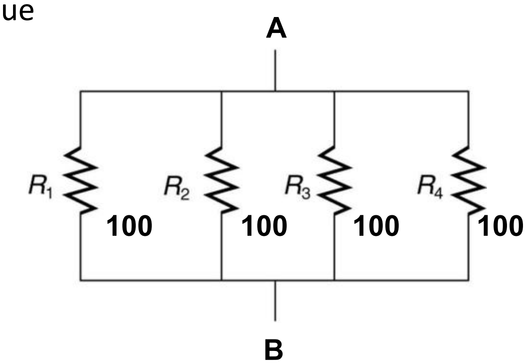
Resistors in Parallel - Tip

- If you have several identical resistors in parallel, the total resistance is the value of one divided by the number of resistors.
- In this example, the total resistance equals 100 Ohms/4, or 25 Ohms.



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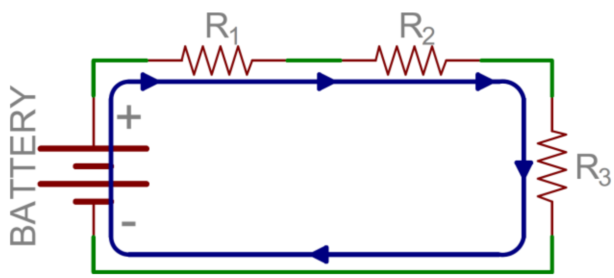
Current in a Series Circuit

- The current through each resistor in a Series Circuit is identical.



$$I_{Total} = I_{R1} = I_{R2} = I_{R3}$$

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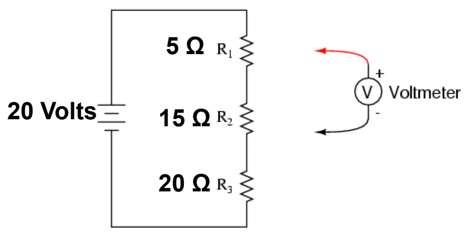
Voltage in Series Circuits

- The sum of all the voltages across each resistor in a Series Circuit will equal the source voltage.



$$E_{source} = E_{R1} + E_{R2} + E_{R3}$$

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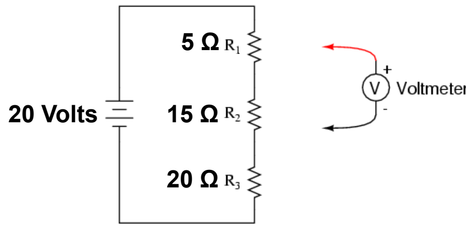
Voltage drop is the decrease of electrical potential along the path of a current flowing in an electrical circuit. Voltage drops in the internal resistance of the source, across conductors, across contacts, and across connectors are undesirable because some of the energy supplied is dissipated. The voltage drop across the electrical load is proportional to the power available to be converted in that load to some other useful form of energy.

Voltage drop is the loss of voltage caused by the flow of current flow through a resistance. The greater the resistance the greater the VD. To check the VD, use a voltmeter connected between the point where the VD is to be measured. In DC circuits and AC resistive circuits the total of all the voltage drops across series-connected loads should add up to the voltage applied to the circuit

To Calculate Voltage Drop…



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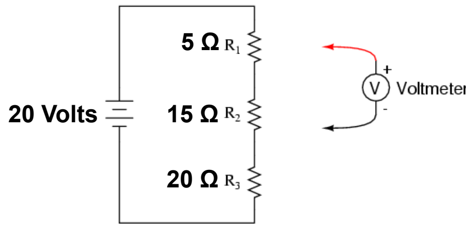
1. Determine Total Resistance



$R_{Total} = R_1 + R_2 + R_3$

$R_{Total} =$

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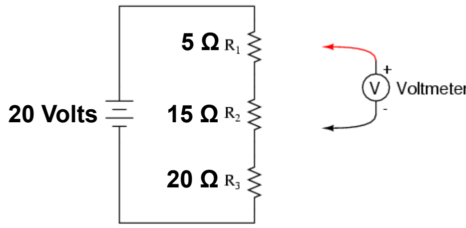
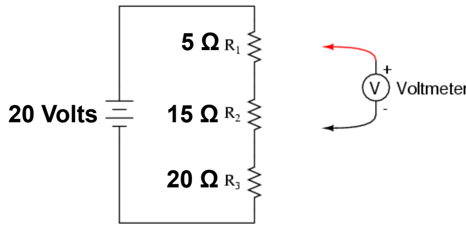
1. Determine Total Resistance



$R_{Total} = R_1 + R_2 + R_3$
$R_{Total} = 5\ \Omega + 15\ \Omega + 20\ \Omega$
$R_{Total} = 40\ \Omega$

2. Determine Current



$R_{Total} = R_1 + R_2 + R_3$
$R_{Total} = 5\ \Omega + 15\ \Omega + 20\ \Omega$
$R_{Total} = 40\ \Omega$

$I = E / R$
$I =$

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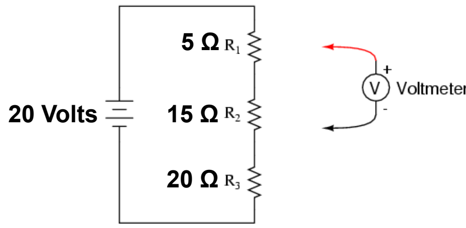
2. Determine Current



$R_{Total} = R_1 + R_2 + R_3$

$R_{Total} = 5\ \Omega + 15\ \Omega + 20\ \Omega$

$R_{Total} = 40\ \Omega$

I = E / R

I = 20 Volts / 40 Ohms

I = 0.5 Amps

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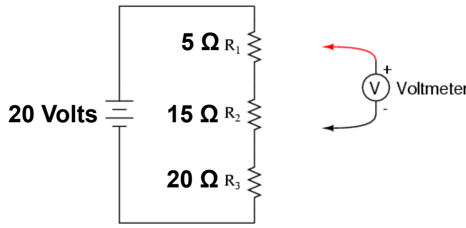
3. Determine Voltage Drops



$R_{Total} = R_1 + R_2 + R_3$
$R_{Total} = 5\ \Omega + 15\ \Omega + 20\ \Omega$
$R_{Total} = 40\ \Omega$

I = E / R
I = 20 Volts / 40 Ohms
I = 0.5 Amps

$E_{R1} = I \times R_1$
$E_{R1} =$

$E_{R2} = I \times R_2$
$E_{R2} =$

$E_{R3} = I \times R_3$
$E_{R3} =$

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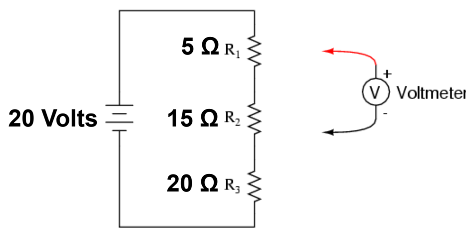
3. Determine Voltage Drops



$R_{Total} = R_1 + R_2 + R_3$
$R_{Total} = 5\ \Omega + 15\ \Omega + 20\ \Omega$
$R_{Total} = 40\ \Omega$

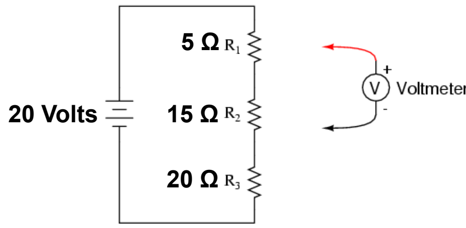
I = E / R
I = 20 Volts / 40 Ohms
I = 0.5 Amps

$E_{R1} = I \times R_1$
$E_{R1} = 0.5$ Amps x 5 Ω
$E_{R1} = 2.5$ Volts

$E_{R2} = I \times R_2$
$E_{R2} = 0.5$ Amps x 15 Ω
$E_{R2} = 7.5$ Volts

$E_{R3} = I \times R_3$
$E_{R3} = 0.5$ Amps x 20 Ω
$E_{R3} = 10$ Volts

4. Check Your Results!



$R_{Total} = R_1 + R_2 + R_3$
$R_{Total} = 5\ \Omega + 15\ \Omega + 20\ \Omega$
$R_{Total} = 40\ \Omega$

I = E / R
I = 20 Volts / 40 Ohms
I = 0.5 Amps

$E_{R1} = I \times R_1$
$E_{R1} = 0.5$ Amps x 5 Ω
$E_{R1} = 2.5$ Volts

$E_{R2} = I \times R_2$
$E_{R2} = 0.5$ Amps x 15 Ω
$E_{R2} = 7.5$ Volts

$E_{R3} = I \times R_3$
$E_{R3} = 0.5$ Amps x 20 Ω
$E_{R3} = 10$ Volts

$$E_{source} = E_{R1} + E_{R2} + E_{R3}$$
$$E_{source} = 2.5V + 7.5V + 10V = 20V$$

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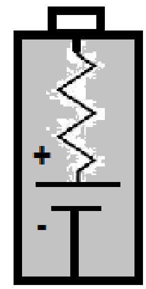
Battery Internal Resistance

- **Materials** that make up batteries (plates and electrolyte) have **resistance**.
- When used with a low-resistance load (and therefore high-current), the **battery's internal resistance** becomes a **significant part of the load**.
- The voltage drop across the battery's internal resistance means that **less voltage** is delivered to the **load**.
- This is why there is a difference in voltages between a battery in an open circuit, and the same one connected to a load.



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All batteries have some internal resistance to some degree.

Batteries have internal resistance because the elements that make it up aren't perfect conductors. The electrodes and electrolytes aren't 100% conductive. So they will have some resistance (internal resistance) in them.

Ideally, a battery should have 0Ω internal resistance. So during battery operation, all the voltage will be dropped across the element that the battery is powering instead of the battery dropping voltage across itself. According to voltage division, voltage drops across the element with the higher impedance. Ohm's law tells you this in V=IR, showing the higher the resistance, the greater the voltage drop. So if a battery has 0Ω of resistance and it will power a device that has at least some impedance, this ensures, according to ohm's law, that the device will get the voltage and not the battery. This is the ideal case but it doesn't occur in real life.

Batteries will always have some resistance. Though the internal resistance may be or appear low, around 0.1Ω for an AA alkaline battery, and about 1Ω to 2Ω for a 9-volt alkaline battery, it can cause a noticeable drop in output voltage if a low-resistance load is attached to it.

This is understood when you take into account how voltage division works. Taking into account ohm's law, voltage is equal to current * resistance (v=ir). The larger the resistance is, the more voltage gets allocated to that component. If a component has a very large impedance, that component will get most of the voltage, which comes from the battery. However, if the component has a small impedance, say, a few ohms, the voltage output from the battery will not necessarily be received fully by the component. Voltage may be lost, because the battery's internal resistance may compete with that element and the battery will drop voltage across itself instead of the component. This is for small load impedances. Remember, voltage gets allocated according to impedance values. So the impedance of the output device and the battery will always be divided up between each other.

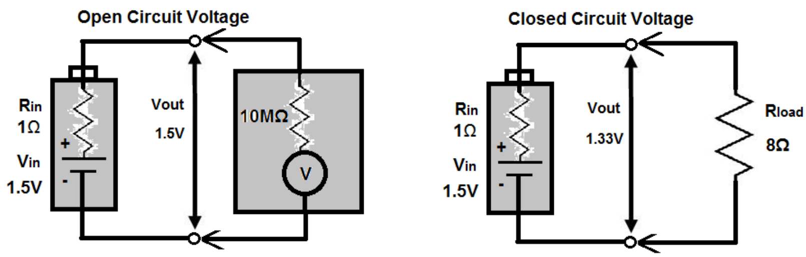
Without any load, we can measure the open-circuit voltage of the battery by placing a multimeter on the DC voltage setting to measure voltage. This voltage is essentially equal to the battery's rated nominal voltage- the voltmeter has such high input impedance that all of the voltage drops across it. Therefore, it's able to measure the voltage fully. Another way to consider it is that is has such high input impedance that it draws practically no current (v=ir), so there is no appreciable voltage drop.

However, if we attach a load to the battery, the output terminal voltage of the battery drops. By treating the internal resistance Rin and the load resistance Rload as a voltage divider, you can calculate the true output voltage presence across the load.

Batteries with large internal resistance show poor performance in supplying high current pulses. This is because current is decreased with higher resistance. Current equals voltage divided by resistance (i=v/r). So the higher the internal resistance, the lower the current output ability. Low internal resistance batteries are much better at supplying high current pulses.

Internal resistance also increases as the battery discharges. Therefore, a typical alkaline AA battery may start out with an internal resistance of 0.15Ω but may increase to 0.75Ω when 90 percent discharged.

Battery Internal Resistance



$I_T = E/R$
$I_T = 1.5V/9\Omega$
$I_T = 0.17$ A

Note: Voltmeters have a very high resistance, and so do not affect the circuits they are connected to.

Battery Voltage Drop
$E_{BD} = IR$
$E_{BD} = 0.17A \times 1\Omega$
$E_{BD} = 0.17$ V

Voltage at load is
1.5 – 0.17 = 1.33V

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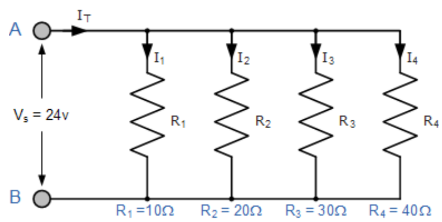
Voltage in Parallel Circuits

- The voltage applied to each resistor in a Parallel Circuit is the same as the source voltage.



$$E_{source} = E_{R1} = E_{R2} = E_{R3} = E_{R4}$$

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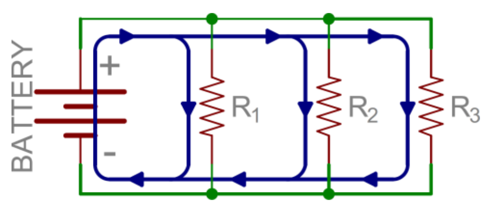
Current in a Parallel Circuit

- The total current in a Parallel Circuit is divided among the resistors.
- The sum of the currents through each resistor equals the total current.



$$I_{Total} = I_{R1} + I_{R2} + I_{R3}$$

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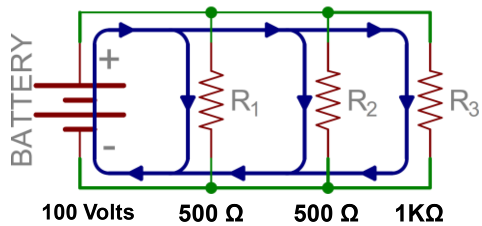
To Calculate Currents…



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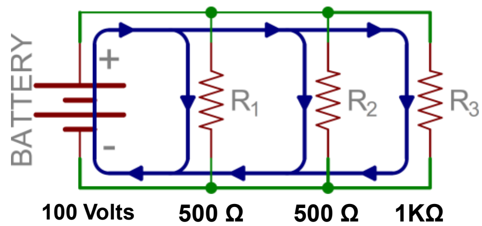
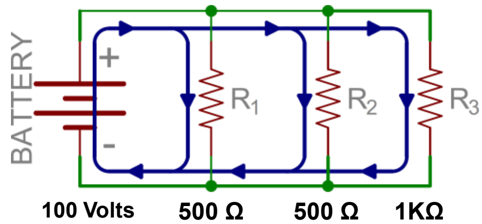
Determine Equivalent Resistance



$1/R_{Total}$ =

Determine Equivalent Resistance



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$

$1/R_{Total} = 1/500 + 1/500 + 1/1K$

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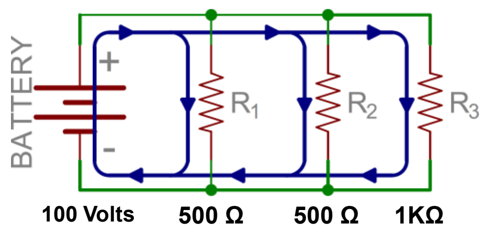
Determine Equivalent Resistance



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$
$1/R_{Total} = 1/500 + 1/500 + 1/1K$
$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$
$1/R_{Total} = 5/1000$

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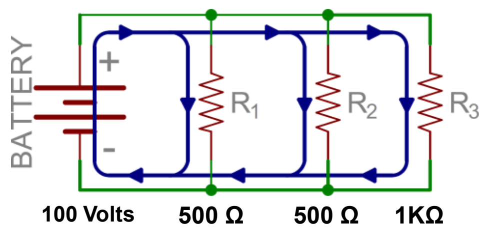
Determine Equivalent Resistance



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$

$1/R_{Total} = 1/500 + 1/500 + 1/1K$

$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$

$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

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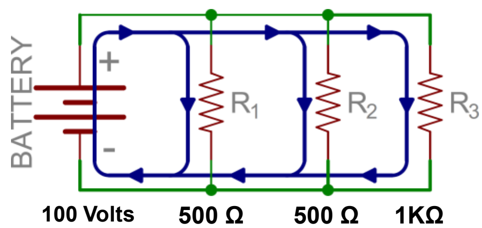
Determine Overall Current



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$
$1/R_{Total} = 1/500 + 1/500 + 1/1K$
$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$
$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

I =

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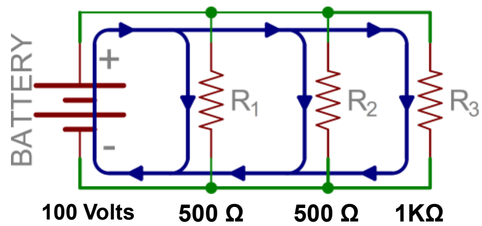
Determine Overall Current



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$

$1/R_{Total} = 1/500 + 1/500 + 1/1K$

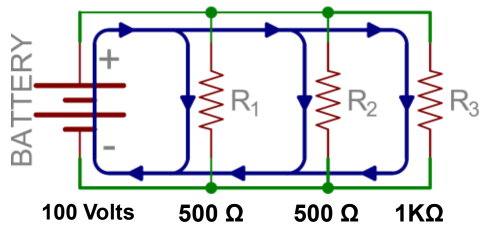
$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$

$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

$I = E / R$

Determine Overall Current



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$
$1/R_{Total} = 1/500 + 1/500 + 1/1K$
$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$
$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

I = E / R
I = 100 V / 200 Ω
I = 0.5 Amps

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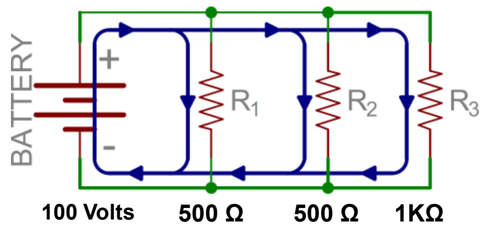
Determine Individual Currents



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$
$1/R_{Total} = 1/500 + 1/500 + 1/1K$
$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$
$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

$I = E / R$
$I = 100\ V / 200\ \Omega$
$I = 0.5$ Amps

$I_{R1} =$ $I_{R2} =$ $I_{R3} =$

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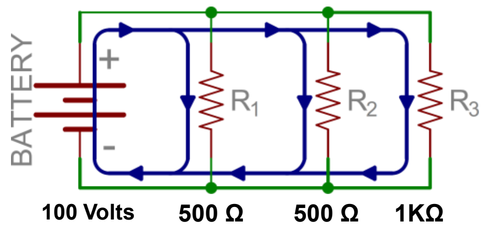
Determine Individual Currents



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$
$1/R_{Total} = 1/500 + 1/500 + 1/1K$
$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$
$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

$I = E / R$
$I = 100\ V / 200\ \Omega$
$I = 0.5$ Amps

$I_{R1} = E / R_1$ $I_{R2} = E / R_2$ $I_{R3} = E / R_3$

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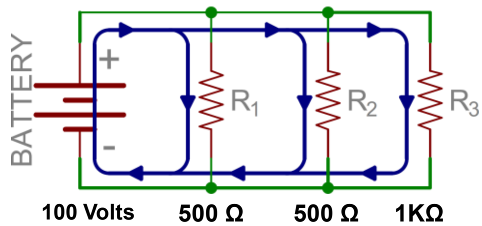
Determine Individual Currents



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$
$1/R_{Total} = 1/500 + 1/500 + 1/1K$
$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$
$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

I = E / R
I = 100 V / 200 Ω
I = 0.5 Amps

$I_{R1} = E / R_1$
$I_{R1} = 100\ V / 500\ \Omega$
$I_{R1} =$

$I_{R2} = E / R_2$
$I_{R2} = 100\ V / 500\ \Omega$
$I_{R2} =$

$I_{R3} = E / R_3$
$I_{R3} = 100\ V / 1000\ \Omega$
$I_{R3} =$

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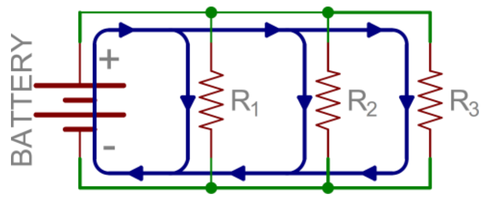
Determine Individual Currents



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$
$1/R_{Total} = 1/500 + 1/500 + 1/1K$
$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$
$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

$I = E / R$
$I = 100\ V / 200\ \Omega$
$I = 0.5$ Amps

$I_{R1} = E / R_1$
$I_{R1} = 100\ V / 500\ \Omega$
$I_{R1} = 0.2$ Amps

$I_{R2} = E / R_2$
$I_{R2} = 100\ V / 500\ \Omega$
$I_{R2} = 0.2$ Amps

$I_{R3} = E / R_3$
$I_{R3} = 100\ V / 1000\ \Omega$
$I_{R3} = 0.1$ Amps

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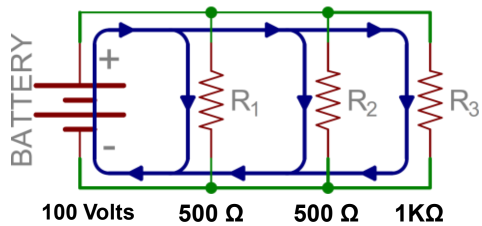
Check your Answer!



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$
$1/R_{Total} = 1/500 + 1/500 + 1/1K$
$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$
$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

$I = E / R$
$I = 100\ V / 200\ \Omega$
$I = 0.5$ Amps

$I_{R1} = E / R_1$
$I_{R1} = 100\ V / 500\ \Omega$
$I_{R1} = 0.2$ Amps

$I_{R2} = E / R_2$
$I_{R2} = 100\ V / 500\ \Omega$
$I_{R2} = 0.2$ Amps

$I_{R3} = E / R_3$
$I_{R3} = 100\ V / 1000\ \Omega$
$I_{R3} = 0.1$ Amps

$I_{Total} =$

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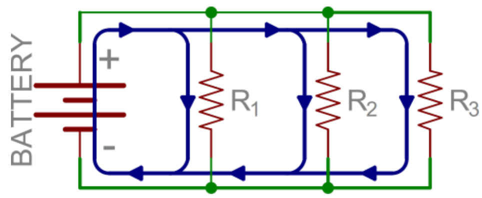
Check your Answer!



$1/R_{Total} = 1/R_1 + 1/R_2 + 1/R_3$
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$1/R_{Total} = 2/1000 + 2/1000 + 1/1000$
$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

$I = E / R$
$I = 100\ V / 200\ \Omega$
$I = 0.5$ Amps

$I_{R1} = E / R_1$
$I_{R1} = 100\ V / 500\ \Omega$
$I_{R1} = 0.2$ Amps

$I_{R2} = E / R_2$
$I_{R2} = 100\ V / 500\ \Omega$
$I_{R2} = 0.2$ Amps

$I_{R3} = E / R_3$
$I_{R3} = 100\ V / 1000\ \Omega$
$I_{R3} = 0.1$ Amps

$I_{Total} = I_{R1} + I_{R2} + I_{R3} =$

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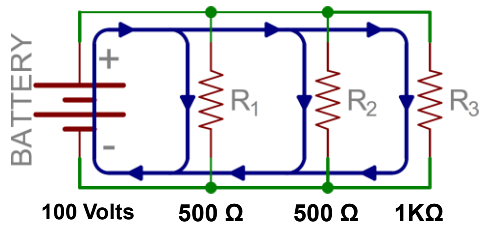
Check your Answer!



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$1/R_{Total} = 5/1000$

$R_{Total} = 1000/5 = 200\ \Omega$

$I = E / R$
$I = 100\ V / 200\ \Omega$
$I = 0.5$ Amps

$I_{R1} = E / R_1$
$I_{R1} = 100\ V / 500\ \Omega$
$I_{R1} = 0.2$ Amps

$I_{R2} = E / R_2$
$I_{R2} = 100\ V / 500\ \Omega$
$I_{R2} = 0.2$ Amps

$I_{R3} = E / R_3$
$I_{R3} = 100\ V / 1000\ \Omega$
$I_{R3} = 0.1$ Amps

$I_{Total} = I_{R1} + I_{R2} + I_{R3} = 0.2 + 0.2 + 0.1 = 0.5$ Amp

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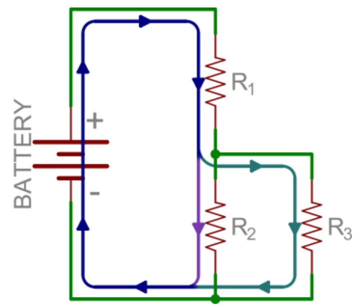
Series Parallel Combinations



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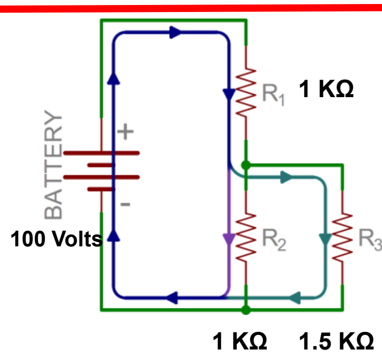
Series Parallel Combinations



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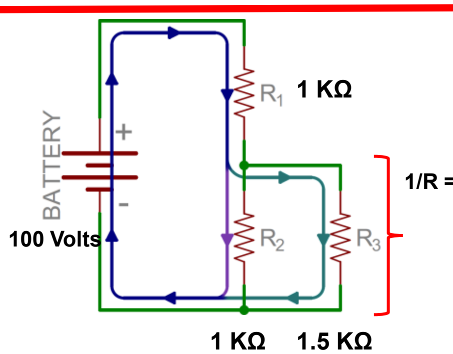
Series Parallel Combinations



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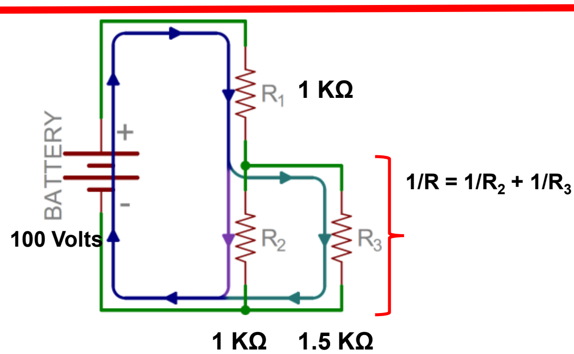
Series Parallel Combinations



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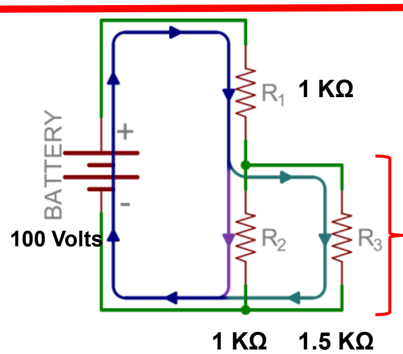
Series Parallel Combinations



$1/R = 1/R_2 + 1/R_3$

$1/R = 1/1\ K + 1/1.5\ K$

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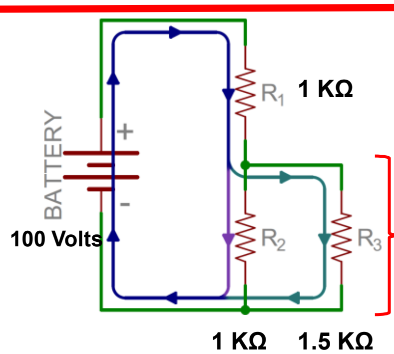
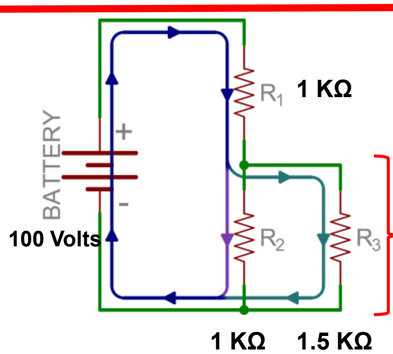
Series Parallel Combinations



$1/R = 1/R_2 + 1/R_3$
$1/R = 1/1\ K + 1/1.5\ K$
$1/R = 3/3\ K + 2/3\ K$
$1/R = 5/3\ K$

Al Penney
VO1NO

Series Parallel Combinations



$1/R = 1/R_2 + 1/R_3$
$1/R = 1/1\ K + 1/1.5\ K$
$1/R = 3/3\ K + 2/3\ K$
$1/R = 5/3\ K$

$R = 3000/5 = 600\ \Omega$

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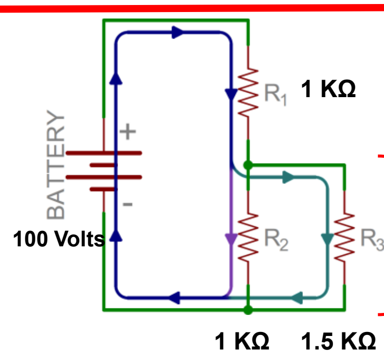
VO1NO

Series Parallel Combinations



$1/R = 1/R_2 + 1/R_3$
$1/R = 1/1\ K + 1/1.5\ K$
$1/R = 3/3\ K + 2/3\ K$
$1/R = 5/3\ K$

$R = 3000/5 = 600\ \Omega$

$R_{Total} =$

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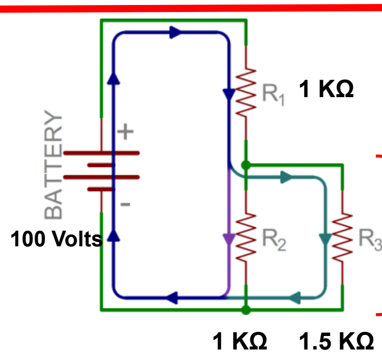
Series Parallel Combinations



$1/R = 1/R_2 + 1/R_3$
$1/R = 1/1\ K + 1/1.5\ K$
$1/R = 3/3\ K + 2/3\ K$
$1/R = 5/3\ K$

$R = 3000/5 = 600\ \Omega$

$R_{Total} = 1\ K\Omega + 600\ \Omega$

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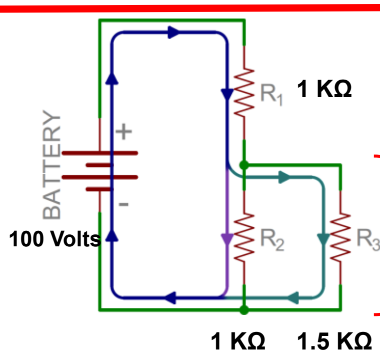
Series Parallel Combinations



$1/R = 1/R_2 + 1/R_3$
$1/R = 1/1\ K + 1/1.5\ K$
$1/R = 3/3\ K + 2/3\ K$
$1/R = 5/3\ K$

$R = 3000/5 = 600\ \Omega$

$R_{Total} = 1\ K\Omega + 600\ \Omega$
$R_{Total} = 1600\ \Omega$

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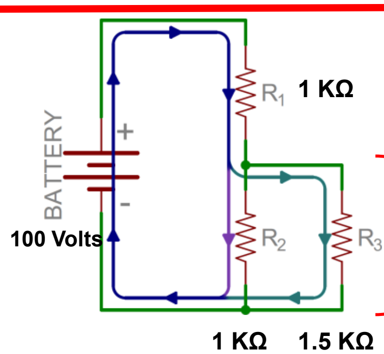
Series Parallel Combinations



$1/R = 1/R_2 + 1/R_3$
$1/R = 1/1\ K + 1/1.5\ K$
$1/R = 3/3\ K + 2/3\ K$
$1/R = 5/3\ K$

$R = 3000/5 = 600\ \Omega$

$R_{Total} = 1\ K\Omega + 600\ \Omega$
$R_{Total} = 1600\ \Omega$
$R_{Total} = 1.6\ K\Omega$

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Energy and Power

- **Energy** is the ability to do work.
- Some common types include **Kinetic** and **Potential.**
- A cell has Potential Energy – it stores chemical energy that can be released to do work.
- When electrons move against a resistance, work is done.
- The **rate** at which work is done is called **Power**.

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An important aspect of any electrical or electronic circuit is the power associated with it. It is found that when a current flows through a resistor, electrical energy is converted into heat. This fact is used by electrical heaters which consist of a resistor through which current flows. Light bulbs use the same principle, heating the element up so that it glows white hot and produces light. At other times much smaller resistors and very much smaller currents are used. Here the amount of heat generated may be very small. However if some current flows then some heat is generated. In this instance the heat generated represents the amount of electrical power being dissipated.

Definition of power

Whether power is used in a mechanical environment or an electrical environment, the definition of power is still the same. The way in which it may be discussed may be slightly different, but nevertheless the definition and actuality of it is exactly the same.

Electric power definition:

Electric power is the rate, per unit time, at which electrical energy is transferred by an electric circuit. It is the rate of doing work.

In physics, **energy** is the quantitative property that must be transferred to an object in order to perform work on, or to heat, the object. Energy is a conserved quantity; the law of conservation of energy states that energy can be converted in form, but not created or destroyed. The SI unit of energy is the joule, which is the energy transferred to an object by the work of moving it a distance of 1 metre against a force of 1 newton.

Common forms of energy include the kinetic energy of a moving object, the potential energy stored by an object's position in a force field (gravitational, electric or magnetic), the elastic energy stored by stretching solid objects, the chemical energy released when a fuel burns, the radiant energy carried by light, and the thermal energy due to an object's temperature.

Gravitational potential energy=mgh mass x 9.8 m/sec^2 x height

What is the potential energy formula? The most common type of potential energy (U) is gravitational potential energy, which is calculated based on the mass of the object (m), the gravitational acceleration constant (g), and the height above the ground (h). The potential energy formula is U=mgh.

Kinetic energy = ½ mass x velocity^2

Power

- Basic unit of Power is the **Watt**, abbreviated W.
- In electrical systems, we can calculate power if we know any two of
  - Voltage;
  - Current; or
  - Resistance.

$P = I \times E = E^2 / R = I^2 \times R$

(Mnemonic PIE)

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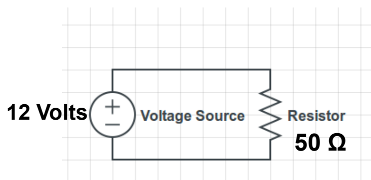
Definition of the watt:
The watt is the SI unit of power defining the rate of energy conversion and it is equivalent to one joule per second.
The watt can be defined according to the application:
•***Electrical definition of the watt:*** one watt is the rate at which work is done when a current of one ampere, I of current flows through a network which has an electrical potential difference of one volt, V. W = V I

The **joule** (symbol: **J**) is a derived unit of energy in the International System of Units. It is equal to the energy transferred to (or work done on) an object when a force of one newton acts on that object in the direction of the force's motion through a distance of one metre (1 newton metre or N·m). It is also the energy dissipated as heat when an electric current of one ampere passes through a resistance of one ohm for one second. It is named after the English physicist James Prescott Joule (1818–1889)

Calculating Power #1



$$P = E \times I = E^2 / R = I^2 \times R$$

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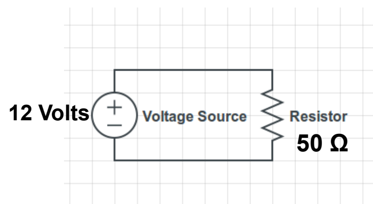
Calculating Power #1



$P = E \times I = E^2 / R = I^2 \times R$

$P = E^2 / R$

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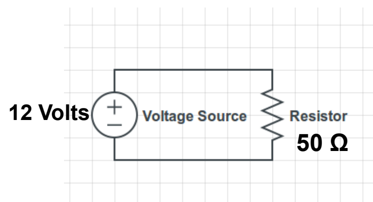
Calculating Power #1



$P = E \times I = E^2 / R = I^2 \times R$
$P = E^2 / R$
$P = 12^2 / 50$
$P = 144 / 50$
$P = 2.88$ Watts

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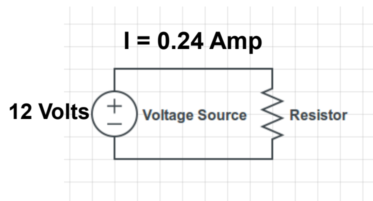
Calculating Power #2



$P = E \times I = E^2 / R = I^2 \times R$

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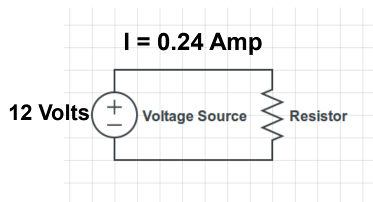
Calculating Power #2



P = E x I = E^2 / R = I^2 x R
P = E x I

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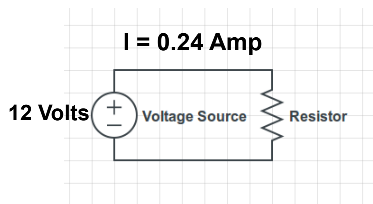
Calculating Power #2



$P = E \times I = E^2 / R = I^2 \times R$

$P = E \times I$

$P = 12 \times 0.24$

P = 2.88 Watts

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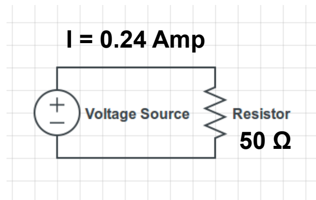
Calculating Power #3



$P = E \times I = E^2 / R = I^2 \times R$

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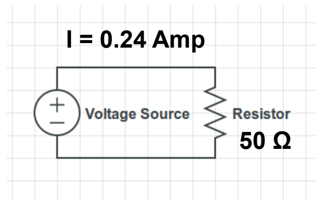
VO1NO

Calculating Power #3



$P = E \times I = E^2 / R = I^2 \times R$

$P = I^2 \times R$

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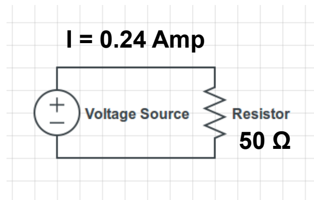
VO1NO

Calculating Power #3



$P = E \times I = E^2 / R = I^2 \times R$

$P = I^2 \times R$

$P = 0.24^2 \times 50$

$P = 0.0576 \times 50$

P = 2.88 Watts

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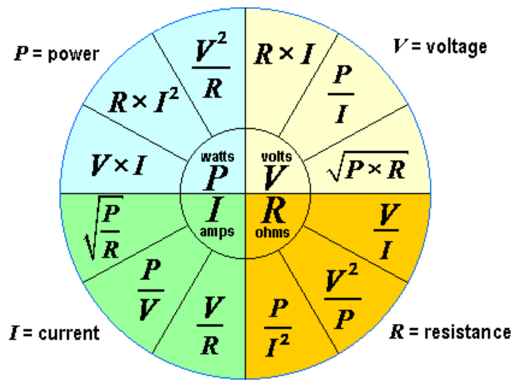
Circuit Calculator



Remember the Units – Ohms, Volts, Amps, Watts!!

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Power and Resistors

- Resistors rated not just by resistance, but also **amount of heat (power)** they can **safely dissipate.**
- Measured in **Watts**.
- In general, bigger resistors can dissipate more heat than smaller resistors.
- Use 50% to 100% safety margin in selecting components.

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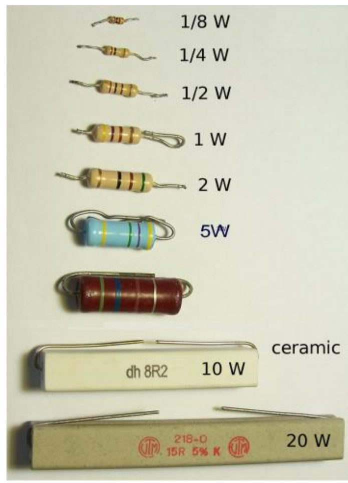
Power and Resistors



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Power Ratings in Circuits

- **Series Circuits**
  - Same current through all resistors.
  - Calculate power dissipated by each separately (**Power = I^2 x R**).
  - Lowest wattage component sets max rating of the overall circuit.

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Power Ratings in Circuits

- **Parallel Circuits**
  - Same voltage applied to all resistors.
  - Calculate power dissipated by each separately **(Power = E^2 / R).**
  - Do not exceed current and power ratings of any resistor in the group.
  - For greater heat dissipation, replace a single resistor with two resistors of twice the resistance (assuming same wattage).

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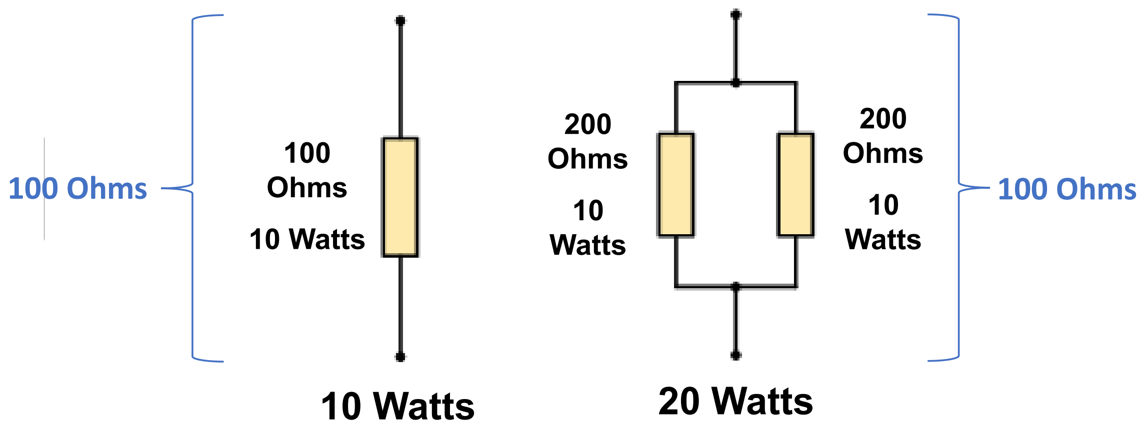
Heat – Parallel Resistors



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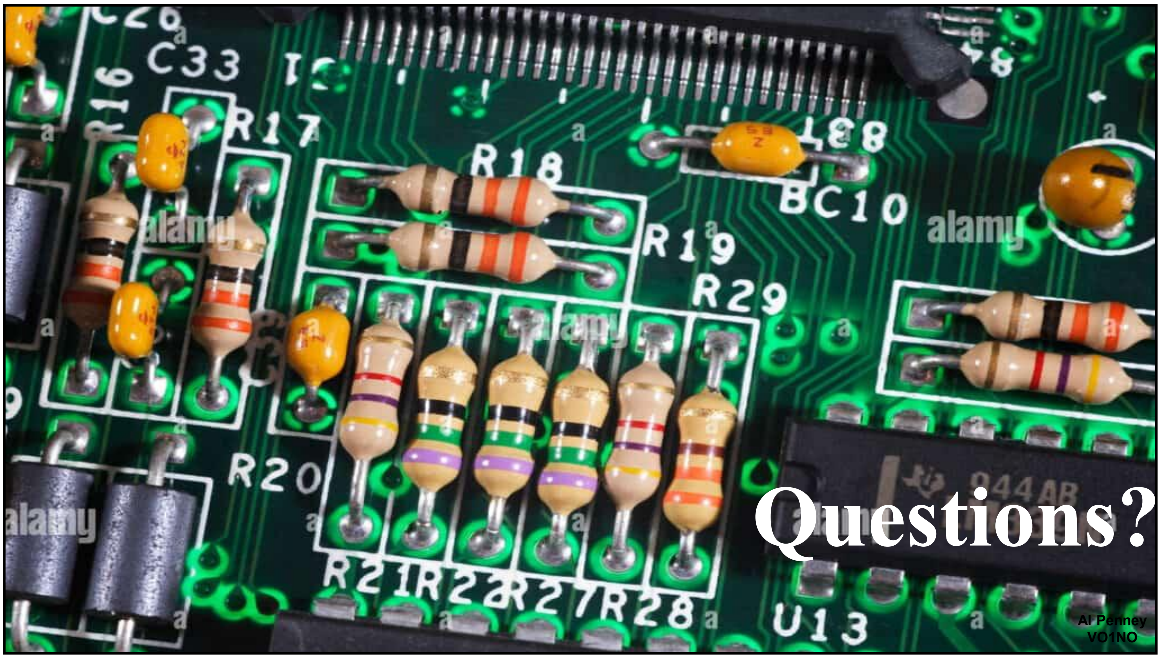
Questions?
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Review Question 1

The voltage at a battery's terminals will drop when it supplies current. What is the cause of the drop?

- A Voltage capacity
- B Internal resistance
- C Electrolyte becoming dry
- D Current capacity

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B

Review Question 1

The voltage at a battery's terminals will drop when it supplies current. What is the cause of the drop?

- A Voltage capacity
- B Internal resistance
- C Electrolyte becoming dry
- D Current capacity

- B Internal resistance

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B

Review Question 2

Why are heavy-gauge wires used for a 100watt transceiver's DC power connection?

- A To minimize the voltage drop
- B To prevent an electrical shock
- C To avoid RF interference
- D To minimize ripple

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A

Review Question 2

Why are heavy-gauge wires used for a 100watt transceiver's DC power connection?

- A To minimize the voltage drop
- B To prevent an electrical shock
- C To avoid RF interference
- D To minimize ripple

- A To minimize the voltage drop

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A

Review Question 3

What is a voltage drop?

- A The difference in voltage at the output terminals of a transformer
- B The voltage output of a step-down transformer
- C The loss of voltage caused by the flow of current through a circuit
- D Any point in a circuit that has zero voltage

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C

Review Question 3

What is a voltage drop?

- A The difference in voltage at the output terminals of a transformer
- B The voltage output of a step-down transformer
- C The loss of voltage caused by the flow of current through a circuit
- D Any point in a circuit that has zero voltage

- C The loss of voltage caused by the flow of current through a circuit

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C

Review Question 4

What term describes the rate at which electrical energy is used?

- A Current
- B Voltage
- C Resistance
- D Power

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D

Review Question 4

What term describes the rate at which electrical energy is used?

- A Current
- B Voltage
- C Resistance
- D Power

- D Power

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D

Review Question 5

If you have light bulbs marked 40 watts, 50 watts, 60 watts and 100 watts, which one will consume electrical energy at the highest rate?

- A The 40-watt bulb
- B The 100-watt bulb
- C The 60-watt bulb
- D The 50-watt bulb

Al Penney
VO1NO

B

Review Question 5

If you have light bulbs marked 40 watts, 50 watts, 60 watts and 100 watts, which one will consume electrical energy at the highest rate?

- A The 40-watt bulb
- B The 100-watt bulb
- C The 60-watt bulb
- D The 50-watt bulb

- B The 100-watt bulb

Al Penney
VO1NO

B

Review Question 6

What is the basic unit of electrical power?

- A The watt
- B The ampere
- C The volt
- D The ohm

Al Penney
VO1NO

A

Review Question 6

What is the basic unit of electrical power?

- A The watt
- B The ampere
- C The volt
- D The ohm

- A The watt

Al Penney
VO1NO

A

Review Question 7

Which of the following two quantities should be multiplied together to find power?

- A Resistance and capacitance
- B Voltage and current
- C Inductance and capacitance
- D Voltage and inductance

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VO1NO

B

Review Question 7

Which of the following two quantities should be multiplied together to find power?

- A Resistance and capacitance
- B Voltage and current
- C Inductance and capacitance
- D Voltage and inductance

- B Voltage and current

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B

Review Question 8

A resistor in a circuit becomes very hot and starts to burn. This is because the resistor is dissipating too much:

- A voltage
- B resistance
- C current
- D power

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VO1NO

D

Review Question 8

A resistor in a circuit becomes very hot and starts to burn. This is because the resistor is dissipating too much:

- A voltage
- B resistance
- C current
- D power

- D power

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D

Review Question 9

What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?

- A 1.0 volts
- B 0.25 volts
- C 2.5 volts
- D 1.5 volts

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VO1NO

A

Review Question 9

What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?

- A 1.0 volts
- B 0.25 volts
- C 2.5 volts
- D 1.5 volts

- A 1.0 volts

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VO1NO

A

Review Question 10

How is the current in a DC circuit calculated when the voltage and resistance are known?

- A Current equals voltage divided by resistance
- B Current equals resistance multiplied by voltage
- C Current equals resistance divided by voltage
- D Current equals power divided by voltage

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VO1NO

A

Review Question 10

How is the current in a DC circuit calculated when the voltage and resistance are known?

- A Current equals voltage divided by resistance
- B Current equals resistance multiplied by voltage
- C Current equals resistance divided by voltage
- D Current equals power divided by voltage

- A Current equals voltage divided by resistance

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VO1NO

A

Review Question 11

How is the resistance in a DC circuit calculated when the voltage and current are known?

- A Resistance equals power divided by voltage
- B Resistance equals current divided by voltage
- C Resistance equals voltage divided by current
- D Resistance equals current multiplied by voltage

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VO1NO

C

Review Question 11

How is the resistance in a DC circuit calculated when the voltage and current are known?

- A Resistance equals power divided by voltage
- B Resistance equals current divided by voltage
- C Resistance equals voltage divided by current
- D Resistance equals current multiplied by voltage

- C Resistance equals voltage divided by current

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C

Review Question 12

How is the voltage in a DC circuit calculated when the current and resistance are known?

- A Voltage equals resistance divided by current
- B Voltage equals power divided by current
- C Voltage equals current multiplied by resistance
- D Voltage equals current divided by resistance

Al Penney
VO1NO

C

Review Question 12

How is the voltage in a DC circuit calculated when the current and resistance are known?

- A Voltage equals resistance divided by current
- B Voltage equals power divided by current
- C Voltage equals current multiplied by resistance
- D Voltage equals current divided by resistance

- C Voltage equals current multiplied by resistance

Al Penney
VO1NO

C

Review Question 13

What is the resistance of a circuit that draws 0.25 amperes from a 12-volt source?

- A 3 ohms
- B 12 ohms
- C 0.25 ohms
- D 48 ohms

Al Penney
VO1NO

D

Review Question 13

What is the resistance of a circuit that draws 0.25 amperes from a 12-volt source?

- A 3 ohms
- B 12 ohms
- C 0.25 ohms
- D 48 ohms

- D 48 ohms

Al Penney
VO1NO

D

Review Question 14

What value of resistance is required to drop 9 volts with a current of 10 milliamperes?

- A 900 ohms
- B 90 ohms
- C 9 ohms
- D 9000 ohms

Al Penney
VO1NO

A

Review Question 14

What value of resistance is required to drop 9 volts with a current of 10 milliamperes?

- A 900 ohms
- B 90 ohms
- C 9 ohms
- D 9000 ohms

- A 900 ohms

Al Penney
VO1NO

A

Review Question 15

If the current flowing through a 50-ohm resistor is 0.44 amperes, what voltage would you measure across the resistor?

- A 0.22 volts
- B 22 volts
- C 222 volts
- D 2.2 volts

Al Penney
VO1NO

B

Review Question 15

If the current flowing through a 50-ohm resistor is 0.44 amperes, what voltage would you measure across the resistor?

- A 0.22 volts
- B 22 volts
- C 222 volts
- D 2.2 volts

- B 22 volts

Al Penney
VO1NO

B

Review Question 16

A 30-ohm resistor is connected across a 6volt battery. What current does it draw?

- A 2 amperes
- B 0.5 amperes
- C 0.005 amperes
- D 0.2 amperes

Al Penney
VO1NO

D

Review Question 16

A 30-ohm resistor is connected across a 6volt battery. What current does it draw?

- A 2 amperes
- B 0.5 amperes
- C 0.005 amperes
- D 0.2 amperes

- D 0.2 amperes

Al Penney
VO1NO

D

Review Question 17

What voltage is needed to supply a current of 200 milliamperes to operate a relay that has a resistance of 25 ohms?

- A 0.5 volts
- B 50 volts
- C 5 volts
- D 8 volts

Al Penney
VO1NO

C

Review Question 17

What voltage is needed to supply a current of 200 milliamperes to operate a relay that has a resistance of 25 ohms?

- A 0.5 volts
- B 50 volts
- C 5 volts
- D 8 volts

- C 5 volts

Al Penney
VO1NO

C

Review Question 18

What is the resistance of a circuit if it draws 300 milliamperes from a 3-volt battery?

- A 5 ohms
- B 3 ohms
- C 10 ohms
- D 9 ohms

Al Penney
VO1NO

C

Review Question 18

What is the resistance of a circuit if it draws 300 milliamperes from a 3-volt battery?

- A 5 ohms
- B 3 ohms
- C 10 ohms
- D 9 ohms

- C 10 ohms

Al Penney
VO1NO

C

Review Question 19

In a parallel circuit with a voltage source and several branch resistors, how is the total current related to the current in the branch resistors?

- A It is the sum of each resistor's voltage drop multiplied by the total number of resistors
- B It equals the sum of the branch current through each resistor
- C It equals the average of the branch current through each resistor
- D It decreases as more parallel resistors are added to the circuit

Al Penney
VO1NO

B

Review Question 19

In a parallel circuit with a voltage source and several branch resistors, how is the total current related to the current in the branch resistors?

- A It is the sum of each resistor's voltage drop multiplied by the total number of resistors
- B It equals the sum of the branch current through each resistor
- C It equals the average of the branch current through each resistor
- D It decreases as more parallel resistors are added to the circuit

- B It equals the sum of the branch current through each resistor

Al Penney
VO1NO

B

Review Question 20

You connect four 100-ohm resistors in parallel across a 12-volt battery. How many milliamperes of current are drawn from the battery?

- A 120 mA
- B 240 mA
- C 480 mA
- D 48 mA

Al Penney
VO1NO

C

Review Question 20

You connect four 100-ohm resistors in parallel across a 12-volt battery. How many milliamperes of current are drawn from the battery?

- A 120 mA
- B 240 mA
- C 480 mA
- D 48 mA

- C 480 mA

Al Penney
VO1NO

C

Review Question 21

Several resistors of various values are connected in parallel. How does the total resistance of the combination compare to the individual resistors?

- A It is greater than the largest resistor
- B It equals the average of the resistors
- C It equals the square root of the sum of the resistors
- D It is less than the smallest resistor

Al Penney
VO1NO

D

Review Question 21

Several resistors of various values are connected in parallel. How does the total resistance of the combination compare to the individual resistors?

- A It is greater than the largest resistor
- B It equals the average of the resistors
- C It equals the square root of the sum of the resistors
- D It is less than the smallest resistor

- D It is less than the smallest resistor

Al Penney
VO1NO

D

Review Question 22

Two 1000-ohm resistors are connected in parallel across a 12-volt battery. What is the total current?

- A 60 milliamperes
- B 120 milliamperes
- C 24 milliamperes
- D 12 milliamperes

Al Penney
VO1NO

C

Review Question 22

Two 1000-ohm resistors are connected in parallel across a 12-volt battery. What is the total current?

- A 60 milliamperes
- B 120 milliamperes
- C 24 milliamperes
- D 12 milliamperes

- C 24 milliamperes

Al Penney
VO1NO

C

Review Question 23

The total resistance of resistors connected in series is:

- A greater than the resistance of any one resistor
- B less than the resistance of any one resistor
- C equal to the highest resistance present
- D equal to the lowest resistance present

Al Penney
VO1NO

A

Review Question 23

The total resistance of resistors connected in series is:

- A greater than the resistance of any one resistor
- B less than the resistance of any one resistor
- C equal to the highest resistance present
- D equal to the lowest resistance present

- A greater than the resistance of any one resistor

Al Penney
VO1NO

A

Review Question 24

What is the total resistance of five 10-ohm resistors in series?

- A 2 ohms
- B 50 ohms
- C 5 ohms
- D 10 ohms

Al Penney
VO1NO

B

Review Question 24

What is the total resistance of five 10-ohm resistors in series?

- A 2 ohms
- B 50 ohms
- C 5 ohms
- D 10 ohms

- B 50 ohms

Al Penney
VO1NO

B

Review Question 25

Which of these series combination of resistors would replace a single 120-ohm resistor?

- A Five 24-ohm resistors
- B Six 22-ohm resistors
- C Two 240-ohm resistors
- D Five 100-ohm resistors

Al Penney
VO1NO

A

Review Question 25

Which of these series combination of resistors would replace a single 120-ohm resistor?

- A Five 24-ohm resistors
- B Six 22-ohm resistors
- C Two 240-ohm resistors
- D Five 100-ohm resistors

- A Five 24-ohm resistors

Al Penney
VO1NO

A

Review Question 26

If ten resistors of equal value "R" are wired in parallel, what formula yields the total resistance?

- A 10 / R
- B 10 x R
- C 10 + R
- D R / 10

Al Penney
VO1NO

D

Review Question 26

If ten resistors of equal value "R" are wired in parallel, what formula yields the total resistance?

- A 10 / R
- B 10 x R
- C 10 + R
- D R / 10

- D R / 10

Al Penney
VO1NO

D

Review Question 27

What is the total resistance of four 68-ohm resistors wired in parallel?

- A 272 ohms
- B 17 ohms
- C 12 ohms
- D 34 ohms

Al Penney
VO1NO

B

Review Question 27

What is the total resistance of four 68-ohm resistors wired in parallel?

- A 272 ohms
- B 17 ohms
- C 12 ohms
- D 34 ohms

- B 17 ohms

Al Penney
VO1NO

B

Review Question 28

Two resistors are in parallel. Resistor "A" carries twice the current of resistor "B," which means that:

- A the voltage across "A" is twice that across "B"
- B "B" has half the resistance of "A"
- C "A" has half the resistance of "B"
- D the voltage across "B" is twice that across "A"

Al Penney
VO1NO

C

Review Question 28

Two resistors are in parallel. Resistor "A" carries twice the current of resistor "B," which means that:

- A the voltage across "A" is twice that across "B"
- B "B" has half the resistance of "A"
- C "A" has half the resistance of "B"
- D the voltage across "B" is twice that across "A"

- C "A" has half the resistance of "B"

Al Penney
VO1NO

C

Review Question 29

The total current in a parallel circuit is equal to the:

- A sum of the currents through all the parallel branches
- B source voltage divided by the value of one of the resistive elements
- C source voltage divided by the sum of the resistive elements
- D current in any one of the parallel branches

Al Penney
VO1NO

A

Review Question 29

The total current in a parallel circuit is equal to the:

- A sum of the currents through all the parallel branches
- B source voltage divided by the value of one of the resistive elements
- C source voltage divided by the sum of the resistive elements
- D current in any one of the parallel branches

- A sum of the currents through all the parallel branches

Al Penney
VO1NO

A

Review Question 30

Why would a large size resistor be used instead of a smaller one of the same resistance?

- A For higher conductance
- B For less impedance in the circuit
- C For greater power dissipation
- D For better response time

Al Penney
VO1NO

C

Review Question 30

Why would a large size resistor be used instead of a smaller one of the same resistance?

- A For higher conductance
- B For less impedance in the circuit
- C For greater power dissipation
- D For better response time

- C For greater power dissipation

Al Penney
VO1NO

C

Review Question 31

What is the DC input power of a transmitter operating at 12 volts and drawing 500 milliamperes?

- A 600 watts
- B 6 watts
- C 24 watts
- D 60 watts

Al Penney
VO1NO

B

Review Question 31

What is the DC input power of a transmitter operating at 12 volts and drawing 500 milliamperes?

- A 600 watts
- B 6 watts
- C 24 watts
- D 60 watts

- B 6 watts

Al Penney
VO1NO

B

Review Question 32

When two 500-ohm 1-watt resistors are connected in series, the maximum total power that can be dissipated by the resistors is:

- A 4 watts
- B 2 watts
- C 1 watt
- D 0.5 watts

Al Penney
VO1NO

B

Review Question 32

When two 500-ohm 1-watt resistors are connected in series, the maximum total power that can be dissipated by the resistors is:

- A 4 watts
- B 2 watts
- C 1 watt
- D 0.5 watts

- B 2 watts

Al Penney
VO1NO

B

Review Question 33

When two 500-ohm 1-watt resistors are connected in parallel, they can dissipate a maximum total power of:

- A 0.5 watts
- B 1 watt
- C 4 watts
- D 2 watts

Al Penney
VO1NO

D

Review Question 33

When two 500-ohm 1-watt resistors are connected in parallel, they can dissipate a maximum total power of:

- A 0.5 watts
- B 1 watt
- C 4 watts
- D 2 watts

- D 2 watts

Al Penney
VO1NO

D

Review Question 34

If the voltage applied to two resistors in series is doubled, how much will the total power change?

- A Double
- B Decrease to one quarter
- C Increase four times
- D Decrease to half

Al Penney
VO1NO

C

Review Question 34

If the voltage applied to two resistors in series is doubled, how much will the total power change?

- A Double
- B Decrease to one quarter
- C Increase four times
- D Decrease to half

- C Increase four times

Al Penney
VO1NO

C

Review Question 35

Which of these combinations of resistors could make up a 50-ohm dummy load capable of safely dissipating 5 watts?

- A Four 2-watt 200-ohm resistors in parallel
- B Two 5-watt 100-ohm resistors in series
- C Two 2-watt 25-ohm resistors in series
- D Ten quarter-watt 500-ohm resistors in parallel

Al Penney
VO1NO

A

Review Question 35

Which of these combinations of resistors could make up a 50-ohm dummy load capable of safely dissipating 5 watts?

- A Four 2-watt 200-ohm resistors in parallel
- B Two 5-watt 100-ohm resistors in series
- C Two 2-watt 25-ohm resistors in series
- D Ten quarter-watt 500-ohm resistors in parallel

- A Four 2-watt 200-ohm resistors in parallel

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A

Review Question 36

How much current is drawn by a 12-volt, 30-watt light bulb?

- A 18 amperes
- B 4.8 amperes
- C 0.4 amperes
- D 2.5 amperes

Al Penney
VO1NO

D

Review Question 36

How much current is drawn by a 12-volt, 30-watt light bulb?

- A 18 amperes
- B 4.8 amperes
- C 0.4 amperes
- D 2.5 amperes

- D 2.5 amperes

Al Penney
VO1NO

D

Review Question 37

What is the advantage of replacing a 50ohm resistor with a parallel combination of two 100-ohm resistors of the same power rating?

- A Lesser resistance and same power rating
- B Same resistance but greater power rating
- C Same resistance but lesser power rating
- D Greater resistance and same power rating

Al Penney
VO1NO

B

Review Question 37

What is the advantage of replacing a 50ohm resistor with a parallel combination of two 100-ohm resistors of the same power rating?

- A Lesser resistance and same power rating
- B Same resistance but greater power rating
- C Same resistance but lesser power rating
- D Greater resistance and same power rating

- B Same resistance but greater power rating

Al Penney
VO1NO

B

Review Question 38

Resistor wattage ratings are:

- A expressed in joules
- B variable in steps of one hundred
- C determined by heat dissipation qualities
- D calculated according to physical size and tolerance rating

Al Penney
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C

Review Question 38

Resistor wattage ratings are:

- A expressed in joules
- B variable in steps of one hundred
- C determined by heat dissipation qualities
- D calculated according to physical size and tolerance rating

- C determined by heat dissipation qualities

Al Penney
VO1NO

C

For Next Class:

- Review Chapter 3 of Basic Study Guide;
- Read Chapter 4 of Basic Study Guide; and
- Read RBR-4:
  - https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10650.html

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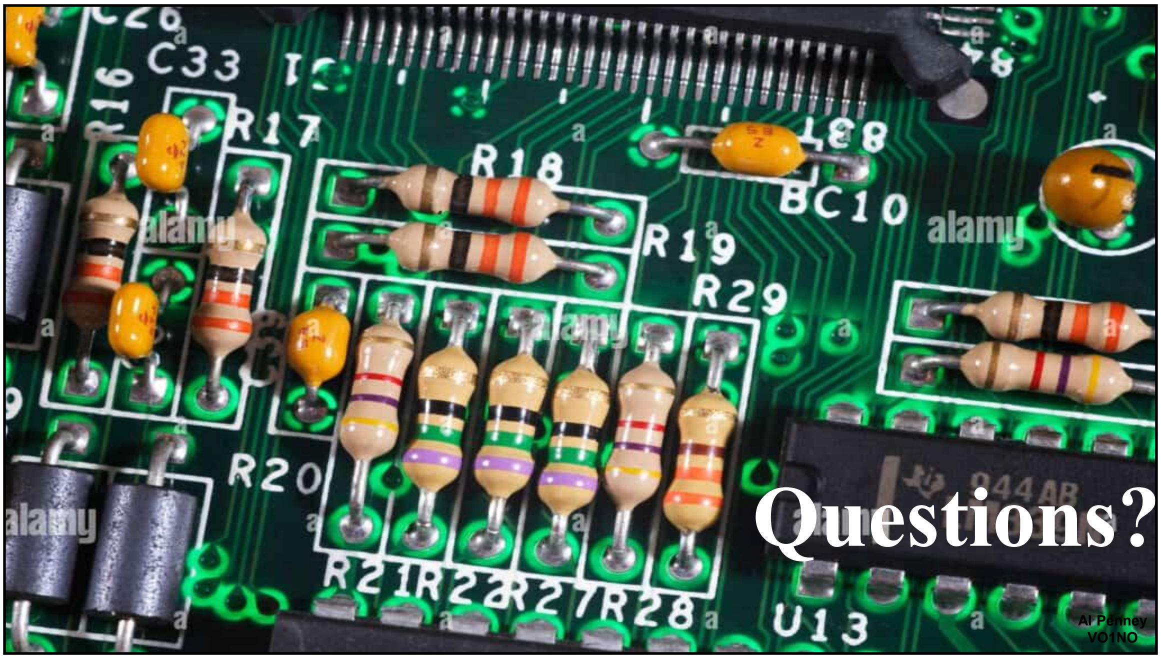
Questions?
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