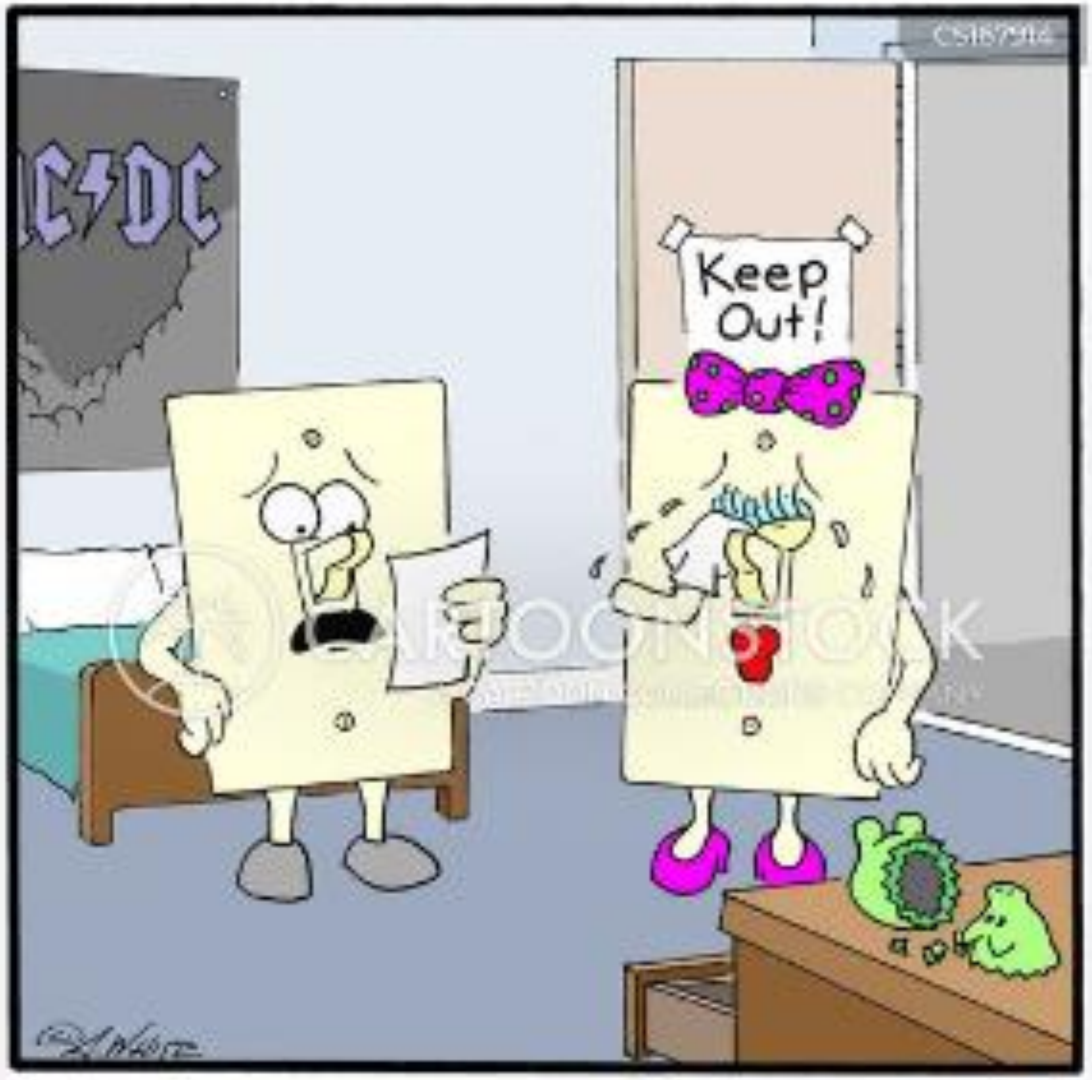
PARALLEL CIRCUITS

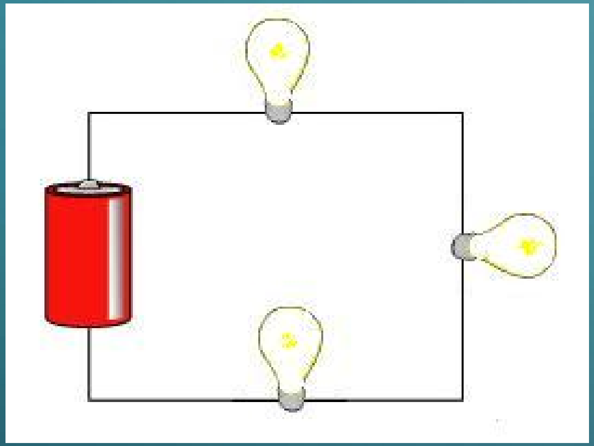


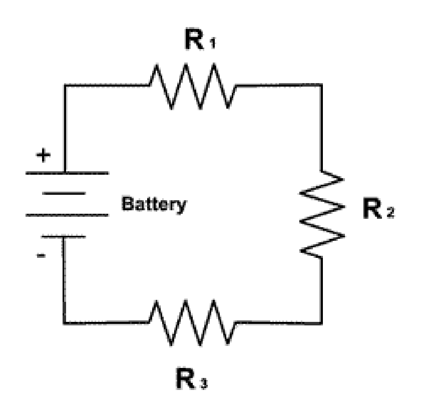
"Dear Mom and Dad, I'm running away from home to join the circuits."

SERIES VS. PARALLEL CIRCUITS

Series Circuit

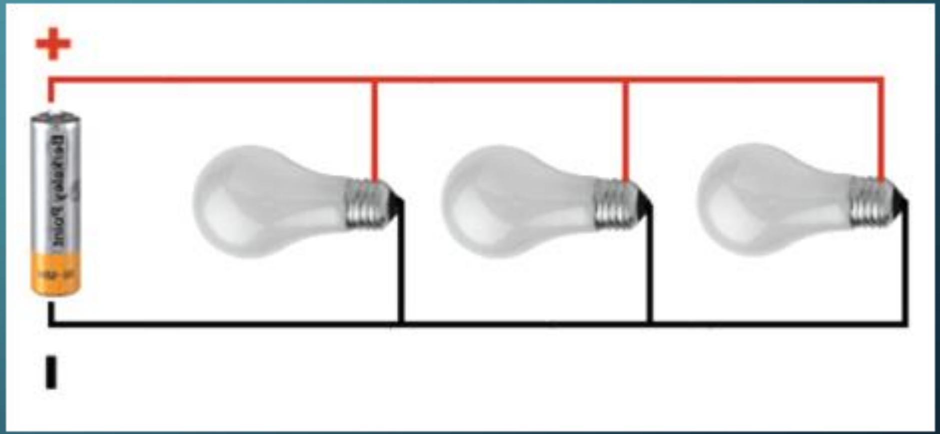
Electrons only have one path to flow through.

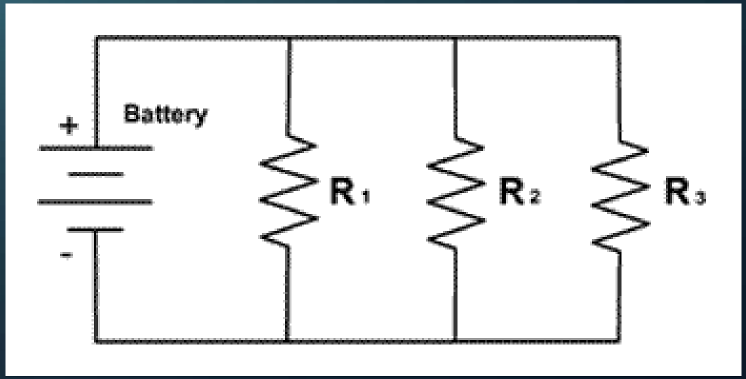




Parallel Circuit

There are MULTIPLE paths for the current to flow through.



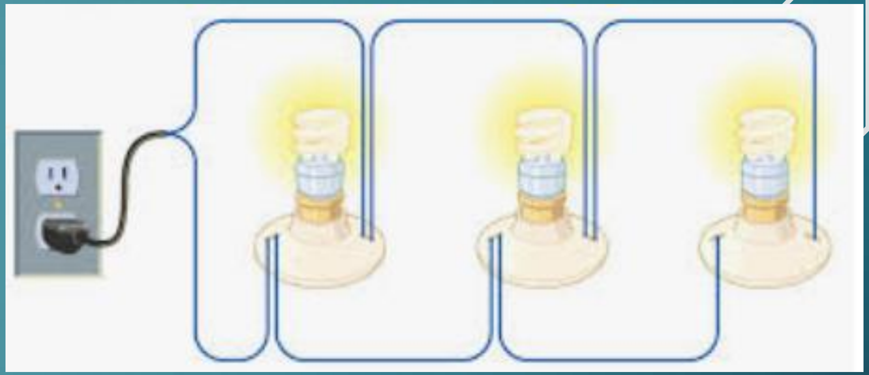


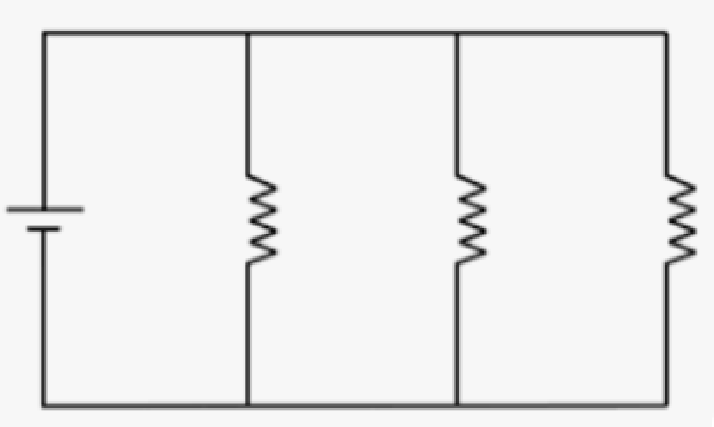
PARALLEL CIRCUITS

- A parallel circuit is one that has two or more paths for the electricity to flow, the loads are parallel to each other.

- There are several different paths for the electricity to travel.

- It's like a river that has been divided up into smaller streams, however, all the streams come back to the same point to form the river once again.





PARALLEL CIRCUIT RULES

Voltage is equal across all components in a parallel circuit.

The **total** circuit **current** is equal to the sum of the individual branch currents.

Individual resistances reduce to equal a smaller total resistance rather than add to make the total.

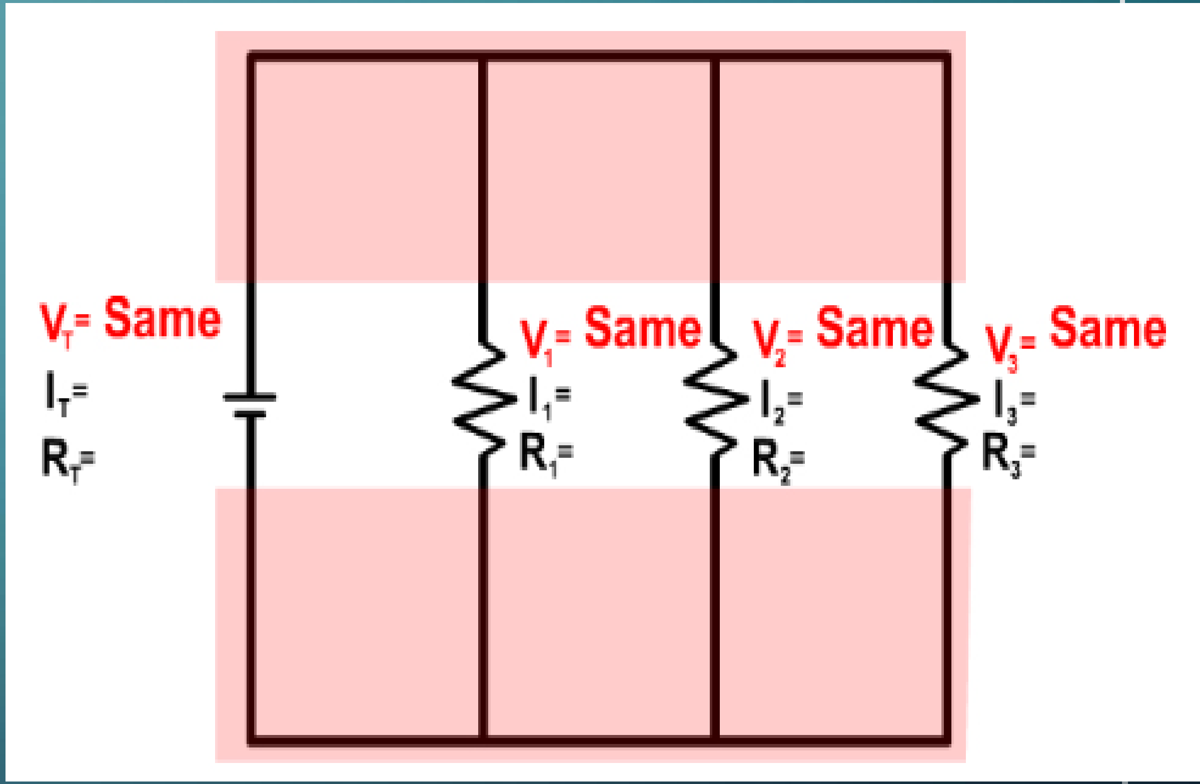
Ohm's Law	Parallel Rules
$V = IR$	$V_T = V_1 = V_2 = V_3 = \cdots$
$I = \frac{V}{R}$	$I_T = I_1 + I_2 + I_3 + \cdots$
$R = \frac{V}{I}$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$

PARALLEL CIRCUIT RULES

1) The entire voltage drops equally by the entire amount through all resistors in parallel.

Because the voltage along each branch is equal to that provided to the branch, it is equal to the power source.

$$V_T = V_1 = V_2 = V_3 = \dots$$



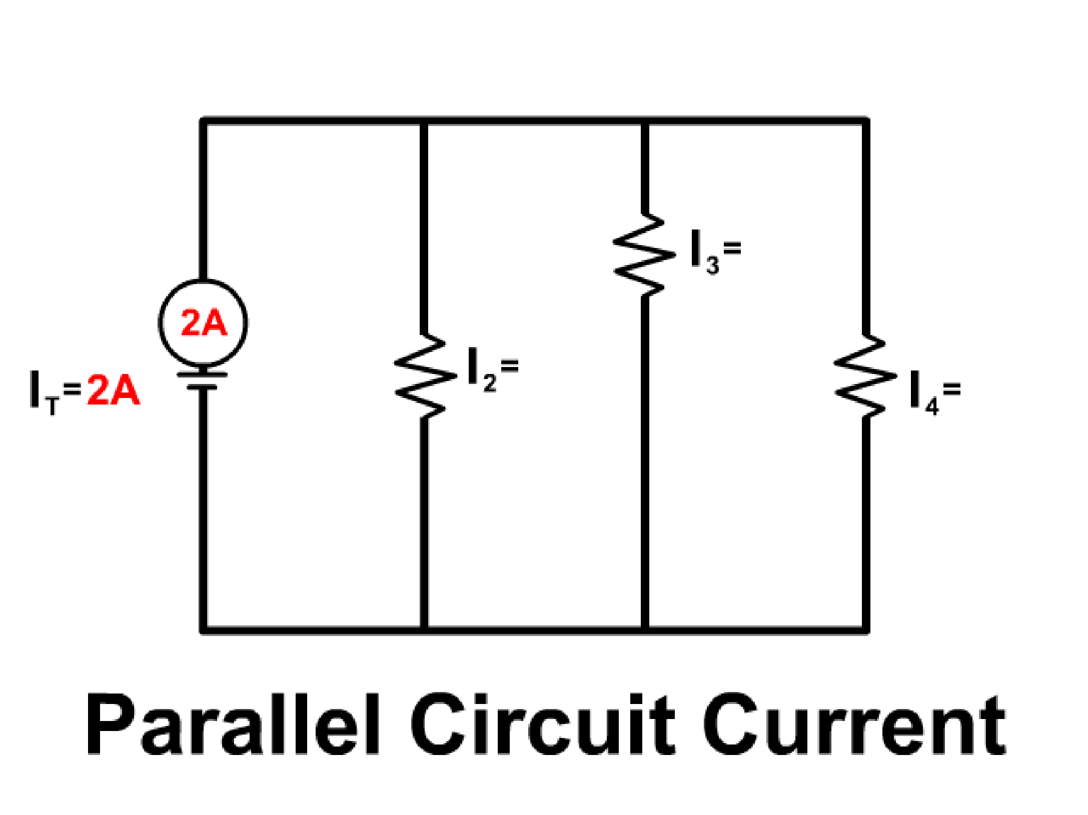
PARALLEL CIRCUIT RULES

2) **Current** flows like water through a parallel circuit separating down branches and coming back together.

The amount of current flowing down each branch depends on that branch's resistance.

The entire current provided by the battery is equal to the sum of current going down each branch.

$$I_T = I_1 + I_2 + I_3 + \ldots$$



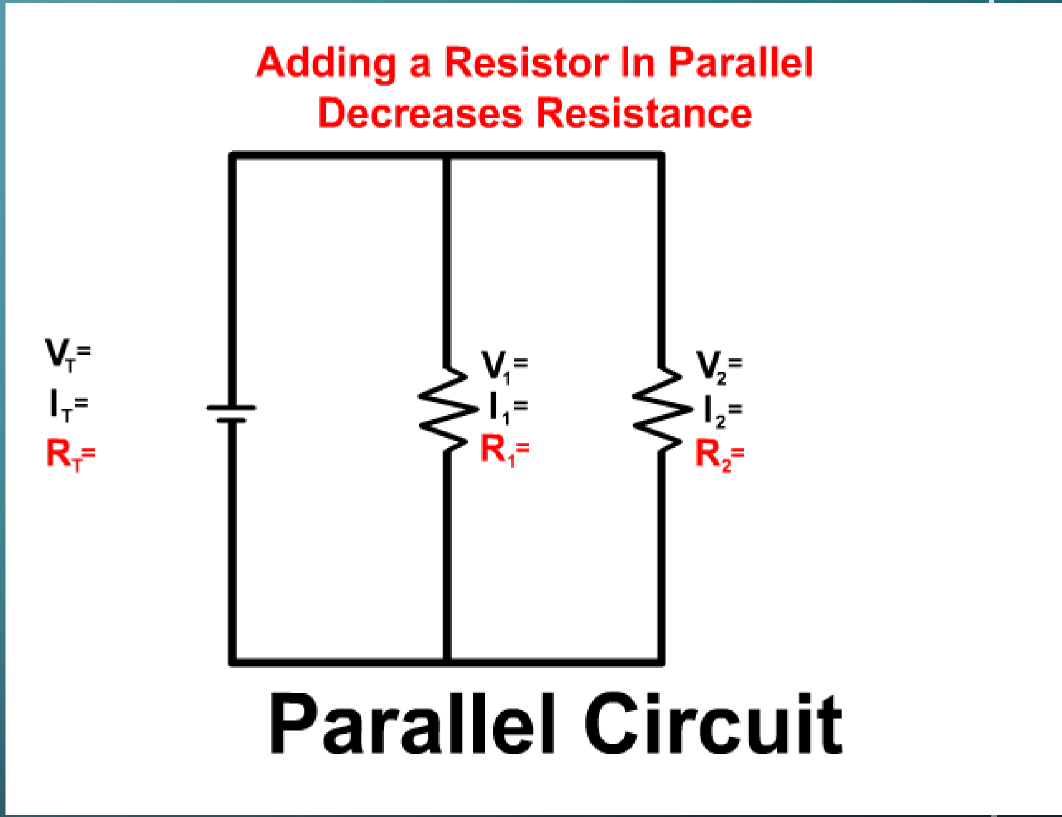
PARALLEL CIRCUIT RULES

3) Resistance in a parallel circuit is unique.

In order to add a resistor in parallel you also have to add another path for current to follow. Because you add another path, you decrease resistance and therefore increase current.

The total resistance in parallel will always be less than the lowest resistor.

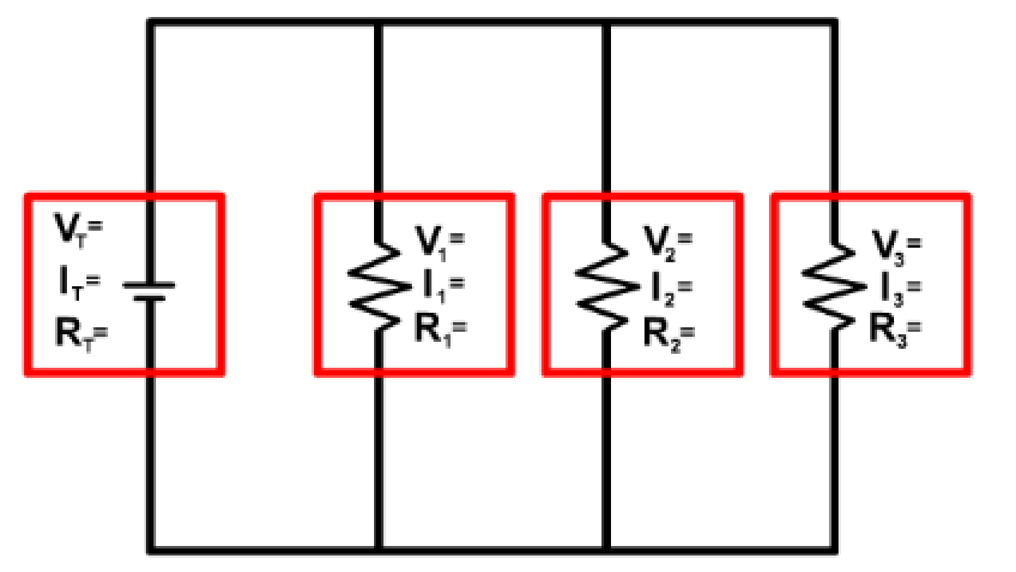
$$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 + ...$$



*__NOTE__: We do not expect / force you to use this rule and formula to figure out resistance in a circuit problem for grade 9!

APPLYING PARALLEL CIRCUIT RULES

- Ohm's Law (**V=IR**) can be used anywhere in the circuit **but only at a single location**.



- See all the squares in red above, if you are using Ohm's law you can only use information in that location, the V,I, and R **within a single square.**

BASIC STEPS TO A PARALLEL CIRCUIT PROBLEM

1) See if you can do Ohm's Law (V=IR) at any location in the circuit.

2) See if you have voltage anywhere because that voltage will be the same everywhere following the parallel circuit rule below.

$$V_T = V_1 = V_2 = V_3 = \ldots$$

3) Check if you can do any of the other parallel circuit rules.

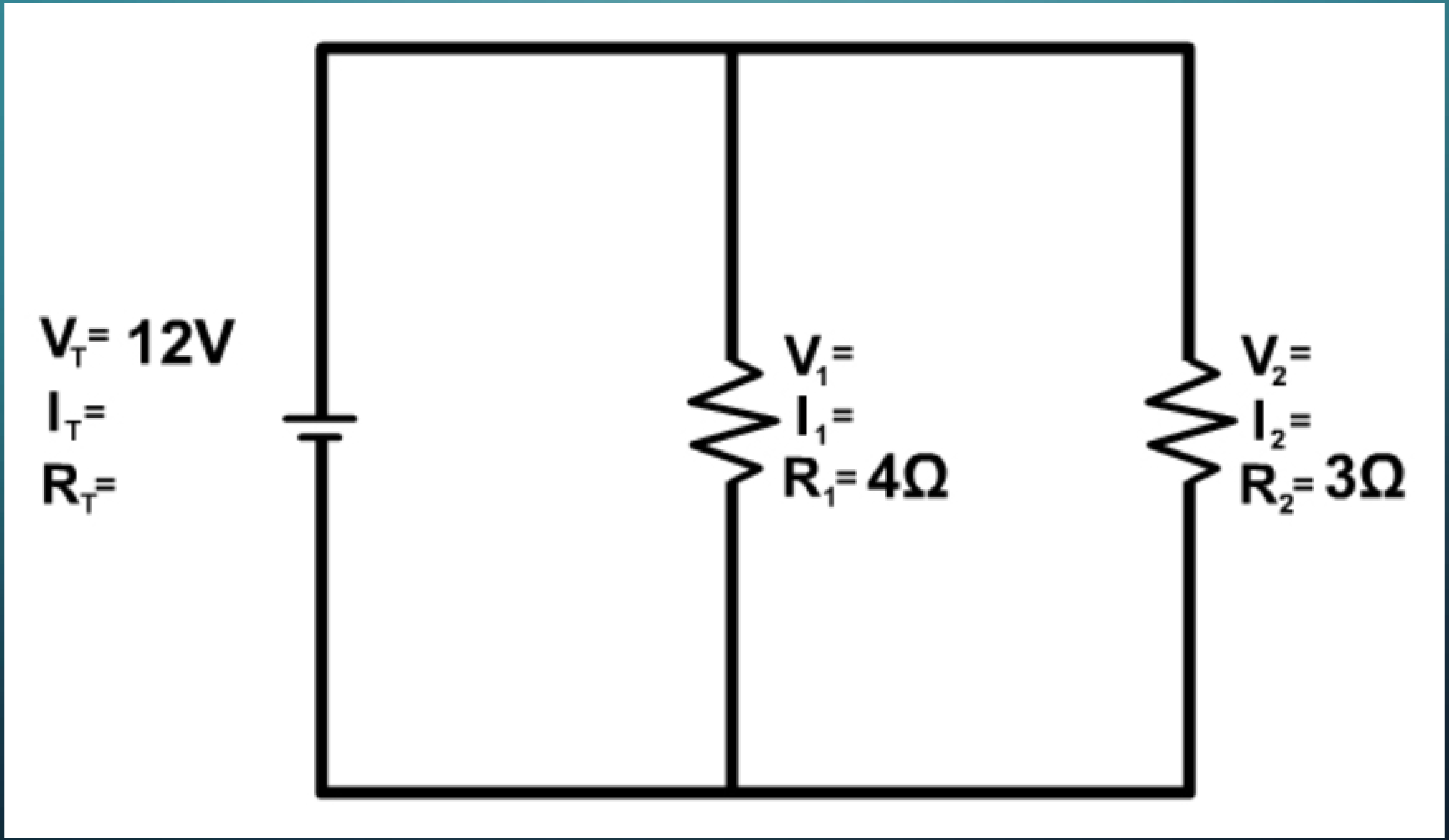
$$I_T = I_1 + I_2 + I_3 + \ldots$$

$$1/R_T = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$$

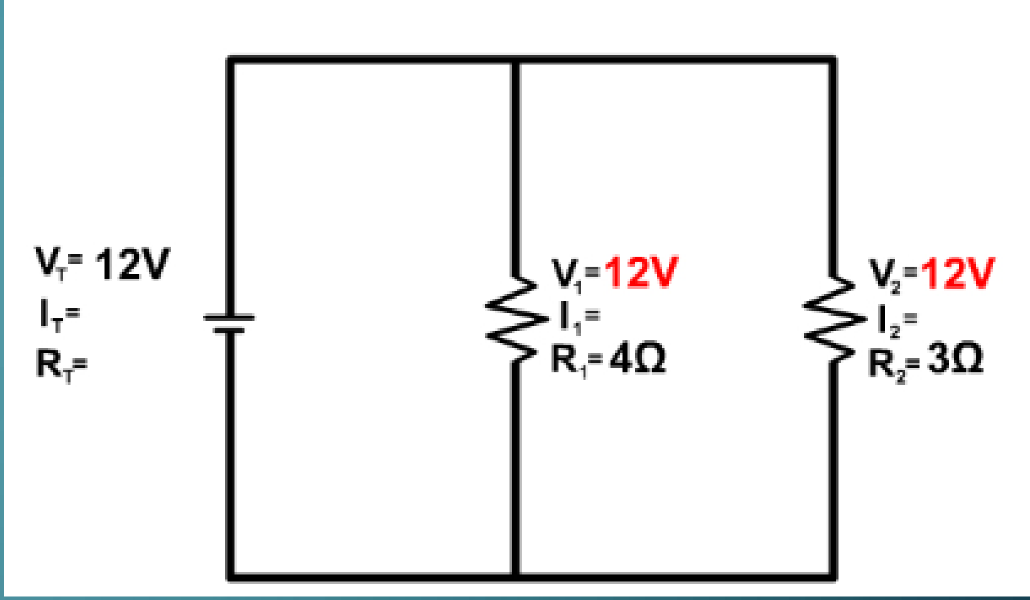
You will continue to follow these steps over and over until everything in the circuit is complete.

EXAMPLE PROBLEM

Solve for all the components of the parallel circuit using the information given.



EXAMPLE



You don't have two out of three of the individual components on location to do Ohm's Law (V=IR)

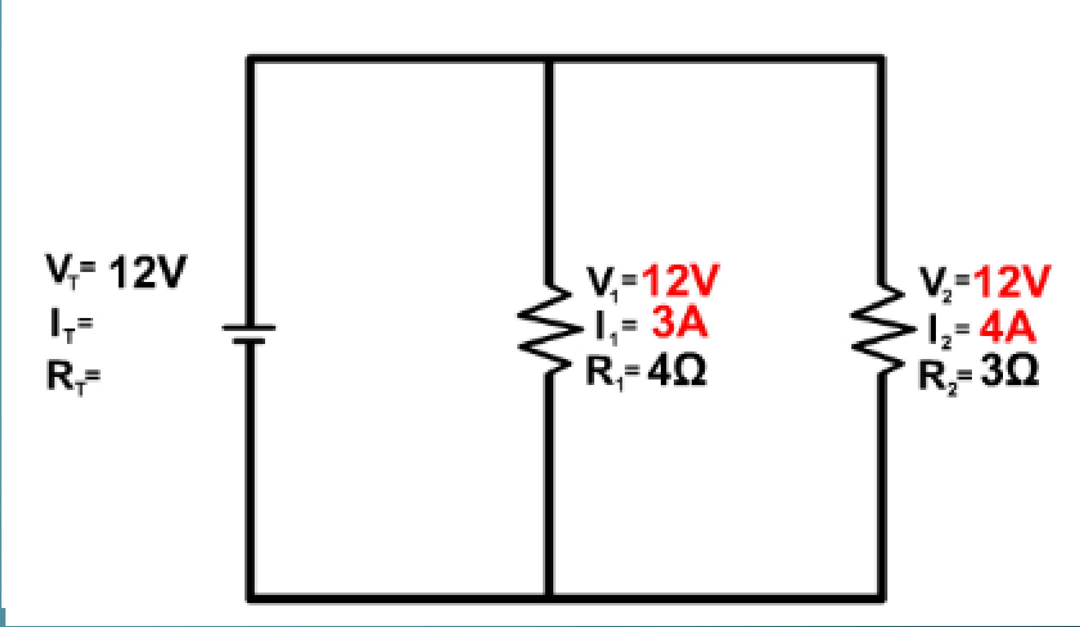
We could start this problem solving for total resistance or voltage. **The easiest way is to start with voltage.**

You have voltage at the battery and that voltage is dropped equally and in its entirety at all other resistors using the following parallel circuit rule: $V_T = V_1 = V_2$

12V = 12V = 12V

EXAMPLE

You now have enough information to solve for current at resistors #1 & #2 using Ohm's Law (V=IR)



$V_1 = I_1 \times R_1$

$I_1 = V_1 / R_1$

$I_1 = 12V / 4\Omega$

$I_1 = 3A$

$V_2 = I_2 \times R_2$

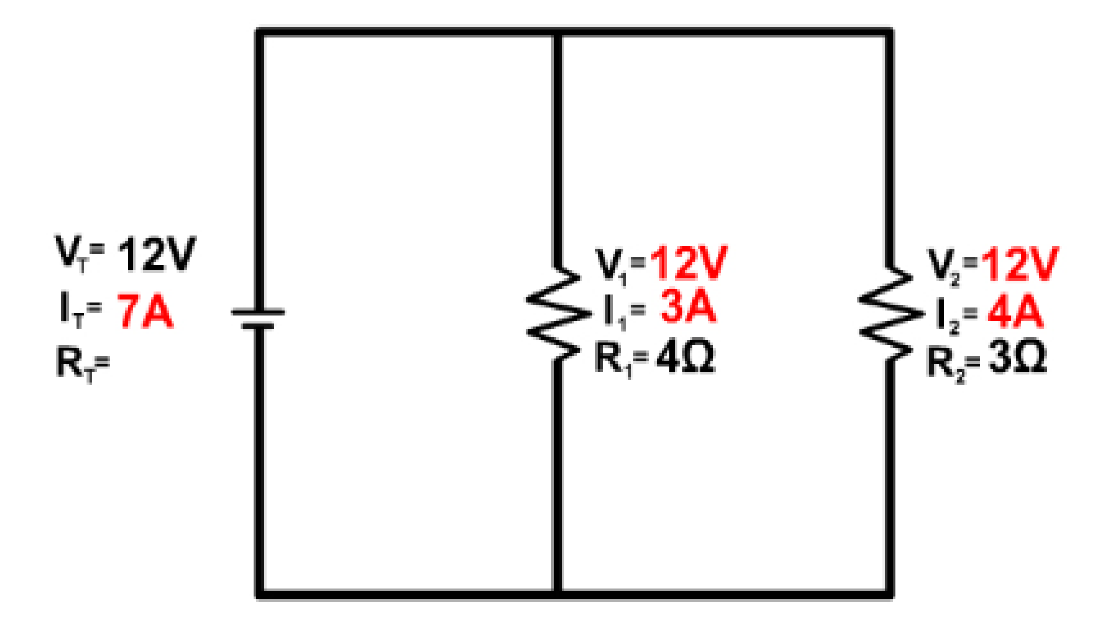
$I_2 = V_2 / R_2$

$I_2 = 12V / 3\Omega$

$I_2 = 4A$

EXAMPLE

Now you can add up the current before it branched out using the parallel circuit rule.



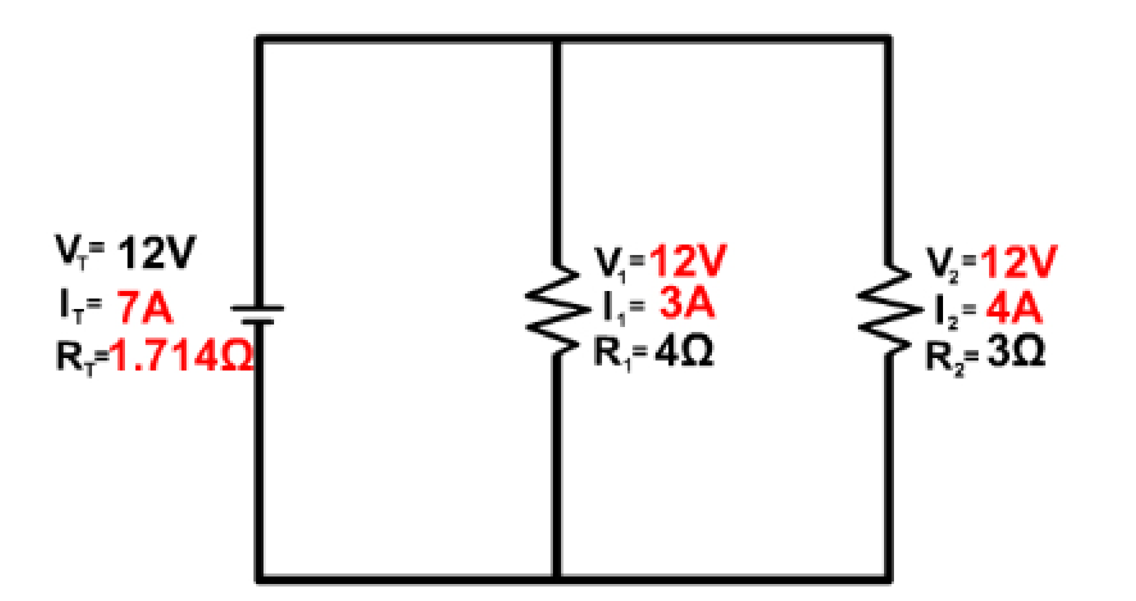
$$I_T = I_1 + I_2$$

$$I_T = 3A + 4A$$

$$I_T = 7A$$

EXAMPLE

Now you can use Ohm's Law to solve for the resistance at the battery for the entire circuit.



$$V_T = I_T \times R_T$$

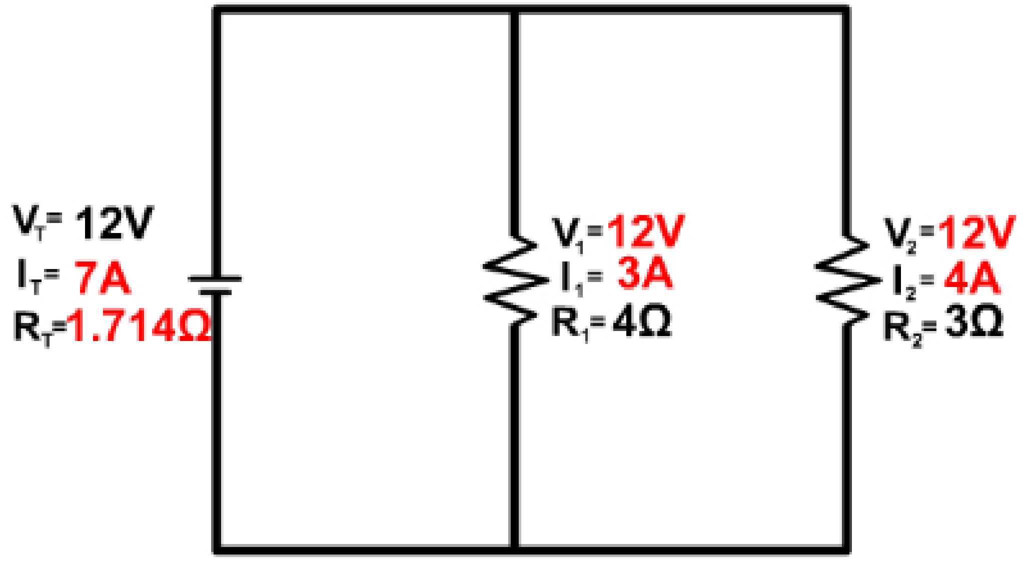
$$R_T = V_T / I_T$$

$$R_T = 12V / 7A$$

$$R_T = 1.714\Omega$$

EXAMPLE

If you want to (*and understand how to use the resistance formula for a parallel circuit*) you can now do a final check and see if the following parallel series circuit remains.



$$1/R_T = 1/R_1 + 1/R_2 + 1/R_3$$

$$1/R_T = 1/4 + 1/3$$

$$1/R_T = 0.25 + 0.3333...$$

$$1/R_T = 0.5833$$

$$R_T = 1/0.5833\ ^*$$

$$R_T = 1.714\Omega$$

* or use the 1/x button on calculator

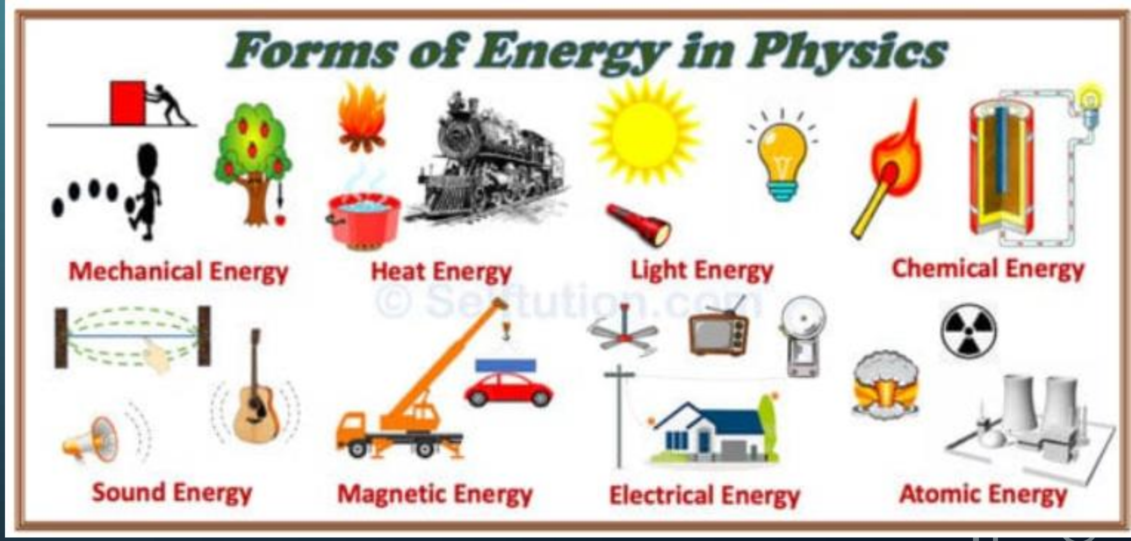
ENERGY & POWER IN CIRCUITS

Energy is the "ability to do work"

Energy is just the force that causes things to move.

Two types: *potential (stored energy)* and *kinetic energy from motion)*.

Energy (E) is measured in joules (J)



ENERGY & POWER IN CIRCUITS

In an electric circuit, electrical energy is continuously converted into other forms of energy.

Power is the rate at which we change electric energy into some other kind of energy.

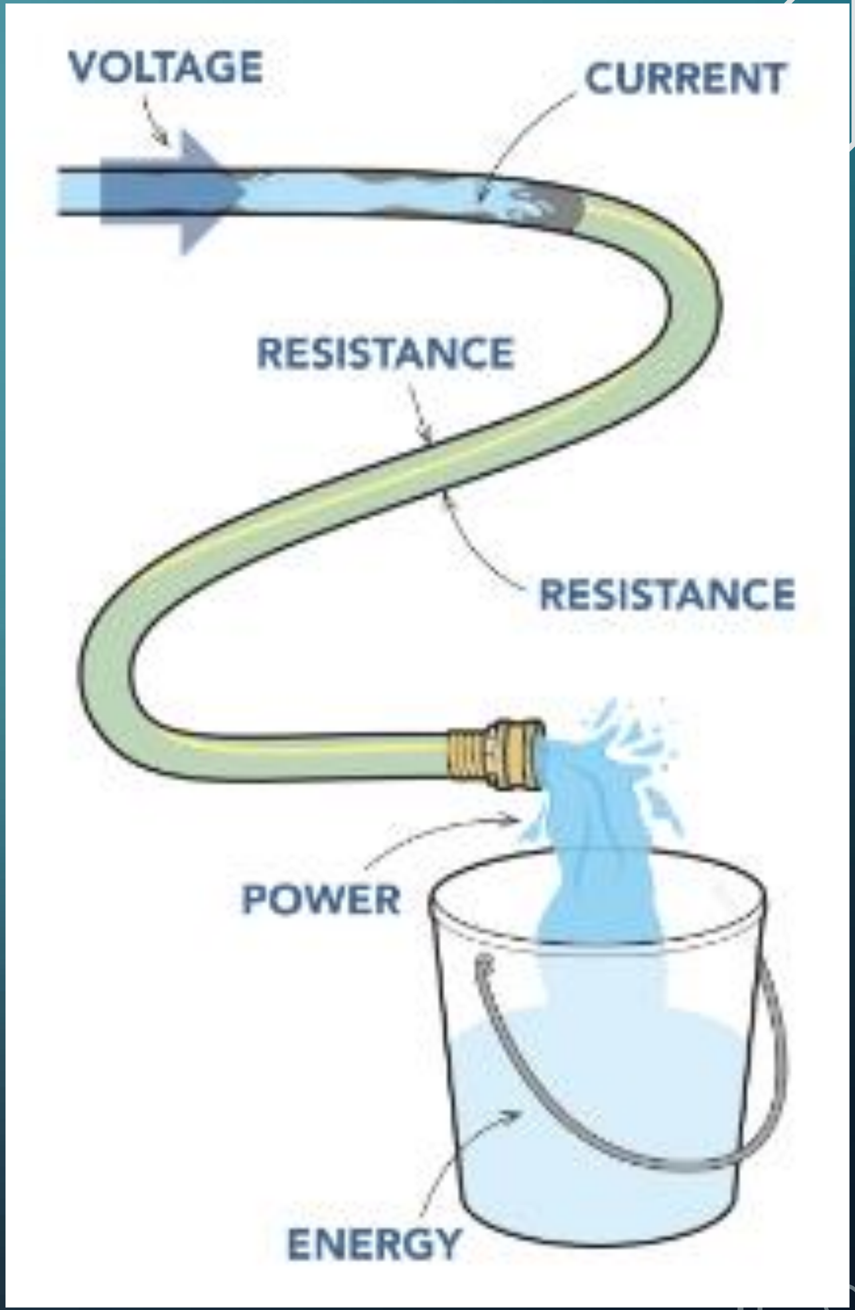
- *The rate at which energy is transferred*

Power (P) is measured in watts (W)

ENERGY & POWER IN CIRCUITS

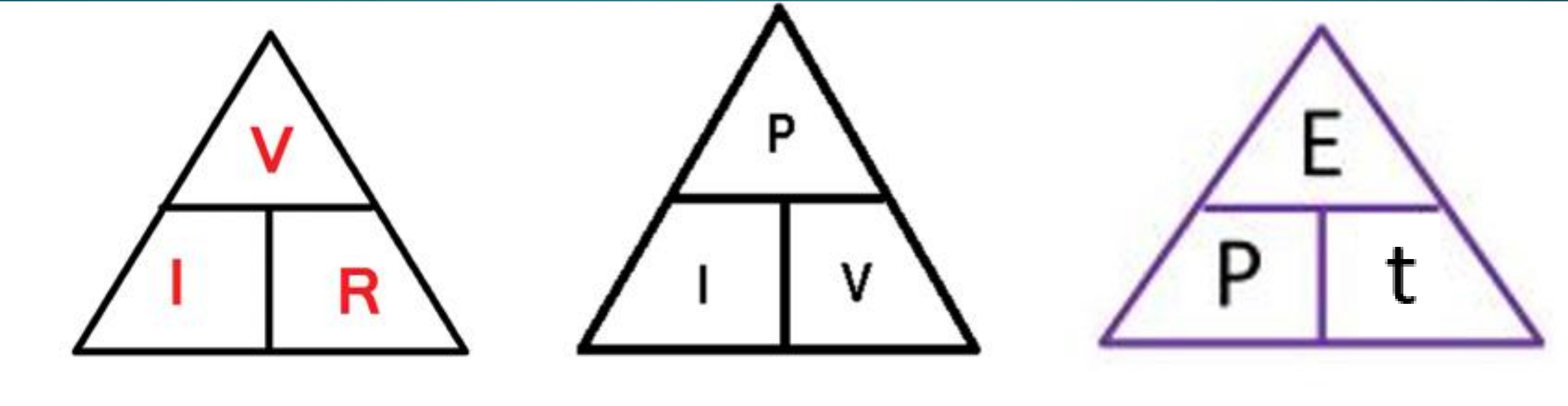
Power is a measure of the rate at which energy flows, like the volume of water flowing from the hose, given a specific pressure and hose diameter.

Energy is like measuring the volume of water that has flowed through the hose over a period of time.



CALCULATING ENERGY & POWER

- Like Ohm's Law, both Energy & Power formulas have three variables.
- If we know two of the variables, we can solve for the third one!
- We can use the shared variables to help calculate the missing one in questions related to power and energy consumption.



P = Power (W)

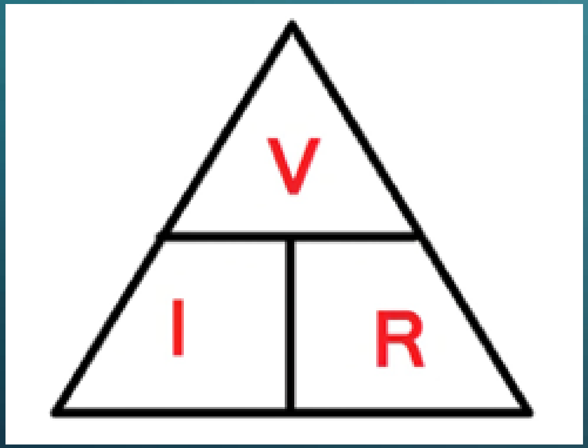
E = Energy (J)

t = Time (s)

EXAMPLE (PART 1)

What is the power of a bulb that has a resistance of 200Ω when the potential difference (voltage) supplied to it is 100V? How much energy is used to keep the bulb lit for 60 seconds?

We don't know enough to find the power directly, so let's find the current first!



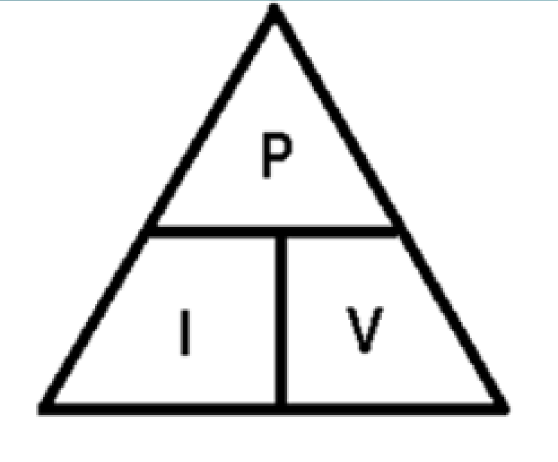
Known values:	Formula & re-arrange	Fill & Solve
R = 200Ω	V = I x R	I = 100V / 200Ω
V= 100V	I = V / R	I = 0.5 A

Don't forget about units!

EXAMPLE (PART 2)

What is the power of a bulb that has a resistance of 200Ω when the potential difference (voltage) supplied to it is 100V? How much energy is used to keep the bulb lit for 60 seconds?

Now we can use the values we have to solve for power.



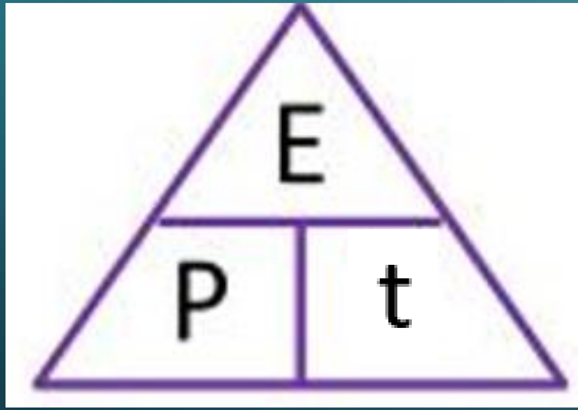
Known values:	Formula	Fill & Solve
V = 100V	P = I x V	P = 0.5A x 100V
I = 0.5 A		P = 50W

Don't forget about units!

EXAMPLE (PART 3)

What is the power of a bulb that has a resistance of 200Ω when the potential difference (voltage) supplied to it is 100V? How much energy is used to keep the bulb lit for 60 seconds?

We can now solve for the energy used!



Known values:	Formula	Fill & Solve
P = 50W	E = P x t	E = 50W x 60s
t = 60 s		E = 3000 J

Don't forget about units!