# Circuit Wizardry!

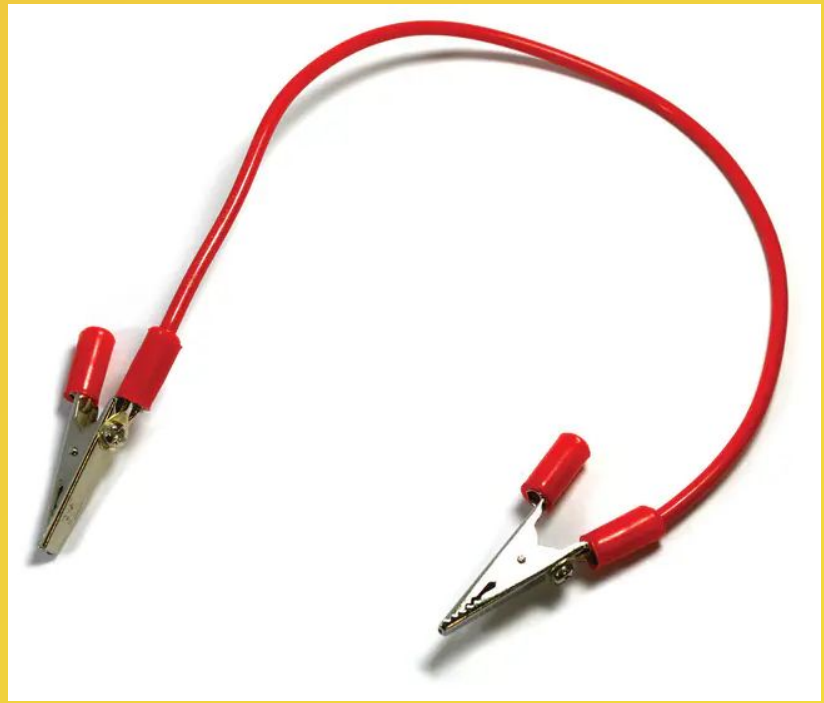
JCC Workshop #4

# Rules

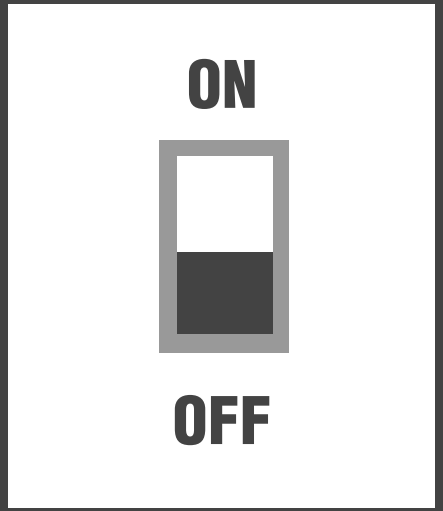
You will be tested on all of the content covered in these slides, as well as some simple Ohm’s Law calculations.

There may also be a lab portion similar to the labs we run today.

# Get a load of this



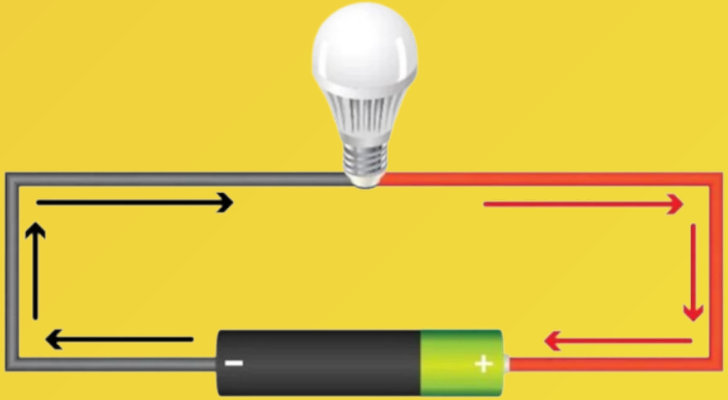

# 01 What is a Circuit?



# What is a circuit?

**A circuit is a closed loop that allows electric current to flow through it.**

- Contains a **power source** that provides energy to the circuit
- Contains some way to turn the energy into **work**



In this simple circuit, the battery is the power source, and the light bulb converts electrical energy into light.

# Conductors and Insulators

Trying to move electricity through any material takes energy! However, it takes a lot more energy to move electricity through some materials compared to others.

It is very easy to move electricity through **conductors**.

It is very hard to move electricity through **insulators**.

Wires have a metal core because metal is a good conductor, so electricity moving through it won't lose much energy.

Wires have a plastic coating so that electricity won't move from the metal to you if you touch it. Plastic is a good insulator.

# How does the switch work?

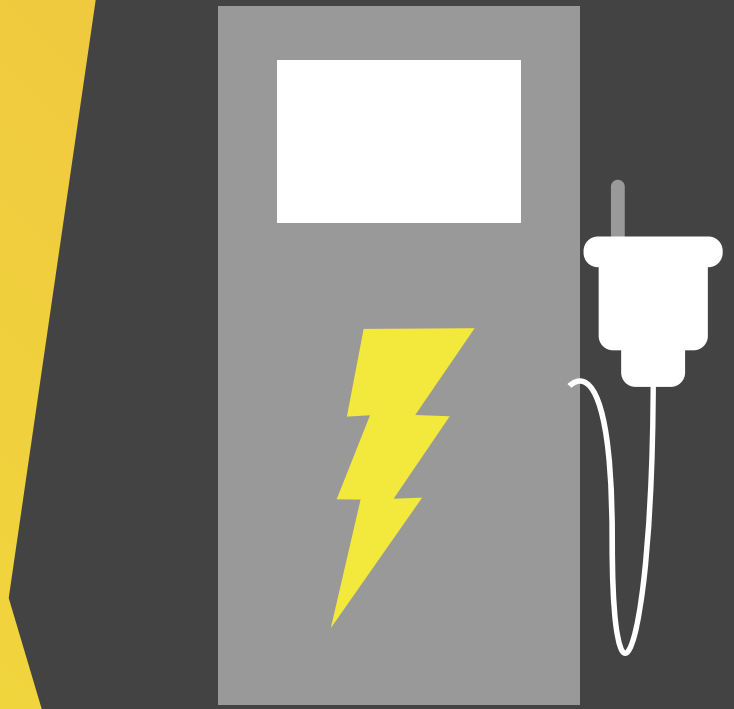
# How does the switch work?

Right now, the electricity needs to go through the air (an insulator) to reach the other end of the switch.

Closing the switch would create a path made up of only conductors, so electricity can go through.

# 02

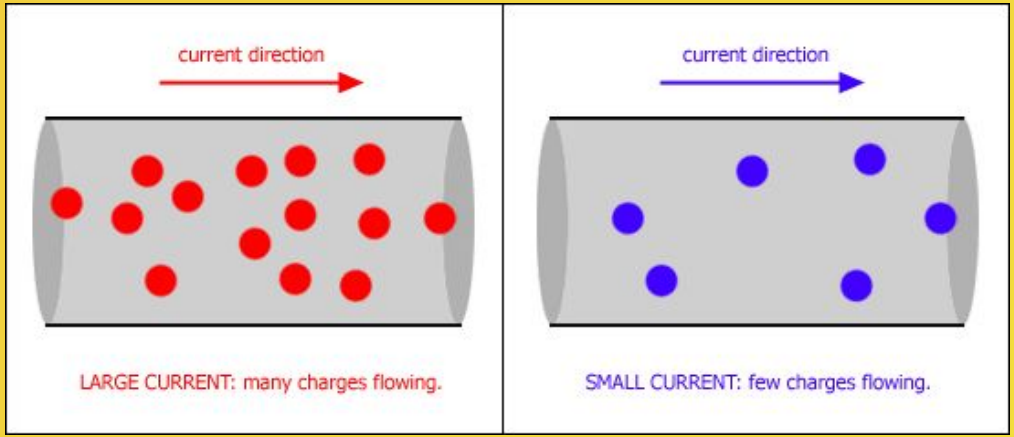
# Voltage, Current, & Resistance

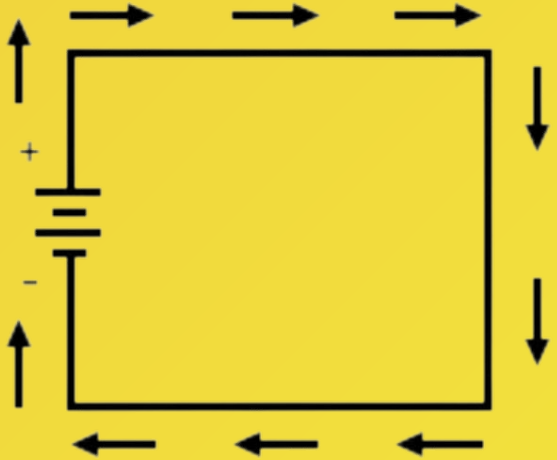


# Current

**Current is the flow of charge.**

- Specifically, it measures the **amount** of charge that flows through a point of a wire at a given time
- Measured in Amperes (A) → the higher the value, the higher the charge flow



# Voltage and Power

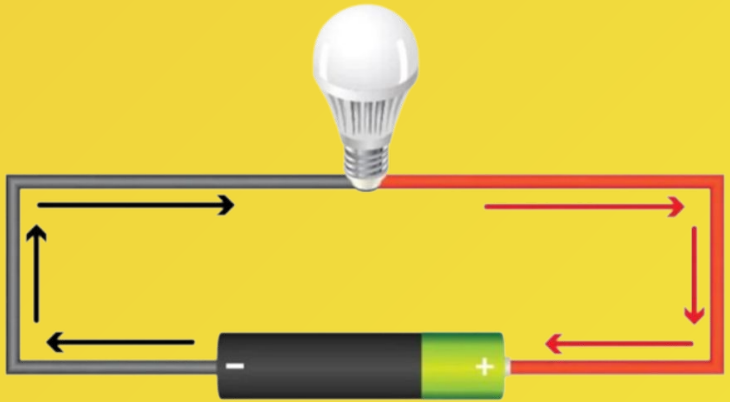
Voltage is a measure of the difference in energy between two points. **The higher the voltage drop, the more energy is used up between the two points.**

**Power = Voltage x Current**

The higher the current, the more charge is flowing every second.

The higher the voltage, the more energy is used up for every unit of charge.

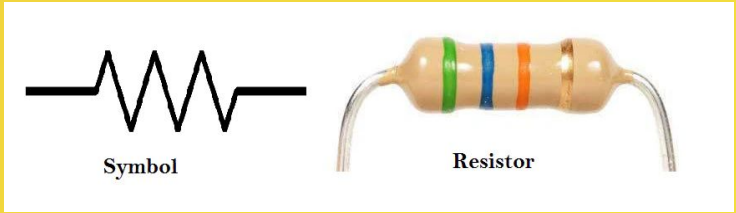
With a high voltage and current, a circuit can expend energy very quickly. This means that the circuit has a high power.

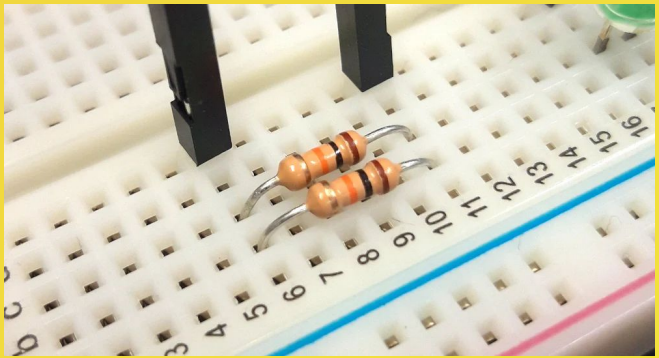


# Resistance

**Resistance is the opposition to the flow of current.**

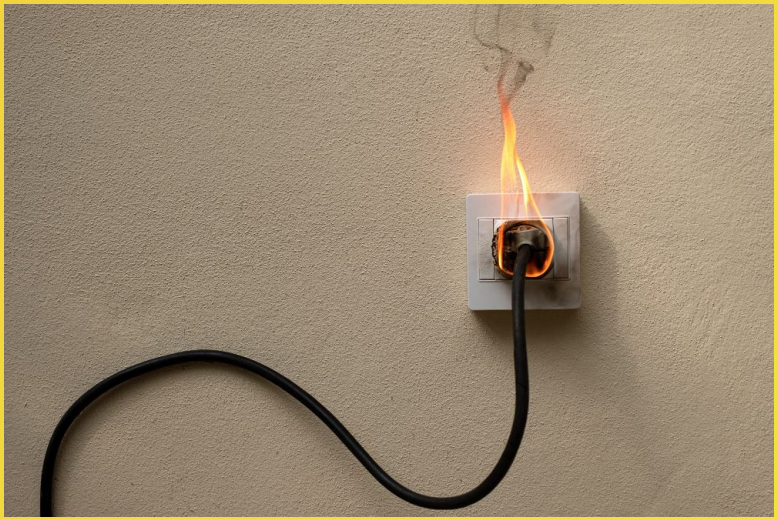
- **A resistor limits the current going through the circuit by dissipating energy.**
- It takes energy to move electricity through a resistor! This means that there is a voltage drop.
- However, resistors are not perfect insulators.
- Measured in Ohms (Ω)
- Different resistors have different resistances.
  - Higher resistance → less current
- Think of a resistor as creating “traffic” for electrons
  - Reducing number of “lanes” prevents electrons from flowing through
- Lightbulbs can act as resistors!



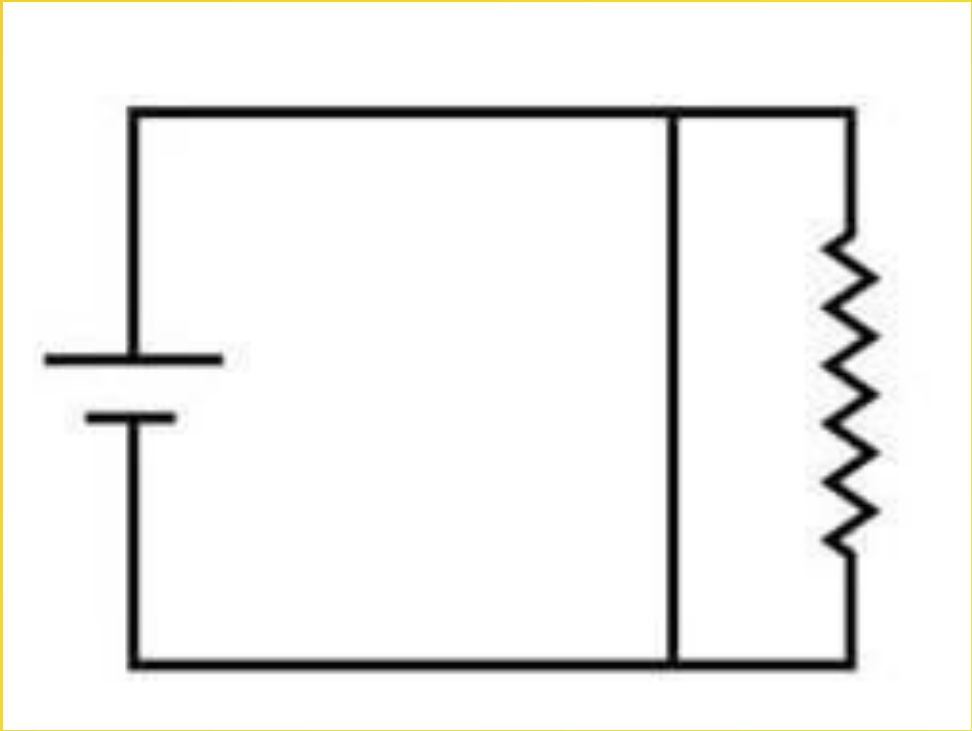



# Short Circuits ⚠

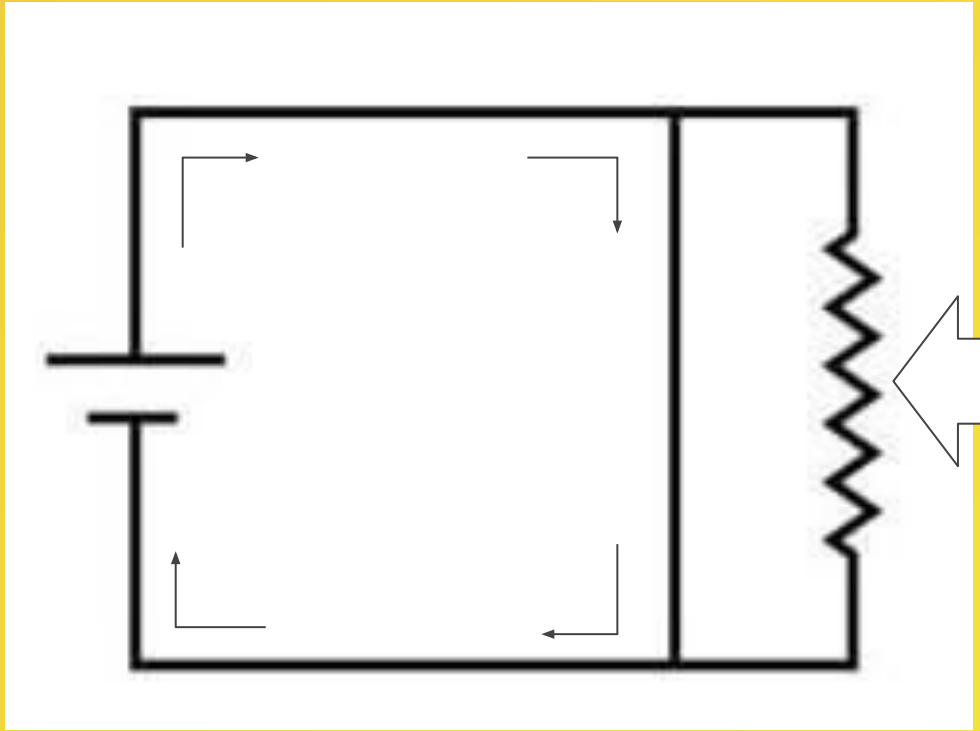
- Happens where there is too little resistance in the circuit
- All of the current flows from the positive to the negative end of the battery
    - The negative terminal is not designed to handle that current flow
    - This causes 🔥🔥🔥! Too much power!
- **Always make sure your circuit has a sufficient resistor or insulating component**
- **Never touch 2 electrodes together**



# Is this a short circuit?



# Yes.



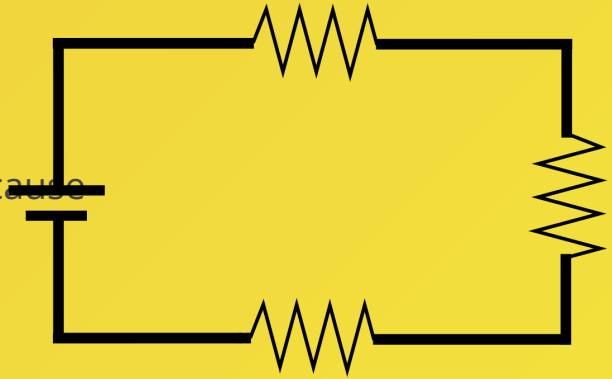
None of the current flows through the resistor because it's much easier to go through the wire!

# 03
# Series vs. Parallel

# Series

**With elements in series, electricity has ONE path to go through the circuit.**

Current has to go through ALL resistors.



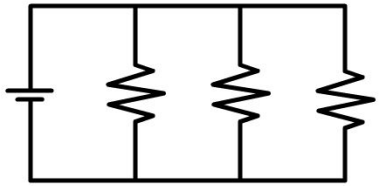
- Equivalent resistance **increases** with more resistors, because it has to go through all of them.
  - $R_{eq} = R_1 + R_2 + R_3$
- Current is **the same** across all the resistors
  - Only one path to go
- Voltage is **divided** among the resistors
  - Ex. if 9 V battery and 3 resistors (of the same resistance), **3 V each**

# Parallel

**With elements in series, electricity has MULTIPLE paths to go through the circuit.**

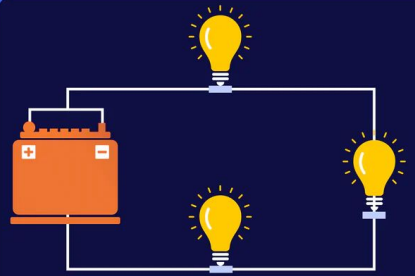
Current only goes through ONE resistor. The most current will flow through the one with the LEAST resistance.

- Equivalent resistance **decreases** with more resistors, because it can split up and go through any of them.
  - $R_{eq} = 1 \div (R_1 + R_2 + R_3)$
- Current **can be different** across all the resistors
  - The charges split up and move across all 3 branches
- Voltage is **the same** among the resistors
  - The difference in energy between the start and the end is the same



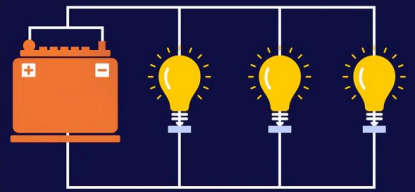
Parallel Circuit

# SERIES vs PARALLEL CIRCUITS



**SERIES CIRCUIT:**

- Linear Pathway
- Voltage Divides
- Current Constant
- Less Reliable
- Holiday Lights



**PARALLEL CIRCUIT:**

- Multiple Pathways
- Voltage Constant
- Current Divides
- More Reliable
- Residential Wiring

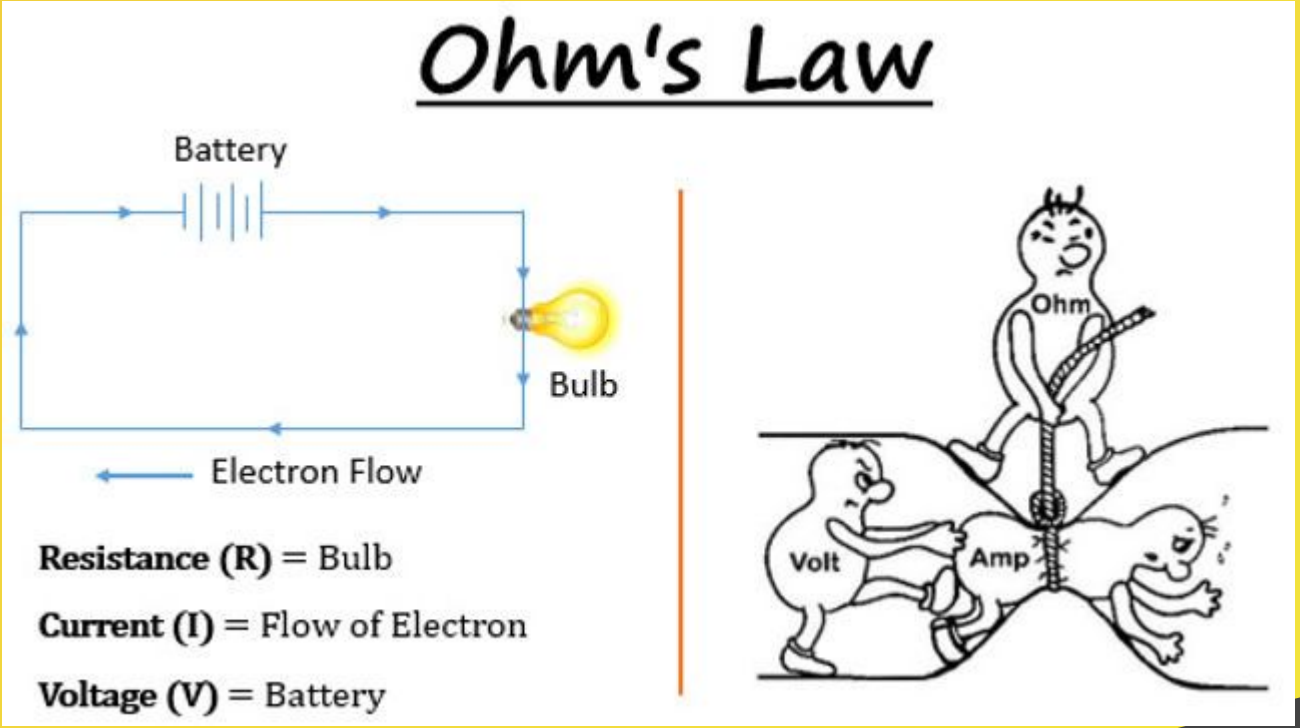
NNC

# Ohm’s Law

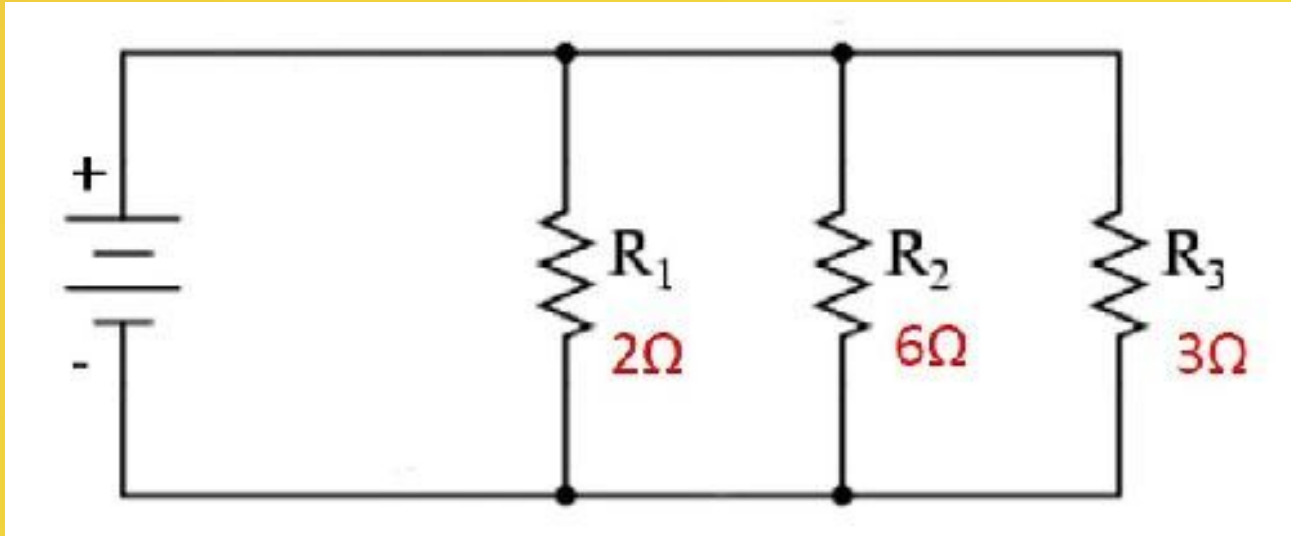
**V = IR**

More voltage and less resistance will increase current.

More resistance and less voltage will decrease current.



# Which resistor has the most current going through it?



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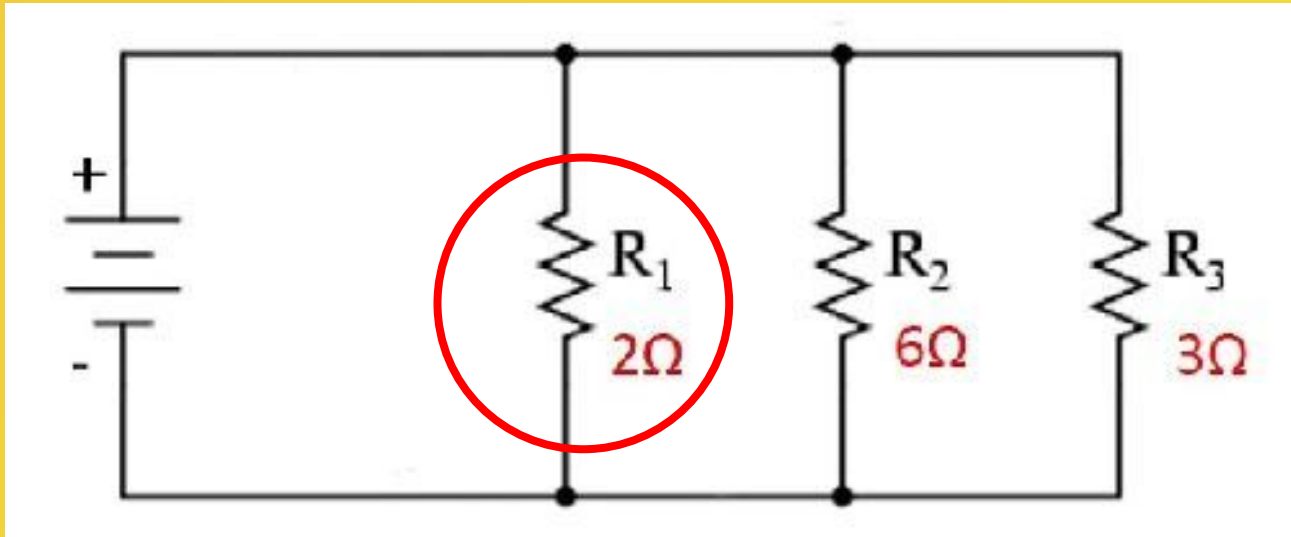
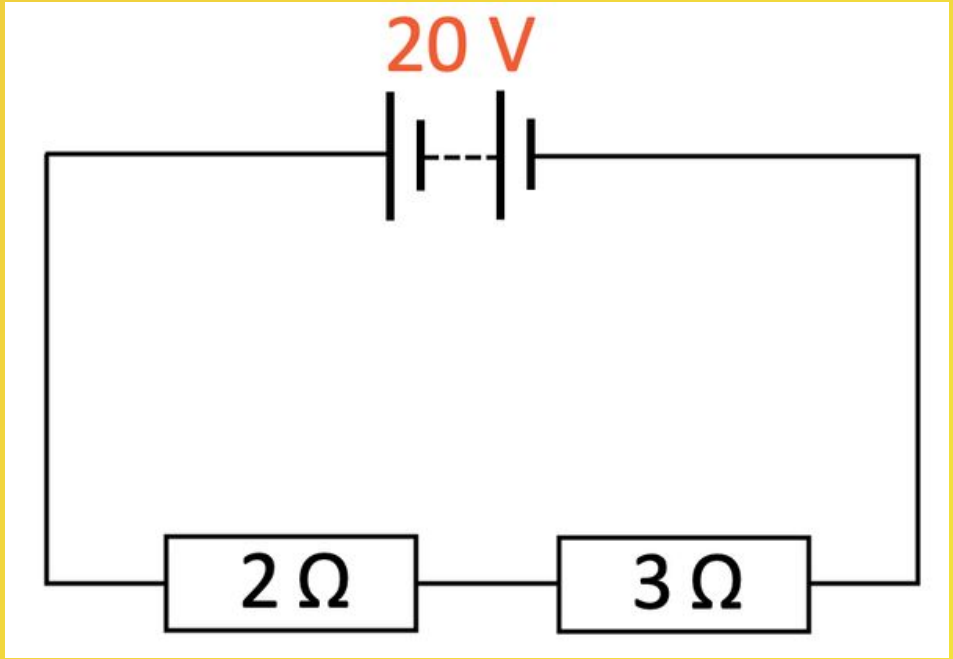
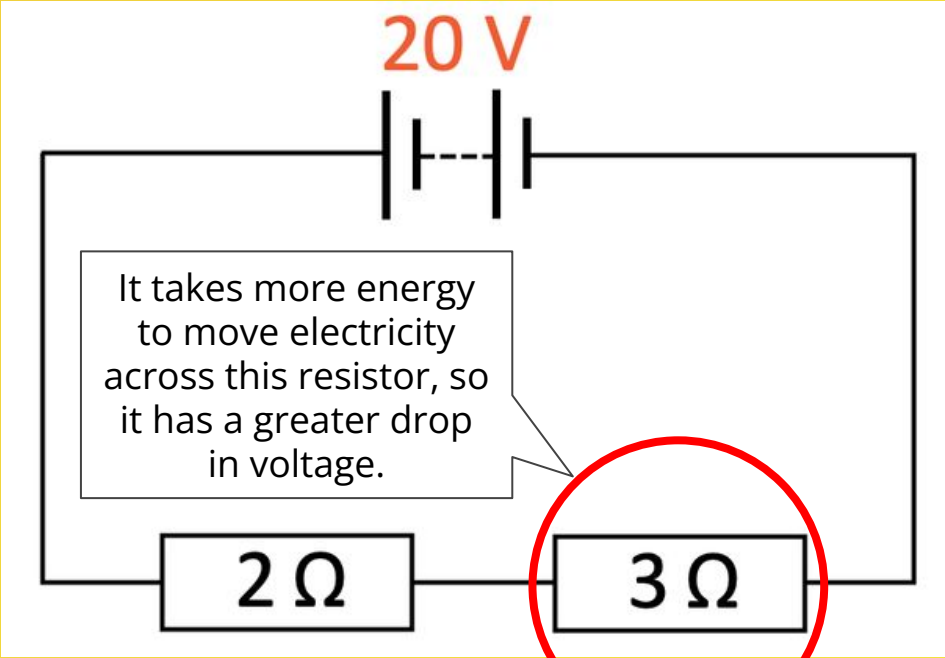



The voltage is the same for all three resistors, so the current must be highest in the resistor with the lowest resistance.

# Which resistor has a greater drop in voltage across it?

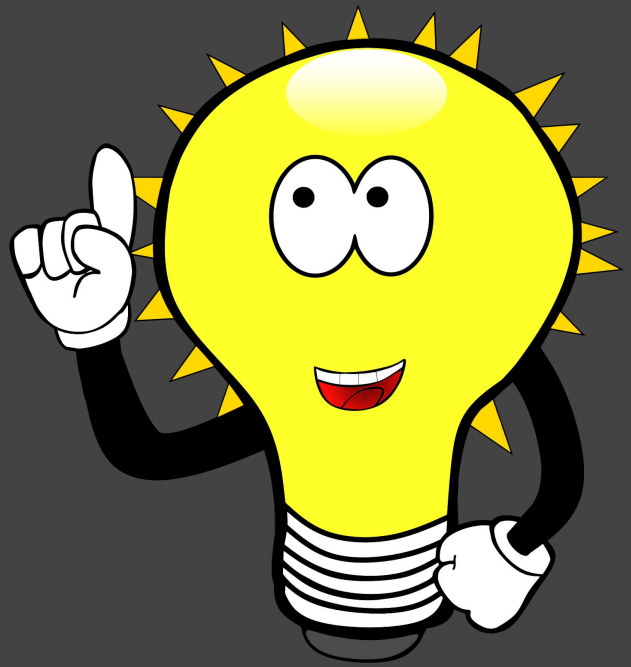


# Which resistor has a greater drop in voltage across it?



# 04

# Lightbulbs



# Types of Lightbulbs

**Incandescent lightbulbs** work by having a thin filament in the middle that becomes so hot it starts glowing. Electricity can flow through it either way.

**LEDs** work by having electrons move from a high-energy region to a low-energy region in such a way that it releases light.

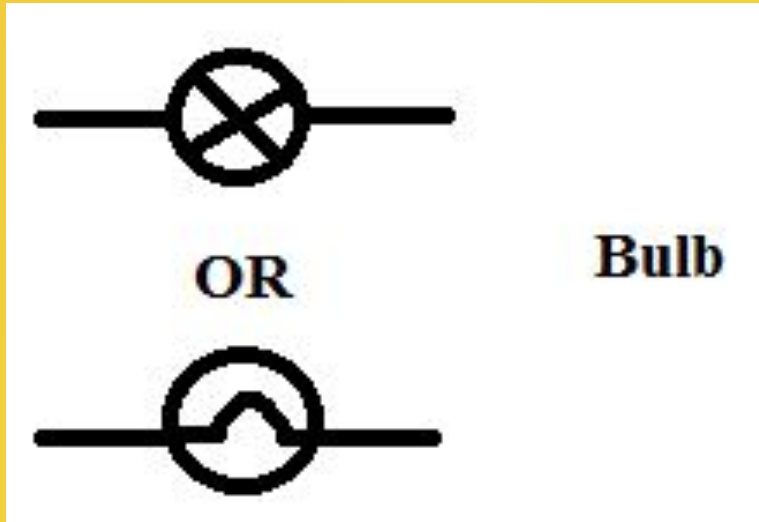
Electricity can only flow through it one way (long leg is positive).

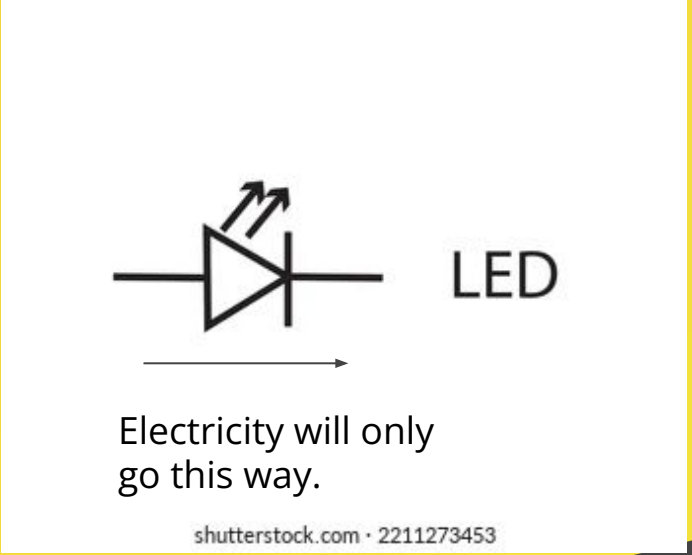
They tend to have super low resistances, so make sure to add a resistor to avoid a short circuit.

# Lightbulbs

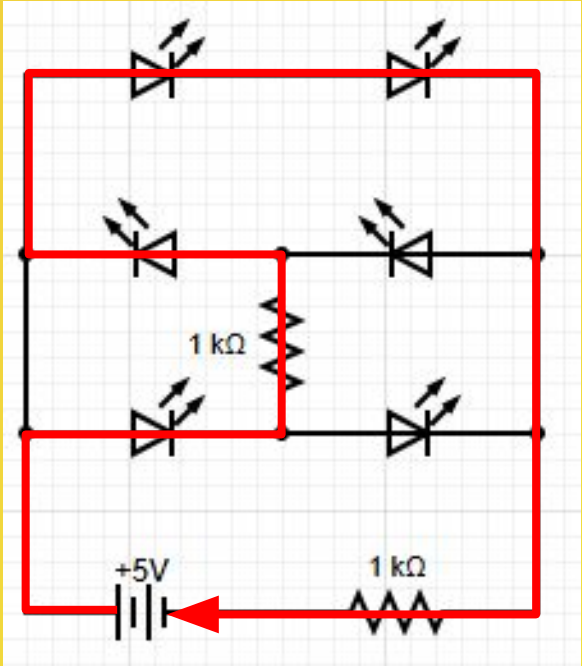
**Lightbulbs will light when current passes through them.**

The higher the current, the brighter the bulb!



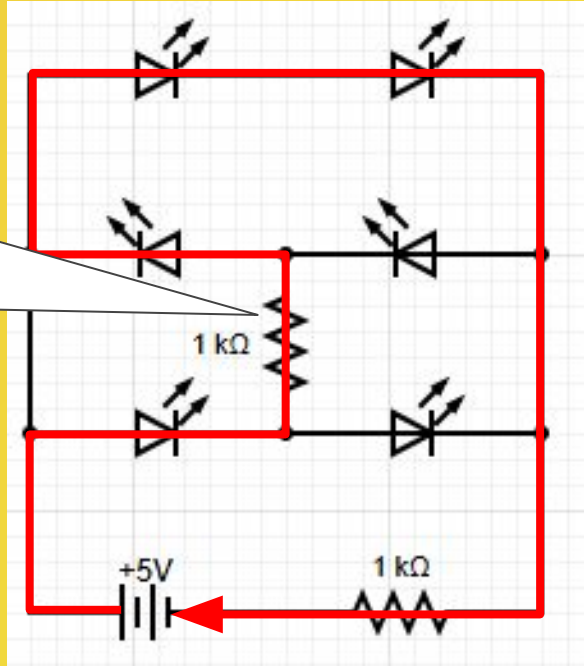



# Can electricity flow this way?



# No.

If the electricity went through the resistor, it would lose potential energy. It would not flow back to a wire that has a high potential energy.



# CRACK THE CIRCUIT

# Mystery Circuit!

Try to draw up a diagram for how the switchboard in front of you is wired up!
Pro Tip: be deliberate and discuss every step