OHM'S LAW AND ELECTRONIC CIRCUITS

ELECTRICAL CIRCUITS

All you need to be an inventor is a good imagination and a pile of junk.

-Thomas Edison

OHM'S LAW

Georg Simon Ohm (1787-1854)

$$I = V / R$$

I = Current (Amperes) (amps)

V = Voltage (Volts)

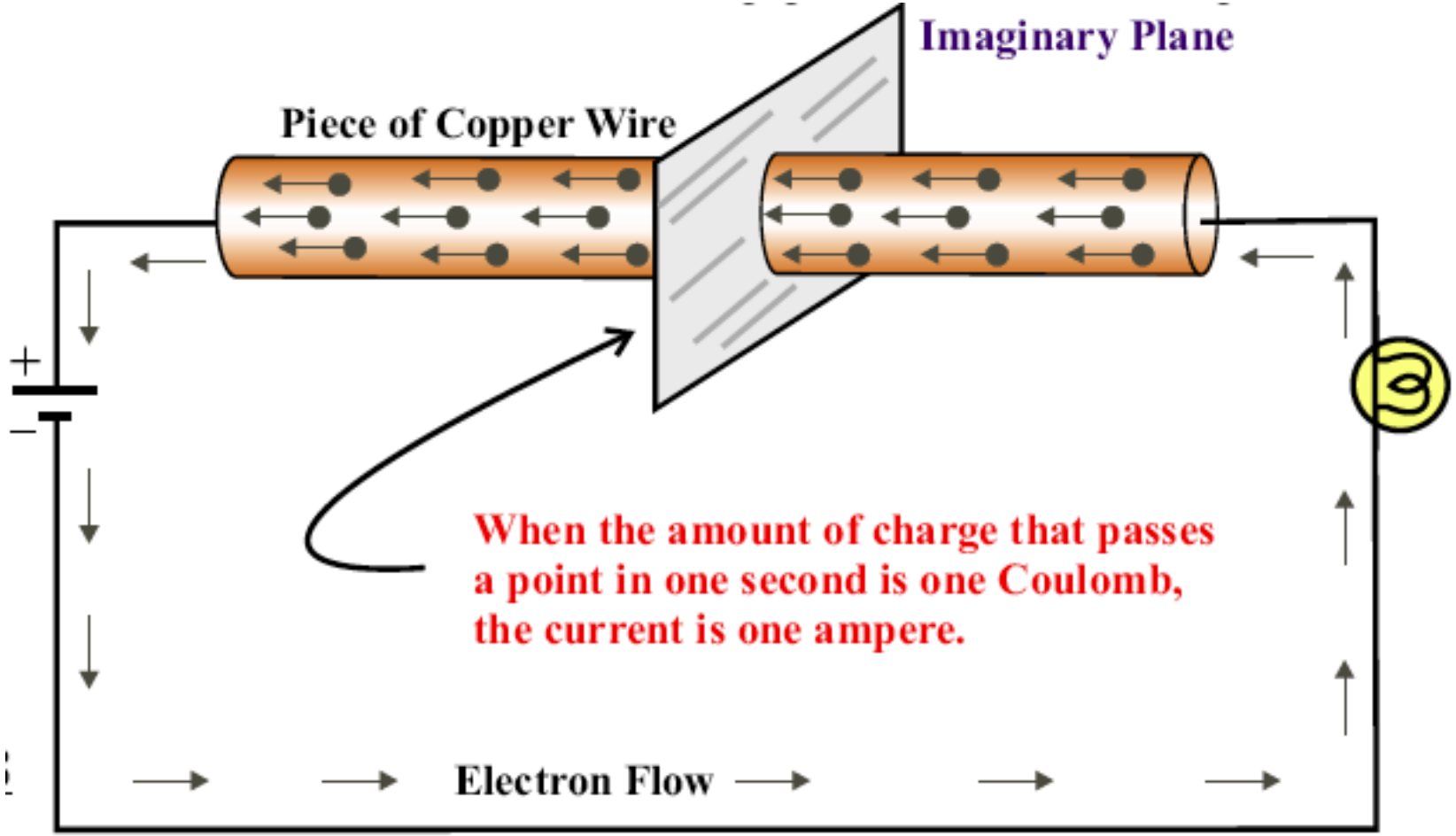
R = Resistance (ohms)

Ohm's Law

- Ohm's Law explains the relationship between voltage (V or E), current (I) and resistance (R)
- The amount of current in a circuit is dependent on its resistance and the applied voltage. Specifically I = V/R

- If you know any two of the factors V, I, and R you can calculate the third.
- Current I = V/R
- Voltage V = IR
- Resistance R = V/I

1 ampere = 1 coulomb per second



CHART

Quantity	Symbol	Unit of Measurement	Unit Abbreviation
Current	I	Ampere ("Amp")	A
Voltage	E *or* V	Volt	V
Resistance	R	Ohm	Ω

VOLTAGE (V)

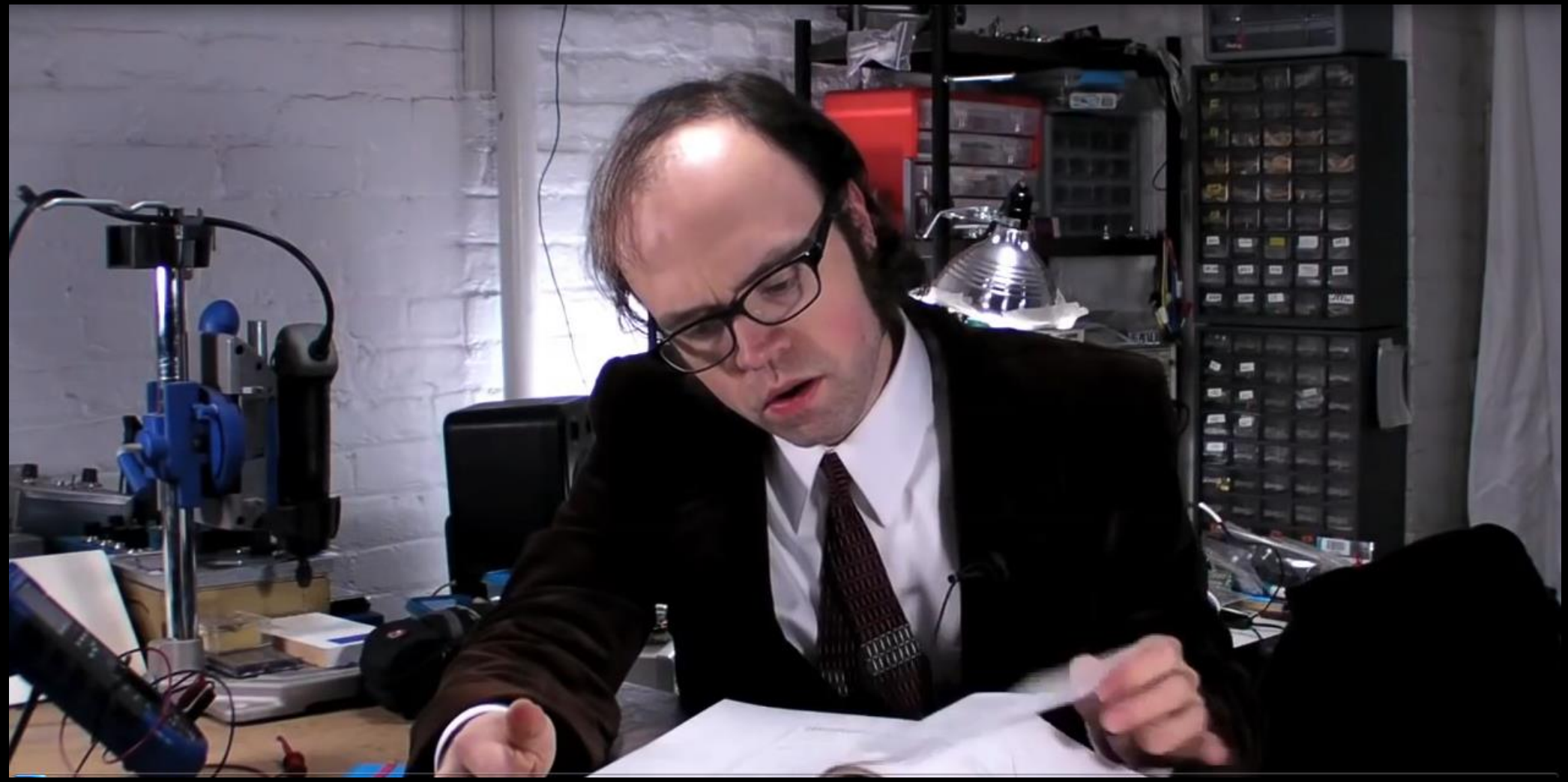
- It is the push or pressure behind current flow through a circuit, and is measured in (V) volts.

CURRENT

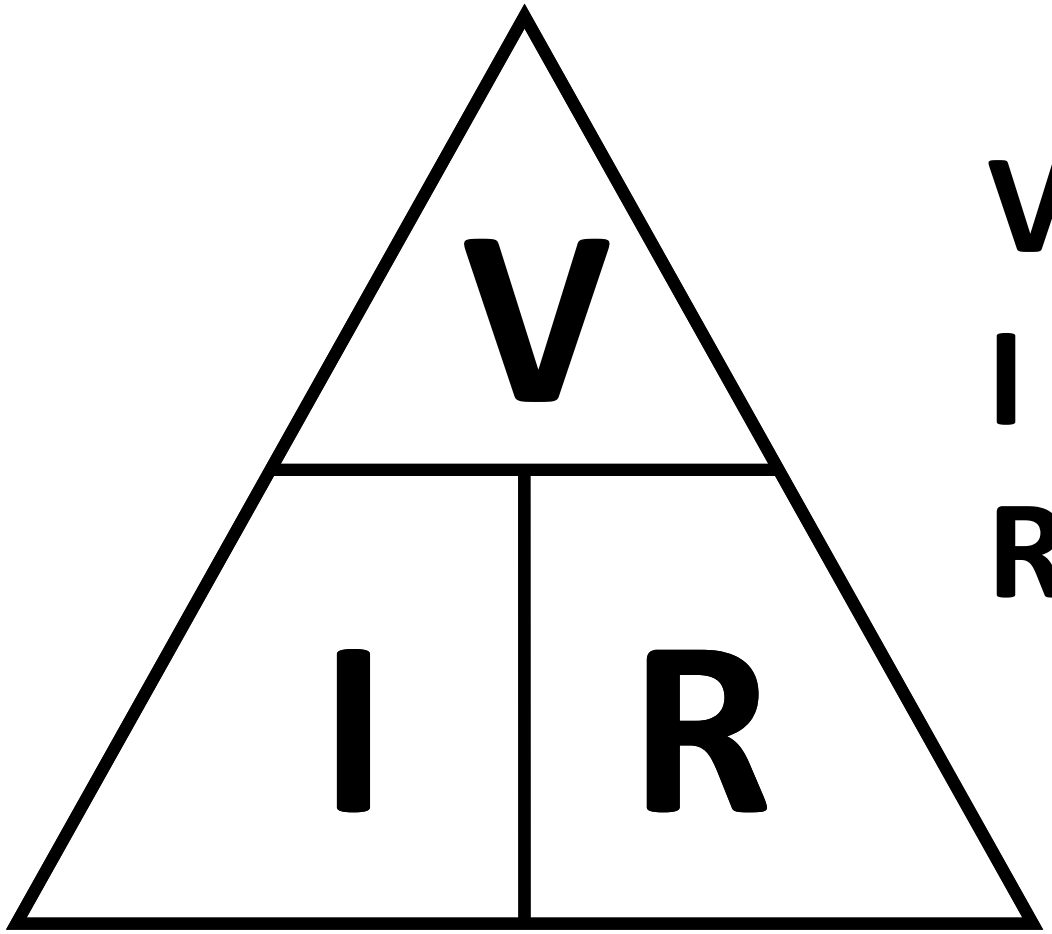
- Current refers to the quantity/volume of electrical flow. Measured in Amps (A)
- The symbol for current is I (for intensity) and is measured in **amperes**

RESISTANCE

- Resistance to the flow of the current. Measured in Ohms Ω
- Opposition to the flow of current is termed resistance.
- The fact that a wire can become hot from the flow of current is evidence of resistance.
- Conductors have very little resistance.
- Insulators have large amounts of resistance.



TRICK TO REMEMBER OHM'S LAW



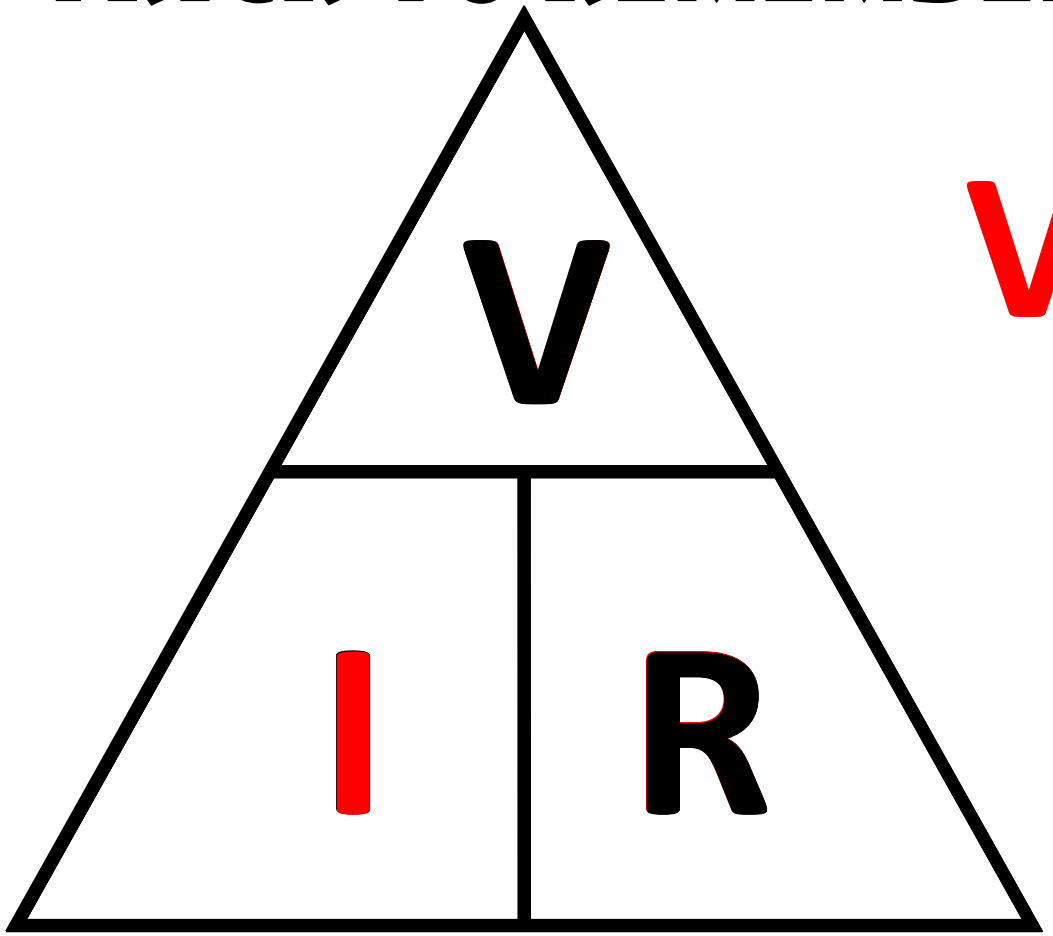
V = Voltage = Volts

I = Amperes = Amps

R = Resistance = Ohms

Ω

TRICK TO REMEMBER OHM'S LAW



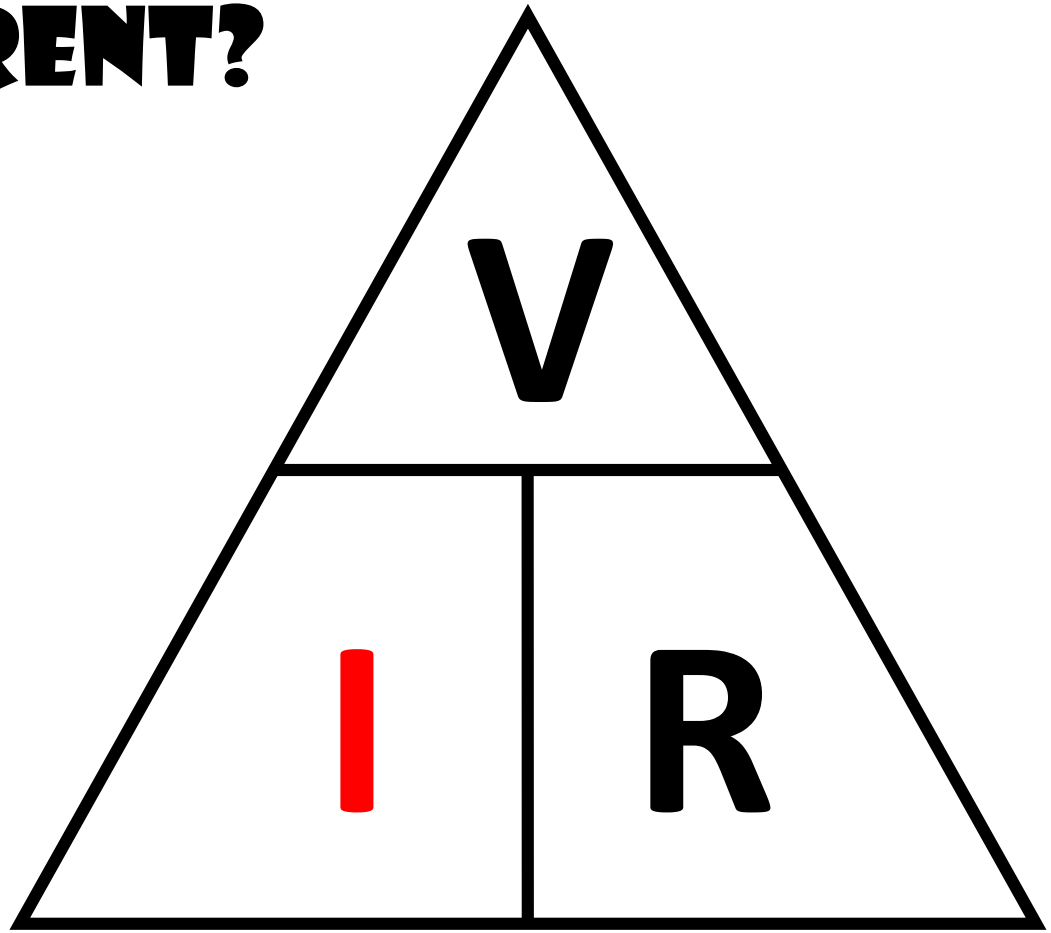
$$V = I * R$$

$$R = \frac{V}{I}$$

$$I = \frac{V}{R}$$

How do calculate current?

- Voltage is 5V
- Resistance is 220 Ω
- Current = Amp ?

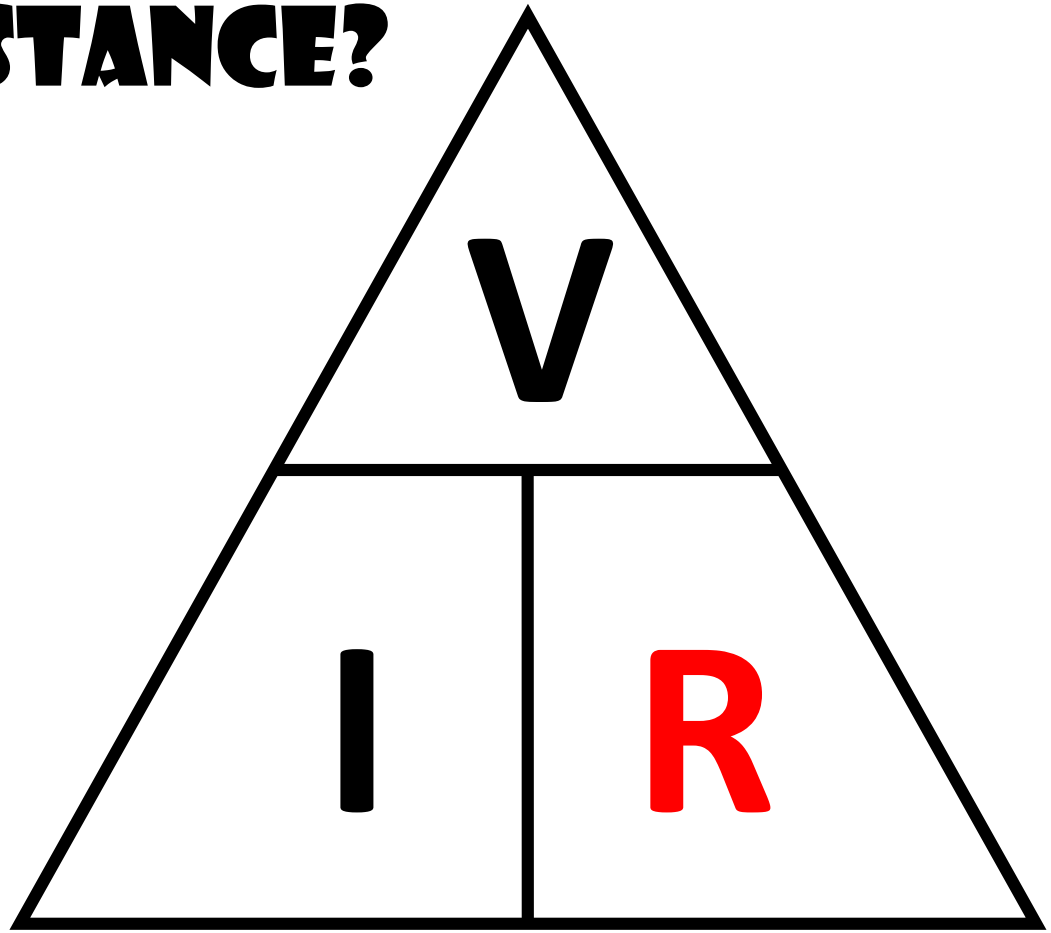


$$I = \frac{V}{R} \qquad I = \frac{5}{220}$$

$$I = 22.7\ mA$$

How do calculate resistance?

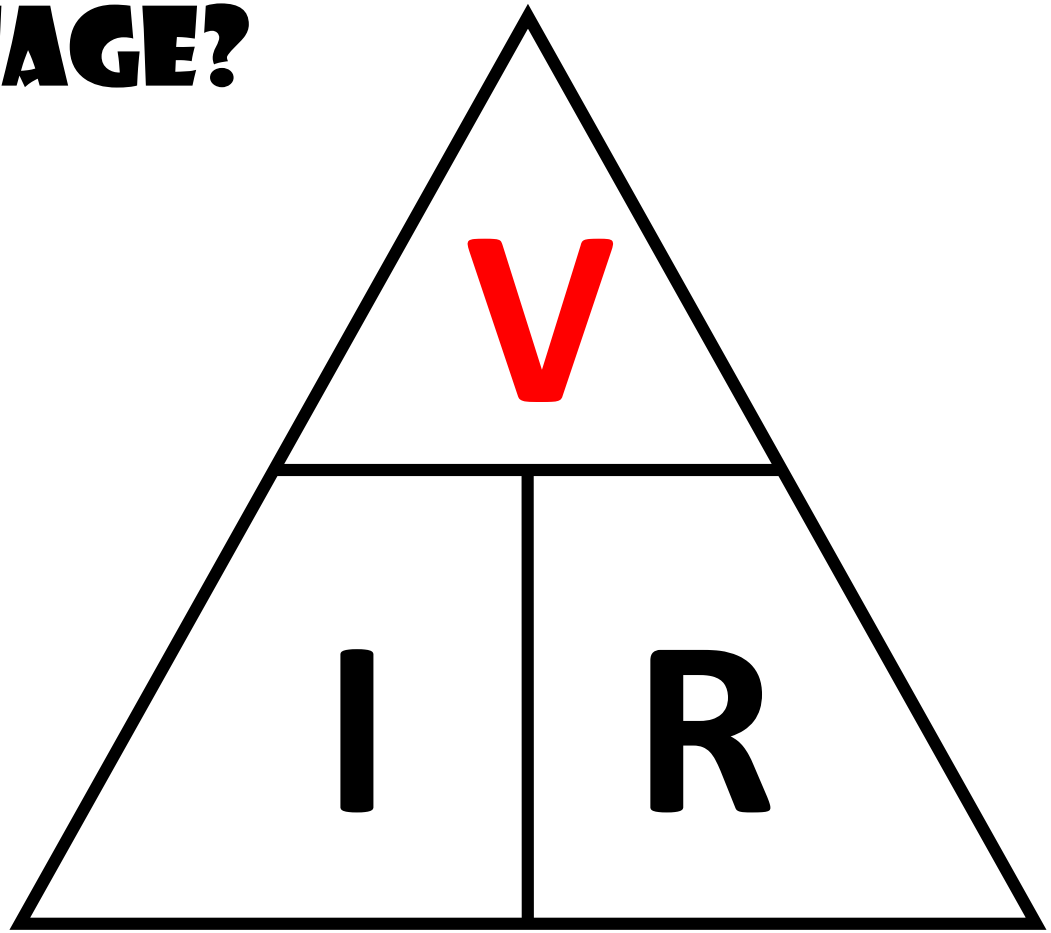
- Voltage is 5V
- Current is 10mA
- Resistance = Ohm?



$$R = \frac{V}{I} \qquad R = \frac{5}{.010_{amp}} \qquad R = 500\ \Omega$$

How do calculate voltage?

- Resistance is 1KΩ
- Current is 200 mA
- Voltage = V?



V=I*R V= .2*1KΩ V = 200v

WOULD THIS WORK?

WOULD THIS WORK?

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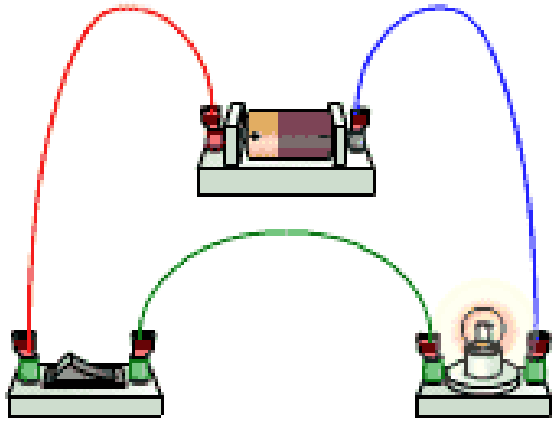
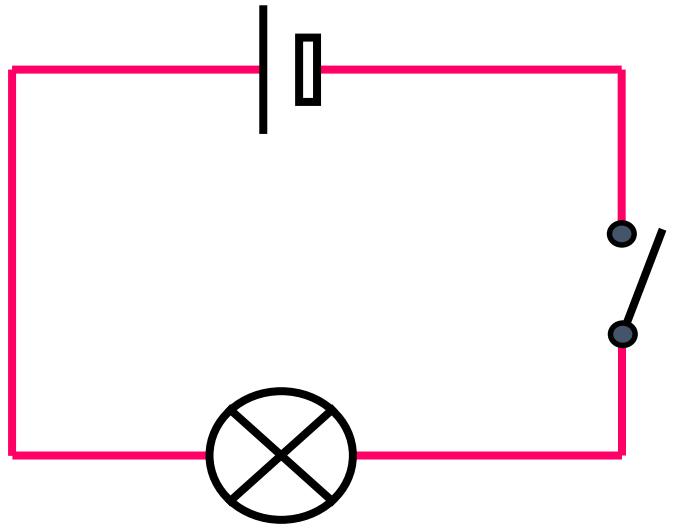
WOULD THIS WORK?

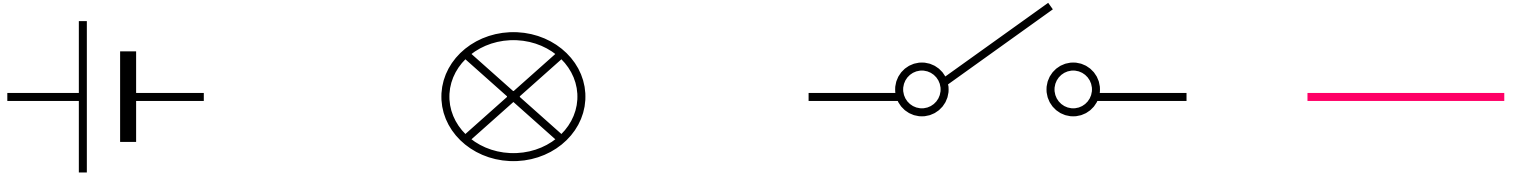
THE CENTRAL CONCEPT: CLOSED CIRCUIT

CIRCUIT DIAGRAM

Scientists usually draw electric circuits using symbols;







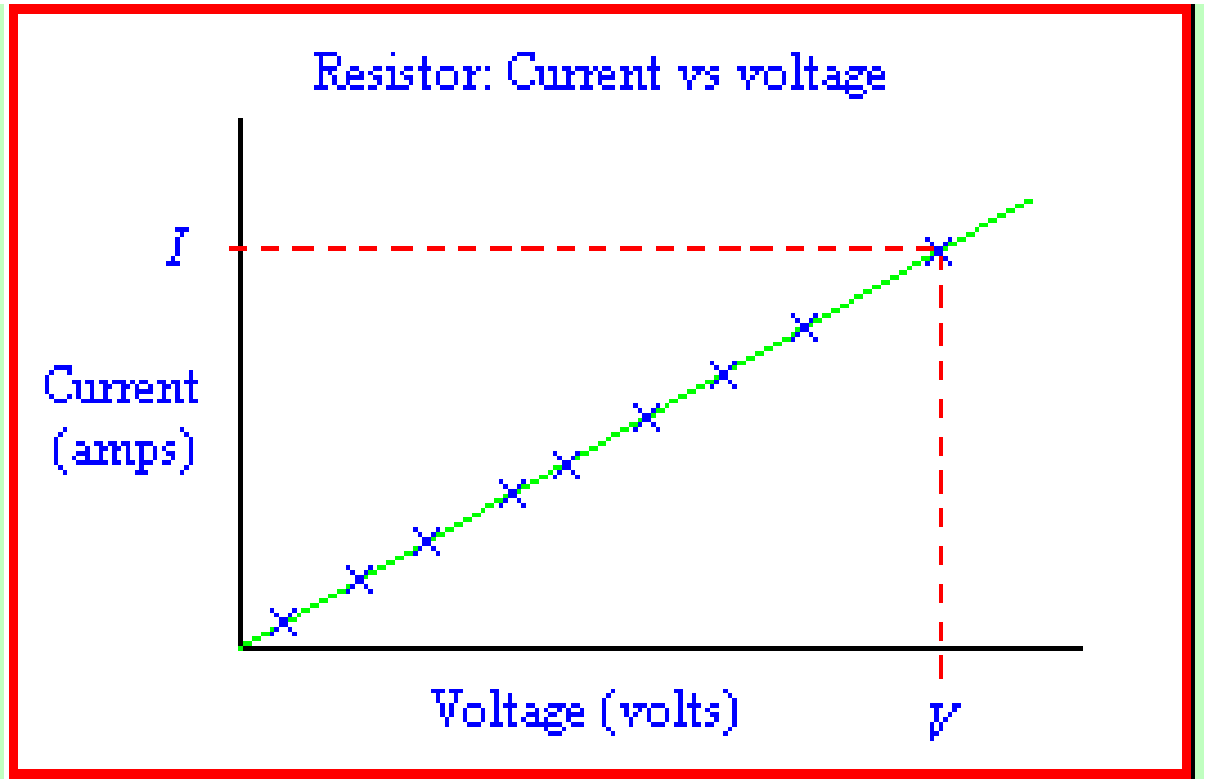
cell lamp switch wires

Current is Directly Proportional to Voltage for a Constant Resistance

- For the same resistance, 330Ω, if the voltage is increased, then the current will increase as well

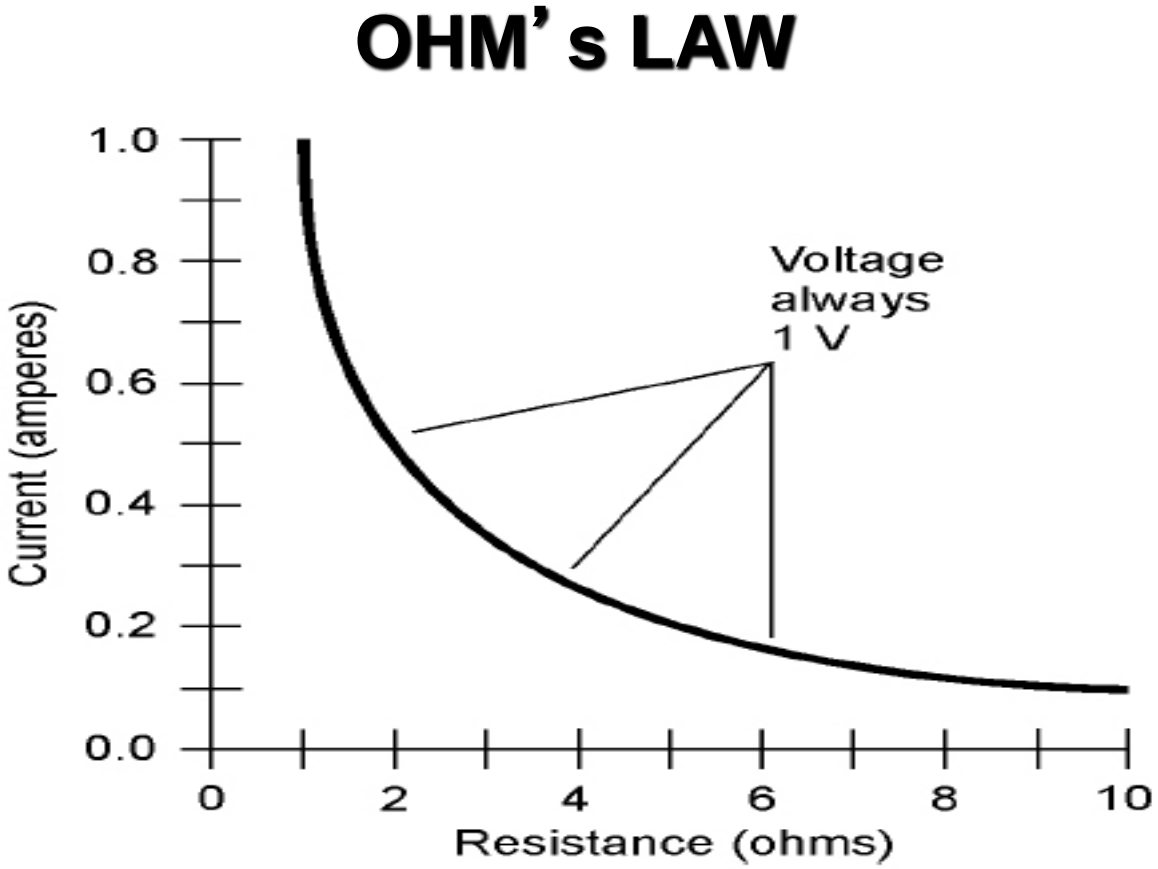
R = 330Ω, Volts = 1V, Current will = 3.0mA
R = 330Ω, Volts = 2V, Current will = 6.0mA
R = 330Ω, Volts = 5V, Current will = 15.1mA
R = 330Ω, Volts = 12V, Current will = 36.3mA
R = 330Ω, Volts = 15V, Current will = 45.5mA
R = 330Ω, Volts = 25V, Current will = 75.8mA

OHM's LAW



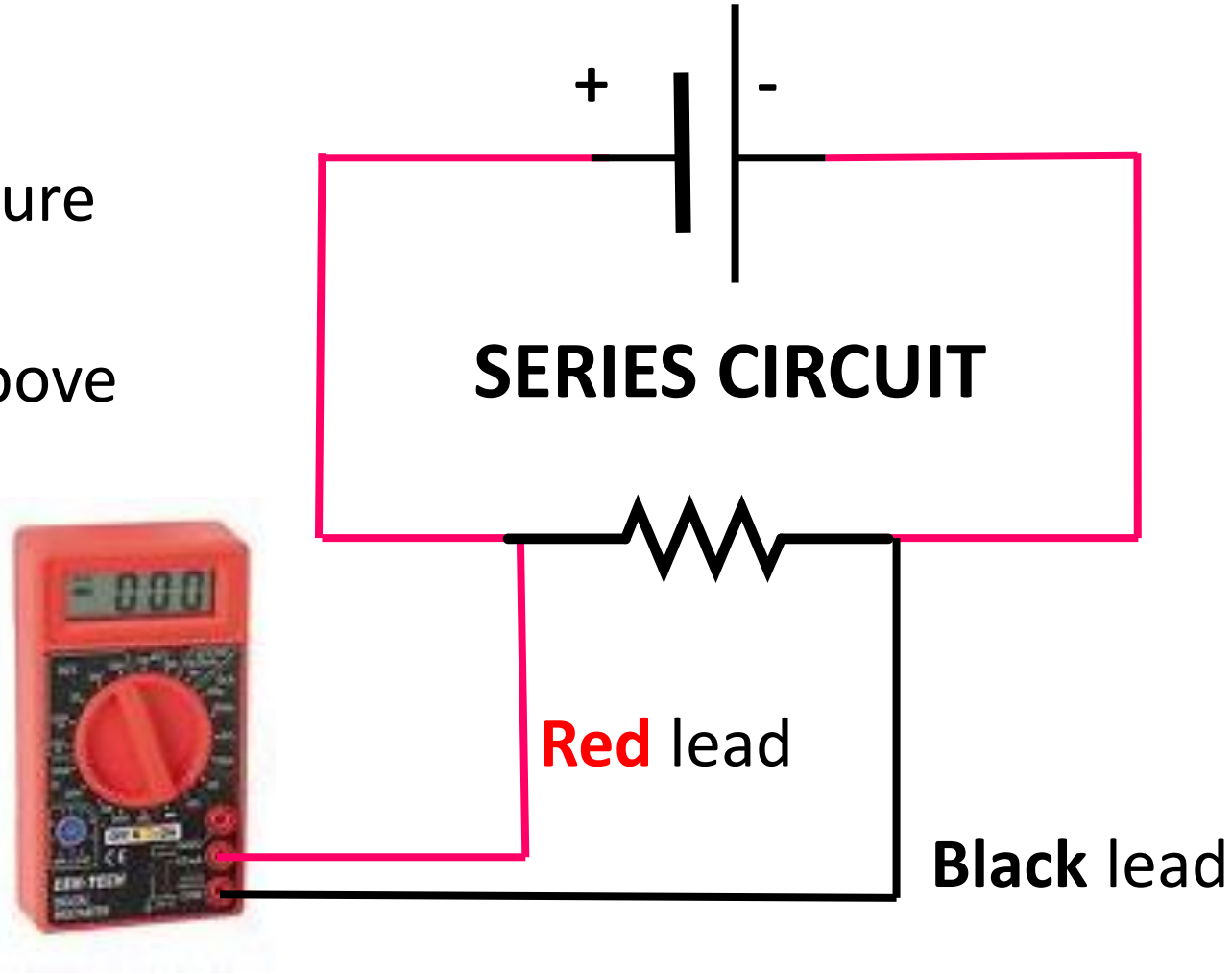
Current is Inversely Proportional to Resistance for a Constant Voltage

Volts = 1V, R = 1Ω, Current will = 1A
Volts = 1V, R = 2Ω, Current will = 500mA
Volts = 1V, R = 4Ω, Current will = 250mA
Volts = 1V, R = 6Ω, Current will = 167mA
Volts = 1V, R = 8Ω, Current will = 1.25mA
Volts = 1V, R = 10Ω, Current will = 100mA
Volts = 1V, R = 12Ω, Current will = 83.3mA



MEASURING VOLTAGE

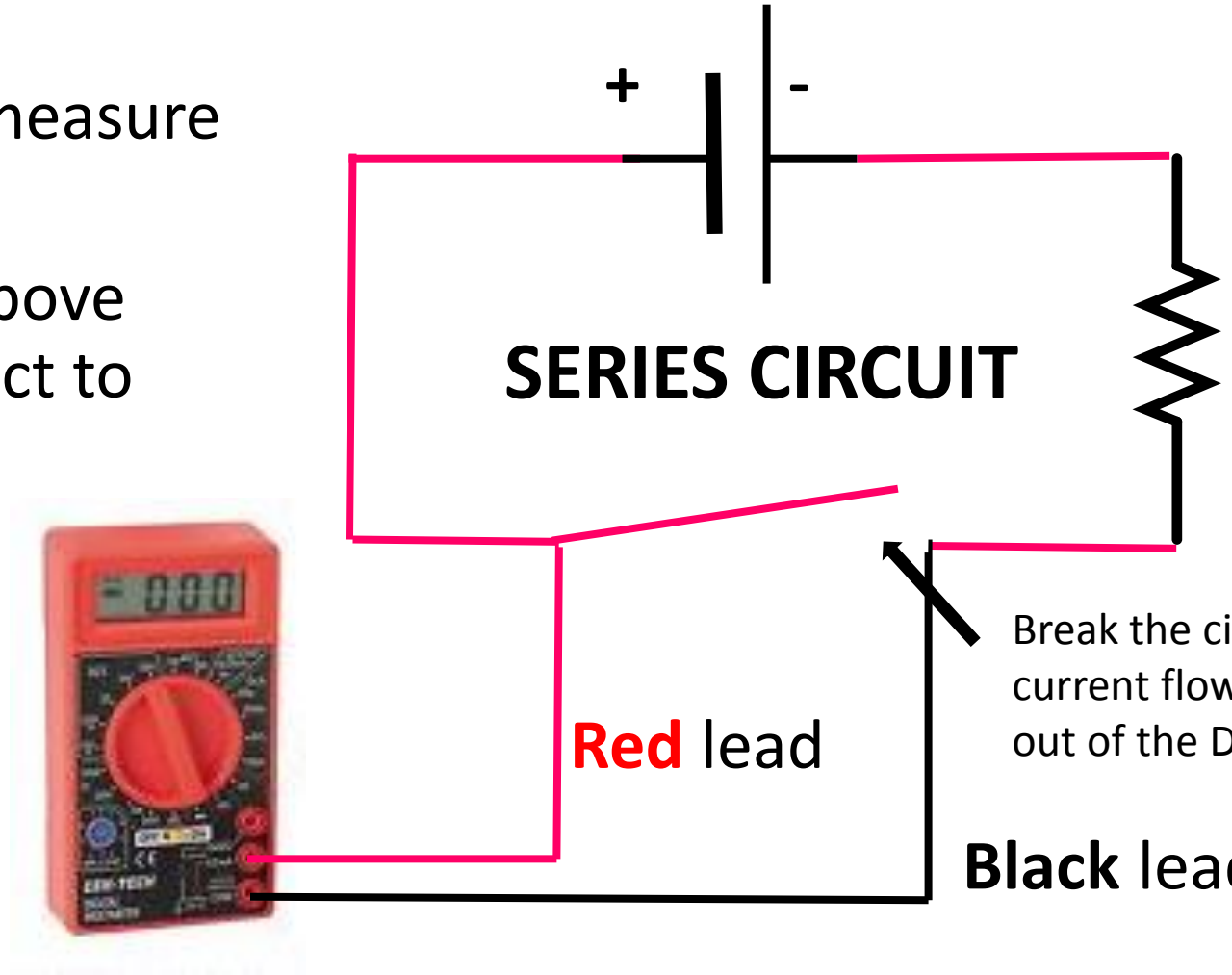
- Set the DMM to Ω (to measure Resistance)
- Set it to the closest value above the target resistor you are measuring



This is how we measure volts in a circuit

MEASURING CURRENT

- Set the DMM to Amps (to measure Current)
- Set it to the closest value above the target current you expect to measure



This is how we measure Amps in a circuit

General Rule.

1. Assuming the resistance does not change:

- As voltage increases, current increases.
- as voltage decreases, current decreases.

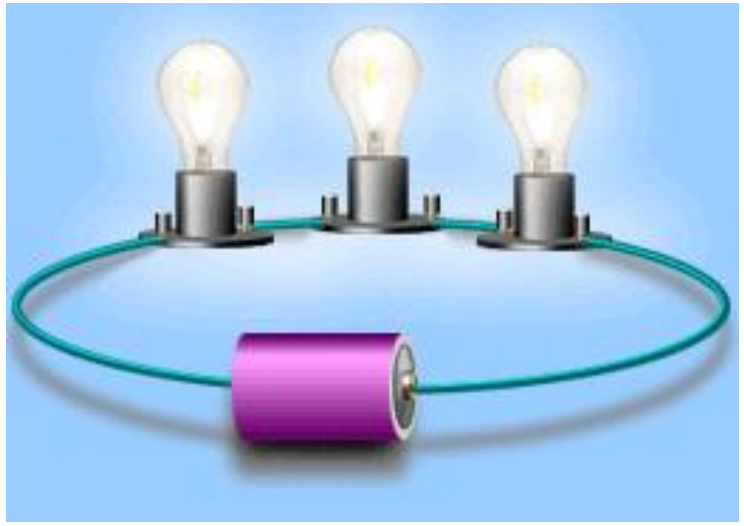
2. Assuming the voltage does not change:

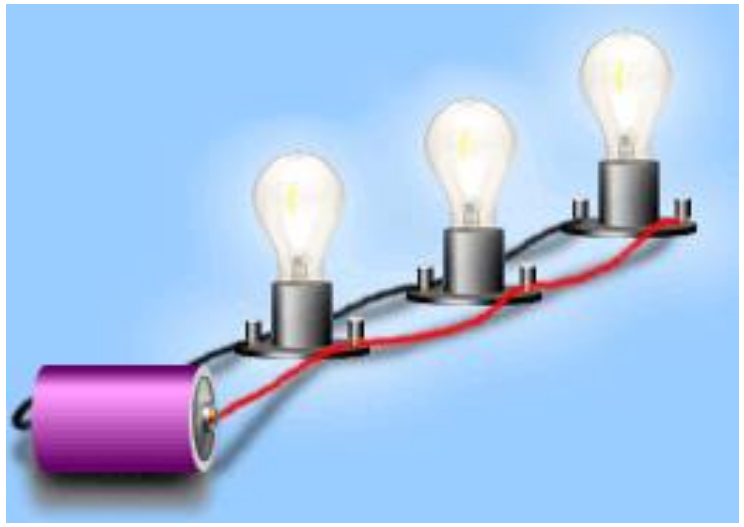
- As resistance increases, current decreases.
- As resistance decreases, current increases.

RECAP!!

- What is Voltage?
- What is Current?
- What is Resistance?

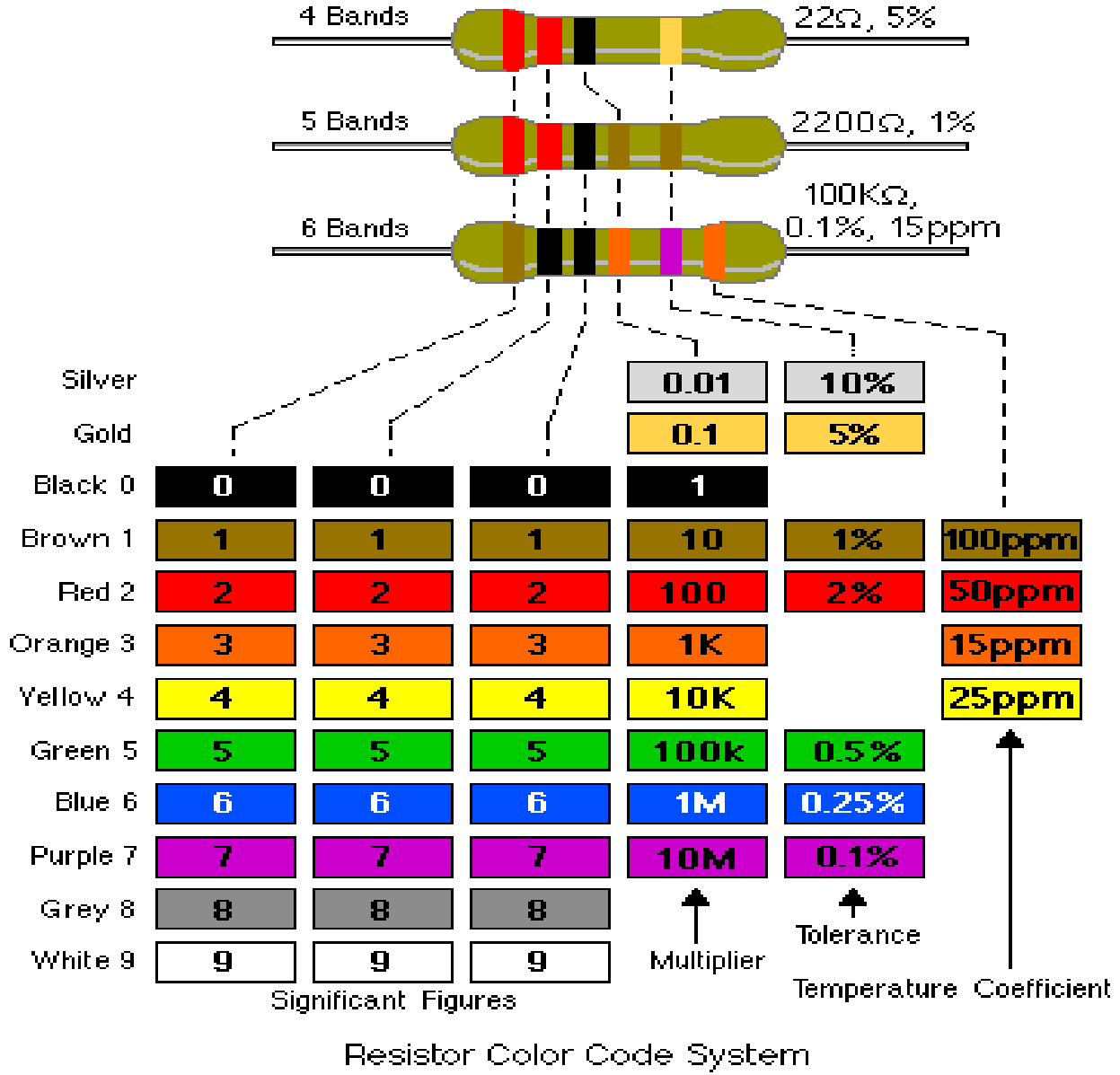
SIMPLE CIRCUITS





- Series circuit
  - All in a row
  - 1 path for electricity
  - 1 light goes out and the circuit is broken
- Parallel circuit
  - Many paths for electricity
  - 1 light goes out and the others stay on

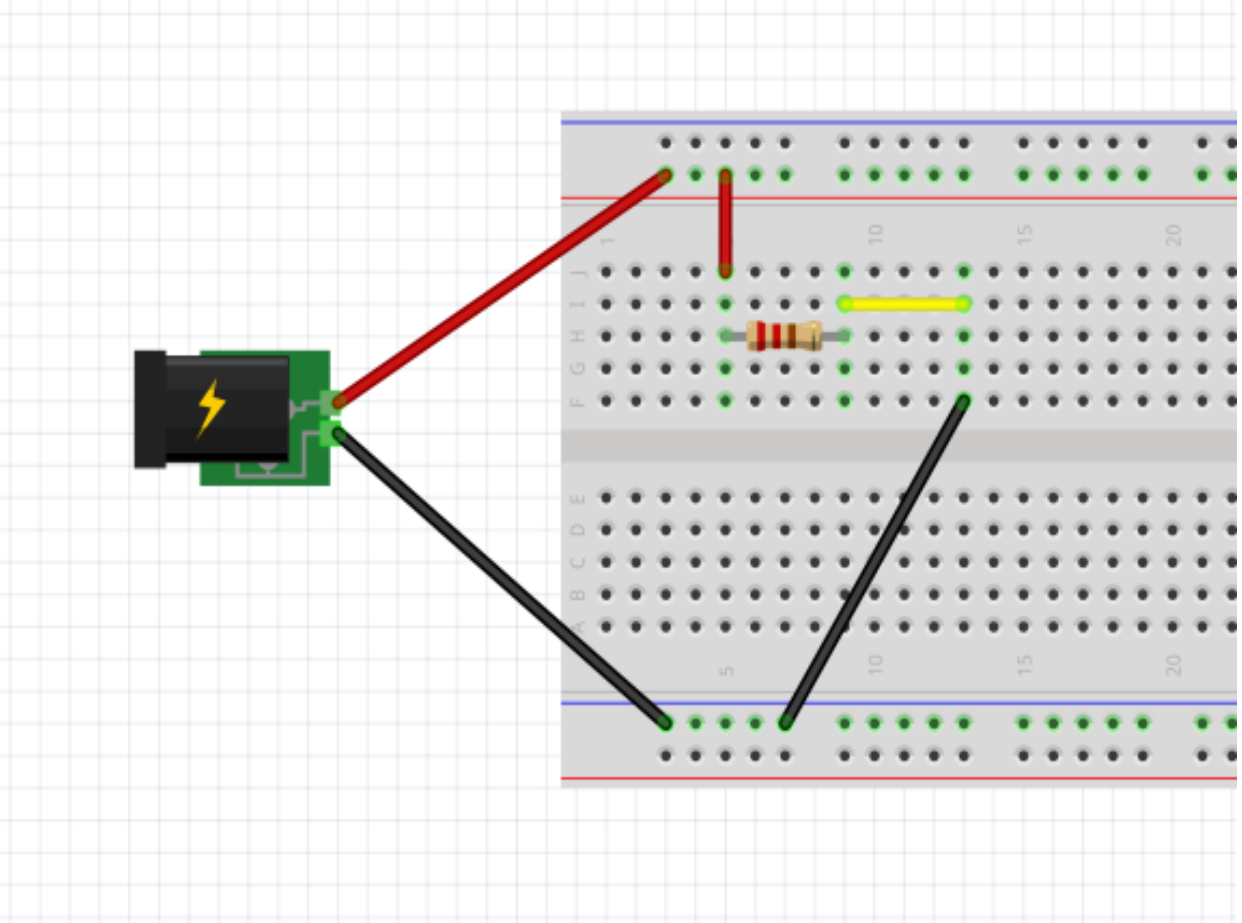
RESISTOR COLOR CHART

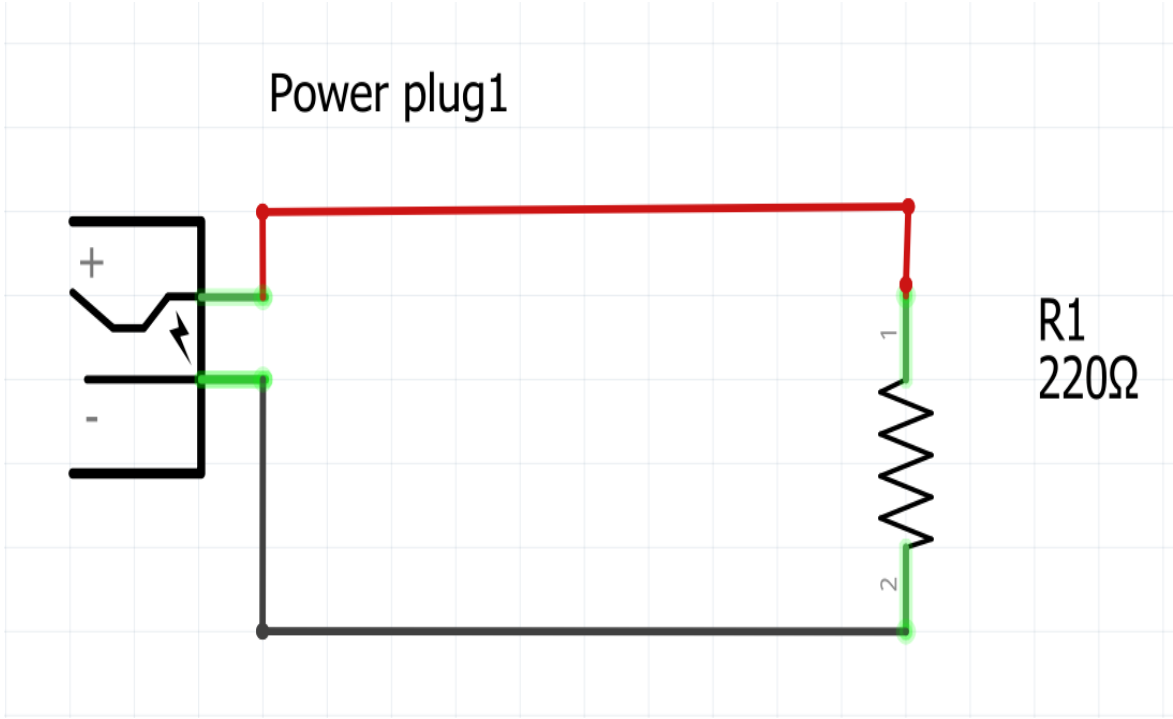


Resistor Color Code System

LAB TIME

TESTING DIFFERENT RESISTOR CIRCUIT





LOG SOME DATA

- Open your log books
- On the next available space
  - Note the Date
  - Draw a table (add table label that says “for a fixed 5 volt power supply”

Resistor Marked Value	Resistor Measured Value	Measured Voltage	Expected Current	Measured Current

Make some measurements

- On your lab book table, note the marked value of each Resistor
- The measure each Resistor and record the measured value
  - How do we do that?

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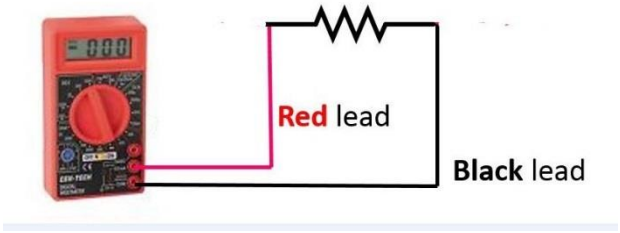

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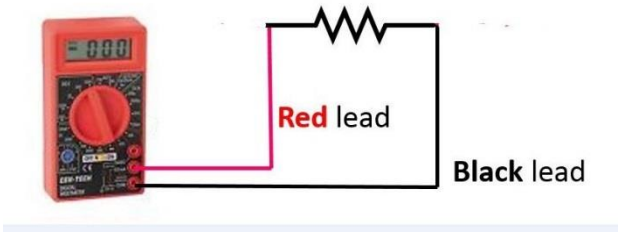

- You have a 5 Volt supply, but it is not exact, so measure it too
  - How do we do that?

MAKE SOME MEASUREMENTS

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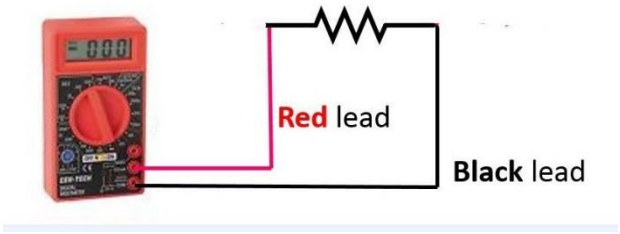

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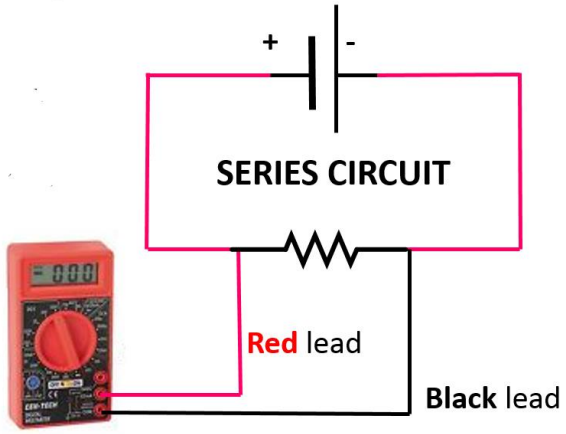

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MAKE SOME MEASUREMENTS

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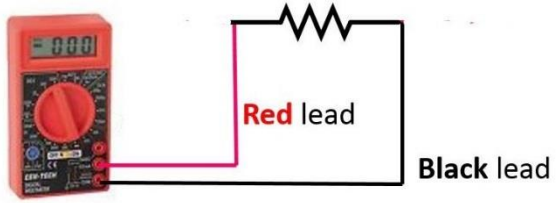

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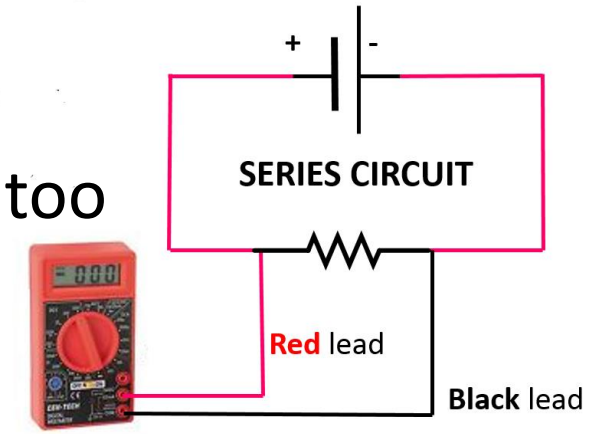

- Now Measure the current for each Resistor
  - How do we do that?

MAKE SOME MEASUREMENTS

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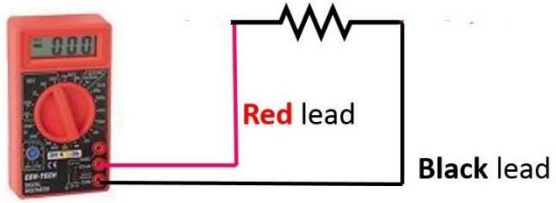

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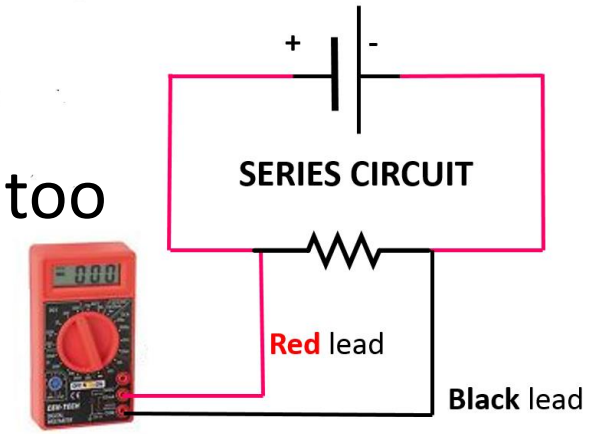

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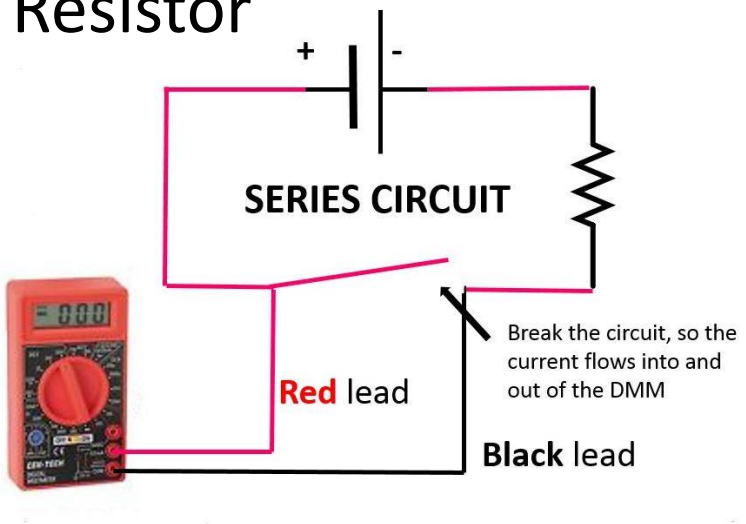

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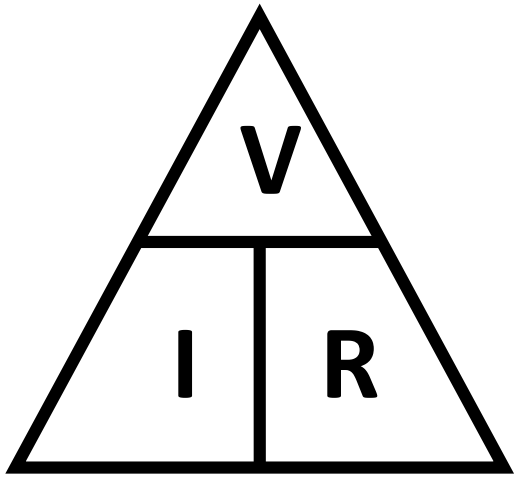
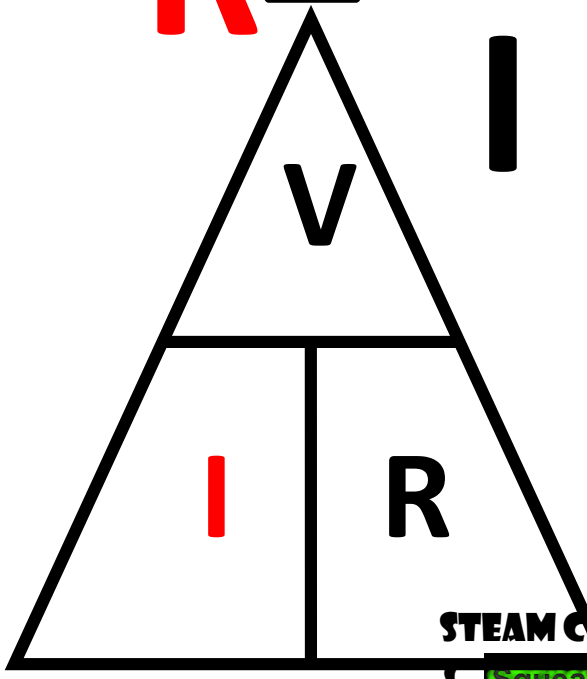
Trick to Remember Ohm's Law

$$V = I * R$$



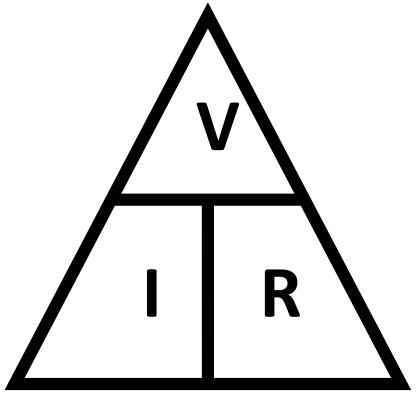
$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$



Ohm's Law Practice Sheet #1

- The only way to master Ohm's law is with practice



$$R = \frac{V}{I}$$

$$I = \frac{V}{R}$$

$$V = I * R$$

Volts (V)	Resistance (Ω)	Current (Amps)
5V	20KΩ	_____ __A
_____ __V	5Ω	2A
12V	_____ __Ω	40mA
_____ __V	330Ω	500mA
5V	220Ω	_____ __A
5V	_____ __Ω	35mA
24V	1.2KΩ	_____ __A

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REFERENCE SLIDES

RESISTANCE

- Opposition to the flow of current is **resistance**
- The fact that a wire can become hot from the flow of current is evidence of resistance.
- **Conductors** have very little resistance.
- **Insulators** have large amounts of resistance.

CONDUCTORS

- Have 1 valence electron
- Materials in which electrons can move freely from atom to atom are called conductors.
- In general all metals are good conductors.
- The purpose of conductors is to allow electrical current to flow with minimum resistance.

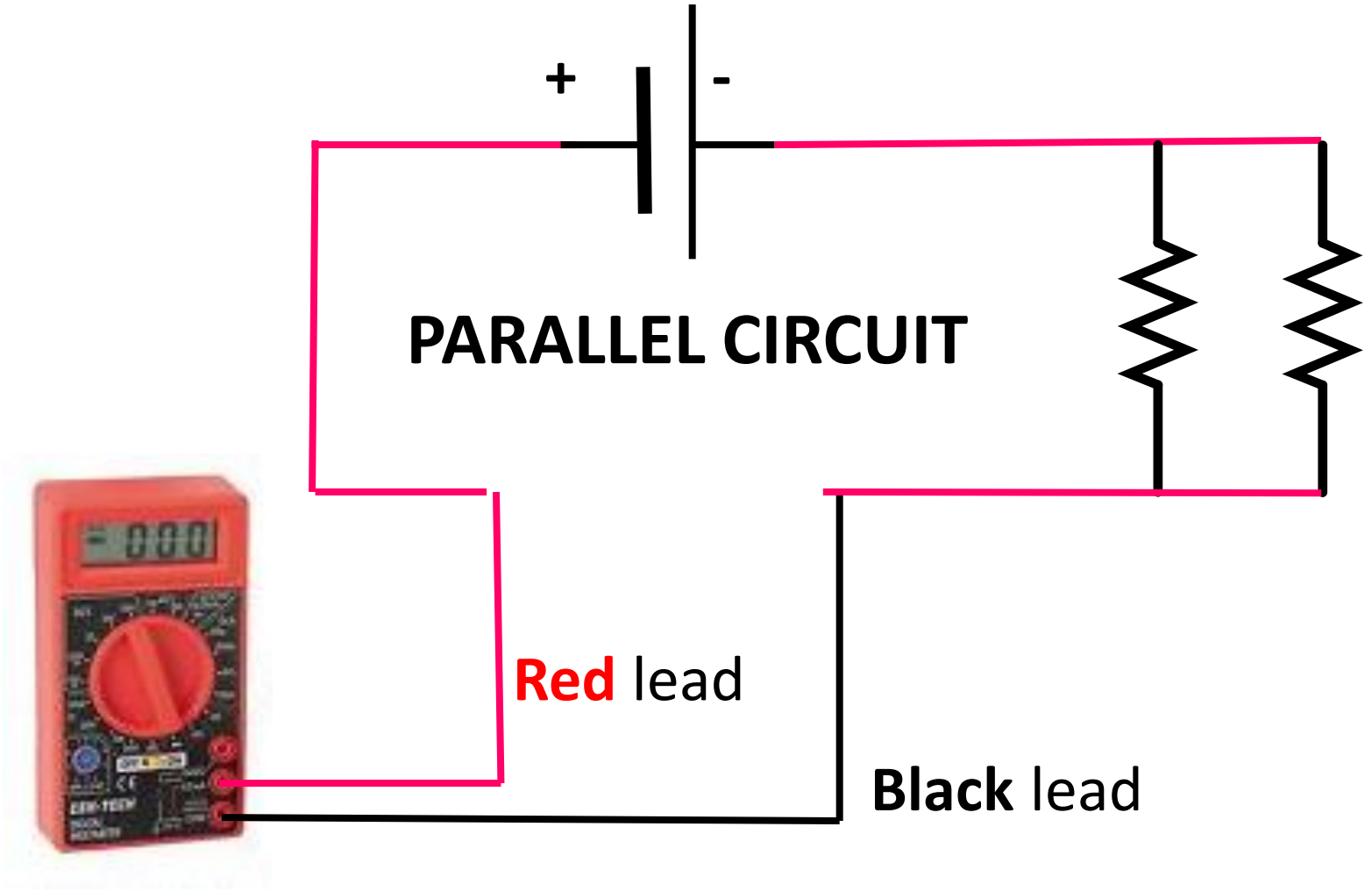
INSULATORS

- Have 8 valence electrons
- Materials in which electrons tend to stay put and do not flow easily from atom to atom are termed insulators.
- Insulators are used to prevent the flow of electricity.
- Insulating materials such as glass, rubber, or plastic are also called dielectrics, meaning they can store charges.
- Dielectric materials are used in components like capacitors which must store electric charges.

SEMI-CONDUCTORS

- Have 4 valence electrons
- Materials which are neither conductors nor insulators
- Common semi conductor materials are carbon, germanium and silicone.
- Used in components like transistors

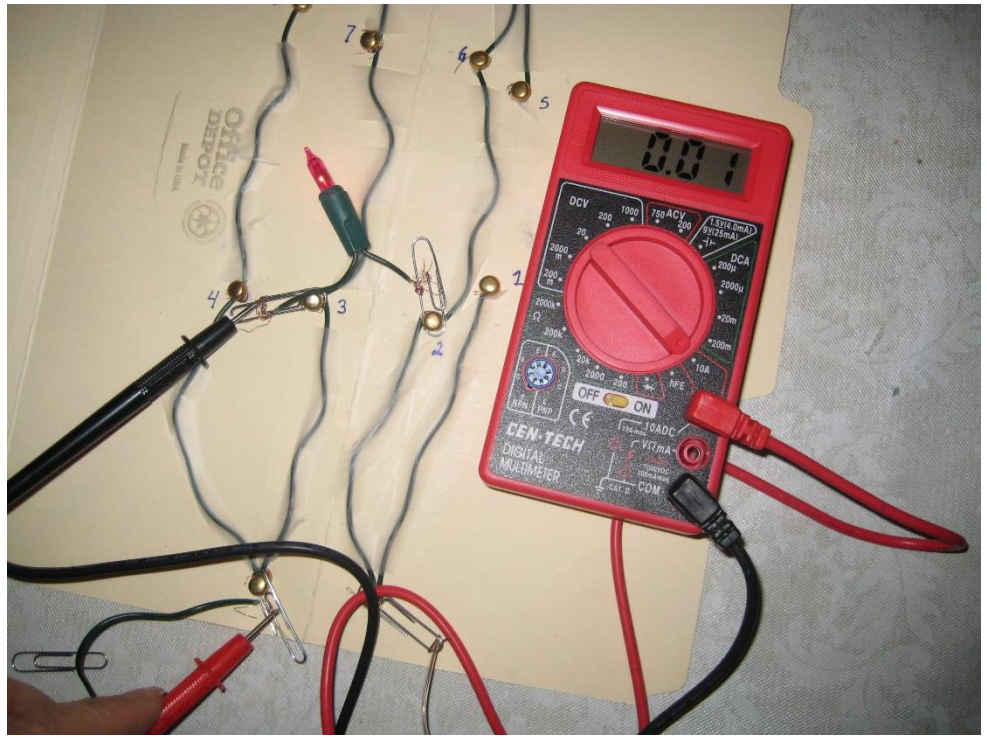
MEASURING VOLTAGE



This is how we measure volts in a circuit

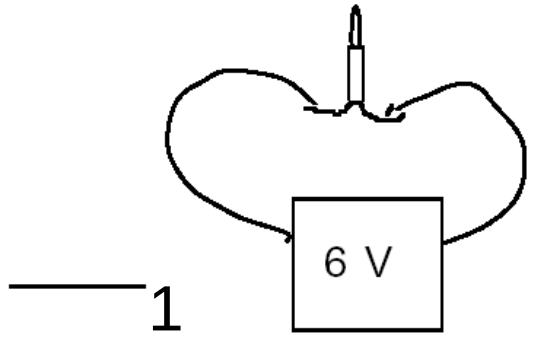
MEASURING CURRENT

Electric current is measured in **amps** (A) using an ammeter connected in series in the circuit.



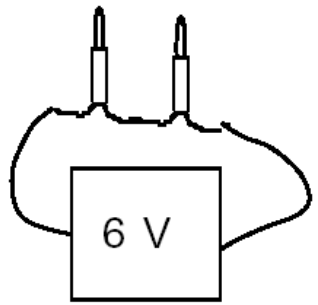
SERIES CIRCUITS

Connect one bulb to the battery.



_____ 1

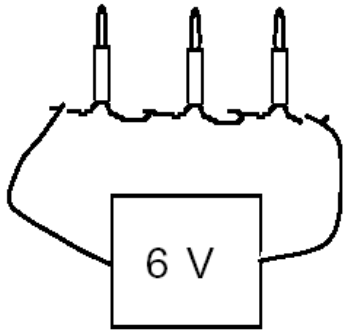
Connect 2 bulbs and the battery to form a series circuit.



_____

Connect 3 bulbs and the battery to form a series circuit.

2



_____

Mark from 1 to 3 each diagram according to brightness. (3 - brightest)

Since the brightness of the bulbs indicate how much current

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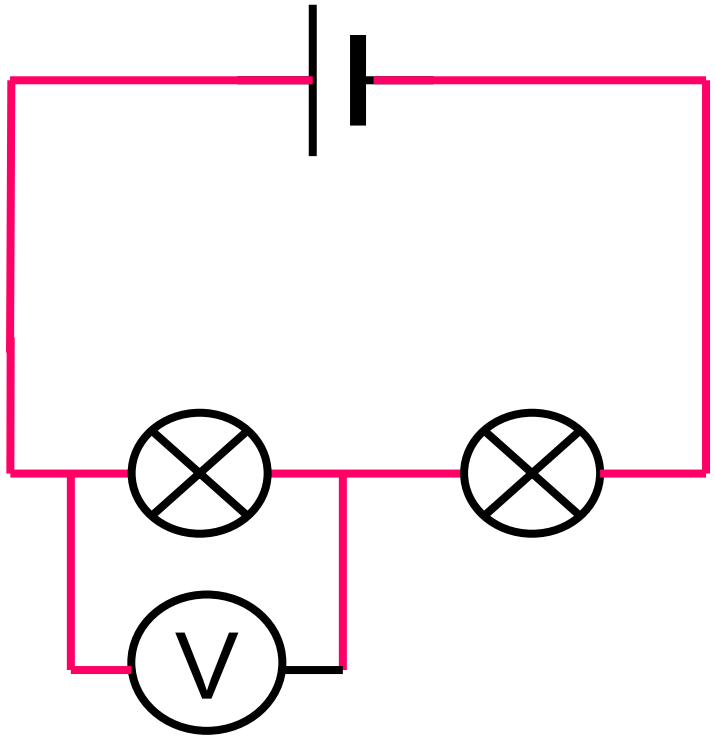
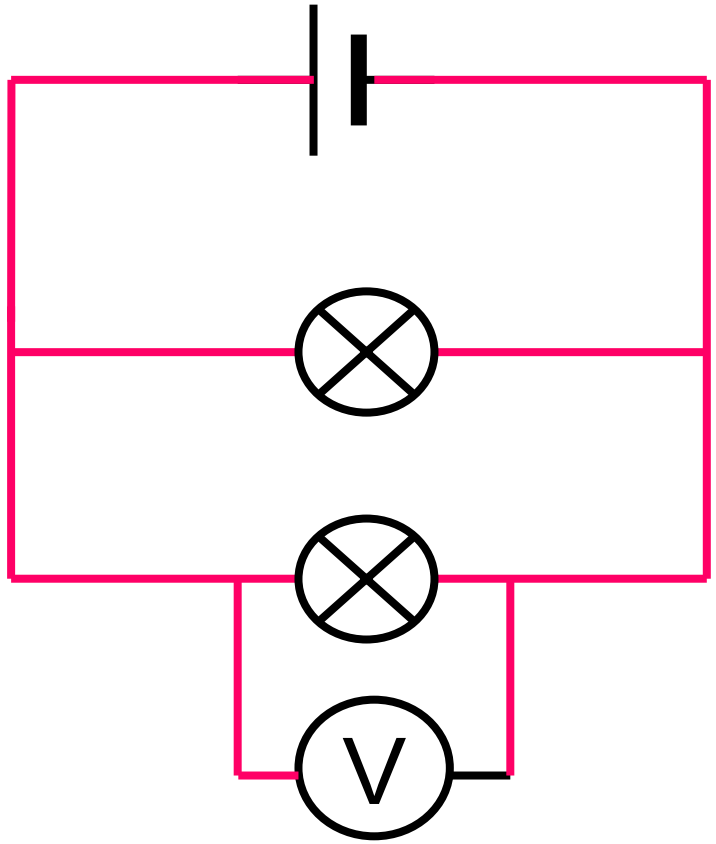
measuring voltage

This is how we draw a voltmeter in a circuit.



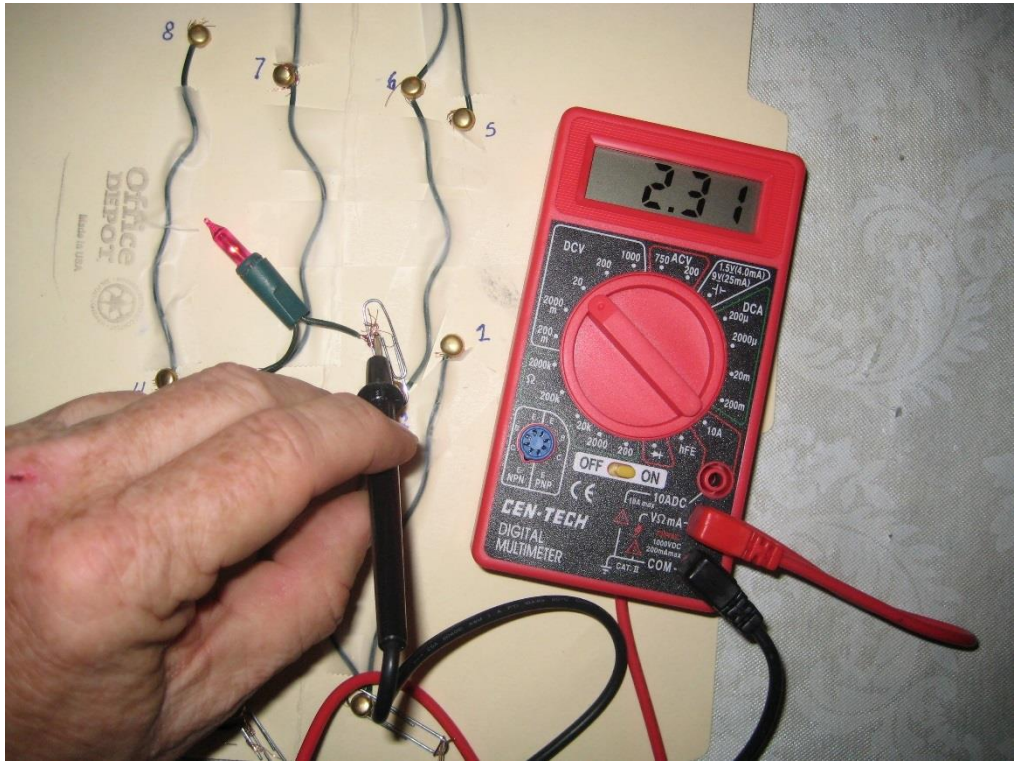
SERIES CIRCUIT



PARALLEL CIRCUIT

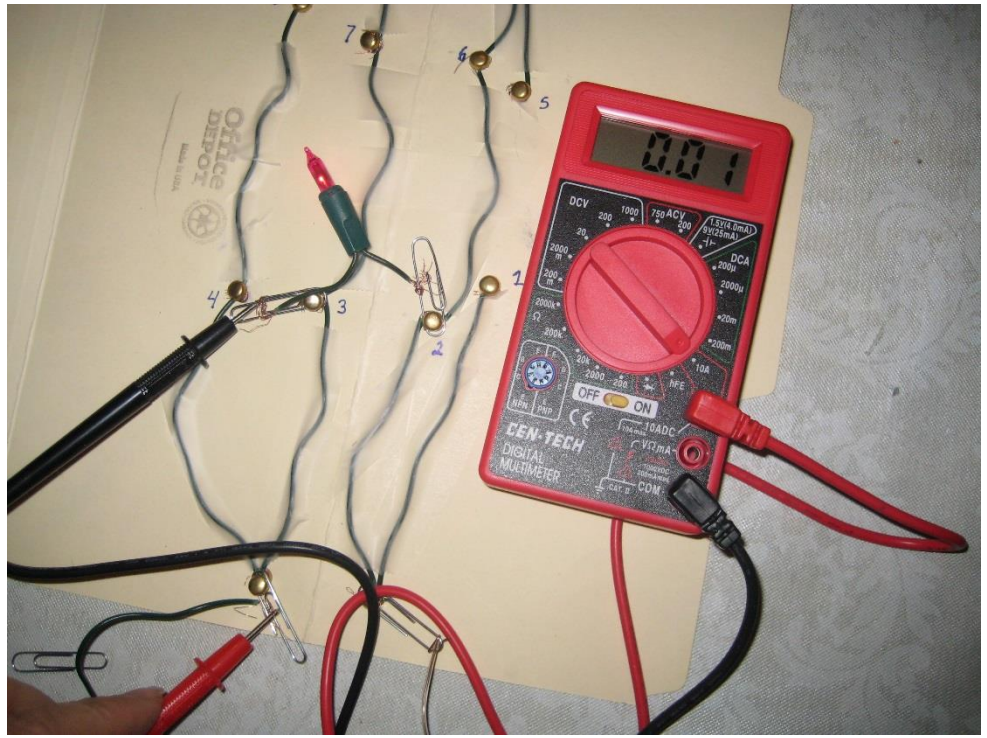
MEASURING VOLTAGE

The 'electrical push' which the cell gives to the current is called the voltage. It is measured in **volts** (V) on a **voltmeter**



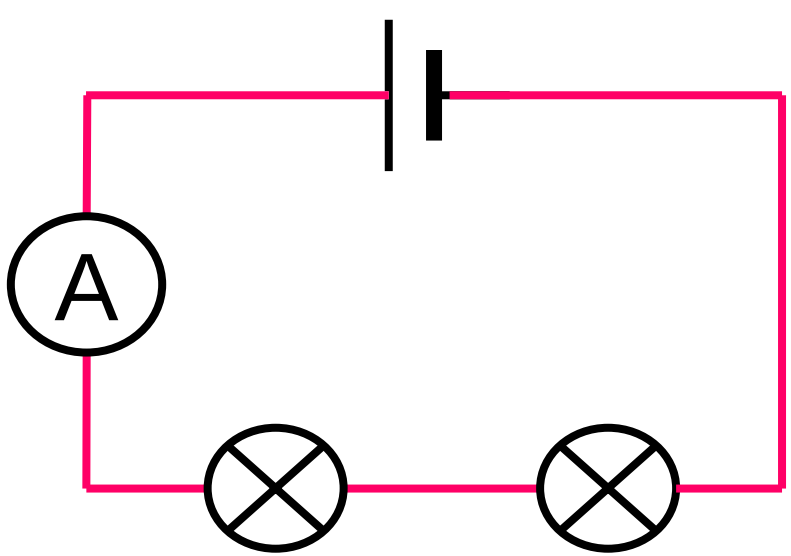
MEASURING CURRENT

Electric current is measured in **amps** (A) using an ammeter connected in series in the circuit.

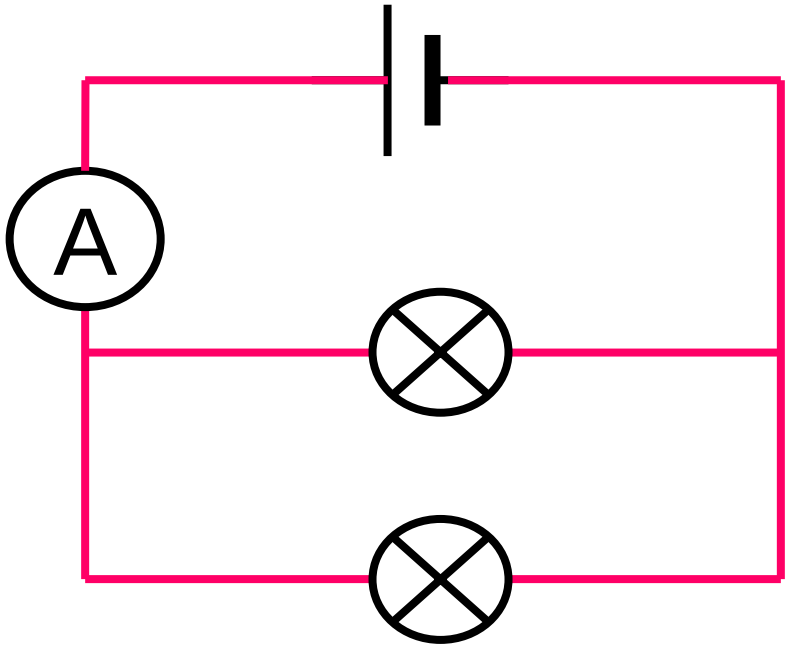


measuring current

This is how we draw an ammeter in a circuit.



SERIES CIRCUIT



PARALLEL CIRCUIT