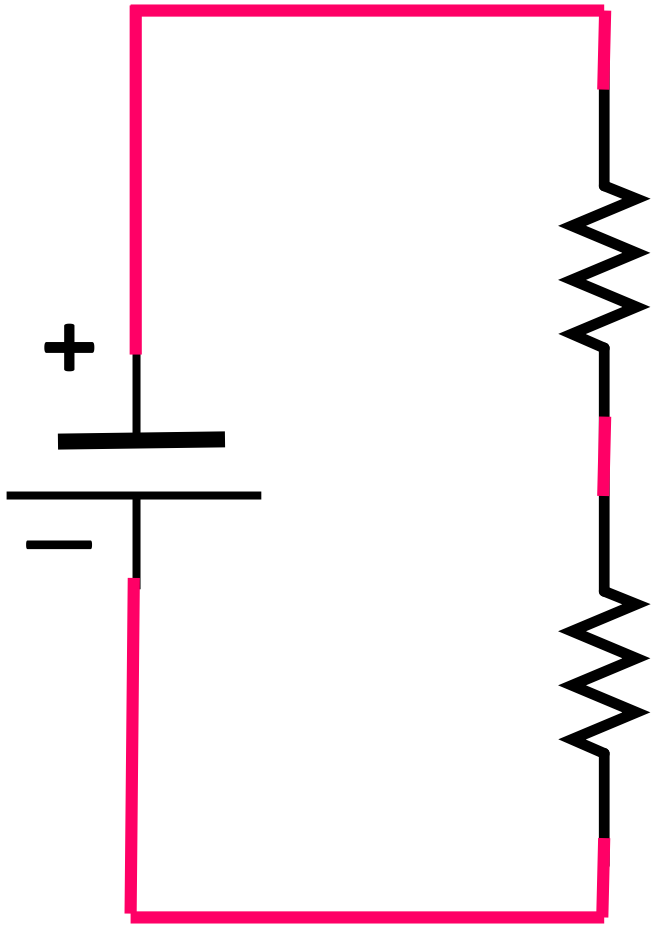
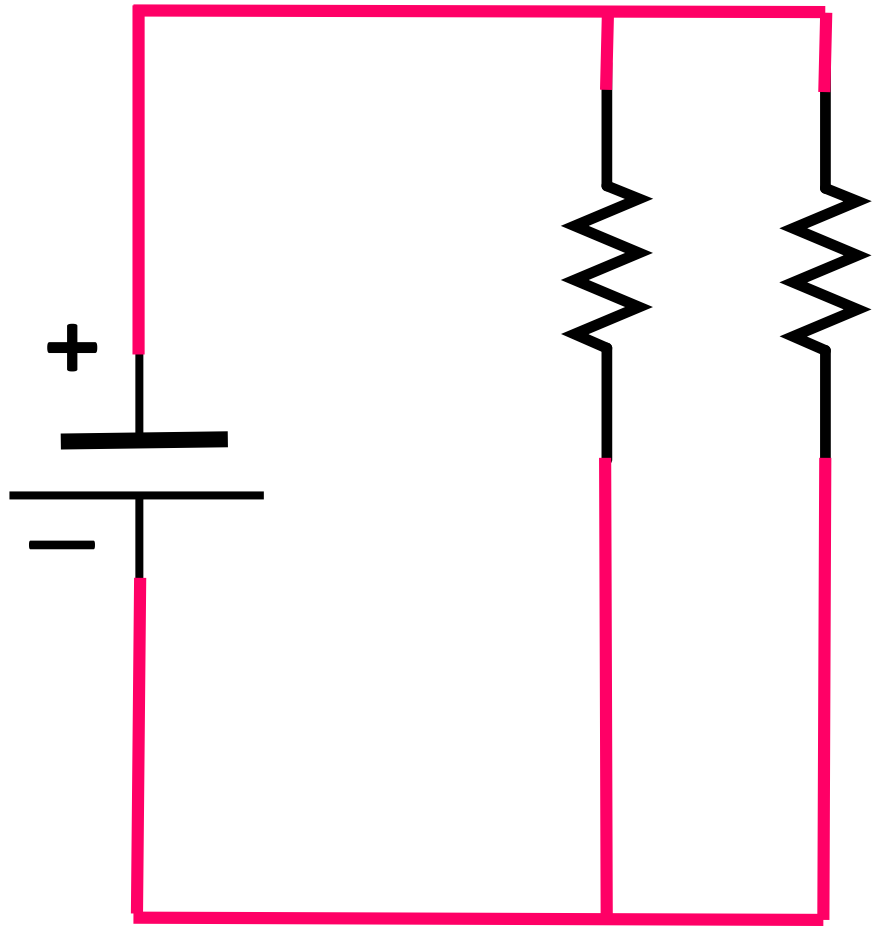
SERIES CIRCUITS

SERIES & PARALLEL CIRCUITS

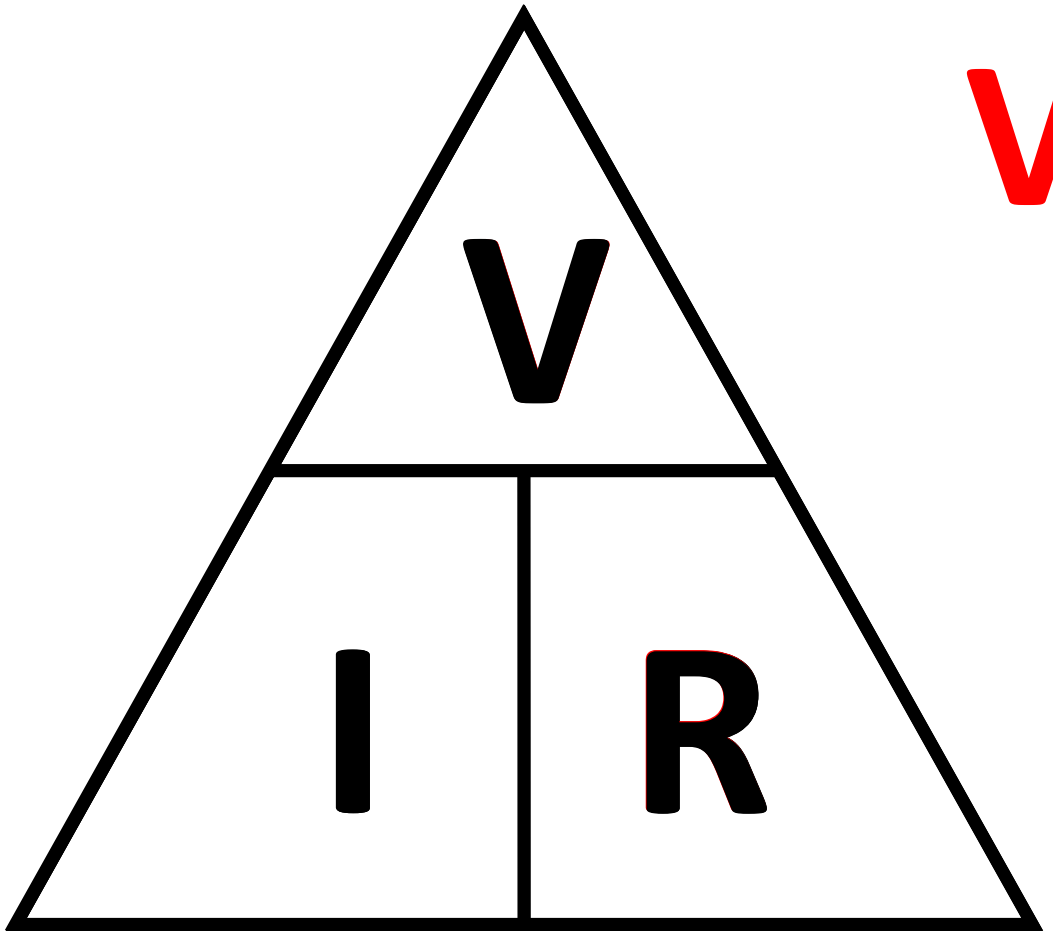


SERIES CIRCUIT



PARALLEL CIRCUIT

TRICK TO REMEMBER OHM'S LAW



$$V = I * R$$

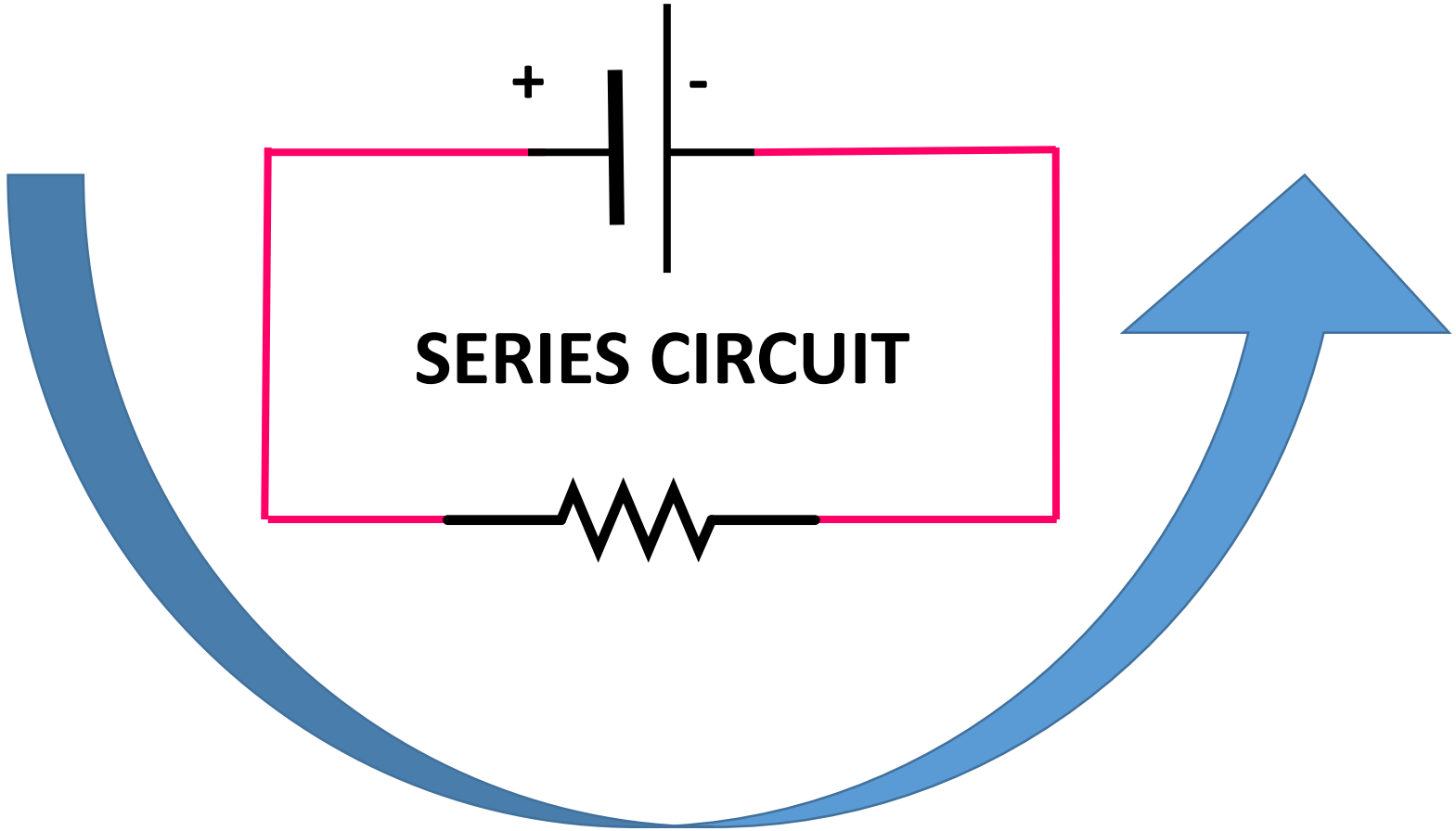
$$R = \frac{V}{I}$$

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

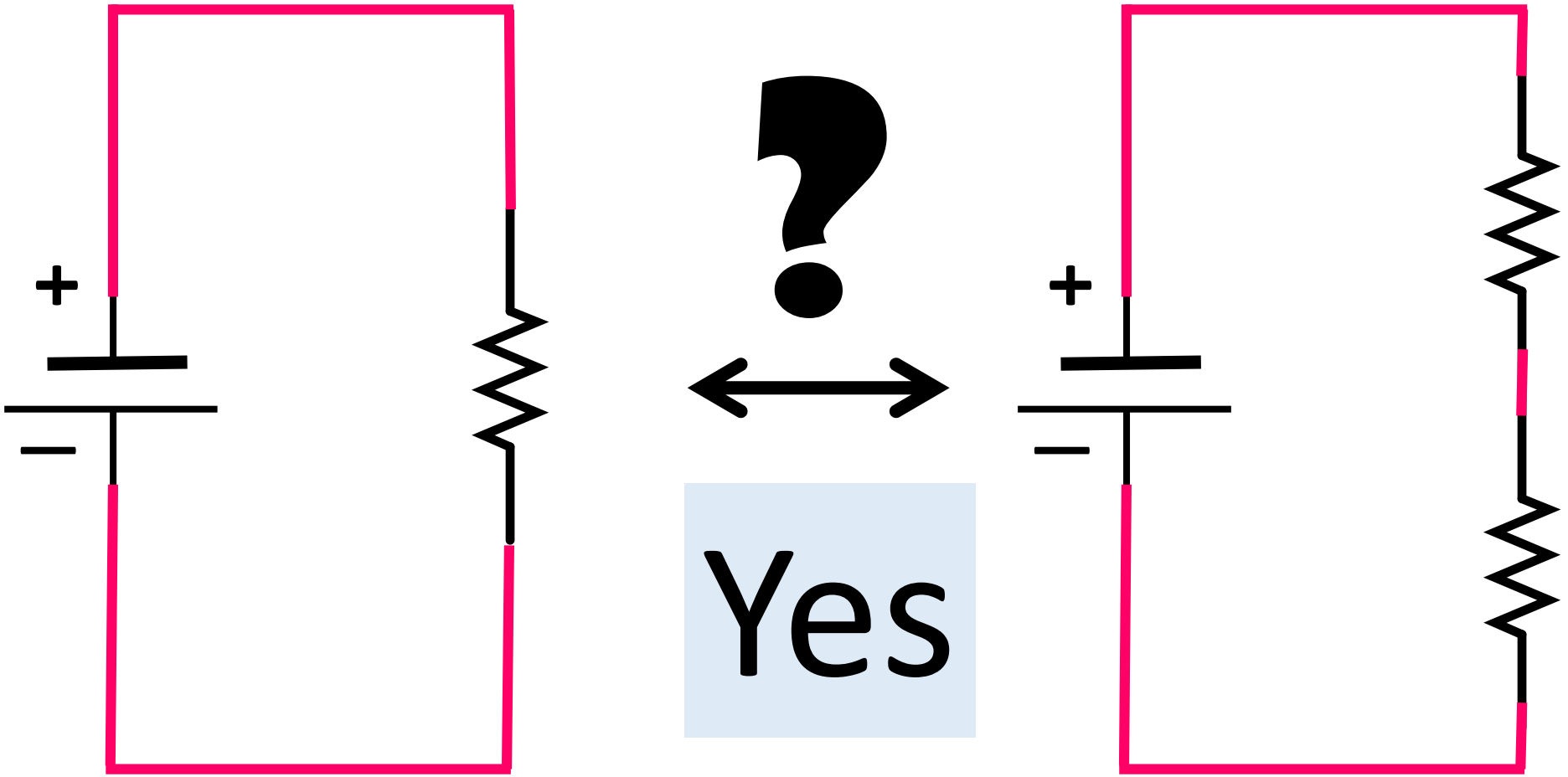
STEAM CLOWN™ & Squeaky Hinge PRODUCTIONS

SERIES CIRCUIT

- Closed Circuit
- Single Path from +V to GND



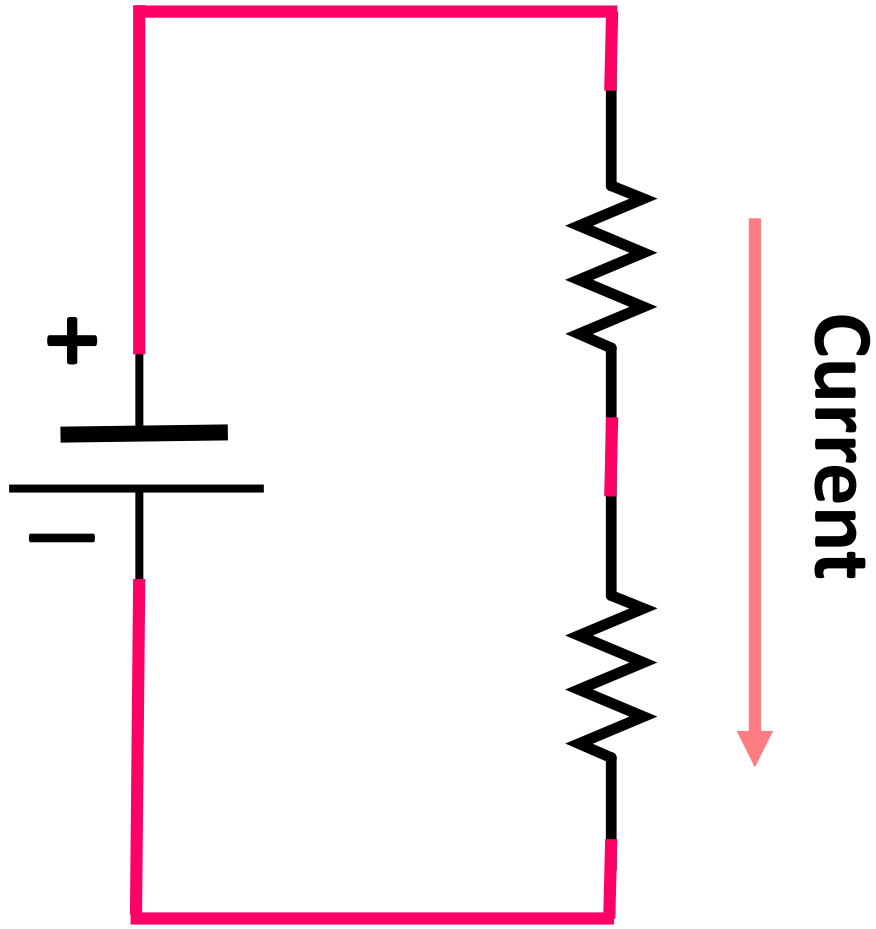
SERIES CIRCUITS



SERIES CIRCUIT

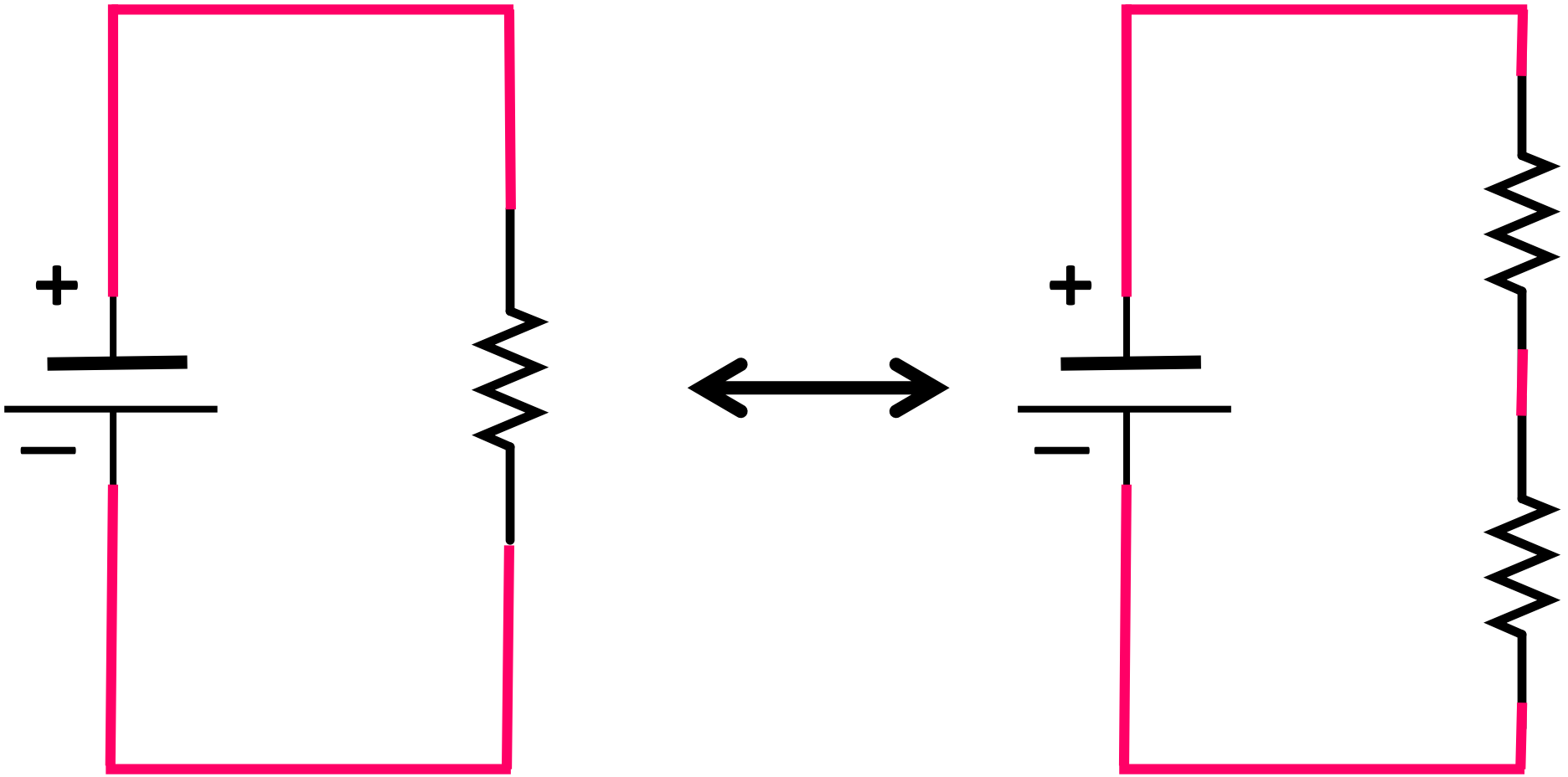
- Is the same current is flowing in both resistors?

Yes, there is only one path for the current and it is the same at all points ion the circuit



SERIES CIRCUIT

SERIES CIRCUITS



LAB TIME...

GO GET THE FOLLOWING

- Power Supply ← the smaller ones are better
- Power to Breadboard Adaptor
- Breadboard
- About 6 wire
- 1 plastic cup

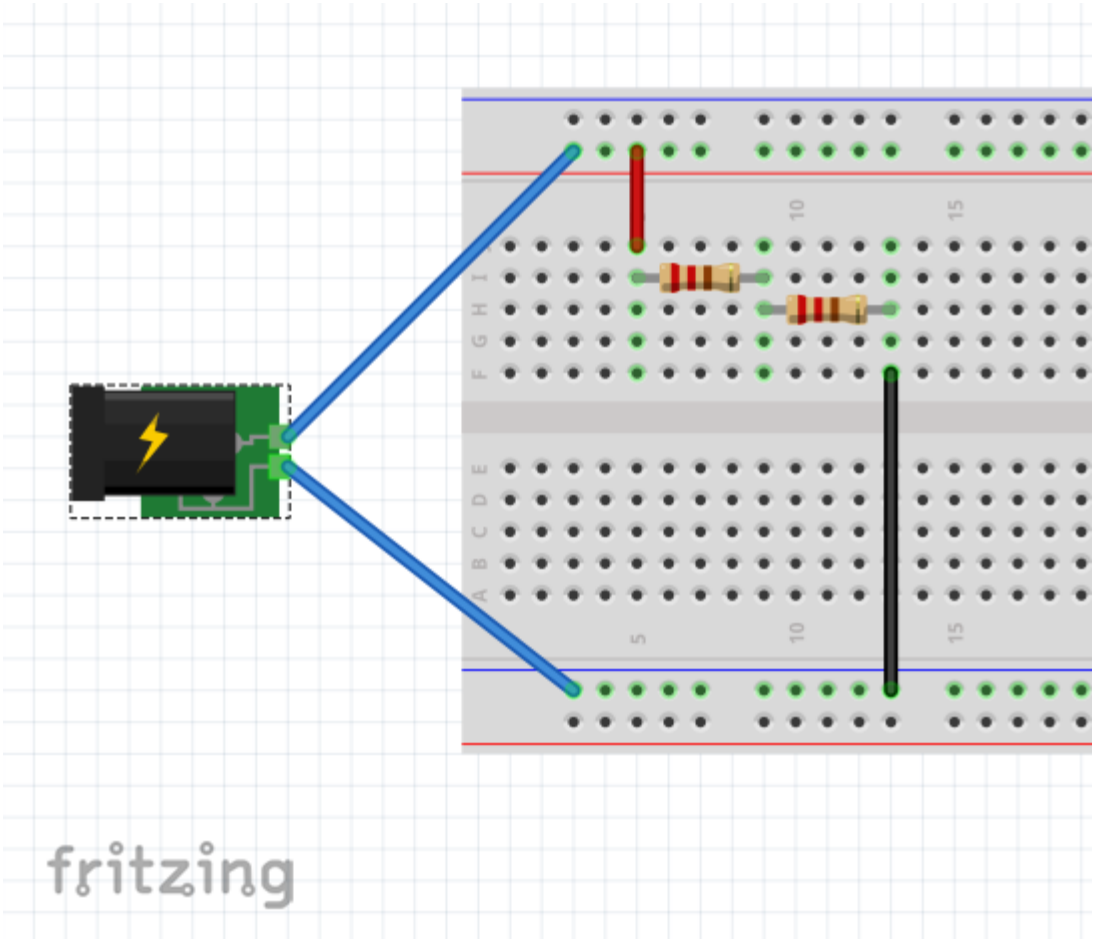
- Resistors:
  - One **10Ω** resistor
  - Three **330Ω** resistors
  - One **680Ω** resistor
  - Two **1KΩ** resistors
  - One **2KΩ** resistor

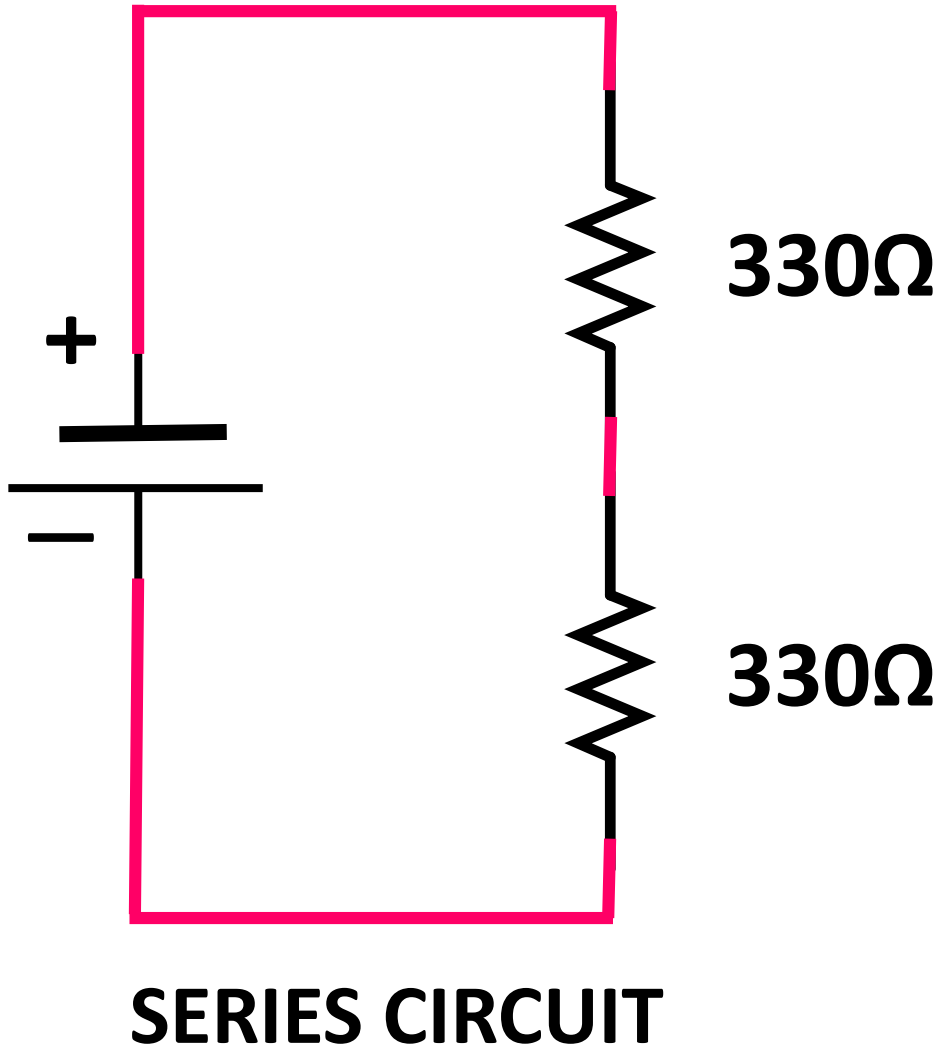
LOG SOME DATA

- Open your log books
- On the next available Page
  - Note the Date
  - Draw a table (“for a fixed 5 volt power supply”)

	Measured Resistance	Measured Voltage	Measured Current
R1 + R2 (measure together)			X
R1			X
R2			X
I (for circuit)	X	X	

SERIES CIRCUIT





SERIES CIRCUIT

LAB QUESTION?

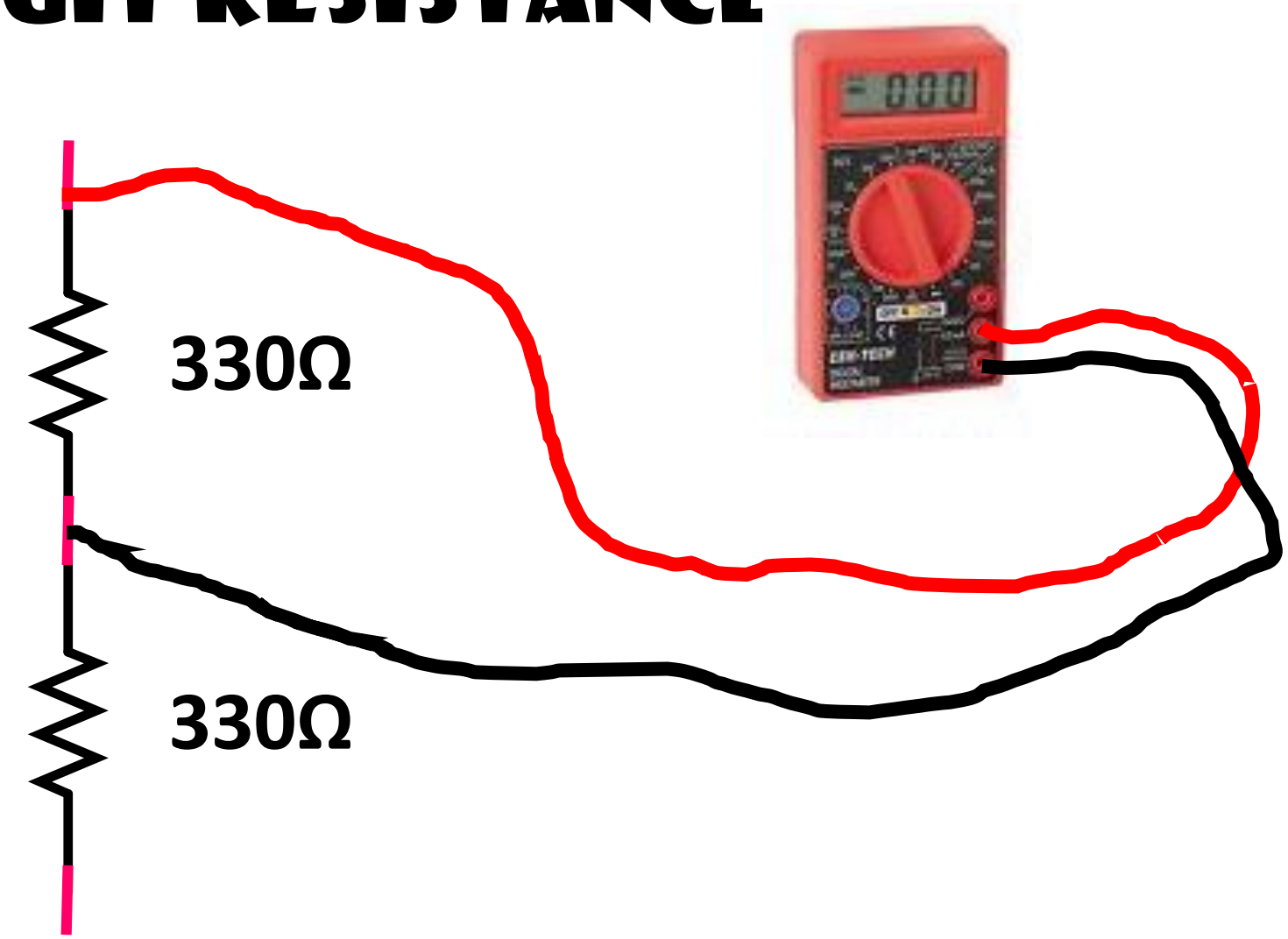
How do we measure the total resistance in our series circuit?

What about individual resisters?

SERIES CIRCUIT RESISTANCE

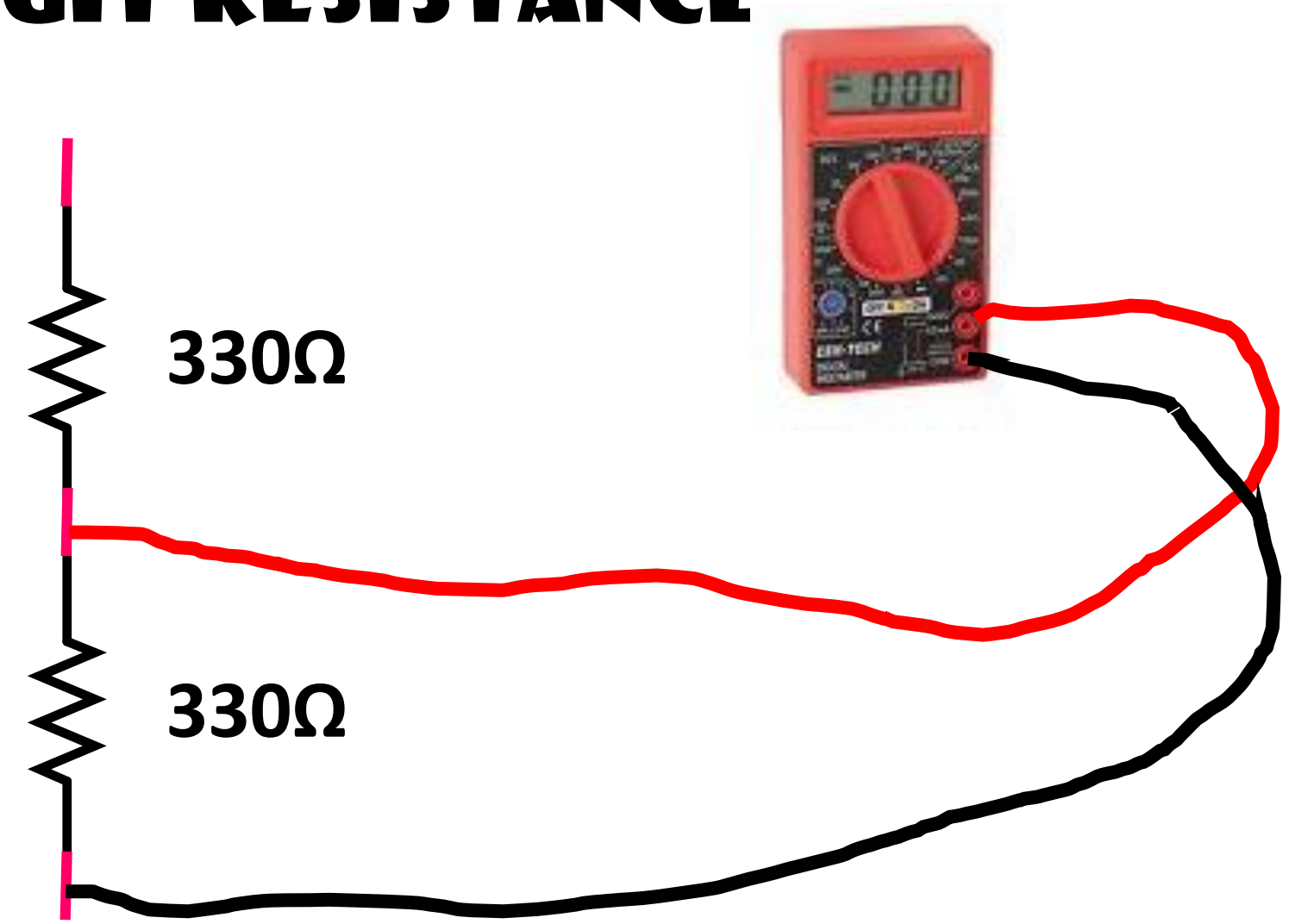
Measure Combined Resistance

SERIES CIRCUIT RESISTANCE



Measure Individual Resistance

SERIES CIRCUIT RESISTANCE



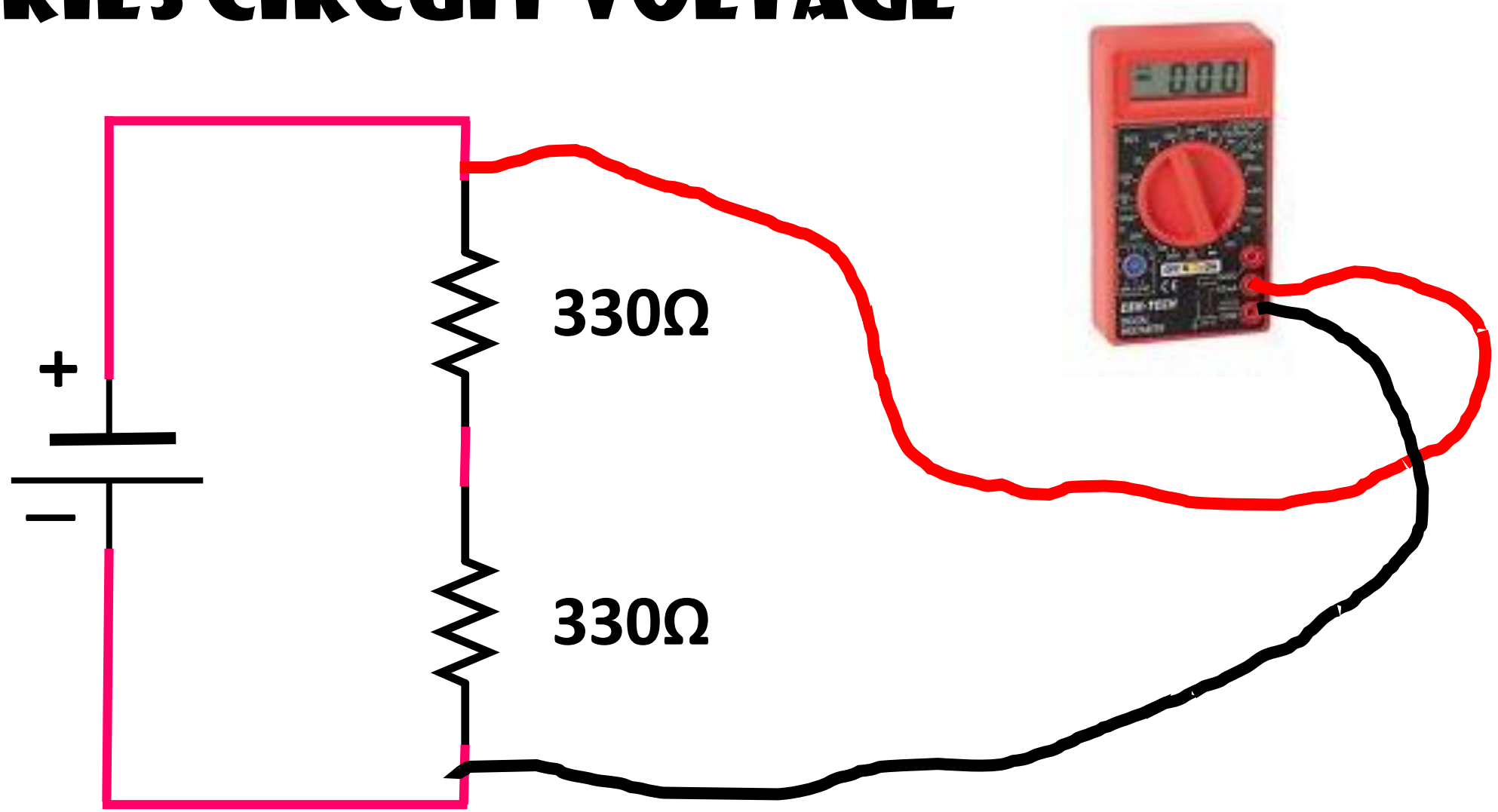
Measure Individual Resistance

LAB QUESTION?

How do we measure the total Voltage in our series circuit?

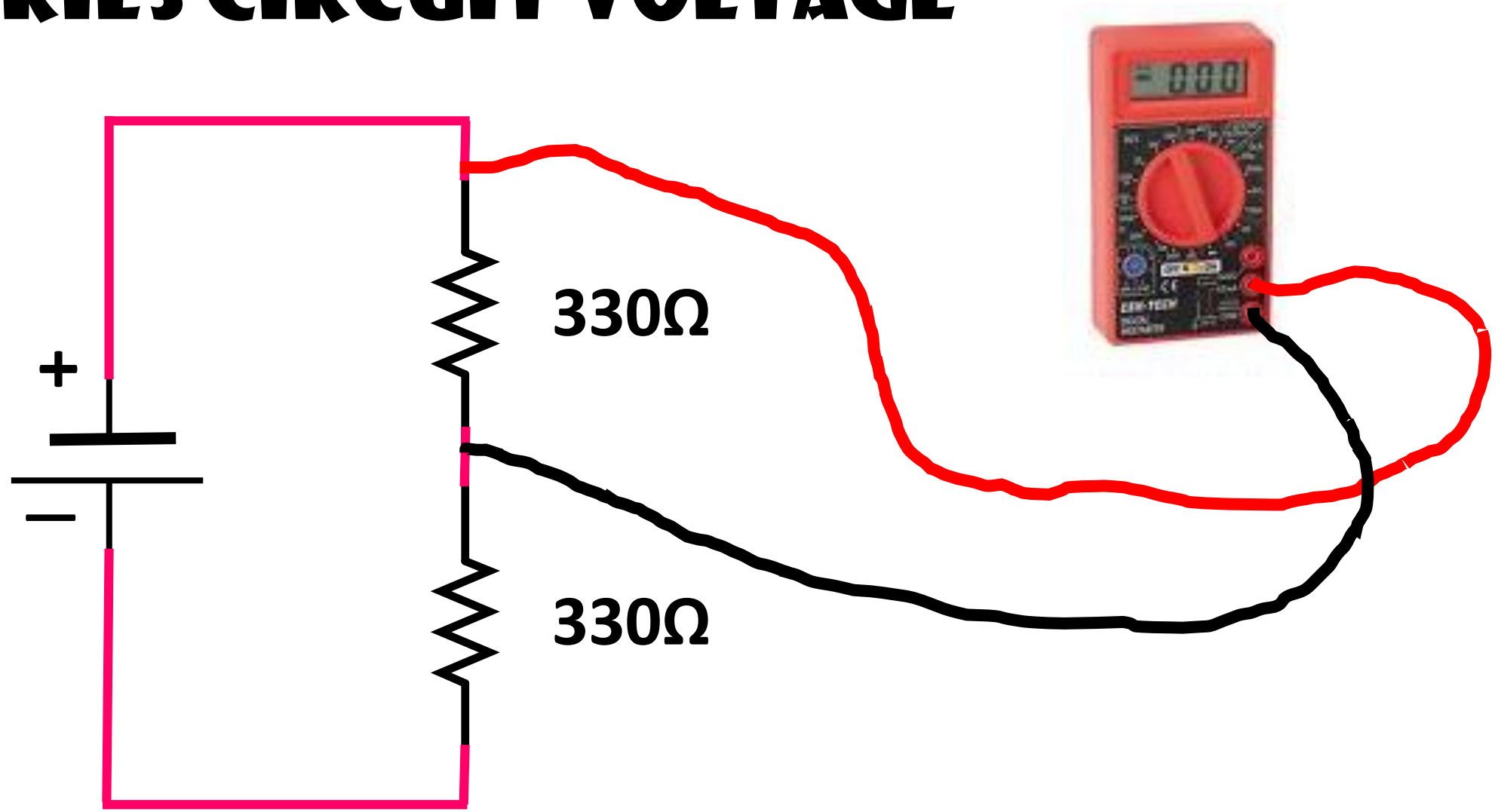
What about the voltage across the individual resisters?

SERIES CIRCUIT VOLTAGE



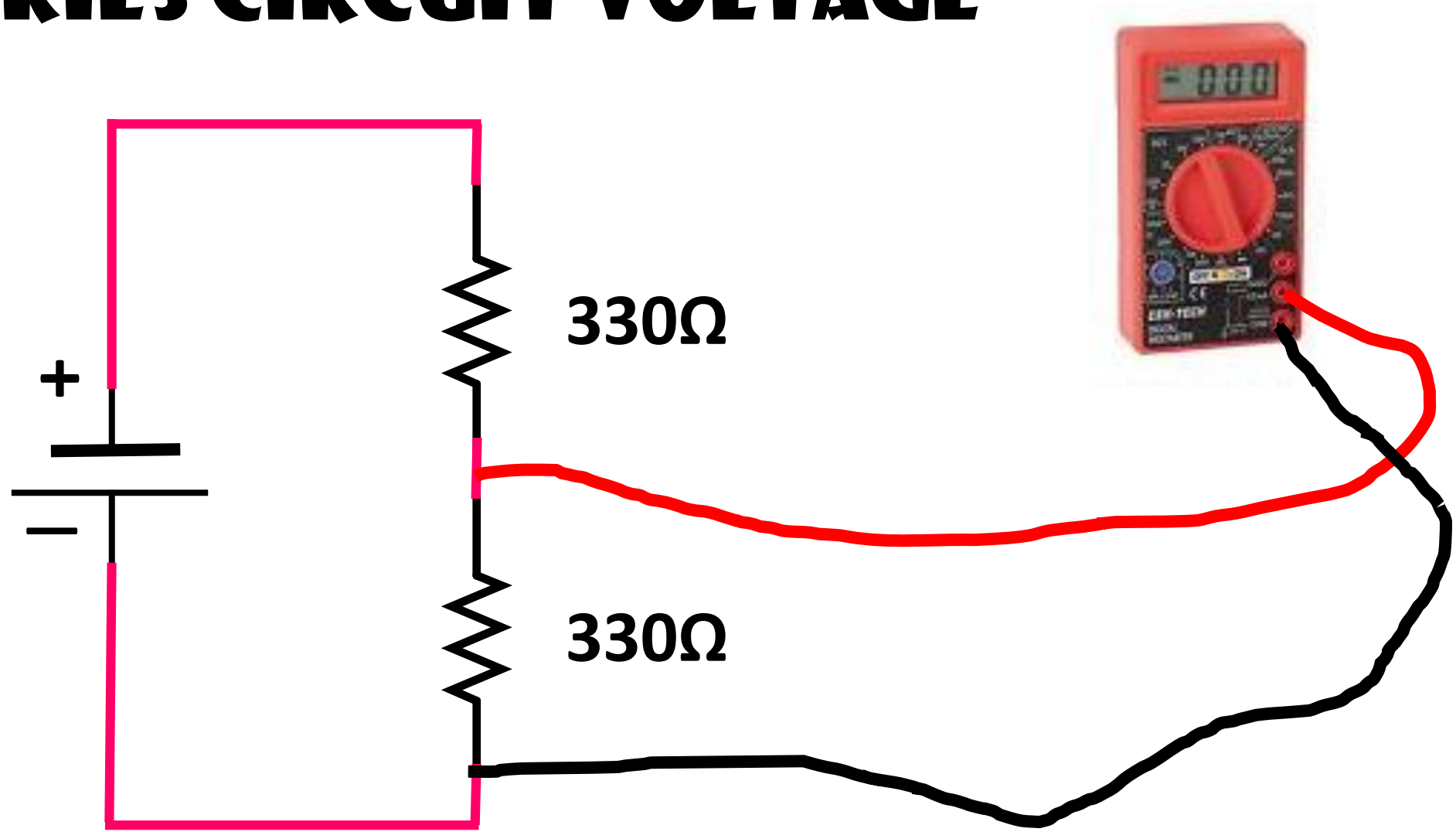
Measure Combined Voltage

SERIES CIRCUIT VOLTAGE



Measure Individual Voltage

SERIES CIRCUIT VOLTAGE



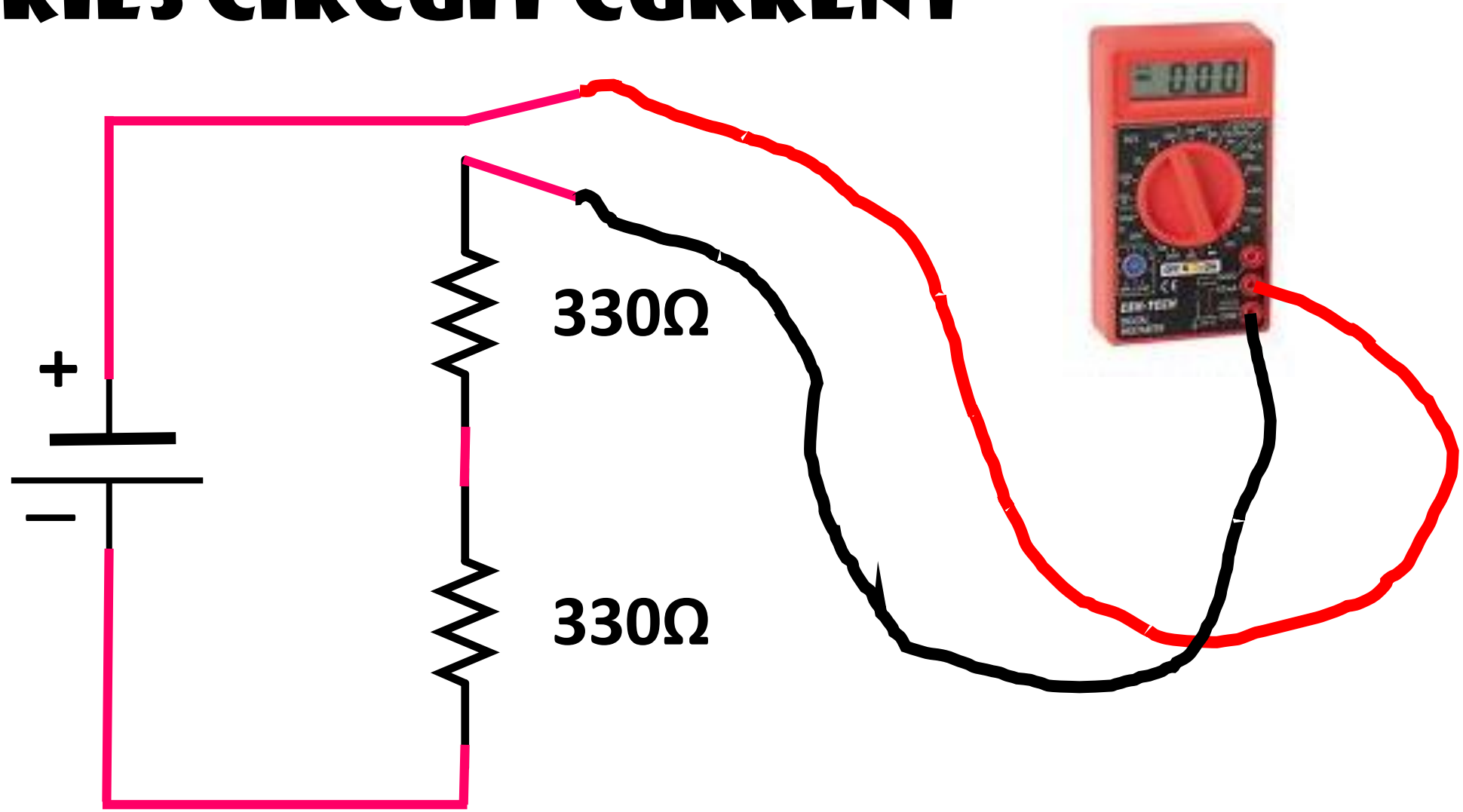
Measure Individual Voltage

LAB QUESTION?

How do we measure the total Current in our series circuit?

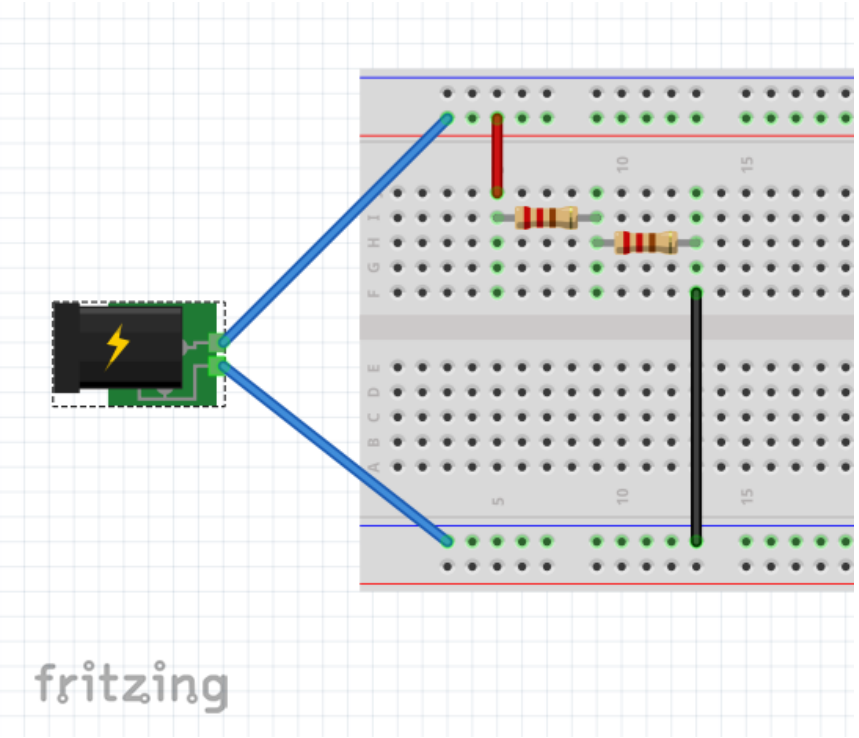
What about the voltage through the individual resisters?

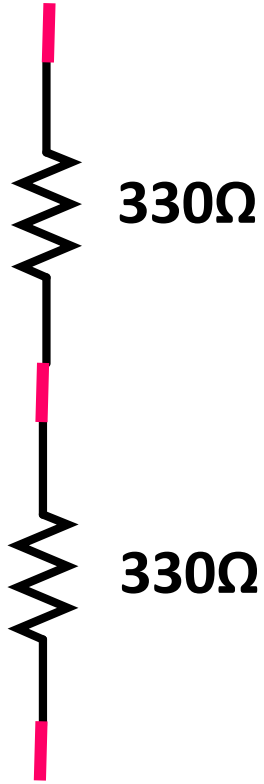
SERIES CIRCUIT CURRENT

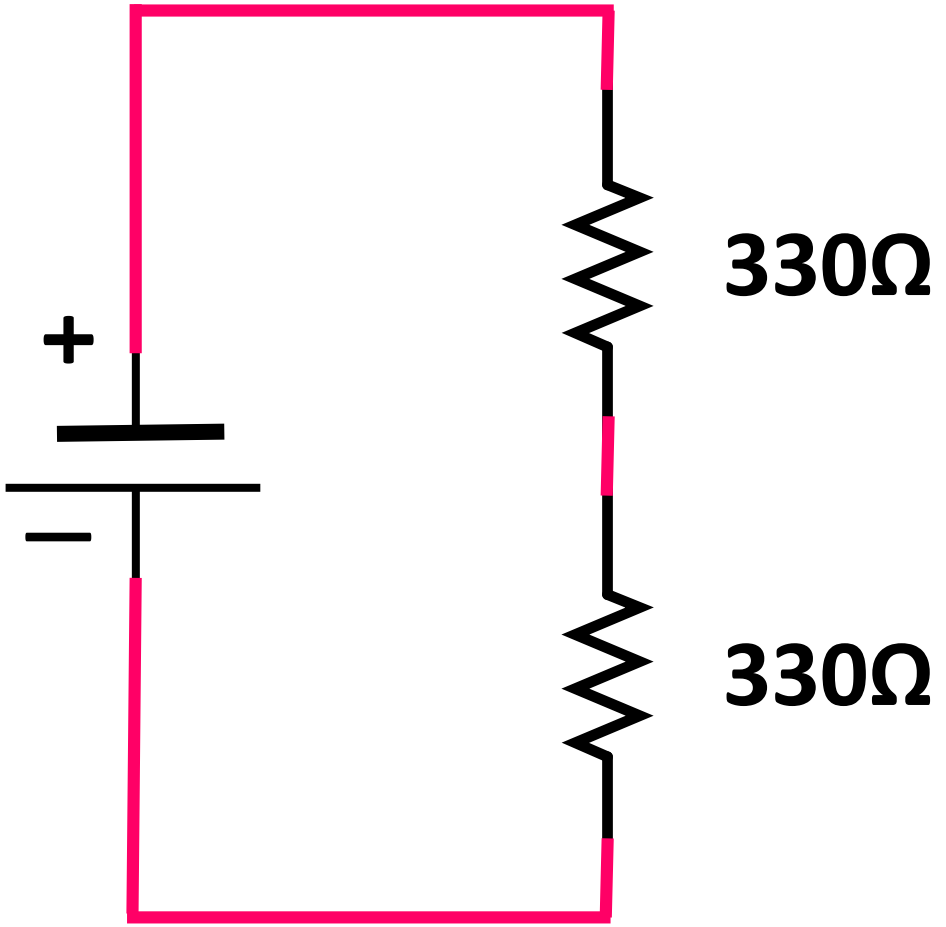


Measure Combined Voltage

LAB #1 SERIES CIRCUIT







SERIES CIRCUIT

Create table and make the measurements

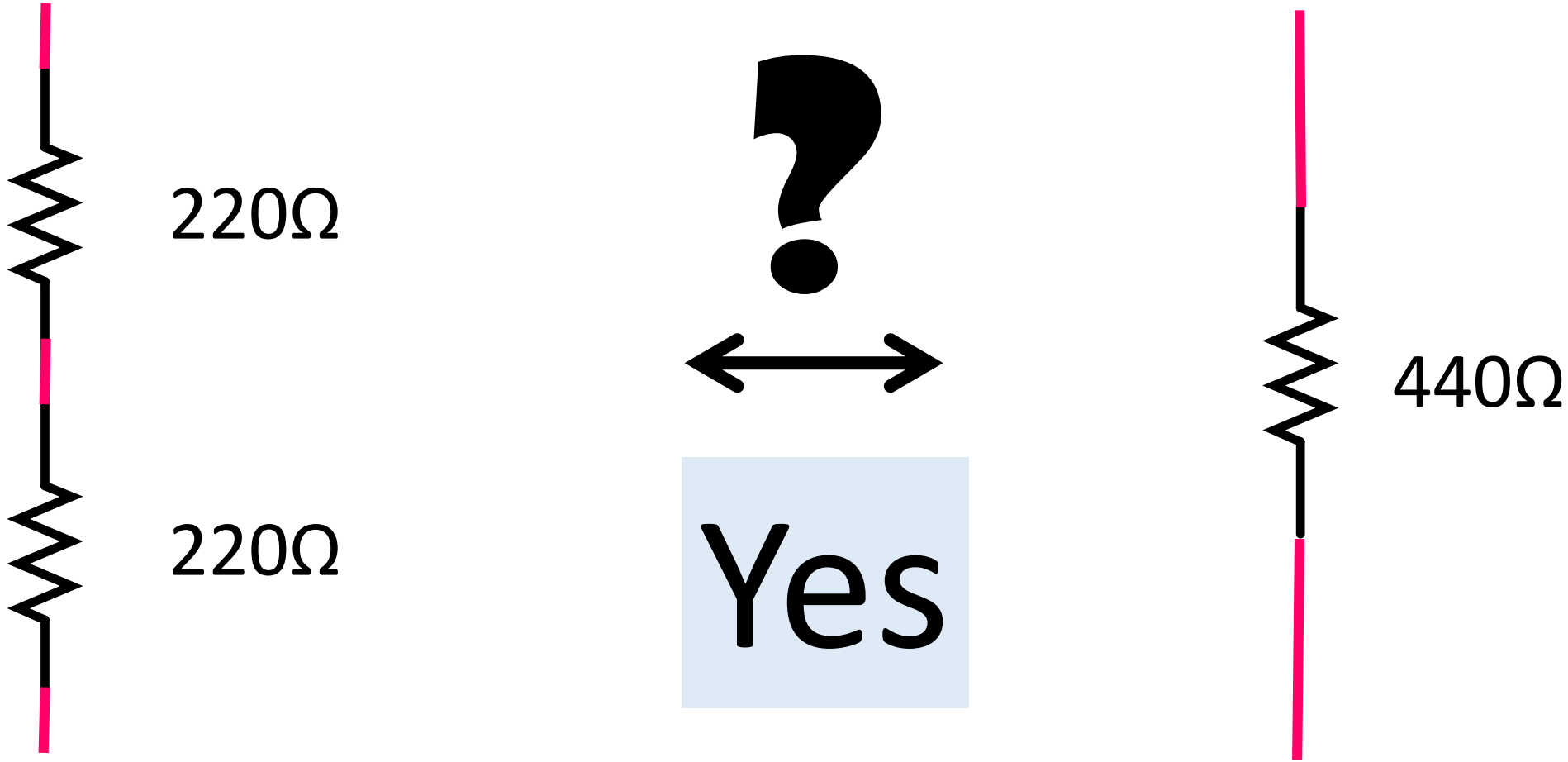
LOG SOME DATA

- Open your log books
- On the next available Page
  - Note the Date
  - Draw a table (“for a fixed 5 volt power supply”)

	Measured Resistance	Measured Voltage	Measured Current
R1 + R2 (measure together)			X
R1			X
R2			X
I (for circuit)	X	X	

MATH BEHIND THE MEASUREMENTS

SERIES CIRCUITS



CALCULATING SERIES RESISTANCE

220Ω

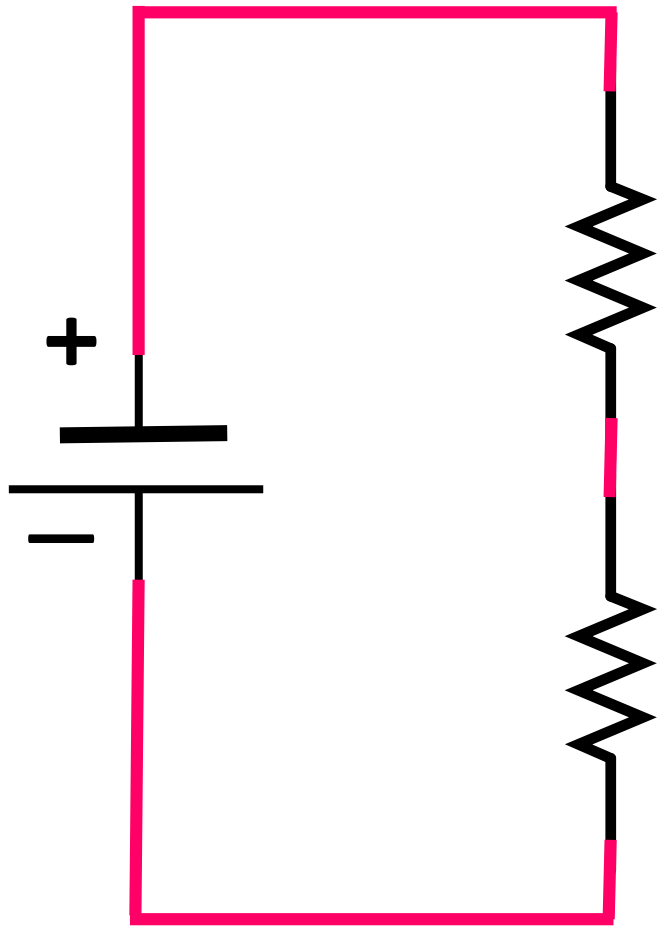
220Ω

$$R_t = R_1 + R_2 + R_3 + \text{etc.}$$

To find the total resistance of a series circuit, just add the values of the individual resistors together

440Ω

SERIES CIRCUIT RESISTANCE



Calculate R_t

$$R_t = R_1 + R_2 + R_3 + \text{etc.}$$

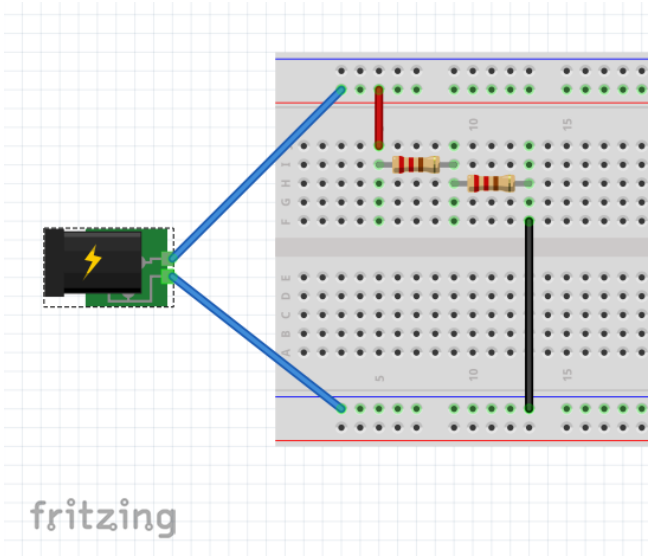
$R_1 = 330\Omega$, $R_2 = 330\Omega$ $R_t =$ _____

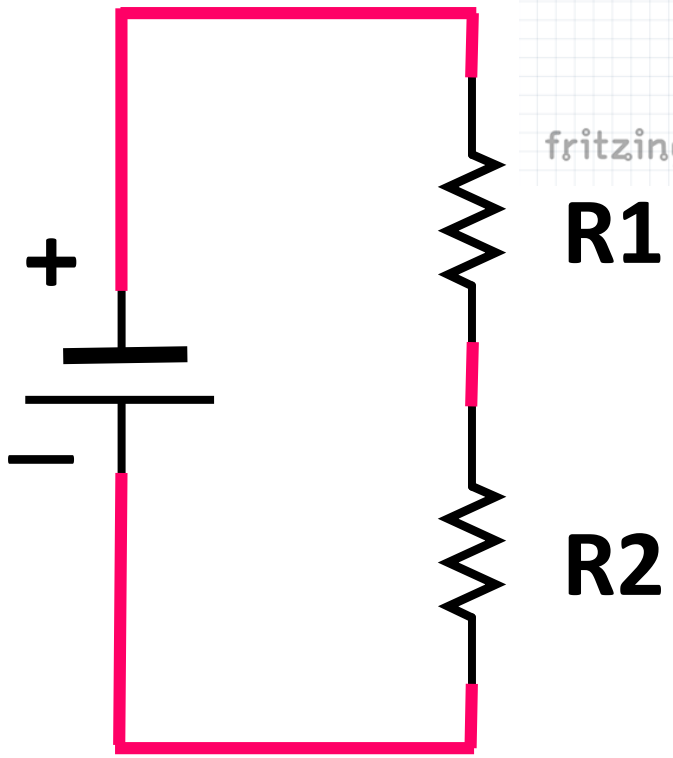
$R_1 = 330\Omega$, $R_2 = 680\Omega$ $R_t =$ _____

$R_1 = 1K\Omega$, $R_2 = 2K\Omega$ $R_t =$ _____

$R_1 = 680\Omega$, $R_2 = 1K\Omega$ $R_t =$ _____

LAB #2 SERIES CIRCUIT





$R_1 = 330\Omega$, $R_2 = 680\Omega$

$R_1 = 1K\Omega$, $R_2 = 2K\Omega$

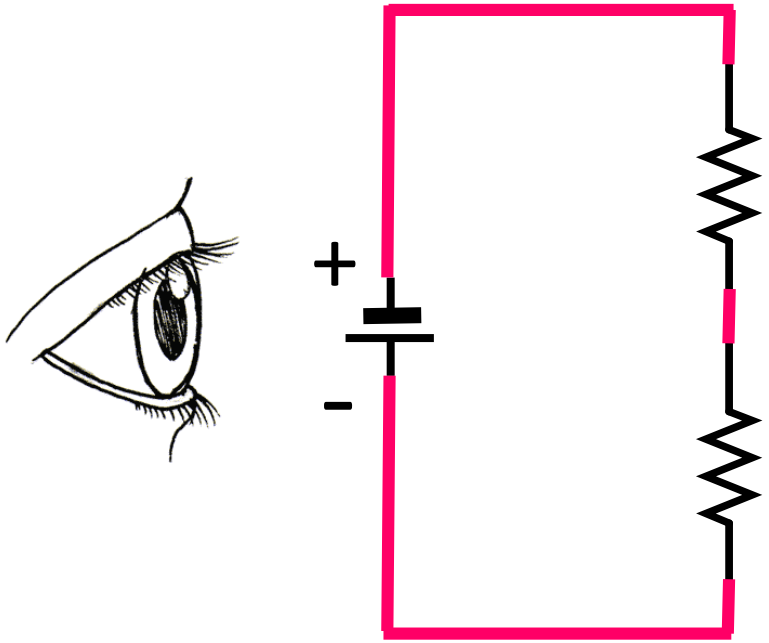
$R_1 = 680\Omega$, $R_2 = 1K\Omega$

Create 3 more tables like lab #1, and make the same measurements

MATH BEHIND THE MEASUREMENTS

Can we calculate the voltage on a resistor in a series circuit?

- How does the “battery” “see” the combination of the 2 resistors?
- How do the Resistors “see” the “battery”?
- Nether Resistor is connected directly across the “battery”
- How much voltage is applied to each Resistor?



Series Resistors share or *Divide* the applied voltage

VOLTAGE DIVISION WITH RESISTORS

$$V_x = V\left(\frac{R_x}{R_t}\right)$$

Where:

R_t = Total Resistance of series string

R_x = Resistor for which we are calculating the voltage drop

V = Applied voltage

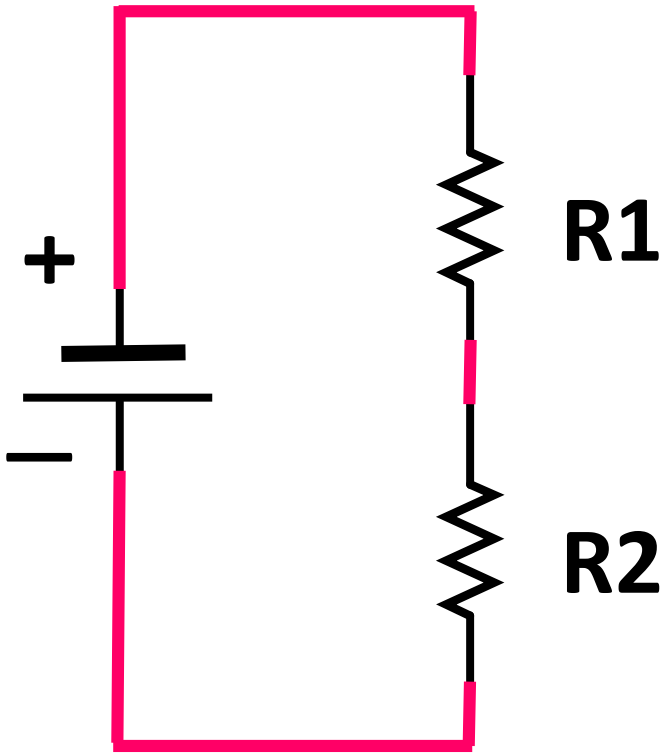
V_x = Voltage drop across R_x

LETS DO SOME CALCULATIONS

$$V_x = V(\frac{R_x}{R_t})$$

$R_1 = 330\Omega$, $R_2 = 680\Omega$, $V = 5v$

$R_t = 1.01K\Omega$ $R_x = 330\Omega$



$$V_x = 5(\frac{330\Omega}{1.01K\Omega})$$

$$V_x = 1.63V$$

LETS DO SOME CALCULATIONS

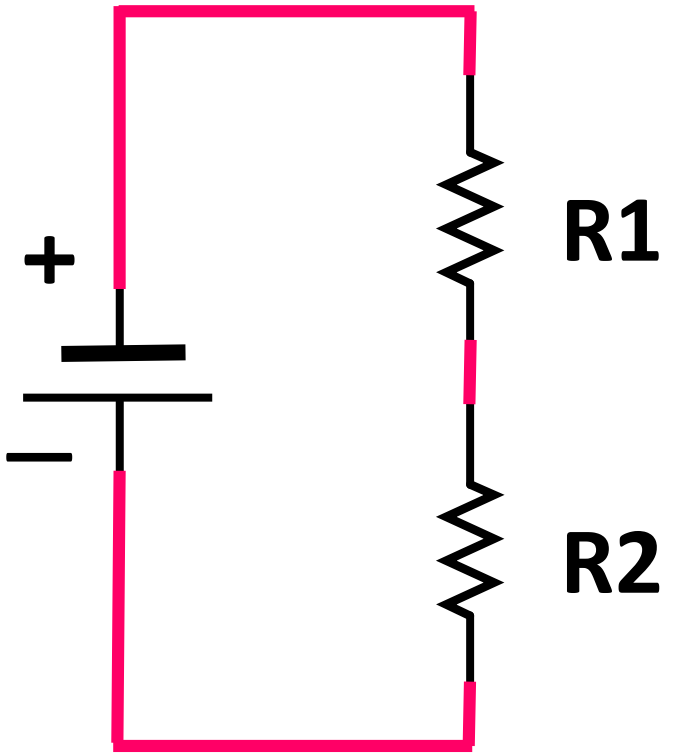
$$V_x = V(\frac{R_x}{R_t})$$

$R_1 = 330\Omega$, $R_2 = 680\Omega$, $V = 5v$

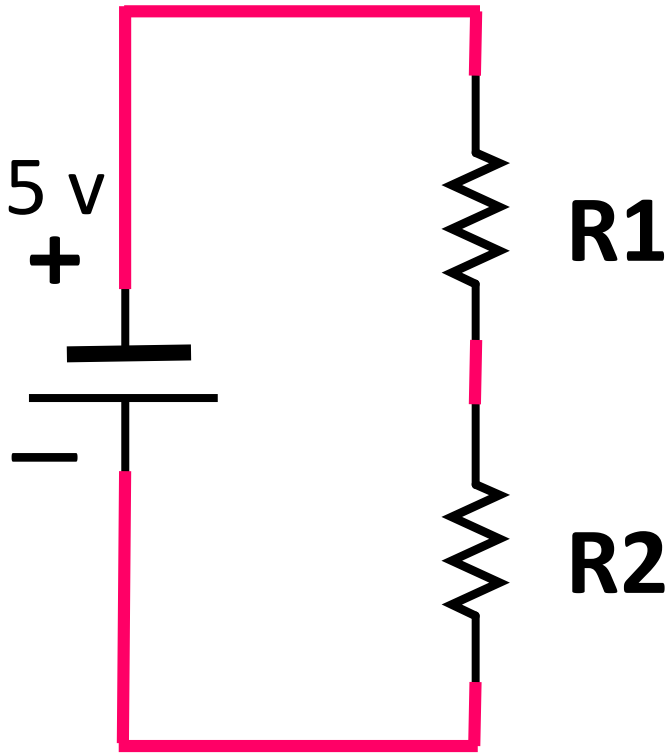
$R_t = 1.01K\Omega$ $R_x = 680\Omega$

$$V_x = 5(\frac{680\Omega}{1.01K\Omega})$$

$$V_x = 3.37V$$



LAB #3 SERIES CIRCUIT



$R_1 = 330\Omega$, $R_2 = 330\Omega$

$R_1 = 330\Omega$, $R_2 = 680\Omega$

$R_1 = 1K\Omega$, $R_2 = 2K\Omega$

$R_1 = 680\Omega$, $R_2 = 1K\Omega$

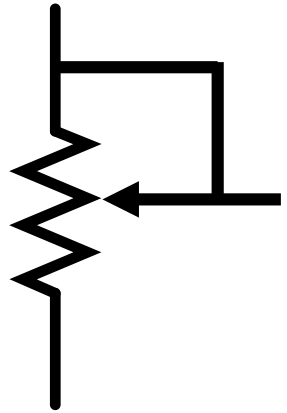
$$V_x = V\left(\frac{R_x}{R_t}\right)$$

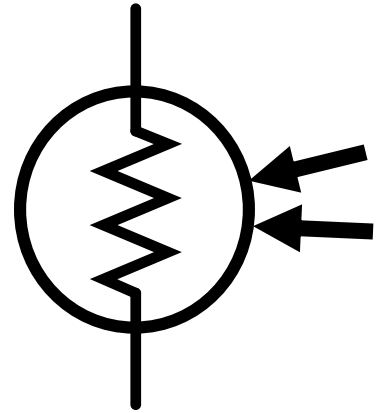
Using the data from your 4 tables, calculate the voltage over R1 and R2. Verify that your measurements are correct.

VARIABLE RESISTORS

- Resistor that has the ability to change resistance manually
- Resistor that have it's resistance change do to environmental effects

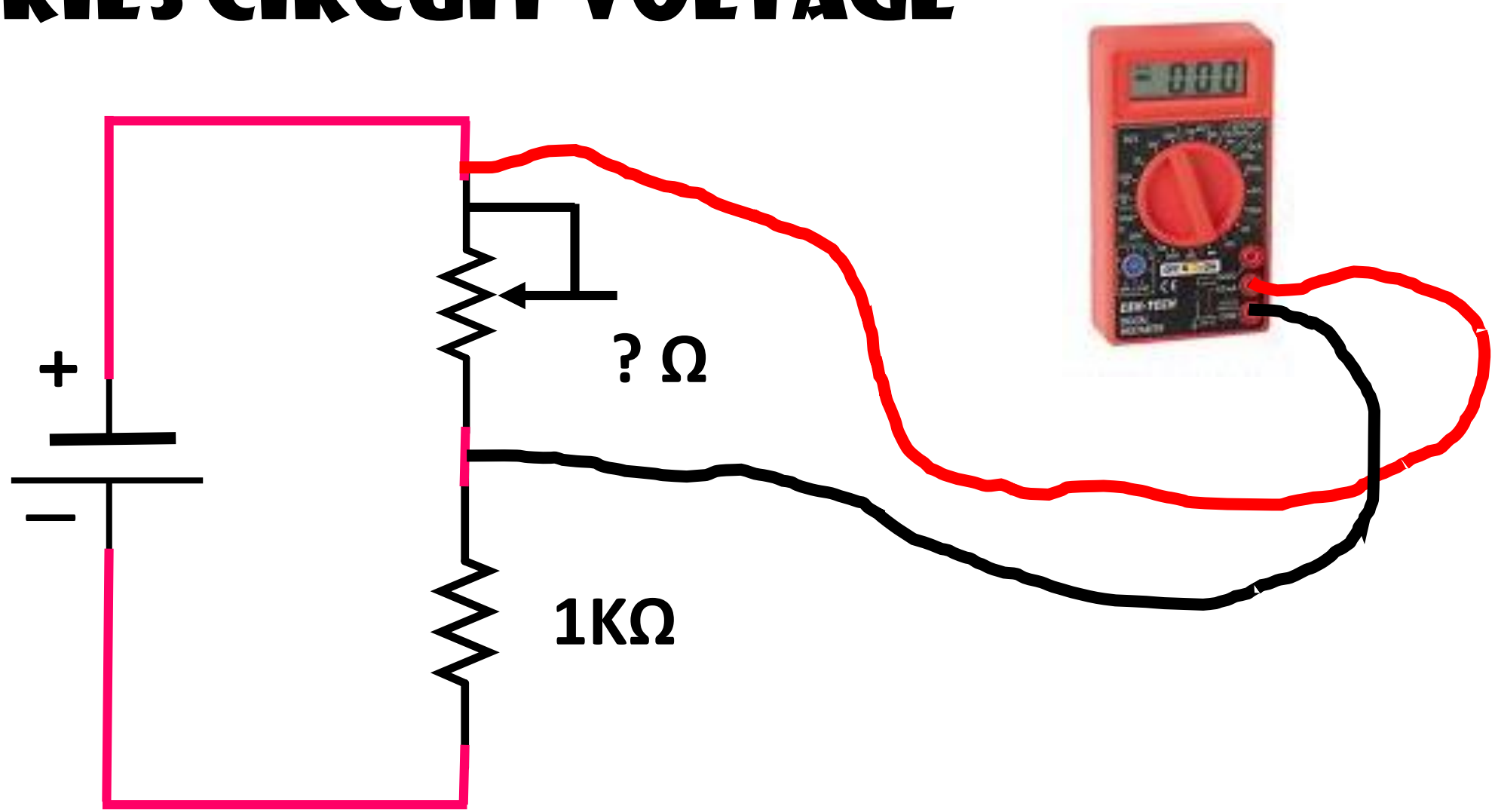
Potentiometer





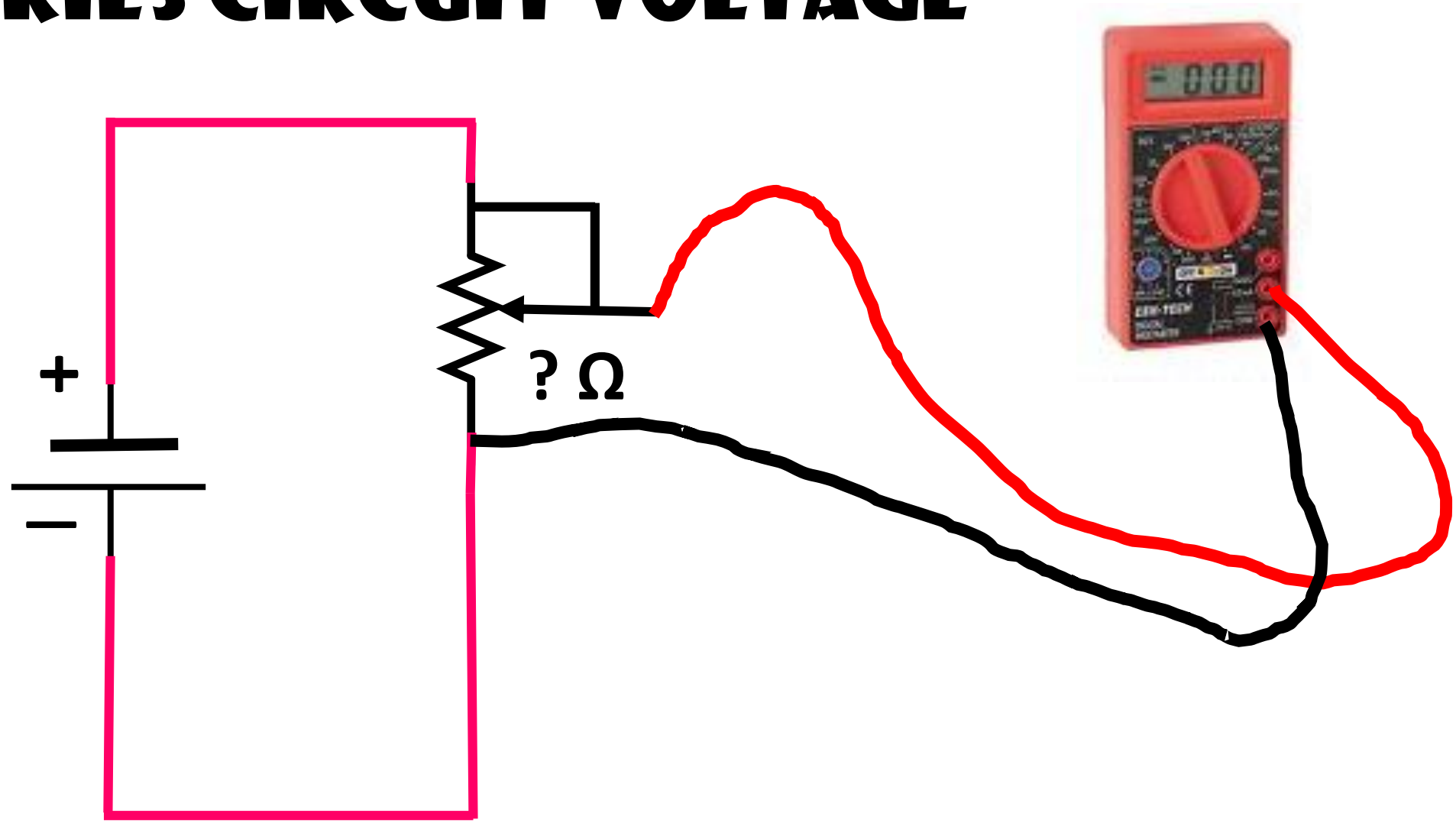
Photoresistor

SERIES CIRCUIT VOLTAGE



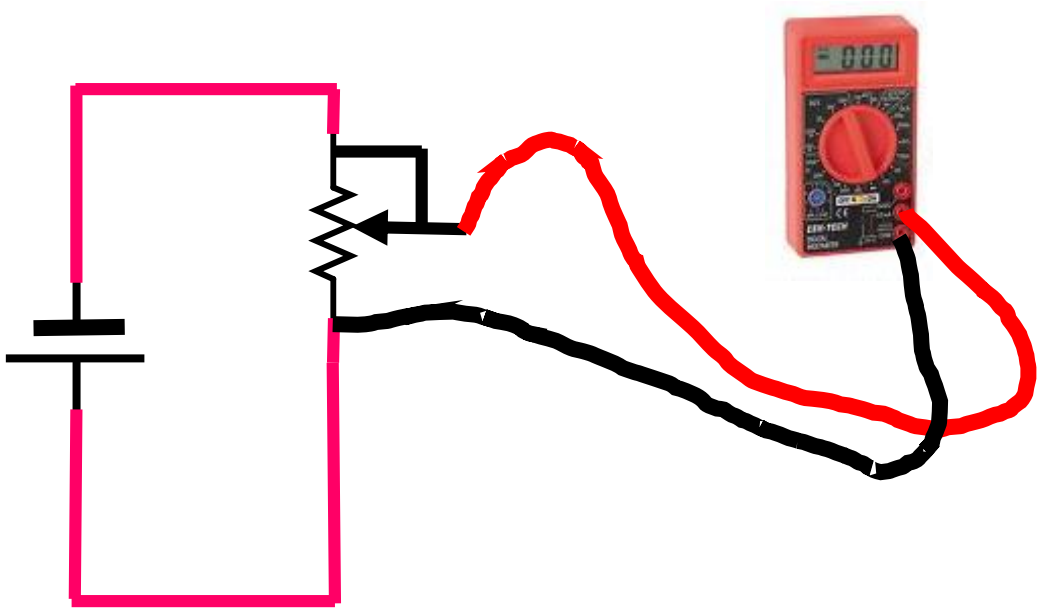
Measure Variable Voltage

SERIES CIRCUIT VOLTAGE



Measure Variable Voltage

SERIES CIRCUIT VOLTAGE

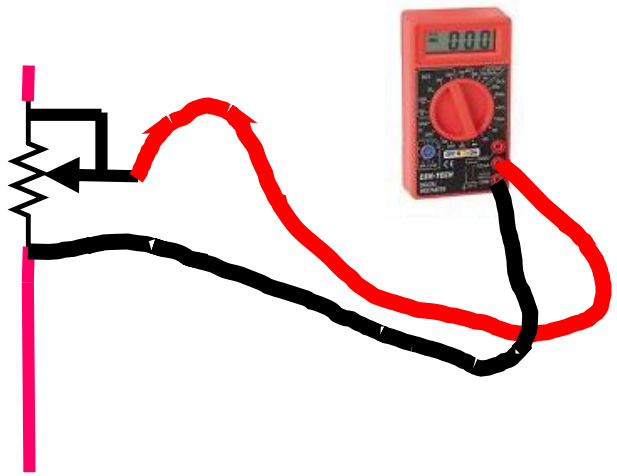


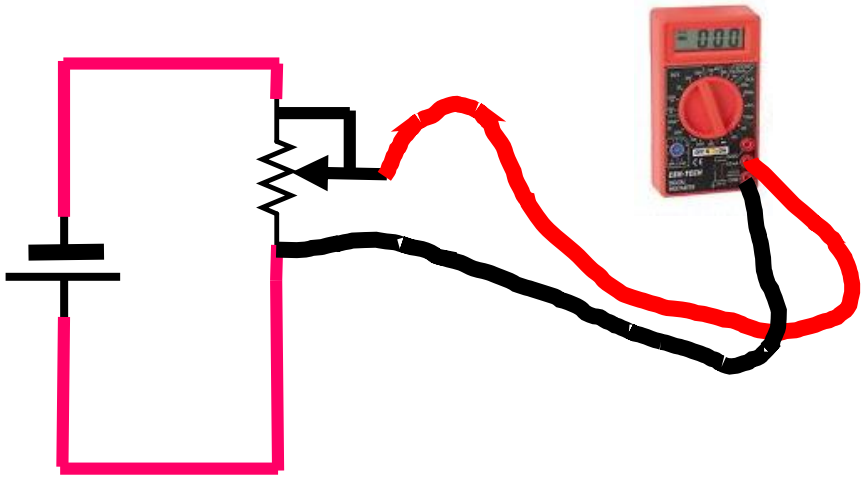
Measure Variable Voltage

? Ω

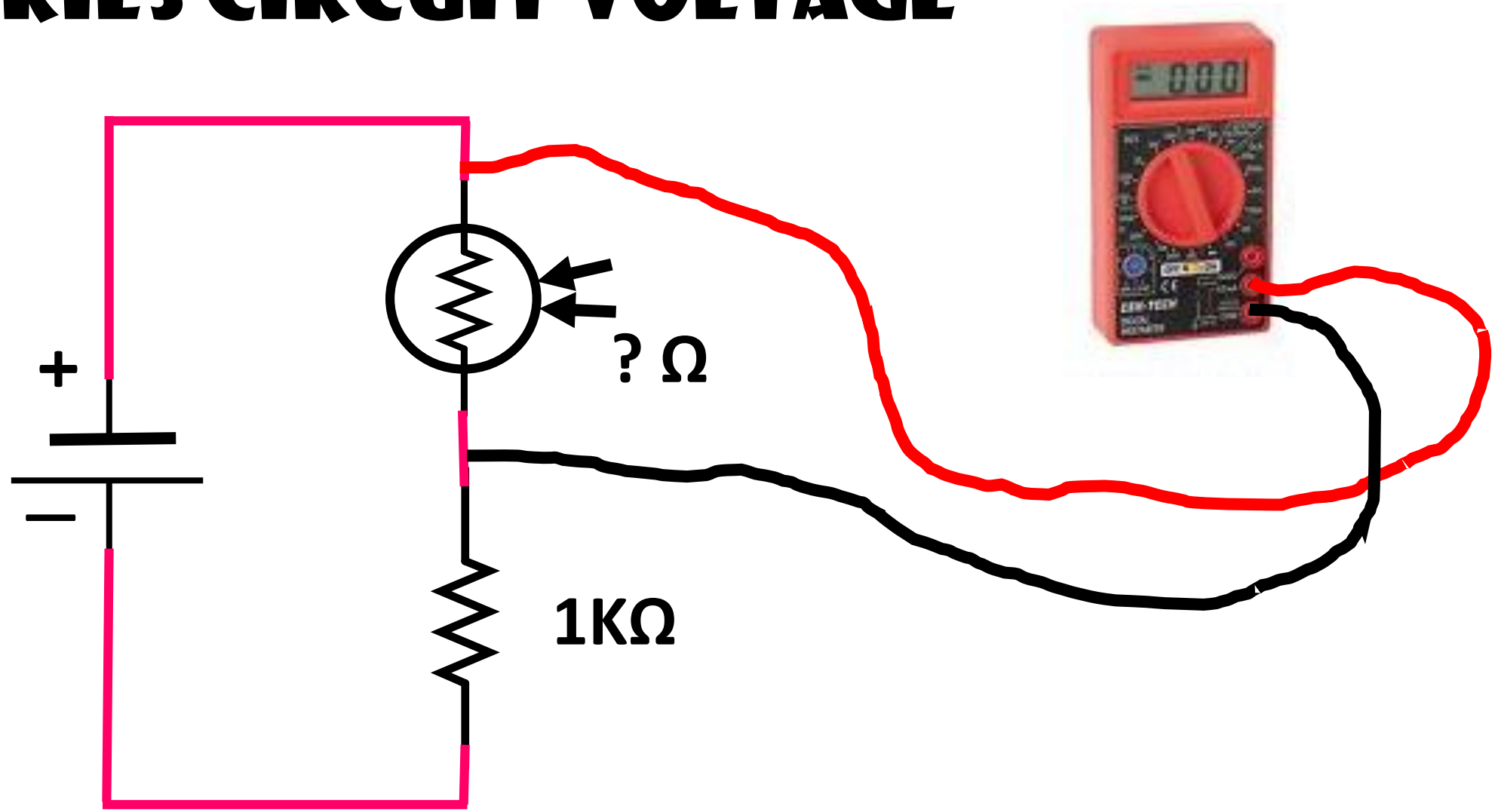
VARIABLE RESISTOR LAB

- Turn the Potentiometer to have equal resistance on both sides
  - ie: for a 10KΩ Potentiometer each segment should be about 5KΩ
- Measure:
  - The resistance of each side,
  - then connect power, and measure the voltage





SERIES CIRCUIT VOLTAGE



Measure Variable Voltage

MATH BEHIND THE MEASUREMENTS

How do you find the resistance given a known voltage divider?

- We know that you can find V_x When you know R_x
- How do we manipulate to solve for R_x?

$$V_x = V\left(\frac{R_x}{R_t}\right)$$

Manipulate to solve for R_x

$$V_x = V\left(\frac{R_x}{R_t}\right)$$

Manipulate to solve for R_x

$$R_t * Vx = V\left(\frac{R_x}{R_t}\right) * Rt$$

Manipulate to solve for R_x

$$R_t * Vx = V(Rx)$$

$$R_t * Vx = VRx$$

Manipulate to solve for R_x

$$\frac{R_t * Vx}{V} = \frac{VR_x}{V}$$

Manipulate to solve for R_x

$$\frac{R_t * Vx}{V} = Rx$$

Manipulate to solve for R_x

$$R_x = \frac{R_t * Vx}{V}$$

Manipulate to solve for R_x

$$R_x = \frac{R_t * Vx}{V}$$

LETS DO SOME CALCULATIONS

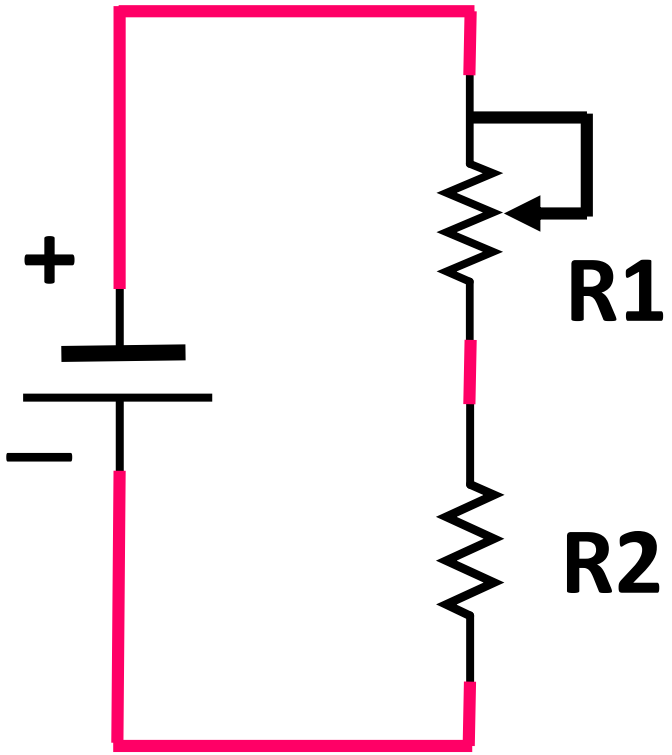
$$V_x = V(\frac{R_x}{R_t})$$

R_1 = 5.24KΩ, R_2 = 10KΩ , V = 5v

R_t = 15.24KΩ R_x = 5.24KΩ

$$V_x = 5V(\frac{5.24K\Omega}{15.24K\Omega})$$

$$V_x = 1.719V$$



LETS DO SOME CALCULATIONS

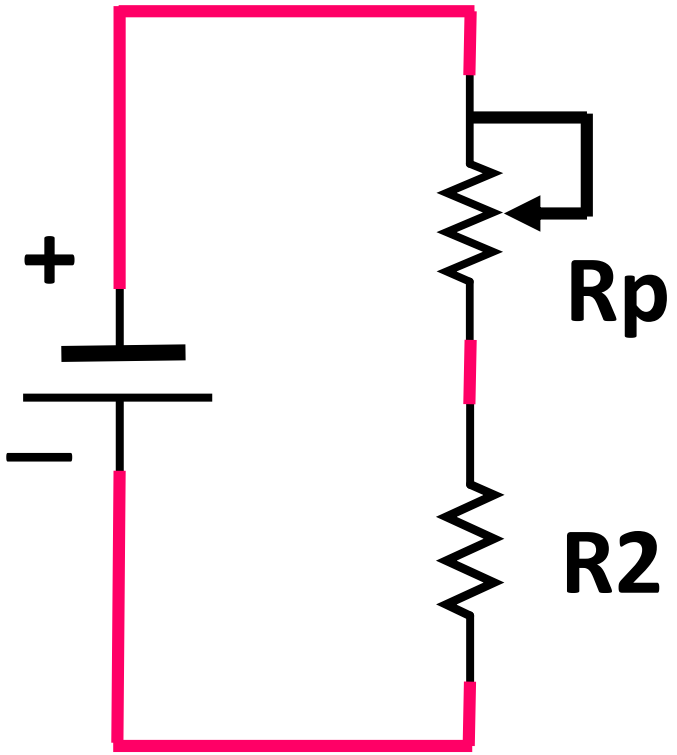
$$R_x = \frac{R_t * Vx}{V}$$

R_1 = ? Ω, R_2 = 10KΩ , V = 5v

R_t = 15.24KΩ V_x = 1.719V

$$R_x = \frac{15.24K\Omega * 1.719V}{5V}$$

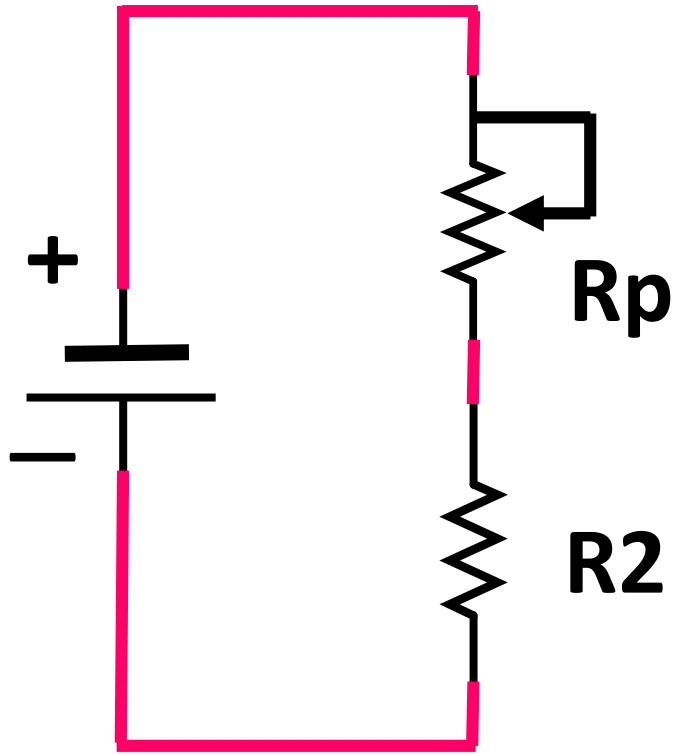
$$R_x = 5.24K\Omega$$



VARIABLE RESISTOR LAB

- Build the circuit with the variable R_p and fixed R_2
- Turn the Potentiometer and measure the Voltage
- Using this formula calculate R_p

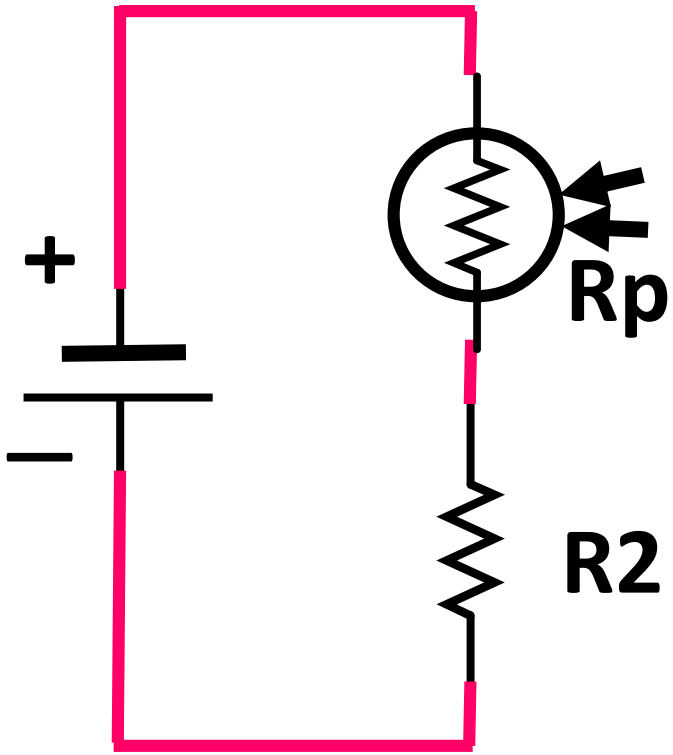
$$R_x = \frac{R_t * Vx}{V}$$



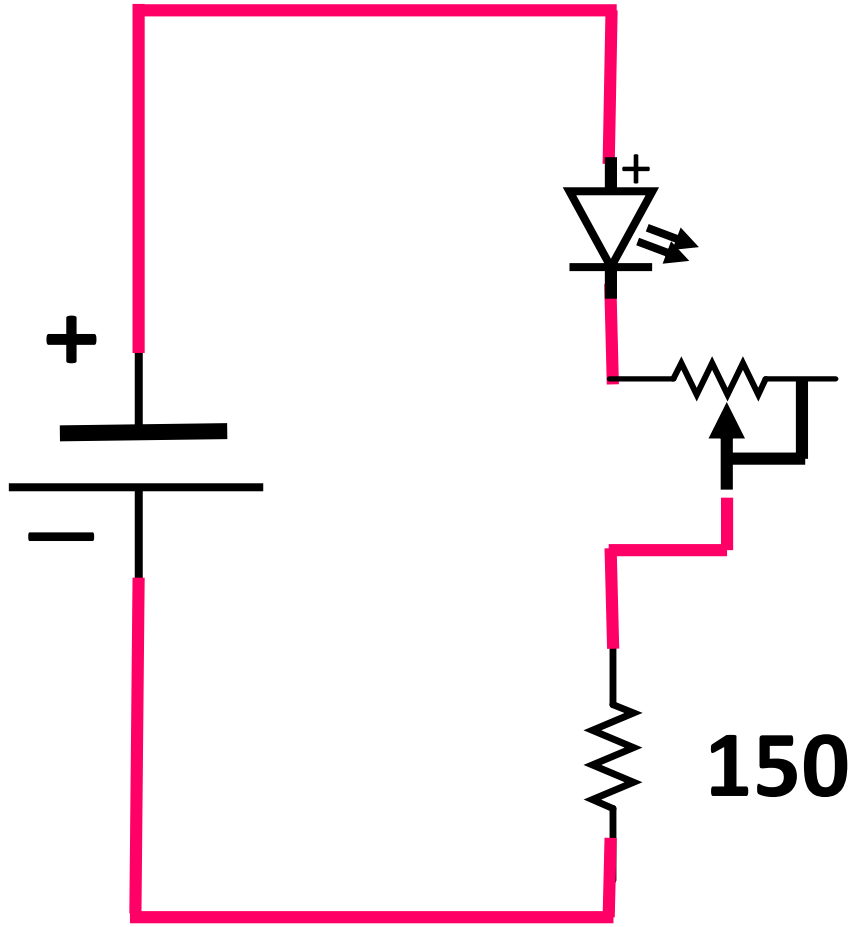
VARIABLE RESISTOR LAB

- Build the circuit with the variable R_p and fixed R_2
- Turn the Potentiometer and measure the Voltage
- Using this formula calculate R_p

$$R_x = \frac{R_t * Vx}{V}$$

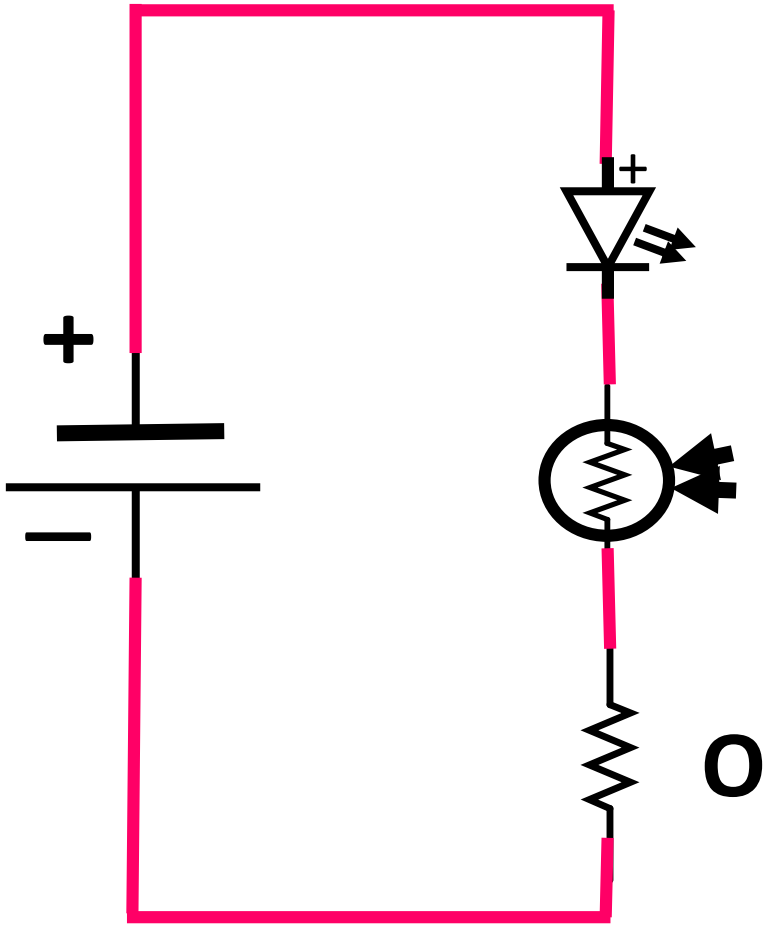


SERIES CIRCUIT VOLTAGE



See What Effect Variable Resistance Has On the LED brightness?

Series Circuit Voltage

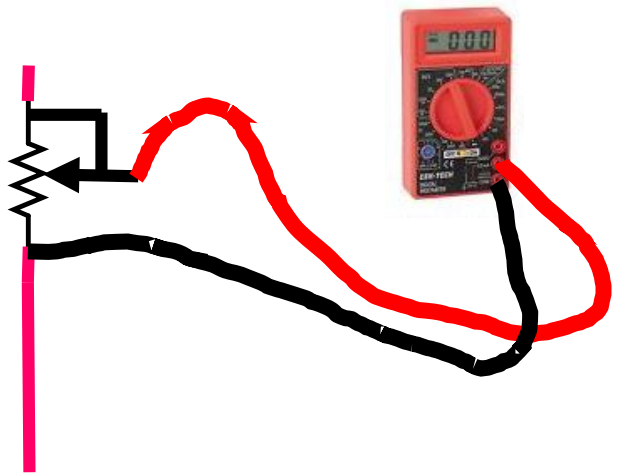


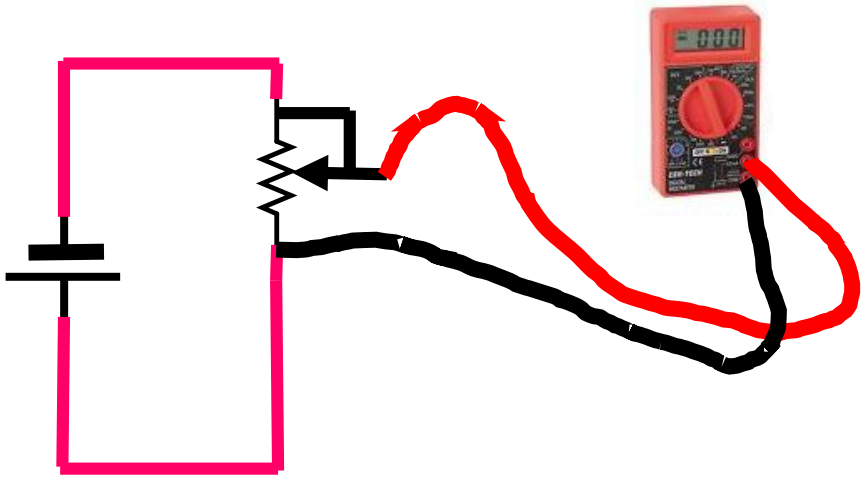
See What Effect Light Has On the LED brightness?

Optional… Why?

VARIABLE RESISTOR LAB

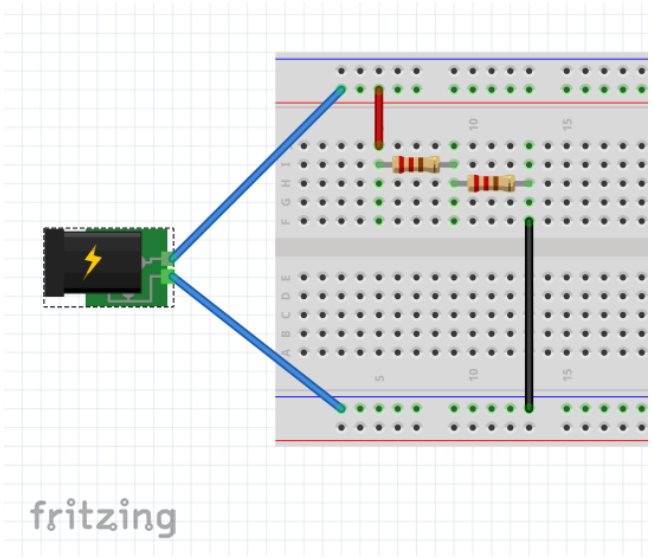
- Turn the Potentiometer to have equal resistance on both sides
  - ie: for a 10KΩ Potentiometer each segment should be about 5KΩ
- Measure:
  - The resistance of each side,
  - then connect power, and measure the voltage

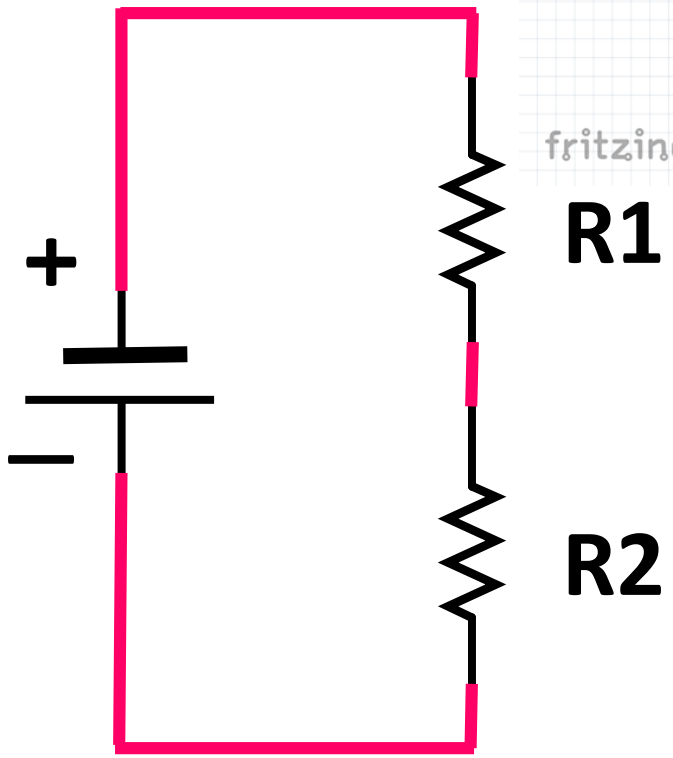




REFERENCE

LAB #2 SERIES CIRCUIT



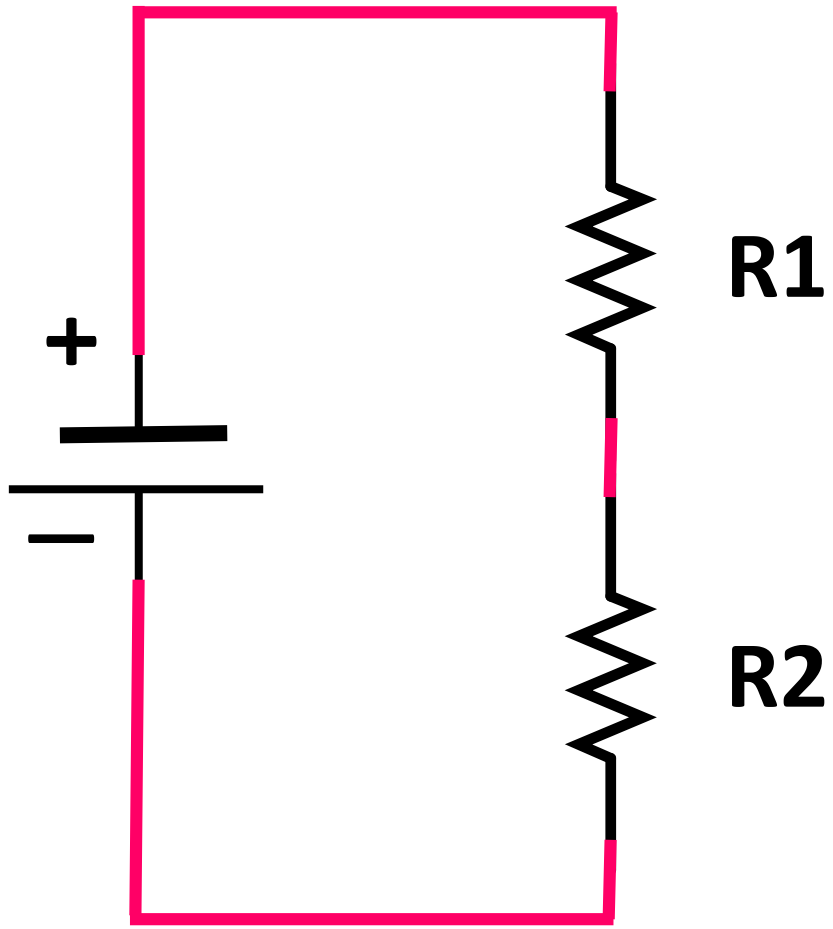


$R_1 = 330\Omega$, $R_2 = 680\Omega$

$R_1 = 1K\Omega$, $R_2 = 2K\Omega$

$R_1 = 680\Omega$, $R_2 = 1K\Omega$

SERIES CIRCUIT RESISTANCE



Calculate R_t

$$R_t = R_1 + R_2 + R_3 + \text{etc.}$$

$R_1 = 680\Omega$, $R_2 = 1K\Omega$ $R_t =$ _____

Work Sheet – Lab / Quiz

- Objectives
  - Demonstrate knowledge of Ohms Law
  - Demonstrate proper use of a Digital Multi Meter
  - Demonstrate knowledge of Series Circuits fundamentals
  - Apply the Voltage divider principles
- Equipment needed
  - 5 volt DC power supply and bread board adaptor
  - DMM
  - Bread board
  - Assorted resistors and wires

LETS DO SOME CALCULATIONS

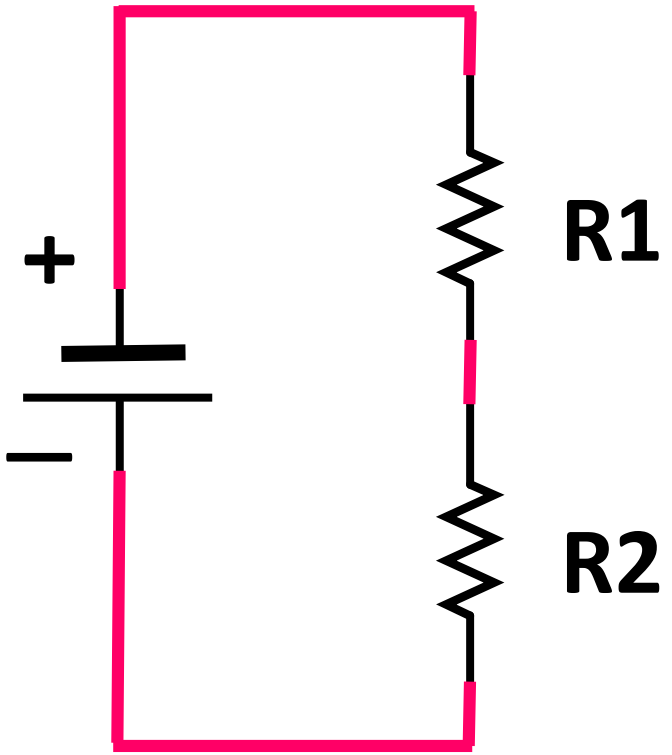
$$V_x = V(\frac{R_x}{R_t})$$

$R_1 = 330\Omega$, $R_2 = 680\Omega$, $V = 5v$

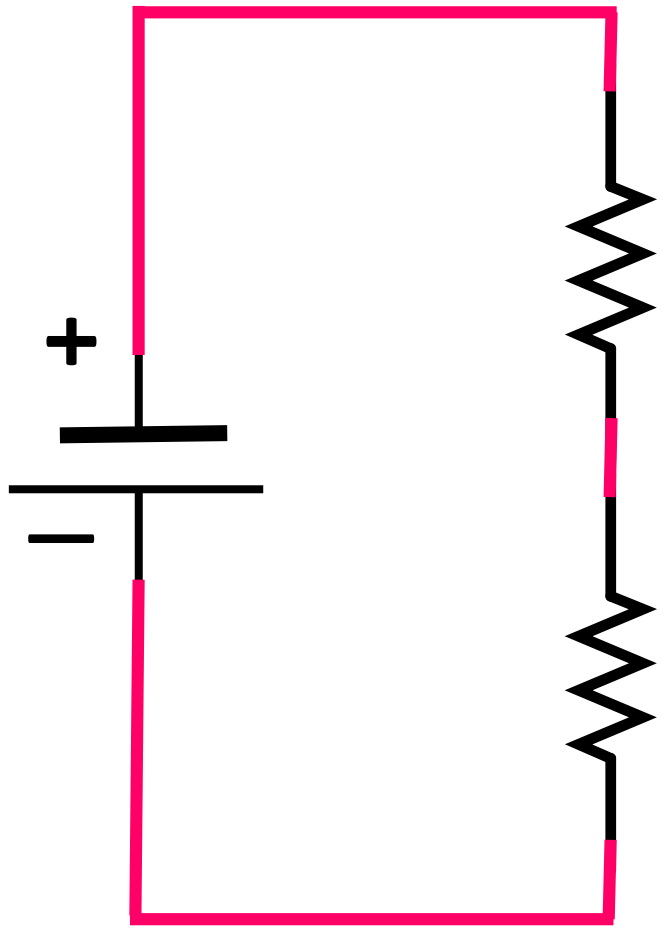
$$R_t = 330\Omega + 680\Omega$$

$$R_t = 1010\Omega \qquad R_t = 1.01K\Omega$$

$$V_x = V(\frac{R_x}{R_t})$$



SERIES CIRCUIT RESISTANCE



Calculate R_t

$$R_t = R_1 + R_2 + R_3 + \text{etc.}$$

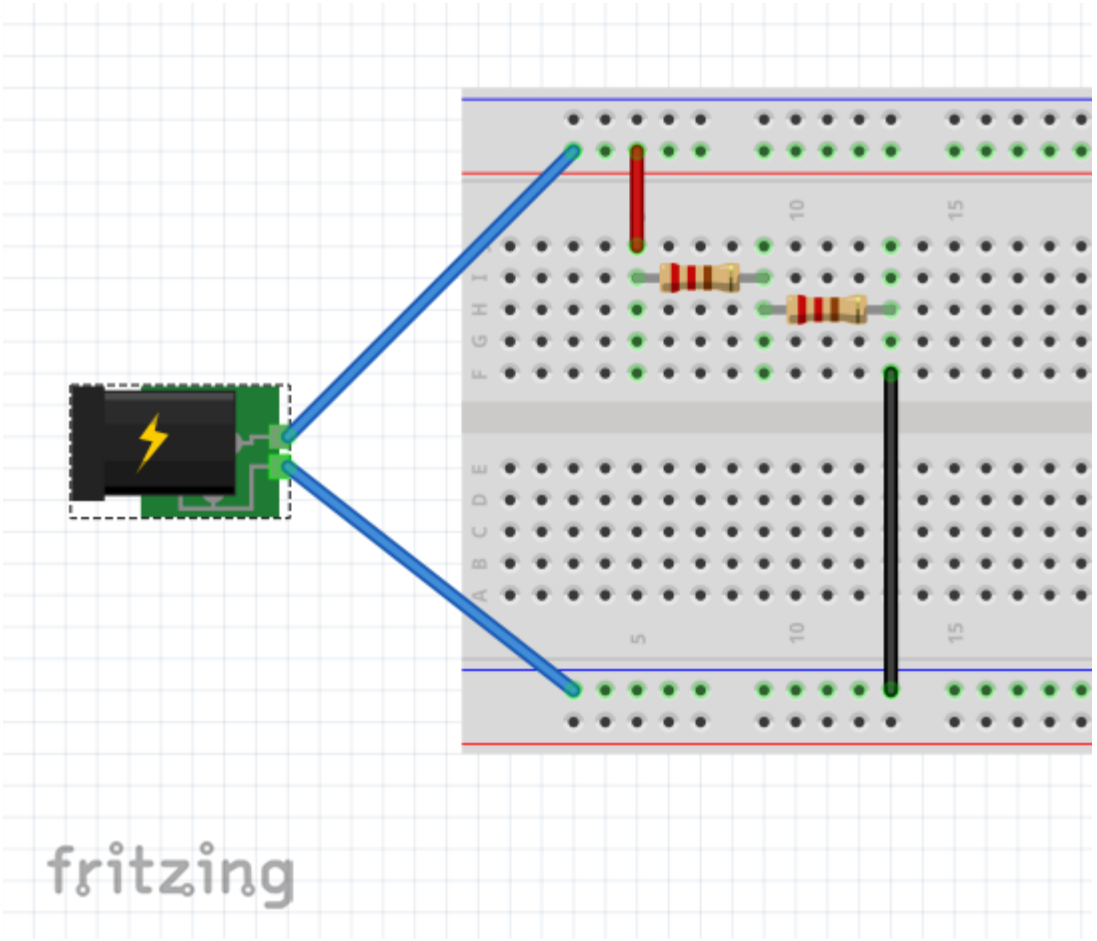
$R_1 = 330\Omega$, $R_2 = 330\Omega$ $R_t =$ _____

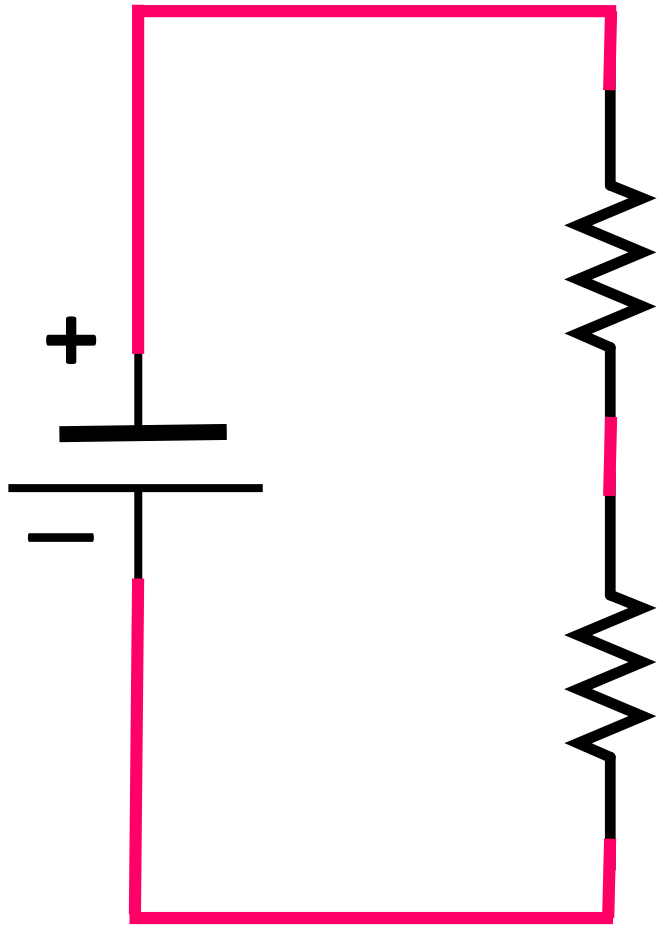
$R_1 = 330\Omega$, $R_2 = 680\Omega$ $R_t =$ _____

$R_1 = 1K\Omega$, $R_2 = 2K\Omega$ $R_t =$ _____

$R_1 = 6800\Omega$, $R_2 = 1K\Omega$ $R_t =$ _____

SERIES CIRCUIT

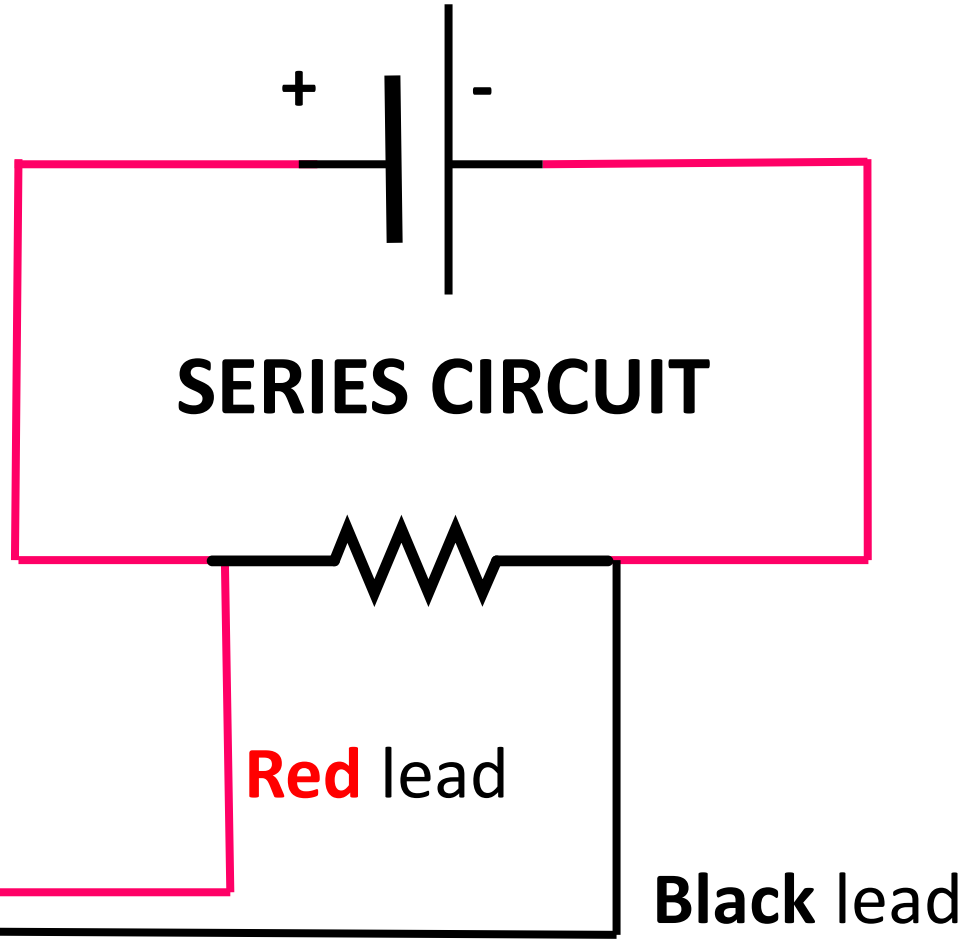




SERIES CIRCUIT

MEASURING VOLTAGE

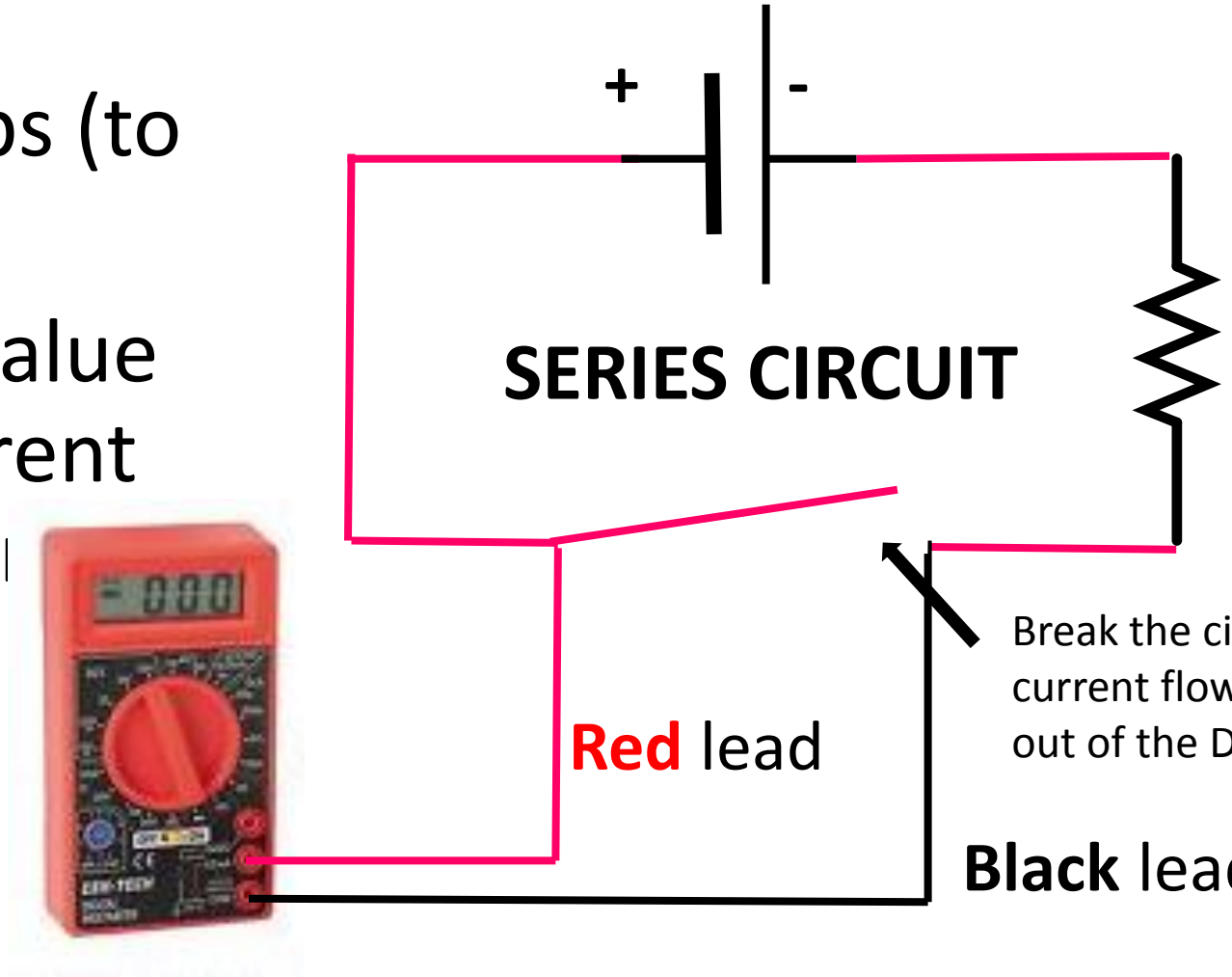
- Set the DMM to Ω (to measure Resistance)
- Set it to the closest value above the target resi you are measuring



This is how we measure volts in a circuit

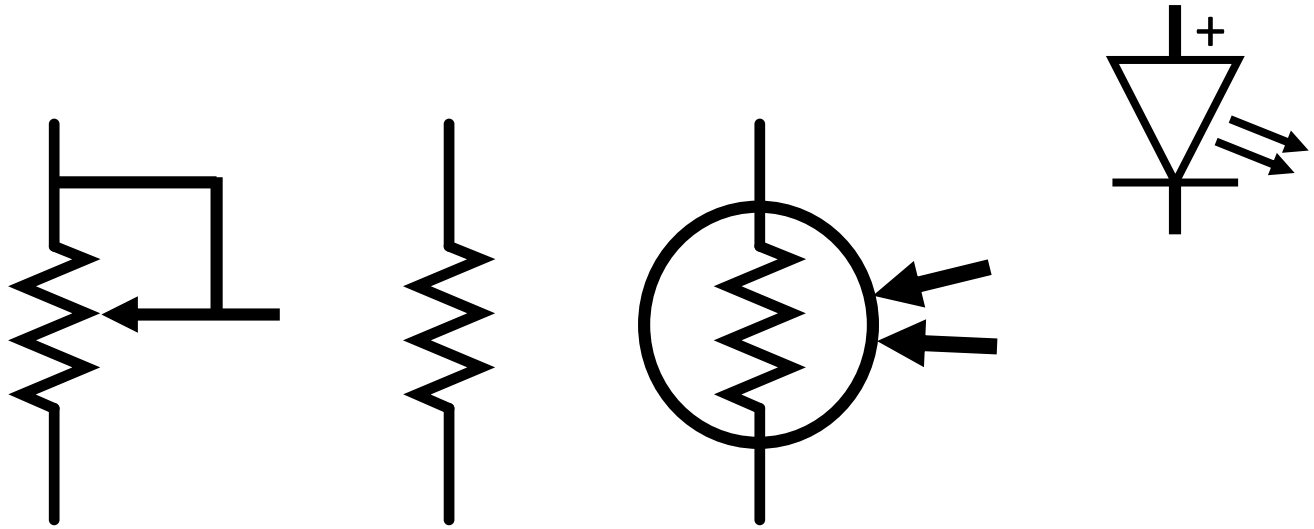
MEASURING CURRENT

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



This is how we measure Amps in a circuit

ELECTRONIC SYMBOLS



SOURCES

- 30 years of electronics in my head…
- Electronic Projects for Photographers
- https://www.youtube.com/watch?v=Hck8k6ALBV8
- https://www.youtube.com/watch?v=2d8CUQokims
- https://adamcap.com/schoolwork/series-and-parallel-circuits-lab/ ← add some of the hypothesis and Questions to the labs
- http://www.thephysicsaviary.com/Physics/Programs/Labs/SeriesCircuitLab/index.html <-- maybe add a lab to prove current is the same…
- http://www.freeclassnotesonline.com/Series-Circuits-Lab.php <-- good lab work sheet… add to presentation