

TANGIBLE MEDIA & PHYSICAL COMPUTING

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# ESSENTIAL ELECTRONICS



# AGENDA

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WHAT IS ELECTRICITY

OHMS LAW (RESISTANCE, VOLTAGE, CURRENT)

POWER

CIRCUITS

SERIES & PARALLEL CIRCUITS

POLARITY

COMPONENTS & SYMBOLS

BREADBOARDS \*

DIGITAL MULTI-METERS \*

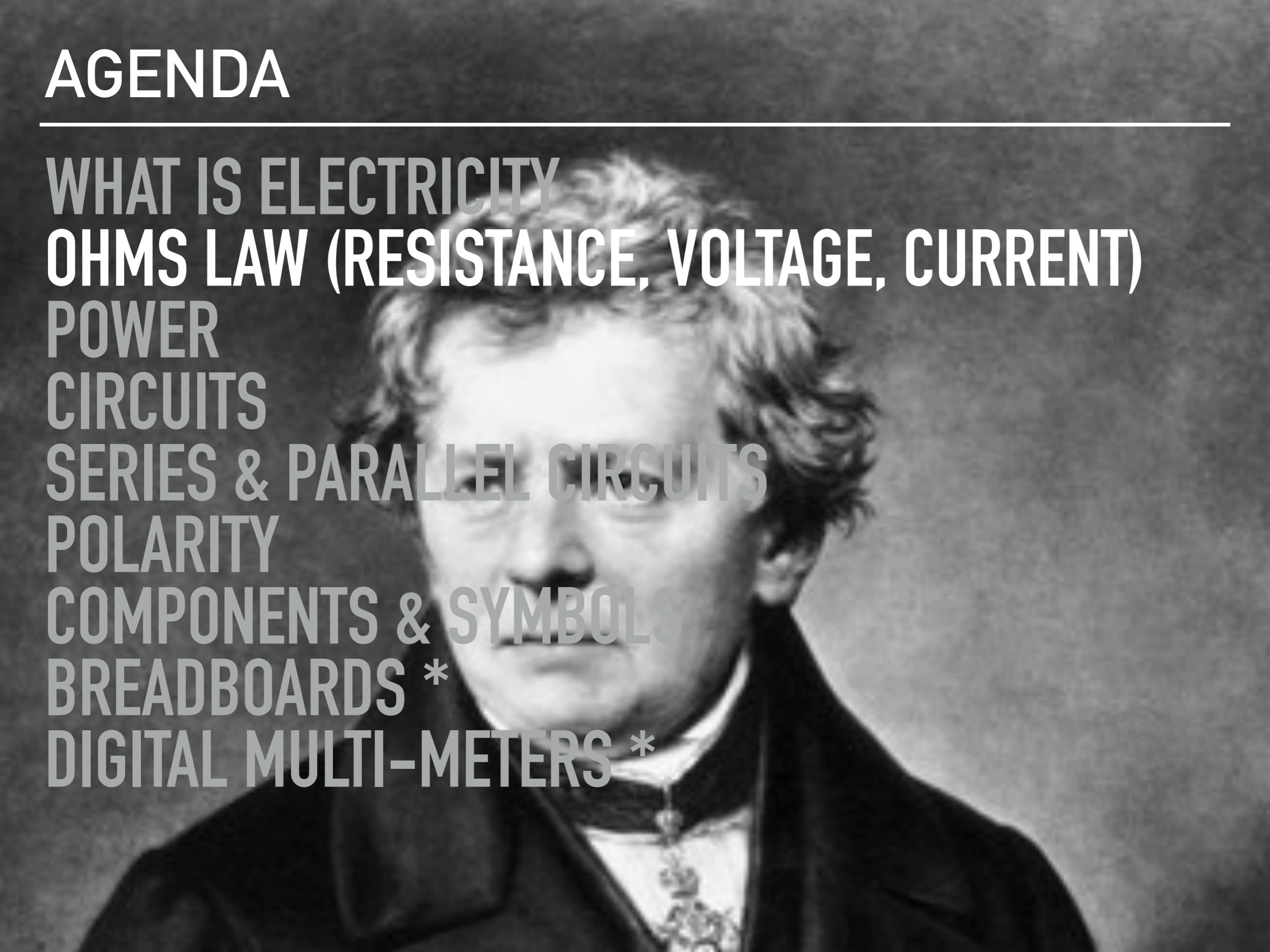
# ELECTRICITY

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ELECTRICITY IS THE MOVEMENT OF ELECTRONS. ELECTRONS CREATE CHARGE, WHICH WE CAN HARNESSTO DO WORK. ALL OUR ELECTRIC DEVICES OPERATE USINGTHE SAME BASIC POWER SOURCE: THE MOVEMENT OFELECTRONS.

# AGENDA

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A black and white portrait of James Watt, a Scottish engineer and a mechanical designer. He is shown from the chest up, wearing a dark coat over a white cravat and a patterned waistcoat. His hair is powdered and styled upwards. He has a thoughtful expression, looking slightly to the right.

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# WHAT GEORG OBSERVED

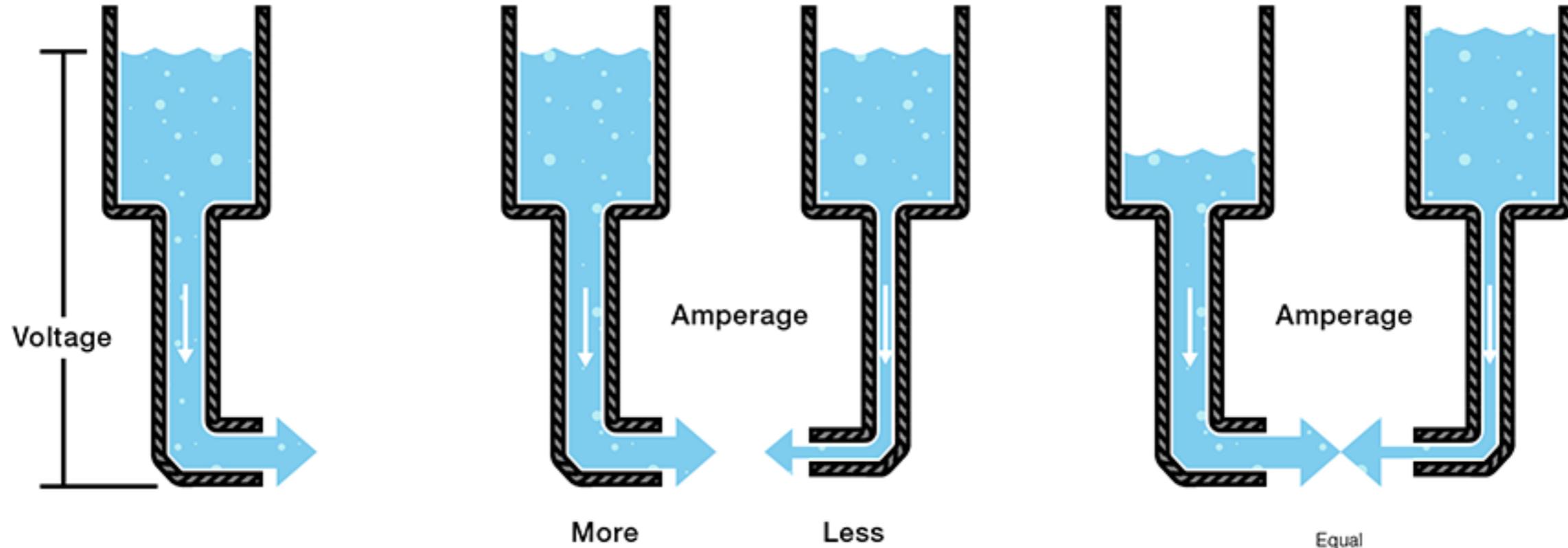
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AT A CONSTANT TEMPERATURE, THE ELECTRICAL CURRENT FLOWING THROUGH A FIXED LINEAR RESISTANCE IS DIRECTLY PROPORTIONAL TO THE VOLTAGE APPLIED ACROSS IT, AND ALSO INVERSELY PROPORTIONAL TO THE RESISTANCE.

THIS RELATIONSHIP BETWEEN THE VOLTAGE, CURRENT AND RESISTANCE FORMS THE BASIS OF OHMS LAW.

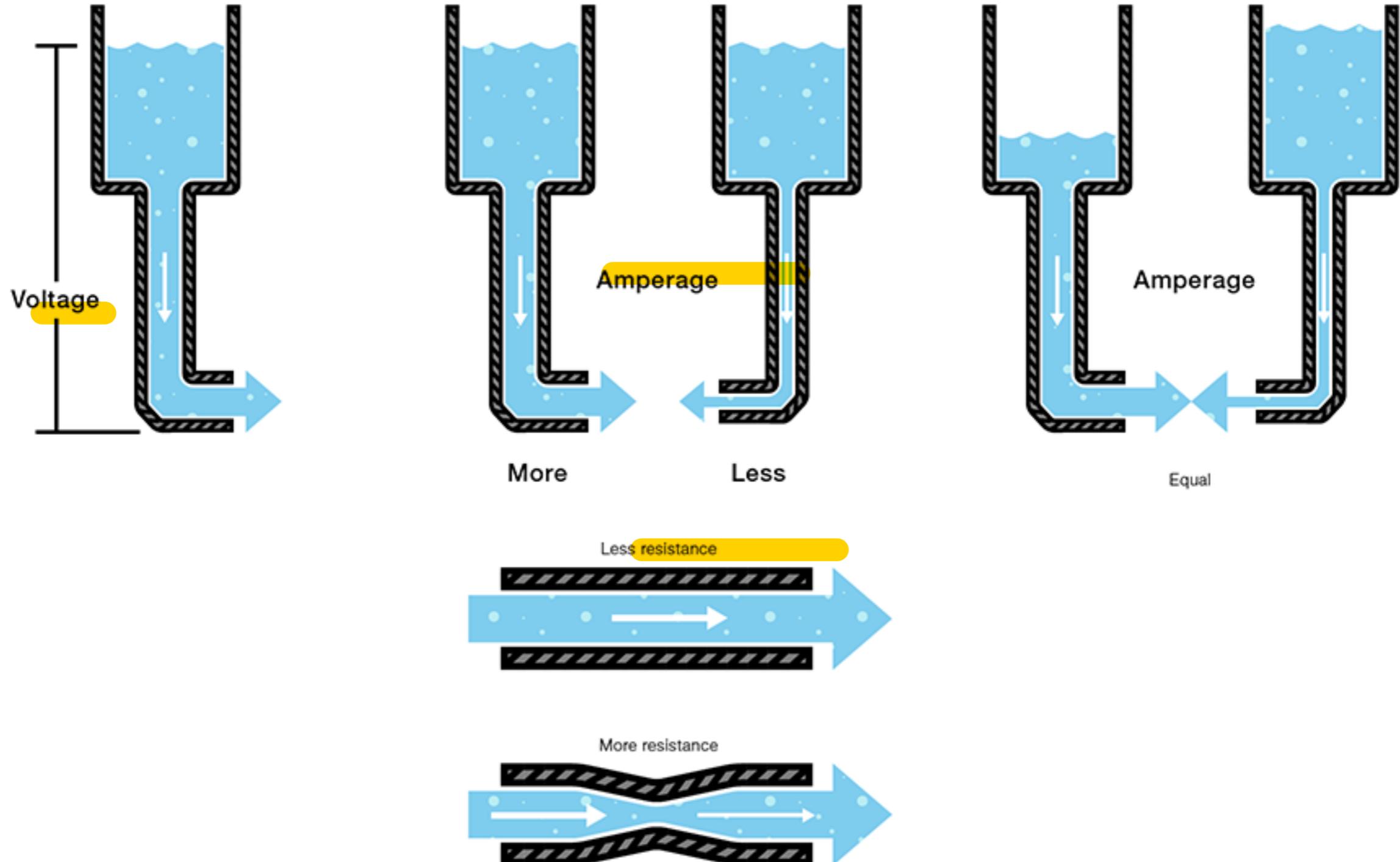
# AN ANALOGY: VOLTAGE & CURRENT

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# AN ANALOGY: RESISTANCE

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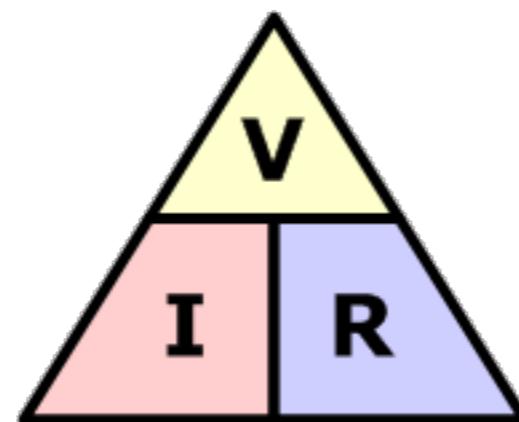


# OHMS LAW

COMBINING THE ELEMENTS OF VOLTAGE, CURRENT, AND RESISTANCE, WE DERIVE THE FOLLOWING:

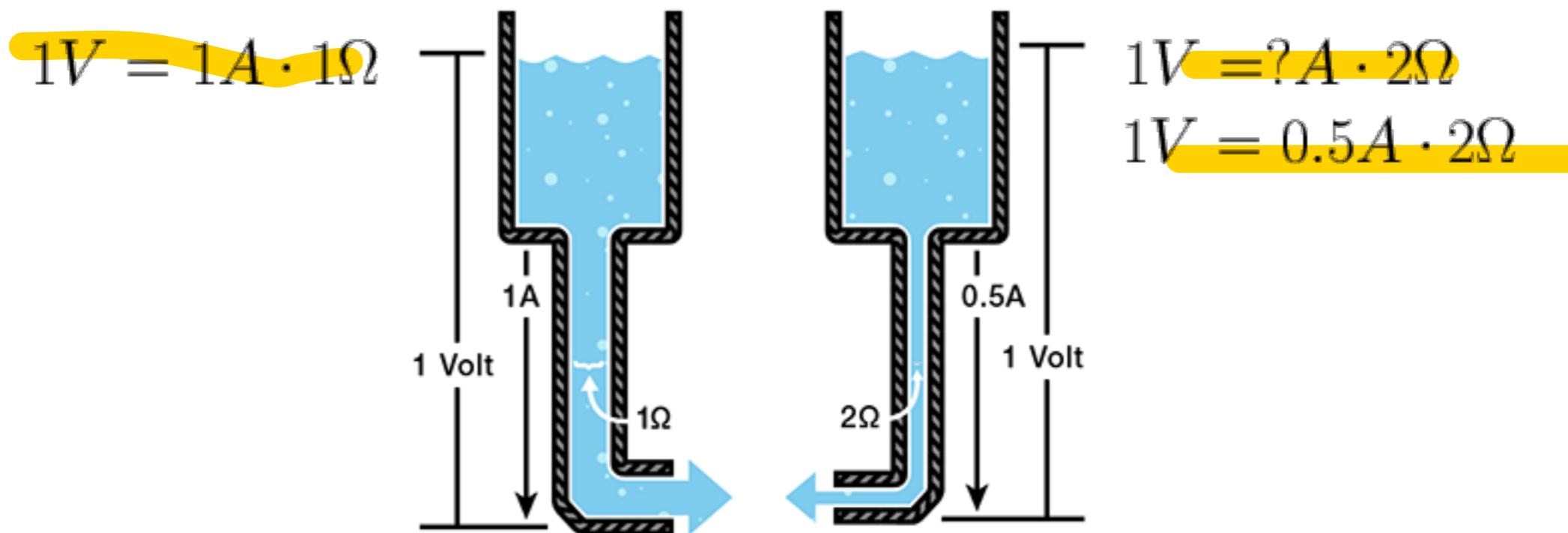
The diagram shows three triangles, each with a yellow top section containing a symbol (V, I, or R) inside a circle. The bottom section is divided into two colored sections: pink on the left and light blue on the right. In the first triangle, 'V' is at the top, 'I' is in the pink section, and 'R' is in the light blue section. In the second triangle, 'V' is at the top, 'I' is in the pink section, and 'R' is in the light blue section. In the third triangle, 'V' is at the top, 'I' is in the pink section, and 'R' is in the light blue section. Below each triangle is a corresponding Ohm's Law equation:

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



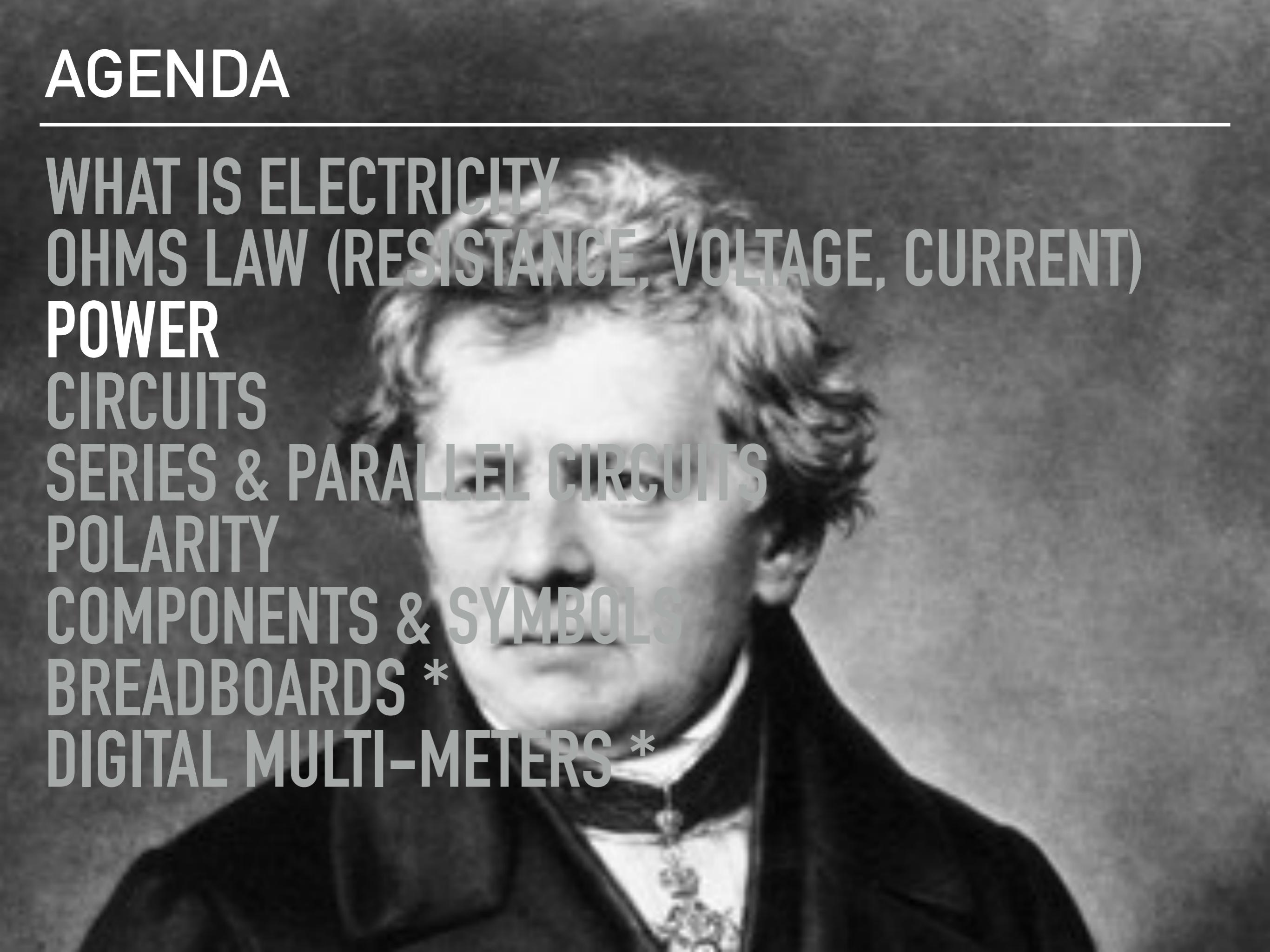
# OHMS LAW (IN PRACTICE)

COMBINING THE ELEMENTS OF VOLTAGE, CURRENT, AND RESISTANCE, WE DERIVE THE FOLLOWING:



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A black and white portrait of James Watt, a Scottish engineer and a mechanical designer. He is shown from the chest up, wearing a dark coat over a white cravat and a patterned waistcoat. His hair is powdered and styled upwards. He has a thoughtful expression, looking slightly to the right.

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# POWER

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POWER IS ONE OF THE MORE FUNDAMENTAL CONCEPTS IN ELECTRONICS. IN GENERAL TERMS, POWER IS DEFINED AS THE RATE AT WHICH ENERGY IS TRANSFERRED (OR TRANSFORMED) IN A CIRCUIT.

ELECTRIC POWER IS MEASURED BY COMBINING BOTH HOW MUCH VOLTAGE IS TRANSFERRED, AND HOW FAST THAT TRANSFER (CURRENT) HAPPENS.

# PRODUCERS AND CONSUMERS

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EACH COMPONENT IN A CIRCUIT EITHER CONSUMES OR PRODUCES ELECTRIC ENERGY. A CONSUMER TRANSFORMS ELECTRIC ENERGY INTO ANOTHER FORM.

ELECTRIC POWER IS PRODUCED WHEN ENERGY IS TRANSFERRED TO ELECTRIC FROM SOME OTHER FORM.

# WATTAGE

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POWER IS A MEASURE OF ENERGY OVER A SET AMOUNT OF TIME, WE CAN MEASURE IT IN JOULES PER SECOND. THE SI UNIT FOR JOULES PER SECOND IS THE WATT ABBREVIATED AS W.

$$watt = W = \frac{joule}{second} = \frac{J}{s}$$

# CALCULATING POWER

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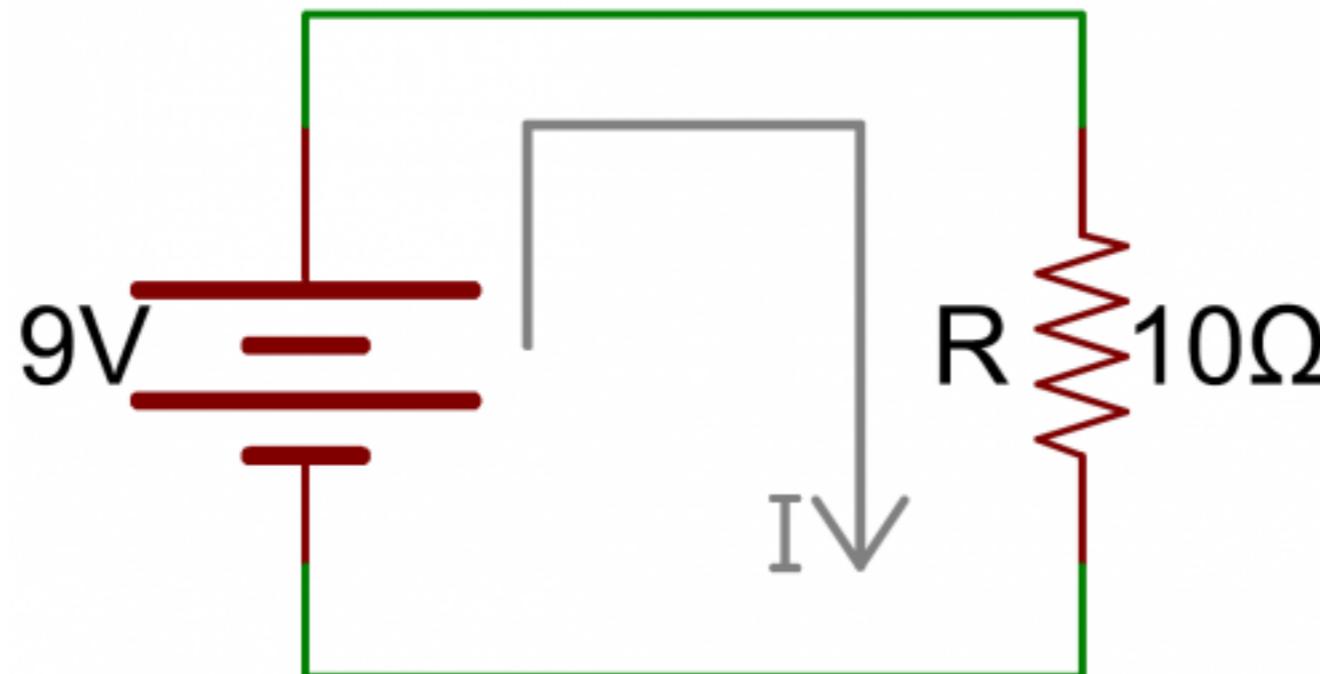
WE KNOW POWER IS THE RATE AT WHICH ENERGY IS TRANSFERRED. IT'S MEASURED AS – A WATT (W). GIVEN THE FEW ELECTRICITY TERMS WE KNOW, HOW COULD WE CALCULATE POWER IN A CIRCUIT?

$$\text{power} = \text{volts} \times \text{amperes} = \frac{\text{joules}}{\text{coulomb}} \times \frac{\text{coulomb}}{\text{second}} = \text{watt}$$

# EXAMPLE

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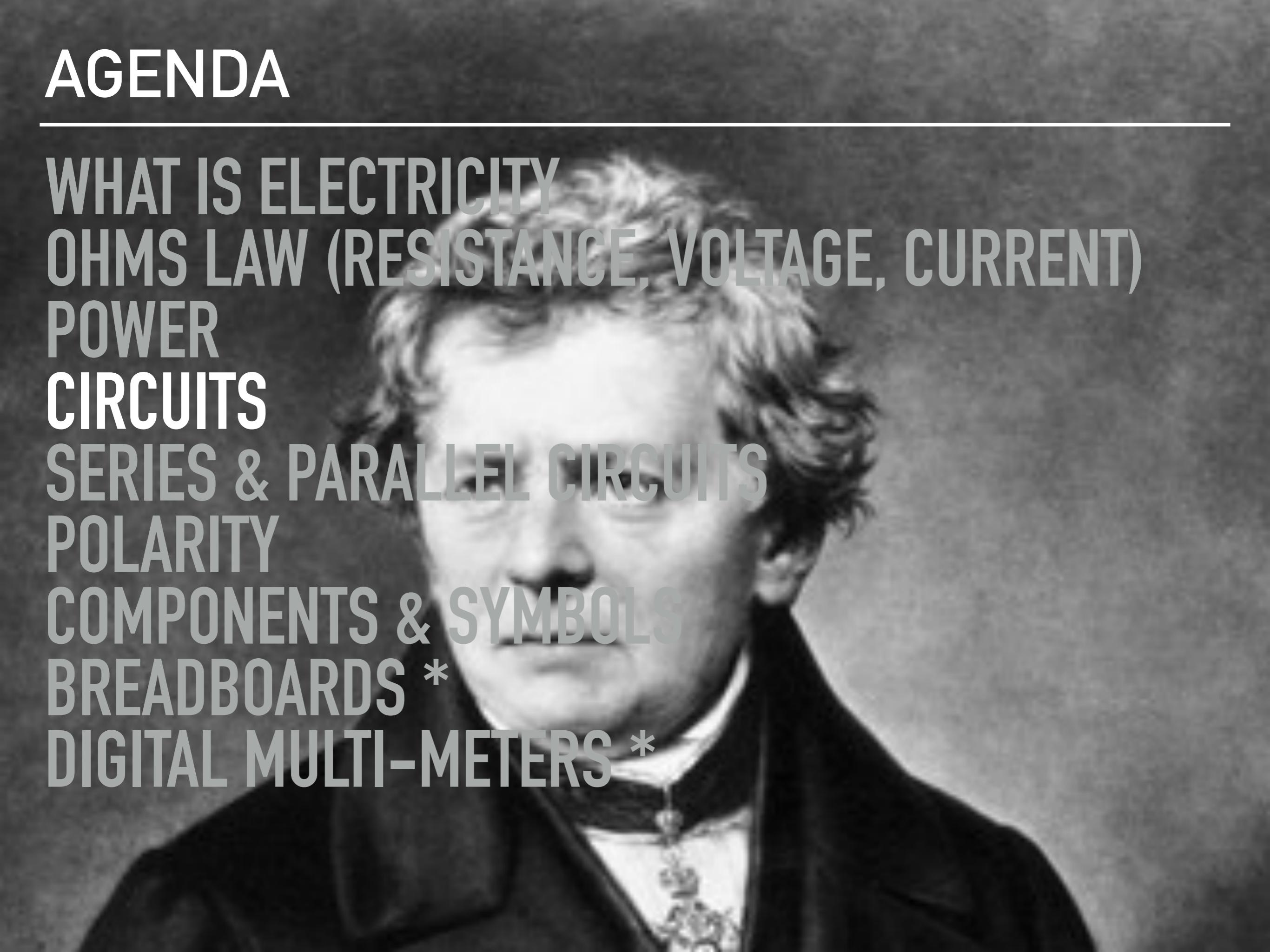
HOW DO WE CALCULATE THE POWER ACROSS THE RESISTOR?



$$I = \frac{V}{R} = \frac{9 V}{10 \Omega} = 0.9 A = 900 mA$$
$$P = I \times V = 9 V \times 0.9 A = 8.1 W$$

# AGENDA

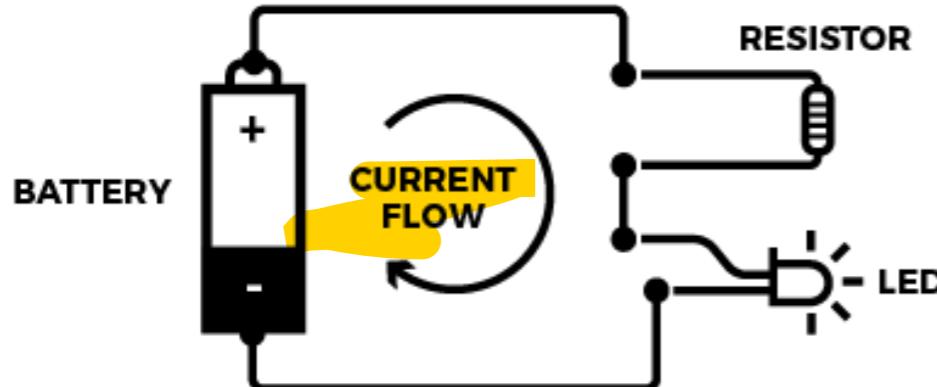
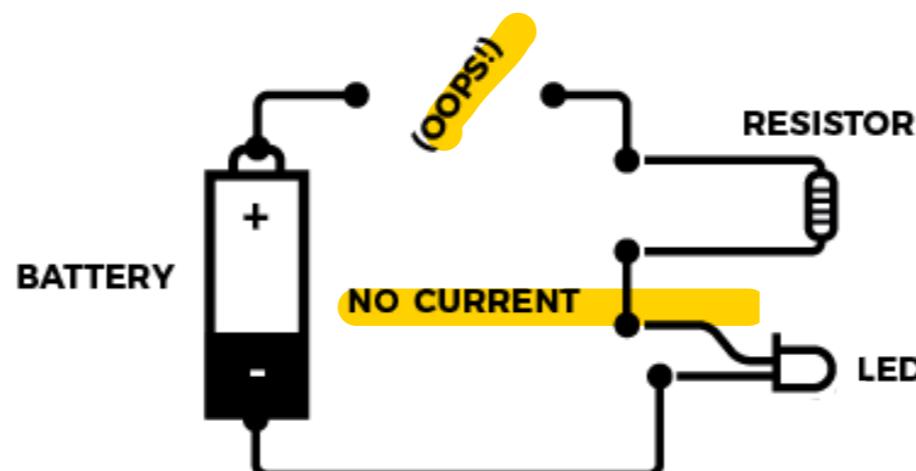
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A black and white portrait of James Watt, a Scottish engineer and a mechanical designer. He is shown from the chest up, wearing a dark coat over a white cravat and a patterned waistcoat. His hair is powdered and styled upwards. He has a thoughtful expression, looking slightly to the right.

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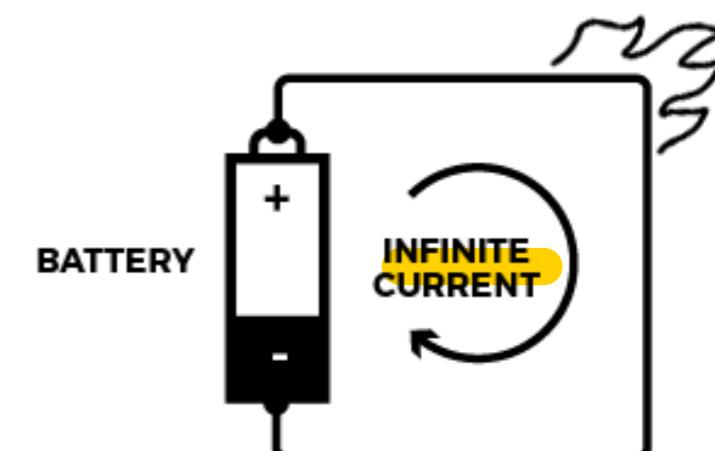
# CIRCUITS

A CIRCUIT IS A PATH THAT STARTS AND STOPS AT THE SAME PLACE. THIS CIRCULAR PATH IS ALWAYS REQUIRED TO GET ELECTRICITY TO FLOW AND DO SOMETHING USEFUL.



**BROKEN  
CIRCUIT**

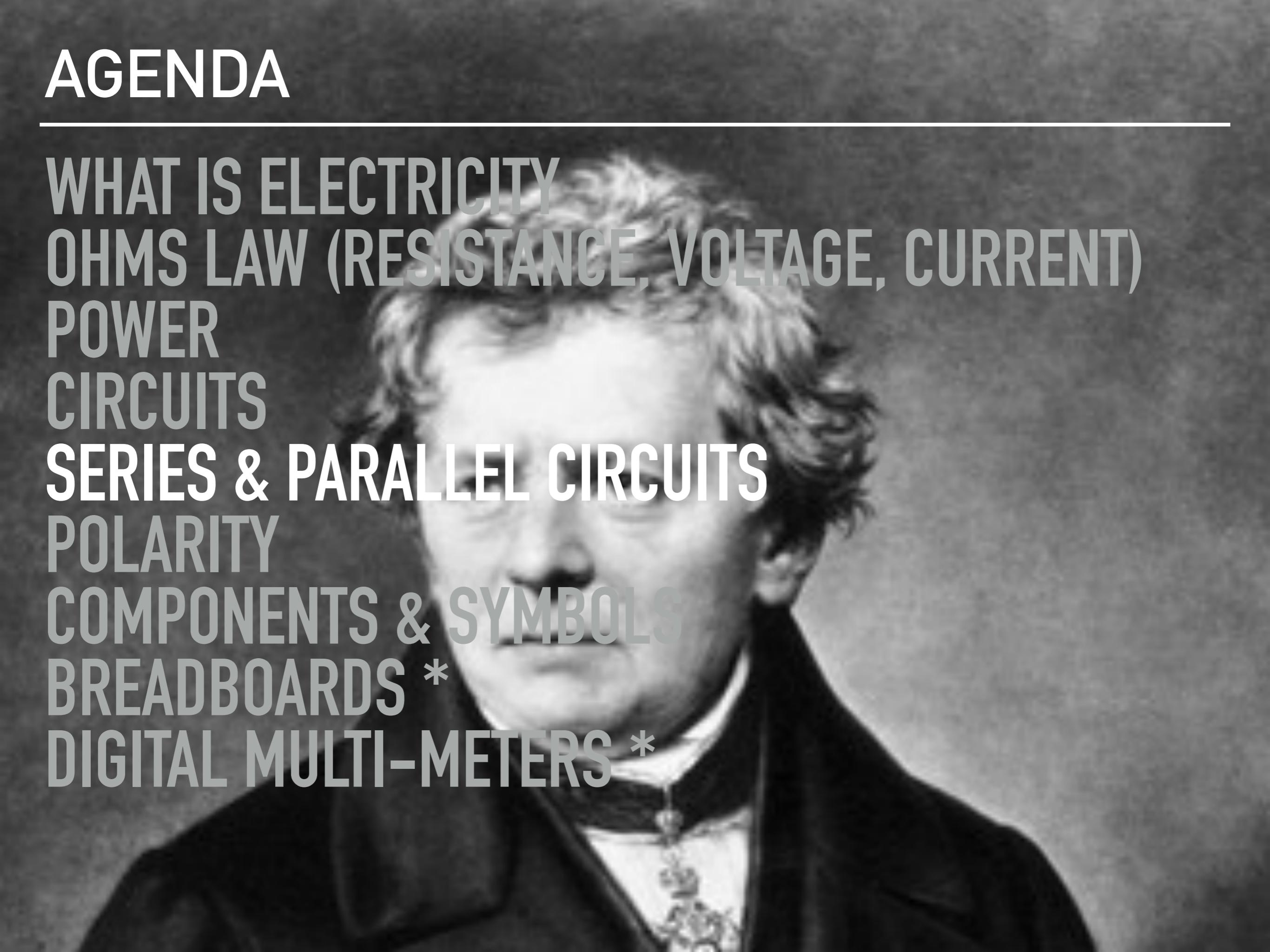
**PROPER  
CIRCUIT**



**SHORT  
CIRCUIT**

# AGENDA

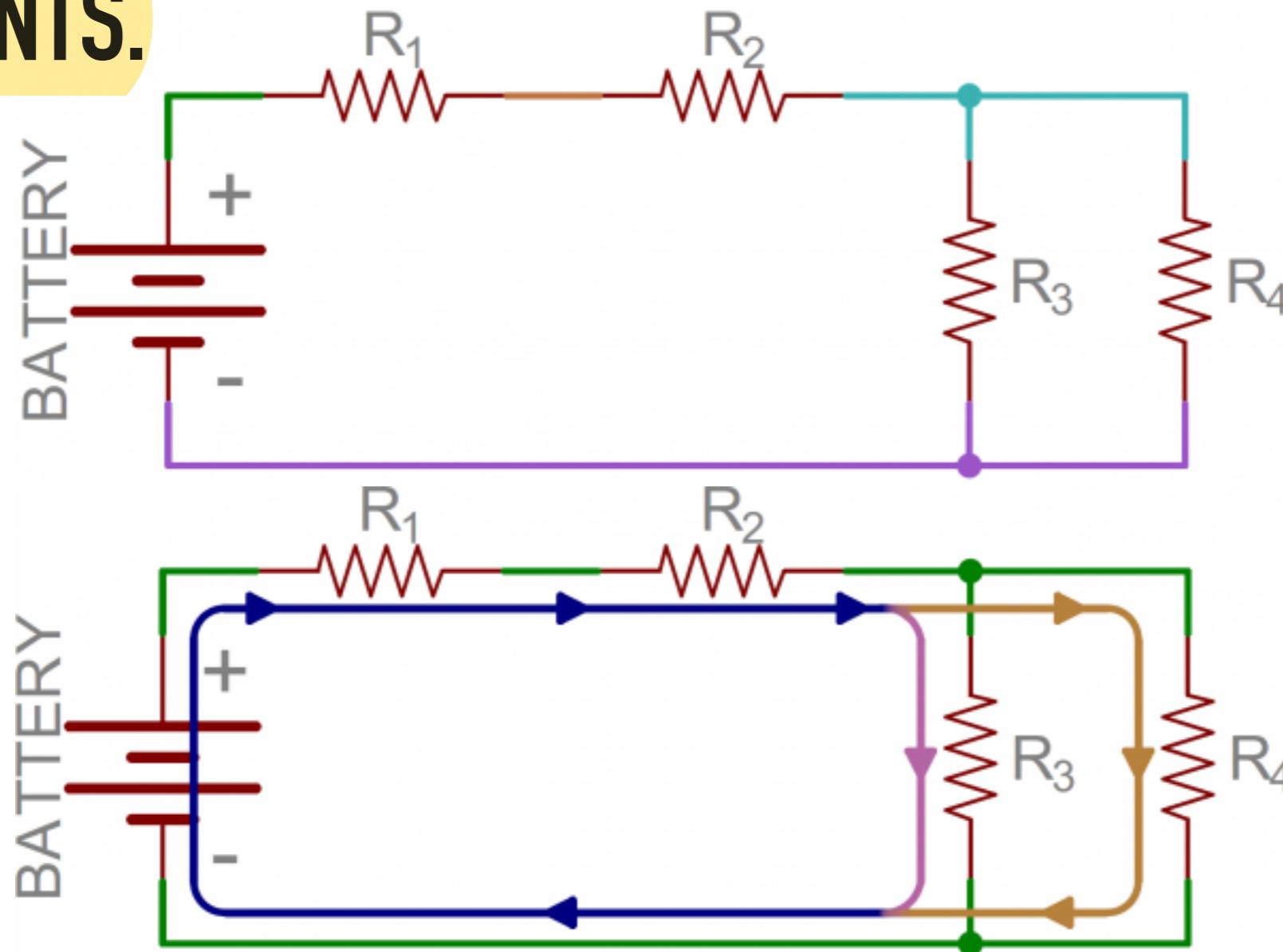
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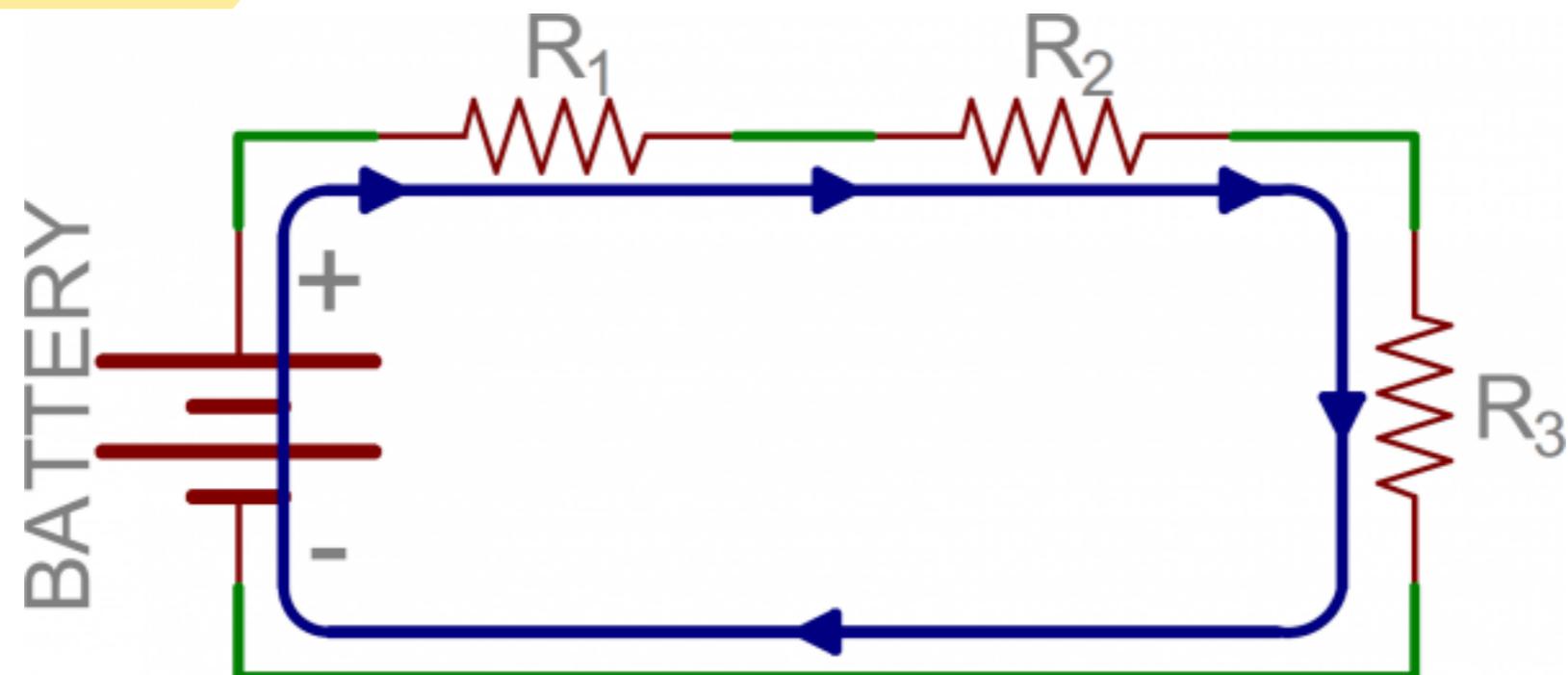
# CIRCUIT NODES

WHAT IS A NODE? A NODE IS AN ELECTRICAL JUNCTION BETWEEN TWO OR MORE COMPONENTS. IN A CIRCUIT SCHEMATIC, THE NODES ARE THE WIRES BETWEEN COMPONENTS.



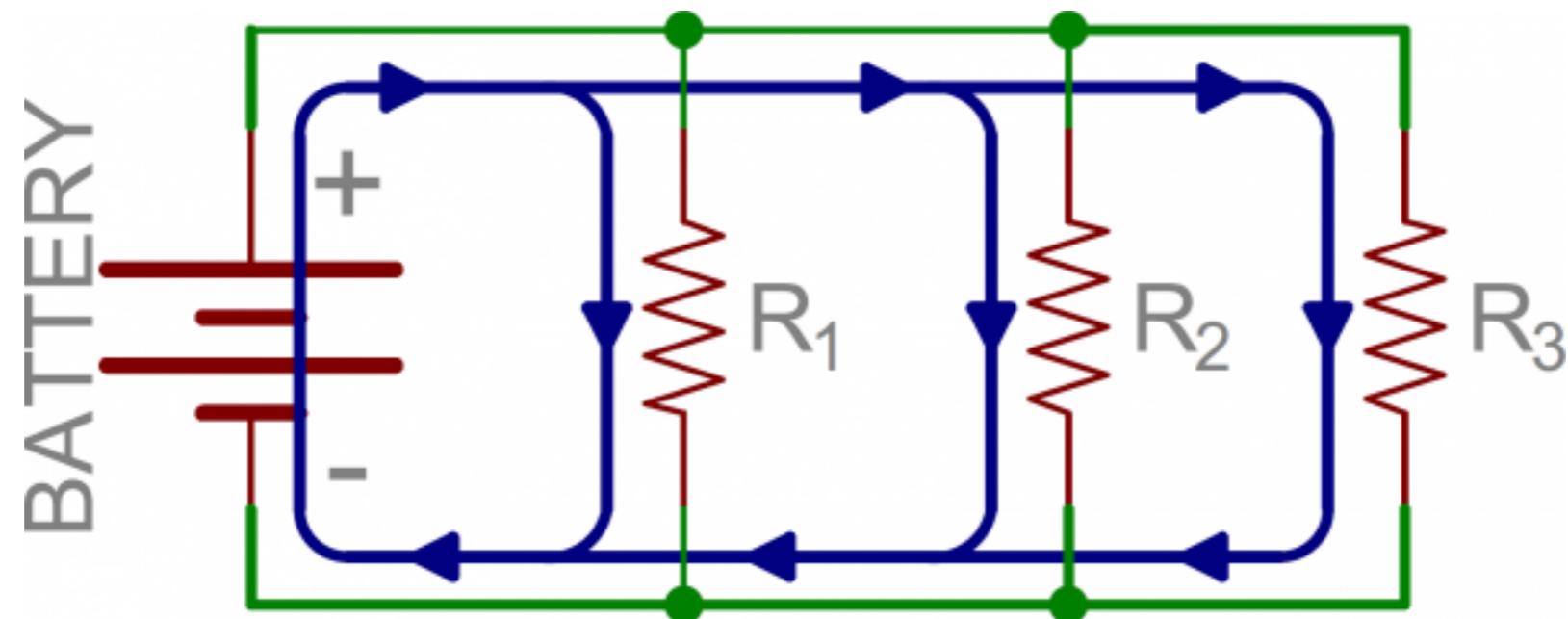
# SERIES CIRCUIT

TWO COMPONENTS ARE IN SERIES IF THEY SHARE A COMMON NODE AND IF THE SAME CURRENT FLOWS THROUGH THEM.



# PARALLEL CIRCUIT

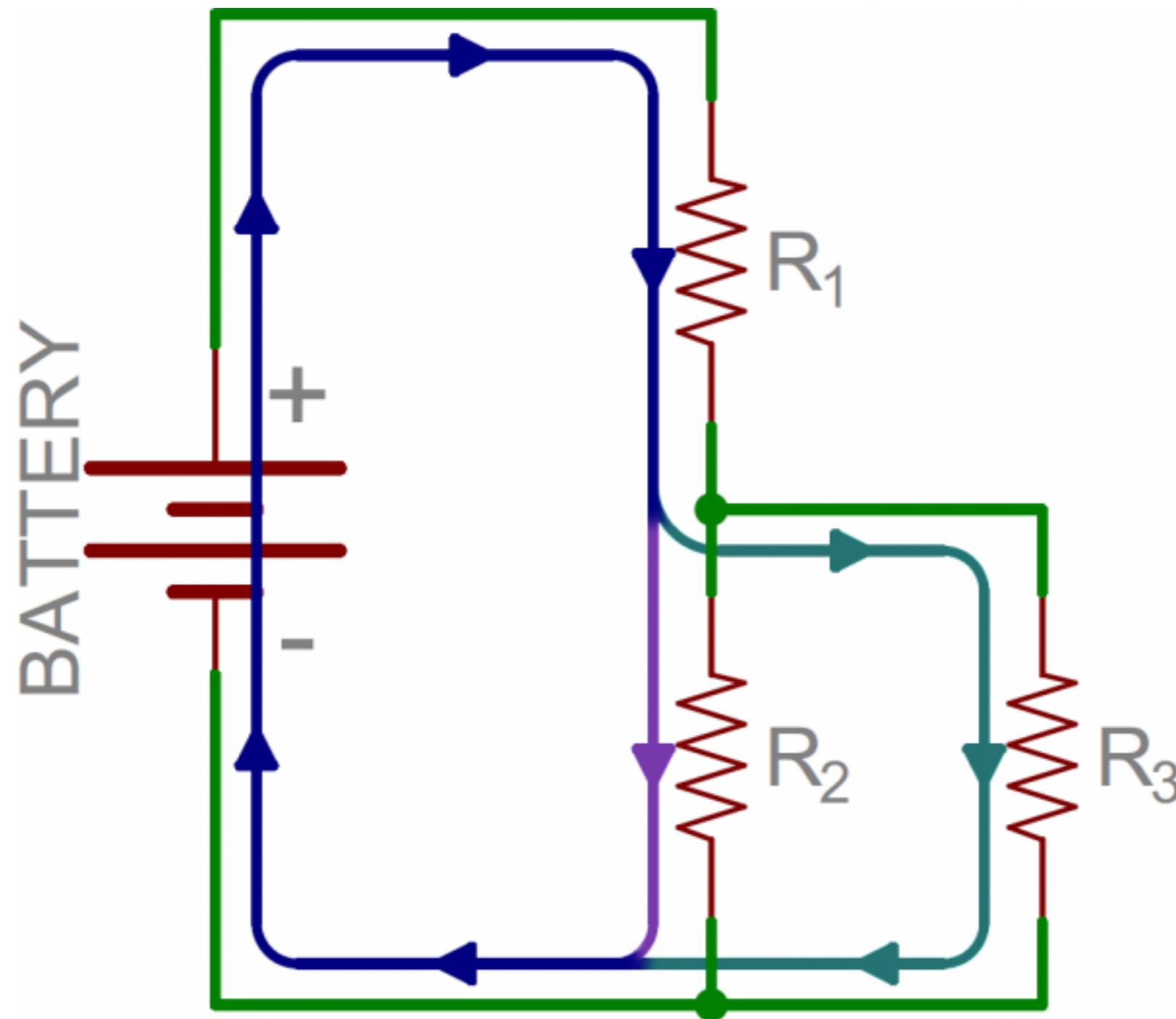
IF COMPONENTS SHARE TWO COMMON NODES, THEN THEY ARE IN PARALLEL.



# SERIES & PARALLEL CIRCUITS

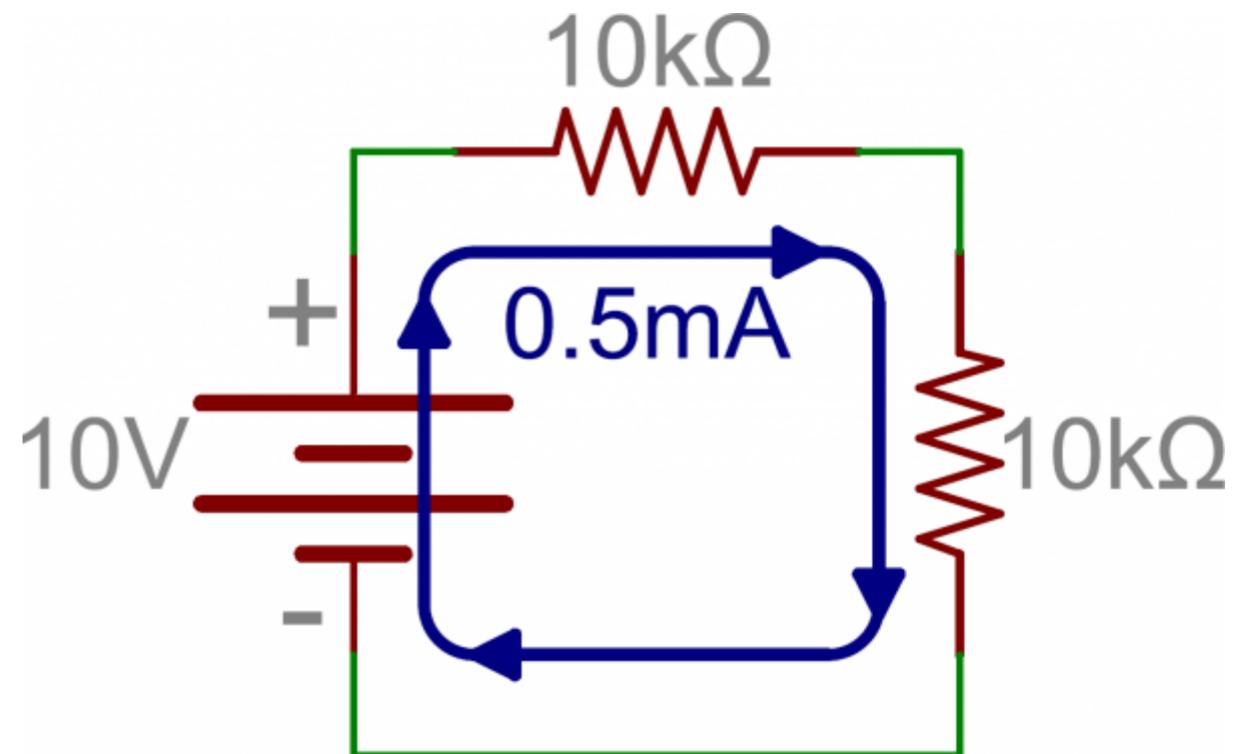
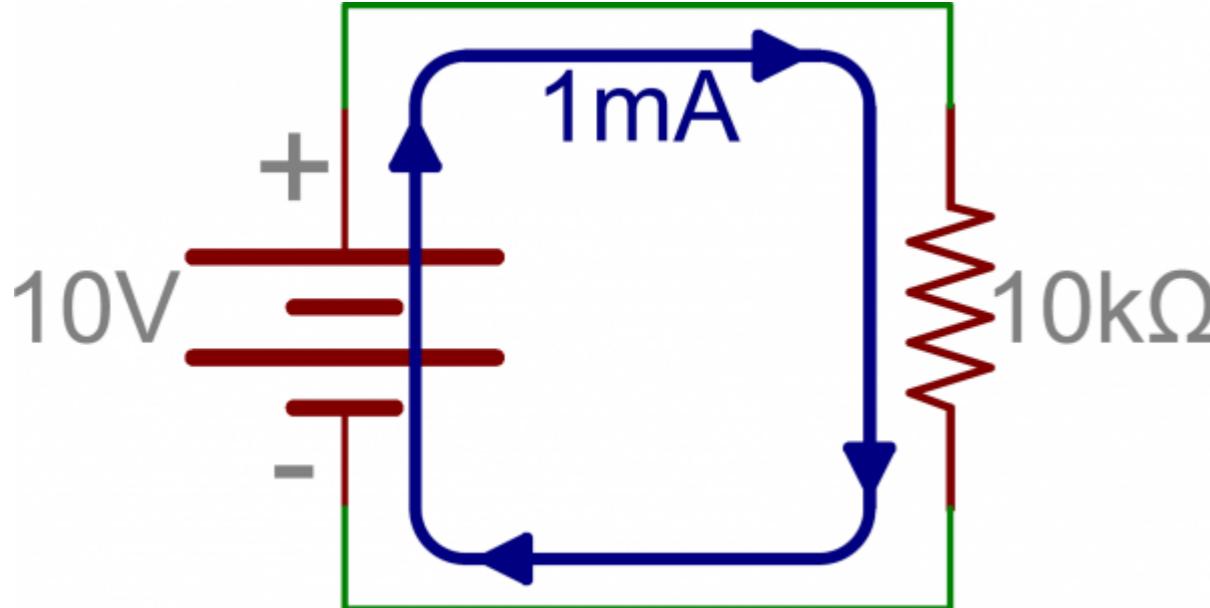
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NOW WE CAN MIX AND MATCH.



# RESISTORS IN SERIES CIRCUITS

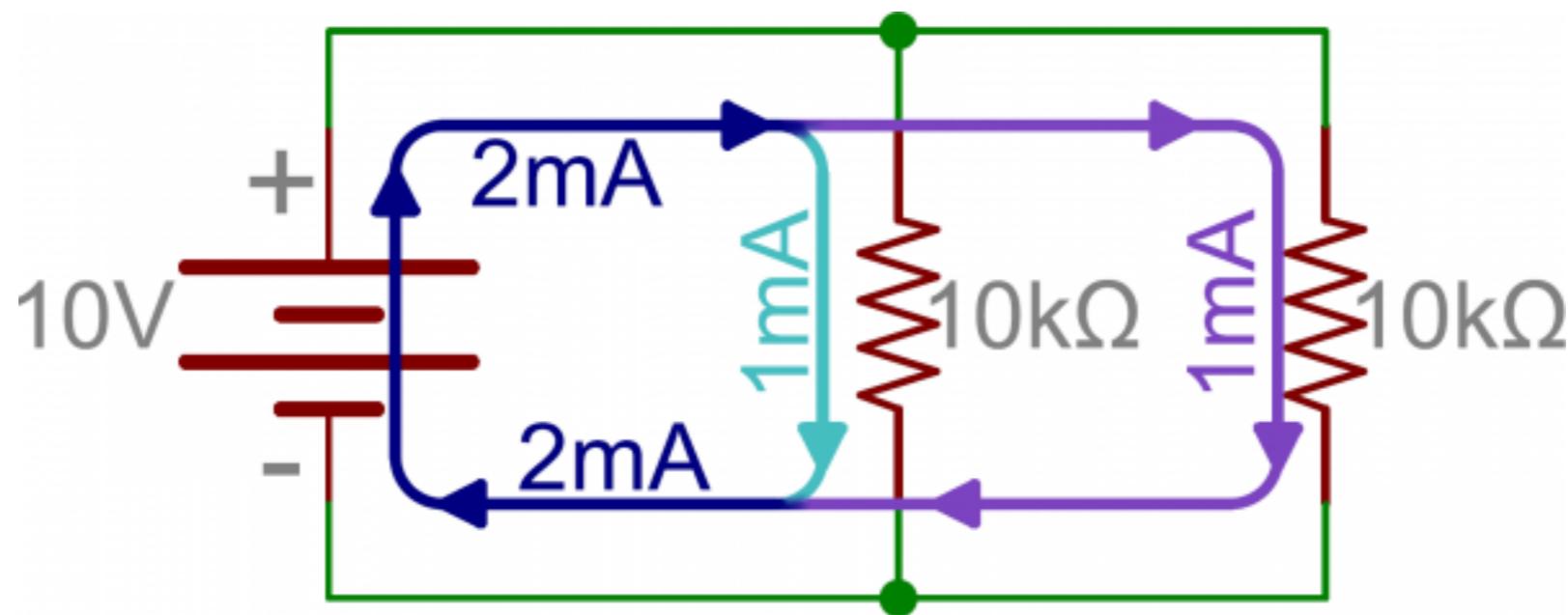
RESISTORS, IN SERIES AND PARALLEL, CHANGES THE WAY CURRENT FLOWS THROUGH THEM.



$$R_{tot} = R_1 + R_2 + \dots + R_{N-1} + R_N$$

# RESISTORS IN PARALLEL CIRCUITS

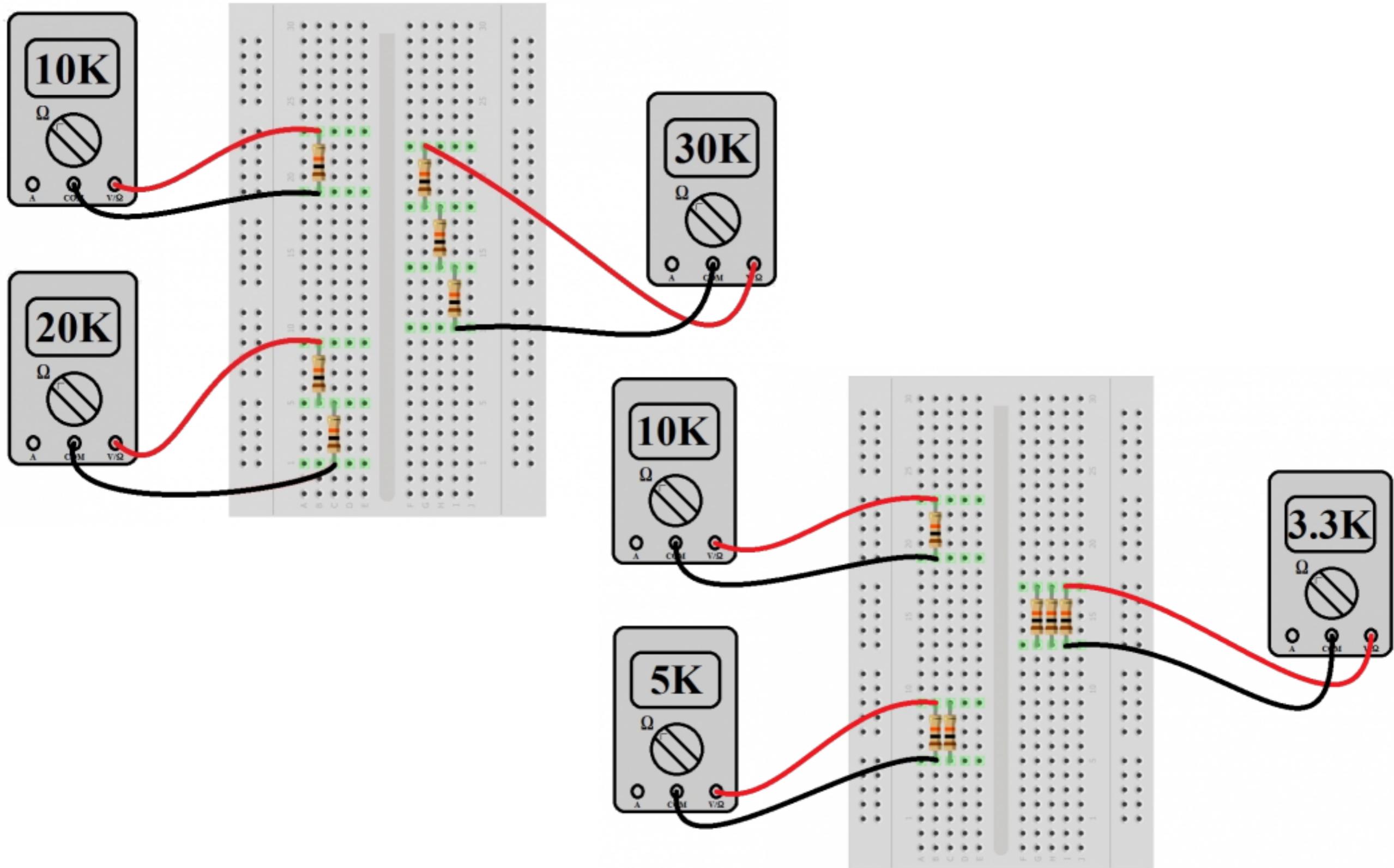
RESISTORS, IN SERIES AND PARALLEL, CHANGES THE WAY CURRENT FLOWS THROUGH THEM.



$$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_{N-1}} + \frac{1}{R_N}$$

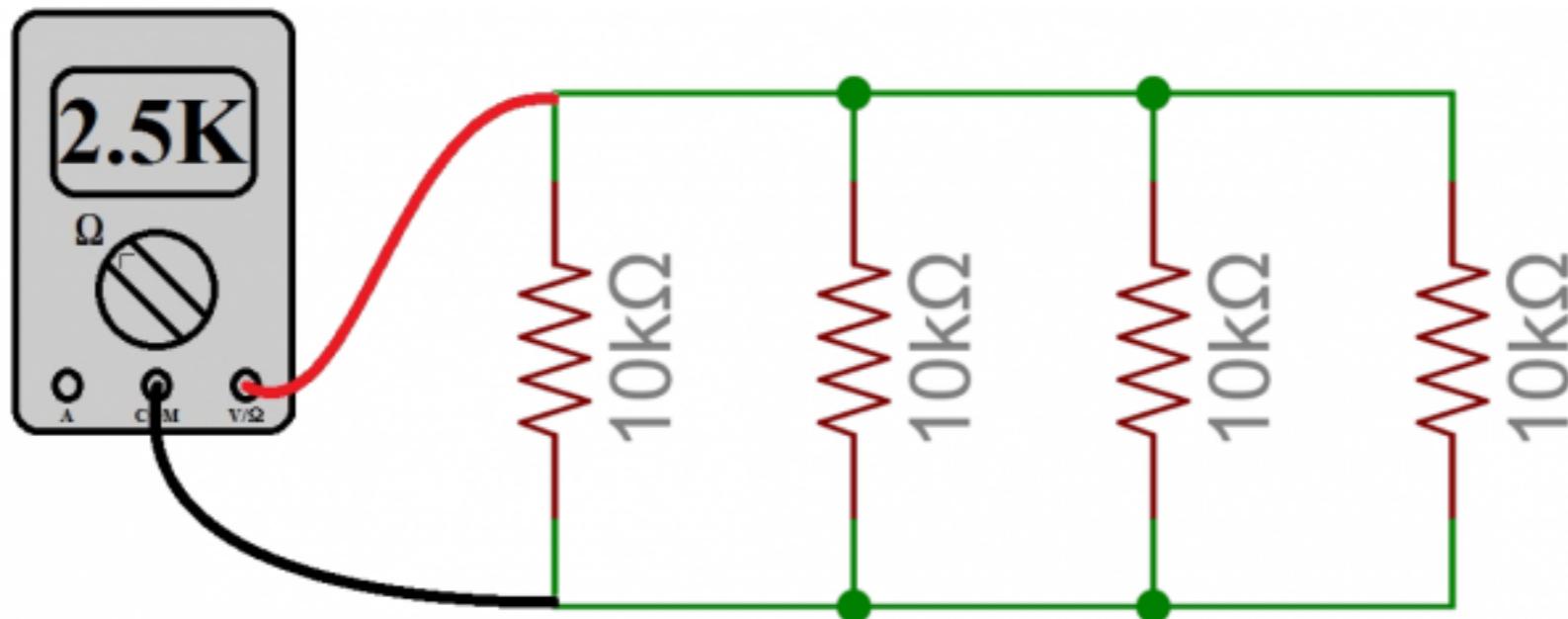
# EXPERIMENT

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# RESISTORS RULE OF THUMB

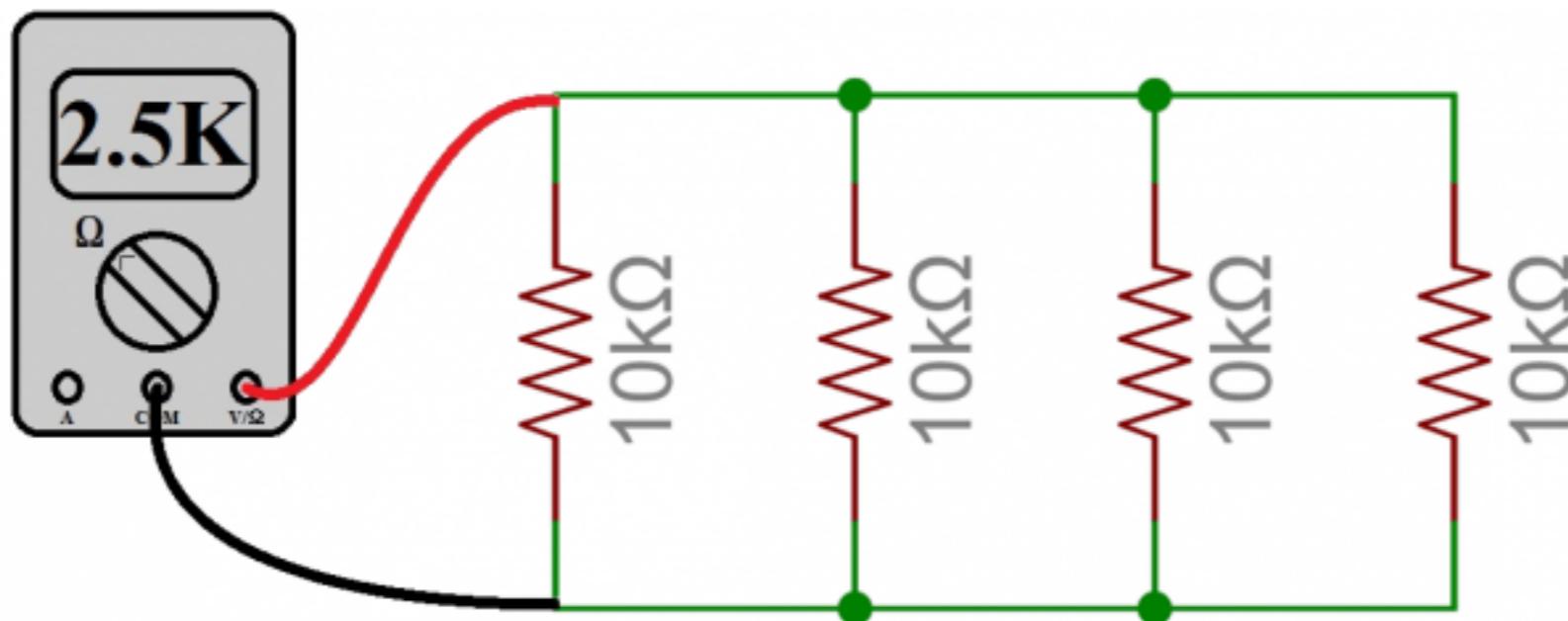
## TIP #1: EQUAL RESISTORS IN PARALLEL



Total Resistance = Value of One Resistor / Number of Resistors  
2.5K = 10K / 4

# RESISTORS RULE OF THUMB

## TIP #2: POWER RATINGS IN PARALLEL



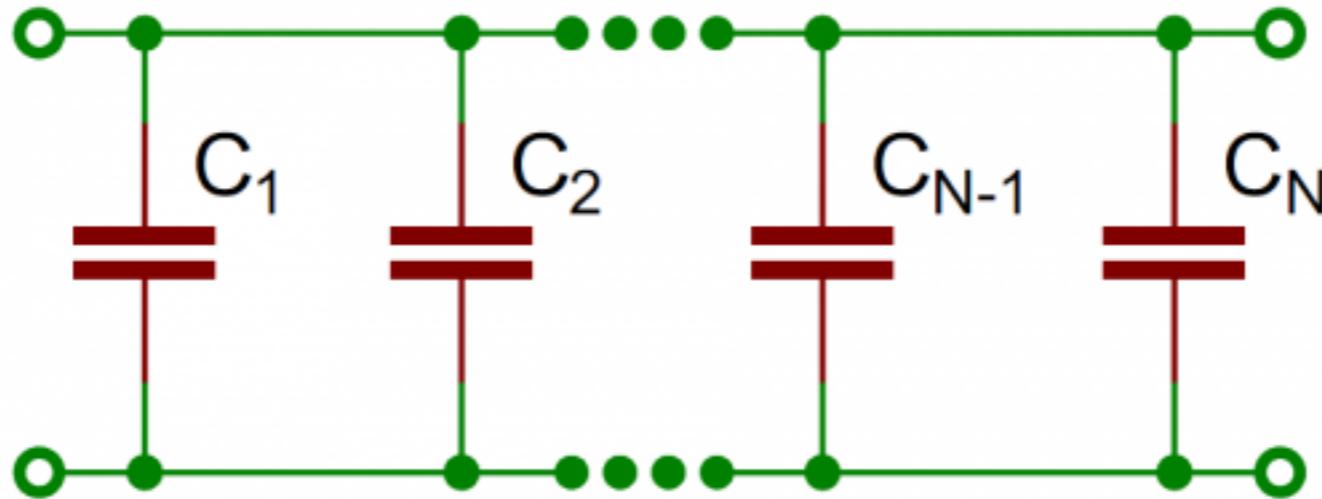
Total Resistance = Value of One Resistor / Number of Resistors  
 $2.5K = 10K / 4$

# CAPACITORS IN SERIES & PARALLEL

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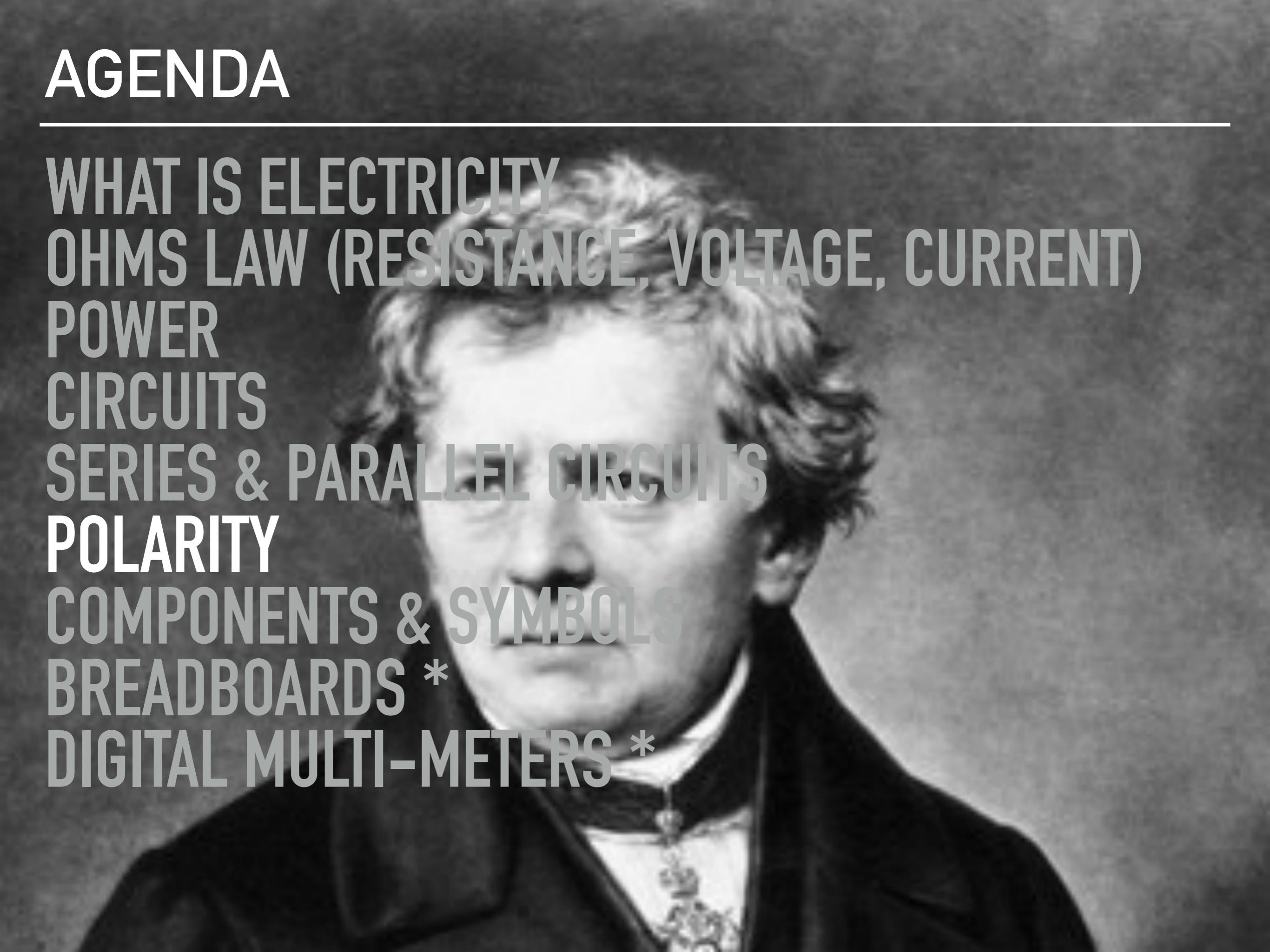
$$\frac{1}{C_{Tot}} = \frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_{N-1}} + \frac{1}{C_N}$$



$$C_{Tot} = C_1 + C_2 + \dots + C_{N-1} + C_N$$

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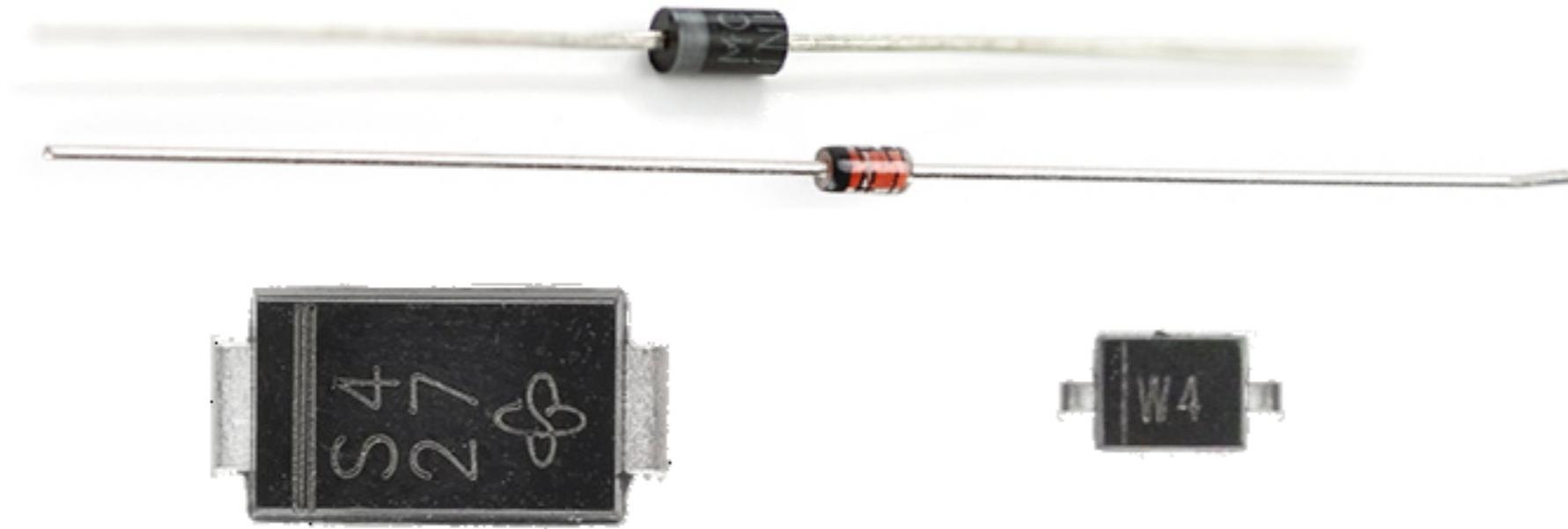
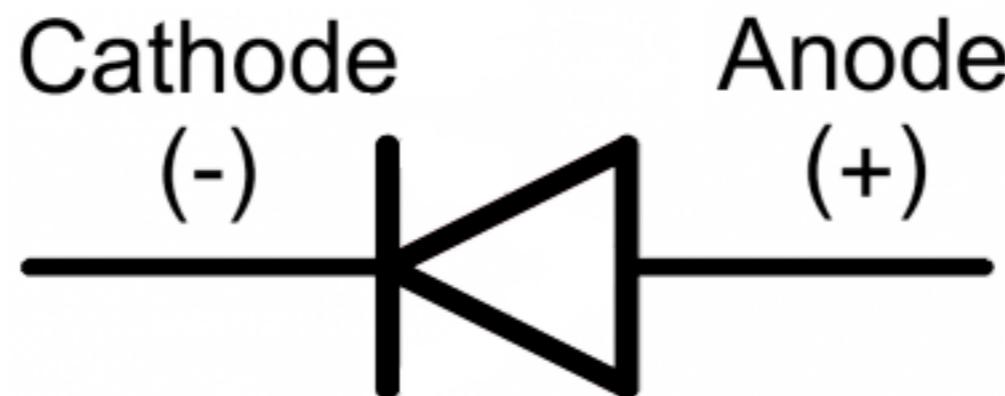
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# POLARITY



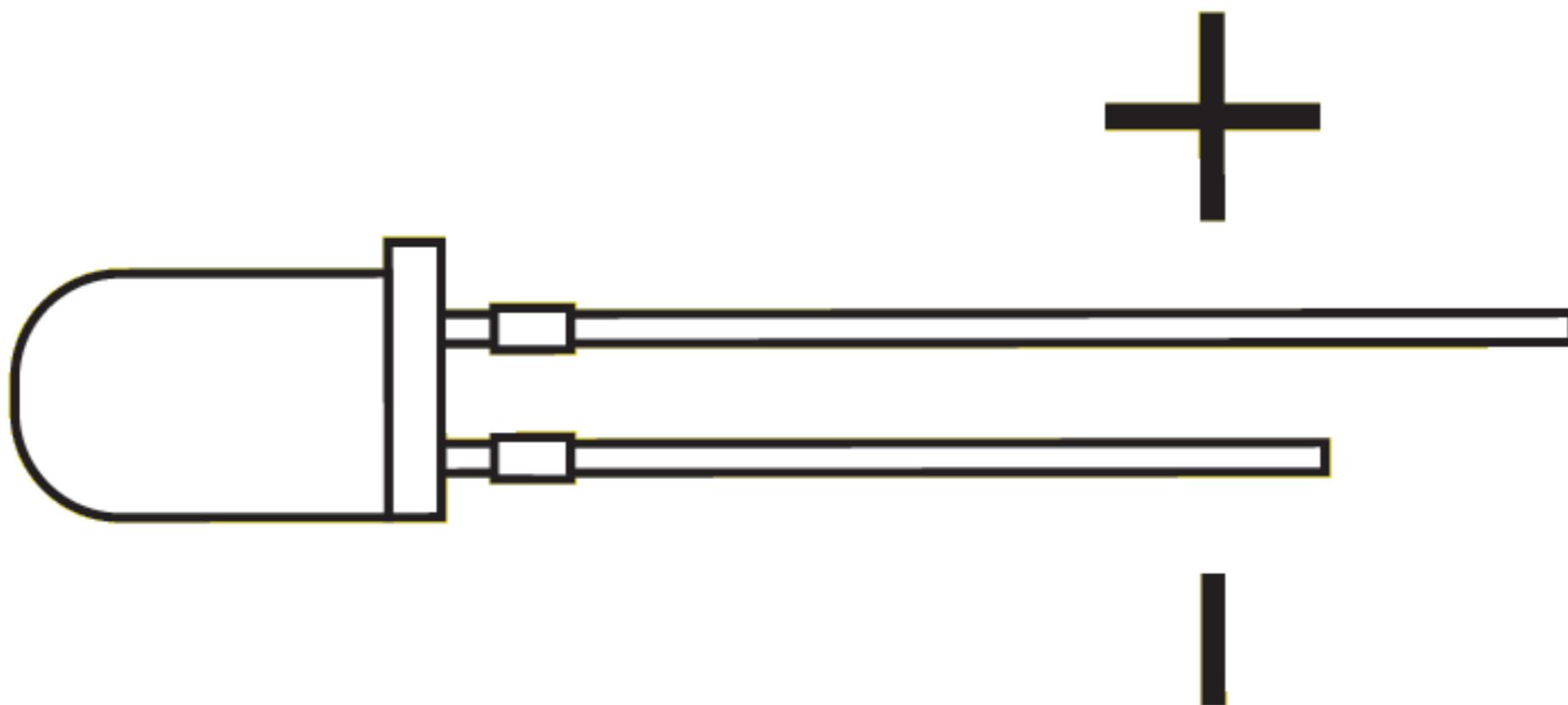
# DIODES

DIODES ONLY ALLOW CURRENT TO FLOW IN ONE DIRECTION, AND THEY'RE ALWAYS POLARIZED. A DIODE HAS TWO TERMINALS. THE POSITIVE SIDE IS CALLED THE ANODE, AND THE NEGATIVE ONE IS CALLED THE CATHODE.



# LEDS

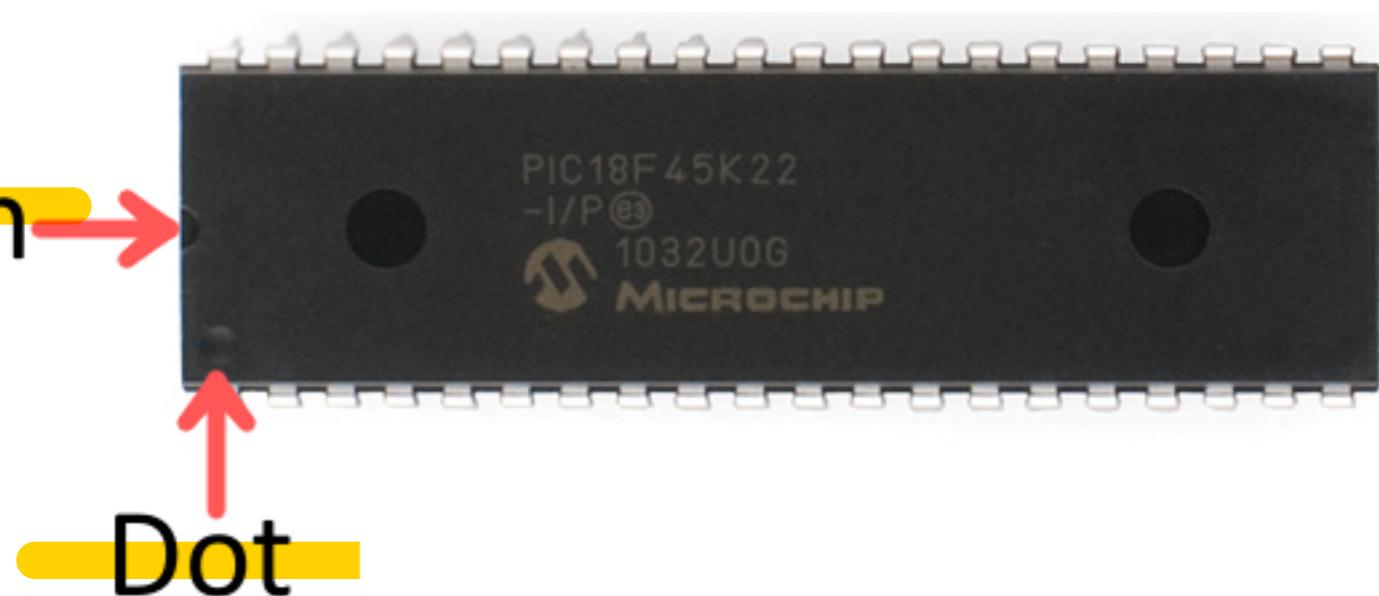
LED STANDS FOR LIGHT-EMITTING DIODE, WHICH MEANS THAT MUCH LIKE THEIR DIODE COUSINS, THEY'RE POLARIZED.



# INTEGRATED CIRCUITS

INTEGRATED CIRCUITS (ICs) MIGHT HAVE EIGHT PINS OR EIGHTY PINS, AND EACH PIN ON AN IC HAS A UNIQUE FUNCTION AND POSITION. IT'S VERY IMPORTANT TO KEEP POLARITY STRAIGHT WITH ICs.

Notch →



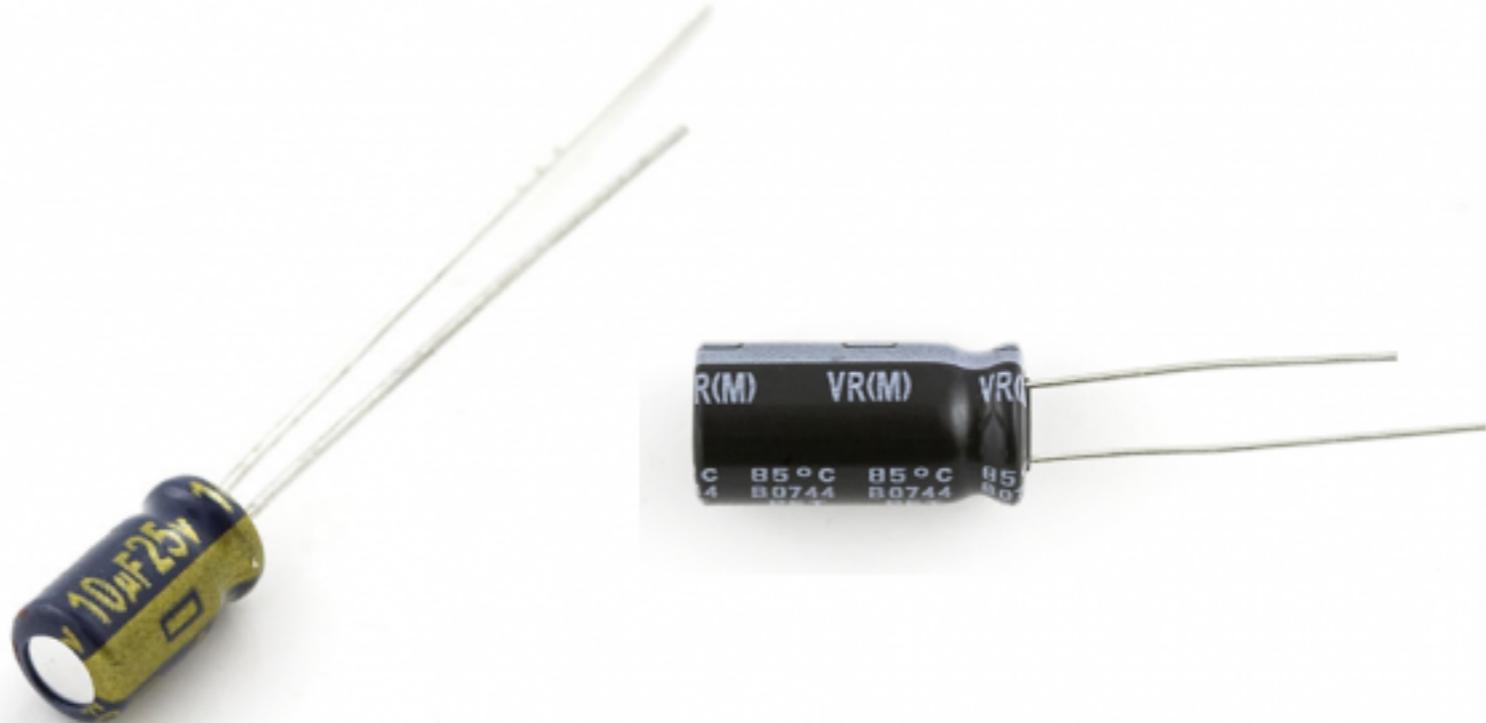
8 7 6 5



1 2 3 4

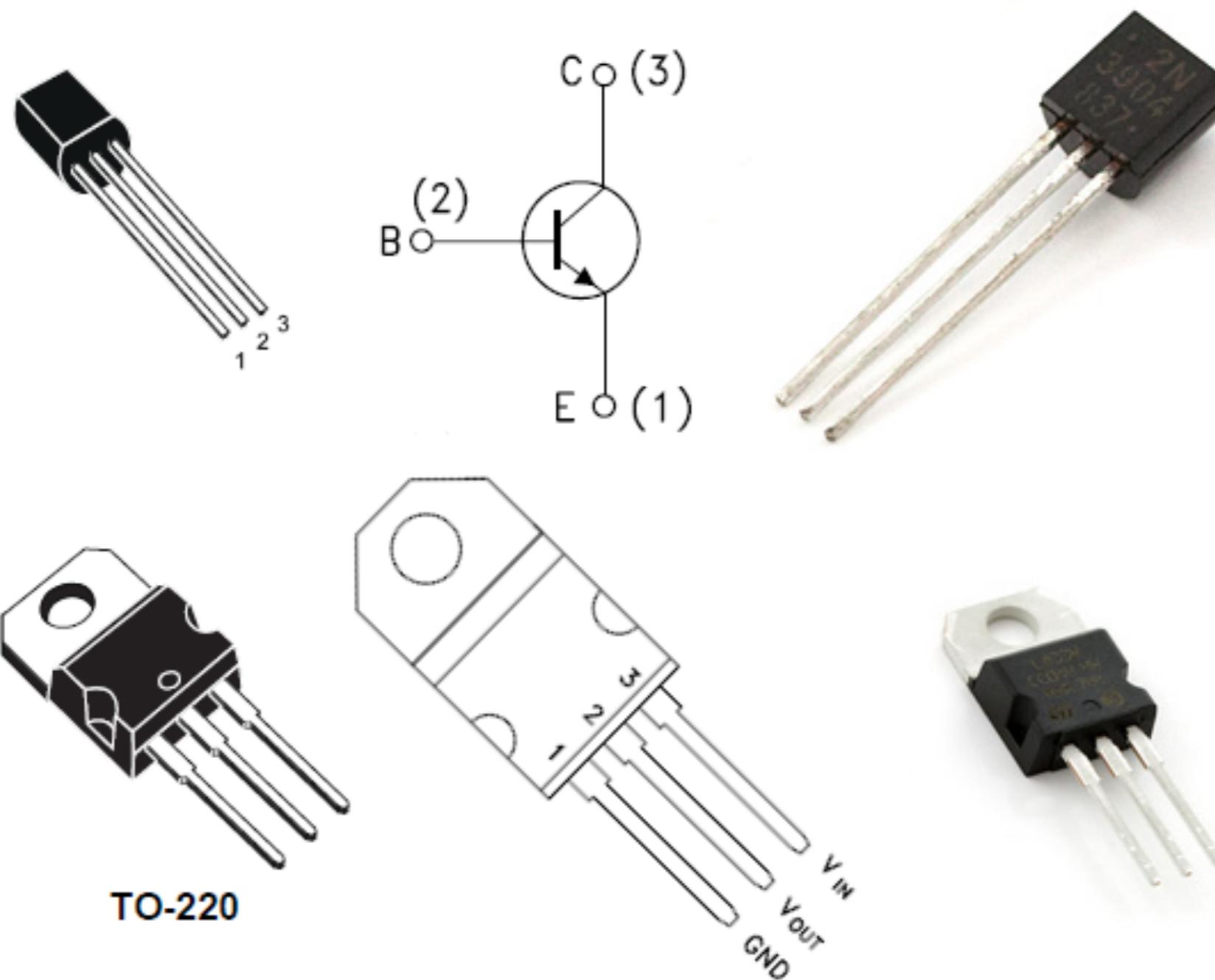
# ELECTROLYTIC CAPACITORS

NOT ALL CAPACITORS ARE POLARIZED, BUT WHEN THEY ARE, IT'S VERY IMPORTANT NOT TO MIX THEIR POLARITY UP.



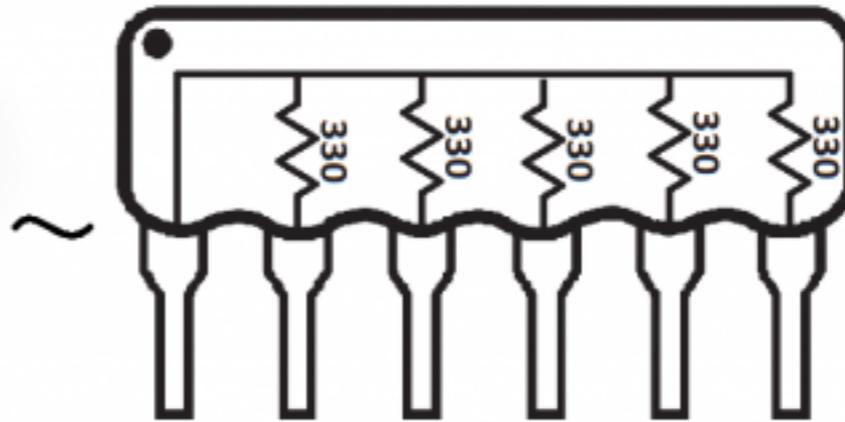
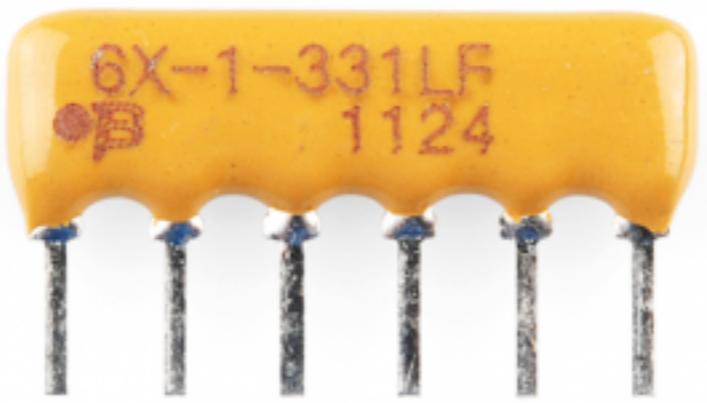
# MOSFETS & VOLTAGE REGULATORS

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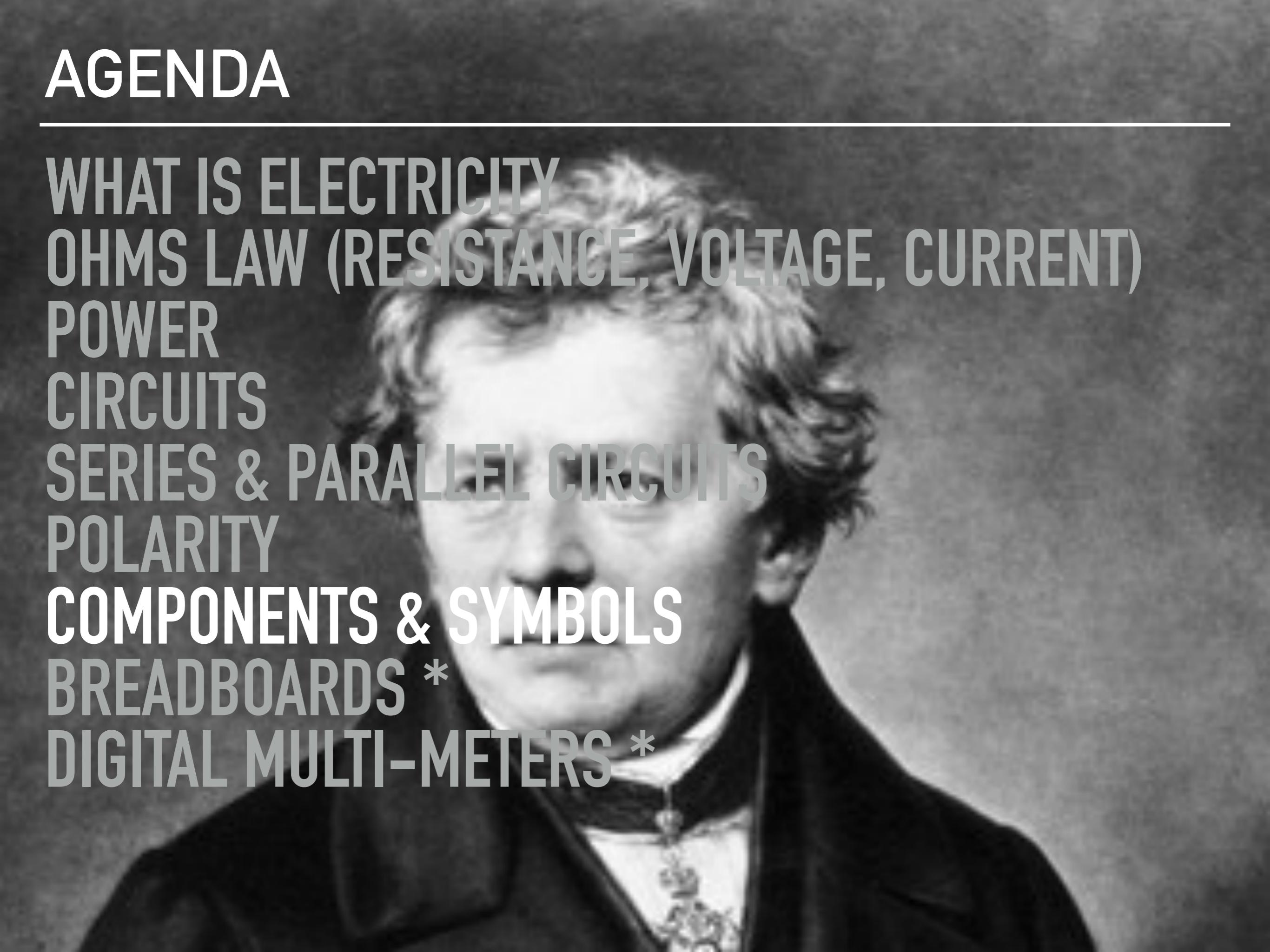
# ETC.

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# AGENDA

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A black and white portrait of a man with voluminous, curly hair, wearing a dark suit jacket over a white collared shirt. He is looking towards the right of the frame.

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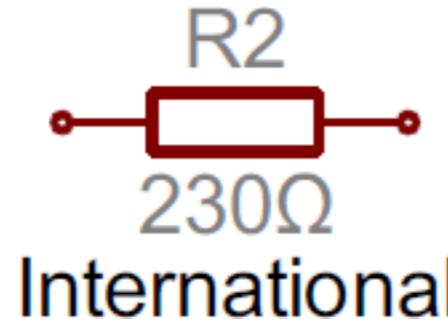
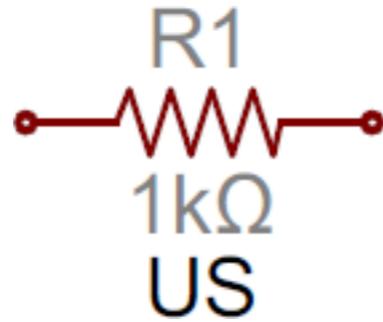
# COMPONENTS & SYMBOLS

Resistors	Variable Resistors	Switches	
	Inductors	Diodes	
Polarized			
Voltage Sources	Batteries	Voltage Nodes	
BJTs	n-Channel MOSFETs	p-Channel MOSFETs	
NPN			



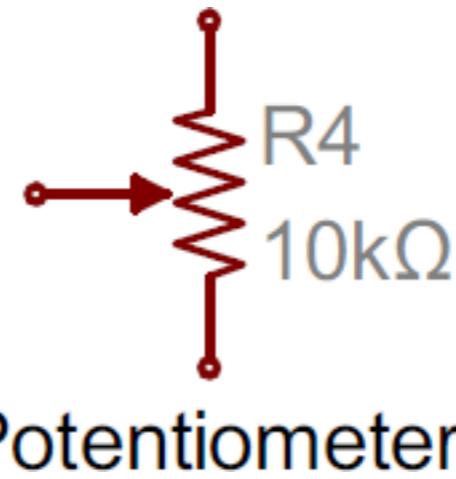
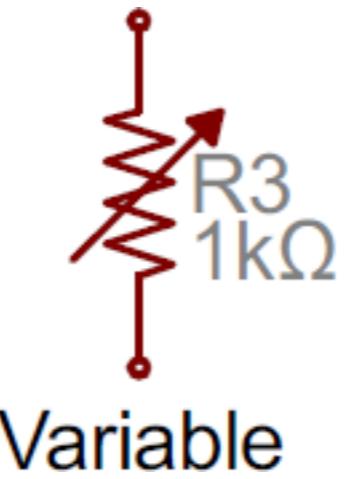
# RESISTORS

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# POTENTIOMETERS

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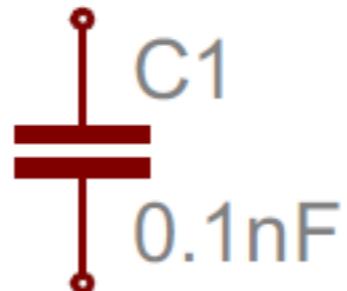
Variable

Potentiometer

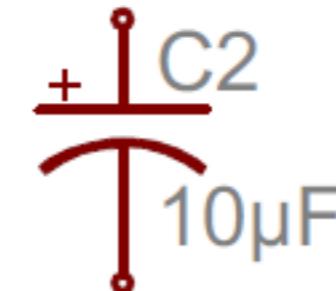


# CAPACITORS

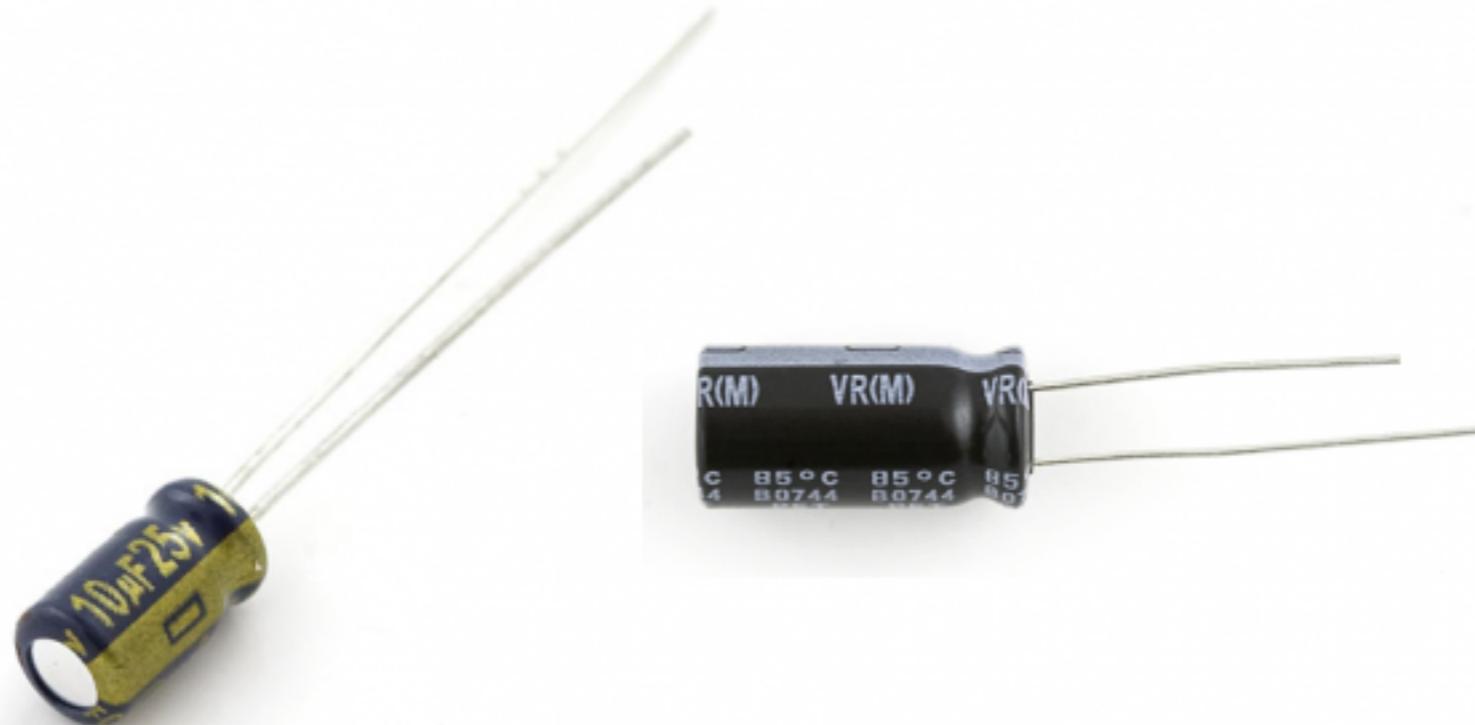
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Non-polarized



Polarized



# SWITCHES

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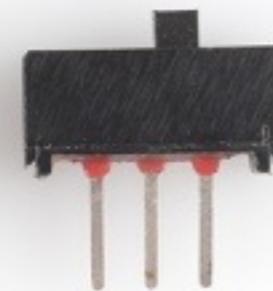
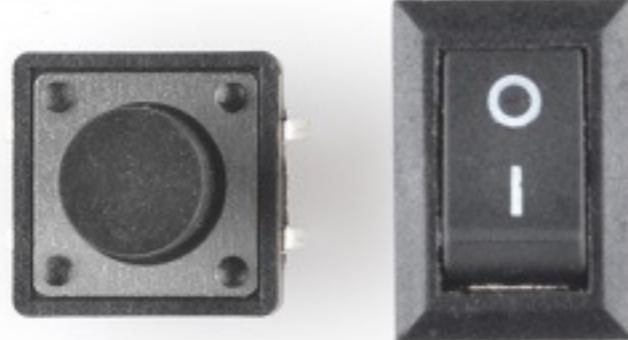
1P —— 1T [SPST]



1P —— 1T  
1P —— 2T [SPDT]

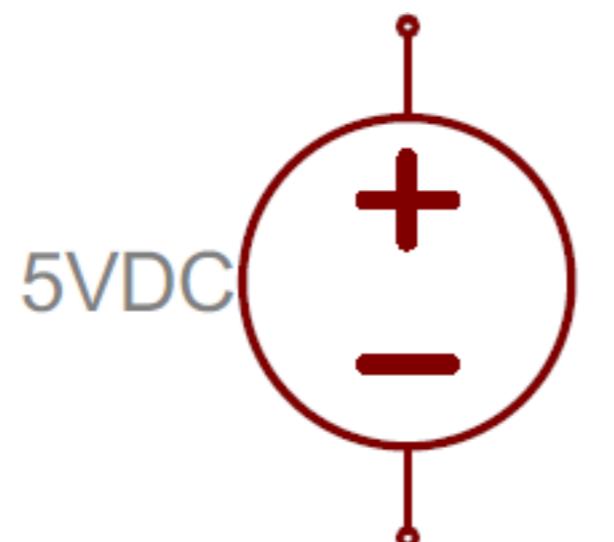


1P  
2P  
1T  
2T  
1T  
2T [DPDT]



# AC / DC POWER SUPPLIES

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5VDC

DC Source



120VAC

AC Source



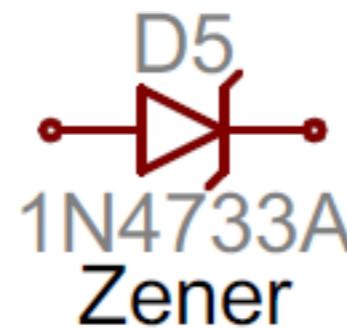
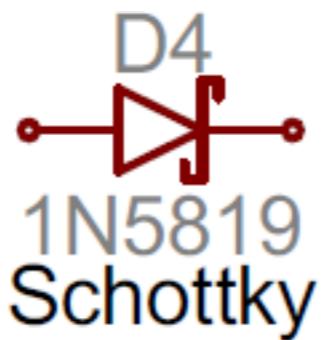
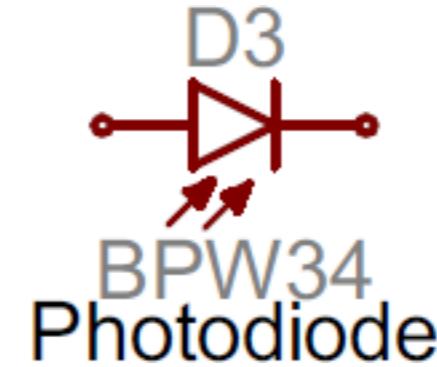
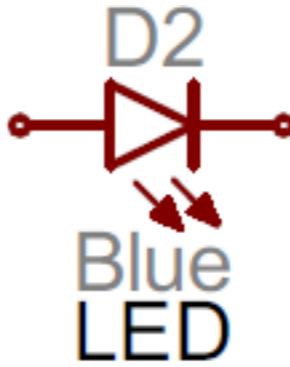
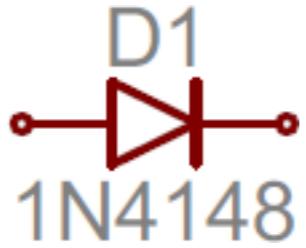
# BATTERIES

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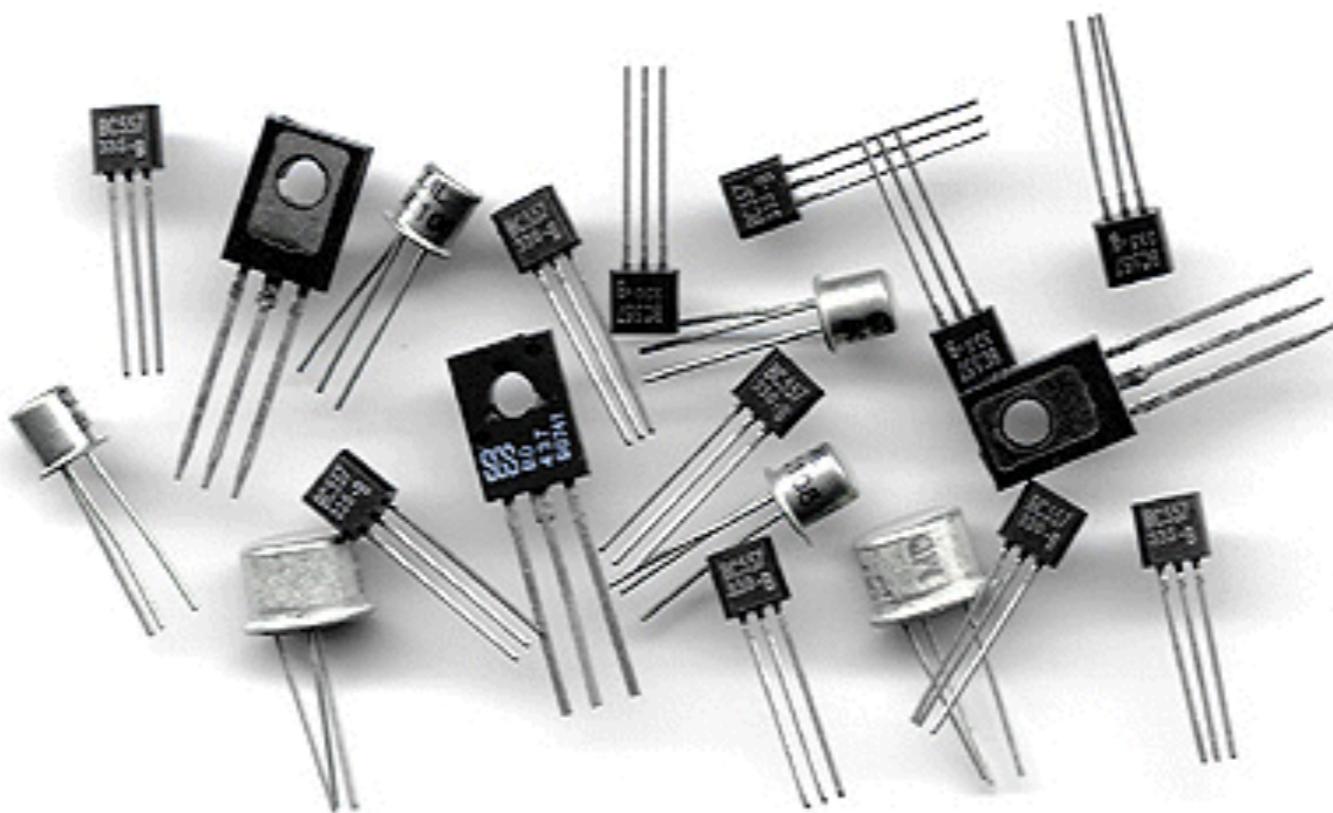
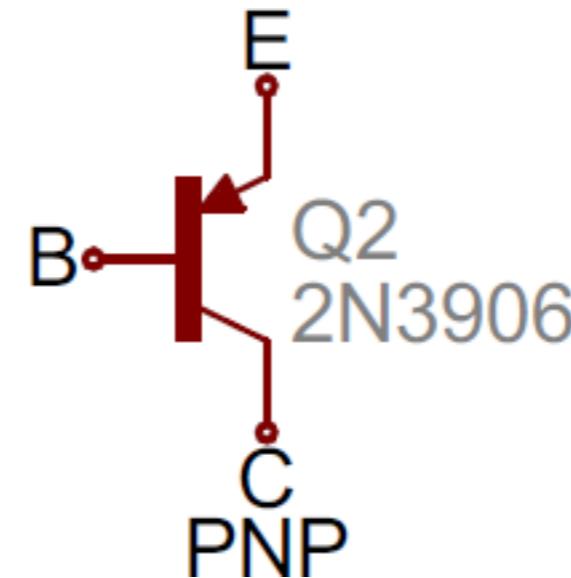
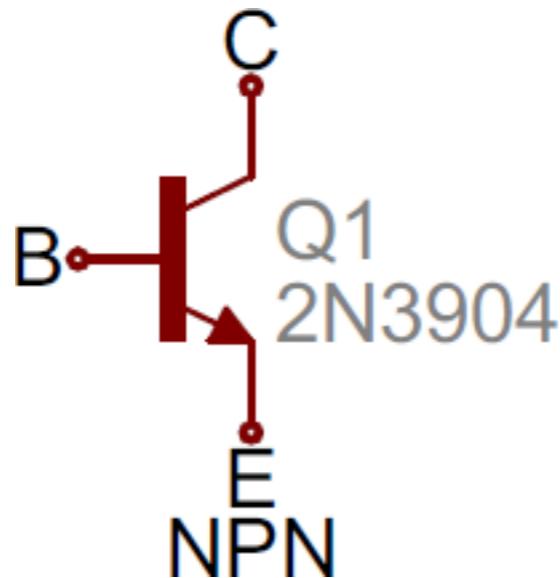
# DIODES

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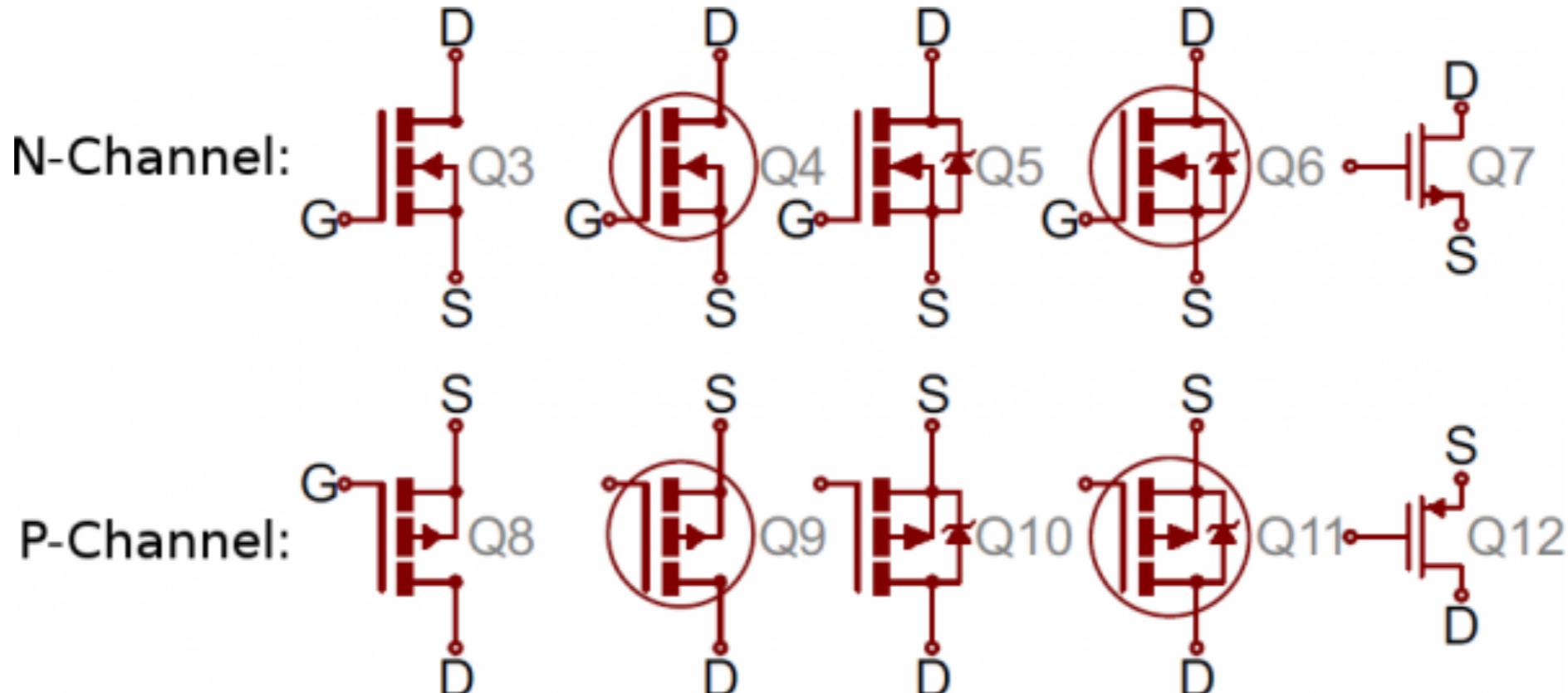
# BJTS

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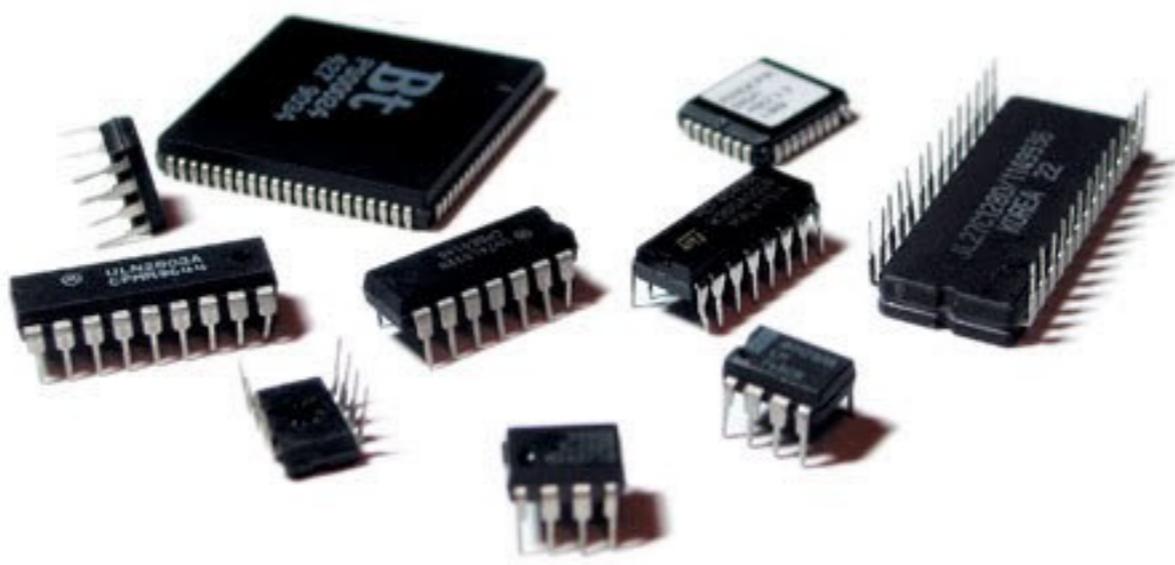
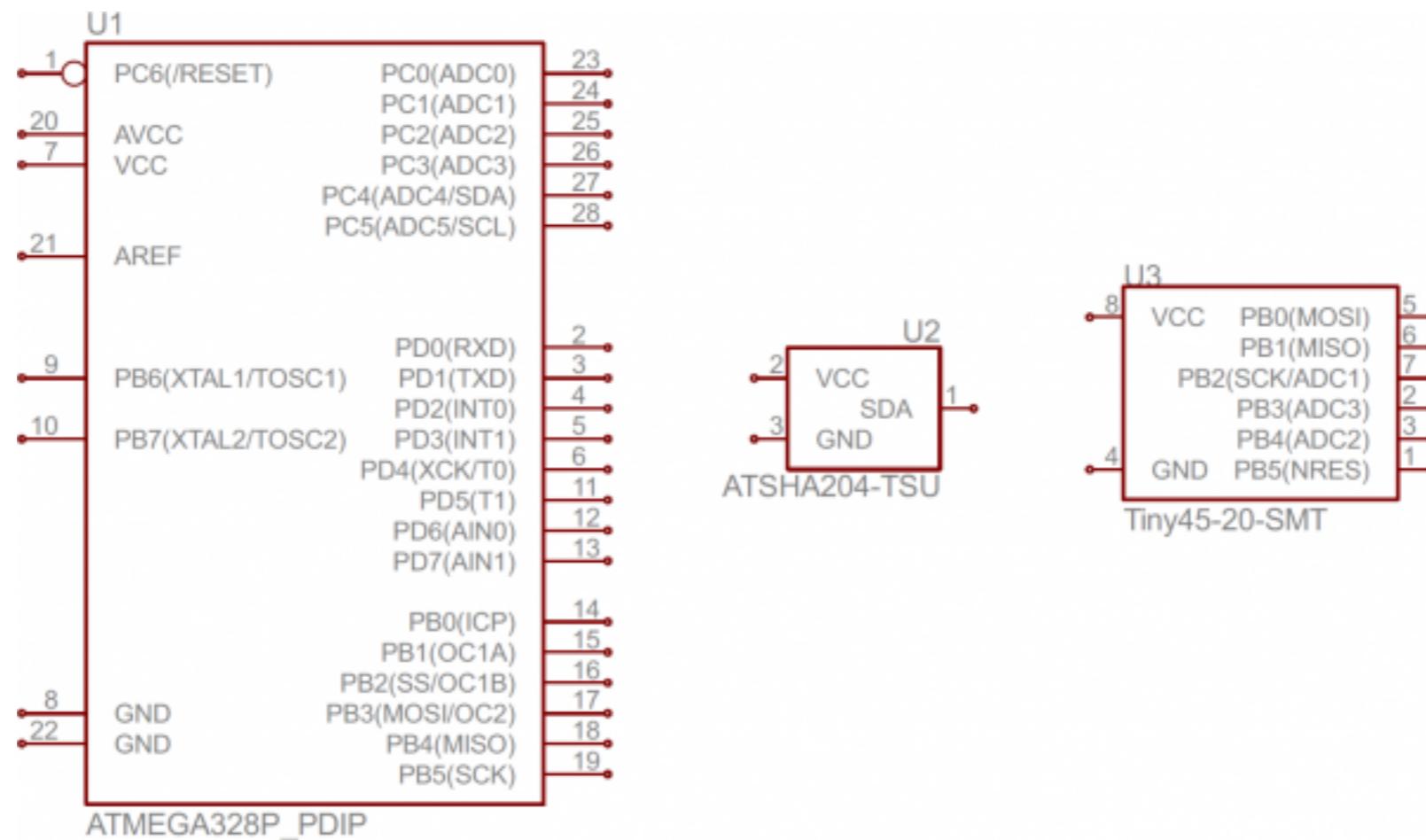


# MOSFETS

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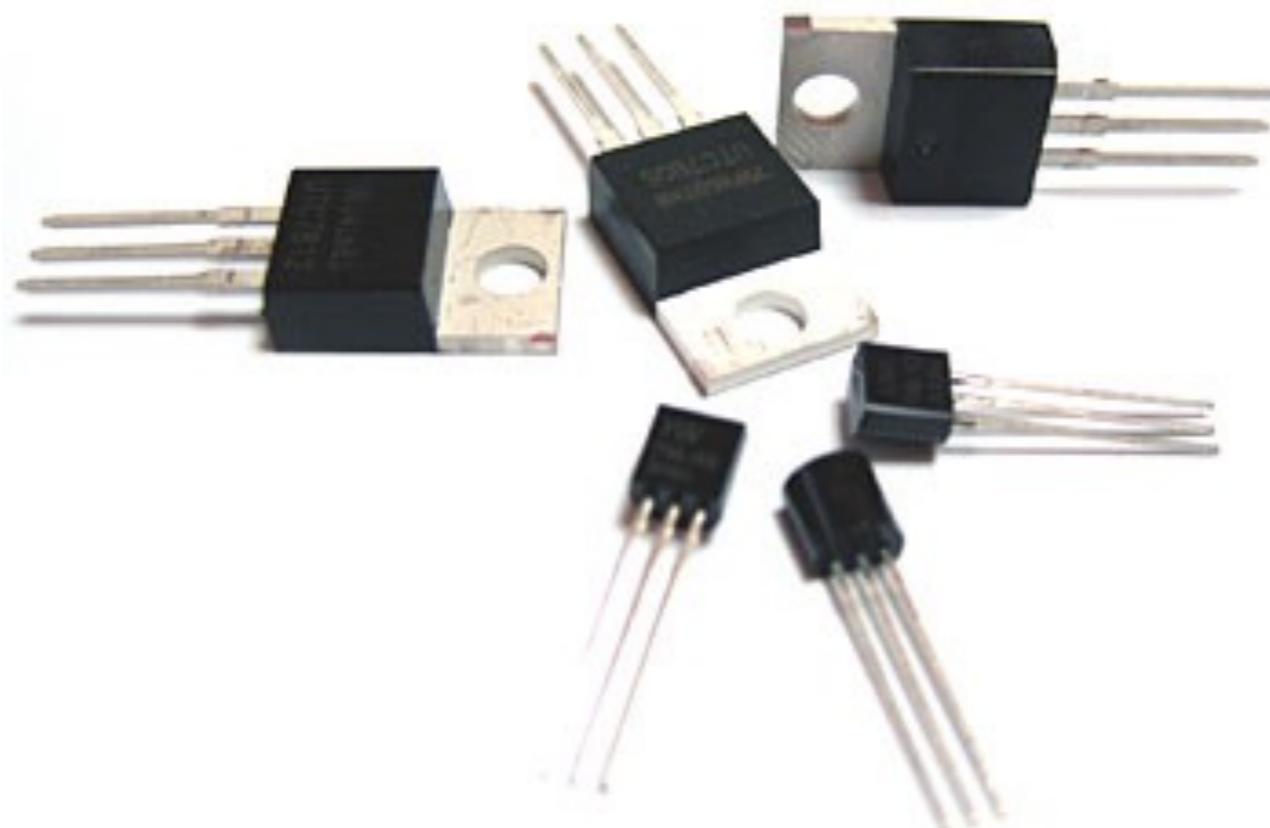
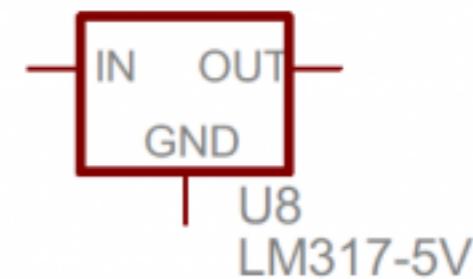
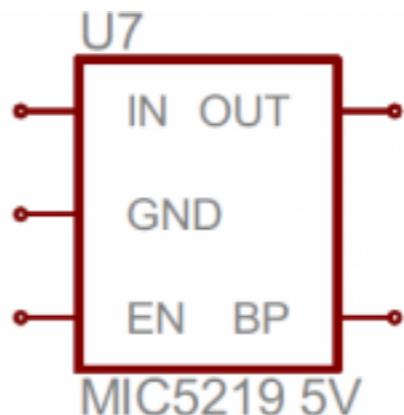
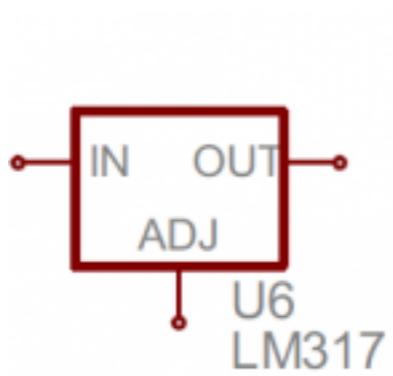


# INTEGRATED CIRCUITS



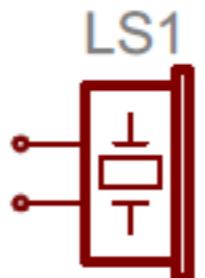
# VOLTAGE REGULATORS

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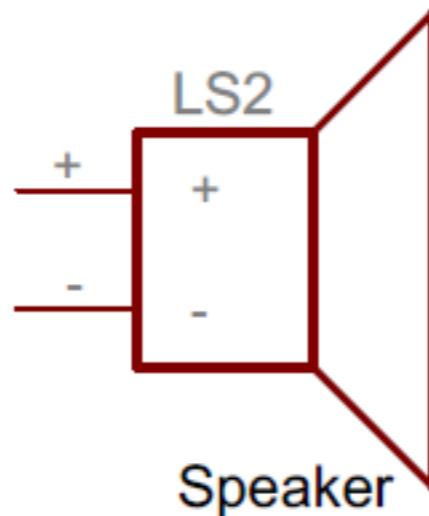


# MOTORS, SPEAKERS & RELAYS

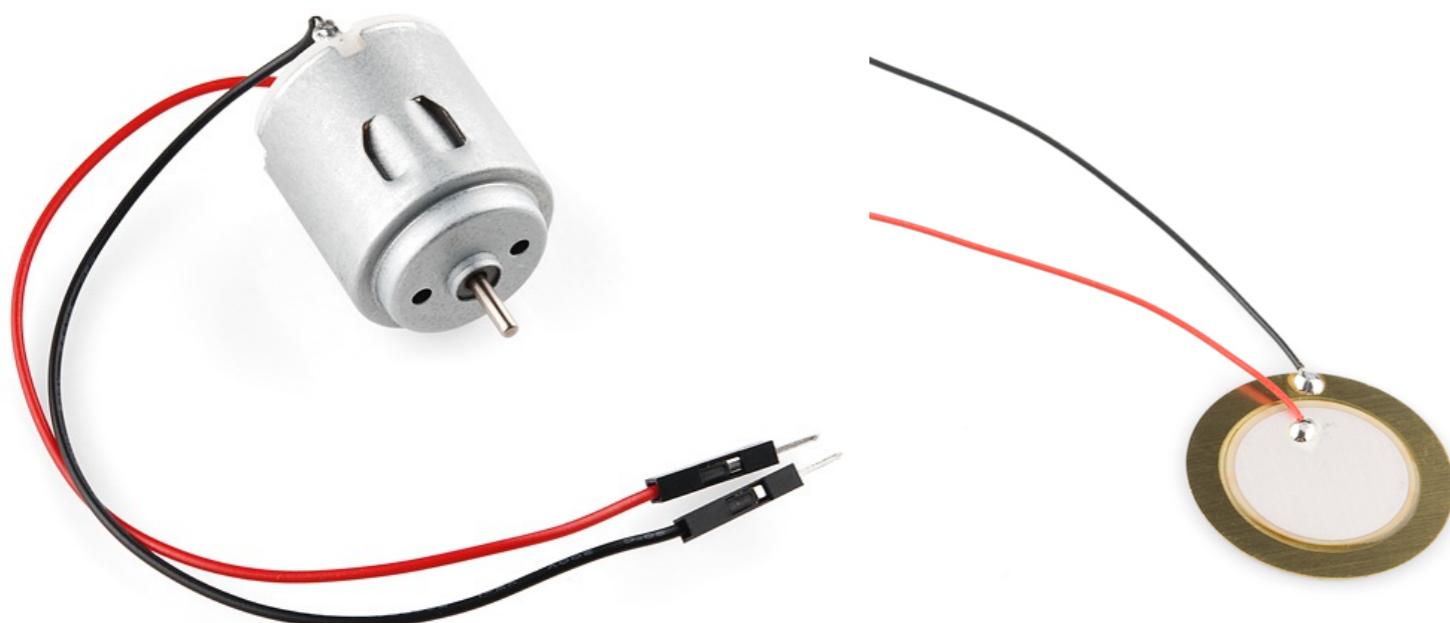
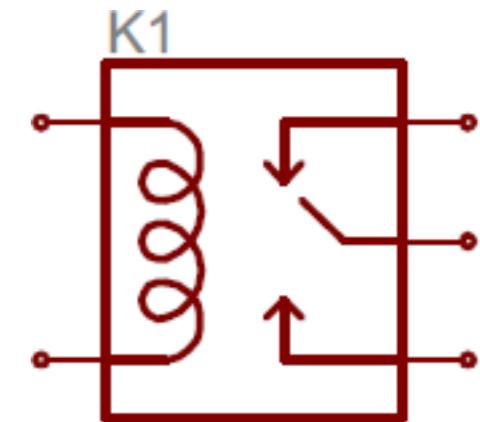
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Piezo Buzzer

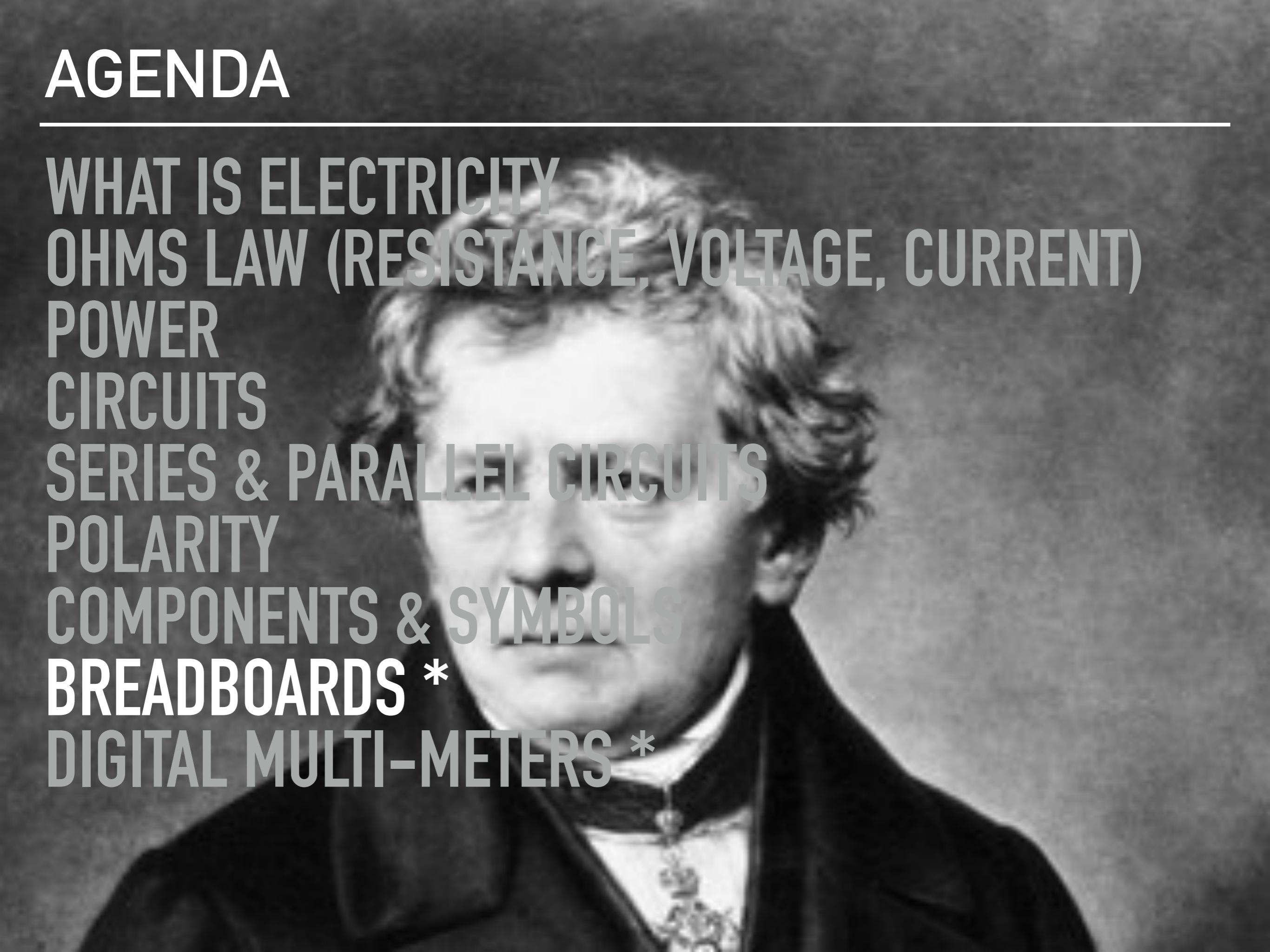


Speaker



# AGENDA

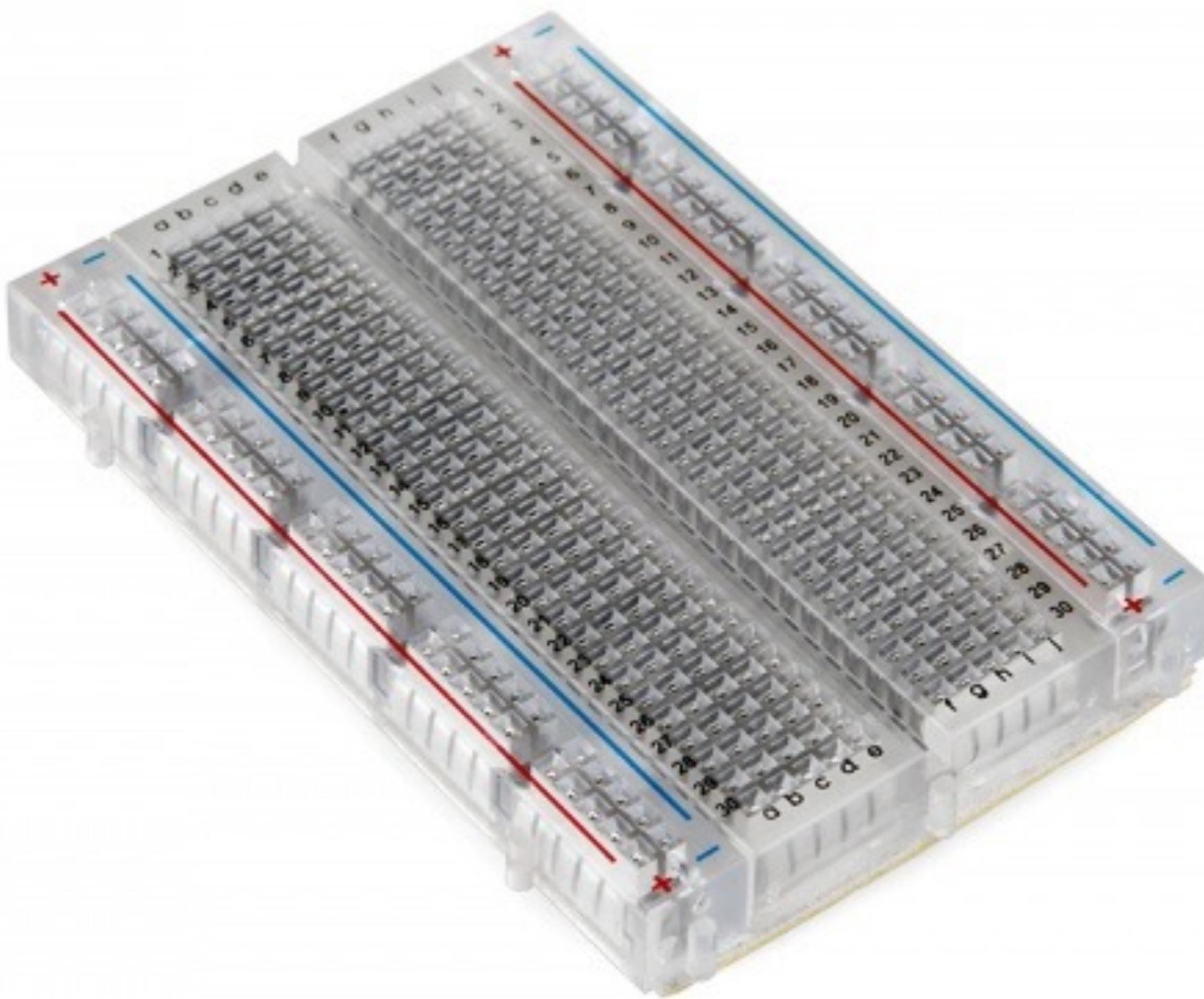
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A black and white portrait of James Watt, a Scottish engineer and a mechanical designer. He is shown from the chest up, wearing a dark coat over a white cravat and a patterned waistcoat. His hair is powdered and styled upwards. He has a thoughtful expression, looking slightly to the right.

WHAT IS ELECTRICITY  
OHMS LAW (RESISTANCE, VOLTAGE, CURRENT)  
POWER  
CIRCUITS  
SERIES & PARALLEL CIRCUITS  
POLARITY  
COMPONENTS & SYMBOLS  
BREADBOARDS \*  
DIGITAL MULTI-METERS \*

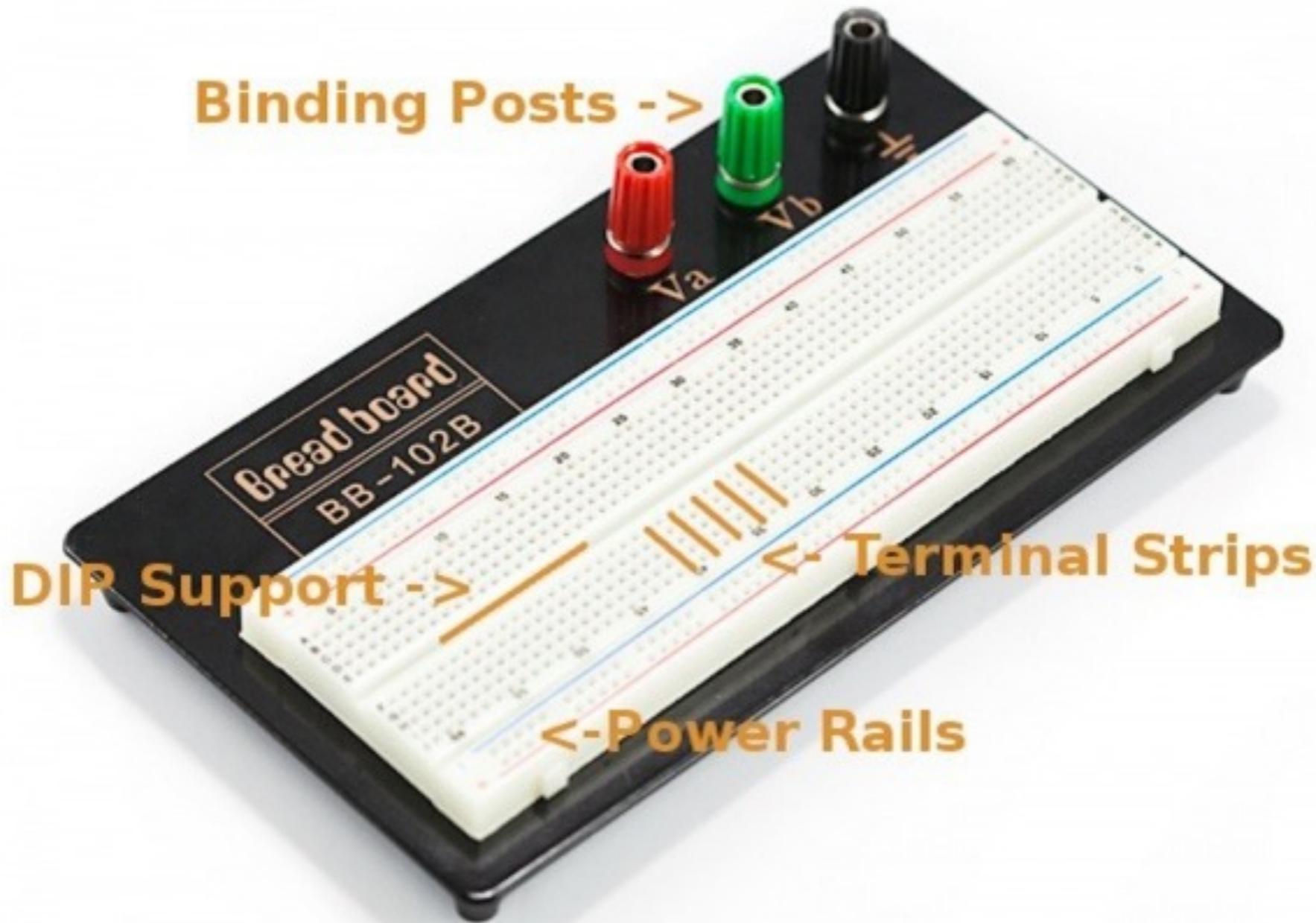
# ANATOMY OF BREADBOARD

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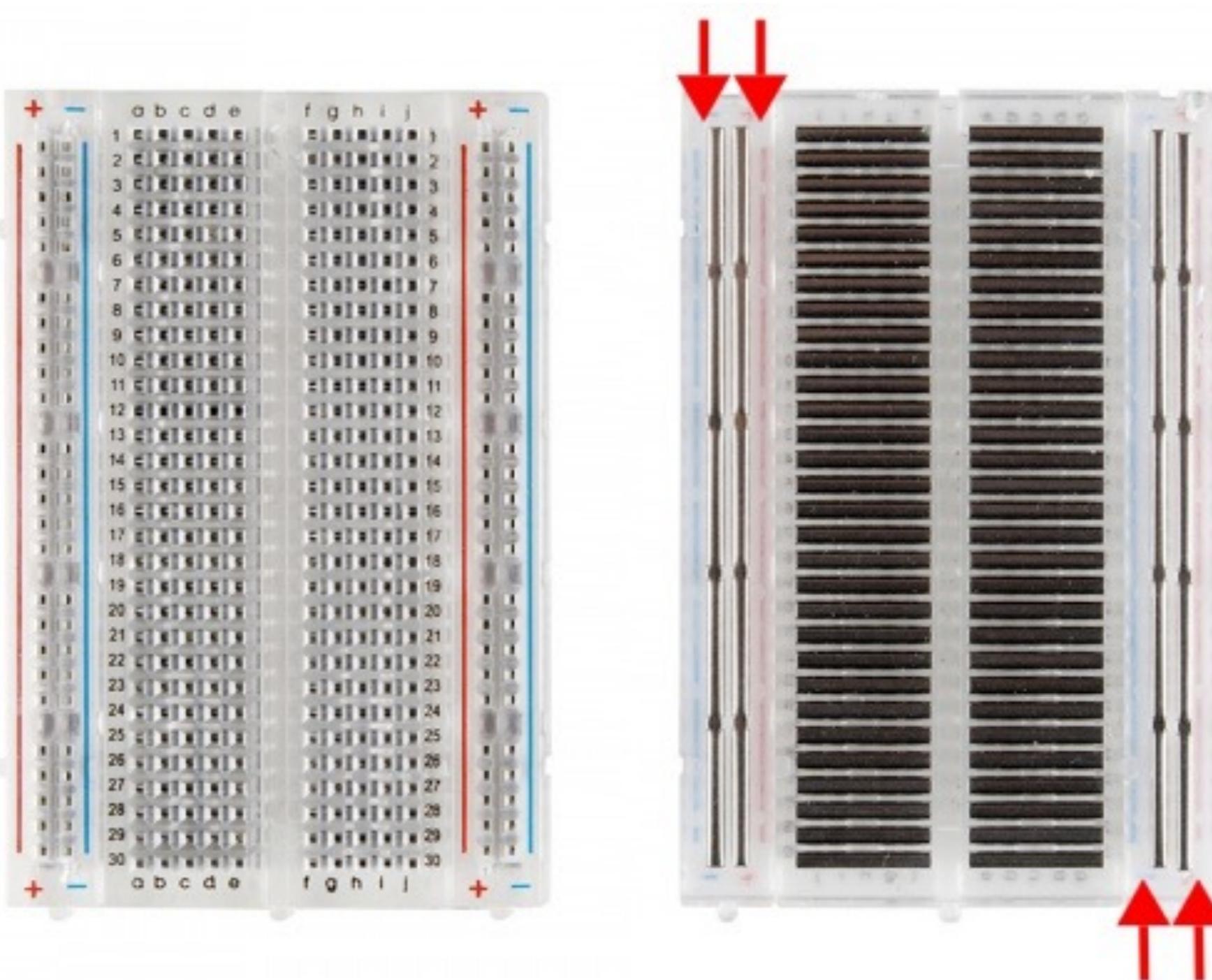
# ANATOMY OF BREADBOARD

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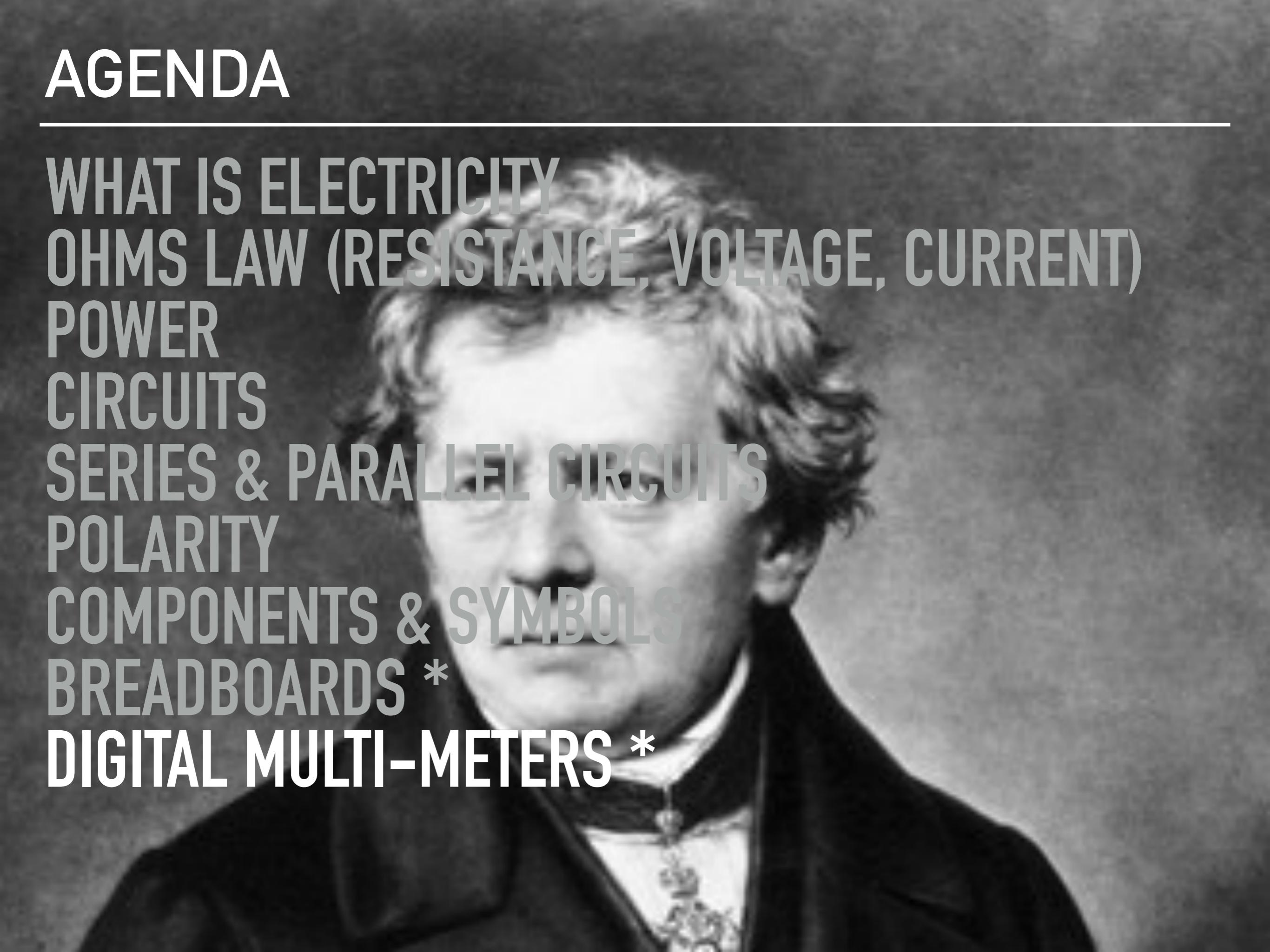
# ANATOMY OF BREADBOARD

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# AGENDA

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A black and white portrait of a man with voluminous, curly hair, wearing a dark suit jacket over a white shirt with a patterned collar. The portrait is centered in the background of the slide.

WHAT IS ELECTRICITY  
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BREADBOARDS \*  
DIGITAL MULTI-METERS \*

# ANATOMY OF DIGITAL MULTIMETER

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# ANATOMY OF DIGITAL MULTIMETER

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# REFERENCES

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**SPARKFUN:**

**VOLTAGE, CURRENT, RESISTANCE, AND OHM'S LAW**

**ELECTRIC POWER**

**WHAT IS A CIRCUIT?**

**SERIES AND PARALLEL CIRCUITS**

**POLARITY**

**HOW TO READ A SCHEMATIC**

**ANALOG VS. DIGITAL CIRCUITS**

**DIODES**

**RESISTORS**

**CAPACITORS**

**VOLTAGE DIVIDERS**