Electric Circuits
Vocabulary

Term	Definition
Electric Current	The flow of electric charge.
Electric Circuit	Any complete path through which electricity travels.
Closed Circuit	A circuit in which there is a complete path for electricity to flow.
Open Circuit	A circuit in which there is a break so current can not flow.
Conductors	A material that easily carries electrical current.
Insulators	A material that poorly conducts electrical current or heat.
Ohm's Law • Current • Voltage • Resistance	A formula that says the current flowing in a circuit is the voltage divided by the resistance. $V = IR$
Series Circuit	A circuit that has only one path for current to flow through.
Parallel Circuit	A circuit that has multiple paths for the current to flow through.

Activity – And Then There Was Light!

Focus Question:
What are the essential components and configurations needed to make a bulb light?

Equipment:
One cell, one bulb, one wire.

Directions:
Make the bulb light using only the given equipment. Draw each successful circuit you create.

There is more than one configuration that will be successful. You need to have at least two.

Once you identified a successful configuration, you also need to trace the closed loop path around the circuit.

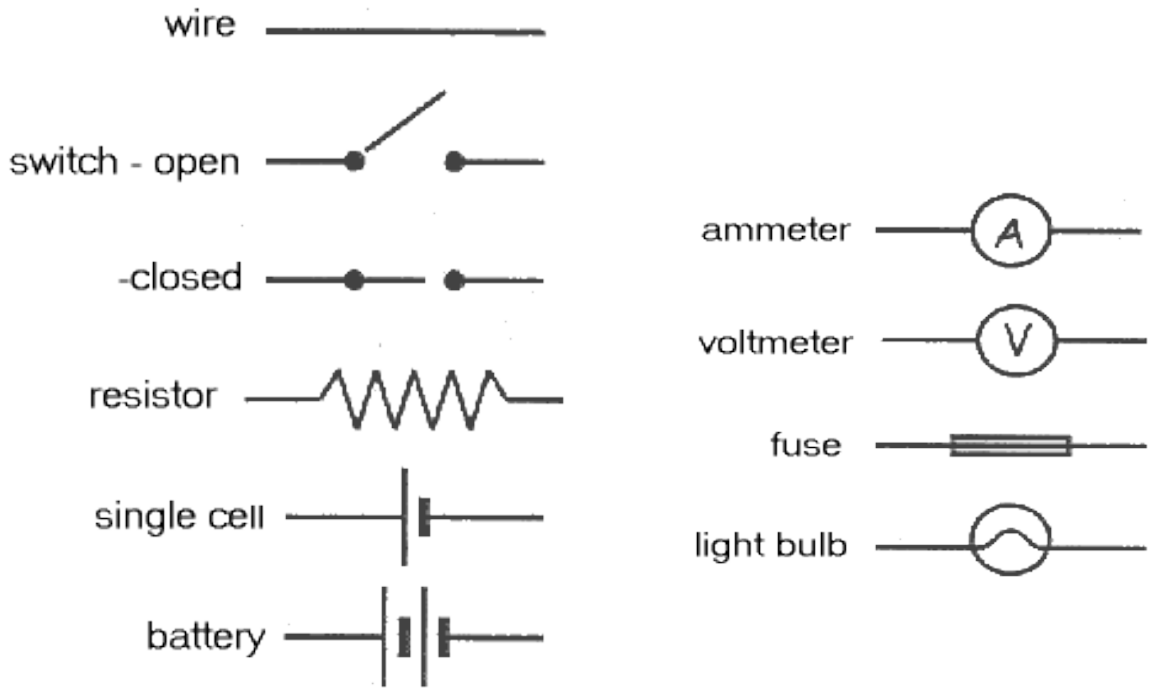
Successful attempts (at least 2)

Unsuccessful attempts (2)

Conclusion:

Consensus:

Symbols Used in Basic Circuits



Sketch a circuit with 2 resistors, a light bulb and a single cell battery.

Sketch a circuit with 3 light bulbs, an open switch, and a single cell battery.

Series Circuits

Main Ideas

Current	Voltage	Total Resistance	Adding a bulb
Is the same everywhere in the circuit.	Is different for each bulb/resistor.	Add the resistance of each bulb.	Decreases brightness.

Draw three 10 Ω resistors connected in series to a 6 volt battery:

To determine the total resistance in a series circuit you add:

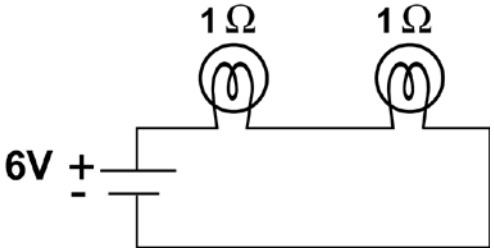
$$\mathbf{R_{total} = R_1 + R_2 + R_3 + \ldots}$$

Thus the total resistance of a circuit that has a 2 Ω , 4 Ω and 10 Ω resistor is:

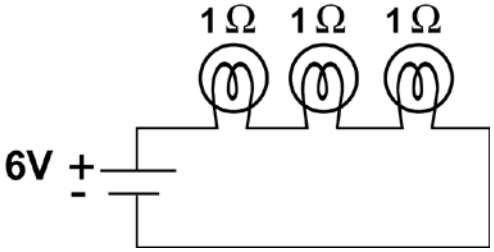
$\mathbf{R_{total} = 2 + 4 + 10}$

$\mathbf{R_{total} = 16\ \Omega}$

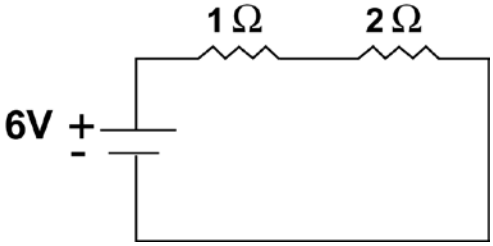
Determine the total resistance in each circuit below.

1. 

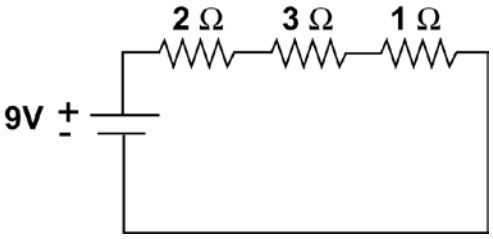
2 **Ω**

2. 

3 **Ω**

3. 

3 **Ω**

4. 

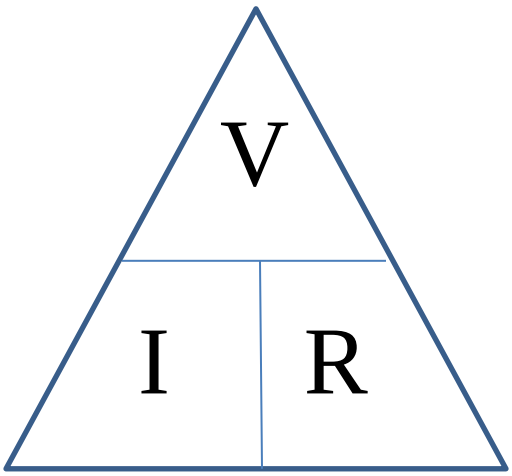
6 **Ω**

Information: Resistance and Ohm’s Law

The electrical resistance of a circuit component or device is defined as the ratio of the voltage applied to the electric current which flows through it:

$$V = IR$$

Triangle:



If the resistance is constant over a considerable range of voltage, then **Ohm's law**, V = IR, can be used to predict the behavior of the material.

Problem Solving Steps:

1. **Write down givens and unknown.**
2. **Write down equation.**
3. **Plug in variables.**
4. **Solve for unknown.**

Don't forget proper units!!!!

Example #1: If the Current= 2A and the Resistance = 500Ω, then determine the voltage.

Looking For	Given	Relationship	Solution
Voltage	**I=2 amps** **R=500 ohms**	**V=IR**	**1000 volts**

Example #2: If the voltage in a circuit is 160 V, and the current is 4A, then what is the resistance of the circuit?

Looking For	Given	Relationship	Solution
Resistance	**V=160 V** **I=4 amps**	**R=V/I**	**40 ohms**

Example #3: A 140 Volts is applied to a 200 Ohm resistor. How much current passes through the resistor?

Looking For	Given	Relationship	Solution
current	**V=140 volts** **R=200 ohms**	**I=V/R**	**1.43 amps**

Classwork Practice Problems

1. A light bulb is plugged into a wall outlet (120 V). It uses 16 A. What is the light bulbs resistance?

Looking For	Given	Relationship	Solution
Resistance	**V=120 V** **I=16 amps**	**R=V/I**	**7.5 ohms**

2. A flash light bulb is labeled to uses 1.77 A. Its resistance is 3.20 Ω. What voltage is the light bulb rated for?

Looking For	Given	Relationship	Solution
Voltage	**I=1.77 amps** **R=3.2 ohms**	**V=IR**	**5.664 volts**

3. A stereo speaker has a resistance of 16.00 Ω. When it is operating at full power (exactly 200 watts) it uses 50 volts of electricity. What is the current drawn by the speaker?

Looking For	Given	Relationship	Solution
current	**V=50 volts** **R=16 ohms**	**I=V/R**	**3.125 amps**

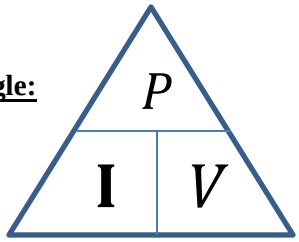
4. A toaster plugged into the wall, (120 volts), uses 24 amps of electricity. What is the resistance of the toaster?

Looking For	Given	Relationship	Solution
Resistance	**V=120 V** **I=24 amps**	**R=V/I**	**5 ohms**

Information: Power

The electric power in watts (W) is associated with a complete electric circuit. A circuit component represents the rate at which energy is converted from the electrical energy of the moving charges to some other form, e.g., heat, mechanical energy, or energy stored in electric fields or magnetic fields. For a resistor in a circuit the power is given by the product of applied voltage and the electric current:

$$P = \frac{V^2}{R} \quad \text{or} \quad P = I^2R \quad \text{or} \quad P = IV \longrightarrow$$ **Triangle:**



Classwork Practice Problems

1. Find the current drawn from a 1200 W hair dryer connected to a 120 V source. Find the resistance of the hair dryer.

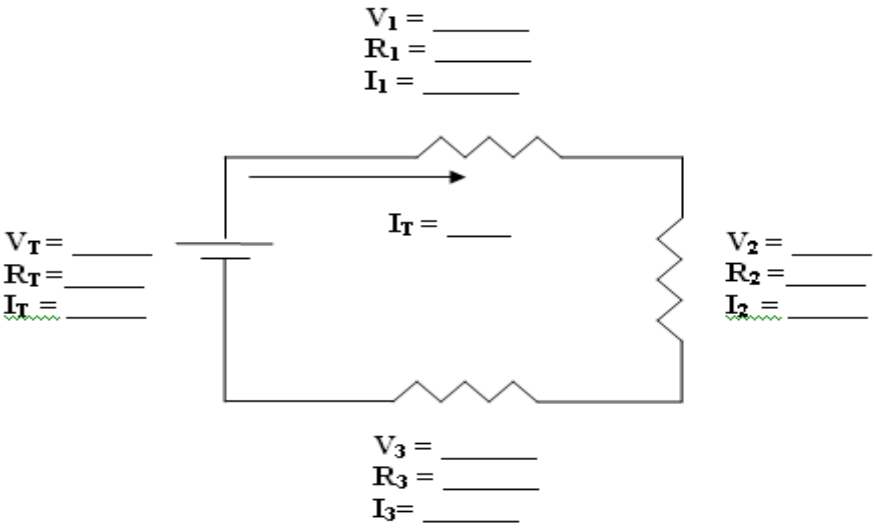
Looking For	Given	Relationship	Solution
current	**P=1200 watts** **V=120 volts**	**R=V²/P**	**12 ohms**

2. A car lighter has a resistance of 4 Ω. If it draws from a 12 V battery, what is the power dissipated?

Looking For	Given	Relationship	Solution
power	**R= 4 ohms** **V=12 volts**	**P=V²/R**	**36 watts**

Series Circuit Worksheet

Be sure to NEATLY draw the circuit for each problem and fill in the table. Show your work!! Use the sample layout below.



1. A series circuit contains a 12-V battery and three bulbs with a resistance of 4 Ω, 6 Ω, and 8 Ω. Fill in the values in the circuit diagram below. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (amps)**	**Resistance (ohms)**
Bulb 1	2.67	0.67	4
Bulb 2	4	0.67	6
Bulb 3	5.33	0.67	8
Total	12	0.67	18 **Ω**

2. A series circuit contains a 120-V battery and three bulbs with a resistance of 12 Ω, 20 Ω, and 60 Ω. Fill in the values in the circuit diagram below. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (Amps)**	**Resistance (Ohms)**	**Power (Watts)**
Bulb 1	15.65	1.3	12	20.35
Bulb 2	26	1.3	20	33.8
Bulb 3	78	1.3	60	101.4
Total	120	1.3	92	156

3. A series circuit contains a 6-V battery and three bulbs with a resistance of 2 Ω, 4 Ω, and 6 Ω. Fill in the values in the circuit diagram below. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (amps)**	**Resistance (ohms)**	**Power (Watts)**
Bulb 1	1	0.5	2	0.5
Bulb 2	2	0.5	4	1
Bulb 3	3	0.5	6	1.5
Total	6	0.5	12	3

Series Circuits - Homework

1. A series circuit contains a 9-V battery and three bulbs with a resistance of 1 Ω, 3 Ω, and 6 Ω. Fill in the values in the circuit diagram below. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (amps)**	**Resistance (ohms)**	**Power (Watts)**
Bulb 1	0.9	0.9	1	.81
Bulb 2	2.7	0.9	3	2.43
Bulb 3	5.4	0.9	6	4.86
Total	9	0.9	10	8.1

2. A series circuit contains a 60-V battery and three bulbs with a resistance of 5 Ω, 10 Ω, and 15 Ω. Fill in the values in the circuit diagram below. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (amps)**	**Resistance (ohms)**	**Power (Watts)**
Bulb 1	10	2	5	20
Bulb 2	20	2	10	40
Bulb 3	30	2	15	60
Total	60	2	30	120

Parallel Circuits

Main Ideas

Current
Is different across each bulb.
(if the resistance is different)

Voltage
Is always the same for each bulb.

Total Resistance:
adding a bulb decreases the resistance.

Adding a bulb
Does not affect bulb brightness.

Draw three 10 Ω resistors connected in parallel:

Parallel Circuit Worksheet

Be sure to NEATLY draw the circuit for each problem and fill in the table. Show your work!! Use the sample layout below.

1. A parallel circuit contains a 12-V battery and three bulbs with a resistance of 4 Ω, 6 Ω, and 8 Ω. Fill the values in on the circuit diagram. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (amps)**	**Resistance (ohms)**	**Power (Watts)**
Bulb 1	12	3	4	36
Bulb 2	12	2	6	24
Bulb 3	12	1.5	8	18
Total	12	6.5	1.84	78

2. A parallel circuit contains a 120-V battery and three bulbs with a resistance of 20 Ω, 30 Ω, and 60 Ω. Fill the values in on the circuit diagram. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (amps)**	**Resistance (ohms)**	**Power (Watts)**
Bulb 1	120	6	20	720
Bulb 2	120	4	30	480
Bulb 3	120	2	60	240
Total	120	12	10	1440

3. A parallel circuit contains a 6-V battery and three bulbs with a resistance of 2 Ω, 4 Ω, and 8 Ω. Fill the values in on the circuit diagram. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (amps)**	**Resistance (ohms)**	**Power (Watts)**
Bulb 1	6	3	2	18
Bulb 2	6	1.5	4	9
Bulb 3	6	0.75	8	4.5
Total	6	5.25	1.14	31.5

Parallel Circuit Homework

1. A parallel circuit contains a 20-V battery and three bulbs with a resistance of 2 Ω, 4 Ω, and 6 Ω. Fill the values in on the circuit diagram. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (amps)**	**Resistance (ohms)**	**Power (Watts)**
Bulb 1	20	10	2	200
Bulb 2	20	5	4	100
Bulb 3	20	3.33	6	66.7
Total	20	18.33	1.09	366.7

2. A parallel circuit contains a 60-V battery and three bulbs with a resistance of 5 Ω, 10 Ω, and 15 Ω. Fill the values in on the circuit diagram. What is the total resistance in the circuit? What is the voltage drop of each bulb? What is the current that each bulb uses? What is the power in each bulb?

	Voltage (Volts)	**Current (amps)**	**Resistance (ohms)**	**Power (Watts)**
Bulb 1	60	12	5	720
Bulb 2	60	6	10	360
Bulb 3	60	4	15	240
Total	60	22	2.72	1320

Summary Information: Series and Parallel

A series circuit (Figure 1) is a circuit in which resistors are arranged in a chain, so the current has only one path to take. The current is the same through each resistor. The total resistance of the circuit is found by simply adding up the resistance values of the individual resistors:

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

A parallel circuit (Figure 2 & 3) is a circuit in which the resistors are arranged with their heads connected together, and their tails connected together [Figures 2 and 3]. The current in a parallel circuit breaks up, with some flowing along each parallel branch and re-combining when the branches meet again. The voltage across each resistor in parallel is the same. The total resistance of a set of resistors in parallel is found by adding up the reciprocals of the resistance values, and then taking the reciprocal of the total:

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

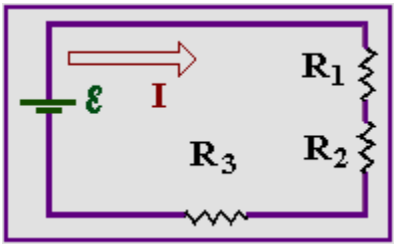


Figure 1 *Resistors connected in series.*

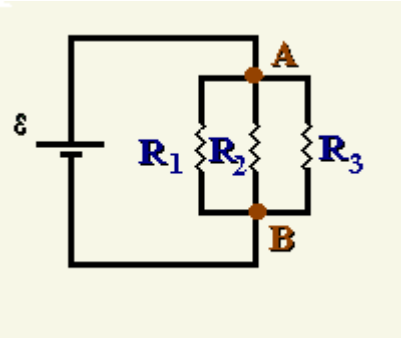


Figure 2 *Example of a circuit containing three resistors connected in parallel*

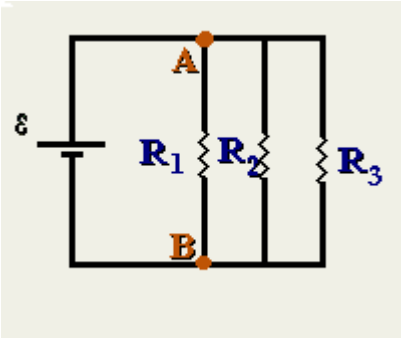


Figure3 *Circuit containing resistors in parallel, equivalent to Figure 2*

If you add a resistor in:	Series	Parallel
equivalent resistance	increases	Decreases
total current in circuit	decreases	Increases
current through each device	the same	depends on its resistance
voltage across each device	depends on its resistance	the same