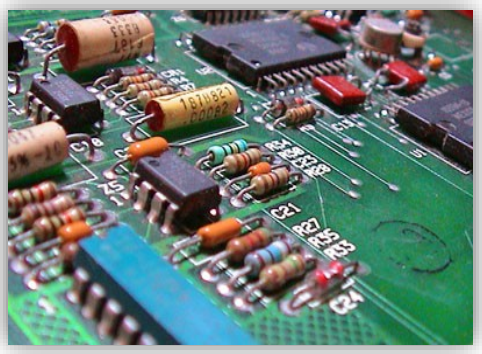
FIRST® at Home

Series and Parallel Circuits

PROBLEM STATEMENT



Have you ever wondered what *really* makes robots move? What's inside those motors and circuit boards? They are made up of all types of electronic components, things like resistors, capacitors, integrated circuits and many more. **Electronics** is the study of how we control the movement of electrons – negatively charged sub-atomic particles – through all these components.

Electronics allows us to create the devices that help run the modern world. From robots to computers, from automobiles to airplanes, an **electrical engineer** has had a part in the design of the products that make life easier for all.

CRITERIA & CONSTRAINTS

- You will need an internet connected computer or tablet. (A smartphone should work if that's all you have.)
- You won't need an electronics kit or components: these exercises will use an online circuits simulator. You will do your work in a browser (Chrome, Firefox, Safari, etc.) on your computer or tablet.
- You'll be creating virtual circuits and answering questions.
- Your final task will be to create an original circuit using what you've learned about electronics. Your solution can be saved as a screen capture, or you can draw a diagram of your solution on a sheet of paper.
- You will reflect on your work and how you solved the problem.

ENGINEERING DESIGN PROCESS & *FIRST*® CORE VALUES

FIRST® Engineering Design Process | Explore *FIRST*® Core Values

ACTIVITY STEPS

- Open a browser on your computer or tablet and navigate to the circuit simulator
- Complete the building background section.
- Solve the circuit challenge and share your solution.
- Answer the reflection questions and complete the Core Values Self-Reflection rubric.

BUILDING THE BACKGROUND

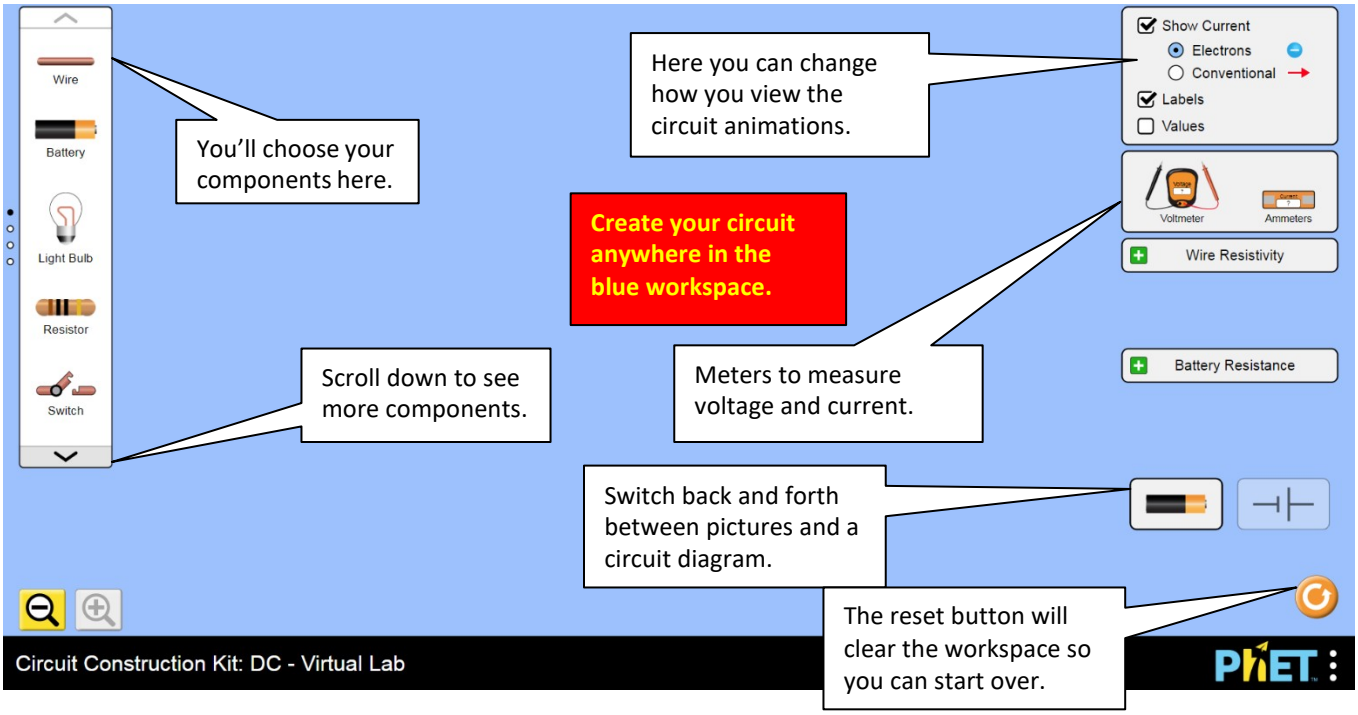
Review the Autodesk website. Use the information on the page to think about the following questions.

1. What are the basic electrical elements that make a circuit work?
2. What properties do materials that use electricity efficiently have?
3. What is the purpose of different types of circuits?
4. What types of electronic devices make up simple circuits?

Series and Parallel Circuits Simulator

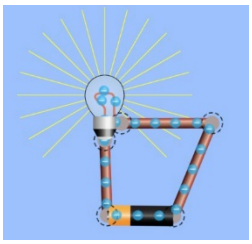
Creating Your First Circuit

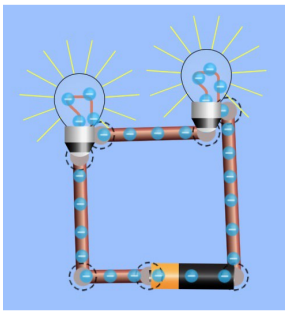
a) Open and browser and navigate to the simulator. Your screen should look something like this:



Review the workspace detail above.
Create a circuit that lights the bulb.

What did you notice about making connections in the circuit?





Now let's add another bulb to our circuit. See if you can create the circuit that has 2 light bulbs and 1 battery. Use the image below as an example

What do notice about the brightness of the bulbs in this circuit?

This type of circuit is called a **series circuit**. In a series circuit, all the components – in this case the light bulbs and the wires – share a single path back to the power source, or battery. So, all the electrons have only one route to travel.

In a series circuit, the bulbs must share the voltage from the battery. In the case of this circuit, the default setting is for a 9-volt battery, so we should be able to measure half of that or 4.5 volts at each bulb.

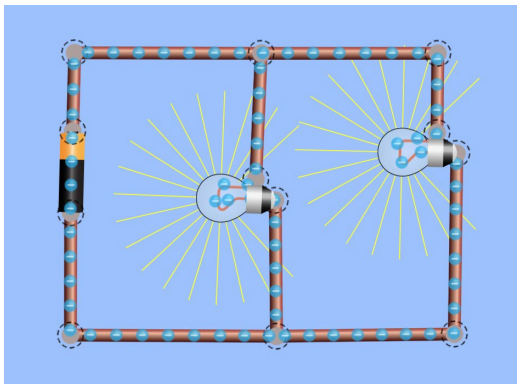
What does your voltmeter read?

What do you think you'll read across the other bulb?

How can measuring the flow of energy (hint – not volts) in this circuit help explain why when you add the additional bulb, they are both less bright?

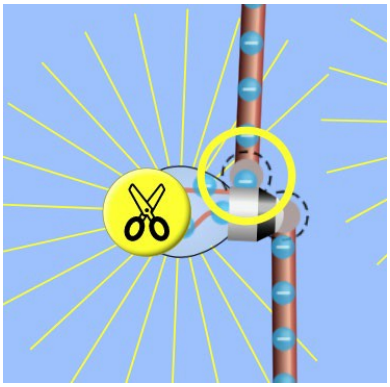
Parallel Circuits

Use the orange reset button  to clear the workspace. Now create the circuit pictured to the right. Make sure each component has its own pathway back to the battery. This may not sound like a big difference, but it really changes everything.



What do you notice about the brightness of the 2 bulbs compared to the series circuit?

What information can you learn using your meter to measure the voltage and amps in the circuit to explain the difference in brightness?



Use the scissors tool to break the wire in front of one of the bulbs.

What happens to the bulbs?

Use the meter and observe the measurement. *How have your readings changed that explain what you observe with the bulbs?*

Final Challenge

Using what you've learned so far, create a parallel circuit with **3 bulbs.**

Observe what happens to the brightness of the bulbs and take measurements to prove your observations.

SKETCH OR PASTE YOUR CIRCUIT SOLUTION

Sketch the circuit you created to solve the final challenge. This should be a circuit with 3 light bulbs in parallel. Be sure to draw all the values you recorded with the voltmeter and the ammeters. You may also take a screen capture of your solution and paste it here if you are saving your work to a file.

REFLECTION QUESTIONS

1. Think about the lights and wiring in your home or apartment. Do you think these devices use mostly series or parallel circuits? Explain your answer.

2. What would be the advantage of a series or parallel circuit?

3. As an electrical engineer what other components might you need to use to build more complex circuits?

GO FURTHER!

Explore some of the other physics and electronics simulators available from the University of Colorado at Boulder

With your parent or guardian's permission, explore some hands-on electronics activities. With online searches, you can find many fun activities to do with items you can find around the house. There are also many inexpensive kits available that will let you continue experimenting with electricity and electronics.

Explore Ohm's Law. Ohm's Law will let you predict exactly how much voltage, current and resistance to expect in any circuit.

CORE VALUES SELF-REFLECTION

	Amazing Skill	Great Job	Making Progress	Could Be Better
Discover	I approached the tasks looking for all possible answers independently and used perseverance to discover the answer on my own.	I approached the tasks and asked questions from one other person but persevered to discover the answer on my own.	I approached tasks but needed assistance multiple times to reach a point of discovery.	I depended on others to make the discovery for me.
Innovation	I used creativity and perseverance to solve problems on my own, coming up with unique solutions for the tasks I was given.	I used creativity and perseverance to solve problems on my own coming up with different solutions for the tasks I was given.	I used creativity but struggled with perseverance to solve problems on my own.	I struggled with being creative and only used the information given and needed a lot of encouragement from others to complete the task.
Impact	I approached the tasks applying understanding of the information with the impact it can have on me and my future as well as how I could help others.	I approached the tasks knowing and applying the information with impact it can have on me and my future.	I understand the tasks but struggle to apply how it will help me in my future or to influence others.	I understand the tasks but did not approach it with understanding the impact it can have on my future or others.
Inclusion	I approached all tasks with inclusion of others' ideas, I showed tremendous kindness by including others' views in my projects and work. I approached my solution thinking how all people would interact with the solution.	I approached most with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution mostly incorporates needs of others.	I approached some tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution meets only a few needs of others.	I did not approach tasks with inclusion of others' ideas, I tried to understand others' views and include them in my projects and work. My solution is not inclusive of different types of people.
Teamwork	I used collaboration, communication and project management to get all tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get most tasks accomplished for myself as well as the others.	I used collaboration, communication and project management to get some tasks accomplished for myself as well as the others.	I only sometimes used collaboration, communication and project management and accomplished a few tasks for myself as well as the others.
Fun	I kept a positive attitude throughout and found opportunities to have fun even through struggle. I looked for additional opportunities to have fun in my tasks.	I kept a positive attitude throughout and found opportunities to have fun even through struggle.	I saw the enjoyment and fun after the activity but struggled to see it during.	I only saw struggle in completing my tasks and did not look for times to have fun.