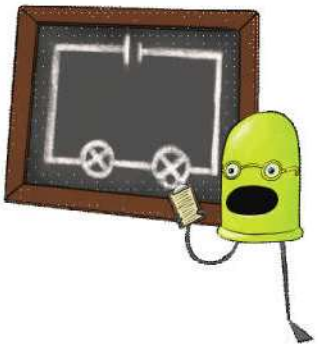
Lesson 2: Series and Parallel Circuits

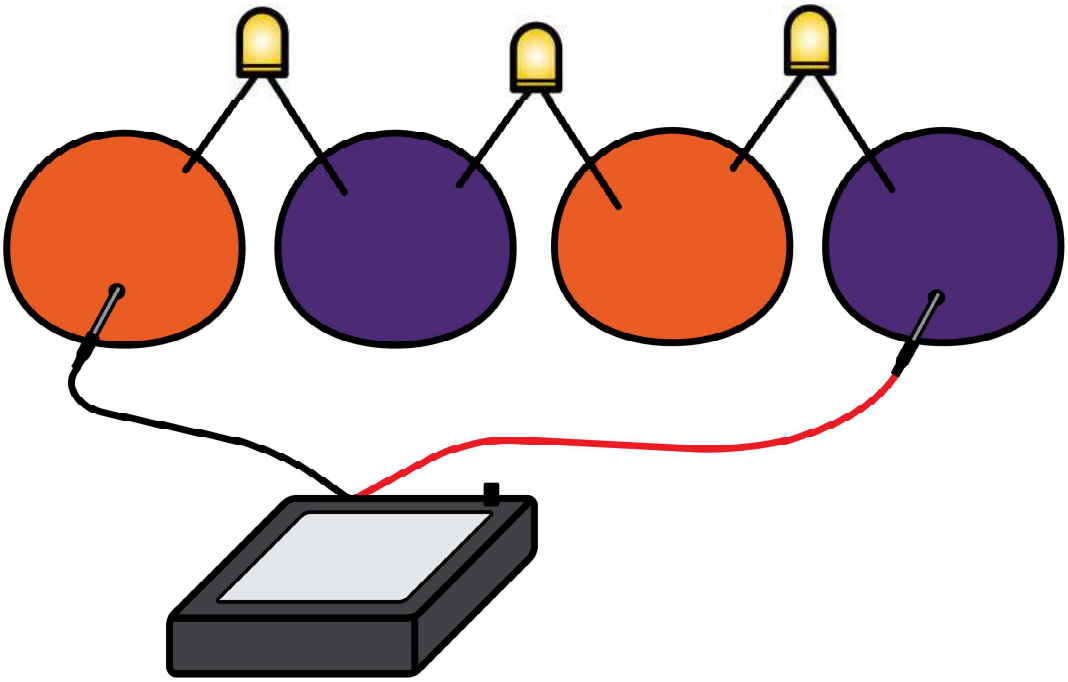
Summary and Background Knowledge:

In this lesson, students will build on their existing knowledge regarding circuits by experimenting with Squishy Circuit materials to discover the differences between parallel and series circuits. The circuits students created in Lesson 1 were simple circuits, meaning that they comprised of a power source, a single energy output (LED or motor), and an optional switch.

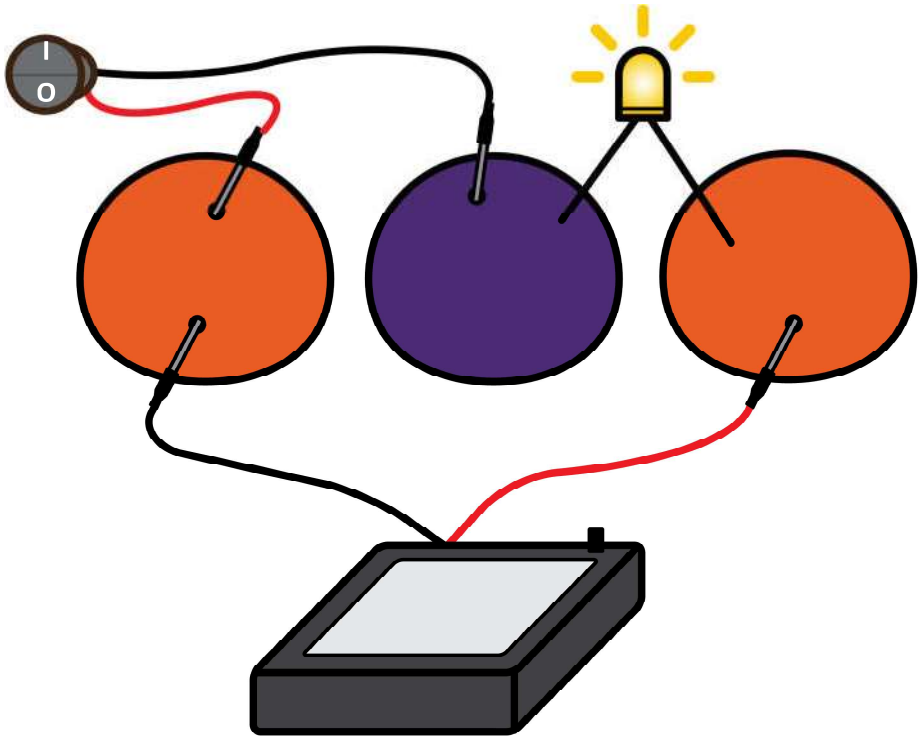
Series and parallel circuits are more intensive, and contain more than one output. If a circuit is connected in series, the electrical charge passes through each output (use LEDs of the same color) in a consecutive order.



The circuit created in lesson was a **series circuit**. If one output is removed in the circuit, all future outputs will no longer turn on. This is because the circuit is no longer complete, and the electrical charge cannot reach those other LEDs. Users will notice that the LEDs are also dimmer. This is because the 6 volts from the batteries must be shared by all the LEDs. Each LED requires ~2.5v to turn on, so if you have three LED lights connected in **series,** they require more voltage than the batteries can provide and likely won't turn on at all!

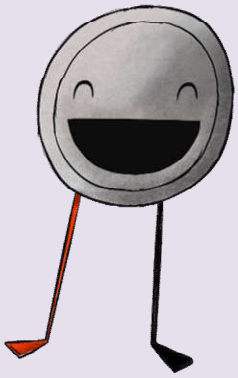


A more useable example of a series circuit is to use the switch. If you put the switch in series with the LED, then the circuit will either be open or closed depending on the switch!

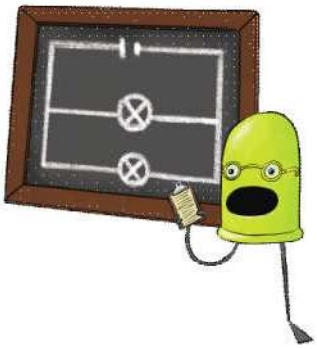


Did You Know? –

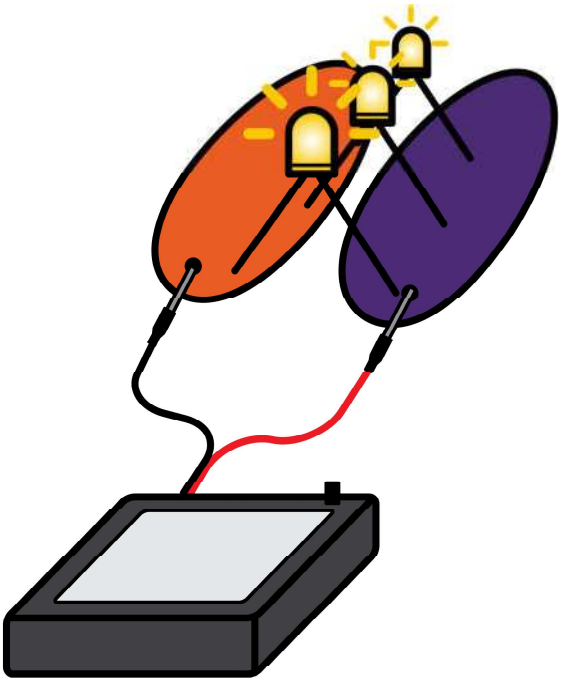
Many switches use 'I' and 'O' to indicate on and off. It is believed that these symbols originate from binary which uses 0 to represent off and 1 to represent on. Binary is a way to denote numbers with only 0 and 1s and is used for coding, data storage, and more.



If a circuit is organized in **parallel,** each output (LED etc.) is independent of the others. If one output is disconnected, all others will still function.



This is because they are connected on their own circuit and they all operate independently from each other.

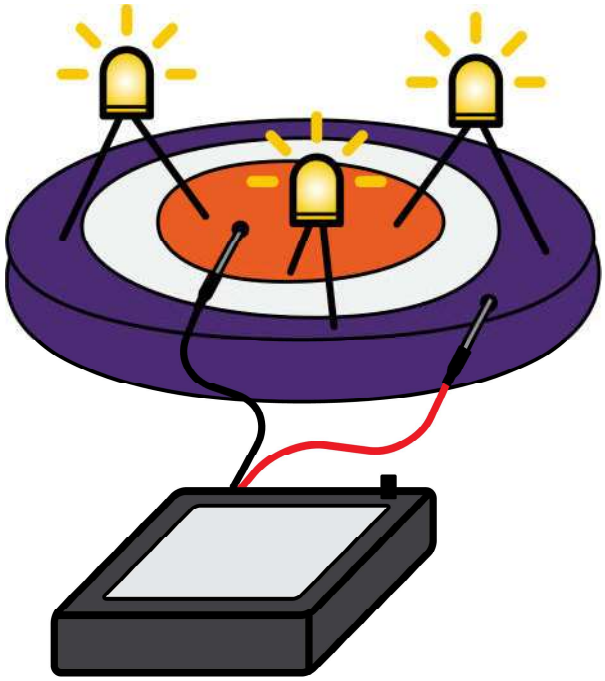


Try and think of different real-world applications for series and parallel circuits.

If you have many lights in a room, typically they are connected in **series** with the switch – that way one switch can control all of the lights at once.

Christmas lights are a good example of **parallel** circuits because if one bulb burns out, the rest continue to glow. Older sets of these lights actually were in series so if one burnt out, you had to try every single bulb to find the bad one and replace it to make the rest turn on!

Remember, the shape of the dough does not matter. This is another example of a parallel circuit with the two pieces of conductive dough separated with a layer of insulating dough.



Applicable Vocabulary:

- Series circuit
- Parallel circuit

Main Objective:

Upon completion of this lesson, students will be able to explain using models and verbal and/or written language the difference between series and parallel circuits, and demonstrate examples of a use for each.

Materials:

- Insulating dough (roughly ¼ cup per pair of students)
- Conductive dough (roughly 2 cups per pair of students)
- 1 battery pack with four (4) AA batteries
- At least three light emitting diodes
- Optional: motors, switches, fans, and buzzers
- Student science journal or provided handout

Time:

- Pair students and hand out materials: 5 minutes
- Discovery time (Steps 2-3): 5 minutes
- Sharing: 5 minutes
- Instruction: 5 minutes
- Redesign, retest: 10 minutes
- Data recording: 5 minutes

Total Time: 35 minutes

Instructor Procedure:

1. After students have been divided into pairs or trios, provide each student with the materials listed above
2. Provide students with the following directions:
    a. *With your partner, discuss different ways you think you could make the two LEDs to light up. (Use this time to investigate your materials, but don't hook anything up yet)*
    b. *Draw in your science journal how you will attempt to solve the challenge: "Make two LEDs light up using only the materials in front of you."*
    c. *Using the materials, work with your partner as a team to create working circuit.*
3. Spend time wandering the classroom to identify student misunderstandings, comprehension, and answer questions as well as ask questions. *Provide guidance as you see fit.*
4. When students have completed the challenge, ask pairs to share with neighboring groups. Allow students one minute to do this.
5. Bring the class together. Invite a few groups to share what they now know, and what they wonder about as a result of the activity.
6. Instruct class on two different types of series and parallel circuits' configurations. Brainstorm benefits of each together.
7. Provide students with another challenge: "*Can you design both series and parallel circuits? What are other examples of them in your life?"* Encourage students to plan and document in their journals or handout as a way of emphasizing the engineering design process.
    a. Optional: Allow groups to join together.