



TryEngineering

Series and Parallel Circuits



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Lesson Focus

Demonstrate and discuss simple circuits and the differences between parallel and serial circuit design and functions. Note: This lesson plan is designed for classroom use only, with supervision by a teacher familiar with electrical and electronic concepts.

Lesson Synopsis

The Series and Parallel Circuits activity encourages students to test two different circuit designs through the use of low voltage light bulbs. Students work in teams to predict the difference between the two circuit designs, and then build examples of the two different circuits using wires, bulbs, and batteries. After testing several predictions about each circuit type, the groups will compare results and discuss findings.

Age Levels

8-14.

Objectives

- ✦ Learn that different circuit designs result in different electrical behaviors.
 - ✦ Learn about current flow and the operational differences between series and parallel circuits.
 - ✦ Learn to predict outcomes and draw conclusions.
 - ✦ Learn about teamwork and working in groups.
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Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- ✦ parallel and series circuits
 - ✦ circuits and current flow
 - ✦ making and testing predictions
 - ✦ teamwork
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Lesson Activities

Students perform experiments using two different types of circuit arrangements: series and parallel circuits. Students compare a set up of series and parallel bulbs, make predictions about how the circuit will function, record results, and discuss the circuits as a group.

Resources/Materials

- ✦ Teacher Resource Documents (attached)
- ✦ Student Worksheet (attached)
- ✦ Student Resource Sheets (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- ✦ TryEngineering (www.tryengineering.org)
- ✦ National Institute of Standards and Technology (NIST) (www.nist.gov)
Information about measurements and measurement uncertainty.
- ✦ ITEA Standards for Technological Literacy: Content for the Study of Technology (www.iteaconnect.org/TAA)
- ✦ National Science Education Standards (www.nsta.org/publications/nses.aspx)

Recommended Reading

- ✦ DK Eyewitness Series: Electricity (ISBN: 0751361321)
- ✦ Make Cool Gadgets for Your Room by Amy Pinchuk and Teco Rodriques (ISBN: 1894379128)
- ✦ My World of Science: Conductors and Insulators by Angela Royston (Heinemann Educational Books, ISBN: 0431137269)

Optional Writing Activity

- ✦ Write an essay (or paragraph depending on age) describing how replacing one light on a holiday string of bulbs with a "blinking" light would cause all the lights in the string to also blink? Is this an example of a parallel or series circuit? Why?

Series and Parallel Circuits



For Teachers: Teacher Resources

◆ Materials

- Student Resource Sheets
- Student Worksheet
- Notebooks
- Pencils
- Two set-ups for each group of students, each consisting of:
 - 6 pieces of bell wire (6" each) with ends stripped
 - Battery holder
 - Socket
 - Three or more 1.5 volt bulbs
 - Size D batteries

◆ Procedure

1. Review the definitions of series and parallel circuits with the class. Use Student Reference Sheets for background information. These may also be distributed as homework reading on the night prior to the activity.
2. Divide students into small groups of 3-4 students and distribute Student Worksheet and two set-ups (see materials above) to each group.
3. Ask the groups to examine the schematic of a series circuit on the Student Worksheet and draw their own plan for a parallel circuit in the space provided.
4. Have each student group make a series and parallel circuit using batteries, wires, and bulbs.
5. Once the circuits are complete, ask student groups to make predictions as to how the circuits will function if a light bulb is removed. Also discuss whether the bulbs might burn brighter in one set up than another. Students should record their predictions on the Student Worksheet.
6. Have each student group test their predictions using their circuits, and compare their results to their predictions.
7. Bring the student groups together to discuss their findings.

◆ Time Needed

45 Minutes

◆ Tips

- Teachers may want to set up the series circuit before class and ask students to create the parallel circuit to save time.
- Teachers should consider distributing the student resource sheets as reading material/homework for the night before the activity will be conducted in class.
- Encourage students to compare all the circuits built by different student groups.

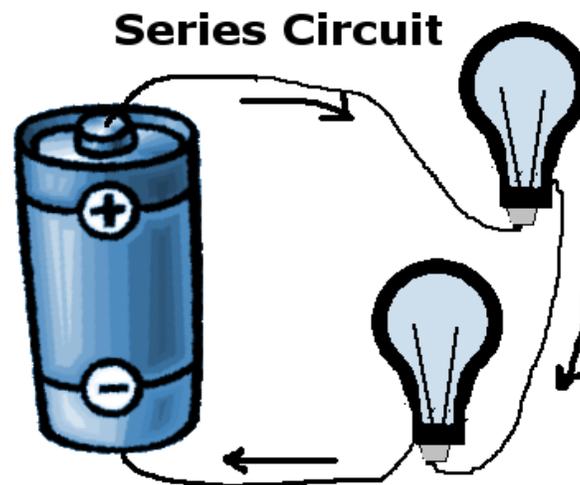
Series and Parallel Circuits



Student Resource: What is a Simple Circuit?

◆ Simple Circuit

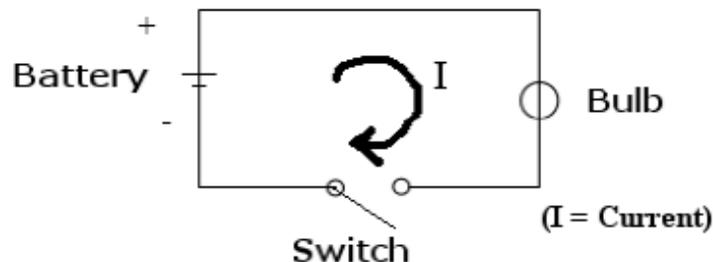
A simple circuit consists of three elements: a source of electricity (battery), a path or conductor on which electricity flows (wire) and an electrical resistor (lamp) which is any device that requires electricity to operate. The illustration below shows a simple circuit containing a battery, two wires, and a low voltage light bulb. The flow of electricity is caused by excess electrons on the negative end of the battery flowing toward the positive end, or terminal, of the battery. When the circuit is complete, electrons flow from the negative terminal through the wire conductor, then through the bulb (lighting it up), and finally back to the positive terminal - in a continual flow.



◆ Schematic Diagram of a Simple Circuit

The following is a schematic diagram of the simple circuit showing the electronic symbols for the battery, switch, and bulb.

Schematic Diagram of a Simple Circuit



Series and Parallel Circuits

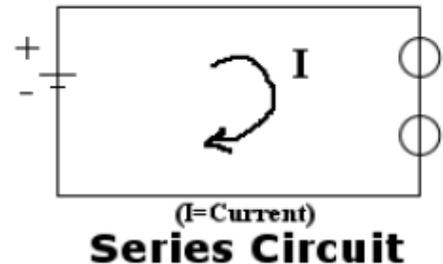


Student Resource: What are Series and Parallel Circuits?

Series and parallel describes two different types of circuit arrangements. Each arrangement provides a different way for electricity to flow throughout a circuit.

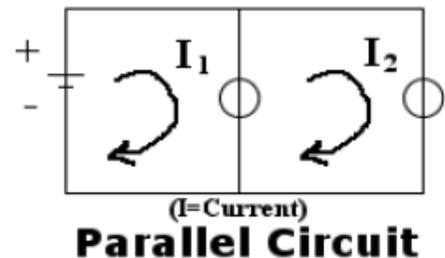
◆ Series Circuits

In a series circuit, electricity has only one path on which to travel. In the example to the right, two bulbs are powered by a battery in a series circuit design. Electricity flows from the battery to each bulb, one at a time, in the order they are wired to the circuit. In this case, because the electricity can only flow in one path, if one of the bulbs blew out, the other bulb would not be able to light up because the flow of electric current would have been interrupted. In the same way, if one bulb was unscrewed, the current flow to both bulbs would be interrupted.



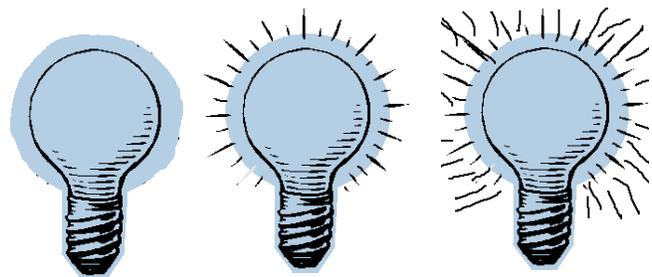
◆ Parallel Circuits

In a parallel circuit, electricity has more than one path on which to travel. In the example to the right, two bulbs are powered by a battery in a parallel circuit design. In this case, because the electricity can flow in more than one path, if one of the bulbs blew out, the other bulb would still be able to light up because the flow of electricity to the broken bulb would not stop the flow of electricity to the good bulb. In the same way, if one bulb were unscrewed, it would not prevent the other bulb from lighting up.



◆ What About Resistance?

The flow of electricity depends on how much resistance is in the circuit. In our examples, the bulbs provide resistance. In a series circuit, the resistance in the circuit equals the total resistance of all the bulbs. The more bulbs in the circuit,



the dimmer they will light. In a parallel circuit, there are multiple paths through which current can flow, so the resistance of the overall circuit is lower than it would be if only one path was available. The lower resistance means that the current will be higher and the bulbs will burn brighter compared to the same number of bulbs arranged in a series circuit.

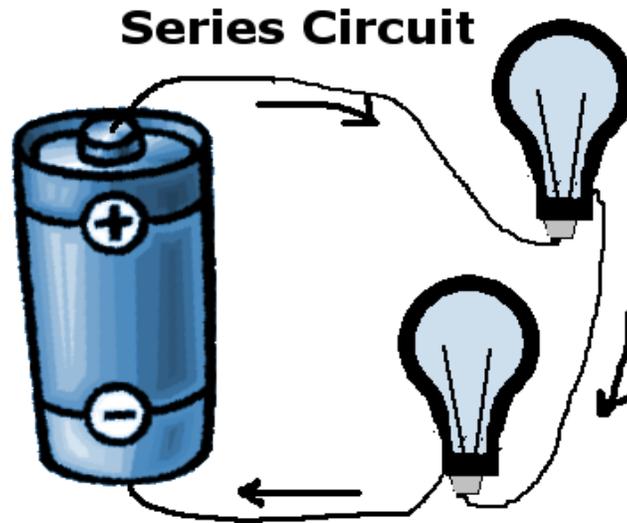
Series and Parallel Circuits



Student Worksheet:

◆ Instructions

You are the engineer! You need to design a system where one switch can turn on multiple lights! An example might be a string of holiday lights. Now, construct both a series circuit and a parallel circuit using the batteries, wires, and bulbs provided to you. Your series circuit will look something like the drawing below:



Draw your own diagram below that illustrates how your Parallel Circuit will look:

Series and Parallel Circuits



Student Worksheet (continued):

◆ Group Predictions

After you have constructed both a series and parallel bulb circuit, make some predictions on the following as a group:

1. Do you think holiday lights are an example of parallel or series bulbs in a circuit? Explain why:
2. Do you think the bulbs in the parallel circuit or the series circuit will burn brighter? Explain why:
3. If you remove a bulb in your parallel circuit, with the other bulb(s) still light? Explain why:
4. If you remove a bulb in your series circuit, with the other bulb(s) still light? Explain why:

◆ Test and Results

Now test your predictions for questions 2, 3 and 4 above. Then respond to the questions below:

1. Were your predictions about the brightness of the bulbs accurate? If not, what happened that was different from what your group expected?
2. Were your predications about what happened if a bulb was removed from the parallel and serial circuits accurate? If not, what happened that was different from what your group expected?

Series and Parallel Circuits



For Teachers: Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (<http://www.nextgenscience.org/>)
- International Technology Education Association's Standards for Technological Literacy (<http://www.iteea.org/TAA/PDFs/xstnd.pdf>)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (<http://www.nctm.org/standards/content.aspx?id=16909>)
- U.S. Common Core State Standards for Mathematics (<http://www.corestandards.org/Math>)
- Computer Science Teachers Association K-12 Computer Science Standards (<http://csta.acm.org/Curriculum/sub/K12Standards.html>)

◆ National Science Education Standards Grades K-4 (ages 4 - 9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ✦ Abilities necessary to do scientific inquiry
- ✦ Understanding about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- ✦ Light, heat, electricity, and magnetism

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- ✦ Understanding about science and technology

◆ National Science Education Standards Grades 5-8 (ages 10 - 14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ✦ Abilities necessary to do scientific inquiry
- ✦ Understandings about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- ✦ Transfer of energy

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- ✦ Understandings about science and technology

◆ Next Generation Science Standards Grades 3-5 (Ages 8-11)

Energy

Students who demonstrate understanding can:

- ✦ 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

◆ Standards for Technological Literacy - All Ages

Design

- ✦ Standard 8: Students will develop an understanding of the attributes of design.
- ✦ Standard 9: Students will develop an understanding of engineering design.
- ✦ Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.