

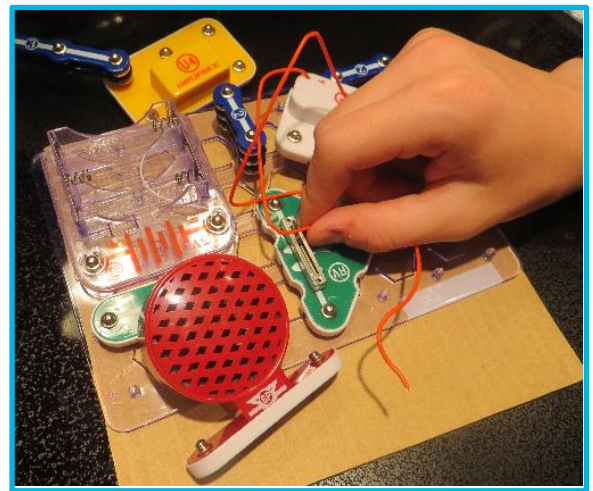
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### Lesson Focus

Lesson explores the electronics behind radio, and its impact on society. Students work in teams to build and test a radio receiver and optional transmitter from either a snap or soldering kit (depending on level and age). They review challenges encountered in the building and testing process, evaluate their results, and share observations with their class.

### Lesson Synopsis

The "Radio Reception & Transmission" lesson explores how radio has impacted society, and impacted communications globally. Students work in teams to construct a working radio receiver that can receive FM broadcasts. An extension is to also build a FM transmitter, or to have an older student team build a transmitter, and partner with younger students who build the radio receiver. Very young students can build a snap kit. Older students will be more challenged to build the radio receiver or transmitter using kits of resistors, capacitors, coils, semiconductors, a PC board, and other parts. Teams build their radio and transmitter, test it, reflect on the challenge, and present their experiences to their class.



### Age Levels

8-18. Note: This lesson may be shared where younger students build the radio receiver, and partner with older students who build the radio transmitter.

### Objectives

- ◆ Learn about engineering design and redesign.
- ◆ Learn about circuits and computers.
- ◆ Learn about radio receivers and transmitters.
- ◆ Learn about teamwork and problem solving.

### Anticipated Learner Outcomes

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

- ◆ engineering design
- ◆ computer engineering
- ◆ radio
- ◆ teamwork

### Radio Reception and Transmission

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## **Lesson Activities**

Students explore how advances in radio communications have impacted society. Students work in teams to build and test a working FM radio receiver and an FM transmitter. They review challenges encountered in the building and testing process, evaluate whether they are able to both send and receive radio transmission, and share observations with their class.

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## **Resources/Materials**

- ◆ Teacher Resource Documents (attached)
- ◆ Student Resource Sheet (attached)
- ◆ Student Worksheet (attached)

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## **Alignment to Curriculum Frameworks**

See curriculum alignment sheet at end of lesson.

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## **Internet Connections**

- ◆ TryEngineering ([www.tryengineering.org](http://www.tryengineering.org))
- ◆ US National Radio and Television Museum (<http://ncrtv.org/>)
- ◆ History of the BBC ([www.bbc.co.uk/historyofthebbc /](http://www.bbc.co.uk/historyofthebbc/))
- ◆ Radio Museum (International listings and resources) ([www.radiomuseum.org](http://www.radiomuseum.org))
- ◆ Wikipedia Radio (<https://en.wikipedia.org/wiki/Radio>)

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## **Recommended Reading**

- ◆ Inventing the Radio (Breakthrough Inventions) (ISBN: 978-0778728399)
- ◆ Radio Tubes and Boxes of the 1920's (ISBN: 978-1886606135)
- ◆ Wireless: From Marconi's Black-Box to the Audion (Transformations: Studies in the History of Science and Technology) (ISBN: 978-0262514194)

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## **Optional Writing Activity**

- ◆ Write an essay or a paragraph that examines who invented radio -- there is much controversy on this topic!

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## **Safety Regulations**

- ◆ In some areas, operating even a very short range FM transmitter without a license may conflict with applicable laws and/or regulations. Check the rules for your area - often schools are exempt.

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## For Teachers: Teacher Resource

### ◆ Lesson Goal

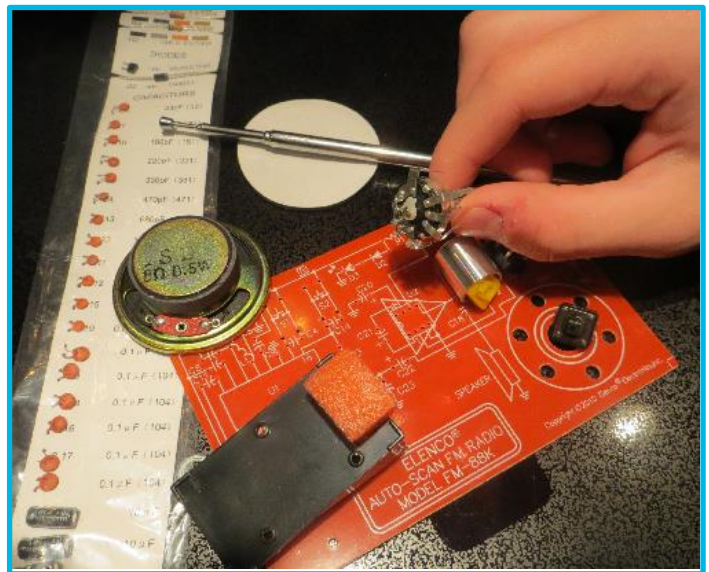
The "Radio Reception & Transmission" lesson explores how radio has impacted society, and impacted communications globally. Students work in teams to construct a working radio receiver that can receive FM broadcasts. An extension is to also build a FM transmitter, or to have an older student team build a transmitter, and partner with younger students who build the radio receiver. Very young students can build a snap kit. Older students will be more challenged to build the radio receiver or transmitter using kits of resistors, capacitors, coils, semiconductors, a PC board, and other parts. Teams build their radio and transmitter, test it, reflect on the challenge, and present their experiences to their class.

### ◆ Lesson Objectives

- ◆ Learn about engineering design and redesign.
- ◆ Learn about circuits and computers.
- ◆ Learn about radio.
- ◆ Learn about teamwork and problem solving.

### ◆ Materials

- ◆ Student Resource Sheets
- ◆ Student Worksheets
- ◆ Classroom Materials: 25 or 30 watt soldering unit (all soldering should be under supervision of teacher)
- ◆ Younger Student Team Receiver Materials: FM Radio Snap Model Kit (\$15-22) Edmund Scientifics [www.scientificsonline.com](http://www.scientificsonline.com), Item <https://www.scientificsonline.com/product/haynes-retro-radio-kit>).
- ◆ Older Student Team Receiver Materials: Circuit board based FM Radio Model Kit (\$15-40) (Elenco - [www.elenco.com](http://www.elenco.com), Model FM88K, .
- ◆ Older Student Team Transmitter Materials: FM Stereo Transmitter Kit (\$18-45) (Carls Electronics [www.electronickits.com](http://www.electronickits.com), <https://www.electronickits.com/9-volt-fm-transmitter-kit/>; or similar); batteries, long nose plier, small screwdrivers. Or, purchase individual items and build it all from scratch following instructions such as those found on Jameco's website ([www.jameco.com/Jameco/workshop/JamecoFavorites/fmtransmitter.html](http://www.jameco.com/Jameco/workshop/JamecoFavorites/fmtransmitter.html)).



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## **For Teachers:** **Teacher Resources (continued)**

### ◆ **Procedure**

1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, consider asking the students how radio transmission is possible. Ask them to consider what components might be inside a radio receiver and how they work. Prompt students to consider radio transmission as well.
3. Consider if your students will be working on the receiver only, or building both a receiver and transmitter. Divide your class into teams of 3-4 students, and consider partnering with an older or younger class at your school where one grade builds the receivers, and an older grade builds the transmitters -- perhaps present the work of both at a parent night or science fair event.
4. Teams of 3-4 students will consider their challenge, and work as a team to build a functional FM radio receiver or transmitter based on age and experience.
5. Student teams test their radio receivers and transmitters, review challenges encountered in the building and testing process, evaluate their results, and share observations with their class.

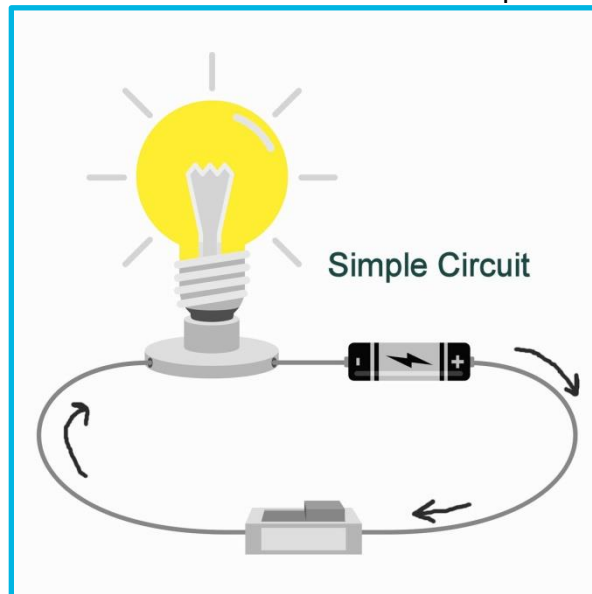
### ◆ **Time Needed**

Two to four 45 minute sessions (some student teams may work on this outside of class).

**Student Worksheet:**  
**What is a Simple Circuit?**

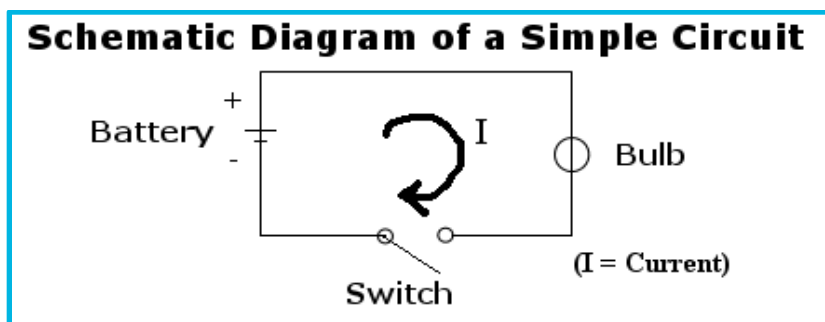
◆ **Simple Circuit**

A simple circuit consists of three minimum elements that are required to complete a functioning electric circuit: 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, one battery, two wires, a switch, and a bulb. The flow of electricity is from the high potential (+) terminal of the battery through the bulb (lighting it up), and back to the negative (-) terminal, in a continual flow when the switch is in the on position so current can 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.





## Student Worksheet:

### ◆ Engineering Teamwork and Planning

You are part of a team of engineers given the challenge of creating a working FM radio receiver and transmitter and then sending and receiving your own broadcast! You'll work as a team and divide up the work and have a system for keeping track of parts.

### ◆ Research Phase

Read the materials provided to you by your teacher. Visit Wikipedia Radio (<https://en.wikipedia.org/wiki/Radio>) to learn about the history and technology behind radio transmission and reception.

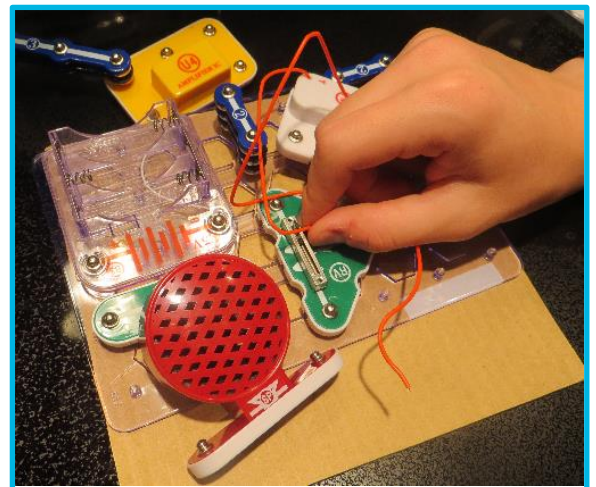
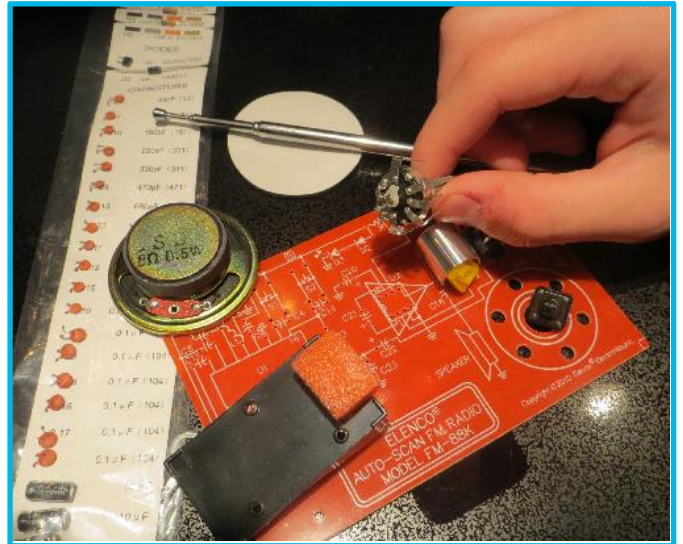
### ◆ Building Phase

Follow the detailed instructions within your kit to create your team's radio. If you are building the advanced kit that requires soldering, be sure to do this only under the supervision of your teacher.

### ◆ Reflection

Complete the reflection questions below:

1. What challenges did you have, if any, in constructing your radio? How did you resolve any challenges you encountered?
2. Was your radio transmitter able to send FM transmissions? If not, what troubleshooting steps did you take to resolve the problem?
3. Was your radio receiver able to receive FM transmissions? If not, what troubleshooting steps did you take to resolve the problem?
4. Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?
5. Were you surprised to see how complex the inner workings of a radio could be? Why or why not?
6. What do you think engineers might do to improve how a radio works in the future? What would you recommend?



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**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](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

- ◆ Properties of objects and materials
- ◆ Light, heat, electricity, and magnetism

**CONTENT STANDARD E: Science and Technology**

As a result of activities, all students should develop

- ◆ Abilities of technological design
- ◆ Understanding about science and technology

**CONTENT STANDARD F: Science in Personal and Social Perspectives**

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

- ◆ Science and technology in local challenges

**CONTENT STANDARD G: History and Nature of Science**

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

- ◆ Science as a human endeavor

◆ **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 in grades 5-8, all students should develop

- ◆ Abilities of technological design
- ◆ Understandings about science and technology

**CONTENT STANDARD F: Science in Personal and Social Perspectives**

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

- ◆ Science and technology in society

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**For Teachers:****Alignment to Curriculum Frameworks****◆ National Science Education Standards Grades 5-8 (ages 10-14)****CONTENT STANDARD G: History and Nature of Science**

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

- ◆ Science as a human endeavor
- ◆ Nature of science
- ◆ History of science

**◆ National Science Education Standards Grades 9-12 (ages 14-18)****CONTENT STANDARD A: Science as Inquiry**

As a result of activities, all students should develop

- ◆ Abilities necessary to do scientific inquiry

**CONTENT STANDARD E: Science and Technology**

As a result of activities, all students should develop

- ◆ Abilities of technological design
- ◆ Understandings about science and technology

**CONTENT STANDARD F: Science in Personal and Social Perspectives**

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

- ◆ Science and technology in local, national, and global challenges

**CONTENT STANDARD G: History and Nature of Science**

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

- ◆ Science as a human endeavor
- ◆ Nature of scientific knowledge
- ◆ Historical perspectives

**◆ 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.

**Engineering Design**

Students who demonstrate understanding can:

- ◆ 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- ◆ 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- ◆ 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

**◆ Next Generation Science Standards Grades 6-8 (Ages 11-14)****Engineering Design**

Students who demonstrate understanding can:

- ◆ MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

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**For Teachers:**  
**Alignment to Curriculum Frameworks****◆ Next Generation Science Standards Grades 9-12 (Ages 14-18)****Waves and their Applications in Technologies for Information Transfer**

Students who demonstrate understanding can:

- ◆ HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

**◆ Standards for Technological Literacy - All Ages****The Nature of Technology**

- ◆ Standard 1: Students will develop an understanding of the characteristics and scope of technology.
- ◆ Standard 2: Students will develop an understanding of the core concepts of technology.

**Technology and Society**

- ◆ Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- ◆ Standard 7: Students will develop an understanding of the influence of technology on history.

**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.

**Abilities for a Technological World**

- ◆ Standard 12: Students will develop abilities to use and maintain technological products and systems.

**The Designed World**

- ◆ Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.