Mission 8
Building a Radio Receiver

Hearing the Radio Waves That Surround You!

Notes

In Mission 7, students learned that there are methods for indirectly detecting other planetary systems, and that very recently, planets have been detected around other stars. This raises a question that is fundamental to SETI: Could intelligent life in some distant planetary system have advanced enough technologically to build radio transmitters? Perhaps here on Earth, given the proper "listening" technology, we can capture radio signals being sent, either intentionally or unintentionally, from a planet in some distant star system.

Overview

In this mission, students get firsthand experience with radio technology. In Mission 8.1, students are involved in an electrical engineering challenge–building a radio receiver. Students find that there are radio waves in the air that are invisible to us. Students experience some of the thrill of "inventing" a radio, and then they manipulate this technical tool that has the capacity to detect a signal (message) against a background of noise (static). This mission may take up to three class periods.

Mission 8.1
Materials

For a Class of 30

- 3 wire strippers
- Long wire for antenna

For Each Radio

Depending upon your budget, each student should build a radio, or have each team of students build one radio. Each radio will cost less than $10.00 (see "Teacher Background Information" in the appendixes).

- 25-by-12-cm piece of cardboard
- 15 cm length, 7.5 cm diameter hollow cardboard cylinder
- 7.5 cm length, 7.5 cm diameter hollow cardboard cylinder
- 16 meters of 24-gauge solid copper wire (enamel coated)
- 3.5 meters of 24-gauge stranded wire
- Germanium diode: type 1N34A (see appendixes)
- Crystal radio earphone (see appendixes)

For Each Team

- Meter stick
- Highlighter pen (wide tip)
- Aluminum foil
- Clear tape
- Extra fine sandpaper
- Sheet of plain white paper
- Scissors
- Single-edge razor blade (or an X-acto® knife)
- Grocery bag for teams' materials

For Each Student

- "Radio Technology" worksheet (page xxx)
- "Building an AM Radio" directions (7 pages)
- "How Does a Radio Work?" description (5 pages)
- Pencil

Getting Ready

1. Collect hollow cardboard cylinders that are three inches (~7.5 cm) in diameter. Try fabric stores. Frozen orange juice containers can also be used if the metal parts are removed. Students might be able to supply some of the tubes if you ask them ahead of time.

2. Purchase the 24-gauge stranded wire and 24gauge enamel-coated copper wire and organize it for easy student distribution (16 meters of wire tangles easily). If you have enough toilet paper tubes, pre-cut the wire and carefully wind it around tubes.

Teacher's Note: *Do not confuse these tubes, used to minimize tangling, with the three-inch cylinders used for the radio.*

3. Cut the sandpaper into small squares.

4. You may want to cut the radio cardboard bases to size (25 cm x 12 cm) yourself to save time in class. Heavy poster board can be used. Cardboard boxes work the best, but they are sometimes difficult to cut through.

5. Copy the "Radio Technology" worksheet, the "Building an AM Radio" directions, and the "How Does a Radio Work?" description for each student. Organize these pages into booklet form before distributing them.

6. Build a radio yourself, so students can use it as a model. Also, you will experience for yourself the problems that they will encounter when they build theirs. Check the troubleshooting guide if necessary.

7. Layout the materials for students in a centrally located place where students can easily access them. Place your model radio where it can be seen by everyone.

8. Arrange the room so that there is a flat work surface for each student group. Arrange a storage area for the partly completed radios.

9. Hang a wire out a window as an antenna that students can hook onto (attach it to a tree outside the window, if possible). (This main antenna is not needed until the day students actually test their radios.)

Classroom Action

1. **Directions.** Divide the class into teams (or ask students to work individually). Each team will make one radio. Decide whether or not students will keep the radios when this mission is completed. If students will be keeping them, each group decides who will get their radio. Hand out a "Building an AM Radio" booklet of directions to each student. It is very important to allow time for teams to read through the complete set of directions before starting. Take a few minutes to tell students about the strategy of marking off each direction with a highlighting pen as it is completed. The highlighting allows students to see what has been done and to go back and reread if necessary. Students should not use a pencil or a pen to cross out the instructions.

2. **Activity: Building the Radios.** Direct students to gather their equipment and begin construction of their radios. It may take between three and four class periods for all students to complete their radios. Encourage students to work carefully, and not to rush to finish quickly. As students are building their models, remind teams to troubleshoot their hookups frequently by checking with and comparing their radios to the classroom model that you have built. Give each team a grocery bag and ask them to write their names on it. All their materials, including the radio building instructions, can be placed into the bag for safekeeping between class periods.

3. **Activity: Testing the Radios.** When students are ready to test their radios, the radio signals will be very faint, as these radios do not have any circuitry to amplify the signal.

4. **Worksheet.** Hand out the "Radio Technology" worksheet to each student. The directions will require them to make measurements from the base of the radio to the bottom of the variable capacitor. Sliding the variable capacitor up and down will change the stations. This measurement helps to ensure that students are indeed listening to different radio stations and not just tuning in to the same one that they were listening to earlier. Instruct students to complete the worksheet. A fun activity is to see which team of students can find the most stations with their radios. This is easier in urban areas where there is an abundance of AM radio stations. No doubt students will wish to share their joy in finding a radio station by asking you to listen to their radio, which is a good way to verify that they are picking up a radio station.

5. **Discussion.** Take some time to talk to students about how their radios work. Hand out the "How Does a Radio Work?" description to each student. Give students time to read the description before the discussion so they can be knowledgeable about the functions of the different parts of the radio and how radios work in general.

Going Further

Activity: Radio Stations

After students have listened to radio stations on their receiver, challenge them to find the locations of the transmitters for the stations. These locations might be illustrated on a map. As a follow-up activity, take the class on a field trip to visit a radio station and its transmitter.

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Radio Technology–Teacher's Key

1. The power or energy comes from electromagnetic waves traveling through space and passing through the antenna. These waves are generated by the station transmitter, which gets its power from a power plant. The station modulates the electricity in the transmitter, which creates and modulates electromagnetic waves so that they carry a signal.
2. The reception should be better if there is less obstruction by buildings and hills, or if there is less interference caused by electrical devices that produce electromagnetic waves, which interfere with the waves coming from the station transmitter. When indoors, the metal framing in the building may screen out radio waves, making reception difficult.
3. It may work better or worse depending on the type of interference that is contributed to the circuit. If your body provides constructive interference for the electromagnetic waves in the air, or acts as an additional antenna, then your radio will receive better when you press your fingers on the connection point. If your body provides destructive interference then you will not be able to receive signals as well when you touch the connection point.
4. Because the wires connecting the various components of your radio are quite long, they can act as a small antenna, so you may still receive stations even without a long "real" antenna.
5. No, because the circuitry is measuring differences in amplitudes between the electromagnetic waves in the air and the base level (ground); if you are not well connected to the ground, your radio will have trouble detecting any differences.
6. Your radio is actually receiving electromagnetic waves that are modulated in amplitude by the station transmitter. The change in amplitude of the wave contains the "information," and that's why it's called amplitude modulation, or AM radio.
7. You cannot hear radio waves in the room because your eyes and ears do not detect electromagnetic waves at radio frequencies. The radio device transforms the electromagnetic waves into sound waves, which can then be detected by your ear. Radio waves are just like infrared light, which your eyes and ears also cannot detect, except that radio waves have longer wavelengths than infrared. Your skin can detect infrared, as it feels warm. However, we cannot detect radio waves with any of our senses.
8. The carrier is a radio wave sent out at a certain number of cycles per second (*e.g.*, 810 or 1400 kilohertz). It is the pure radios tone.
9. By modulating the carrier, it is possible to add information to the radio wave, which is then picked up by a radio receiver and transformed into audible signals (music and speech).
10. Answers will vary from school to school. A sample answer is found in Table 8.1.

Table 8.1.

#3	**1 cm**	**Next to window**	**101.5**

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