Mission 11
Do You Get the Message?

What Are Those Extraterrestrials Trying to Tell Us?

Notes

In Mission 1, students learned that a message would be received in a later mission but they did not know where it would be coming from, or what it would say. In Mission 10, students received the promised message and learned where it came from.

Overview

In Mission 11.1, students decipher the simulated message that has just arrived from deep space. In Mission 11.2, students respond to the message–they choose their response and how to send it. This mission includes a review of the “Big Ideas” from *Project Haystack*, providing an opportunity for students to synthesize and express what they have learned about communicating across the vast dimensions of our Milky Way Galaxy.

Mission 11.1
Materials

For Each Team

- Scissors
- Tape
- *(optional)* Calculators
- *(optional)* Electric motor or other electric device
- *(optional)* Student-built radios from mission 8

For Each Student

- “Background Information and a Practice Message” sheet (pages xxxxx)
- “Decoding the Message-Directions” worksheet (page xxx)
- A Message for Earth” sheet (page xxx)
- “Summary Questions” worksheet (page xxx)
- Pencil

Getting Ready

1. Copy the sheets “Background Information and a Practice Message” and “A Message for Earth” and the worksheets “Decoding the Message” and “Summary Questions” for each

student. Make extra copies of the sheet “A Message for Earth” in case teams need to start over.

2. Work through this activity on your own before you have students do it.

Classroom Action

1. **Discussion.** Hand out the “Background Information and a Practice Message” worksheet to each student. Go over this background information with students. From Mission 10, review which star had evidence of an extraterrestrial signal and how far away the star is in light-years.

2. **Activity: Practice Message.** Divide the class into teams of two to four students each. Tell students that before they begin deciphering the longer, simulated message, the class will work on the practice message in Figure 11.1, which contains 35 bits of information. For this simulation, explain that the radio telescope was aimed at the star Tau Ceti and was tuned to a single frequency. An observer listening with earphones heard this signal loud and clear above the static, and wrote down the pattern. He wrote a white dot whenever a short tone was heard and a dark dot whenever he heard a long tone. The signal continued for several hours, repeating its pattern of 35 short and long tones until it suddenly went off in mid-pattern.

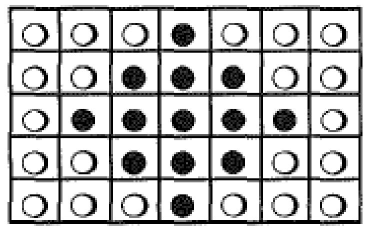
   Have someone sound out the pattern of short and long tones so that the class can hear what the observer heard in this simulation. The challenge for the extraterrestrial senders and the human receivers is to convert the string of tones into something that both can understand, even though they have no common language. This exercise shows a scheme devised by SETI researchers for reading such strings of data. Students should use the paper copies of the practice message on their sheets. Give students two copies of the same message so that they may experiment with several arrangements of the data.

Figure 11.1–A Simple Message.

Hints: How many dots are there? *(There are* 35.) Is there anything special about this number? *(It is a product of two prime numbers, 5 and* 7.) Can you arrange them in a way that would make sense other than in a straight row? *(Yes.)* Go ahead and try other ways of arranging this series of dots. You have two sets so that you can try both ways. The practice message will look like figure 11.2 after it is decoded in both of the possible ways.

Teacher’s Note: *A prime number is an integer which can be divided evenly only by itself and one.* 1, 2, 3, 5, 7, 11, 13, 17, 19 ... *are prime numbers.* 4, 6, 8, 9,10,12,14,15,16,18 ... *are not.*

Figure 11.2–A Simple Message Decoded.



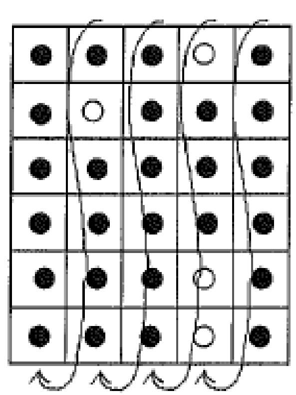
Teacher's Note: *Data is arranged into rectangular arrays to look for picture messages. But rectangles can have many dimensions. A data set of 24 bits could be arranged six different ways:* 2 x 12, 12 x 2, 6 x 4, 4 x 6, 8 x 3, 3 x 8. *A longer data string would have many other possibilities, unless the length of the string (e.g.,* 35) *is the product of two prime numbers* (*5 x 7 or 7 x 5*). *Then, there are only two possible rectangular arrays for the data which makes decoding the message much simpler.*

Optional: It is possible to have students receive the practice message data to solve the puzzle with the radios they made in mission 8. Set up an electric motor or other electric device such as mixer. Turn it on for long and short amounts of time, such as in Morse code, to simulate strong and weak pulses of radio energy. Students listen to the stream of data, write the long and short dashes, and solve the message puzzle as it is outlined on their sheets. Allow students to work on this practice message exercise with minimal help. This independence will be critical when it comes to the longer, simulated message.

3. **Activity: Real Message.** Hand out the worksheets "Decoding the Message" and "Summary Questions" to each student. Inform students that the signal–the wake-up call–information was received in a linear fashion, like a long line of data. Tell them that this signal arrived a day after the practice message wake-up call. Their first message was so short that it was already one line of data when they first saw it. Therefore, the first thing that students must do is rearrange the information in a long line, as shown in figure 11.3.

   Show them how to cut and line up the columns of data. The top of each column attaches to the bottom of the preceding column. Advise students to tape as they go along or they could become easily confused.

Figure 11.3–How to Arrange Data.



Once students have all the information in one long chain, they can begin to cut apart the signal data and rearrange it. Urge students to assemble the data very carefully. A sloppy job will not be useful in eventually interpreting the signal. Students are now ready to work on the longer, simulated message. This one will be considerably more difficult for students.

The bits of information can be placed horizontally or vertically in a rectangular array. Your students may express considerable discomfort in not knowing which arrangement is correct. Encourage them to explore both possibilities. Perhaps two teams can collaborate. One team can do it one way, another team another way, and then they can look at both together.

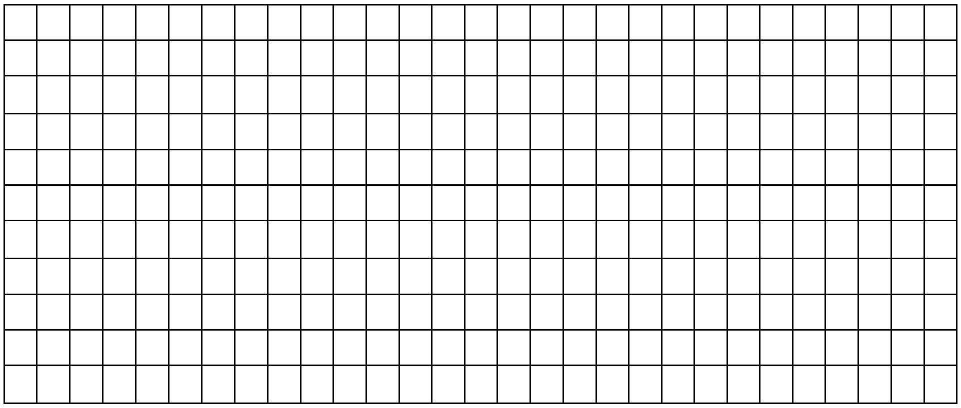
When the data are assembled correctly, one way shows a definite pattern of strong pulses and most students will come to agreement on one particular arrangement over another.

4. **Discussion.** If students become stuck, engage them in a discussion of how to arrange the 319 bits of information. Since 319 is the product of two prime numbers, they have two arrangement choices: 29 x 11 or 11 x 29, as shown in Figure 11.4. You will most likely need to lead a discussion about prime numbers or prod students into the direction of thinking in terms of prime numbers. This is where calculators can come in handy.

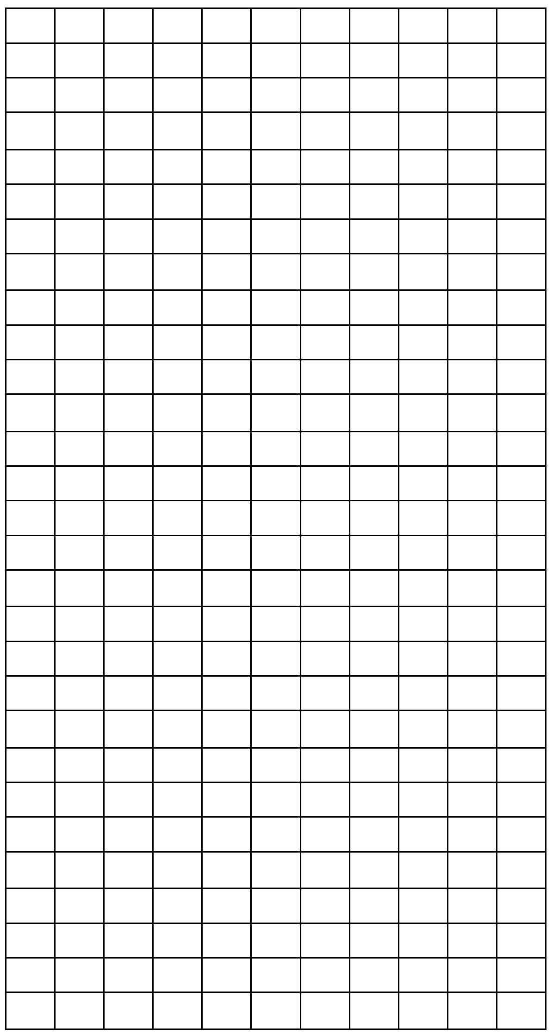
Teacher's Note: *If your students are at a higher level of mathematics and thinking skills, let them work on their own to figure out this message without clues about prime numbers.*

Figure 11.4–Prime Number Arrangements.

11 x 29



29 x 11

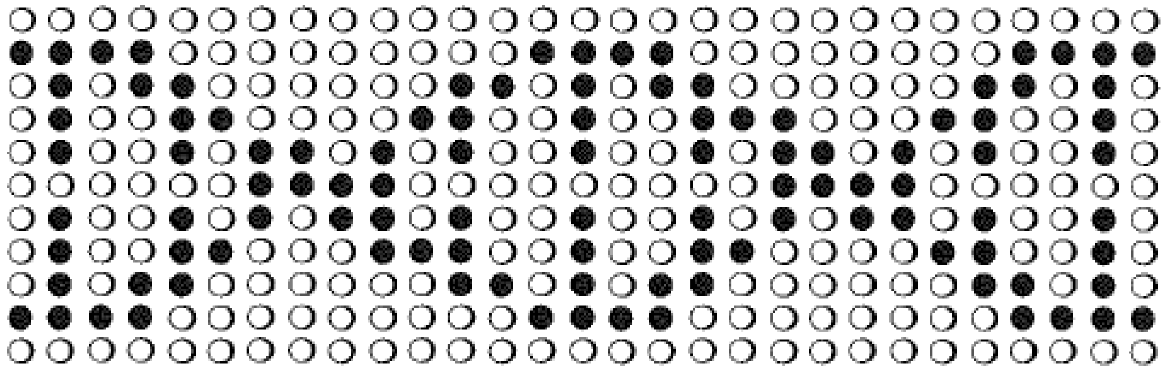


Once done, ask students to attach their assembled message onto a piece of white paper. Have them answer the questions on their worksheets.

5. **Display.** Have teams display their work and report their findings to the rest of the class, including an interpretation of what they think the signal means. When the data are all assembled, the solution will look something like Figure 11.5.

   The meaning of this "message" can be interpreted in several different ways: the DNA molecule, an hourglass, a test pattern, and so forth. Let students come up with their own interpretations! Do not let your students view this answer page.

Figure 11.5–The Decoded Message.



Mission 11.2
Materials

For a Class of 30

- *Project Haystack* "Big Ideas" chart on butcher paper.

For Each Student

- Graph paper
- "Sending a Reply" Directions (page xxx)
- Pencil

Getting Ready

1. On a sheet of butcher paper, make a chart of the *Project Haystack* "Hey, What's the *Big Idea?"* pages (pages xxxxxx).

2. Copy the "Sending a Reply" directions for each student.

Classroom Action

1. **Discussion.** Review with your students the “Big Ideas” that have been investigated during the last 10 missions. Record these ideas on large sheets of butcher paper that students can refer to as they work their way through Mission 11.2. An alternative is to pass out “Big Ideas” sheets to each team (copy the ones provided for you here in the guide) or post them in the classroom.

2. **Worksheet.** Hand out the “Sending a Reply” directions to each student. Go through the directions with the class. Make sure students have a clear understanding of how you plan to evaluate their projects–students need to know your expectations ahead of time. Give students time in class to construct an organizational plan. Assist them with planning their projects. Give a clear deadline for when you would like to have their projects presented to the class.

3. **Self-Evaluation.** Have students respond to themselves and what they wrote on the butcher paper in Mission 1 about the ways we would be affected by a signal from an extraterrestrial intelligence and the ways we would try to communicate. If students did the “A Letter to Yourself” activity in the “Going Further” section in Mission 1, have them open the sealed envelopes and read the letters they wrote earlier. Have their ideas changed since then? In what way?

Going Further

Activity: Secret Messages

Challenge students to devise and send actual messages to one another using the binary code they have just learned to interpret. Can they devise a way to send pictures? Messages written in English (*i.e.*, send letter shapes)? Can they send a message that expresses mathematical concepts?

Activity: Color-Coded

Have students devise a method to construct and transmit a three-dimensional image, or a color message. Would they transmit several single layers of an image (which could then be recombined to form a three-dimensional image), give vertical values for a two-dimensional grid, or devise some new approach? One approach to color images that was used on the *Voyager* record was to include three separate layers–red, green, and blue–which can be combined to form a single color picture.

Research: War

Have students investigate the history of cryptography, code, and communication theory to further their understanding of the complexities of sending messages. One fertile topic is warfare. How did the Allies break the German codes? The Japanese codes? What effect did codes and code breaking have on world history?

Mission 11
Do You Get the Message?

Summary Questions–Teacher's Key

1. Answers will vary. Accept all reasonable attempts.

2. Answers will vary. Accept all reasonable attempts.

3. For Tau Ceti, it would take 11.9 years. Because the signal is an electromagnetic wave (radio), it travels at the speed of light; so, the travel time of the message is the distance to this star in light-years.

4. The reply will take the same amount of time that the original message took to get here because it travels at the same speed (the speed of light) along the same path.

5. Answers will vary. Accept all reasonable attempts.

6. Answers will vary. Accept all reasonable attempts.

Project Haystack
The Search for Life in the Galaxy

"Hey, What's the *Big Idea*?"

Big Idea One

It is difficult to send a message that conveys an intended communication. **Missions 2 and 11**

Big Idea Two

Sending a probe across space as a messenger takes a lot of time, and uses vast amounts of energy. **Missions 2, 3, and 4**

Big Idea Three

Parallax makes it possible to calculate the distances to the closest stars by using simple geometry: the closest stars appear to change their position against the background of stars that are the farthest away. **Mission 3**

Big Idea Four

There are inherent difficulties in communicating across the vast distances of interstellar space. **Missions 3, 4, 10, and 12**

Big Idea Five

Electromagnetic radiation, which includes light and radio waves capable of carrying vast amounts of information, is the fastest thing that we know of, moving at 300,000 km per second, or 186,000 miles per second. **Missions 4, 8, and 10**

Big Idea Six

It seems to make sense that we should listen to stars that are in our more immediate stellar neighborhood (out to a distance of 200 light-years or so) for two reasons: transmitted signals get weaker over greater distances, and the time that it would take for a reply equals the distance to the source in light-years. **Missions 4 and 9**

Big Idea Seven

The Milky Way Galaxy has many varied objects within it, such as stars, nebulae, and star clusters, as well as our own solar system. The distances between the stars and the size of the Milky Way itself is enormous. **Mission 5**

Big Idea Eight

We can tell if a star may have planets by looking at the Doppler shift of its spectral lines at several different times. **Mission 6**

Big Idea Nine

The elements that occur on Earth can also be found in the stars, nebulae, and other objects in our universe. **Mission 6**

Big Idea Ten

We can gather information about places we can never go to by using tools such as the telescope, the radio receiver, and the spectroscope. **Missions 6 and 7**

Big Idea Eleven

Some star systems are more likely to have planets around them, and therefore are more likely to have developed intelligent civilizations. We prefer to concentrate our listening time on these star systems. **Missions 6, 7, and 10**

Big Idea Twelve

A radio receiver such as a radio telescope allows us to pick up signals that are present in space. Using radio waves could be an important means of communication between the stars. **Mission 8**

Big Idea Thirteen

A transmitter that has sent a signal might be so far away that the signal will be weak and difficult to pick up. **Mission 9**

Big Idea Fourteen

It is difficult to separate a nonrandom signal from the surrounding noise that is always present. **Missions 9 and 10**

Big Idea Fifteen

It is difficult to decipher an intended meaning from a received signal. **Missions 11 and 12**