## Sending Pictures With Waves-4 ${ }^{\text {th }}$ Grade

| NGSS | 4-PS4-3. Generate and compare multiple solutions that use patterns to transfer <br> information. [Clarification Statement: Examples of solutions could include drums <br> sending coded information through sound waves, using a grid of 1's and 0's <br> representing black and white to send information about a picture, and using Morse <br> code to send text.] |
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| CCSS:M | 4.OA.B.4 Find all factor pairs for a whole number in the range 1-100. Recognize <br> that a whole number is a multiple of each of its factors. Determine whether a given <br> whole number in the range 1-100 is a multiple of a given one-digit number. <br> Determine whether a given whole number in the range 1-100 is prime or <br> composite. |

## Background

All of our TV, computer, and cell phone images are composed of tiny picture elements called "pixels." The more pixels there are the sharper the image. For example consider the following images of the same photo, but made with fewer pixels on the left and more pixels on the right.


You can use a high power magnifier to see these on your own computer or TV screen. You'll notice that each pixel is made of up of three tiny colored dots that make up all colors in the image. (What colors are they?)


Radio Telescope: Wikipedia Commons

## Context

SETI, the Search for Extraterrestrial Intelligence, is a scientific research project in which scientists "listen" for radio or light signals that might be sent by other intelligent beings in the universe. One of the search strategies is to figure out how a string of dots and dashes, or ones and zeros, could be interpreted as a picture-perhaps of the life forms themselves. Such a string could be made visible if the ones were dark pixels and the zeros were light pixels. But how would we know when one line ends and one begins?


Dr. Jill Tarter, Chief Scientist, SETI Institute
courtesy of SETI Institute

That puzzle was solved by scientists at the Search for Extraterrestrial Intelligence (SETI) Institute who realized that other intelligent beings might share our understanding of mathematics. If so they would know the concept of prime numbers. If the entire message consisted of a multiple of two prime numbers, then one of the numbers could be rows and the other columns. The output shows the results of a message that was 77 characters long. 77 is the product of two prime numbers, 7 and 11 .

Color the cells with 1 s in them to see the image.

| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Task

Your task is to work with team-mates to decide on a method of sending a string of 35 ones and zeros, using sound, light, or some other method of sending a message across a large room. ( 35 is the product of two prime numbers: 7 and 5.) Then you will divide your team in half and go to opposite sides of the room. Each team will use a $5 \times 7$ grid to make up a message to send to the other half of your team. To practice you might start with a smaller set, say 15 characters making up a grid of $3 \times 5$ pixels.

Here's a $3 \times 5$ practice grid.

|  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- |
|  |  |  |  |  |
|  |  |  |  |  |

