Name of lesson- **Waves Within Space**

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Where lesson was found (if personally created, write "self")- self

Grade level band (K-2, 3-5, 6-8, 9-12, 12+, informal)- 3-12

State/national standards (if not NGSS, which state is the standard from) *NGSS DCI PS4.A- Wave Properties*-
Elementary- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks)
Middle- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude; A sound wave needs a medium through which it is transmitted
High- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

Time needed for lesson (time to prep/time to teach)- 15 minutes

Supplies required per person/group/class (please specify)
- Copy of ISS and Satellite worksheet (below)
- colored pencils, crayons, or markers

Video of this lesson can also be found at ARISS-USA.org under Educational Resources (Waves within Space)

Directions -

1) Make sure everyone has a copy of the activity sheet (either paper or digital in Google Paint or a similar program)

2) Start by explaining that waves can be found everywhere, even if we can't see them.
   Ex. Ocean waves, sound waves, light waves

3) Demonstrate that all waves work in the same way as ocean waves. Using a Slinky or some rope, demonstrate how sound waves work the same way as ocean waves. The Slinky or rope just helps us see the waves.

4) Using the Slinky or rope, show that the SIZE of waves can change. These changes are a function of the type of waves. You can also discuss amplitude and frequency wave differences.
   Ex. Sound waves that we can hear are from as long as 17 meters to as small as 17mm. Any wavelengths above or below this create sounds that are either too high or too low for humans to hear.

5) On the worksheet, and using the color code, color a wavelength of 2m from the Earth to the ISS. The amplitude (half of the wave) should be about the length of the person standing on the Earth.

6) From there, we can determine the wavelength of the sound wave range that humans can hear. Students use the color code to color in the possible wavelengths for humans to hear from person to person on the Earth (the first 2 on the worksheet in the data table). The highest tones will look almost like a straight line, whereas the lowest tones will only show about the first ⅓ of the amplitude, due to the wavelength being 17 meters long. Explain that these sounds are traveling the speed of sound.

7) Explain that computers can use different wavelengths to communicate. Using a radio, we can send waves into space. These waves travel at a different speed (the speed of light). The International Space Station is 250 miles above the Earth. The sound from the radio wave can send a sound across the sky to talk to astronauts at that distance.

8) Have students use the color code to color in different waves to the satellites.Similar to the sound waves, the wavelengths will have pretty tight and small amplitude, but should be more identifiable than the sound waves from person to person.

Wrap Up

Waves can be many different sizes and the information the waves carry could be both voice and computer data. We may not understand the computer data since we aren't a computer, but different waves can carry different types of information.

Additional Information

ARISS (Supports Voice and Low rate telemetry--Packet):

Band	Frequency	Wavelength (SI units)	Wavelength (English Units)
VHF	145.80 MHz	2 meters	6.5 feet

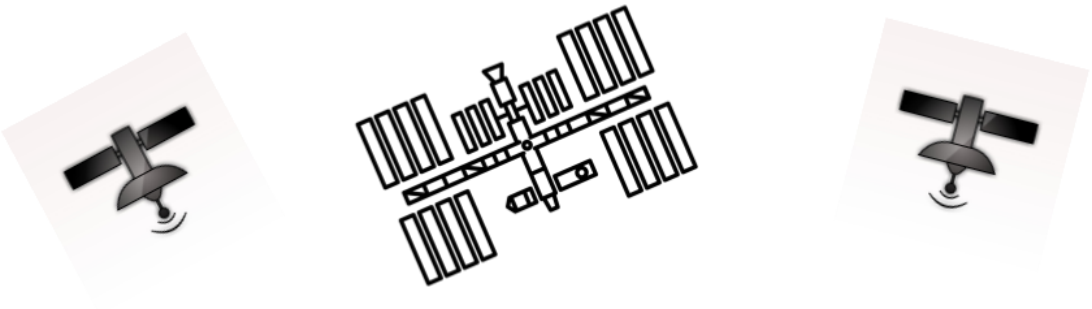
NASA/satellites Communications (Supports Voice, Video, High Speed Telemetry)

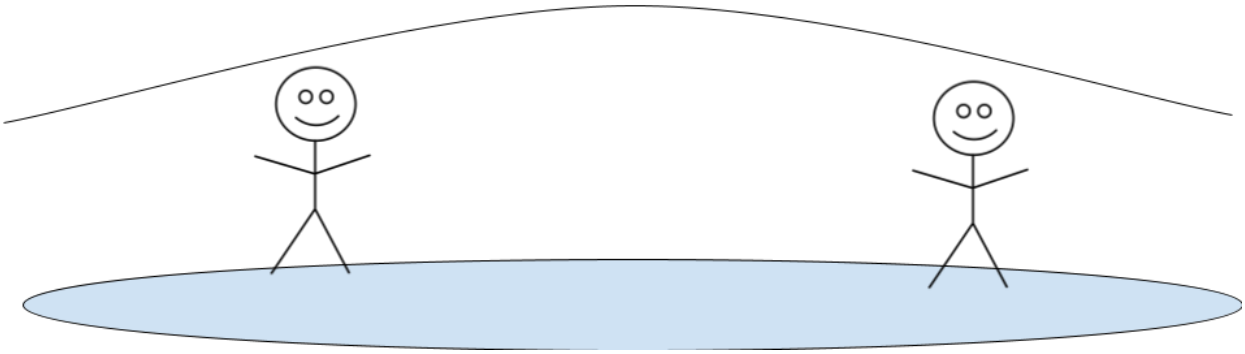
Band	Frequency	Wavelength (SI units)	Wavelength (English Units)
S-Band	2200 MHz	13.6 cm	5.3inches
Ku-Band	15,000 MHz	2 cm	0.8 inches

Humans hearing range at sea level and 60 degree Fahrenheit

	Frequency	Wavelength (SI units)	Wavelength
Lower limit	20 Hz	17m	56 feet
Higher limit	20 kHz	1.7cm	0.67 inches

Waves Within Space





Traveling Medium	Type of information carried	Frequency of wave in Hz (Hertz)	Length of wavelength	color
Sound wave - speed of sound	Sound- lowest tones	20 Hz	17 meters	red
Sound wave - speed of sound	Sound- highest tones	20,000 Hz	1.7 centimeters	blue
Radio wave - speed of light	Voice (radio- ARISS)	145,800,000 Hz	2 meters	green
Radio wave - speed of light	Voice & video on S-band (NASA/satellites)	2,200,000,000 Hz	13.6 centimeters	orange
Radio wave - speed of light	Voice & video on Ku-band (NASA/satellites)	1,500,000,000,000 Hz	2 centimeters	purple