Science **SCI.IV.4.6**	**Grade: 7**

<u>Strand IV :</u> **Using Scientific Knowledge in Physical Science**

<u>Standard 4:</u> **Waves and Vibrations - All students will explain how waves and vibrations transfer energy.**

<u>Benchmark 6:</u> **Explain how mechanical waves transfer energy.**

Constructing and Reflecting:
SCI. I.1.1 - Generate scientific questions about the world based on observation.
- Construct questions for each of the investigations suggested below to guide the design of the investigation.

SCI.I.1.2 - Design and conduct scientific investigations**.**
SCI.I.1.5 - Use sources of information in support of scientific investigations.
SCI.II.1.3 - Show how common themes of science, mathematics, and technology apply in real-world contexts.
SCI.II.1.4 - Describe the advantages and risks of new technologies.
SCI.II.1.5 - Develop an awareness of and sensitivity to the natural world.

Vocabulary/Key Concepts	**Context**
• sound energy • absorption - energy that is taken in by the matter. • transmission - transfer of energy from one molecule to another through a medium. • reflection - the bouncing back of energy media: • air • solids • water See <u>IV.1.MS.6</u> Electrical circuits transfer electrical energy	Waves in slinkies and long springs • sound waves • water waves • earthquakes

Knowledge and Skills	Resources
Students will: • Identify a mechanical wave. • Explain how a mechanical wave transfers energy. Energy is transferred in mechanical waves via a medium (e.g., slinky, water waves, the Earth's crust as a result of an earthquake) when molecules of matter bump into each other and transfer their energy. Matter interacts with energy by absorption, transmission, or reflection. (Resources continued from column on right) **Videoconferences Available** For more information, see www.remc11.k12.mi.us/dl or call Janine Lim 471-7725x101 or email jlim@remc11.k12.mi.us **IV.4.MS.6 Students will identify the components of a radio wave and create waves in different frequencies** *Sounds of Science* from COSI Toledo *Wave Watch* from Louisville Science Center	Coloma Resources: Sound & Light – Chapter 1 & 2 Labs: Making Waves – Pages 30-31 The Speed of Sound – Page 45 Musical Notes – Pages 60-61 • Physical Science Activity Manual –book written by a group of teachers using the learning cycle and 34 activities to teach physical science. Excellent resource! • ExploreLearning – Waves, sound, and light – excellent site – free preview, but requires subscription. • NASA Explores – Wave Lesson • NASA Explores – tons of science articles with complete lessons. Excellent!! • DiscoverySchool – The Phenomenon of Sound – Waves • The Exploratorium – Science Snacks about Waves • Michigan Teacher Network Resources • How Satellites See– excellent interactive learning! – from UC Berkeley Center for Science Education • Smile Physics Program – Waves, Sound and Optics - Illinois Institute of Technology • Science Explosion: Waves and Vibrations • Bill Nye: Eyeball, Light/Color, Light/Optics, Sound, Waves

<table>
<tr><th>Instruction</th><th>Assessment</th></tr>
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Focus Question:
How is energy transferred through a medium?

Teacher is to decide on whole group or small group instruction.

Stretch a Slinky across the floor and quickly push the Slinky forward and pull it quickly back to its original position. Describe the motion of the coils in a Slinky. NOTE: put 3 pieces of tape on different places on the slinky and have students describe how the pieces of tape move. Repeat this motion and have the students watch the movement of the wave through the entire Slinky (reflection) and how the coils interact with one another to produce the wave.

Each student will write a lab report that includes answers to the following questions:

- How is the energy transferred from one end of the slinky to the other (collision of one coil into another)?
- What do the coils represent (the particles of matter in a medium)?
- How is this movement like an earthquake wave?
- How is this movement like a water wave?
- How is this movement like a sound wave?

Extended Activity: Have students research the use or effects of waves in real-world situations, such as the new technologies used in building earthquake-resistant buildings, ultrasound, lithotriptor, sonar, etc.

Appendix Activity - Physical Science Waves - Hamming It Up On ISS – AWESOME!

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<u>Optional Assessment</u>

Using their bodies as particles, students will work in groups of six to eight to prepare demonstrations showing how a mechanical wave can be transmitted from one person to another. Each group will present to the class.

(Give students rubric before activity.)

Scoring Rubric
Criteria: Accuracy of demonstration
Apprentice - Interprets some information correctly. (Particles move too much or not enough to transfer energy.)
Basic - Provides an interpretation with some understanding of how the particle motion is related to the transmission of the wave's energy. (Particles move back and forth while their position changes only slightly.)
Meets - Provides a correct interpretation of how the vibration of the particles of matter transmits the wave's energy. (Particles move back and forth while their position changes only slightly, causing the wave to move from one end of the chain to the other.)
Exceeds Provides a thorough and accurate interpretation of a mechanical wave continuing to transfer energy as the source of the vibration causes the particles of matter to continue to vibrate. (Particles move back and forth while their position changes only slightly. The wave moves from one end of the chain of students to the other and back again.)

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Teacher Notes:

• "Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials" (BSL). These waves transfer energy by setting the material (medium) in vibrating motion. The strength of the motion is in the amplitude of the wave; the speed of vibration is its frequency.

Focus Questions

- What is a vibration?
- How do vibrating objects move?
- How do mechanical waves transfer energy?

Notes

The state benchmarks are very deliberately constructed to take students through these topics sequentially and developmentally. For example, students do not talk about sound and light as waves until the high school benchmarks – they only look at vibrating objects and mechanical waves such as those in slinkies or on water in middle school. They recognize sound as produced by vibrations at the elementary level; they study the motion of vibrating objects at the middle school level; and they apply the concepts of vibrations to sounds at the high school level.

Physical Science
Waves

Hamming It Up On ISS

OBJECTIVE: Students will identify the components of a radio wave and create waves in different frequencies.

Grade 7: SCI.IV.4.MS.6

BACKGROUND:

Transverse waves cause the particles of a medium to move perpendicular to the direction of the wave. In a Slinky, the spring is displaced up and down at right angles to the motion of the wave. Waves in piano and guitar strings are examples of transverse waves. A longitudinal wave causes the particles of a medium to move parallel to the direction of the wave. The displacement of the spring is parallel to the motion of the wave. A sound wave is an example of a longitudinal wave. Fluids - either liquids or gases - transmit only longitudinal waves.

GUIDELINES:

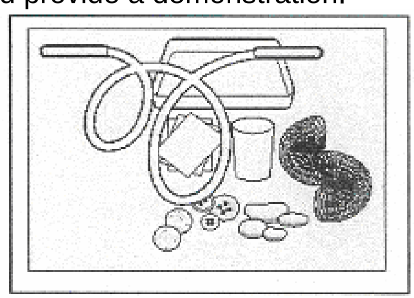
- Read the NASA explores article, "Hamming It UP ON 155." Discuss the use of the amateur radios and how they are being used to communicate to astronauts.
- After dropping water in the pan, guide students to observe the wave that has been created as it moves outward along the surface of the water in expanding circles. "
- Explain how the Slinky represents waves and how students might look at different frequencies. Guide students to understand that faster movement corresponds to higher frequency and shorter wavelengths.
- Show a chart of the electromagnetic spectrum. Discuss the different forms of waves contained in the spectrum. Discuss the size of the wavelengths and the energy of each type of wave.

EXTENSIONS:

- Have interested students contact a local ham radio operator or local amateur radio club to learn more.
- Invite a ham radio operator to speak to your class and provide a demonstration.

MATERIALS NEEDED:

- Glass, plastic, or metal pan
- Water
- Eye dropper
- One slinky per group of two; or
- One short rope or jump rope
- Data collection sheet



PROCEDURE BACKGROUND INFORMATION:

When Heinrich Hertz first demonstrated radio waves in 1886, he found the source of al waves was something that vibrates. Radio waves vibrate at the lowest frequency and have the longest wavelengths on the electromagnetic spectrum. Radio waves are electromagnetic waves that originate form the vibration of electrons. Sound waves are not electromagnetic waves, but a mechanical vibration of matter. So even though we hear a radio by means of sound waves, radio waves and sound waves are not the same.

Electromagnetic waves are classified according to their frequency. Waves all move, or vibrate, at the same speed ("c" for constant), but differ in their frequency. The frequency is how often a vibration occurs. This unit of frequency is called a hertz (Hz). Thus, the speed of a given wave is measured in meters per second.

A **wavelength** is the distance, measured in meters; a wave travels through space in a single cycle. It can be measured from any point along the wave as long as it is consistently measured from the same point. The speed of the wave is equal to the frequency times the wavelength. The amplitude of a wave is the maximum displacement on either side of the midpoint of a wave. The midpoint is the point at which the wave is at rest.

A specific radio frequency is assigned to amateur radio operators when they are transmitting to space. All amateur radio operators, this includes those who operate for Space Amateur Radio Experiments (SAREX) missions, use a small portion of the frequency bands on the electromagnetic spectrum. Any amateur station that is located more than 50 km above Earth's surface is defined by the Federal Communications Commission (FCC) as a space station. Amateur satellites, the Space Shuttle orbiters, the Russian MIR Space Station, and the International Space Station all fall under this category.

CLASS ASSIGNMENT:

1. Predict what will happen when a drop of water is dropped into a pan of water, where the surface of the water is flat. Write predication on the data collection sheet.

2. Drop water from an eyedropper into the center of the pan. Write down your observations. What shapes were the waves that were created? How did the waves move? Were the circles evenly spaced?

3. Draw a picture of the wave. Label the crest, trough, amplitude, midpoint, and wavelength.

4. Stretch the slinky to about 1 meter on the floor (not carpet) or tabletop. (Do not overstretch.)

5. One student holds one end of the Slinky still.

6. Another student will move the other end slowly back and forth. Start slowly then increase the rate at which the Slinky is moved back and forth.

7. This time you and your lab partner will create equal-sized pulses at the same time from opposite ends of the Slinky. It may require some practice to get your timing synchronized. Try it both ways - that is, with pulses on the same side and then with the pulses on opposite sides of the line of propagation. Pay special attention to what happens as the pulses overlap. Record your observations.

Berrien County ISD Collaborative Curriculum
Data Collection Sheet

Name:_____________________________

Group Names:______________________

Date:________________________

1. Predict: what will happen when a drop of water is dropped into the pan of water?
2. Draw observations.
3. Written observations of Slinky.
4. Draw a picture of a wave and label.
5. Describe observations of equal-sized pulses.
6. Distinguish among the wavelength, frequency, and period of a wave.
7. What is the amplitude of a wave, and what does it measure?
8. What is the midpoint?
9. If you want to increase the wavelength of waves in a rope, should you shake it at a higher or lower frequency?
10. Distinguish between a mechanical wave and an electromagnetic wave.

11. When a wave crosses a boundary between thin and thick rope tied together, its wavelength and velocity change, but its frequency does not. Explain why the frequency is constant.

12. In step six, is the Slinky producing a transverse or longitudinal wave?

13. What did you learn from this activity?

ADDITIONAL RESOURCES:
Amateur Radio in Space
http://spacelink.nasa.gov/Instructiona.Materials/NASA.Educational.Products/Amateur.Radio.in.Space/Amateur.Radio.in.Space.pdf

Space Amateur Radio Experiment
http://sarex.gsfc.nasa.gov/

Hamming It Up On ISS
http://www.nasaexplores.com/show2_articlea.php?id=01-018