Science - - PHYSICAL SCIENCE GRADE 9

Unit 7: WAVES (3 WEEKS)

SYNOPSIS: In this unit students will discover the different types of waves and their affect on everyday life. They will explore generated waves as well as electromagnetic waves. At the end of the unit, students will demonstrate their knowledge of wave travel by predicting wave patterns or designing changes in a room to improve acoustics.

STANDARDS

II. ENERGY AND WAVES

C. Waves

1. Refraction, reflection, diffraction, absorption, and superposition occur as a result of a change in wave pattern.
   a. sound [energy], light, water, seismic energy all travel in waves
   b. the result of a wave encountering a new material is that the new material may absorb the energy of the wave by transforming it to another form of energy - - usually thermal energy
   c. waves can be *reflected* off solid barriers
   d. waves can be *refracted* when a wave travels from one medium to another medium
   e. waves can undergo *diffraction* around small obstacles or openings
   f. two waves traveling through the same medium meet, pass through each other, and continue as before
   g. waves that meet undergo *superposition* (i.e., constructive or destructive interference).

2. Radiant energy is measured on the electromagnetic spectrum.
   a. radiant energy travels in waves and does not require a medium
   b. sources of light energy radiate energy continually in all directions
   c. the electromagnetic spectrum exhibits the wide range of frequencies, wavelengths, and energies of radiant energy; the continuum of bands is radio (lowest energy); microwaves; infrared; visible light; X-rays; and gamma rays (highest energy)
      (1) the "bands" have different applications in everyday life (e.g., infra-red lights warming the food at McDonald's; sun burn is caused by ultra-violet rays; etc.)
      (2) rather than memorizing specific frequencies, students should understand the relative positions of the bands, including the colors of visible light, are important (e.g., ultraviolet has more energy than microwaves)
   d. the wave behavior of radiant energy depends on the nature of the medium (i.e., opaque/ transparent; rough/ smooth; and dull/ shiny)

3. The Doppler Shift involves the relative position of wavelengths, frequencies, and the observer.
   a. diagrams show how changes in the observed frequency and wavelength of a wave can occur if the wave source and the observer are moving relative to each other
      (1) toward each other = the wavelength is shorter, and the frequency is higher
      (2) away from each other = the wavelength is longer, and the frequency is lower
   b. explain how the universe was formed and is applied in other sections of the course

LITERACY STANDARDS: READING (RST) and WRITING (WHST)

WHST.3 Write precise descriptions of step-by-step procedures used in investigations so that another person could replicate and obtain the same results.

VOCABULARY:

Science Technical Words		
Refraction	❖ Amplitude	Radiant Energy
Reflection	❖ Wavelength	Doppler effect
Diffraction	❖ Frequency	Crest
Absorption	❖ Speed	Trough
Superposition	❖ Longitudinal	
Wave	❖ Compression	❖ Words from Grade 7-8
Thermal Energy	❖ Rarefaction	
	❖ Transverse	

Non-Technical Words
Encountering
Transforming
Barriers: solid – liquid
Medium
Undergo
Obstacles

VOCABULARY: Post words in room and leave up for the unit. Create a word wall where students know to look for new words.

Address roots and affixes of new words
Use a diagram to show meaning of new words
Relate the new word to a similar and/or familiar word
In the course of teaching, define the word in the context of where if falls in the unit rather than in isolation
Throughout the teaching of the unit, use the word in conversation/discussion
Require students to use the word(s) in: discussion, investigations, and in 2-and 4-point response questions
Use new words in Rubric for the Authentic Assessments

MOTIVATION	TEACHER NOTES
1. Teacher shows students how a wave moves by having students stand in a line with linked elbows; push on one student and the force goes all the way down the line - - a force carried from end to the other through a medium - - leads to definition of waves as a force traveling through a medium. (Note: if you did this in a previous unit, just reference back to the activity and stretch to waves) 2. Put on music, play for 30 seconds and ask students how the sound got to their ears? Have students explore turning the speaker down so they feel vibrations of music; play different styles of music and have students feel vibration. Next tap on table vs. pounding on table http://sunshine.chpc.utah.edu/labs/waves/wave_basics/wave.htm 3. Students establish both academic and personal goals for this unit 4. Teacher previews the Authentic Assessments for the end of the Unit	**Note: each class needs to have an Aquarium with tubing to show distortion and refraction**.

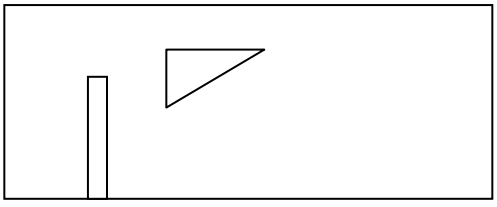
TEACHING-LEARNING	TEACHER NOTES
1. Waves: Tie force into waves: force = push/pull on physicsclassroom.com\class\waves and then focus on waves. **(IIC1a)** 2. Parts of a wave: "Anatomy of a Wave:" calculation: calculate speed of a wave: Speed = Frequency x Wave Length. Focus on key terms: crest, amplitude, equilibrium, trough, frequency, wave length. Students take notes with diagrams. **(IIC1a)** 3. Demonstrate with a slinky the different waves - - longitudinal and transverse (p. 362) and relate the earth quakes to waves. (Lab idea on page 364-365 of text) **(IIC1a)** 4. Next go to waves in water, showing creation of waves with a pencil in water. This shows different types of waves where each is a disturbance passing through a medium (physicsclassroom.com\class\waves is a good site). Show reflection off of barriers (break wall with waves crushing against it). **(IIC1a)** 5. Do the "**How Do Whales Hear" (attached on pages 5-7)** Do lesson activities; the purpose is not to focus on whales, but how the sound is moving. Students should be able to explain that sound energy travels in waves. Student text, p. 360 is a good source for vocabulary **(IIC1a)** 6. Teacher asks student to recall sitting at RR tracks as a train passed. How did the sound of the whistle	

TEACHING-LEARNING	TEACHER NOTES
change as the train passed? Ask students how the sound of a siren changed as it passed them. Have class discussion on these. Ask students to exchange ideas about why the differences in the sounds happened. Discuss the wave length of the sounds as they approach and as they pass and move away. **(IIC3)** 7. Use the following interactive animation to instruct students on the **Doppler effect**. **(IIC3)** http://molebash.com/doppler/home.htm Students discuss and interact with presentation and each other. The following site has information and ideas to enhance instruction for the Doppler effect. http://www.studyphysics.ca/2007/20/04_waves/53_doppler.pdf 8. Set up an aquarium of water with solid barriers set in a pattern. Use a force to create a wave in the tank and have students predict beforehand what will happen to the wave when it hits the barriers. They may draw their predictions in their notes. Complete the demonstration and have students compare their predictions to the actual result. Set a series of solid cylinders from the Density Kit in the water tank and create waves in previous demo and have student observe how the waves move around the obstacles (it bends around rather than reflect off of it. **(IIC1c).** 9. Using the aquarium, have two students create waves on each side of tank by hitting each side of the tank or disturbing surface of water with an object. Students predict what will happen and draw in notes; do activity and compare results to predictions. **(IIC1f)** 10. **Refraction:** Teacher does demo of pencil in water; ask students what they think will happen. Remind them they have done this in 5th grade; have them do bottles with straws and work in groups and look at the container from top and side. Students explain why the refraction happens, and discuss how when you look at something underwater, it is not where it appears to be; if they were to reach in to pick up something, they must take into account refraction. (Discovery education video on Archer Fish; teachers must first log on to Discovery Education) **(IIC1g)** http://app.discoveryeducation.com/player/view/assetGuid/7CD9D5A3-144C-48E8-911D-E02EEBE6EF32 Use prisms to show refracted light and formation of rainbows **(IIC1d)** Use **OGT released item on page 8** for Speed of Sounds in Solids 11. **Thermal Energy**; if students do not remember the following activity from the first unit, come back to this and repeat or review the activity: Students heat water to 80°C, and pour into glass containers, one covered with black paper and one covered with white paper; one container gets warmer (absorption). Another student sets up containers covered with felt and silk; students measure the temperature every 30 seconds to determine the heat loss and graph results. Students then use the graphs to compare heat loss in different types of containers. **(IIC1b)** **OGT question attached on page 9** 12. **Diffraction of Light**: View YouTube demo for this: youtube.com/#/watch?v=mNQW50ShMA&desk Students cut cardboard circle and make a diffraction grating; students explain why the grating works. **(IIC1e)** 13. **Superposition** (result when two waves meet) – waves that require a medium that meet undergo superposition http://youtube.com/watch?v=BWraEDaVXZM When two waves meet what can happen: crest-crest, trough-trough - - wave will increase in intensity. If they meet crest-trough, it cancels the wave; it they meet half way up, the size of the wave is diminished. Demonstrate this for students using the aquarium. Relate to seismic activity in earthquakes. Discuss the terms **constructive** - crest to crest of trough to trough gets larger, and **destructive** – the other examples listed above. **(IIC1g)** Use Physics Classroom video for constructive and destructive and use discussion questions on the site: http://www.physicsclassroom.com/class/waves/u103c.cfm 14. **Radiant Energy**: Electromagnetic Spectrum: Teacher discusses with students what Radiant Energy	

TEACHING-LEARNING	TEACHER NOTES
is - - energy of electromagnetic waves, and electromagnetic waves do not require a medium to travel. Students should state that sound, light, water, seismic waves all have to have a medium to travel. Use video on introduction to the electromagnetic spectrum; Introduction to electromagnetic spectrum video from NASA: http://www.youtube.com/watch?feature=player_embedded&v=lwfJPc-rSXw# Alternate link to EM video through NASA site -- in case YouTube link doesn't work. http://imagine.gsfc.nasa.gov/docs/science/know_l2/emspectrum.html After students view the entire video, go back and play segments and have students find standard that a segment covered in EMS-02 through 08. Give a group of students one of the videos and have them develop questions for a segment and other students answer the questions. **(IIC2a, b, c1,2)** 15. Students use flashlights and shine through different substances (mirrors, black paper, white paper, etc.); students use terms **opaque, transparent, rough, smooth, dull, shiny** to determine amount of energy before light hits it and if when the light goes through (relate to things in everyday life - - cold day, hot summer day color of clothing for summer and winter) **(IIC3)**	

TRADITIONAL ASSESSMENT	TEACHER NOTES
1. Multiple-Choice **Unit Test**	

TEACHER CLASSROOM ASSESSMENT	TEACHER NOTES
1. Teacher Classroom Assessments:	

AUTHENTIC ASSESSMENT	TEACHER NOTES
1. Students evaluate progress on their goals 2. Students are given a situation where there are echoes in a lecture hall or the gym at school and they are to identify ways to absorb the sound to prevent it from being garbled. Their solution must include what the changes are, what materials they would use, and why the changes would make a difference. A diagram may be included in addition to their written description. **(IIC1b) (WHST.3)** 3. Set up a wave tank with one half inch of water in it. Make a disturbance on the water's surface. Be sure the wave created moves over the surface and reflects back to the source of the disturbance. Adjust the depth of the water as necessary. Prepare a handout for students with drawings indicating the wave tank with several patterns of barriers in the path of the waves to be created. Ask students to hypothesize what the wave will do when it strikes the barriers. Any pattern of variables may be used. **(WHST.3)** For example:  Have students exchange papers and provide feedback to each other's hypotheses. After several moments, have students retrieve their papers. Go around as this activity occurs to make sure each student has clearly drawn their predictions. Teacher will create a disturbance in the tank and have students use a different color to draw the pattern of the wave as it actually occurred. This may be repeated for several examples.	

T-L #5 HOW DO WHALES HEAR?

Background Information for How Do Whales Hear?

Sound waves travel not only through the air (gas) but through solids and liquids too. Because of this, animals that live underwater can hear just fine, although their ear structures are different from those of land animals.

The Lesson

Have students plug their ears with their fingers. Turn your back to them and talk quietly. Then have them unplug their ears, and ask them the following:

- Could you hear me talking?
- Think about what you know about hearing. What are you preventing from happening by blocking your ears? (Sound vibrations are not reaching the ear drum/tympanic membrane.)
-

Give each student a copy of, “How Do Whales Hear?” handout. Teacher should focus on the movement of the sound, and not whale hearing. Teacher could briefly mention that the lab simulates how whales hear, but the focus should stay on sound movement.

What will students hear? A church bell sound (dong-dong)

What's going on? Hitting the spoon causes it to vibrate. These vibrations (or sound waves) are conducted up the string, through the fingers, through the bones of the skull and into the inner ear. Because the sounds are traveling through solids (instead of through air), they sound much louder and deeper than they normally would.
Have the students try a slight variation of the experiment: Tell them to put their index fingers gently into their ears, so that they **just barely** touch the bones surrounding their ear canals. Now have them hit the spoon on the desk. Discuss their observations.

What will they observe? They will feel the vibration passing from their fingers to their ear canal.

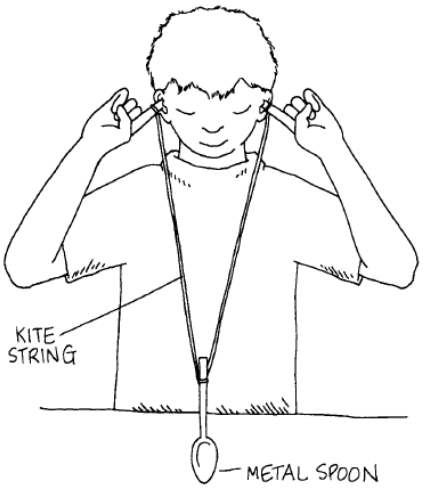
Discuss students' findings as a class. What conclusions can they make?

Make sure students understand that the ability to hear is due to one's ability to detect vibrations.

Have students repeat the experiment with different-shaped metal and wooden forks and spoons, and different types and lengths of string. Encourage them to mix and match materials to investigate the properties sound [pitch, volume, and timbre (sound quality)].

How Do Whales Hear?

Directions: Work with a partner to complete the investigation below.



1. Tie the handle of a metal spoon to the middle of a long (3-foot) piece of dental floss. Wrap one end of the dental floss around your right index finger, and the other end around your left index finger. Make sure the lengths of the two sides are equal.

2. Press the tips of your index fingers firmly over the opening of your ear canals. Stand next to a desk. Bend over so that the spoon is dangling down in front of you.

3. Make a prediction. What do you think you will hear when you hit the spoon on the side of the desk?
   Have your partner write down your prediction.

4. Now move your body so that the spoon swings and taps the edge of the desk. What do you hear? Record your observations.

5. Explain your findings. Why do you think you heard what you did?

6. In what way are your fingers in this experiment similar to the fat pads in a whale?

7. In what ways do they NOT model the fat pads in a whale?

8. How does the human ear normally detect sound vibrations?

Science

Use the table to answer question 7.

Speed of Sound in Solids

Solids	Density (g/cm^3)	Speed (m/s)
cork	0.25	500
brick	1.80	3650
glass	2.24	4540
stainless steel	7.90	5000

7. For the solids listed in the data table, which seems to be true about the relationship between the speed of sound and density?

   A. The speed of sound decreases as density increases.

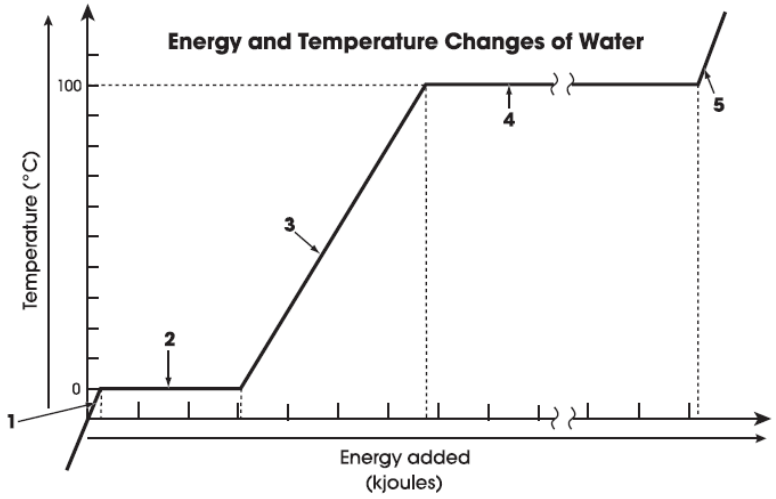
   B. The speed of sound increases as density increases.

   C. The speed of sound increases as density decreases.

   D. There is no apparent relationship between density and the speed of sound.

Use the information to answer question 22.

The following graph shows the change in temperature of a sample of H_2O, which begins as ice, as thermal energy is added.



22. Which region of the graph represents water (H_2O) in the liquid form only?

A. 1

B. 2

C. 3

D. 4