

Let's Do the Wave!

Grade Level or Special Area: 8th grade Science and Technology

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Length of Unit: Three lessons (11-14 45-minute class periods)

I. ABSTRACT

The focus of this 8th grade Science and Technology unit is a systematic approach to understanding the topic of Waves within Physical Science. In addition, technology components are included to enhance the understanding of the topics and fulfill the National Standards for Technology Literate Students. Hands-on activities, labs and tricks-of-the-trade will enhance "Let's Do the Wave!"

II. OVERVIEW

A. Concept Objectives (Colorado Model Content Standards for Science (CS), United States Content Standards for Physical Science (USCS) and National Performance Indicators for Technology-Literate Students (NPIT))

1. Students will understand the processes of scientific investigation and design, conduct, communicate about and evaluate such investigations. (CS1)
2. Students understand the interactions between Energy and Matter. (USCSB)
3. Students understand legal and ethical behaviors when using information and technology. (NPIT3)
4. Students will understand the process of using technology resources to demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)

B. Content from the *Core Knowledge Sequence –Science* (8th grade, p. 200)

1. Sound Waves
 - a. General Properties of Waves
 - i. Waves transfer energy by oscillation without transferring matter; matter disturbed by a wave returns to its original place.
 - ii. Wave properties: wavelength, frequency, speed, crest, trough, amplitude
 - iii. Two kinds of waves: transverse (for example, light) and longitudinal (for example, sound)
 - iv. Common features of both kinds of waves:
 - a) Speed and frequency of wave determine wavelength.
 - b) Wave interference occurs in both light and sound.

C. Skill Objectives

1. Students will participate in class discussion and take notes.
2. Students will observe and analyze observations.
3. Students will use problem -solving skills to invent solutions.
4. Students will formulate conclusions based on experimentation and write them in paragraph form.
5. Students will make hypotheses based on prior knowledge.
6. Students will use the scientific method to test hypotheses.
7. Students will use gross and fine motor skills to perform experiments.
8. Students will make connections between content learned in this lesson and daily life.
9. Students will apply these lessons to life situations.
10. Students will record and analyze data and observations.

11. Students will tabulate hypotheses and data.
12. Students will perform mathematical calculations using a calculator.
13. Students will use Microsoft Word to produce neat, complete final products.
14. Students will use interactive web sites to gain information.
15. Students will manipulate objects on the computer using the mouse.
16. Students will use the Internet to research problems.
17. Students will work cooperatively in groups.
18. Students will use video camera and equipment to produce a video.

III. BACKGROUND KNOWLEDGE

- A. For Teachers
 1. Kuhn, Karl F. *Basic Physics: A Self-teaching Guide*
 2. The Physics Classroom Physics Tutorial website:
<http://www.glenbrook.k12.il.us/gbssci/phys/Class/Bboard.html>, click on “waves” in index
 3. Familiarity with Netscape Composer, Microsoft Publisher, Microsoft Office Suite, Paint program, and Internet searches
 4. Familiarity with video camera and video equipment
- B. For Students
 1. Energy, Heat and Energy transfer: *Core Knowledge Sequence*, Grade 6
 2. Physics: *Core Knowledge Sequence*, Grade 8
 3. Familiarity with Netscape Composer, Microsoft Publisher, Microsoft Office Suite, and Paint program
 4. Familiarity with video camera and video equipment

IV. RESOURCES

- A. The Internet (all lessons)
- B. Video clip of ocean waves breaking on a shore and/or seismic waves moving the ground (Lesson One)
- C. Dominoes (optional) (Lesson One)
- D. Puddle or pond (any body of still water) (optional) (Lesson One)
- E. Toy boat (optional) (Lesson One)
- F. Rope (optional) (Lesson One)
- G. Aquarium with clear water (optional) (Lesson One)
- H. Ping-pong balls (optional) (Lesson One)
- I. Thread (optional) (Lesson One)
- J. Lead sinkers (optional) (Lesson One)
- K. An open area (Lesson Two)
- L. Wooden meter stick – one per lab group or a few to share. (Lesson Two)
- M. Wave table(s) (alternately, a large clear glass baking dish, big enough to cover most of an overhead projector and the projector) (Lesson Three)
- N. Oblong wood blocks and other barriers that do not float to place in water table (curved, flat, square, etc.) (Lesson Three)
- O. Ruler (30cm) - one per lab group or a few to share (Lesson Three)
- P. Tuning fork – one per lab group or a few to share (Lesson Three)
- Q. String – one piece, about 30cm long per lab group or a few to share (Lesson Three)
- R. Beaker or drinking glass – one per lab group or a few to share (Lesson Three)
- S. Tuning fork mallet– one per lab group or a few to share (Lesson Three)
- T. Water (Lesson Three)
- U. Bottle cork – one per lab group or a few to share (Lesson Three)
- V. Wristwatch or small clock that ticks – one per lab group or a few to share (Lesson Three)

- W. Solid metal rod 1 meter long (iron, steel or aluminum) – one per lab group or a few to share (Lesson Three)
- X. Piece of cardboard 1 meter long – one per lab group or a few to share (Lesson Three)
- Y. Large sheets of white paper OR an overhead screen (Lesson Three)
- Z. Light sources - one per lab group or a few to share (if using ripple tanks) (Lesson Three)
- AA. Square objects - one per lab group or a few to share (Lesson Three)
- BB. Rubber hose or bendable metal strip to fit into tank – one per lab group or a few to share (Lesson Three)
- CC. Medicine dropper – one per lab group or a few to share (Lesson Three)
- DD. Student supplied-calculators (Lesson Three)
- EE. Computer (all lessons)
- FF. Printer (all lessons)
- GG. Internet Connection (all lessons)
- HH. Microsoft Office Suite (all lessons)
- II. Storage media (floppy disk, CD Rom, network storage, etc) (all lessons)
- JJ. CDROM “Future Lab- Optics for physical science” by Simulations Plus (optional) (Lesson Three)
- KK. Slinky toys (Lesson Two)
- LL. Video camera and video equipment (Culminating Activity)

V. LESSONS

Lesson One : Wave Basics (two to three 45-minute class periods)

A. *Daily Objectives*

1. Concept Objective(s)
 - a. Students understand the interactions between energy and matter. (USCSB)
 - b. Students understand legal and ethical behaviors when using information and technology. (NPIT3)
 - c. Students will understand the process of using technology resources to demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
2. Lesson Content
 - a. General Properties of Waves
 - i. Waves transfer energy by oscillation without transferring matter; matter disturbed by a wave returns to its original place.
3. Skill Objective(s)
 - a. Students will participate in class discussion take notes.
 - b. Students will observe and analyze observations.
 - c. Students will use problem -solving skills to invent solutions.
 - d. Students will make connections between content learned in this lesson and daily life.

B. *Materials*

1. Photocopies of Appendices A (or template saved) and C for students
2. Video clip of ocean waves breaking on a shore and/or seismic waves moving the ground
3. Dominoes (optional)
4. Puddle or pond (any body of still water) (optional)
5. Toy boat (optional)
6. Rope (optional)
7. Aquarium with clear water (optional)
8. Ping-pong balls (optional)

9. Thread (optional)
 10. Lead sinkers (optional)
 11. Internet Access (optional)
- C. *Key Vocabulary*
1. Wave: a traveling disturbance that carries energy from one place to another
 2. Vibration: Any movement that follows the same path repeatedly
 3. Medium: the matter or substance through which a wave is transmitted
- D. *Procedures/Activities*
1. Have the class do “The Wave” (as in stadiums at sporting events) and discuss how the students knew when to stand up and when to stay sitting. Later in the lesson refer back to this periodically in explaining wave propagation.
 2. Present an introduction to waves by showing a video clip of ocean waves or seismic waves. Point out how the ocean waves are continually coming in to shore without piling more and more water up on shore. The same works for seismic waves. This is a good way to illustrate that waves move THROUGH matter, and don’t actually carry matter with them very far.
 3. Have students complete Appendix A from a textbook (most textbooks will contain this information), from lecture, from class discussion or from this website: <http://www.physicsclassroom.com/Class/waves/wavestoc.html>. These notes can be graded as part of a Science Notebook grade. My key for these notes is included in Appendix B and the Rubric for grading all notes is Appendix C. You may make a template that they can fill in directly in Word. See Appendix I for directions on making a template. Remind students that most websites (including this one) are copyrighted so they may not copy and paste into their Word document.
 4. Demonstration ideas: Set up a long string of dominoes and knock them down to show that the energy traveled and the medium did not. Find a puddle or pond and demonstrate wave movement with a leaf or boat. Tie a rope to a doorknob and wave the rope up and down. The wave moves, but the rope stays. Fill a fish tank with water and float ping-pong balls in it to show that the ball doesn’t move far sideways when the water ripples. You can also attach lead sinkers to the ping-pong balls by a thread and have them at different depths to show the difference in movement from top to bottom of the water.
- E. *Assessment/Evaluation*
1. Teacher will use Rubrics, Appendix C to determine application of skills evaluated. The grade will be determined from the rubric.

Lesson Two: Characteristics and Types of Waves (three to four 45-minute class periods)

- A. *Daily Objectives*
1. Concept Objective(s)
 - a. Students understand the interactions between Energy and Matter. (USCSB)
 - b. Students apply strategies for identifying and solving routine hardware and software problems that occur during everyday use. (NPIT1)
 - c. Students understand legal and ethical behaviors when using information and technology. (NPIT3)
 - d. Students will understand the process of using technology resources to demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
 2. Lesson Content
 - a. General Properties of Waves

- i. Wave properties: wavelength, frequency, speed, crest, trough, amplitude
 - ii. Two kinds of waves: transverse (for example, light) and longitudinal (for example, sound)
- 3. Skill Objective(s)
 - a. Students will use the internet to research problems
 - b. Students will apply the lesson to life situations.
 - c. Students will use problem -solving skills to invent solutions.
 - d. Students will use Microsoft Word to produce neat, complete final products
 - e. Students will use interactive web site to gain information.
 - f. Students will manipulate objects on the computer using the mouse.
 - g. Students will work cooperatively in groups.
- B. *Materials*
 - 1. Photocopies of Appendix D for students or Templates saved
 - 2. Computer
 - 3. Printer
 - 4. Internet connection
 - 5. Storage media for computer data
 - 6. Slinky toys with small pieces of string or yarn tied to them
 - 7. An open area
- C. *Key Vocabulary*
 - 1. Wavelength: the distance between two consecutive identical points on a wave
 - 2. Frequency: the number of complete waves (or cycles) per unit of time
 - 3. Amplitude: the maximum movement from rest (measured from rest to a crest OR a trough)
 - 4. Crest: the highest point of a wave (analogous to compression)
 - 5. Trough: the lowest point of a wave (analogous to rarefaction)
 - 6. Transverse Wave: a wave in which the motion of the medium is at right angles to the direction of the wave (EM waves)
 - 7. Longitudinal Wave: a wave in which the motion of the medium is parallel to the direction of the wave (sound)
- D. *Procedures/Activities*
 - 1. Have students complete the Web Treasure Hunt at: <http://www.kn.pacbell.com/wired/fil/pages/huntwavesem.html>. They may work alone, in pairs or in small groups according to facilities and equipment. They will need to have paper of their own to write the answers, you may photocopy Appendix D and distribute or you may make a template that they can fill in directly in Word. See Appendix I for directions on making a template. Remind students that most websites are copyrighted so they may not copy and paste into their Word document.
 - 2. Let students explore wave types visually with Slinky toys. Tie small pieces of string or yarn onto the Slinky toys in a straight line about every 6th or 7th spring loop. This helps to see the compressions and rarefactions easier, and lets them see that the spring loops themselves don't actually travel very far, just like particles in a wave do not. Have them stretch the Slinky toys out on the floor or across at least 2-3m of tabletops so that they can get good repeating waves going. If they move the anchored Slinky side to side, they get a transverse wave, and if they move it forward and back, they get a longitudinal wave. They can try different amplitudes and frequencies.

3. If possible take the students outside, into a large hallway or another open space without obstructions. Have students work together as a class to come up with a way to use themselves (as an entire class) to demonstrate both transverse and longitudinal waves. One way to show a transverse wave is for the whole class to hold hands in a line or a circle and have one person wave one arm up and then down and transfer the movement to the next person, who waves one arm and then the other and so on and so on. One way to show a longitudinal wave is to have the students stand close together shoulder-to-shoulder. If the first student is gently pushed, the disturbance should pass down the line. Warning: there may be some dramatic over-acting and falls. (I would love to hear if teachers or students come up with any other dramatizations)
- E. *Assessment/Evaluation*
1. Teacher will grade Web Hunt for understanding using Note Taking Rubric (Appendix C). The grade will be determined from the Rubric.
 2. Teacher will participate in closing activity (procedure step 3) and evaluate understanding while observing interactions.

Lesson Three: Wave speed and Interactions (six to seven 45-minute class periods)

- A. *Daily Objectives*
1. Concept Objective(s)
 - a. Students will understand the processes of scientific investigation and design, conduct, communicate about and evaluate such investigations. (CS1)
 - b. Students understand the interactions between energy and matter. (USCSB)
 - c. Students understand legal and ethical behaviors when using information and technology. (NPIT3)
 - d. Students will understand the process of using technology resources to demonstrate and communicate curriculum concepts to audiences inside and outside the classroom. (NPIT6)
 2. Lesson Content
 - a. General Properties of Waves
 - i. Common features of both kinds of waves:
 - a) Speed and frequency of wave determine wavelength.
 - b) Wave interference occurs in both light and sound.
 3. Skill Objective(s)
 - a. Students will perform mathematical calculations using a calculator.
 - b. Students will participate in class discussion and take notes.
 - c. Students will observe and analyze observations.
 - d. Students will use problem -solving skills to invent solutions.
 - e. Students will formulate conclusions based on experimentation and write them in paragraph form.
 - f. Students will make hypotheses based on prior knowledge.
 - g. Students will use the scientific method to test hypotheses.
 - h. Students will use gross and fine motor skills to perform experiments.
 - i. Students will make connections between content learned in this lesson and daily life.
 - j. Students will record and analyze data and observations.
 - k. Students will tabulate hypotheses and data.
 - l. Students will use Microsoft Word to produce neat, complete final products.

m. Students will work cooperatively in groups.

B. *Materials*

1. Wave table(s) (alternately, a large clear glass baking dish, big enough to cover most of an overhead projector and the projector)
2. Oblong wood blocks and other barriers that do not float to place in water table (curved, flat, square, etc.)
3. Photocopies of Appendices E, G, H and J for students
4. Ruler (30cm) - one per lab group or a few to share
5. Tuning fork – one per lab group or a few to share
6. String – one piece, about 30cm long per lab group or a few to share
7. Beaker or drinking glass – one per lab group or a few to share
8. Tuning fork mallet– one per lab group or a few to share
9. Water
10. Bottle cork – one per lab group or a few to share
11. Wristwatch or small clock that ticks – one per lab group or a few to share
12. Wooden meter stick – one per lab group or a few to share
13. Solid metal rod 1 meter long (iron, steel or aluminum) – one per lab group or a few to share
14. Piece of cardboard 1 meter long – one per lab group or a few to share
15. Quiet
16. Large sheets of white paper OR an overhead screen
17. Light sources - one per lab group or a few to share (if using ripple tanks)
18. Square objects - one per lab group or a few to share
19. Rubber hose or bendable metal strip to fit into tank – one per lab group or a few to share
20. Medicine dropper – one per lab group or a few to share
21. Computer
22. Printer
23. Storage media for computer data
24. Student supplied calculators
25. CDROM “Future Lab- Optics for physical science” by Simulations Plus (optional)

C. *Key Vocabulary*

1. Wave Speed: how fast waves move ($\text{Speed} = \text{frequency} \times \text{wavelength}$)
2. Wave Interactions: when two or more waves meet and affect each other
3. Reflection: waves bounce off of surfaces
4. Refraction: waves change directions (bend) when they pass from one medium to another of differing densities
5. Diffraction: waves change directions (bend) when they pass through an opening or around a barrier
6. Constructive Interference: two or more waves meet and add together to make a larger wave
7. Destructive Interference: two or more waves meet and add together to make a smaller wave

D. *Procedures/Activities*

1. Lead class discussion in completing the notes from Appendix E. The key is Appendix F.
2. Have students do the lab activities in Appendices G and H to demonstrate how sound waves affect different media, and how media density effects sound wave propagation. Note: lab supplies can always be shared among several groups to

cut down on supplies needed, although silence is essential. (Adapted from Addison-Wesley Physical Science lab manual.)

3. Students use Word template (Appendix I gives instructions on how to make templates) to type up a final lab write-up and turn it in electronically. See Rubric for grading Lab write-ups. Make sure that students save this template correctly as this will be included in their science portfolio.
 4. Go over “Wave Interactions” with students, Appendix J. Key is Appendix K.
 5. Reinforce learning of Wave interactions by completing the ripple tank lab (appendix L). This can be done as a whole-class lab if you only have an overhead and a baking dish: have different students come up to perform different steps of the procedure (recommended if your classroom shouldn’t get wet, and also for water/electricity safety), or if you have multiple ripple tanks or setups, the lab can be done in groups. (Lab adapted from Prentice-Hall Sound and Light Lab manual.)
 6. Students use Word template (Appendix I gives instructions on how to make templates) to type up a final lab write-up and turn it in electronically. See Rubric for grading Lab write-ups. Make sure that students save this template correctly as this will be included in their science portfolio.
 7. In addition to or as a replacement for the ripple tank lab, the CDROM “Future Lab- Optics for physical science” by Simulations Plus, www.simulations-plus.com is a great tool, to be used by individuals or groups at computers or projected on a screen and explored as a class.
- E. *Assessment/Evaluation*
1. Teacher will use Rubric, Appendices C and M, to determine application of skills evaluated. The grade will be determined from the rubric.

VI. CULMINATING ACTIVITY

- A. The students will be divided into groups to create a video presentation demonstrating their understanding of wave characteristics and interactions presented in this unit. Guideline and Rubric are Appendices N and O.
- B. Waves Test, Appendix P.

VII. HANDOUTS/WORKSHEETS

- A. Appendix A: Waves student notes
- B. Appendix B: Key for Appendix A
- C. Appendix C: Rubric for notes in science notebook
- D. Appendix D: Hunt for Waves student worksheet
- E. Appendix E: Wave Speed student notes
- F. Appendix F: Wave Speed key
- G. Appendix G: Sound Waves in Different Media lab
- H. Appendix H: Sounds in Solids lab
- I. Appendix I: Making a Template
- J. Appendix J: Wave Interactions student notes
- K. Appendix K: Wave Interactions key
- L. Appendix L: Ripple Tank lab
- M. Appendix M: Rubric for Lab Write up
- N. Appendix N: Rubric for culminating activity
- O. Appendix O: Video production procedures
- P. Appendix P: Waves Test

VIII. BIBLIOGRAPHY

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- B. *Introduction to Physics*. Dubuque, IA: William C. Brown Publishers, 1992. 0-697-06463-8.
- C. Hooper, Debi. *Integrating Technology into the Science Curriculum*. Westminster, CA: Teacher Created Materials, Inc, 1999. 1-57690-429-6.
- D. Kuhn, Karl F. *Basic Physics A Self-Teaching Guide, second edition*. United States: John Wiley & Sons, Inc, 1996. 0-471-13447-3.
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Appendix A

Waves

1. How do ocean waves keep coming up onto the beach without all the water eventually ending up on the beach?
2. Define wave:
3. How does a leaf on a pond illustrate the movement of waves?
4. What happens to water particles after a disturbance has passed by?
5. What do waves carry?
6. What is a vibration?
7. An object that is vibrating is _____. And an object that is moving has _____. What kind?
8. How do waves transfer this energy?
9. What is a medium?
10. What kinds of things can act as a medium?
11. Waves that require a medium are called _____.
12. Give some examples of mechanical waves:

Appendix B Waves (Key)

1. How do ocean waves keep coming up onto the beach without all the water eventually ending up on the beach?
As waves come up on shore, the water in the waves moves mostly up and down, but really very little horizontally. What little water actually comes up on shore flows back out after the wave breaks because of gravity pulling it down (beaches are almost always sloped down into the water)
2. Define wave:
A traveling disturbance that carries energy from one place to another.
3. How does a leaf bobbing on ripples in a pond illustrate the movement of waves?
The leaf stays in essentially the same place, moving up and down, and only slightly horizontally back and forth. The particles in a wave actually move in an ellipse, just like the path of a leaf bobbing in a pond.
4. What happens to water particles after a disturbance has passed by?
They eventually return to rest in their original position.
5. What do waves carry?
Energy, not matter
6. What is a vibration?
Any movement that follows the same path repeatedly.
7. An object that is vibrating is ***moving*** . And an object that is moving has ***energy*** . What kind? ***Mechanical (or kinetic)***
8. How do waves transfer this energy?
The particles carrying the wave vibrate and come into contact with other particles, causing them to vibrate and pass this energy on to the particles near them, and then they do the same, and on and on.
9. What is a medium?
The matter or substance through which a wave is transmitted.
10. What kinds of things can act as a medium?
Any phase of matter (solid, liquid, gas, plasma, Bose-Einstein Condensate)
11. Waves that require a medium are called ***mechanical***
 waves .
12. Give some examples of mechanical waves:
ocean waves, sound, seismic waves, shockwaves

Appendix C

RUBRIC FOR NOTES IN SCIENCE NOTEBOOK

Category	Outstanding	Accomplished	Developing	Beginning	Total Points	Teacher's Score
CONTENT	Contains all content given in class	Contains most content given in class	Contains some content given in class	Contains little or no content given in class	10	
NEATNESS	Neat and easy to read and follow	Neat	Somewhat messy	Messy and unable to follow	5	
APPLICATION	Demonstrates understanding by including additional information whenever possible	Demonstrates understanding by including some information	Very little information included	No additional information included	8	
				TOTALS	23	

Appendix D Hunt For Waves

Questions:

1. Crest:

Trough:

Amplitude:

Wavelength:

Compression:

Rarefaction:

2. Did you get all the questions right? Keep trying until you do.

3. Medium to high amplitude?

Increase frequency?

4. Three or more sentence paragraph about the differences between longitudinal and transverse waves:

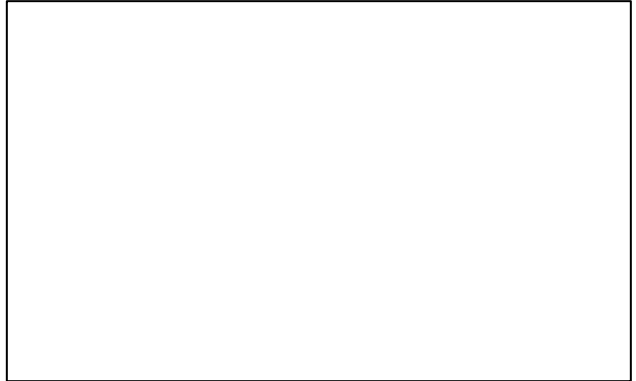
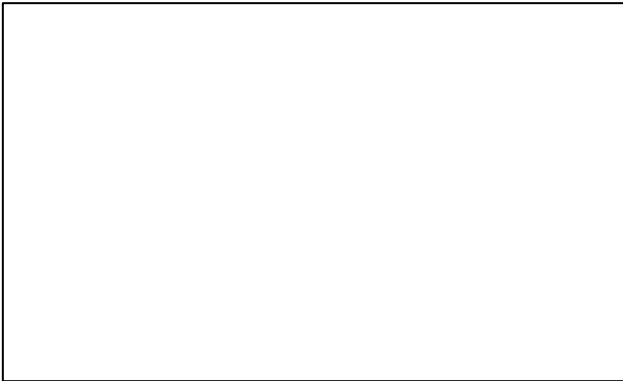
5. Raise amplitude?

Lower amplitude?

Increase frequency?

Appendix D, page 2

The Big Question(s)



Sound wave?
Light wave?

Appendix E Wave Speed

1. Write the formula for the Speed of a wave:
2. What is the unit for the speed of a wave?
3. What is the speed of a wave with a frequency of 80 Hz and a wavelength of 4 meters?

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4. In a given medium, the speed of a wave is _____.
 5. If the wavelength of a wave increases, what must its frequency do if it stays in the same medium?
 6. What two things does the speed of a wave NOT depend on?
 7. What DOES the speed of a wave depend on?
 8. There are two properties of a medium that affect the speed of a transverse wave. What are they, and how exactly do they affect the speed?
-
9. These same two properties affect the speed of a longitudinal wave, but in a different way. How?
-
10. On your own: At 0°C, sound travels through air at 331 m/s, but at 20°C, sound travels at 343m/s in air.

Appendix F Wave Speed (Key)

1. Write the formula for the Speed of a wave:
Speed = frequency x wavelength (v=f λ)
2. What is the unit for the speed of a wave? **m/s**
3. What is the speed of a wave with a frequency of 80 Hz and a wavelength of 4 meters?

V=fλ	V=80Hzx4m	V= 240m/s
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4. In a given medium, the speed of a wave is **constant**__.
5. If the wavelength of a wave increases, what must its frequency do if it stays in the same medium?
The frequency must decrease (the answer to the multiplication problem must remain the same, so if either variable increases, the other must decrease to match.)
6. What two things does the speed of a wave NOT depend on?
The source of the wave (its intensity) and the speed of the source.
7. What DOES the speed of a wave depend on?
The medium through which the wave is raveling
8. There are two properties of a medium that affect the speed of a transverse wave. What are they, and how exactly do they affect the speed?
The density: the denser the medium, the more inertia there is to overcome, so the wave is slower. (Ex: light travels faster in air than water)
The elasticity: If the medium moves back to its original position quickly, the wave can move more quickly.
9. These same two properties affect the speed of a longitudinal wave, but in a slightly different way. How?
Density: within the same medium, more dense=slower, BUT sound moves slowest in gases, medium speed in liquids, and fastest in solids.
Elasticity: The same as transverse waves.
10. On your own: At 0°C, sound travels through air at 331 m/s, but at 20°C, sound travels at 343m/s in air. **The warmer air is less dense.**

Appendix G
Sound Waves in Different Media

Purpose: To find the effects of Sound waves on different types of media.

Hypothesis: How do you think sound waves affect each of these media? Tell what you think will happen to each medium when they come in contact with sound waves.

Water: _____

Wood: _____

Glass: _____

Bone: _____

Cork: _____

Air: _____

After you write down what you think will happen to each medium when they come in contact with sound waves, open Microsoft Word.

1. Click on Table
2. Click on insert
3. Click on table
4. You want two columns and seven rows.
5. Click OK

Appendix G, page 2

You must come up with your ranking and rank the media. See example:
(you may not use these rankings)

SAMPLE TABLE

Rank	Medium (Hypothesis)
Splendid	Bone
Pretty Good	Wood
So-so	Glass
Not so great	Cork
Barely	Air
Not even	Water

Materials:

Tuning fork

Beaker or drinking glass

Water

String

Tuning fork mallet

Bottle cork

Procedure:

1. Work with a partner. Practice tapping the tuning fork ONCE to produce a nice even tone. Tapping more than once will deaden the sound.
2. Strike the fork once sharply with the mallet. Hold the fork upright near, but not touching your ear. Observe what happens when you hold the fork still as compared to when you slowly rotate it around while it is still ringing.
3. Fill the beaker halfway with water. Do not fill to the top. Strike the tuning fork and lower the prongs into the beaker until they JUST touch the surface of the water. It will not work if you put them actually IN the water. Observe what happens to the water. Please clean up any splashes.
4. Strike the fork and hold the bottom (handle) of the fork against your desk. Observe what happens. Now put your ear on your desk while you perform this step. Observe.
5. Strike the fork and VERY GENTLY let one of its prongs touch the SIDE of an empty beaker. DO NOT touch the rim: it may shatter the beaker, and no one wants that. Record observations.

Appendix G, page 3

6. Tie a length of string to a bottle cork so that you can hang the cork about 30 cm from your hand. Strike the tuning fork and gently allow one of the prongs to barely touch the hanging cork. Note observations.
7. Find the bony protrusion on your skull behind your ear. It is hard and sticks out a little farther than the bone around it. Strike the tuning fork and quickly press the handle against this bone. Note observations.
8. For fun: Strike the tuning fork and lightly let one of the prongs graze the fuzz on your cheek. Observe.

Observations:

1. What happens to the sound quality and pitch when you move the fork around as compared to holding it still (step 2)?

2. What happens to water when it is touched with the fork (step 3)?

3. What happens when you put the handle of the fork on your desk? Is there any difference with your ear on your desk? Explain. (Step 4)

4. What happens when the fork touches the beaker (step 5)?

5. What happens when the cork is touched by the fork (step 6)?

6. How does the intensity of the sound when you hold the fork against your skull compare with the intensity when you hold the fork in the air (step 7)?

Appendix G, page 4

7. What happens when you brush your cheek with the fork (step 8)?

Analysis:

1. Why do you think the fork's sound waves change when you move the fork around?
2. What caused the effect you saw when...
You touched the water: _____
You touched the beaker: _____
You touched the cork: _____
3. Why do you think the fork sounded different when you held it on your skull than when it was just in the air near your ear?

Conclusion:

Give details about the correctness or incorrectness of your hypothesis, then review and discuss what actually happened during the experiment. Tell what type of medium you think sound travels best through.

When writing up your Conclusion, copy the table from the Hypothesis and paste it at the end of the Conclusion and then insert a column.

Inserting a column is done using the following steps.

1. Highlight the Table
2. Click on Table
3. Click on Insert
4. Click on Columns to the Right
5. Click OK

The new column's heading should be **Medium (Actual)**. Put what rank each medium's data showed.

Appendix H, page 1

Sound in Solids

Purpose: To compare the transmission of sound in different media.

Hypothesis: Which of these materials do you think will transmit sound the best? How do you think you will be able to tell how well the sound is transmitted? Read the procedure before hypothesizing.

Materials:

Wristwatch or small clock that ticks

Wooden meter stick

Solid metal rod 1 meter long (iron, steel or aluminum)

Piece of cardboard 1 meter long

Quiet

Procedure:

1. Work with a partner. Hold the watch up against your ear. Concentrate and note what you hear. See if you can hear the sound of the secondary tick, which is the balance wheel spring. Note how loud this sound is on a scale of 1-10. Note: during this entire experiment, always concentrate on listening for about 10 seconds before making observations. Closing your eyes also helps.
2. Hold the watch in the air 1 meter from your partner's ear. Concentrate for at least 5-10 seconds. Note the intensity (loudness) of the tick on a scale of 1-10.
3. Hold a wooden meter stick gently but firmly against your ear canal. Have your partner press the back of the watch against the side of the meter stick at the far end. Note intensity.
4. Repeat step three with the metal rod.
5. Repeat step three with the cardboard.
6. Can you think of any other solid in the room that you can test? Note what the solid is and test it.
7. Switch roles with your partner and repeat if time allows.

Appendix H, page 2

Observations:

1. Intensity in air: (1-10)_____
2. Intensity in wood: (1-10)_____
3. Intensity in metal: (1-10)_____
4. Intensity in cardboard: (1-10)_____
5. Your personal solid: _____
6. Intensity in your solid: (1-10)_____

Other notes:

Analysis:

1. Which was the best medium for sound transmission? Why do you think it was best?

2. What was the worst medium for sound transmission? Why do you think it was worst?

3. Do you think some sound other than ticking would have the same results if passed through the same mediums? Explain your answer, using what you have learned about sounds and mediums so far:

Conclusion:

Give details about the correctness or incorrectness of your hypothesis, then review and discuss what actually happened during the experiment.

Appendix I

MAKING A TEMPLATE

1. Open document that you want to make a template for.
2. Open **File**.
3. Click **Save As**.
4. Name your document.
5. Under the **File Name** box is a box that says **Save As Type**. Click on the arrow on the right and find **Document Template**.
6. **Remember this!!** The **Document Template** automatically wants to save your document in the **Office Templates Folder**. This is OK, but it makes it hard for you to find specific templates. Every time you open up a new document you would have this template to chose from in the template folder. It is better to save this template someplace that is easy for you to find. Therefore, up at the top again, where it says **Save In**, find the place you want the template to be saved.

When you open up this template from the folder where you saved it, the information you had will be there. Add new information to this template. The name of the document on the top left will say Document 1 until you save it with a new name. When you save this time, you will be saving your document under a new name, and it won't be a template unless you specify this. After closing, your original template will still be there without any changes.

If you need to change the template for any reason:

1. Instead of opening up your template from the folder you saved in, open up Word.
2. Go to **File** ® **Open** ® Find your template and open. The name at the top of the document should now read the name of your template.

Appendix J, page 1
Wave Interactions

I. Wave Interactions- Four Basic Types

A.

1. Definition-
2. Examples-
3. Diagram with Labels-

4. Angle of _____ is...
5. Angle of _____ is...
6. Law of _____ :

B.

1. Definition-
2. Examples-
3. Diagram-

4. Why does _____ happen?

C.

1. Definition-

Appendix J, page 2

2. Examples-
3. Diagram with Labels

4. Cases where _____ works well:

5. Cases where _____ does not work well:

D.

1. Definition-
2. Two types-
 - a.

1. Diagram-

2. Examples-

b.

1. Diagram-

2. Examples-

Appendix K, page 1
Wave Interactions (Key)

I. Wave Interactions- Four Basic Types

A. **Reflection**

1. Definition- ***the bouncing back of a wave after it strikes a boundary that does not absorb all of the wave's energy.***
2. Examples- seeing ***yourself in a mirror, the acoustics in theaters, and echoes.***
3. Diagram with Labels-

4. Angle of ***_incidence_*** is... ***the angle formed by the incident ray and an imaginary line drawn perpendicular to the barrier***

5. Angle of ***_reflection_*** is... ***the angle formed by the same perpendicular line and the reflected ray***

6. Law of ***_Reflection_***: ***The angle of Incidence (i) is equal to the angle of Reflection (r)***

B. **Refraction**

1. Definition- ***The bending of waves due to a change in speed.***
2. Examples- ***a pencil looks "bent" when it's standing in a glass of water, mirages.***
3. Diagram-