

# **TIES** *2003*

Teachers in Industry for Educational Support

## **Making Waves!**

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## **(Making Waves!) Curriculum Unit Overview**

### **Summary**

This curriculum unit is designed for a unit on waves. It can be used to cover the topic of waves, including sound, light, and earthquake waves. Special emphasis is placed on lasers, because I worked in a laser lab at Wright Patterson Air Force Base and lasers are now widely used for many applications. Some of the applications involve medical uses, remote sensing, manufacturing, and measuring.

### **Big Picture**

Waves are mathematical and graphical representations of periodic motion. In science, there are many phenomena that exhibit wave properties. This unit is on the concept of waves as a graph and on the subjects of earthquake waves, sound waves, and light waves. The following are all “hook activities.”

1. Demo.: playing around with simple cheap lasers that can be bought for less than 10 dollars. Can easily show absorption, reflection, interference, refraction and diffraction. Can also attach amusing attachments to front of lasers. Students are asked question throughout the discussion. Dry ice vapors are good for showing the beam.
2. Students make simple waves by standing and sitting.
3. Demo. of transverse and longitudinal waves, using long spring

### **Preparation for the Unit**

1. Work with computer coordinator to arrange for lab time.
2. Assemble materials needed.

### **Overview**

On the following page is a summary of the unit including brief summaries of each Authentic Learning Task (ALT). This table provides an overview of the tasks in the unit sections and shows how the activities in the different teaching areas relate to each other.

**(Making Waves!)  
Curriculum Unit Summary**

<b>Earthquakes and other waves</b>	<b>Sound and Light</b>	<b>Technology</b>
<p><b>ALT 1 – Making waves</b> Students work in pairs to produce seismograms.</p>	<p><b>ALT 1 – Learning about light and sound.</b> Students move through stations to discover properties of sound and light. This activity takes several days.</p>	<p><b>ALT 1 –Real Lasers!</b> The students will use inexpensive lasers do experiment with light properties.</p>
<p><b>ALT 2 – Waves are graphs</b> Students graph data that is of the shape of a wave. Waves are always graphs. Waves are a mathematical concept.</p>		<p><b>ALT 2 - Title</b> Briefly describe this ALT—what competencies will be learned and method for learning.</p>
<p align="center"><b>Transfer or Culminating Activity- Internet Research on Lasers</b></p> <p>Students do research on lasers, using the Internet.</p>		

## Section One: (Earthquakes)

### ALT One: Making Waves

#### Summary

Students work in pairs constructing waves and label the parts of the waves and then answer questions about their wave patterns.

#### Competencies

1. Teamwork- Students should be on task and be courteous to teacher and other students. Students converse with each other to reach a common conclusion.
2. Identification and measuring- Student will label the parts of the waves and give a wavelength and amplitude measurement.
3. Analysis- Students will compare and contrast their waves with actual earthquake waves. Students will identify areas of high amplitude and frequency.

#### Time

One class period

#### Materials

Paper, Pencil, Blackboard

#### Instructions

1. Students work in pairs. One student is instructed to move his hand up and down while keeping his eyes closed and holding a pencil to the paper.
2. The other student pulls the paper horizontally, perpendicular to the direction of the other students writing.
3. Students switch roles.
4. Students label horizontal and vertical axes of their graphs.
5. Students complete the worksheet.

#### Evaluation/Assessment of Student's Competency

1. Teacher will walk around to the groups and check on their work and ask them questions at the places marked "checkpoints" on their worksheets. As a group and individually, the students should correctly answer the questions.
2. Students written work is graded with 80 percent correct considered an acceptable level of performance.
3. Students score at least 80 percent on quiz.

Worksheet on Making Waves

1. Label your axes with "amplitude" and "time."
2. Label your graph with crest, trough, high frequency areas, low frequency areas, and wavelength.
3. Why wasn't the amplitude constant?
4. Why wasn't the frequency constant?
5. Why do wave lines not cross?
6. Would real earthquakes look like this?
7. Explain how a seismograph works.

**Closure**

Demonstration using a weight on a spring and a weight on a string showing how these can be used to measure vertical and horizontal earth movements. Emphasis is placed on the fact that waves are always a mathematical representation of a periodic phenomenon. Waves are graphs.

ALT One: Handout One

**(Handout Title)**

Worksheet is above.

## Section One: (Earthquakes)

### ALT TWO: Making Waves

#### Summary

Students work in pairs making graphs of wave data. Students calculate amplitude, wavelength, and frequency.

#### Competencies

1. Teamwork- Students should be on task and be courteous to teacher and other students. Students converse with each other to reach a common conclusion.
2. Graphing- Students plot the points, connect them with a smooth curve, and label the axes on the graph.
3. Calculation- Student will label the parts of the waves and give a wavelength and amplitude measurement. They also calculate the frequency.
4. Analysis- Students will compare and contrast their waves with their previous waves earthquake waves. They will describe how these waves are different from the waves we did earlier.

#### Time

One class period

#### Materials

Paper, Pencil, Blackboard

#### Instructions

Teacher must prepare wave data ahead of time. Wave data just be made up or the following table may be used. It approximates a sign wave. Student use this data to plot the points and draw their waves. It is a good idea to just have the student plot the data and connect the points and then ask what shape does the data take on.

X	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Y	0	1.5	2	1.5	0	-1.5	-2	-1.5	0	1.5	2	1.5	0	-1.5	-2	-1.5	0

#### Evaluation/Assessment of Student's Competency

1. Teacher will walk around to the groups and check on their work and ask them questions at the places marked "checkpoints" on their worksheets. As a group and individually, the students should correctly answer the questions.
2. Students written work is graded with 80 percent correct considered an acceptable level of performance.

3. Students score at least 80 percent on quiz.

### Worksheet on Graphing Wave Data

1. Plot the data and connect with a smooth curve.
2. Label the axes.
3. Give the amplitude, frequency, and wavelength.
4. Write a paragraph explaining what you learned and what you still don't understand regarding waves.
5. Compare and contrast the waves you did here with the waves you did before.

### **Closure**

Discussion of how these were similar and different to previous graphs. What kinds of phenomena might have graphs like these?

ALT One: Handout One

### **(Handout Title )**

Handout is above

## Section Two: (Sound and Light)

### ALT One: Sound and Light Stations

#### Summary

Students work in groups of 5 or six moving through several stations involving sound and light and waves in general. The stations consist of (1) A station with tuning forks (2) A station involving filters and colored paper for examining absorption and reflection. (3) A station with polarizing lenses (4) A station with a spectroscope and a Newton wheel to spin to see the transmitted colors are white (5) A station with a long spring for generating waves and examining transverse and longitudinal waves (6) A station for working on questions related to wave behavior.

#### Competencies

1. Teamwork- Students should be on task and be courteous to teacher and other students. Students converse with each other to reach a common conclusion.
2. Time management- Students must use time wisely to get all the work done.
3. Writing skills- Students prepare written work in pencil. Writing must be legible with no cross outs and there should be few grammatical errors.
4. Analysis- Students must analyze each situation and come up with correct interpretations of the situations.
5. Hypothesizing/ scientific method- Students will experiment with the equipment and use the scientific method to achieve desired results.

#### Time

Two or three class periods

#### Materials

Paper, Pencil, Blackboard, polarizing filters, springs which are several feet long, Newton color wheel, spectroscope, colored filters, colored paper, two tuning forks, text books or other source of information.

#### Instructions

1. Divide the student up into six groups.
2. Hand out worksheet.
3. Each group starts at a different station and then rotates through all the other stations at the teacher's direction.
4. Students complete the worksheet.

### **Evaluation/Assessment of Student's Competency**

1. Teacher will walk around to the groups and check on their work and ask them questions at the places marked "checkpoints" on their worksheets. As a group and individually, the students should correctly answer the questions. Students should be able to show the teacher the relationship between wavelength and frequency.

2. Students written work is graded with 80 percent correct considered an acceptable level of performance.

3. Students score at least 80 percent on quiz.

4. Students write a one-page report on what they learned and what they still don't understand. The report should be neat, with correct grammar and spelling, no cross outs and concisely and correctly convey the students' learning.

### **Closure**

General discussion on waves and what students learned in each section.

ALT One: Handout One

### **(Sound and Light)**

Handout on sound and light is attached.

## **Section Three: (Technology)**

## **ALT One: Real Lasers!**

### **Summary**

Students work with inexpensive, easy to obtain, lasers to learn about various properties of waves.

### **Competencies**

1. Teamwork- Students should be on task and be courteous to teacher and other students. Students converse with each other to reach a common conclusion.
2. Scientific method- Students will make observations, experiment, and draw conclusions.
3. Application- Students will apply their knowledge to new situations.
4. Writing skills- Students prepare written work in pencil. Writing must be legible with no cross outs and there should be few grammatical errors.

### **Time**

One class period

### **Materials**

Paper, Pencil, Blackboard, lasers, water in beakers or clear cups.

### **Instructions**

1. Students must observe all safety rules. It is very important not to stare at the laser light.
2. Students will work on the following worksheet.

### **Evaluation/Assessment of Student's Competency**

1. Teacher will walk around to the groups and check on their work and ask them questions at the places marked "checkpoints" on their worksheets. As a group and individually, the students should correctly answer the questions.
2. Students written work is graded with 80 percent correct considered an acceptable level of performance.
3. Students score at least 80 percent on quiz.
4. Students should demonstrate to the teacher refraction, diffraction, and reflection.

Worksheet on Making Waves

1. What did you discover about the angle of incidence and reflection?
2. How did the beam bend when entering the water, toward the normal or away from the normal?
3. Why did the beam bend the way it did?
4. How would the beam bend, coming out of the water to the air?
5. Do fish appear deeper or shallower than they really are? Explain using a drawing and words.
6. Aim the beam through a narrow slit in between your fingers. What happened to the beam?
7. How did it spread?
8. Make a drawing of this spreading.
9. What do you call this spreading?
10. Aim the beam at a black object and a white object. Which reflected beam is brighter?
11. Explain your answer to number 10.
12. What color is your beam?
13. Does your beam spread more or less than a flashlight beam?

**Closure**

Discussion on wave and particle nature of light and why lasers are very useful for studying light and other wave properties.

**Transfer Activity****Summary**

Students will do Internet research on light, waves, and lasers.

**Competencies**

1. Internet research- Students will use the Internet to find out information.
2. Writing skills- Students prepare written work in pencil. Writing must be legible with no cross outs and there should be few grammatical errors.

**Time**

Two or three class periods.

**Materials**

Paper, Pencil, Computer lab

**Instructions**

1. Arrange with lab coordinator to use computer lab.
2. Have student work on the worksheet
3. Student should be instructed on how to use Google or some other search engine.

**Evaluation/Assessment of Student's Competency**

1. Teacher will walk around to the groups and check on their work and ask them questions at the places marked "checkpoints" on their worksheets. As a group and individually, the students should correctly answer the questions.
2. Students written work is graded with 80 percent correct considered an acceptable level of performance.
3. Students score at least 80 percent on quiz.

Worksheet on Lasers

1. What is a laser?
2. How do lasers work? Give detailed explanation with drawings.
3. What is a population inversion?
4. What is the photoelectric effect?
5. Who discovered the photoelectric effect?
6. What does the photoelectric effect have to do with lasers?
7. Describe in detail at least four types of lasers and how they function.
8. Give at least 6 practical uses of lasers and describe these uses.
9. How can lasers be used to perform surgery?
10. How do the lasers work that scan merchandise bar codes?
11. Make a sketch of the electromagnetic spectrum labeling each part with the wavelengths or frequencies.
12. Can lasers only be produced in the visible wavelengths?
13. What are some other wavelengths that are now used for lasers?
14. How could invisible lasers be used?
15. Who invented the laser and when was it invented?

## **Closure**

Discussion on the uses of lasers. , basic science that went into laser development, and who were the major inventors and contributors.

## Appendix One: (ALT 1 Sound and Light Handout)

### Waves- Sound and Light

#### Station 1:

At this station and whenever you have extra time, do the following: Puzzle

#### Station 2:

Along the floor, produce a high frequency transverse wave and a low frequency transverse wave. The high frequency wave will have more waves per time period than the low frequency wave:

1. Which wave had a longer wave length, the high frequency or low frequency wave?
2. Draw a graph of a high frequency wave. Label the horizontal axis "distance" and the vertical axis "amplitude."
3. Draw a graph of a low frequency wave. Label the horizontal axis "distance" and the vertical axis "amplitude."

#### Station 3:

Look at the two tuning forks. There are numbers printed on them. The number tells the frequency of the wave. For example 186.7 means the tuning fork vibrates 186.7 times per second. Hit the forks with the mallet and see if you can see the vibrations.

4. Give the frequency of the tuning fork with the higher pitch.
5. Give the frequency of the tuning fork with the lower pitch.

Place one of the vibrating tuning forks lightly against the glass beaker.

6. What happened when you pressed the tuning fork lightly against the glass beaker?
7. Which had a higher pitch, the high frequency fork or the low frequency fork?
8. Explain how the vibrating tuning fork can make your eardrums vibrate even though it is not touching your eardrum. **DO NOT USE THE WORD "WAVE" IN YOUR ANSWER!**
9. Explain why you could not hear this vibrating tuning fork in space.

#### Station 4:

Read the section in your book on polarizing filters. Rotate the see-through front filter several times and look through it at the back disk.

10. What do you notice about the appearance of the back plastic disk as you rotate the filter?
11. Explain what is happening. **Use the word "waves."**

**12.** Make a sketch like that in your text that explains what is happening.

**13.** A lot of glare coming off a lake comes in sideways (horizontally). Which way would you want the lines on a polarizing filter to be facing to eliminate this glare, horizontally or vertically?

Station 5:

Outdoor light is pretty much white light. Look through the spectroscope at this outdoor light. Go to a window.

**14.** Name the colors that sunlight is really made of.

Spin the Newton color disk quickly.

**15.** What color did it look when you spun the disk quickly? **Explain why this happens.**

Look at the overhead florescent lights through the spectroscope.

**16.** How did the overhead lights look compared to the outdoor light? Compare and Contrast.

Station 6:

Look through the red filter at the white light. We know that white light is really made of all the colors. We can name the colors of white light as red, orange, yellow, green, blue, indigo, and violet.

**17.** Which color of those listed above is allowed to pass through the red filter?

**18.** Name all the colors that the red filter doesn't let pass through it.

Look at the red construction paper.

**19.** Which color of those listed above does the red paper reflect?

**20.** Name all the colors that the red paper absorbs.

**21.** Since we know a white object is reflecting all the colors, what does a black object do?

**22.** What color of clothing is it best to wear when it is hot? **EXPLAIN** in terms of absorption and reflection of colors.