

This guide is a supplement, designed for educators to use when presenting this program in an instructional setting.

**Before Viewing:** Research in learning suggests that it is important for the teacher to discover what the students know — or think they know — about a topic, at the start of a new unit, so that their accurate conceptions can be validated and reinforced, and their misconceptions identified and corrected. Therefore, after reviewing the pre-viewing discussion questions provided for your class, create a “Everything We Know About...” list. Preview key vocabulary words and have students raise additional questions they hope will be answered by this program. Most importantly, students should be told that as “science detectives” they must listen closely, so that after viewing the program, they will be able to tell whether or not the facts/beliefs they put on their list were scientifically accurate.

**After Viewing:** After a brief discussion about the program, challenge your “science detectives” to prove or disprove the accuracy of the facts they put on their “Everything We Know About...” list. Discuss what else they learned and use the follow-up questions and activities to inspire further discussion. Encourage students to research the topic further with the Internet and reading resources provided.

## Program Summary

There are lots of different kinds of waves in the world. Some we can see, like ocean waves, and some we can't see, like radio waves and microwaves. Waves are very important because energy moves from place to place in waves. If there were no light waves, the world would be totally dark. If there were no sound waves, you'd never hear music. The world would be silent. Waves start out as vibrations, which are movements back and forth. When someone jumps into a pool of water, the splash disturbs or vibrates the calmness of the water, causing energy to move in waves across the whole pool. Waves move through all sorts of substances, including air and water. The substance that energy moves through is called a medium. Most waves, like sound waves, need a medium, but light waves do not. Light energy travels to Earth in waves from the sun through the emptiness of outer space. There is no sound in outer space because there is no medium like air for sound waves to travel through.

Waves can move in different ways. Waves that move up and down with high points and low points like a roller coaster are called transverse waves. Other waves travel from end to end through a medium, squeezing together at some points and bouncing back at other points, over and over again. These waves are called longitudinal.

There are three ways a wave can be measured: by their wavelength, amplitude and frequency. Wavelength is how long a wave is. Amplitude is how big a wave is, and frequency is how many waves pass by in a second. In musical instruments, we control the waves by making the vibrations stronger, or the music louder (amplitude). Musicians can also make different sounds, like a low note or a high note, by changing the number of vibrations (frequency).

Light waves travel much faster than sound waves. Though lightning and thunder occur at the exact same time, you always see the lightning before you hear the thunder. Waves can bounce off surfaces, like a sound echo or like a light reflection in a mirror. Dolphins use bouncing sound waves to find out where things are, and police use radio waves to find out how fast cars are going. Waves are all around us; they help to make our world an exciting place.

## Vocabulary

The following words are included for teacher reference or for use with students. They are listed in the order in which they appear in the show.

**energy** — The ability to do work by moving or changing things.

**wave** — A vibration that moves energy from one place to another.

**vibration** — Movement up and down, or back and forth. *(Continued)*

# Physical Science for Children™



## All About Waves

Grades K–4

**medium** — The material through which a wave travels. Light waves do not need a medium but can travel through the vacuum of space. Sound waves must have a medium in order to travel.

**transverse wave** — The way that some waves travel, moving up and down as they move forward, like a tiny roller coaster.

**longitudinal wave** — The way that sound waves travel, squeezing together at some points and spreading out at others, like a slinky being pushed along the floor.

**wavelength** — A measurement of how long a wave is.

**amplitude** — A measurement of how big a wave is.

**frequency** — A measurement of how many waves pass a certain point in a second. Waves with higher frequency have more energy than waves with lower frequency.

**echo** — The bouncing of sound from a source to another object and back again.

**reflection** — The bouncing of waves off a surface, as in a reflection of light off a mirror.

## Pre-viewing Discussion

Before students generate their list of “Everything We Know About...” for this topic, stimulate and focus their thinking by raising these questions so that their list will better reflect the key ideas in this show:

- How does sound move from one place to another?
- How does light move from one place to another?
- What is energy?

After the class has completed their “Everything We Know About...” list, ask them what other questions they have that they hope will be answered during this program. Have students listen closely to learn if everything on their class list is accurate and to hear if any of their own questions are answered.

## Focus Questions

You may wish to ask your class the following questions to assess their comprehension of key points presented in the program:

1. What is an example of a wave we can see?
2. What is an example of a wave we cannot see?
3. What is a wave?
4. What is energy? How does it travel?
5. Why are light waves important to our world?

*(Continued)*

6. Why are sound waves important?
7. What is a vibration? Give an example.
8. How does energy travel through water when you jump into a pool?
9. What is a medium?
10. What are several different mediums that sound travels through?
11. Is outer space quiet? Why?
12. How are light waves different from sound waves?
13. What two patterns of wave motion are there?
14. How do we measure wavelength?
15. How do we measure a wave's amplitude?
16. What happens when we increase the amplitude of a sound wave?
17. How is a wave's frequency measured?
18. In musical instruments, what happens when we change the frequency of the sound waves?
19. What is an echo?
20. How do dolphins use sound waves?
21. Do all waves travel at the same speed?
22. How can we tell from a thunderstorm that sound waves and light waves travel at different speeds?
23. Can sound waves go around corners?

## Follow-up Discussion

The most important part of this segment is to examine both the facts and beliefs generated by the class in their "Everything We Know About..." list. Research indicates that students will retain their previous misconceptions — in preference to the new information — until they actively recognize and correct their own errors. Because of this, it is important to lead students to the correct ideas while identifying and correcting any misconceptions from the class list. After reviewing the list, encourage students to share the answers they got to the questions raised before viewing the program.

Raising a thought-provoking question is a good way to assess the overall depth of understanding. A couple of suggestions are listed below:

1. Explain why energy waves are important in our lives. How would life be different without waves?
2. Discuss the reason we see lightning before we hear thunder.
3. Discuss why a pencil appears to be broken when placed in a glass of water.

## Follow-up Activities

- Replicate the investigation with the slinky or a length of jumping rope. Have students physically demonstrate the following: waves with long and short wavelength, waves with high and low amplitude, and waves with high and low frequency.
- Have students experiment with and record the results made by blowing across and tapping 3 glass drink bottles containing different amounts of water. Ask them to guess why different sounds result from different situations.
- Have students investigate sound waves using various musical instruments. Challenge them to arrange a few common instruments in order from those that make low frequency sounds, like a tuba, to those with high frequency sounds, like a flute.
- Encourage students to discover how light and sound travel through different things using flashlights, tuning forks and a number of mediums, such as water, oil, air, paper and plastic film. Have children record their observations in a table or chart.

## Suggested Internet Resources

Periodically, Internet Resources are updated on our Web site at [www.libraryvideo.com](http://www.libraryvideo.com).

[physics.hallym.ac.kr/education/wave/music/teachgde.html](http://physics.hallym.ac.kr/education/wave/music/teachgde.html)

This "What Makes Music?" teacher's guide is part of an online exhibit at the Franklin Institute, with pages designed to teach students how sound is made, how it travels and how it is heard.

[www.lhs.berkeley.edu/shockwave/jar.html](http://www.lhs.berkeley.edu/shockwave/jar.html)

An interactive Web site from the Lawrence Hall of Science encourages the investigation of sound waves using virtual "instruments".

[imagers.gsfc.nasa.gov/ems/waves.html](http://imagers.gsfc.nasa.gov/ems/waves.html)

The "Echo the Bat" Web site from the USGS and NASA is an excellent interactive multimedia presentation for elementary students that includes a discussion of echolocation and light waves.

## Suggested Print Resources

- Glover, David. *Sound and Light*. Kingfisher Books, New York, NY; 1993.
- Lafferty, Peter. *Light and Sound*. Benchmark Books, Tarrytown, NY; 1996.
- Skurzynski, Gloria. *Waves*. National Geographic Society, Washington, DC; 1996.

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## TEACHER'S GUIDE:

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