Waves Activity 5 Name:_________
5-25-20 to 6-1-20
Read the attached textbook pages (Prentice Hall: chapter 2, section 1.)
Answer the section review questions

1. What is sound? What kind of wave carries sound?

2. What characteristics of the medium affect the speed of sound?

3. Compare the transmission of sound in solids, liquids, and gases.

4. Light travels faster than sound. Thunder and lightning occur at the same time. However, thunder is heard after a flash of lightning is seen. How can the time in between the two be used to calculate how far away a storm is?

Guide for Reading

Focus on these questions as you read.

- *What is sound, and how is it produced?*
- *What factors affect the speed and transmission of sound?*

2–1 What Is Sound?

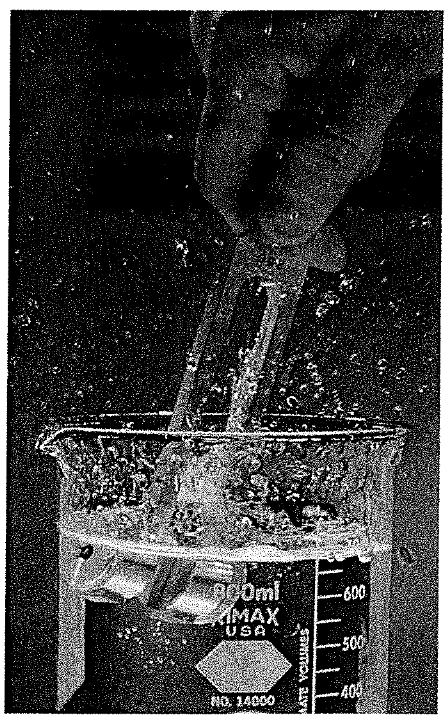
Have you ever noticed that if you lean on a piano while it is being played, you can feel the beat of the music? Or if you place your hand over a loudspeaker, you can actually feel a sensation in the air directly in front of it? And did you also know that if you could take your radio to the moon, you would not be able to hear it (or any noise, for that matter)? In order to understand these facts, you must learn about the nature of sound.

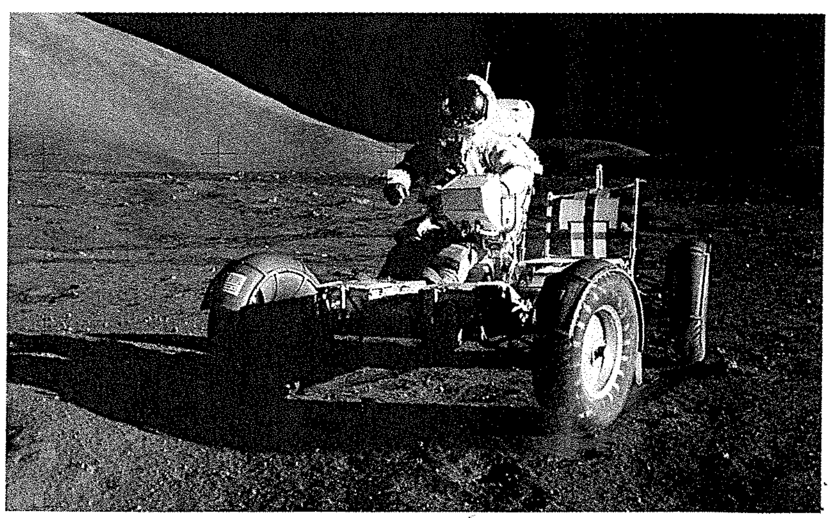
How Sounds Are Made

A bell shaking rapidly, a drum moving up and down, and a harp string bouncing back and forth are all examples of objects that make sounds. What do these examples have in common? They each vibrate when they are making sounds. As an object vibrates, it gives energy to the particles of matter around it. The energy causes the particles of matter to vibrate as well—and in such a way that a series of compressions (crowded areas) and rarefactions (less-crowded areas) moves outward from the source. Recall from Chapter 1 that a moving series of compressions and rarefactions is called a longitudinal wave. **Sound, which is produced when matter vibrates, travels as a longitudinal wave.**

Anything that vibrates produces sound. Your vocal cords, for example, vibrate to produce sound. When you speak, air from your lungs rushes past

Figure 2–1 *Although a tuning fork does not appear to vibrate, you can clearly see that it does from the splashes it makes when placed in water. If there are no particles of a medium to vibrate, there will be no sound. Why can't the astronaut riding along in a lunar vehicle hear the engine?*





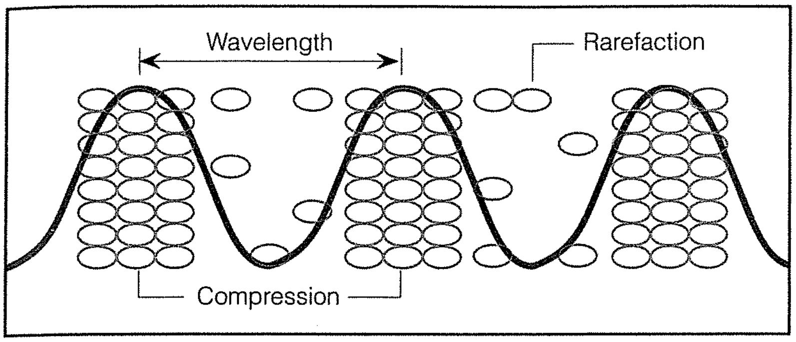


Figure 2–2 *A longitudinal wave is composed of a series of compressions and rarefactions moving through a medium. The compressions form the crests of the wave. The rarefactions form the troughs. What is the distance between consecutive crests called?*

your vocal cords (two folds of tissue located in your throat), causing them to vibrate. As your vocal cords move inward, the air between them is pushed together, forming a compression. As your vocal cords move outward, an area with fewer particles of air is left, creating a rarefaction. A series of compressions and rarefactions travels outward from your vocal cords, making up the sound of your voice. When you speak, therefore, it is not the air you breathe that travels to the receiver; it is the sound waves that travel. The particles of air simply move back and forth.

Think about your radio again. The mechanism in the speaker of your radio actually moves the air in front of it by causing the particles to vibrate. If there were no air (medium) in front of the speaker, there could be no sound. Without a medium to transmit vibrations, there can be no sound. On the surface of the moon, where there is no atmosphere, there is no medium to transmit sound. Thus there can be no sound on the moon or in any vacuum.

Perhaps you are familiar with the age-old question, "If a tree falls in the forest and no one is present to hear it, is there a sound?" Although some people might answer no, you would probably say yes now that you know about sound. A falling tree sends a disturbance through the air and the ground. This disturbance travels as a longitudinal wave—a sound wave. Thus a sound is produced.

Speed of Sound

You learned in Chapter 1 that the speed of a wave depends on the properties of the medium and not on the source of the wave. For example, if a flute and a trumpet are both played in the same orchestra, both sounds will travel through the same

Activity Bank

Bells A' Ringing, p.141

ACTIVITY DOING

Viewing Vibrations

Sounds are caused by vibrations. You can observe this by experimenting with a tuning fork.

1. Strike the prongs of a tuning fork with a pencil and then hold the fork close to your ear. What happens? What happens when you touch the prongs of the fork?

2. Again strike the prongs of a tuning fork and place the ends of the prongs in a glass of water. What happens?

3. Tie a small piece of cork to a string and hold the string in one hand so the cork can swing freely. Strike the prongs of a tuning fork and hold one prong against the cork. Observe what happens.

Activity Bank
Cup-to-Cup Communication, p.142

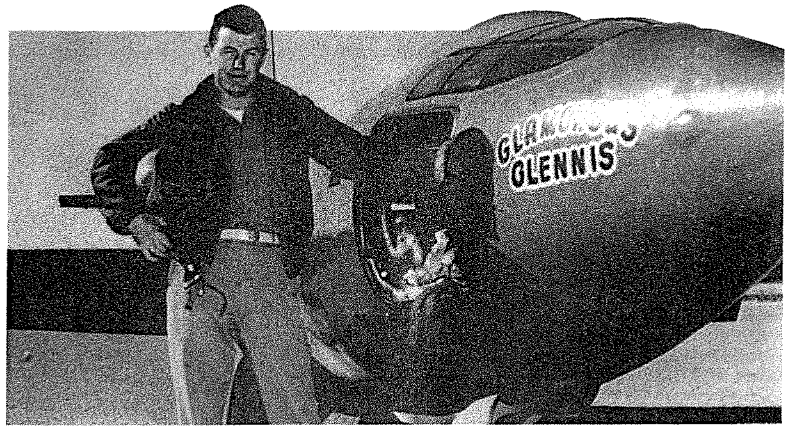


Figure 2–3 *The pioneering flight of Chuck Yeager made possible the now-commonplace flights of airplanes at more than three times the speed of sound.*

Figure 2–4 *Vibrations of the vocal cords cause air particles to vibrate and thus produce sound. This is how the sounds you make when you speak, sing, or yell are produced. It is also the way the operatic artist Jessye Norman produces the beautiful notes of the aria. Norman is an accomplished singer with the New York Metropolitan Opera.*

air and arrive at your ear at the same time. Both sounds will travel at the same speed. **The speed of sound is determined by the temperature, elasticity, and density of the medium through which the sound travels.**

TEMPERATURE One important characteristic of the medium that determines the speed of sound is temperature. Lowering the temperature of a substance makes the motion of the particles more sluggish. The particles are more difficult to move and slow to return to their original positions. Thus sound travels slower at lower temperatures and faster at higher temperatures.

In 1947, Captain Chuck Yeager took advantage of the relationship between the speed of sound and temperature to set a historic record. Captain Yeager was the first person to fly faster than the speed of sound. When he "broke the sound barrier," he was flying at a speed of 293 meters per second. But if the speed of sound in air averages about 340 m/sec (faster than he was traveling), how could Yeager have broken the sound barrier? Yeager was flying at an altitude of 12,000 meters. At this altitude, the temperature is so low that the speed of sound is only 290 m/sec—3 m/sec/sec less than the speed achieved by Yeager. A vehicle on the ground would have to travel about 50 m/sec faster to beat the speed of sound.

ELASTICITY AND DENSITY Although most sounds reach you by traveling through air, sound waves can travel through any medium. To return to the example of the piano, sound waves cause the particles in the wood of the piano to vibrate. That is what you feel when you lean on the piano. Years ago, Native Americans put their ears to the ground in order to find out if herds of buffalo or other animals were nearby. By listening for sounds in the ground, they could hear the herds sooner than if they listened for sounds in the air. The speed of sound in the ground at 20°C is 1490 m/sec—more than four times as fast as it travels in air. Can you think of an example where you listen through some material other than air?

Perhaps from these examples you have realized that sound travels at its greatest speed in solids and at its slowest speed in gases. What is it about the phase of the medium (solid, liquid, or gas) that determines the speed of sound? For one thing, the speed depends on the elastic properties of the medium. This means that if the particles of the substance are disturbed, they must be able to return to their original positions easily.

To understand this, consider the following: You decide to run 1 kilometer down a paved road. You are able to run quickly and steadily because your feet spring off the solid blacktop. By the time you get to the end, you are hardly tired. This is similar to sound traveling through materials in which the particles are rigidly bound together and return to place quickly. Sound travels fastest in elastic materials such as these. But suppose you run the same distance on a wet beach where each time you step, the sand sinks under your feet. This time you have to put more energy into each step. When you finish this jog, you will be more tired. This is what happens to sound waves in less-elastic mediums. The sound waves travel more slowly and lose energy more quickly.

Solids are generally more elastic than either liquids or gases. The particles in a solid do not move very far and bounce back and forth very quickly as the compressions and rarefactions of a sound wave go by. Thus sound travels more easily through solids than it does through liquids and gases. Most liquids are not too elastic. Sound is not transmitted as well in liquids as it is in solids. Gases are even more inelastic than liquids. So gases are the poorest transmitters of sound.

In materials in the same phase of matter, the speed of sound is slower in the denser material.

SPEED OF SOUND

Substance	Speed (m/sec)
Rubber	60
Air at 0°C	331
Air at 25°C	346
Cork	500
Lead	1210
Water at 25°C	1498
Sea water at 25°C	1531
Silver	2680
Copper	3100
Brick	3650
Wood (Oak)	3850
Glass	4540
Nickel	4900
Aluminum	5000
Iron	5103
Steel	5200
Stone	5971

Figure 2–5 *The speed of sound varies in different mediums. In what medium does sound travel the fastest? The slowest?*

Activity Bank

Just Hanging Around, p.143

Figure 2–6 *A piano can be made to send melodious tunes through the air to your ear. But the sound waves also travel through the wood of the piano and can be felt as vibrations. Does sound travel faster through wood or through air? Why?*

Because the denser medium has greater mass in a given volume, it has more inertia. Its particles do not move as quickly as those of the less-dense material. The speed of sound in dense metals such as lead and gold is much less than the speed of sound in steel or aluminum. Lead and gold are also less elastic—another reason why the speed of sound is slower in these metals.

2–1 Section Review

1. What is sound? What kind of wave carries sound?
2. What characteristics of the medium affect the speed of sound?
3. Compare the transmission of sound in solids, liquids, and gases.

Connection—*Earth Science*

4. Light travels faster than sound. Thunder and lightning occur at the same time. However, thunder is heard after a flash of lightning is seen. How can the time in between the two be used to calculate how far away a storm is?

Guide for Reading

Focus on this question as you read.

- *How are the characteristics of sound related to the physical characteristics of the wave?*

2–2 Properties of Sound

Now you know that all sounds originate in the same basic way. They are produced by vibrations and transmitted as longitudinal waves. Yet there are millions of different sounds in everyday life—each having certain characteristics that make it unique. Think about the many sounds you hear every day. How you hear and describe a sound depends on the physical characteristics of the sound wave. As you have read in Chapter 1, the physical characteristics of a wave are amplitude, frequency, and wavelength. These are the factors that determine the sounds you hear.

Frequency and Pitch

Certain sounds are described as high, such as those produced by a piccolo, or low, such as those produced by a bass drum. A description of a sound