unit

3 Sound

Prior Knowledge

The student has

1. worked with examples of at least two forms of energy, such as light and heat
2. had an opportunity to experience or talk about an echo
3. measured length in inches, feet and centimeters
4. worked with forms of matter such as a solids, liquids and gases
5. multiplied and divided single- and double-digit numbers
6. added and subtracted two- and three-digit numbers with re-naming and regrouping
7. interpreted data and summarized it on a graph.

Mathematics, Science and Language Objectives

Mathematics

The student will

1. multiply and divide two- and three-digit numbers
2. solve rate problems related to speed and frequency
3. use fractions to describe parts of a graph.

Science

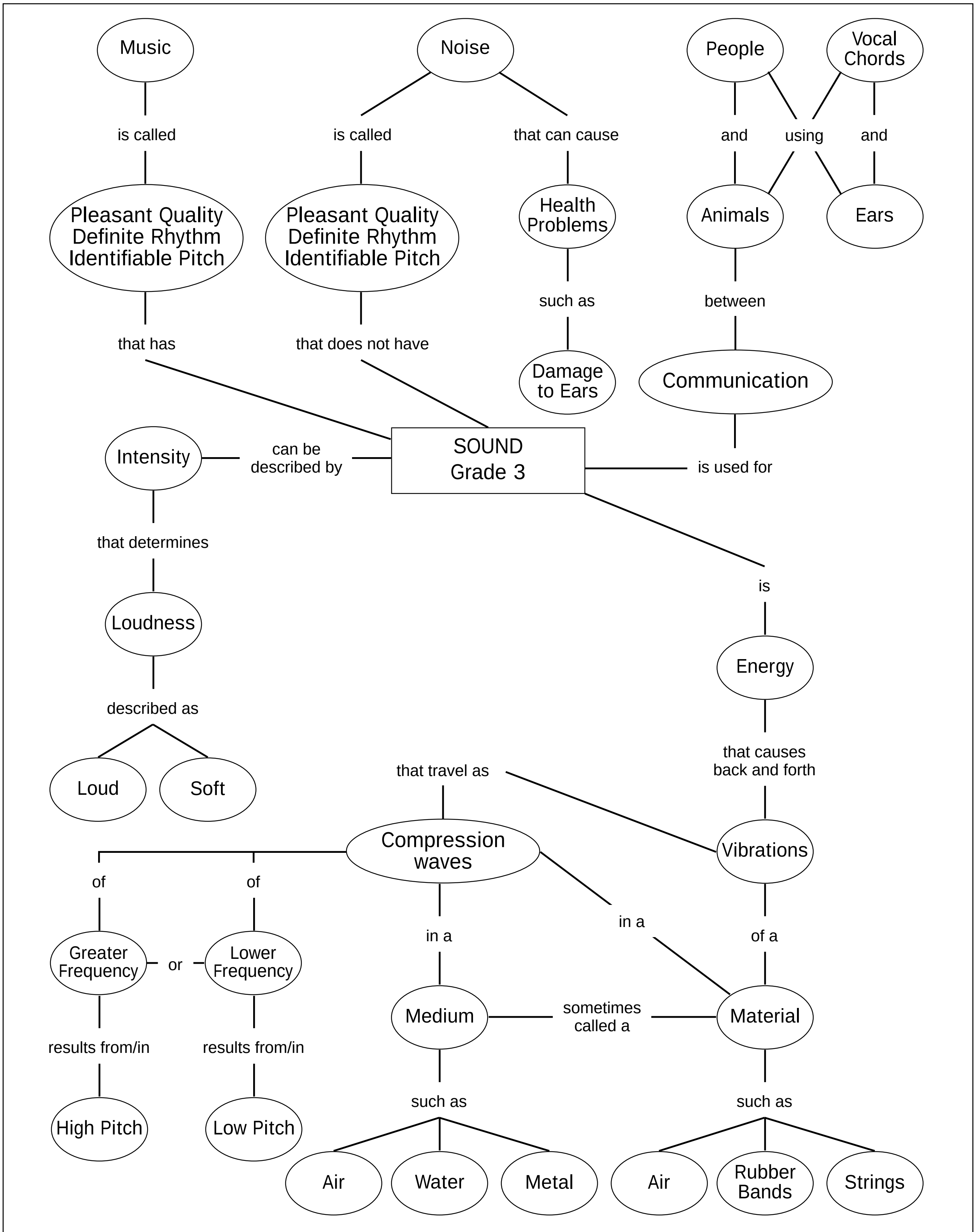
The student will

1. give the location of a sound
2. describe source of sound as the vibration of matter, including air
3. describe and demonstrate with vibrating objects how sound travels through substances by wave motion
4. compare and contrast music and noise using concepts of rhythm, pitch and volume related to wave motion
5. describe the human voice range as related to frequency
6. identify the resonators in the human body that produce the voice
7. describe radiators and resonators.

Language

The student will

1. find needed information in an appropriate reference book
2. follow oral and written multistep directions
3. predict outcome of a story
4. make oral and written inferences and draw conclusions from an activity
5. write poetry related to sound concepts
6. communicate the solution to problems in oral and written form
7. create pattern reports.


Music
is called
Pleasant Quality Definite Rhythm Identifiable Pitch
that has
Noise
is called
Pleasant Quality Definite Rhythm Identifiable Pitch
that does not have
that can cause
Health Problems
such as
Damage to Ears
People
Vocal Chords
and
using
and
Animals
Ears
between
Communication
is used for
SOUND Grade 3
Intensity
can be described by
that determines
Loudness
described as
Loud
Soft
is
Energy
that causes back and forth
Vibrations
that travel as
Compression waves
of
of
Greater Frequency
or
Lower Frequency
results from/in
results from/in
High Pitch
Low Pitch
in a
in a
of a
Medium
sometimes called a
Material
such as
Air
Water
Metal
such as
Air
Rubber Bands
Strings

C O N C E P T W E B

VOCABULARY

sound sonido	vibrations vibraciones	synonyms sinónimos	volume volumen	tuning fork diapasón
noise ruido	energy energía	medium mediano	thickness grueso	hum tararear, zumbar canturrear
length longitud, largo	pluck plectro, pulsar puntear	reflect reflejar	observe observar	pitch tono, entonar
resonate resonar	note nota	stereophonic esterofónico	transfer transferir	amplify amplificar
rhythm ritmo	quality calidad	vocal chords cuerdas vocales	ear oido	radiator radiador
material material	communicators comunicadores	communication comunicación	solid sólido	intensity intensidad
verbal verbal	wave onda	loud alto, fuerte	pleasant agradable	soft silencioso, bajo
cell célula	neuron neurona	rubber band liga, goma	compression wave onda de compresión	
thesaurus diccionario ideólogico				

● ● ● Teacher Background Information

Much of what we learn about our world comes to us through our sense of hearing. Hearing is important not only for learning about the world, but also for communicating with other humans and with animals. The human voice is unique in its ability to express abstract ideas.

Sounds give animals a lot of information, warning them of danger and informing them that possible prey is around. Sounds tell animals and humans about the weather in the form of thunder and the quality of the sound (for example, sounds on a cold, clear night are different from sounds on a hot, muggy evening), or the blowing of the wind. We inform each other as to time with the lunch whistle, danger with the fire alarm or the police whistle, happiness or sadness with music, and so on.

Doctors can listen to their patients' heartbeat, their lungs and their stomachs to help in the diagnosis of illness. We can listen to engines or motors to tell us if we need to repair them. We can identify people by the unique sound of their voices or the sound of their footsteps. We can identify animals by their sounds: birds calling, lions roaring, insects buzzing, and so on. We can all learn from the sounds we hear, and our sense of hearing helps us in learning of the world around us.

Students can learn many technical concepts related to sound by conducting the experiments and activities in the unit. Students can learn concepts of pitch and volume, sound radiation and resonance by playing with objects that vibrate and by making them vibrate in different ways. As students learn to change variables in an experiment and to observe the consequences of the changes, they will begin to develop an approach to problem-solving that will lead them to appreciate the scientific method.

Vibrations, or sound energy, can be felt as a pulsation. The scientists who study these vibrations interpret them as sound waves and picture them on graphs. Students can use these new concepts of energy traveling as waves through a medium to understand the essential notions of sound. We can explain pitch, volume, rhythm, music and noise by looking at graphs of sound waves. Although the production of sound and the ability of humans to detect, analyze and identify sounds are complex, the students can understand the fundamental notions if they are able to experiment with objects in order to become familiar with the ideas.

Sound travels better through solid objects because the molecules pack more tightly and don't have to move a great distance to bump against each other and transmit the vibrations. Sound will travel a greater distance through materials for the same reason. The exception, of course, is specially designed acoustic material that appears to be solid but is designed with spaces to "trap" vibrations.

We can hear the tapping on the desk and the ticking of the clock more clearly when we have an ear against the solid object.

In studying pitch, or the frequency of vibrations per second, children should be aware that the human ear cannot detect the frequency of very high (fast) and very low (slow) vibrations. Dog whistles are too high-pitched for people to hear them, but dogs and some other animals can hear them.

Sound is a very important part of our lives. It is one of the first stimuli to which newborn infants react, and it affects us throughout our lives.

A study of sound can extend greatly to include listening skills. Music can be integrated through a discussion of musical sounds and musical instruments and through producing music by electronic means.

Throughout the unit, encourage children to bring and demonstrate their own musical instruments. Children naturally seem to enjoy music and making music. Music can be used as a motivation for the study of sound. Parents and friends who play musical instruments can be invited to participate in the unit. Architects, doctors (audiologists) and persons with hearing handicaps can also be invited to participate in the unit.

Many children are familiar with the use of electronics to produce sound. They know about electronic musical instruments, radar, sonar and television. All of these methods can be studied through a study of sound waves.

The aesthetics of sound can also be considered. When is a sound pleasant and when does it annoy? Sound has affected how we communicate with each other and entertain each other. Everyone can appreciate the importance of sound in our daily lives.

LESSON FOCUS

LESSON 1 *What Is Sound?*

BIG IDEAS Sounds develop in many ways as they travel through matter. The speed of sound is 770 miles per hour in air.

LESSON 2 *Sound Travels in Waves*

BIG IDEAS A medium such as air, water or metal is necessary for sound waves to travel. A graph shows the characteristics of a sound wave.

LESSON 3 *High/Low and Loud/Soft Vibrations*

BIG IDEAS We hear sound as changes in the frequency and height of sound waves. We hear the frequency of sound waves as pitch, and we hear the height of sound waves as volume, or amplitude.

LESSON 4 *Radiators and Resonance*

BIG IDEAS Radiators are vibrating objects that send out sound energy. Resonators vibrate at the same frequency as the radiators but with different volume (loudness).

LESSON 5 *The Human Voice*

BIG IDEAS The human voice comes from the larynx, the lungs, and the resonators in the mouth, nose and throat. The frequency of the sound waves of the human voice is between 80 and 400 cycles per second.

LESSON 6 *What Is Music? What Is Noise?*

BIG IDEAS Music is sound that has rhythm, pitch and volume and that is pleasant to the ear; noise has none of these but is irregular sound.

LESSON 7 *Sound Is Important in Communication*

BIG IDEAS Sound allows communication among people and between people and animals through the use of vocal chords and ears. Humans can hear sounds that have a frequency between 15 cycles per second to about 20,000 cycles per second.

OBJECTIVE GRID

Lessons	1	2	3	4	5	6	7
Mathematics Objectives							
1. multiply and divide 2- and 3-digit numbers	•					•	
2. solve rate problems related to speed and frequency			•				
3. use fractions to describe parts of a graph.		•	•				
Science Objectives							
1. give the location of a sound.	•		•	•	•	•	•
2. describe source of sound as the vibration of matter, including air		•	•	•	•	•	•
3. describe and demonstrate with vibrating objects how sound travels through substances by wave motion	•	•	•	•	•	•	•
4. compare and contrast music and noise using concepts of rhythm, pitch and volume related to wave motion					•		
5. describe the human voice range as related to frequency					•		
6. identify the resonators in the human body that produce the voice					•		
7. describe radiators and resonators.				•	•	•	
Language Objectives							
1. find needed information from an appropriate source					•		•
2. follow oral and written multistep directions	•	•	•	•	•	•	•
3. predict outcome of a story	•	•	•	•	•	•	•
4. make oral and written inferences and draw conclusions from an activity	•	•	•	•	•	•	•
5. write poetry related to sound concepts						•	
6. communicate the solution to problems in oral and written form	•	•	•	•	•	•	•
7. create pattern reports.				•	•		•

LESSON 1 *What Is Sound?*

BIG IDEAS Sounds develop in many ways as they travel through matter. The speed of sound is 770 miles per hour in air.

Whole Group Work

Materials

Book: **An Upside-down Day** by J. Scheer
Animal whistle
Meter stick
Tuning fork
Puffed rice, puffed wheat
Cellophane or a balloon
8 1/2 x 11 piece of cardboard or heavy paper
Salt or oatmeal box with ends cut out; cover the box at one end with cellophane stretched tightly and secured in place with a rubber band.
Cassette tape: "Wonderful World of Sounds," Lakeshore or a teacher-made one
Word tags: vibrations, sound

Encountering the Idea

Ask students to predict what an "upside-down day" would be like. Write answers on a chart: the car breaks down, the alarm clock does not go off, etc. Read the simple text, pointing at pictures. At the conclusion, ask if the world will be quiet on upside-down days. What would happen if there were no sounds at all?

The lesson begins with a teacher demonstration of **Cereal Vibrations.** Place the cereal on the cellophane on top of the box. Tap the cellophane lightly to make the cereal jump. Ask the students what makes the cereal move. What is needed to make matter move? (Energy.) Where is the energy coming from to make the cereal move? What is making the sound? What is sound? We'll try to discover the answers to all these questions in our exploration activities.

Exploring the Idea

These three activities will help us examine vibrations, how sounds develop and characteristics of sounds.

At the **Science Center,** the students

1. strike a tuning fork and then put it on their hands to sense the vibrations. The students try to discover how to make the tone louder. Ask students if they think they can change the tone. The students describe the tuning fork as they felt it on their hands.
2. place a meter stick with one end extending at least 15 cm. over a table and hold it firmly on the table with one hand. Students pluck the protruding end of the meter stick to make a sound. They determine what the meter stick is doing as it makes a sound.
3. experiment with the meter stick, trying to make high and low and loud and soft sounds. They record their observations for future use.

4. complete **Activity** — Sounds Develop in Many Ways
5. complete **Activity** — Bell in a Jar
6. complete **Activity** — Sound Characteristics.

At the **Art Center,** the students draw the tuning fork as they felt it on their hands.

Getting the Idea

Ask students to tell what they think sound is. Sound develops when something is **vibrating** — when it is moving back and forth. Hold a loose rubber band between your finger and thumb and pluck it gently. Ask the students: Is it making a sound? Why not? You are right. It has to move back and forth — vibrate very fast — for us to hear the sound. Now, pull the rubber band tight and pluck. What happens?

Show the animal whistle to the students and blow it. Can you hear it? Let the students try blowing the whistle to determine whether the whistle is vibrating. Why can't we hear it? There are some vibrations that are so slow, like the loose rubber band, or so fast, like the animal whistle, that the human ear cannot hear them.

The vibration of matter causes all sounds. Sound is very important in our lives. Sound can make us happy, as with music, dancing or playing a musical instrument. However, sound can be harmful when it is too loud. Sounds can also warn us of danger, as with a fire siren. Sometimes when we are home alone, the sound of the radio or television can give us comfort.

Discuss each activity with the students, stressing that sounds develop in many ways as vibrations in matter.

Organizing the Idea

Students choose several or all of the following activities:

At the **Listening Center,** students play a tape containing various sounds. (Animals, water, city, metal.) Students identify and write as many sounds as they can. The student group that makes the longest, justifiable list gets a sticker (recognition). Play the tape again; as students listen, they write down the name of the sounds. Students can use the list in the **Poetry Center.**

At the **Poetry Center,** the students close their eyes and are very quiet for three minutes. They listen carefully to the sounds around them. Each student writes a poem or Haiku to describe "how being quiet makes me feel."

At the **Music Center,** the students listen to a tape of classical music and then to a tape of rock music. They write a paragraph or a story about how the two kinds of music make them feel.

At the **Language Center,** the students

1. make a "thesaurus" to find different words to describe sounds. In the center of a wheel, write one sound word. Students fill in each spoke of the wheel with related words.
2. make a list of "quiet words." They combine this activity with the activity in which the class makes a "thesaurus" for sound words.
3. write and illustrate what happens on their upside-down days for a class Big Book.

Applying the Idea

At the **Mathematics Center,** students working in small groups of four,

1. work on the following problem and then report to the class during **Closure.**

   Students in the third grade are going to use some music tapes at a class party. The length of the tapes are the following: three tapes are eight minutes each; four tapes are 10 1/2 minutes each; and two tapes are nine minutes each.

   The music is to play for 30 minutes during the party, and then there is to be a 10-minute intermission, followed by 20 more minutes of party and music time. How can Disk Jockey Elena and Disk Jockey Rick play the tapes so that the music ends **exactly on time** for the intermission and ends **exactly on time** at the end of the party?
2. work on the **Activity** — Speed of Sound.

Ask students to consider the question, again. How can you change the tone (pitch) of the tuning fork? (You can't change the pitch unless you change the length of the tines on the fork.)

Closure and Assessment

In their logs, students write and illustrate how sound is a form of energy causing vibrations in matter.

List of Activities for this Lesson

▲ Sounds Develop in Many Ways

▲ Bell in a Jar

▲ Sound Characteristics

▲ Speed of Sound

ACTIVITY
Sounds Develop in Many Ways

Objective

Students produce sounds in different ways.

Materials

Peg board; wide rubber band; two 3 x 5 index cards; small bottle with a mouth; Tuning fork; one-hole rubber stopper; pencil; paper soda straw; small wad of paper; thread; masking tape; one wire coat hanger per student; two pieces of string 50 cm. long

Procedures

1. Stretch a wide rubber band between two support nails on the edge of a peg board. Stretch the rubber band as far as possible without breaking it. Pull only the top strand of the rubber band with your finger and then release it. Describe and record what you observe.
2. Hold the edges of two slightly curved index cards between your fingers. Place the two index cards between your lips. Blow hard enough to produce a sound.
3. Describe what happens to the prongs of the tuning fork after you strike it. Explain what is making the sound.
4. Attach the ball of paper to the thread with a piece of masking tape. Strike the tuning fork with the rubber hammer and let the fork touch the suspended ball. Predict and then describe what happens.
5. Pinch one end of a paper soda straw until it is almost flat. Close your lips gently around the end of the straw and blow air through it. What do you think is producing the sound in this case?
6. Tie the strings to the wide ends of the coat hanger.
7. Hold the ends of the strings stretched tight and hit the hanger against a solid object. Listen to the sound it makes.
8. Wrap the ends of the string twice around each of your index fingers. Put your fingers in your ears and get a partner to tap the hanger on the solid object again.
9. What happened? What can you say about this?

Getting the Idea

Tell students that sound is produced when an object vibrates. Ask the students to

1. identify the object that vibrated in each part of the activity above, and
2. identify what made the object begin to vibrate.

ACTIVITY

Bell in a Jar

Note

Teacher demonstration to ensure that students do not touch the hot water or its container.

Objective

Students say that air is necessary for sound waves to travel.

Materials

Four-to-eight ounce glass jar with tight-fitting lid; piece of string; hot (not boiling) water; small bell; tape

Procedures

1. Suspend the bell to the inside of the jar lid with the string and tape. The bell should not touch the sides or bottom of the jar.
2. Put the lid on the jar and close it tightly.
3. Gently shake the jar and listen to the bell.
4. Remove the lid with the bell attached and carefully pour about two to three cm. (one in.) of hot water into the jar.
5. Allow the jar to stand for about 30 seconds and then replace the lid tightly. Be sure the bell does not touch the water or the sides.
6. Gently shake the jar again and listen to the bell.
7. The students describe what they heard the first time and compare it to the second time.
8. What made the sound change?

Getting the Idea

Before hot water is poured into the jar, the students will hear the bell clearly. Hot water in the jar will cause the air to expand and force some of the molecules out. With fewer air molecules in the bottle, sound vibrations will not travel as easily, so the bell will not sound as loud. If there were no air on earth, could we hear sounds by talking to each other? What could we do to communicate if there were no air for sound waves to travel on?

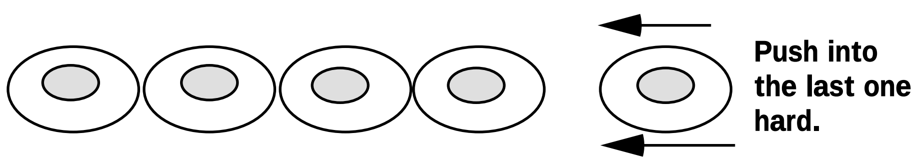
Discuss the problem of communications on the moon or any other place that has no air.

ACTIVITY
Sound Characteristics

Objective
The student demonstrates that energy, such as sound energy, can travel through matter.

Materials
Six metal washers; tuning fork; wooden block; one-hole rubber stopper; pencil; metric ruler; wide rubber band

Procedures
1. Arrange five metal washers in a straight line so that each is touching the other. Place four fingers of your left hand firmly on four of the washers. Place another washer about six cm from the end of the line of washers. With the forefinger of your right hand, flip the washer sharply against the row of washers.
2. Predict what will happen.



3. Describe what you feel.
4. Now place only three of your fingers on the first three washers. Do not touch the last one on the left. Make sure that the last washer is touching the other washer.
5. Again, with the forefinger of your right hand flip the washer sharply against the row of washers. What happened?
6. Place one end of a block of wood against your ear. Strike a tuning fork with a rubber hammer. Touch the other end of the block with the handle of the tuning fork.
7. Predict what will happen.

Discussion
1. What happened when you pushed the washer into the others?
2. Can energy travel through matter? How do you know?

ACTIVITY
Speed of Sound

Objective
The students solve problems using division as repeated subtraction. Students works in groups of three and four to solve this problem.

Problem
Sound travels about 1200 **kilometers per hour** in air. How far does sound travel per minute?

Before students begin to work in their groups ask them if

1. they understand what their task is: tell me in your own words what you are to find.
2. they have all the information they may need to solve the problem.

Give students an opportunity to work on this problem. These are two examples of student work in solving this problem.

Student Group 1 gave this solution: There are 60 minutes in every hour, so we have to divide up the 1200 kilometers into 60 minutes. We made a chart to show that we put 100 kilometers into each 10 minutes because we want to show 60 minutes divided into 10 minute periods. We subtracted 600 first and then 600 again, because 100 x 6 = 600. Then we had 600 more to go.

10 min	10 min	10 min	10 min	10 min	10 min		
100K 100K 200K	100K 100K	100K 100K	100K 100K	100K 100K	100K 100K	600K 600K	1200K in 60 min.

Sound travels at 1200 kilometers per hour, which is the same as 200 kilometers in 10 minutes. If we put 200 kilometers into groups of 10, then each minute gets 20 kilometers. Then: Sound travels at 20 kilometers per minute.

Sound travels about __________ **kilometers per minute.**

Student Group 2 gave this solution: We used colored chips to show the speed of sound. We used 120 red chips because each chip is worth 10 because we couldn't get 1200 chips. Then we put the chips into stacks of 10 each. That gave us 12 chips in each stack. But we didn't understand that so then we put the chips into stacks of 12 and that gave us 10 stacks. Finally we put the 120 chips into six stacks because there are 60 minutes in one hour. Each stack has 20 chips. We got the same answer, but we only used six stacks for the 60 minutes. We think using the chart is easier to understand, even though we got the same answer.

Problem
If sound travels 770 miles per hour in air, how far does it travel in one minute?

Give students an opportunity to solve this problem in groups.

One solution:

10 min	10 min	10 min	10 min	10 min	10 min		770 miles
100K	100K	100K	100K	100K	100K	600K	in 1 hour
10K	10K	10K	10K	10K	10K	60K	
10K	10K	10K	10K	10K	10K	60K	774 miles
9K	9K	9K	9K	9K	9K	54K	in 1 hour
129K							

We started with 100K because 100 is an easy number. 100K $\times$ 6 = 600K.

Sound travels at 770 miles per hour, which is the same as 129 miles in 10 minutes. If we put 129 miles into groups of 10, then each minute gets almost 13 miles. Then: Sound travels at about 13 miles per minute.

Assessment

1. If a jet goes at the speed of sound in air, what is the jet's speed in miles per hour?
2. If the jet is going at 26 miles per minute, what is the jet's speed in miles per hour?
3. Is the jet traveling faster than the speed of sound? Compare the two speeds.

LESSON 2 *Sound Travels in Waves*

BIG IDEAS A medium such as air, water or metal is necessary for sound waves to travel. A graph shows the characteristics of a sound wave.

Whole Group Work

Materials

"Slinky" for each student group; a tuning fork for each student group
Large pan 1/2 filled with water; another pan with bottom covered with two inches of sand

Encountering the Idea

How do we know that sound travels? Students suggest reasons. Yes, because I can call you from one end of the hall, and you can hear me at the other end. I can also call you on the telephone, and I can be very far away, and you can still hear me. How does sound travel through a telephone?

Sound does not always travel. Who has heard of a "soundproof" room? What does that mean? Students give descriptions. For example, if you want to practice a musical instrument in the band room, you practice in a soundproof room so that you won't hear outside noises, and students and teachers outside the room won't be disturbed by your practicing.

Before going to the learning centers, let's try a few things and see what you think about them. Here is a large pan that has water in it. A students strikes the tuning fork and puts it in the water in the center of the pan. The students describe what happens. (Making waves; as the waves hit the sides of the pan, they return and hit the others; the waves go out in circles.) Now, strike the tuning fork harder and place it in the water again. What happened to the waves? (They moved faster and they got bigger; they hit the sides harder.) Are the waves traveling in only one direction? No, they are going out in circles. Follow the same procedures when striking the tuning fork and placing it into the sand.

Let's try something different now. We are going to go to the playground. Let's see what you think is happening when we perform these experiments outside. The students go into a large gymnasium, to the cafeteria or into the playground. They yell or hit an instrument (triangle). Go back into the classroom, designate one person to yell. Ask the children to explain the difference between the sounds. After the students have had an opportunity to express their opinions, tell them that they will discover how sound travels.

Exploring the Idea

At the **Science Center,** the students

1. work with a "Slinky" to discover how a "wave" moves. Tell the students that the slinky is showing a wave motion. Working in pairs, the students draw a

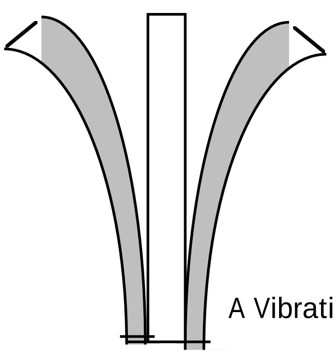
picture of how they think a wave moves and explain it to the class; then the students investigate how sound waves travel by completing **Activity** — Sound Travels in a Medium.

- make a telephone using styrofoam cups, tin cans, plastics with thread, string, yarn, to see that sound waves travel through styrofoam and thread by completing **Activity** — Phone Call

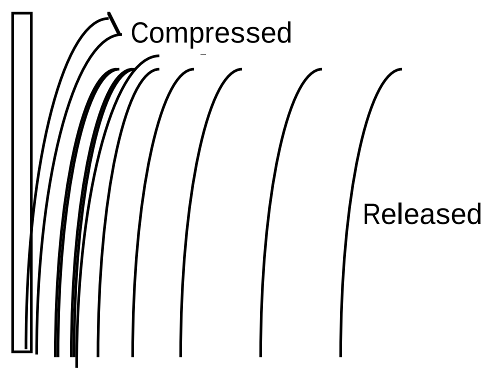
2. experiment with bottles and other objects to understand that sound waves can be reflected or absorbed, depending on the materials with which they come into contact, by
   - completing **Activity** — Musical Bottles
   - completing **Activity** — Reflected or Absorbed?
   - completing **Activity** — Phone Call.

Getting the Idea

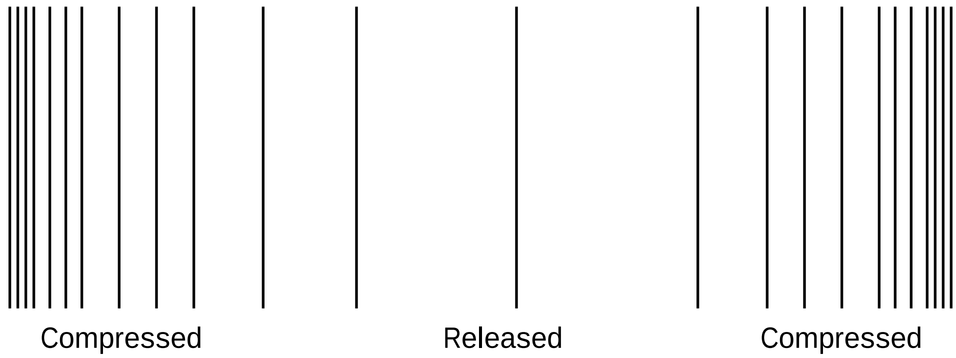
Ask students how they think sound travels. What was alike about the motion of the water and sand waves made by the tuning fork and the motion of the slinky? When we struck the vibrating tuning fork, it made waves in the water, or in the sand, and the waves traveled to the sides of the pan. When the waves hit the sides, they bounced off and hit the new waves coming in. If we had waited a few minutes, we would have seen that the water eventually stopped moving and became calm — there were no more waves. The tuning fork also made waves in the air — that is why we could hear the hum of the tuning fork. Sound needs a medium, such as air, in order to travel. You were able to see the wave motion on the slinky because the slinky was the medium for the wave.



A Vibrating Meter Stick



The vibrations push together and then push back, beginning a back and forth motion.



Is this how a slinky moves? Demonstrate it.

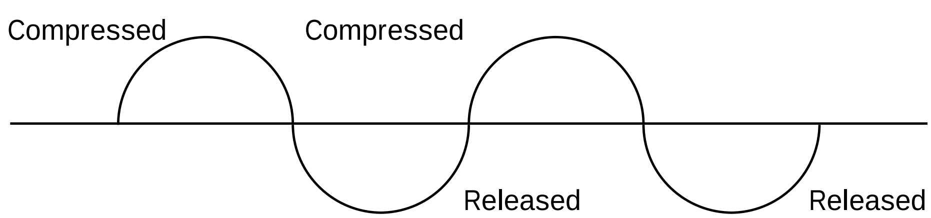
Introduce the words **reflected** and **absorbed.** Ask students to strike a tuning fork and then feel it with their hands. Can they feel the vibrations? Ask students to place a hand on top of a radio as it plays. What can they feel? What is vibrating? What is causing the sound?

Ask students to explain what an echo is, if sound travels in waves? An echo is reflected sound. It strikes matter that is hard and smooth and reflects the sound — bounces it back.

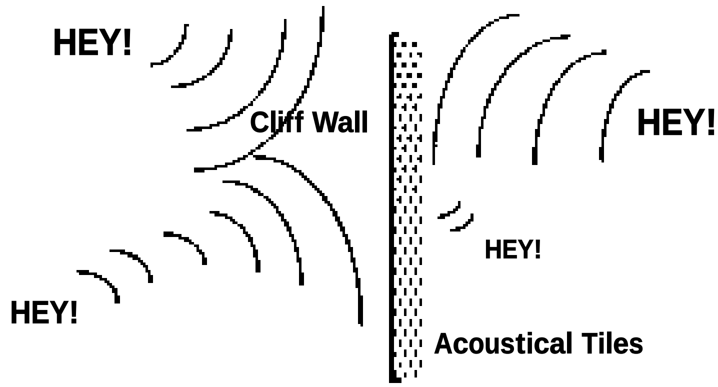
What happens in a carpeted room? What happens in a soundproof room? The walls or floors have materials that are not hard and smooth — they are soft and rough — like carpet, velvet or wool. These materials absorb the sound waves.

Organizing the Idea

1. At the **Mathematics Center,** students draw wave motion as a graph that shows matter being compressed and then being released. The top of the graph, the part above the line, shows that the air, or the medium, is being compressed. The bottom part of the graph, the part below the line, shows that the air, or the medium, is being released. The pattern — compressed, released, compressed, released — we feel as a sensation we call sound.



2. Discuss echos that students have heard (mountains, empty rooms, caves). Students can write a story about an echo, or about a sound that should have been heard but was not because it was absorbed, or a story about a sound wave and its travels.
3. Students can draw an echo (as is shown in cartoons) as a reflection of the waves.



Applying the Idea

Problem Solving

You are an architect and want to build an auditorium for a musical performance. What type of materials are you going to use to build it? Explain your answer.

You are an architect and want to build a new wing in the hospital. What type of materials are you going to use to build it? Explain your answer.

Closure and Assessment

1. Draw a picture to show how sound travels through a medium (air, liquid or solid).
2. Explain or draw a picture to show how an echo develops.
3. Show how sound is reflected or absorbed.
4. Complete a pattern report. The first line begins with:

The important thing about __(topic)__ is __(student's opinion)__. Three to five statements expand on the topic. The final sentence repeats the first: The important thing about _______ is _____________.

Example: The important thing about sound is that I use it to communicate with my friends. It travels in waves. It can be reflected. It can be absorbed. But the important thing about sound is that I use it to talk.

List of Activities for this Lesson

- ▲ Sound Travels in a Medium
- ▲ Musical Bottles
- ▲ Reflected or Absorbed?
- ▲ Phone Call
- ▲ Speed of Sound and Light (Alternative Activity)

ACTIVITY
Sound Travels Through a Medium

Objective
The student demonstrates that sound travels through a medium.

Materials
Windup clock; meter stick; balloon

Procedures
Students work in small groups.
1. Place the clock on your desk. Stand 20 cm away and listen for the ticking.
2. Have your partner hold the clock at the 20-cm mark on the meter stick. Place your ear at the end of the meter stick and listen.
3. Fill a balloon with water and seal it.
4. Have your partner hold the clock against one side of the balloon. Listen to the clock at the opposite side of the balloon.

Answer the following questions:
1. Through what kinds of matter did you hear the clock? (Solid (meter stick), liquid (balloon), gas (air)).
2. Through which type of matter did sound travel best?

Applying the Idea

1. Explain why you may never be in a place where there are no sounds.
2. Suppose you are trying to study for a test and don’t want sounds to disturb you. Name at least three ways to reduce the sound level in your room so that you can study.

ACTIVITY
Musical Bottles

Objective
Students say that vibrating air makes a sound when we blow across the mouth of a bottle.

Materials
Bottles of various sizes and shapes; water; worksheets; pencils

Procedures
1. Fill 1/4 of a bottle with water; mark the water level.
2. Blow across the top of the bottle until you make a sound. Call this sound the “first” or “reference” sound.
3. Create other sounds by blowing into bottles filled with different amounts of water. Record the water level of each bottle and the sound it makes in relation to the first (reference) sound.
4. Put the bottles in order from highest to lowest pitch.
5. Take the long, narrow bottle and fill it 1/4 full of water. First, predict if you will get a higher or lower pitch and record your prediction. Blow across the top of the bottle and compare to the reference bottle. Record your observation.
6. Take a small bottle and put all the water from the first bottle (the reference bottle) into the smaller bottle. First, predict whether the pitch will be higher or lower and record your prediction. Blow across the top of the bottle and compare to the reference bottle. Record your observation.

Getting the Idea

1. What was vibrating to cause the sound — the bottles, the air in the bottles, or the water? Explain your answer.
2. Which bottle had the highest-pitched sound? The lowest?
3. What happened when you took the first bottle and poured the water into a smaller bottle? When you blew on it, did it make the same sound or a different sound? Was your prediction correct? Explain your answer.
4. What happened when you poured the water into a longer, narrow bottle filled to the same level as the reference bottle? When you blew on it did it make the same sound or a different sound? Was your prediction correct? Explain your answer.

ACTIVITY

Reflected or Absorbed?

Objective

The student names at least two types of materials that will reflect sound and two types that will absorb sound.

Materials

Windup clock; cloth; shoe box; cotton; pieces of wood; carpet scraps; aluminum foil; floor tile

Procedures

1. Make a hole in one end of the shoe box with a pencil.
2. Put the windup clock in the box. Place your ear next to the hole and listen for the ticking sound.
3. Cover the inside of the shoe box with each of the materials listed above. Listen for the ticking sound each time.

Answer the following questions based on your observations.

1. What material was in the box when the clock was loudest?
2. What material was in the box when it was hardest to hear the clock?

Applying the Idea

1. Which materials would you use inside an auditorium if you wanted to invite a music group to play there? Explain your ideas. (Do you want the sound reflected or absorbed?)
2. Which materials would you use on the inside of a hospital room? Why?

ACTIVITY
Phone Call

Objective
Students describe how sound travels through a solid.

Materials
String, at least 200 cm. (two yards) long; nail (to make hole); paper cups; scissors; paper clips (or washers)

Procedures
1. Make a small hole in the bottom of two paper cups.
2. Thread the string through the holes; tie each end to a washer so the string won't slip through.
3. Have a friend hold one cup; you hold the other. Gently pull the string until it's tight. Take turns talking into the cup and listening. Be sure that you keep the string taut. Why do you think these phones work?
4. Work with another pair of students and use two phone sets. Cross the lines by looping one over the other. Describe to your partner what you think is happening and why. Then, report to the class.
5. How is the sound traveling?

Applying the Idea
1. Which do you think would make better "telephone wire," thicker string or thinner string? Why?
2. Why doesn't your telephone work when you let the string hang loosely?
3. What are some other things you could use for a receiver instead of a paper cup?

ALTERNATE ACTIVITY
Speed of Sound and Light

Objective

Students describe how we can tell that light travels faster than sound.

Materials

Drum, cymbals, large metal lid or something else that will make a loud sound when visibly struck; stick to strike object

Procedures

1. Take your drum or other object out on the school grounds. Ask another member of the class to go with you.
2. Move at least 100 meters (approximately 105 yards) away from the other students.
3. Strike the object several times so your partner can see the movement of your arm and hear the sound.
4. Remember, when you see an object move at a distance you are seeing reflected light travel. When you hear the sound you are hearing sound vibrations.
5. Have the students tell you what they observed. What can you say about the speed of light and the speed of sound?
6. Discuss these questions:
   a. Would altitude affect the speed of sound?
   b. Would sound travel more easily during the day or night?
   c. Would sound travel better on a cold or a hot day?

Getting the Idea

Light travels very rapidly, at over 186,000 miles a second. By comparison, sound is a slowpoke, moving at about 770 miles per hour at sea level. (The temperature and density of the air affect the speed of sound. The speed range at sea level is about 740 to 780 as the temperature ranges from freezing to 75 degrees Fahrenheit.) Even at the short distance of 100 meters, a student will be able to see another student strike the drum before he/she hears the sound. Children who have been to athletic events in a large stadium may have noticed that they see sounds made in the playing field by athletes or bands before they hear them. Airplanes, especially fast jets, are sometimes difficult to locate in the sky by their sound because the sound is traveling so much more slowly that by the time it arrives, the plane has moved to a new position.

Children should be able to answer the questions in Step 6 if they remember that sound travels better in air when there are more molecules. Higher altitudes have **thinner air,** fewer molecules per cubic centimeter. Cold air contains more molecules and is **more dense.** Therefore, sound travels better at night or on a cold day.

LESSON 3 *High/Low and Loud/Soft Vibrations*

BIG IDEAS We hear sound as changes in the frequency and height of sound waves. We hear the frequency of sound waves as pitch, and we hear the height of sound waves as volume, or amplitude.

Whole Group Work

Materials

Book: **If I Were a Bird** by G. Conkin
The shoe box as described in **Activity** — Rubber Band Band
Small drum; triangle from the rhythm band
Word tags: pitch, tone, volume (sound), compress

Encountering the Idea

The teacher demonstrates change in pitch by stretching and releasing the rubber bands in the shoe box from the Alternative Activity in **Activity** — Rubber Band Band, and asks the students what changes they hear in the tones of the shoe box guitar. (Yes, the tone goes higher or lower depending on how much we stretch the rubber band.) Now, pluck the rubber bands harder. Ask the students what they hear. Now, demonstrating with the small drum, strike the drum and ask the students what you need to do to make it sound louder. (Yes, hit it harder.)

What can you do to make the drum sound higher in tone, or pitch, or sound lower? Let the students give suggestions. Is it always possible to change the tone of something that is vibrating? Follow the same procedure with a rhythm band triangle. Ask the same questions.

Tell students that they will discover what changes the pitch or tone of a sound, and also what will make it loud or soft.

Exploring the Idea

At the **Sound Center,** the students

1. complete **Activity** — Rubber Band Band
2. complete **Activity** — Musical String Instruments
3. complete **Activity** — Wave Frequency
4. complete all or several of the following:
   Activity — Pitch It High
   Activity — Who Likes It Loud?
   Activity — Musical Straws.

Getting the Idea

Reading Conklin's **If I Were a Bird.** Show students the musical charts pointing out high and low sounds. Musical charts are like graphs. They show pitch or frequency. We can change pitch by changing the frequency. But change in volume does not change pitch.

Tell the students that they have been exploring ways to change the tone, or the pitch of a sound. The pitch tells you how high or how low a tone is. We change the loudness by plucking or striking a note harder. The sound waves change with the pitch — the vibrations are faster for high sounds, and slower for low sounds. The sound waves also change when we make an object vibrate with taller sound waves. We learned how to tell these changes one from the other in the **Mathematics Center.**

1. In sequencing the rubber bands in the shoe box experiment, did you notice a pattern on the rubber bands. What was it? Can you make a rule that connects the size of the rubber bands to the sound they make?
2. In teaching your partner the tune you learned to play on your shoe box guitar, did you use the colored rubber bands to help you? What do the different colors help you see on your guitar? (The colors show that the pitch is different from one rubber band to the other.) How?
3. What did you do to make a louder or softer sound on your guitar? Why?

Organizing the Idea

At the **Mathematics Center,** the students continue showing sound waves with graphs.

Applying the Idea

1. Use your mouth and throat to make high- and low-pitched sounds like you did with the musical bottles. What do you have to do to your mouth and throat to make a low-pitched sound? A high-pitched sound?
2. Use your mouth and throat to make loud and soft sounds like you did with the musical bottles. What do you have to do to make a loud sound? A soft sound?

Closure and Assessment

Oral Assessment

The student briefly explains how fast or slow vibrations change the tone in sound waves, and how the size of the sound waves makes the sound loud or soft.

Performance Assessment

1. The student demonstrates how to change the pitch on a musical instrument, a bottle or a shoe box guitar.
2. The student demonstrates how to change the volume on a musical instrument, a bottle or a shoe box guitar.
3. Given several foot rulers and tongue depressors, the student places them one at a time over the edge of a table and plucks each with one hand while holding it firmly on the table with the other hand. The student makes sounds of different pitch and orders the rulers and tongue depressors from low to high tones.

Written Assessment

1. Given a graph, the student draws another graph showing that the pitch of the tone has changed to a higher or lower tone.

2. Given a graph, the student draws another graph showing that the volume of a sound has changed to louder or softer.
3. Select the frequency that is the same as six waves per second by circling it: 12 waves per two seconds, six waves per six seconds, or three waves per two seconds. Draw the frequency's graph.

List of Activities for this Lesson

- ▲ Rubber Band Band
- ▲ Musical String Instruments
- ▲ Wave Frequency
- ▲ Pitch It High
- ▲ Who Likes It Loud?
- ▲ Musical Straws

ACTIVITY

Rubber Band Band

Objective

The student demonstrates how to make high- or low-pitched sounds using rubber bands.

Materials

Several peg boards and pegs; shoe box with lid; different lengths and **only** two thicknesses of rubber bands, each one labeled for identification

Procedures

1. Taking one rubber band at a time, stretch it (not too far), record the distance between two pegs on the peg board and whether the rubber band is thick or thin, and record the sound it makes — whether high-pitched or low.
2. Using the same rubber band, stretch it **tightly** between two pegs and again, record your observations.
3. Do the same thing with several of the other rubber bands.
4. After summarizing your data on your chart, make a rule about how to make a high-pitched or a low-pitched sound. Explain your rule to the class.

Rubber Band	Wide/Narrow	Amount of stretch (distance between pegs)	High/Low Pitch
A	wide	5 cm	low
B	narrow	4½ cm	higher

Alternate Activity

1. Stretch four or five rubber bands of different thicknesses and lengths around a shoe box without its lid. Pluck the rubber bands and describe what you see and hear.
2. Put the lid on the box and repeat the activity.
3. Sequence the rubber bands from the lowest sounding to the highest sounding. Using colored markers, mark the rubber bands, or use colored rubber bands.
4. Play a tune; teach it to your partner.

ACTIVITY
Musical String Instruments

Objective
Students listen to and describe sounds according to their pitch and loudness (volume, intensity); students adjust the sound source to create a different pitch.

Materials
Plastic cups; worksheets; boxes (without lids); pencils; rubber bands (various lengths and thicknesses)

Procedures
1. Put a rubber band around a box or cup. Pluck the rubber band. What do you hear?
2. Try this with different rubber bands. Which ones make the highest or lowest sound? Put the rubber bands in order from highest to lowest sound. Sound is made by vibration. Fast vibration makes a high sound; slow vibration makes a low sound.
3. Try to transfer the vibration of the rubber band to a piece of paper. What happened? Why? How did you do it?
4. Try to change the pitch of the rubber band. How did you do it? Listen to music made by different string instruments.

Getting the Idea

1. Which rubber bands vibrate faster? Slower? How can you tell?
2. Can you think of some ways to change the sound your instrument makes? (Use other objects to stretch the rubber bands. Instead of a cardboard box, try wood. Instead of a glass cup, try styrofoam.)

ACTIVITY

Wave Frequency

Objective

The student says that if a wave has a frequency of 10 cycles (waves) per second, the wave completes 10 vibrations every second.

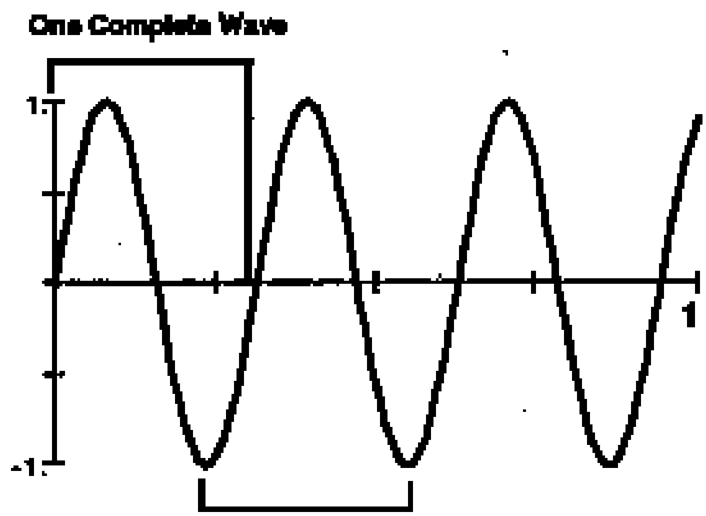
Materials

Pictures of sound waves and blank graphs

Procedures

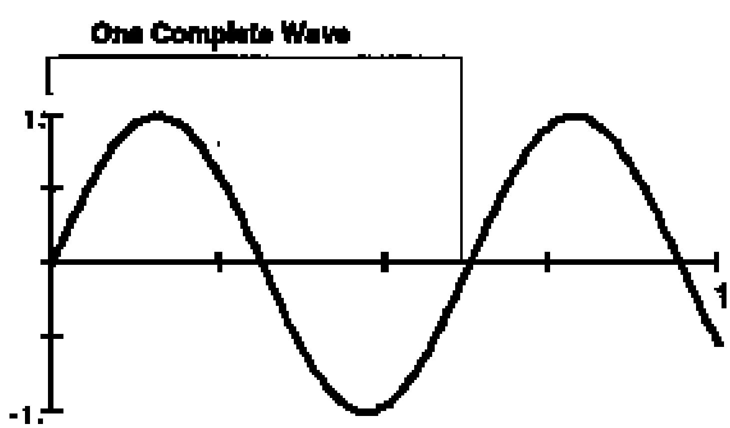
Students describe the waves by counting the number of complete waves between 0 and one second. Give the frequency of the wave as the number of waves per second. We cannot always express wave frequency in whole numbers. Estimate fractions of a wave such as 1/2, 1/4, 3/4 of a wave, or if it is difficult to estimate using fractions, then "about" three or "almost" seven can serve as an estimate.

Frequency of Sound Waves



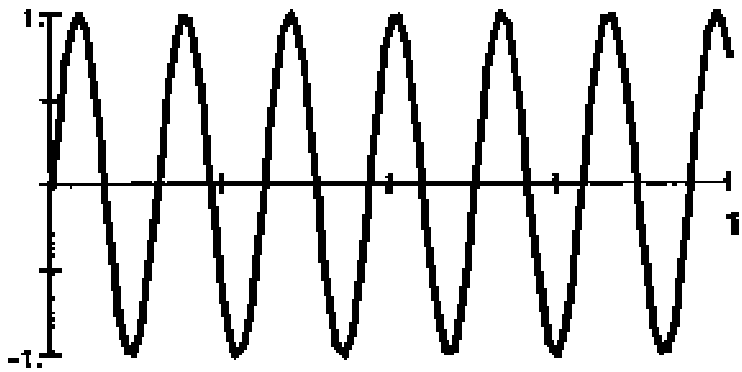
Three and ¼ complete waves in 1 second

Frequency of Sound Waves

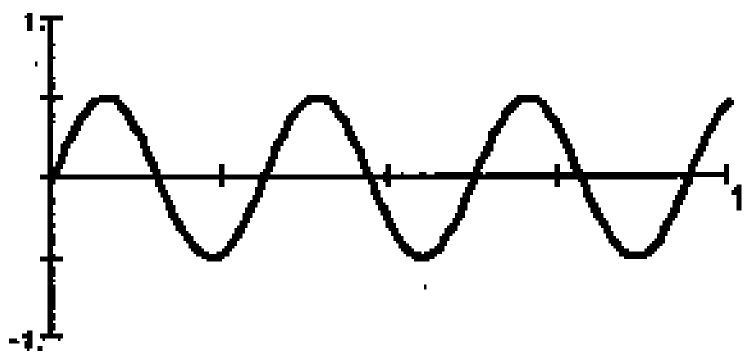


About 1½ waves per second

Frequency of Sound Waves

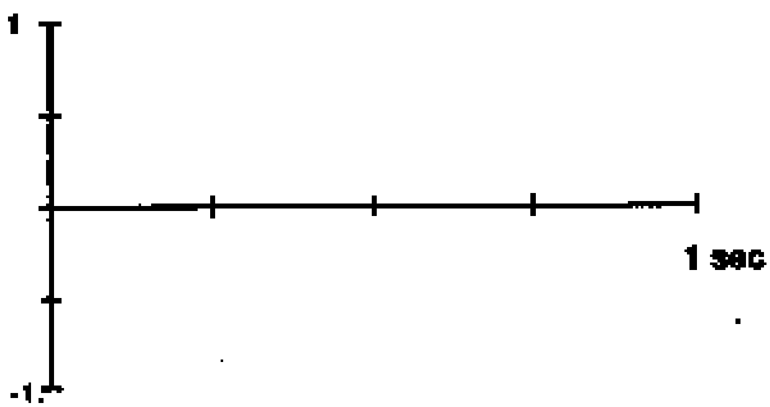


Frequency of Sound Waves

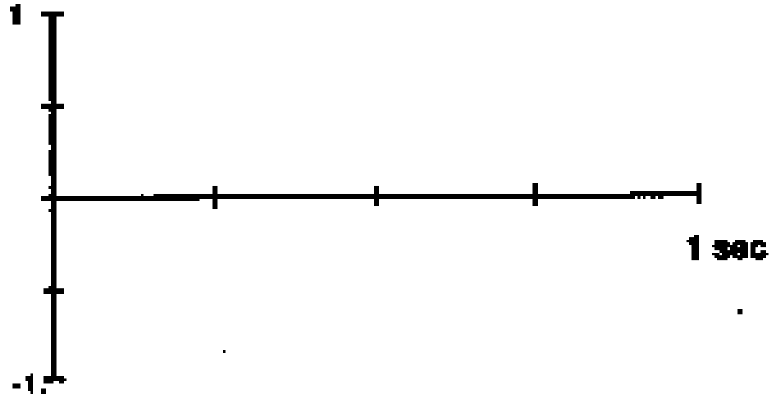


On the blank graphs, draw your own sound waves and tell the frequency of each.

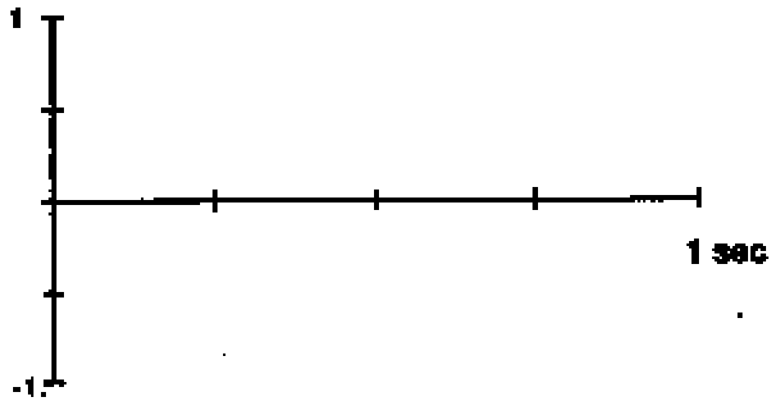
Frequency of Sound Waves



Frequency of Sound Waves

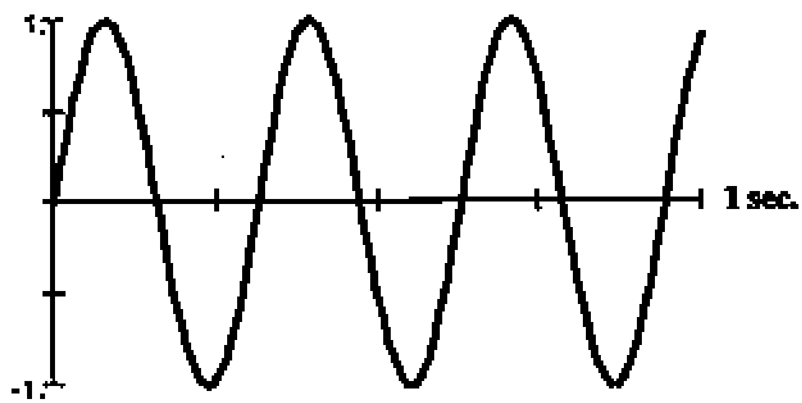


Frequency of Sound Waves

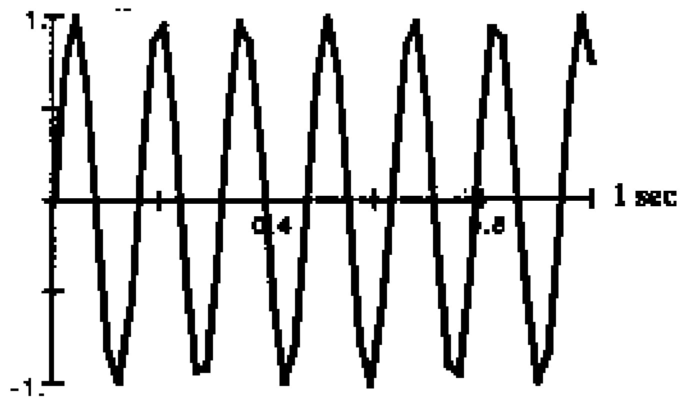


The following are some examples the students might draw freehand.

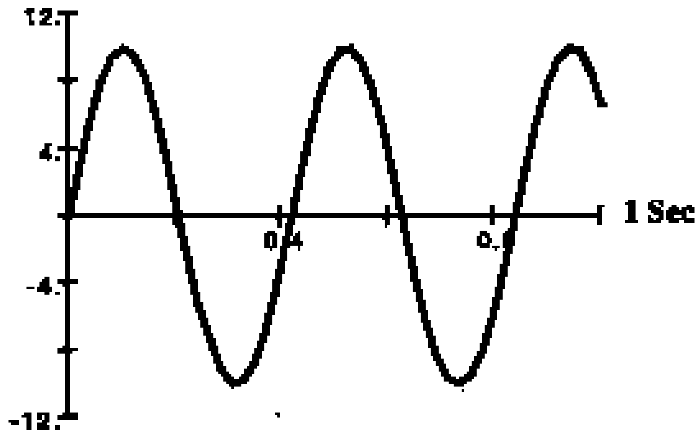
Frequency of Sound Waves



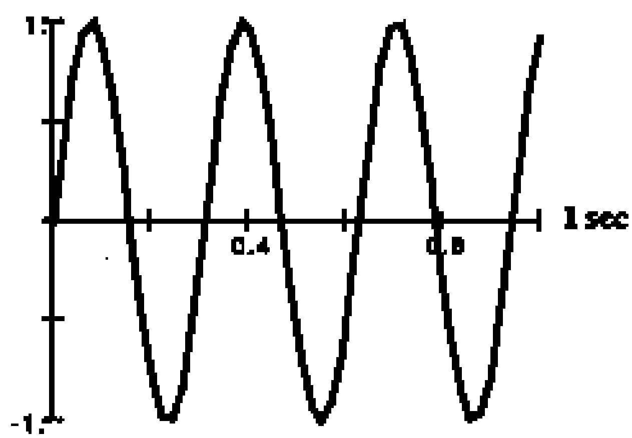
About 3¼ waves per second; amplitude of 1



6 waves per second; amplitude of 1



About 2⅓ waves per second; amplitude of about 10



About 3⅓ waves per second; amplitude of 1

ACTIVITY
Pitch It High

Objective

Students experiment with high and low pitches and say that the sound waves that each note makes are different in frequency.

High or Low?

Materials

a xylophone, autoharp (or piano, if available) or two tuning forks

Procedures

1. Students imitate animals that make high or low sounds, for example: cats, mice, birds, mosquitoes, or elephants, lions, bullfrogs.
2. Play two musical notes on the xylophone, autoharp or tuning forks. Students tell which note was higher and which was lower. Repeat this a few times.
3. Students examine the instruments and hypothesize what makes one sound higher than the other.
4. Students say that the bars on the xylophone or the strings on the autoharp that make higher sounds are shorter; the lower-sounding bars or strings are longer.

Tuning Up

Materials

Eight glasses or jars (all the same size); food coloring; metal spoon; grease pencil; water

Procedures

1. Students make a musical scale by experimenting with the amount of water each jar needs.
2. Students arrange the glasses by sound, from lowest to highest pitch. Number the glasses “1”, “2” and “3” with the grease pencil.
3. Students can play several simple songs on the three jars such as “Mary Had a Little Lamb” by striking the glasses as follows.

- Students add jars to make an eight-note scale. Number the jars 4 through 7.
- Students experiment with the amount of water needed in each jar to get an eight-note scale.
- Ask students if they can detect a relation between jar 1 and jar 8.
- Students experiment with other tunes.

ACTIVITY
Who Likes It Loud?

Objective

Student say that volume (and/or amplitude) means that sounds are loud or soft, and that the sound waves are large or small in size.

Sing a Silly Song

Procedures

1. To practice loud and soft sounds, the class sings “John Jacob Jingleheimer Schmidt” (Juan Paco Pedro de la Mar) or another nonsense song. Students start off singing or chanting as loudly as they can.

John Jacob Jingleheimer Schmidt,	Juan Paco Pedro de la Mar
That’s my name too.	Es mi nombre, sí.
Whenever we go out, the people always shout,	Y cuando yo me voy,
“There goes John Jacob Jingleheimer Schmidt!”	Me dicen lo que soy Juan Paco Pedro de la Mar
Da da da da da da da da!	Ta ra ra ra ra ....

2. Repeat the song several times, each time getting softer and softer, but yelling out the last two lines. The last time around, have children sing silently — only moving their lips — and then yell out the last two lines.

Rocking Rhythm Band

Materials

Shoe boxes; pencils; rubber bands of different widths; paper cups; balloons; rice or beans; scissors; strong tape; jars or plastic cups; wax paper; paper-towel tubes

Procedures

1. Tell children they are going to create a rhythm band with instruments they make themselves. Individual students choose the instruments they want to make: guitar, drum, maracas or “hum-a-zoo”.
2. To make a guitar, have children stretch four or five rubber bands of different widths across a shoe box. When they pluck the strings, each band will have a different pitch.
3. To make a drum, cut the open end of a balloon off and stretch the rest of the balloon over the top of a jar or cup. Students can use the eraser ends of pencils as drumsticks.
4. Students make “maracas” by putting a handful of rice or beans into a paper cup, then inverting and taping another paper cup to the opening. Play the maracas by shaking them.
5. Students make a “hum-a-zoo” by stretching a piece of wax paper over one end of a paper-towel tube and fastening it with a rubber band. Children play the hum-a-zoo by humming into the open end.
6. The students play their instruments in rhythm to a tune they all know while one student acts as the conductor. Using a pencil or ruler as a baton, the conductor raises his/her hands to signal “louder” or lowers his/her hands to signal “softer”. Students take turns choosing a new tune and being the conductor.

ACTIVITY
Musical Straws

Objective

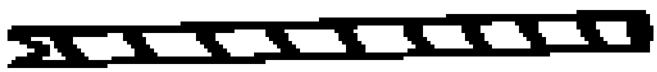
Students associate length of radiators with pitch.

Materials

Paper drinking straws; garden hose one m. long; scissors; mouthpiece from a bugle, a trumpet or a trombone

Procedures

1. Cut one end of a paper drinking straw as shown in the illustration. Moisten the cut end and put it between your lips. Blow gently around the straw. Cut pieces from the end of the straw while playing it. What happened? What can you say about this?



2. Place a mouthpiece in a garden hose. Blow into the mouthpiece to see if you can make a sound. Change the shape of the hose. What happens to the pitch of the sound?

Getting the Idea

With practice, the students will be able to make the cut end of the straw vibrate to produce sound. This "instrument" is similar to a clarinet or oboe. Paper straws work better than plastic because the plastic does not compress as easily to form a reed.

When the group uses the garden hose, a child who plays the trumpet, trombone or bugle may be able to demonstrate and help others learn to play. Changing the shape of the hose will not vary the pitch; however, cutting a length off either the straw or the hose will shorten the vibrating column of air and raise the pitch.

LESSON 4

Radiators and Resonance

BIG IDEAS Radiators are vibrating objects that send out sound energy. Resonators vibrate at the same frequency as the radiators, but with different loudness.

Whole Group Work

Materials

Tuning forks of varying pitch; pieces of wood of varying size and thickness; book, sponge, metal pan, brick, tile and other objects to test as resonators
Word tags: radiator, resonance, amplify, amplitude, sounding board

Encountering the Idea

Strike a tuning fork and hold it in your hand to note its loudness. Touch the base of the tuning fork against a desktop. What happens to the sound? (It gets louder; it gets amplified.) What properties do the objects that made the sound louder have? Ask student if they know what amplifiers are. Have they seen their favorite groups on TV use amplifiers? Tell the students that in the **Science Center** they will experiment with amplifiers of different kinds. They need to think about questions such as: What are the best materials to amplify sound? Does amplifying a sound change its pitch? What does an amplifier do to the sound waves of the vibrating object? Can an amplifier make a sound softer (less loud)?

Exploring the Idea

At the **Science Center,** the students
1. complete **Activity** — Amplifiers
2. complete **Activity** — Musical Resonators
3. complete **Activity** — High/Low and Loud/Soft.

At the **Mathematics Center,** the students complete **Activity** — Music Multiplication.

Getting the Idea

Objects that vibrate and send out sound waves we call **radiators.** Can you think of something else that we call a radiator? Yes, a heater. What does it radiate? Heat, yes. But as you discovered in your experiments, these radiators affect other objects and make them vibrate at the same pitch as their own. The objects that are set to vibrating by the radiators we call **resonators.** You saw that all the musical instruments we investigated had one part that was a radiator (the strings, the drum heads and so on) and other parts that were the resonators. We also call these resonators “sounding boards.” We say that these “sounding boards” **amplify** the sound — they make it louder. Have you heard the word “amplifier” before? How? With rock bands and other types of bands. Any time you want to get a louder sound you can use an amplifier — one that is made of wood or metal, or one that is electric. You can also use an amplifier to make a sound softer; an amplifier changes the volume by making it either higher or lower.

Organizing the Idea

Working in small groups of three to four, students summarize the results of their investigations with the musical resonators. They can do the summary on a chart that lists the instruments, the radiators (strings, drum heads, etc.) and the resonators (the sounding boards, the kettles on the kettle drums, etc., and the materials the resonators are made of — very thin wood, metal, etc.).

Applying the Idea

Students play some of their cassette or video tapes of different kinds of bands and orchestras and see and listen to the instruments to determine how musicians amplify or decrease the sound.

Closure and Assessment

Students write two paragraphs (one for resonators and one for radiators) using the "important thing" pattern for radiators and resonators, e.g. The important thing about radiators (resonators) is ________________. See **Closure** at the end of **Lesson 2.**

List of Activities for this Lesson

- ▲ Amplifiers
- ▲ Musical Resonators
- ▲ High/Low and Loud/Soft
- ▲ Music Multiplication

ACTIVITY
Amplifiers

Objective

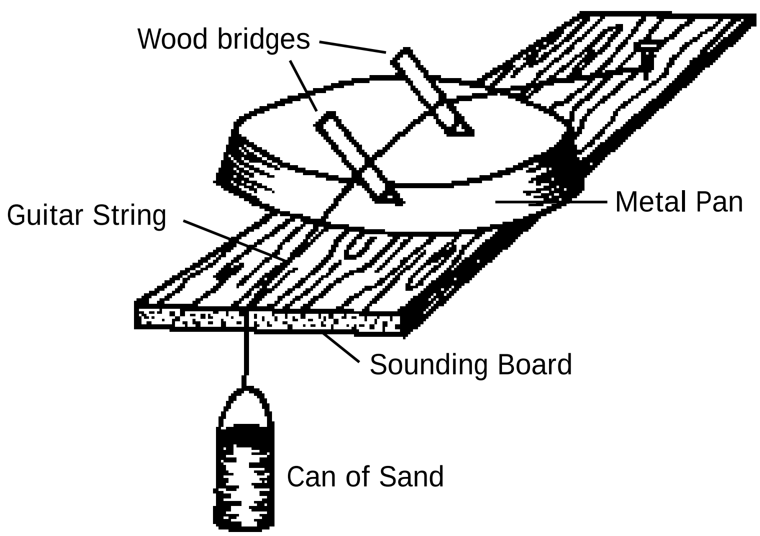
The student describes an amplifier as an object that vibrates at the same pitch as a radiator, or vibrating object, and that increases the volume (loudness) of the sound.

Materials

Large metal pan; pieces of wood to serve as bridges; guitar string; nail; wooden board; pail with handles; sand to put in the pail

Procedures

1. Set up a sounding board as shown below.
2. Pluck the string; the students describe the sound.
3. Compare the sound with and without the metal pan.
4. Use a sponge, thick piece of wood, brick and other materials as possible amplifiers.
5. The students describe the sound the string makes with the different materials.
6. Add sand to the pail or take some out to increase or decrease the tension on the string.
7. Students describe the changes.



Getting the Idea

1. Which materials amplified the sound? Which ones decreased the sound?
2. Make a rule about materials that amplify sound. Tell it to your group and the class so that we can discuss it.
3. How did adding more sand to the pail change the sound? Did it amplify it?
4. What changed the pitch of the string?

ACTIVITY
Musical Resonators

Objective
The student points to the radiators (strings) of a musical instrument, such as a violin or a piano, and to the resonators (sounding boards).

Materials
Musical instruments are usually available in a band room. Since this unit discusses only percussion (drums) and string instruments, the students may want to explore other instruments, such as the reeds and horns, on their own initiative.

Procedures
1. Take students to a band and/or orchestra room, if possible, to examine the various instruments available.
2. The music teacher reminds the students about the care of musical instruments: we can harm them if we drop them. Musical instruments are not easily damaged because they are to be used, but they can be broken or bent if used carelessly.
3. Students examine the drums and predict which ones will sound louder and deeper, or softer and higher. Students record their predictions and then check.

Getting the Idea

1. Which drum had the deepest tone? Why?
2. Find the string on each fiddle that has the highest pitch. Try to make it have a higher pitch. Ask the music teacher to show you how to change the pitch on a fiddle.
3. Which key on the piano has the highest pitch? The lowest? Which string is the longest?

ACTIVITY
High/Low and Loud/Soft: II

Objective

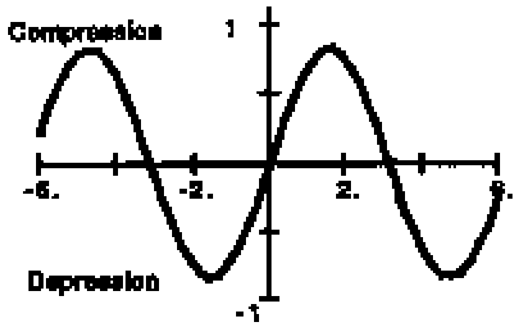
The student identifies the graph of the sound wave that shows a higher (or lower) pitch than another given wave, and a louder (or softer) sound wave than another given wave.

Materials

Laminated sheet of paper showing a coordinate graph; erasable markers of different colors

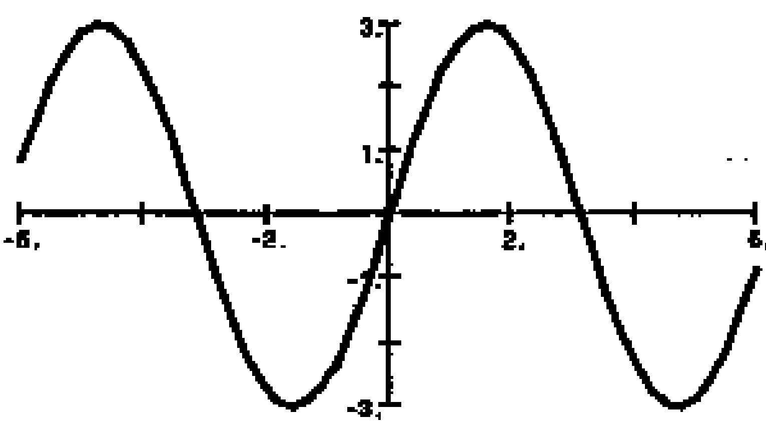
Procedures

Show students the graph of a sound wave as scientists use. The students copy all the graphs on the laminated sheet. After they can copy them with facility, the students draw their own graphs in their journals.

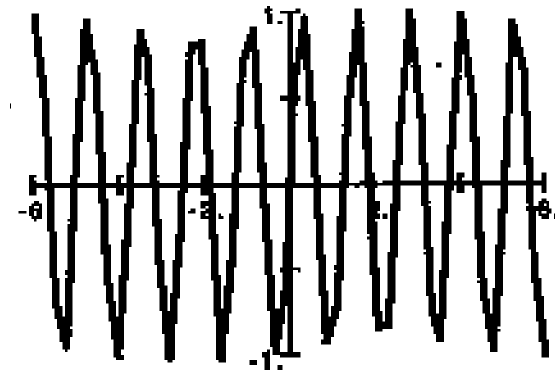


This picture shows the compression (the highest part of the graph) of the wave and the release (the lowest part of the graph).

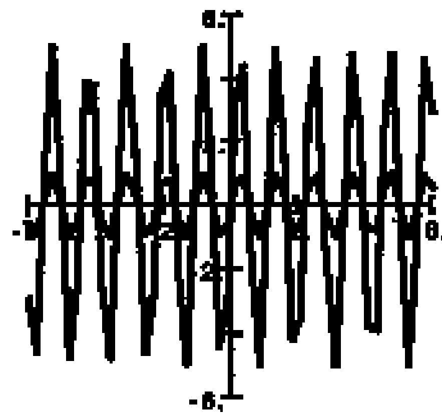
This picture below shows the same sound wave, but now it is louder because the size of the wave is bigger. The volume has changed. The wave goes to only one in the first graph, but it goes to three in the second graph. The volume is three times greater in the second graph.



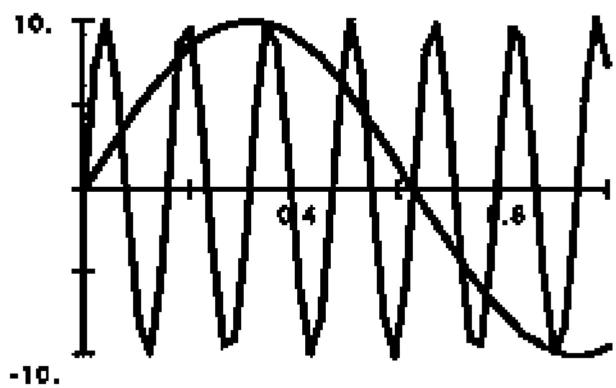
This picture below shows the same sound wave, but now it is higher in pitch because there are more vibrations than in the first one. The pitch has changed.



This picture (graph) below shows two sound waves, one over the other. One is from a rock concert and the other from a school choir singing the National Anthem. Color the wave from the rock band red and the wave from the school choir green. (Hint: Think of the sounds of each before you decide.)



This picture (graph) below shows two sound waves one over the other. One is from a police siren and the other from a bull. Color the wave from the police siren red and the wave from the bull green.



ACTIVITY
Music Multiplication

Objective
The students develop a notion of multiplication as continued addition by 1) using a chart that shows the partial sums and the total sum, and by 2) using an array, which is a set of objects arranged in rows and columns.

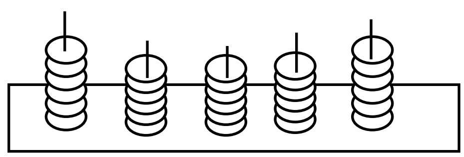
Materials
For each student pair or student group:
paper and pencil to draw chart; counters to make arrays

Encountering the Idea

A wave travels at the speed of six miles every hour.
How far will the wave travel if it travels at that same speed for five hours?

Procedures
The students work in groups to solve the first problem.

1. They summarize the results by using a trading chip board and a chart to show the partial sum each hour until they solve the problem.



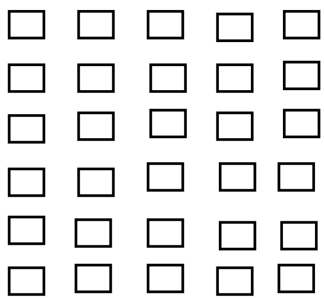
Distance Traveled Each Hour

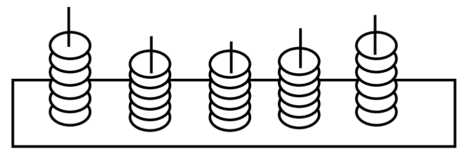
One Hour	2 Hours	3 Hours	4 Hours	5 Hours

2. Give the students the second problem to solve.

A music composer uses paper at the rate of five reams each year.
How many reams will he use in six years?

The students can use a chart or a trading chip board to solve the problem. They defend their solutions every time.





3. Students use the chips and arrays to solve a variety of problems, such as

There are four violin strings in each package of strings.
How many strings will Jerry buy if he buys eight packages?

Each package costs $4. How much will the strings cost?

Organizing the Idea

4. The students write an addition number sentence to represent each of the problems solved above, and read it and explain it to the class.
   Ex. 6 + 6 + 6 + 6 + 6 = 30
   Then they rewrite each additional sentence as a multiplication sentence and read it.
   Ex. 5 X 6 = 30
5. Students write a rule in their journals about when to use multiplication.

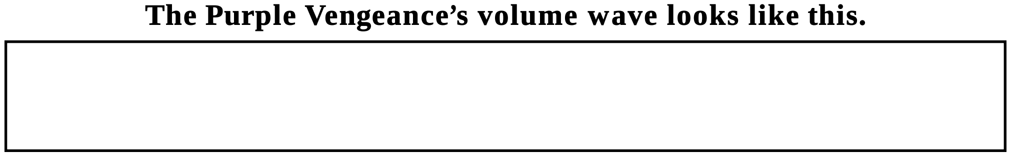
Applying the Idea

6. The students continue to solve problems related to sound, using either a trading chip board, a chart or an array. For example:

One truck can move seven pianos. How many pianos can another truck that is two times as large as the first truck move?

One rock group's volume (The Orange Notes) is five times greater than another rock group's (The Purple Vengeance) sound.

The Purple Vengeance's volume wave looks like this.



On top of The Purple Vengeance's volume wave, draw the Orange Notes' volume wave.

LESSON **5**

The Human Voice

BIG IDEAS The human voice comes from the larynx, the lungs, and the resonators in the mouth, nose and throat. The frequency of the sound waves of the human voice is between 80 and 400 cycles per second.

Whole Group Work

Materials

Story about the three little pigs for the **Language Center**
The shoe box guitars prepared for **Activity** — Rubber Band Band
Word tags: frequency, larynx, vocal chords

Encountering the Idea

Hold your hand around the front of your throat and hum and talk. Ask the students to do the same things you do. Make high sounds and low sounds. Make soft sounds and loud sounds. The students describe what their hands feel. Now, using the shoe box guitar to pluck the string that stretches across the box, the students will try to make a higher-pitched sound. Now, make a lower-pitched sound. Ask: How are these two activities related? Can you explain how you make sounds? The following activities in the learning centers will help you discover how we produce the human voice.

Exploring the Idea

At the **Science Center,** the students

1. complete **Activity** — See Your Voice
2. complete **Activity** — Humans, Sound and Words.

At the **Mathematics Center,** the students complete **Activity** — Frequency of the Human Voice.

Getting the Idea

Show students a diagram of the vocal apparatus of the body: the larynx, which we call the voice box and which contains the vocal chords; the lungs that force air in and out through the vocal chords; and the mouth, nose, tongue and teeth.

Ask the students to list and describe the parts of the body we need to produce our voices. Are there other mammals that can produce human sounds? Why are these sounds not really “speech”?

Discuss why children have higher voices than adults. (Their vocal chords are smaller, thinner and shorter, like piano strings.)

At the **Listening Center,** students

1. listen to vocal music from an opera or a popular musical. They list the different voices they hear and the types of sounds they make.

2. read in an encyclopedia about the different types of voices there are for singing, for drama and so on
3. invite the music teacher to talk about singing and the practice involved in learning to shape the sounds and the words.

Organizing the Idea

At the **Language Center,** the students read "The Three Little Pigs." After the students have had an opportunity to read the story, they gather in a group to discuss the following idea: Some words sound like the object they describe. Ask the students if they read any words that sound like what they are describing. (Huff and puff.) Can you think of other words that do the same thing? (Meow, bark, croak, etc.) The students make a list of the words.

At the **Science Center,** the students make a chart of body parts we use for our voices, classifying them as sound radiators or resonators.

The Human Voice

Radiators	Resonators	
larynx	nose	teeth
	throat	
	chest	

Applying the Idea

If possible, in this activity, students pair off with one student knowing the foreign language better than the other. This student serves as a "tutor" for the other.

Students listen to the tape of a story in a language other than English — Spanish, or some other language frequently spoken in the United States. The students try pronouncing the words and

1. make a list of the new sounds they heard and have trouble producing, such as the double "r" in Spanish
2. describe what they had to do to pronounce the new sounds more accurately than when they first tried them
3. report their efforts and successes to the class.

Closure and Assessment

Students create an "important thing" pattern report. See **Closure** at the end of **Lesson 2.**

List of Activities for this Lesson

- ▲ See Your Voice
- ▲ Humans, Sound and Words
- ▲ Frequency of the Human Voice

ACTIVITY

See Your Voice

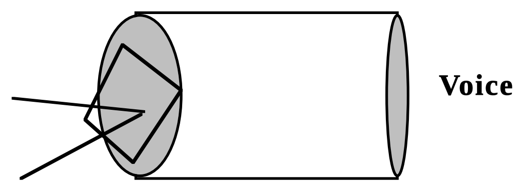
Materials

Mirror two-cm X two-cm (one-inch x one-inch); glue; film screen or white surface; flashlight

Oatmeal box drum, top covered with a large balloon stretched tightly and secured with a rubber band or string. (Cut the bottom end of the box parallel to the top.)

Procedures

1. Glue mirror to drum.
2. Make the room dark and shine the flashlight onto the mirror so the reflected light bounces off the mirror and hits the white surface.
3. Speak in a loud voice into the drum and observe the light on the wall.
4. Practice making different kinds of sounds to see if the pattern changes.



Discussion

1. What is making the mirror move?
2. What makes the light reflect in different patterns?
3. What carried the vibrations from the side of the drum where you talk to the side where the mirror is glued?
4. When you talk louder does that make the sound waves move faster? (No, sound waves move at the same speed. The volume or amplitude of the waves changes.)

ACTIVITY

Humans, Sound and Words

Objective

The student demonstrates that humans shape sounds into words.

Materials

Pictures of the vocal chords, mouth, throat, tongue and teeth
Copy of the rhyme "Mary Had a Little Lamb”

Procedure

1. Say a nursery rhyme like “Mary Had a Little Lamb” until you can say it without hesitating.
2. Try to say the nursery rhyme, except that you have to substitute every vowel for a single vowel, such as “i”. The rhyme is now:
   Miry hid a little limb, its flice wis white as sniw.
   Ind iviri whir thit Miry wint, thi limb wis sire ti gi.
3. Try to say the rhyme with other vowels such as the o, and the u.
4. Hold your tongue and try to say the rhyme normally.
5. Repeat the rhyme with your teeth closed.
6. Sing or hum and note and change the shape of your mouth by opening it, puckering your lips and so on.
7. Think of your best friend and say something that your friend says, trying to imitate his or her voice.
8. Try to repeat the rhyme in Donald Duck’s voice.
9. Pinch your nose and repeat the rhyme in your normal voice. How does it sound? How do you hear yourself? Do you sound the same? What can you say about the use of the nose in speaking?

Getting the Idea

1. When you were saying the nursery rhyme, when were you able to speak most easily?
2. Is talking easy, can you make the words sound the way you want them to when you can’t move your tongue? When do people say “Has the cat got your tongue”?
3. When you are trying to imitate someone you know what parts of your body are you trying to control? (Vocal chords, tongue, teeth, shape of mouth, throat.)
4. Is learning to speak clearly an easy job?
5. Can parrots really talk? Explain your answer.

ACTIVITY
Frequency of the Human Voice

Objective

The student says that the frequency of the sound waves of the human voice is between 80 and 400 waves per second (cycles per second) and describes the graph of those frequencies.

Materials

Several tuning forks of different pitch — middle C, high C, etc. (may be obtained from music teacher)

Blank graphs to describe frequencies

Piano, or some other musical instruments (if possible, conduct this activity where these items are available for student experimentation)

Procedures

Students work in pairs or small groups.

1. The students examine the tuning forks, noting that they are marked with the frequency at which they vibrate. Are these tuning forks within the range of the human voice? Yes. How do you know? (264 cycles per second is between 80 and 400.)
2. The student strikes the tuning fork for middle C. The student hums or sings the note at that pitch. Can she/he sing (or hum) it?
3. At what frequency is the student singing the note? (Answer depends on the tuning fork that the student uses.)
4. The students repeat the procedure with the other tuning forks.
5. The students put the tuning forks in order according to the frequency at which they vibrate.
6. Is there a connection (relation) between the frequency of the tuning fork and the shape or the size of the fork? (Yes, the shorter the fork, the higher the frequency; the shape is the same; only the sizes are different.)
7. Look inside a piano. Describe the strings. (Some of the wires are long and thick while others are short and thin; the long ones have a low sound and the short ones have a high sound.)
8. Examine a bass fiddle and a violin. Compare the strings and predict and record the sounds the strings will make. Pluck the strings and check on your predictions.
9. Ask your teacher to help you find middle C and the C above middle C on the piano. Play one note and then the other. Try to describe the differences in the two sounds. Describe how they may be alike. Can you sing both notes? There are some singers who can sing the C above the high C you played. Can you?

LESSON 6 *What Is Music? What Is Noise?*

BIG IDEAS Music is sound that has rhythm, pitch and volume and that is pleasant to the ear; noise has none of these but is irregular sound.

Whole Group Work

Materials

Tape of children's popular songs: " Puff, the Magic Dragon," "M-i-c-k-e-y M-o-u-s-e,"or something of the students' choice.
Tape with noise recorded — street noise, static, other noises
Cymbals, castanets, other available rhythm band instruments, to place later in the **Rhythm Center**
Tape player/recorder
Reference books on sound and on the harmful effects of loud sounds on the ear
Tapes of Oriental music, music from other cultures, etc.
Word tags: rhythm, pitch, volume, pleasant, unpleasant

Encountering the Idea

Play the two tapes to the students. Ask them what they hear. (One is noise and the other is music.) What makes the difference? When do we call one sound noise, and another sound music? Play students music from other lands — Oriental, American Indian, African, etc. Students discuss the music in terms of pitch and volume. We will discover what qualities of sound humans call "music" and what they call "noise".

Exploring the Idea

At the **Science Center,** the students, in small groups, play segments of the songs and/or music tapes. The students tell the group what they especially like about the music. Then the students describe the music using as many new terms that refer to sound as possible, including the description of voices singing the songs.

Next, the students play segments of the noise tape. The students tell their group what they disliked about the tape. The students describe the sounds using the new terms that refer to sound. Then the groups report to the class.

Getting the Idea

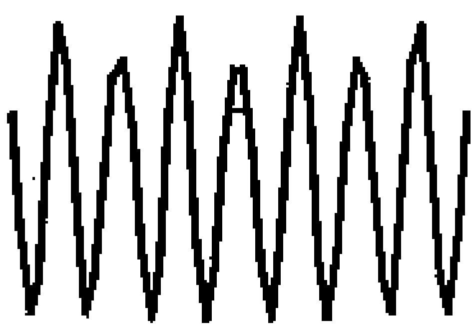
Tell students that music has certain characteristics — some of them students have already investigated, such as pitch and volume; music from all cultures has similar characteristics. Students have not, however, talked about **rhythm.** Other words for rhythm are "beat", "cadence" and "tempo". In pleasant sounds and in musical sounds usually we can detect patterns. One pattern is that of the rhythm, or beat. Can you listen to music and tell if it is rock music? How? How is rock different from the beat of "Mickey Mouse" or "Puff the Magic Dragon"?

At the **Rhythm Center,** the students listen to music of their choice and identify the beat of their favorite songs. They report to the class when they think they can repeat the beat by clapping their hands to the rhythm of the music. The other students check.

Organizing and Applying the Idea

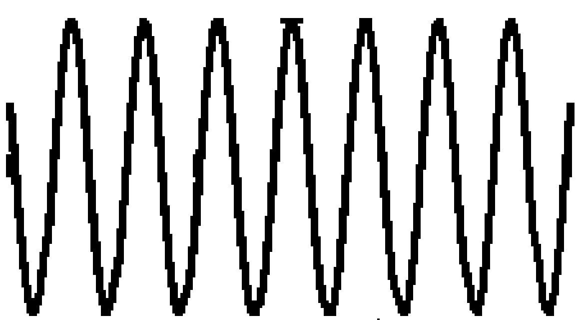
At the **Reading Center,** the students read in reference books about the harmful effects of loud noises and loud music on the human ear.

After the students have had an opportunity to discuss their favorite songs and favorite sounds in the music, ask them to describe graphs of music sounds as compared to graphs of noise. Regular, even sound waves produce a pleasant sensation that we call a musical tone. On the other hand, irregular waves produce a sensation that is not musical and that may be unpleasant. These are pictures, graphs, of some sound waves. Which of these might have been produced by a musical tone and which one might be unpleasant? Which was caused by a breaking dish?

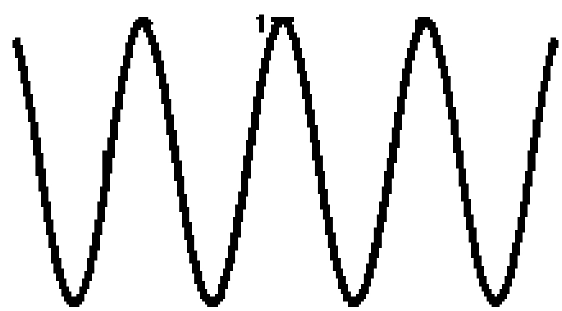


A

B



C



D

Graphs C and D represent regular waves that would usually produce a pleasant sound, while waves A and B are irregular waves that would probably be unpleasant. Encourage the students to give arguments about which of the waves would represent pleasant and unpleasant sounds.

Closure and Assessment

Performance Assessment

1. Working in pairs, the students tap for each other a rhythm to a well-known song. One student taps and the other student tries to guess from the rhythm what the song is. When they find a song that is easy (or hard) to guess, or which has a unique rhythm to it, they demonstrate it to the class.
2. Students write the words to a song based on a popular tune or a nursery rhyme.
3. Students compose a tune to a popular poem or nursery rhyme.

List of Activities for this Lesson

▲ Music Mathematics

ACTIVITY
Music Mathematics

Objective

The students develop the notion of division as continued subtraction by solving various word problems.

Prior Knowledge

The students can subtract one- and two-digit subtrahends from two- or three-digit minuends with and without renaming and regrouping. The students need not have considered the notion of multiplication as continued addition.

Materials

For each student pair or student group:

paper and pencil to draw chart; counters to make arrays

Procedures

Part I

Students work on the following problems and then report solution procedures to the class. Tell students that they may use any of the manipulatives they need to help them solve the problems.

1. **An orchestra composed of 28 musicians is to sit at the front of a dinner party to play for the guests. How many different ways can you arrange the musicians in rows and columns? Which arrangement would you recommend for the occasion?**
    1. Write your solution as a number sentence.
    2. Explain what your group did to solve the problem and why you selected a particular arrangement.
    3. Would you suggest arranging the musicians in five rows? Why, or why not?
2. **A rock group audience of 168 people need to be able to sit in four rows. How many chairs would you set up for each row?**
    1. Write your solution as a number sentence.
    2. Explain what your group did to solve the problem.
    3. Would you suggest arranging the audience in rows of five chairs? Why, or why not?
3. **A rock group audience of 990 people need to sit in rows of 18 chairs each. How many rows will the helpers have to set up in the auditorium?**
    1. Write your solution as a number sentence.
    2. Explain what your group did to solve the problem.
    3. Would you suggest arranging the audience in five rows? Why, or why not?
    4. How are problems # 2 and # 3 alike? How are they different?
    5. Were the methods you used to solve the two problems the same?

4. **The manager of a recording company needs 200 musicians immediately to record some new CDs. She wants to audition the musicians in groups of 10 only and she wants an answer, now, on the telephone.**
   1. Can you send her the musicians in groups of 10 only?
   2. How do you know you can without having to subtract?
5. **Suppose you want to put 420 musical instruments into boxes. How many boxes would you need if you could only put 14 instruments into each box?** Show all your calculations here and then explain them to the class.

Part II

After solving these problems and looking for a process to do others like them, complete this sentence:

The important thing to remember about solving problems that ________________

is to ________________ and to ________________ and to ________________

(as many times as you need.)

LESSON 7 *Sound Is Important in Communication*

BIG IDEAS Sound allows communication among people and between people and animals through the use of vocal chords and ears. Humans can hear sounds that have a frequency between 15 cycles per second to about 20,000 cycles per second.

Whole Group Work

Materials

Book: **The Terrible Thing that Happened at our House** by M. Blaine
Picture of a newborn baby; picture of a pet (dog, cat, etc.)
Stack of cards with "ideas" to communicate such as: a big tree; a monster from outer space; a rabid dog; a singing canary; There is a fire in the house!; I just won a million dollars!; This is the most beautiful rainbow I have ever seen — it is pink, red, purple and extends over half the sky!
Reference books on sound, with pictures of the location of the hearing and speech functions of the brain
Words tags: communication, verbal, cells, neurons

Encountering the Idea

What is the first thing that most babies do when they are born? Yes, most babies begin life by crying. They take their first breath of air and let out a big yell. This is the beginning of communication between the baby and its mother, relatives and then the outside world.

What is the first thing the baby hears? Probably the mother's voice, the father's or the doctor's asking: Is it all right? Is it a boy? Is it a girl? The older brother may even tell the baby, "Hi, baby!" Can the baby hear these words? Is the baby communicating now? It will probably be a few weeks before the family can notice the baby paying attention to conversations and sounds, but eventually the baby begins to try to say words that **sound** like the words that are spoken to him/her. At last, what we usually think of as communication begins. During our exploration phase of the lesson, we will discover how important sound is in communicating with others.

During this lesson, we will explore why communication using sound — using our voices — is important. We will also talk about what makes it possible for humans to communicate — to talk, to hear, to listen and to understand verbal communication.

Exploring the Idea

Play a guessing game. Divide the class into groups of four each. Select one of the groups to be the **communicator group** to communicate a *secret idea* to the class. One student, the **Communicator,** selects a card from the stack, reads it and shows it to the communicator group but does not show it to the other groups. The communicator group plans how the Communicator will reveal the idea to the other groups by **only using body language.** The Communicator cannot speak or write the idea. The first group to guess the mystery idea wins and becomes the communicator group.

As an extension of the game, the **Communicators** suggest their own secret ideas to present to the other groups. They try to get the message to the other groups as quickly as possible, again without using verbal or written symbols.

Students complete **Activity** — Technology and Sound.

Getting the Idea

1. I will now read a story some of you probably can relate to, **The Terrible Thing that Happened at our House.** Teacher reads story. At the conclusion, students discuss why communication between/among human beings is important. Sound helps us to communicate.
2. In playing the guessing game were you successful in communicating all the secret ideas to the class? Why was it difficult? Are speaking and listening important parts of communication? If there had been a real fire in your house, how would you have communicated that news to your family?

How successful were you in communicating to the class that you had a million dollars? What would have been the most effective way to communicate this?

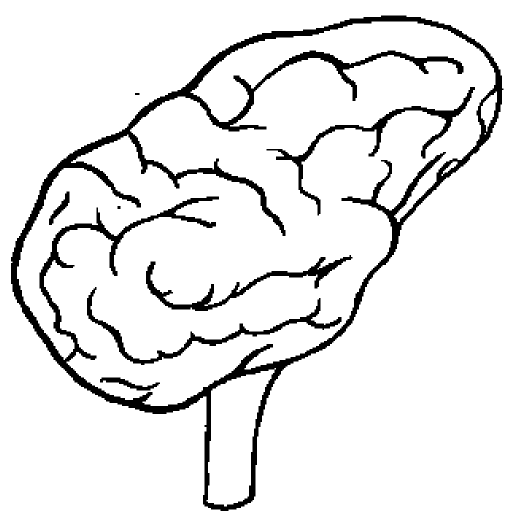
What did you do to communicate the idea of the beauty of the rainbow to the class? Are words always the best method of communication? Would it have been better to show the class a picture of a rainbow or the rainbow itself?

At the **Art Center,** students draw pictures of the brain as they have seen in their reference books and locate the speech and hearing functions.

Organizing the Idea

At the **Sound Center,** you discovered how important communication through sound is and, in the **Library Center,** you were able to see pictures of the brain and how we hear sound.

Tell the students that the brain has many parts, but we will locate and study only two parts of the brain — where speech and hearing form.



Remember that your brain consists of cells called "neurons". Neurons are special nerve cells. They are the main storage units for the information we receive, not only through hearing but through all the other senses.

At the top of the brain are large areas where ideas and relations form — this is where we "think". At the back of the brain is the area where we store what we see. This is the area that helps us "remember" things. Language and hearing — language processing goes on at the lower front area of the brain. Vision is located in the lower back side. The brain is able to coordinate what we see with what we hear.

When we "hear" a sound that means that

1. sound waves have hit the ear drum in the inner ear
2. the drum resonates with the sound from outside and sends the sensations through the nerves and neurons to the part of the brain where sound is "heard"
3. the brain interprets the sound and identifies it. So, really we hear with our brains and not with our ears. The ears only pick up the sound waves and transfer the sensation to the brain.

Applying the Idea

1. Can plants hear? Are plants sensitive to sound waves? Do plants generate (or make) sound waves? Take a position that: Yes, plants can hear, or take the position: No, plants cannot hear, and give reasons why you believe that to be true. Talk with a parent and report your opinions to the class.
2. Do the same with the question: Do plants communicate?
3. What do you think this idea means: A picture is worth a thousand words?

Closure and Assessment

Students write an "important thing" pattern report about the brain or about communication.

List of Activities for this Lesson

▲ Technology and Sound

ACTIVITY
Technology and Sound

Objective
The student names at least five technological inventions that have added to human ability to "hear" sound and thus have added to our ability to communicate.

Materials
Pictures and/or examples of a telephone, a telegraph, a radio, a television, radar, sonar, fax (facsimile), cellular telephone, telephone modem for electronic mail, CDs, video cassettes, tape cassettes, laser disks and any other technology that students know about and that may be available

Reference materials or commercially prepared advertisements from companies dealing with these devices

Procedures
Students work in small groups. Give students sufficient time before they begin the activity to examine each of the devices available to the class. Invite the students to bring to class (with parent permission) any of the items they wish to demonstrate to the class.

1. One group researches and reports to class what the device called "the wireless" was, how it worked and how it was important in the development of the West in the United States.
2. One group researches and reports on what radar is, how its name was selected, who invented it and why it was important during World War II.
3. One group researches and reports on what sonar is, how it got its name, who invented it and why it was important during World War II.
4. One group researches and reports on what the letters FM and AM mean on radios.
5. Student groups may suggest other topics to research and report on, provided the books relate to devices that aid humans in their ability to "hear sound."
6. After the groups have completed their assignments and reports, they make a web of the devices that have been developed to help humans in our ability to hear; then they expand on and describe how the new ability helps us communicate more effectively.

UNIT ASSESSMENT

Oral Assessment

The student will listen to instrumental music and identify sounds that have a high or low pitch and sounds that are loud or soft.

The student will briefly describe how sound develops when matter vibrates and how sound travels in waves.

The student will explain the difference between pitch and volume by describing the different sound waves of the two.

The student will explain the difference between music and noise.

Performance Assessment

The student will make an instrument using a shoe box and rubber bands of different widths (or same width stretched to different tensions (lengths)). The student will compare/contrast the vibrations that each of the rubber bands produce. The student will make loud and soft sounds and will change the pitch at will.

Paper and Pencil Assessment

The student will

1. define sound, sound waves, pitch and volume.
2. draw a sound wave and briefly explain and/or illustrate how the wave travels by compressing and releasing air (or liquid or solid, whatever medium through which it travels).

Annotated Children's Books

Ardley, N. (1984). *Action science: Sound and music.* New York: Franklin Watts.
This text contains simple experiments to explain the concept of sound and music.

Barrett, N. S. (1985). *Picture library: TV & video.* New York: Franklin Watts.
This book shows workings at a TV station and a traveling control room.

Bennett, D. (1989). *Bear facts: Sounds.* New York: Bantam Books.
An easy reader, this acknowledges that sound is heard because of both our outer and inner parts of our ear. It also contains simple illustrations of all kinds of sounds.

Blaine, M. (1975). *The terrible thing that happened at our house.* New York: Four Winds Press.
Mother goes back to work and everything changes. Communication get everything working better.

Branley, F. M. (1967). *High sounds, low sounds.* New York: Thomas Y. Crowell.
This text explains how sounds are produced and received by the ear.

Broekel, R. (1983). *A new true book: Sound experiments.* Chicago: Children's Press.
This introduces the principle of sound using simple experiments.

Catherall, E. (1989). *Exploring sound.* Austin, TX: Steck-Vaughn Library.
Explores aspects of sound and how it travels, how it is received by the human ear, and how it can be recorded. Topics are sequenced from easy to complex.

Conklin, G. (1965). *If I were a bird.* New York: Holiday House.
Bird songs and calls are the main theme of the book. Twenty-seven birds, along with their calls represented by musical notes, are shown in their natural surroundings.

Gibbons, G. (1985). *Lights! Camera! Action! How a movie is made.* New York: Harper.
This book is an overview of the complicated process of making movies.

Jacobsen, K. (1982). *A new true book: Television.* Chicago: Children's Press.
This text provides historical information and other simple materials to show how a TV set works.

Kettelkamp, L. (1982). *The magic of sound* (rev. ed.). New York: William Morrow and Company.
This is a good reference book that gives a clear description of the uses of sound.

Oppenheim, J. (1987). *Have you seen birds?* New York: Scholastic.
Containing pictures by Barbara Reid, this book uses a pattern to describe different birds — how they sound and what they do.

Scheer, J. (1968). *An upside down day.* New York: Holiday House.
Bells won't ring, cows won't moo, balloons won't pop, and drums won't beat are some of the things that happen on an upside down day. Simple text.

Sheldon, D. (1991). *The whale's song.* New York: Dial Books for Young Readers.
This magical story fills the imagination. Do whales really sing?

Webb, A. (1988). *Talkabout: Sound.* New York: Franklin Watts.
This book shows how sound vibrates.

Other resources

The five senses: Wonderful world of sounds [Cassette]. (1989). Carson, CA: Lakeshore Learning Materials.