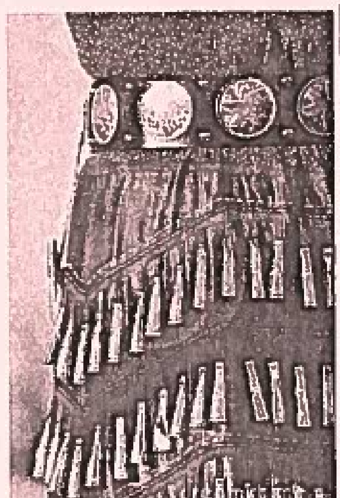
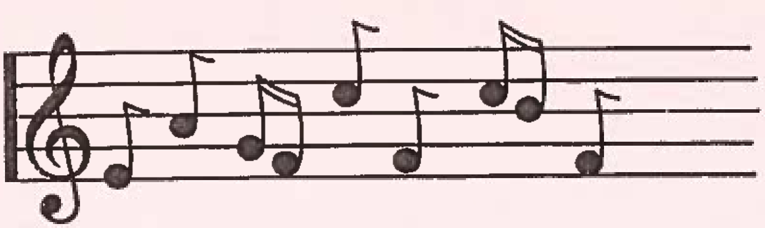
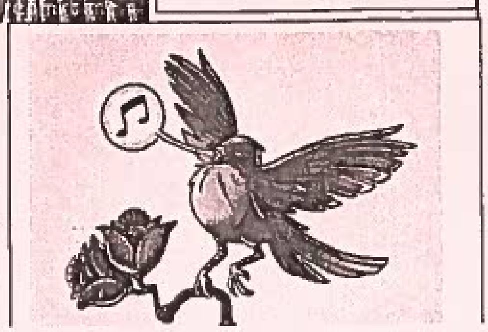
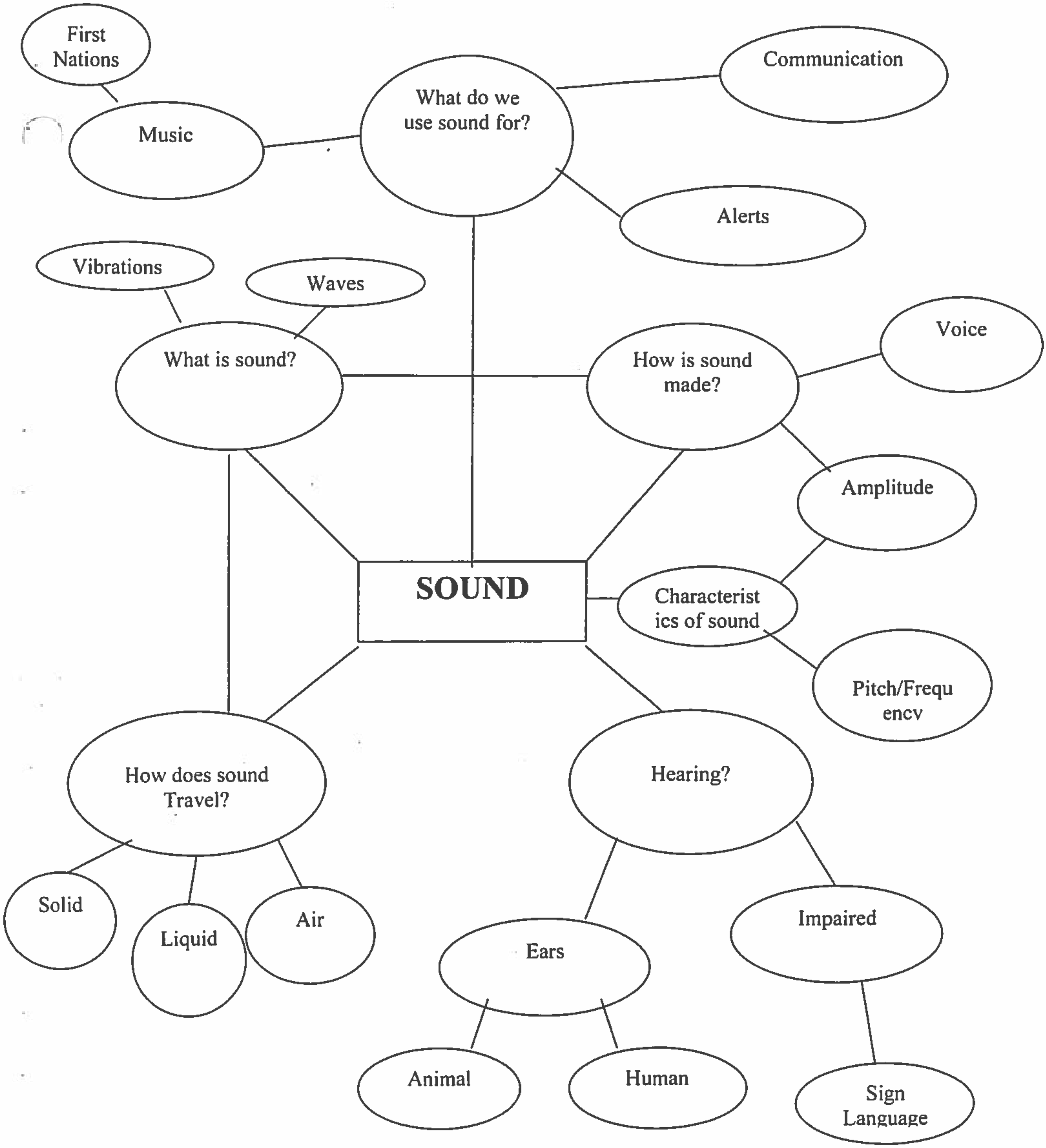
Teacher's Copy.

Sound

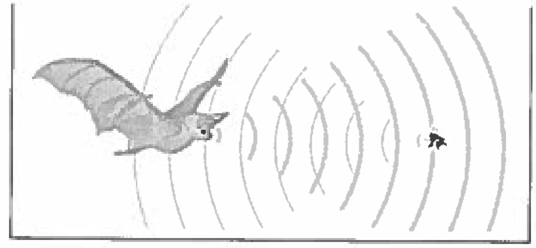








First Nations
Music
What do we use sound for?
Communication
Alerts
Vibrations
Waves
What is sound?
How is sound made?
Voice
Amplitude
SOUND
Characteristics of sound
Pitch/Frequency
How does sound Travel?
Hearing?
Solid
Liquid
Air
Ears
Impaired
Animal
Human
Sign Language



Glossary of Sound Terms

Natural sounds: one way to group sound is by identifying sounds that would be heard in nature like falling rocks, waterfalls, and birds chirping.

Artificial sounds: another way to group sound by identifying sounds made by people and our devices like buzzers, gears turning, and tires on the pavement.

Vibration: when an object moves back and forth quickly (moves many times per second).

Sound waves: energy that vibrates particles as it travels through matter, sensed by the brain as sound.

Frequency: is the number of vibrations an object makes per second.

Pitch: how high or low a sound is which is determined by how fast the sound wave vibrates.

Decibel: a unit used to measure the loudness of a sound (also called dB).

Hertz: a unit of measuring the frequency of sound; one hertz is one vibration per second.

Echo: a sound that bounces off an object and reflects back to the ear.

Amplify: to make sound louder.

Loudness: is how strong the sound seems when it reaches our ears.

Intensity: is defined as the amount of energy flowing in the sound waves.

Volume: the loudness or softness of a sound.

Cavity: a hollow space within an object.

Resonance: the strengthening of sound waves when they bounce off the walls of a cavity.

Compression*:* In air, the forward movement of vibrating objects pushes molecules together.

Rarefaction: When the vibrating object moves back in the opposite direction, the air is separated, causing molecules to move farther apart.

Cochlea: a shell-shaped part of the inner ear that is filled with liquid and lined with thousands of tiny hairs which transmit sound signals.

Eardrum: a thin delicate membrane in the middle ear, it vibrates when sound waves hits it.

Ear canal: a part of the ear that connects the outer ear to the inner ear; tunnel that sound travels through to the ear drum.

Inner ear: the fluid filled part of the ear that sends messages to the brain.

Middle ear: a part of the ear that is inside the head and contains the eardrum and three tiny bones that carry sound waves from the eardrum to the inner ear.

Outer ear: the part of the ear that is outside the head, directs sound waves into the ear canal.

Ultrasonic: vibrations per second above 16 000 vps are known as ***ultrasonic.*** High frequency sounds beyond human hearing. Ultrasonic sound waves are used in various industrial and medical activities.

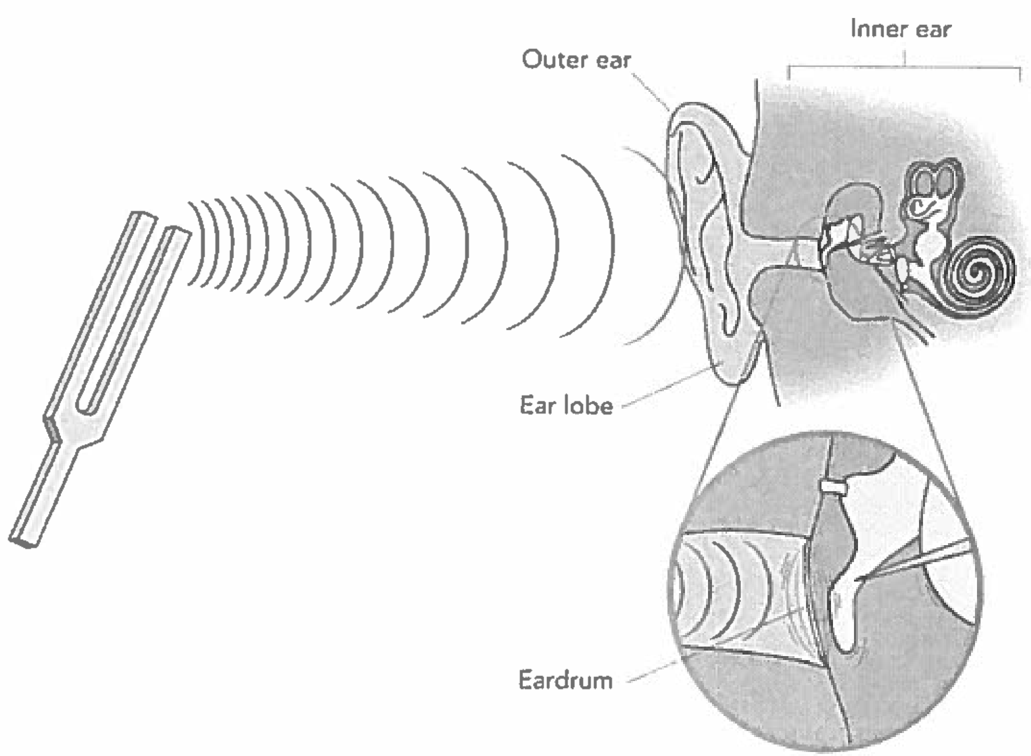
String instruments: produce sounds with one or more vibrating strings. Some examples are cello, violin, guitar, and harp.

Wind instruments*:* depend upon the vibration of a column of air to produce sound. The column of air vibrates when the musician blows into or across the instrument. Some examples are flute, saxophone, trombone, and tuba.

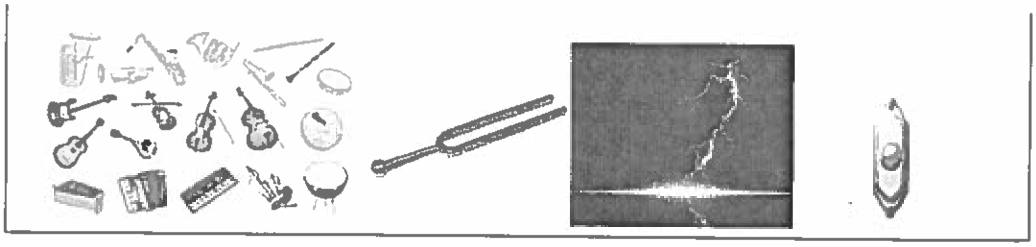
Percussion instruments: produce sounds when the material stretched over a hollow container vibrates when it is struck with a stick or mallet. Some examples are timpani, snare drum, and congas.

Larynx: the area at the upper end of the windpipe containing the vocal chords, known as the "voice box"

Vocal chords: are strong bands of tissue stretched over the top of the voice box (larynx).



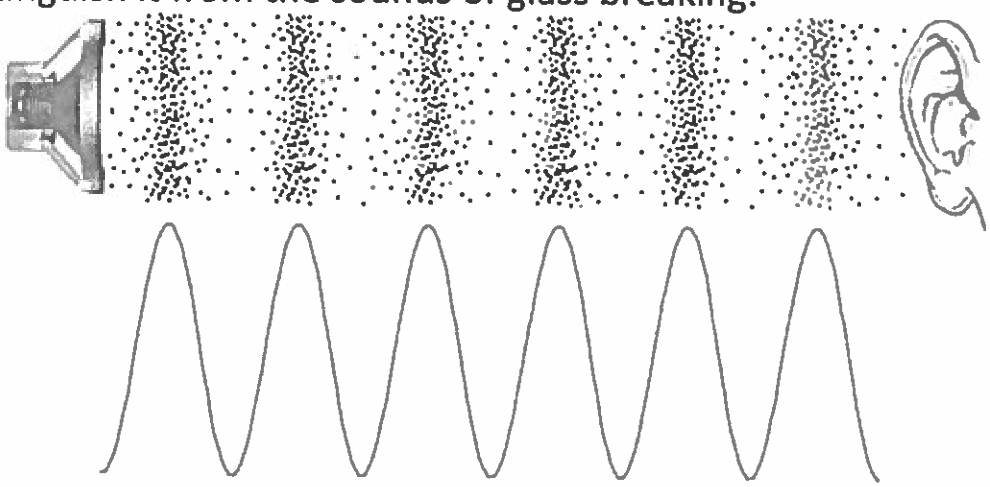
Sound



Learning outcomes: 1). sounds are caused by objects vibrating
2). Sound waves are received by the ear and interpreted by the brain

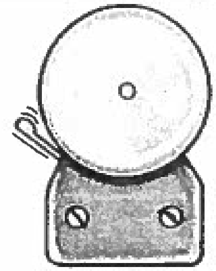
Sound is a vibratory disturbance in a substance or medium such as air. Sounds occur when things vibrate. Vibrating objects send out sound waves that travel in all directions. ***Sound waves*** can travel through solids, liquids and gases by causing these substances to vibrate. However, sound waves cannot move through a vacuum because there is no medium present to vibrate.

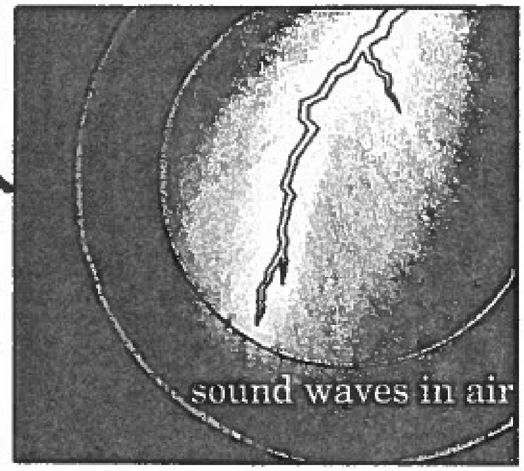
Sound waves travel at different rates through different substances. As they travel, sound waves can also cause nearby substances to vibrate. This helps to make the sound wave. When sound waves strike the ear, they are channeled through the ear canal and strike the eardrum. The vibrations of the eardrum cause the small bones of the inner ear to vibrate. The vibration of these bones causes the fluid that stimulates hearing receptors in the cochlea to vibrate. The auditory nerve then relays the sensation to the brain, which interprets the stimulus. Through experience we learn to associate certain sounds with certain events. This allows us to recognize the voice of a friend, as well as distinguish it from the sounds of glass breaking.

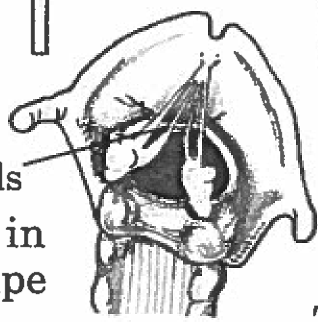


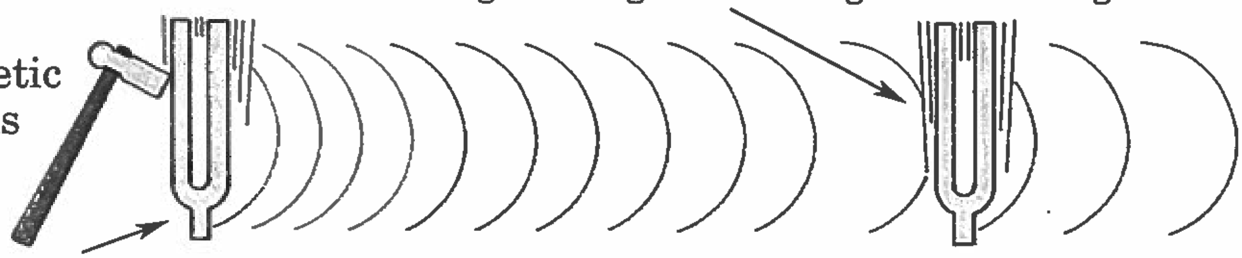
Sound

Sound waves are the result of vibrations.

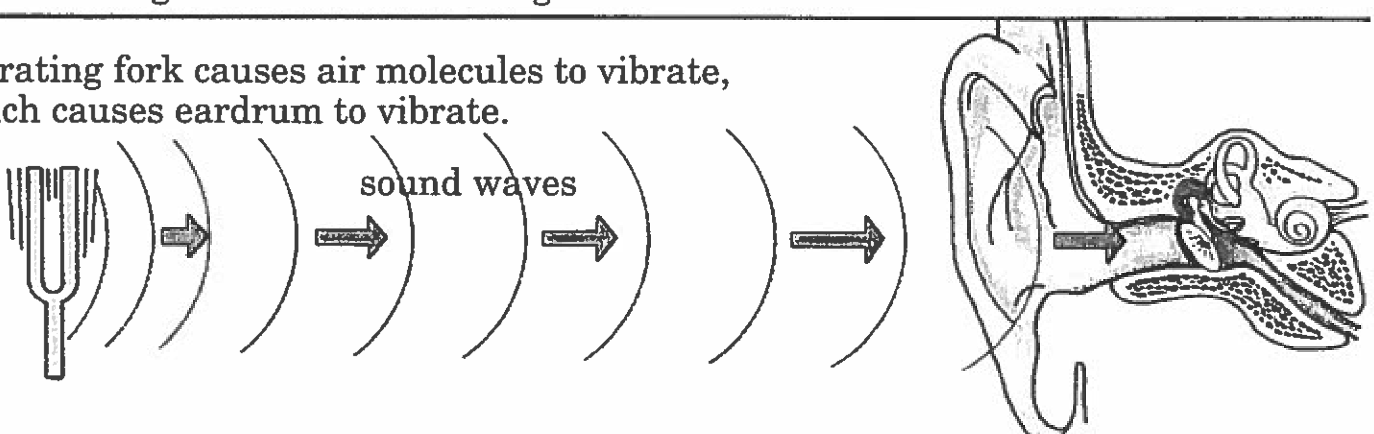






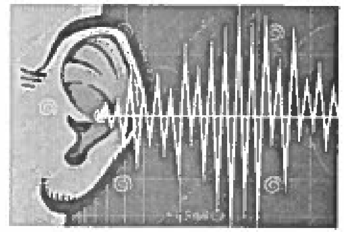


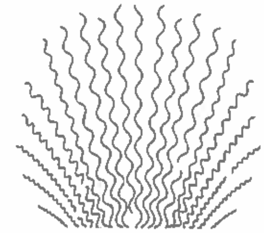
Vibrating fork causes air molecules to vibrate, which causes eardrum to vibrate.



1. What causes sound?
2. How do we hear sound?

STUDY QUESTION: Find out about the sound of space vehicles on the surface of the moon.





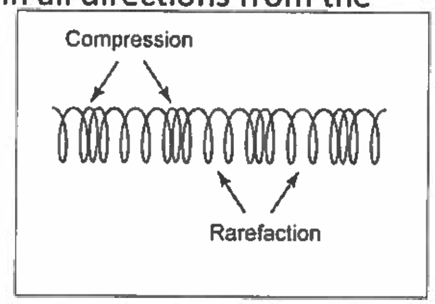
Sound Waves

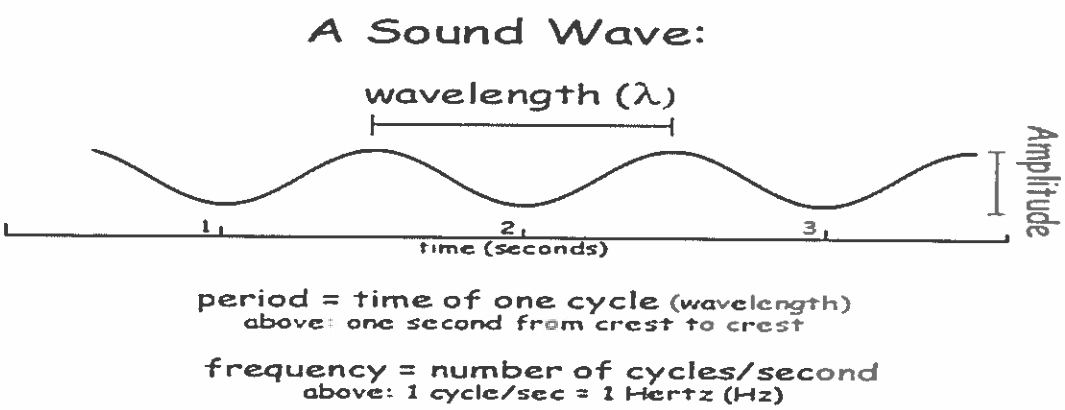
Learning outcomes: 1). A sound wave is a series of compression and rarefaction waves that spread out in all directions from the sound source.

2). Sound waves travel at the speed of 331.5 meters per second at 0◦ (32 ◦F).

Any object or medium caused to vibrate produces ***sound waves.*** In air, the forward movement of vibrating objects pushes molecules together, this is called ***compression.*** When the vibrating object moves back in the opposite direction, the air is separated, causing molecules to move farther apart. This is called ***rarefaction***.

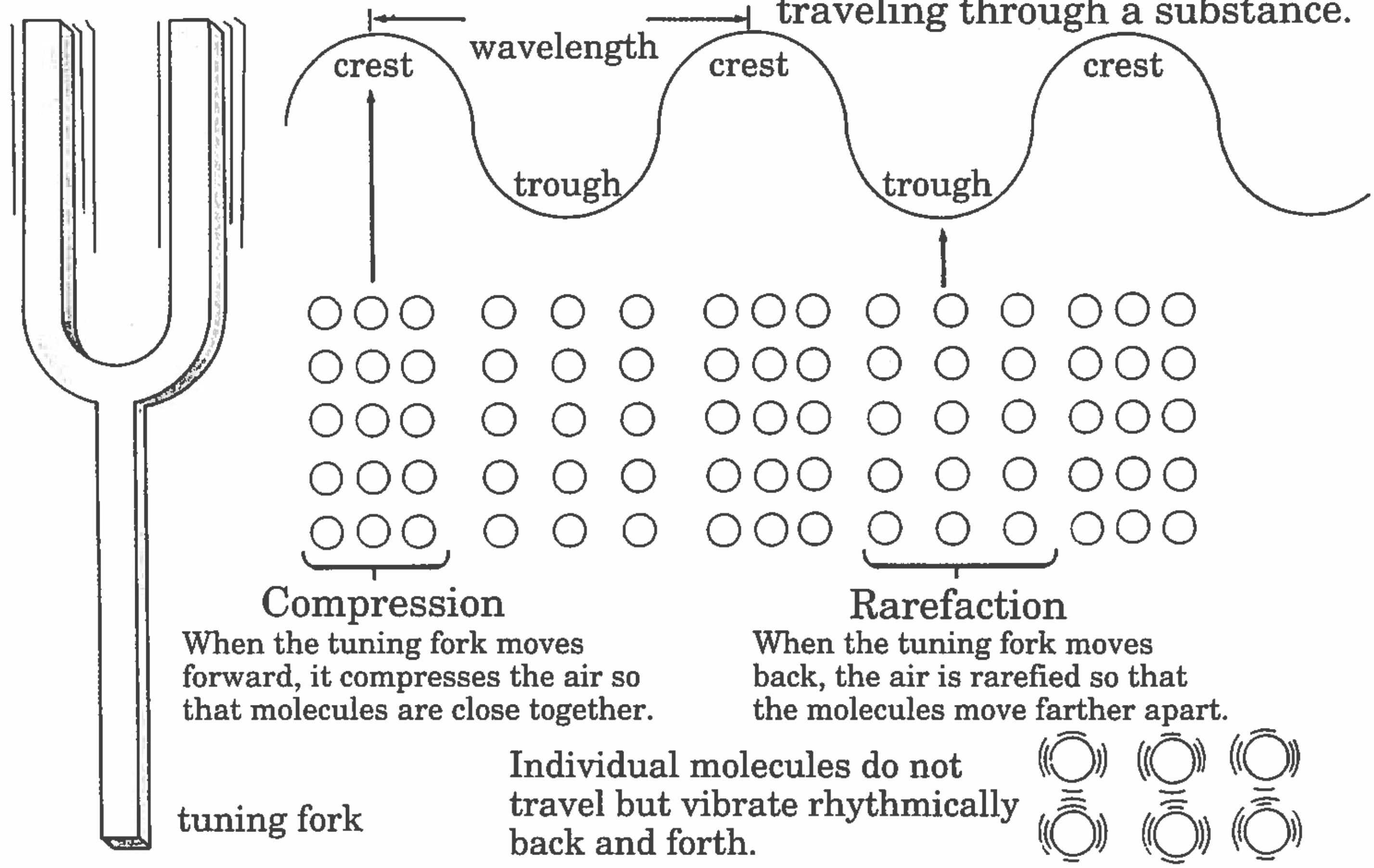
A sound is produces by matter when there is compression and rarefaction disturbances which can be heard by the human ear and detected by an instrument. Like light waves, sound waves spread out in all directions from the source. Sound waves, however, travel much slower than light waves (which is why we see lightening before we hear the thunder during storms). Sound travels through different substances at different speeds. Due to the closeness of molecules in a solid and liquid states of matter, sound waves generally travel faster in solids and liquids than in gases. The speed of sound in a piece of steel is more than 15 times faster than it is in the air at the same temperature (25 ◦C). Temperature also has an effect on the speed of sound waves. It has a small effect in solids and liquids, but in gases, the speed of sound increases at a rate of 0.6 meters (2 feet) per second for each increase in degree Celsius.





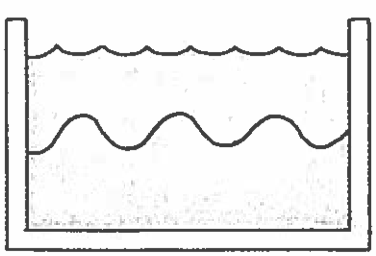
Sound Waves

The **sound wave** is a series of compression and rarefaction areas traveling through a substance.

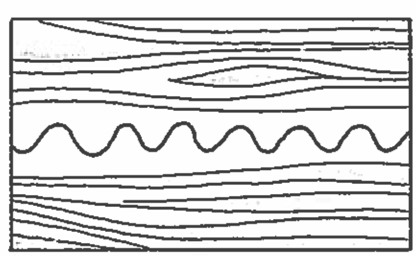


The Speed of Sound

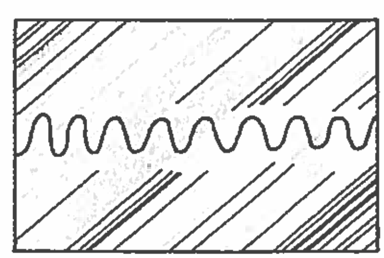
The speed of sound is 331.5 meters per second in air at 0°C. The speed increases about 0.6 meters per second for each degree rise in temperature (°C).



through water (25°C)
1497 m/sec



through pine wood (25°C)
3320 m/sec

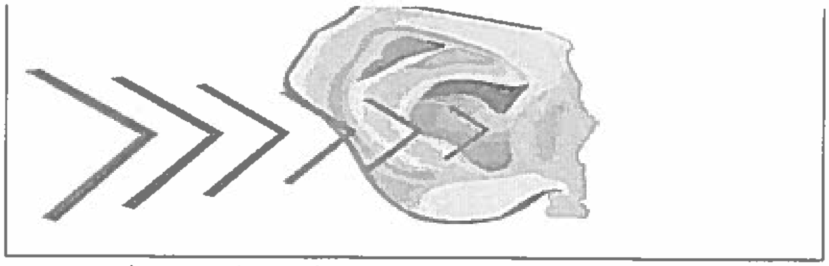


through steel (25°C)
5200 m/sec

1. Describe how a sound wave travels.
2. Does sound travel fastest through a solid, a liquid, or a gas?

STUDY QUESTION: Find out how an echo is produced.

Characteristics of Sound

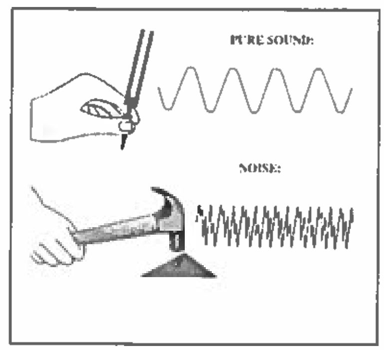


Learning outcomes: 1). Frequency is the number of vibrations an object makes per second.

2). Amplitude is the distance a vibrating particle has been displaced from its resting position.

Sound waves have certain characteristics which enable us to distinguish one sound from another. The ***frequency*** of a sound wave is the number of waves that pass a certain point per unit of time. A rapidly vibrating object has a high frequency. High frequency produce ***high-pitched sound.*** Slowly vibrating objects have a low frequency and produce a ***low-pitched sound***.

The human ear has a normal range capable of hearing sounds about as low as 16 vibrations per second (vps) and those above 16 000 vps are known as ***ultrasonic.*** Ultrasonic sound waves are used in various industrial and medical activities. ***Amplitude*** is the distance a vibrating particle has been displaced from a resting position. Amplitude determines the intensity of sound. ***Intensity*** is defined as the amount of energy flowing in the sound waves. The larger the amplitude, the more intense the sound.



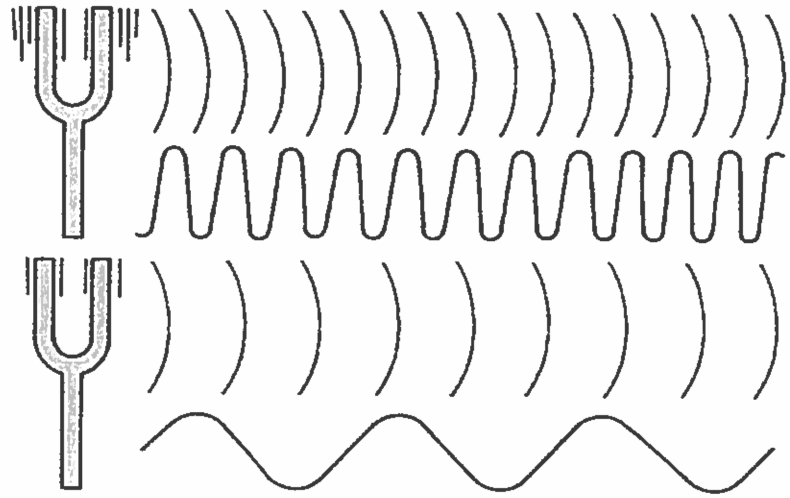
Loudness is how strong the sound seems when it reaches our ears. Although loudness is related to intensity it is not the same due to the interaction of frequency. If frequency is held constant, loudness and intensity vary together. That means that as one increases the other increases at the same rate. However, equally intense sounds travelling at different frequencies are not equally loud. When intensity is held constant, sounds in the middle ranges of frequency are louder than sounds in the upper or lower frequency ranges. Loudness measures in decibel units by sound meters. Sounds above 120 decibels are painful to the ears and can cause injury to the ear.

Some substances conduct sound better than others do. Most sounds come to us through the air, a gas. Gases are not the best conductors of sound. The molecules are spaced far apart, making it a poor conductor of sound energy. Where the air is thin and cool, such as in high altitudes (mountain top) sound does not travel as fast or as far as compared to lower altitudes (ground level) where the air is warmer and denser. Because the molecules are closer together in a liquid than in air, liquids conduct sound better and faster than gases. Sound travels best n hard solids, where the molecules are closer together. When a sound wave bounces back (reflects) from a hard surface, it may be heard as an echo. To hear an **echo**, a person must be at least 16.5 meters away from the reflecting source. Annoying echoes can be eliminated by using acoustical material to absorb the sound. Concert halls and gyms are built with this principle in mind.

Characteristics of Sound

Frequency is the number of vibrations per second.

vibrating rapidly



high frequency = high pitch

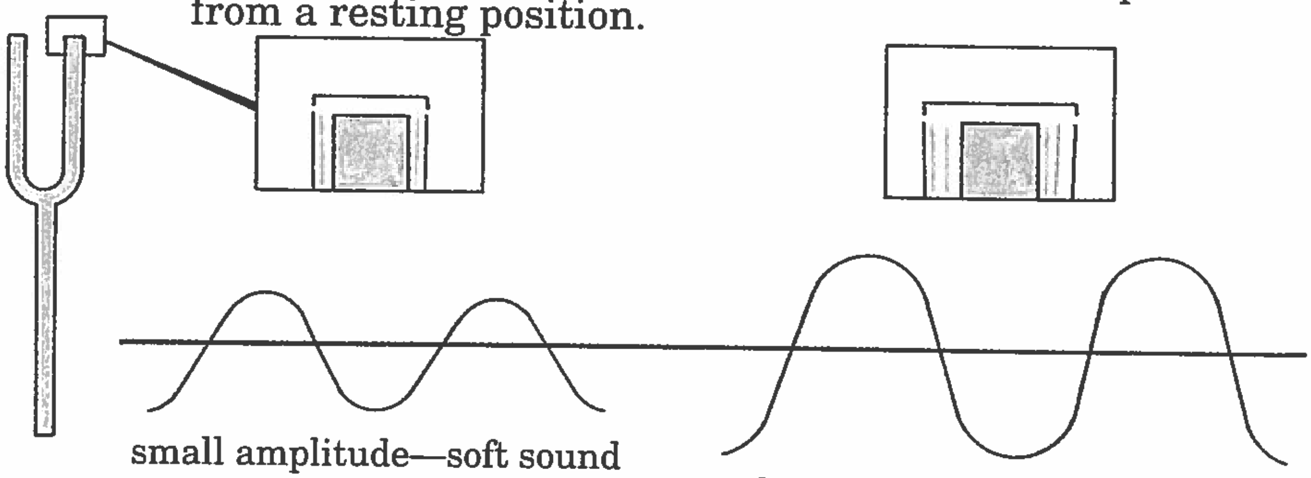
vibrating slowly

low frequency = low pitch

16 vibrations per second ⟵ ⟶ 16,000 vibrations per second

subsonic — Limits of Human Hearing — *ultrasonic*

Amplitude is the distance a vibrating particle has been displaced from a resting position.



small amplitude—soft sound

large amplitude—loud sound

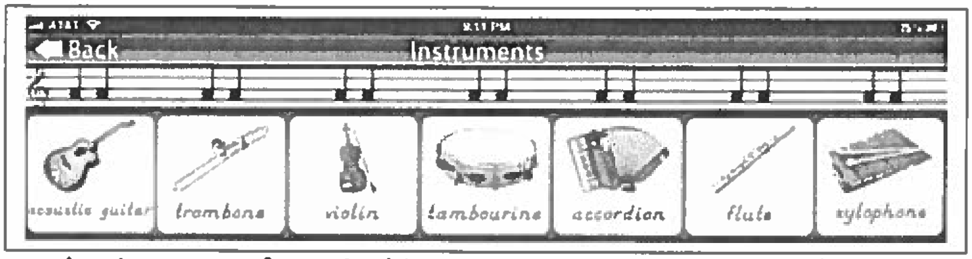
Loudness is the strength of sounds, measured in decibels.

silence		whisper		type-writer		conver-sation		street traffic		air hammer		painful sounds				jet engine
0	10	20	30	40	50	60	70	80	90	100	110	120				170
	heartbeat		soft piano		soft talking		barking dog		food blender		thunder					

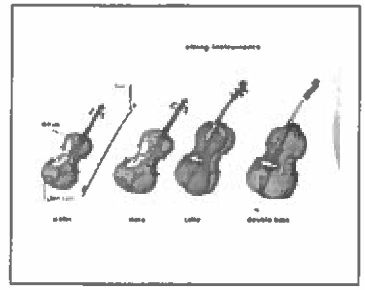
1. What kind of sound would be produced by a rapidly vibrating object?
2. Can you hear a sound produced by 20,000 vibrations per second?

STUDY QUESTION: Find out about the Doppler effect.

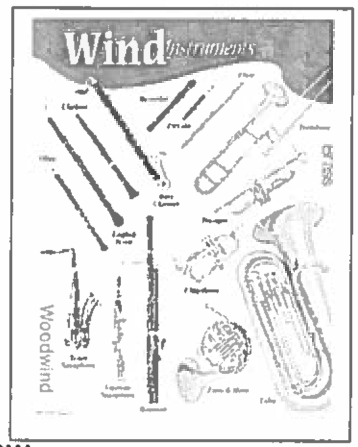
Musical Instruments



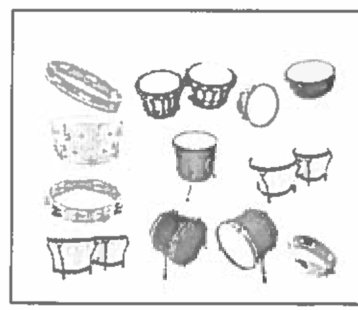
Learning outcomes: The three basic types of musical instruments are string, wind, and percussion.



String instruments produce sounds with one or more vibrating strings. The strings vibrate when the musician plucks them or draws a bow across them. Higher pitch can be attained by tightening or shortening the strings, or by using thinner strings. Opposite actions will produce a lower pitch. The intensity of the string instrument sound depends on how hard the strings are plucked or rubbed.



Wind instruments depend upon the vibration of a column of air to produce sound. The column of air vibrates when the musician blows into or across the instrument. Brass and wood wind instruments make up the two types of wind instruments. ***Brass instruments*** are played by vibrating the lips, which are pressed against the mouthpiece of the instrument. This causes the air column to vibrate. ***Woodwind instruments,*** such as clarinets, need a reed to make the air column vibrate. The column of air vibrated in the flute and piccolo when air is blown across a hole. Higher pitch can be produced in brass and woodwinds by shortening the column of air. The intensity of wind instrument sound depends on how hard air is blown into the instrument.



Most ***percussion instruments*** produce sounds when the material stretched over a hollow container vibrates when it is struck with a stick or mallet. Some percussion instruments are solid and vibrate when struck. Higher pitch can be produced by tightening the stretched material, or by using a thinner or smaller piece of material. The intensity of sound depends on how hard the instrument is struck.

The human voice is a very powerful instrument. ***Vocal chords*** are strong bands of tissue stretched over the top of the voice box (larynx). A narrow gland called the glottis separates the chords. Sound is produced when the air from the lungs is blown through the glottis, which causes the vocal chords to vibrate. Voice pitch is controlled by the muscles attached to the vocal chords which can make the chords tight or loose. Tight chords vibrate rapidly, producing high-pitched sounds; loose chords vibrate slowly producing low-pitched sounds. Controlling the tension of these muscles to adjust pitch of sound is something we learn as we are learning to speak. Other areas that affect the quality of the voice are lips, tongue, teeth, and head sinuses.

Musical Instruments

String instruments use one or more vibrating strings to produce sounds.

Cello
bow

Stroke strings to start vibration.

Banjo
hand

Pluck strings to start vibration.

Pitch Change

higher	lower
• tight strings	• loose strings
• short strings	• long strings
• thin strings	• thick strings

Wind instruments use a column of vibrating air to produce sound.

Pitch Change

higher
- short air columns

lower
- long air columns

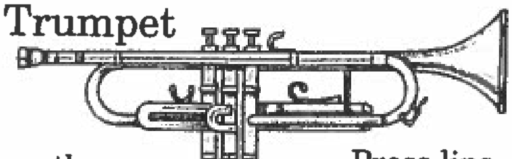
Clarinet

mouth-piece with vibrating reed

column of air

Blow into instrument to vibrate column.

Trumpet



Press lips against mouthpiece. Blow air to vibrate lips, which vibrates column.

Percussion instruments, when struck, produce sounds by vibrating.

Drum

stretched material

air–filled container

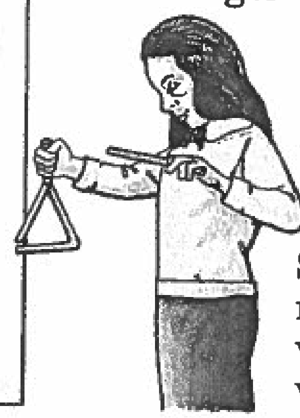
Strike with stick.

Pitch Change

Drum:
- Tighten or loosen cover.
- Use thick or thin material.
- Use large or small piece for cover.

Triangle:
- Use different material.
- Change length of material.

Triangle



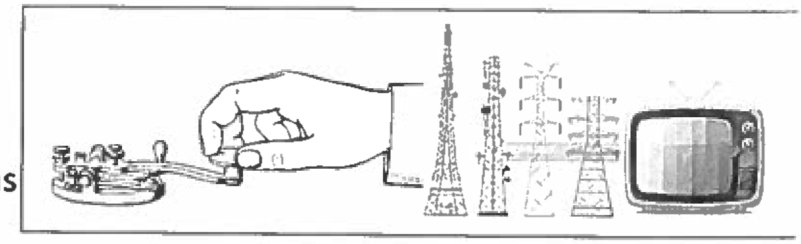
Strike with metal bar.

Solid metal vibrates when struck.

1. How is the pitch changed on a stringed instrument?
2. Why does a bass drum have a low pitch?

STUDY QUESTION: Find out how these instruments are classified: oboe, harp, celesta, glockenspiel, and zither.

Development of Communication Systems

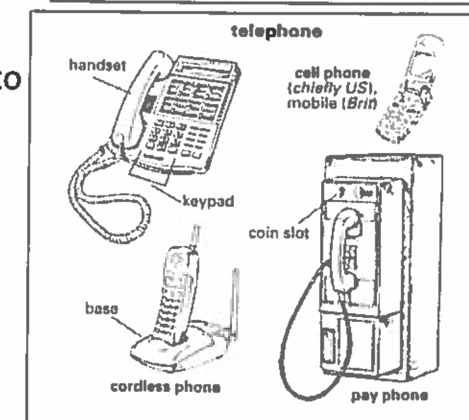


Learning outcomes: 1). Auditory and visual signals have been used by people to communicate since ancient times

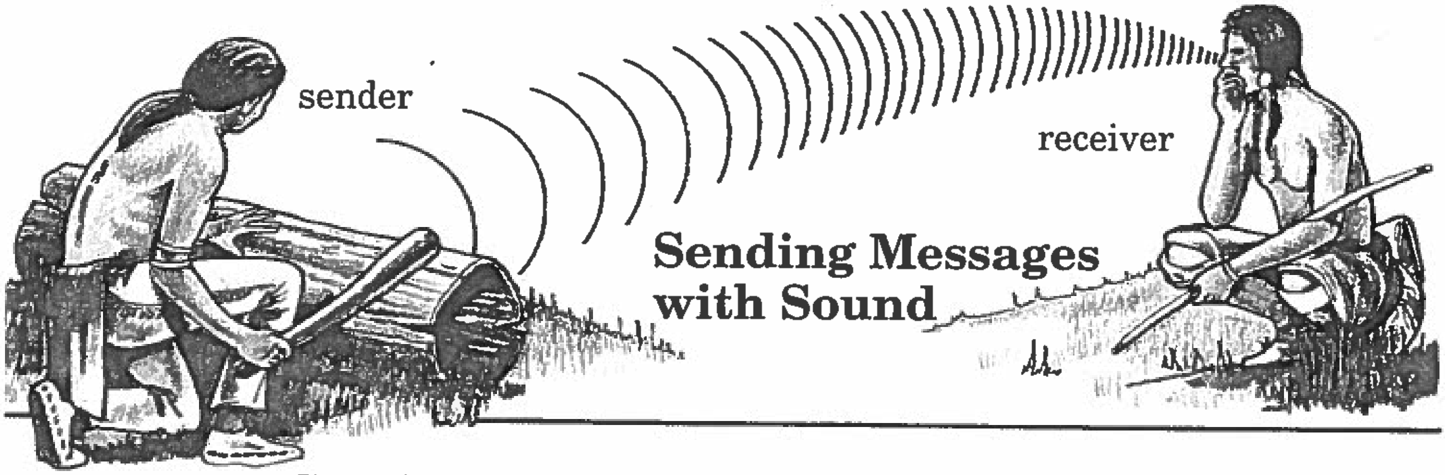
2). Modern methods of communication enable people to communicate worldwide almost instantaneously.

Without the development of a means of communication, people might never have advances beyond the first stages of social development. Pointing and using guttural sounds were probably the first human means of communicating. The development of speech and language enables people to transmit knowledge and cultural heritage. Communication over long distances was an important discovery because it allowed people to convey information to one another by indirect means. Smoke signals and drumbeats may have been the first media used to transmit messages over long distances. With the discovery of electrical energy and the means to control it, the capability of communication devices increased greatly.

The invention of the telegraph, telephone, radio, and television have made communication rapid and far-reaching. The telephone usually uses wires to send electrical energy into a specific receiver, while technologies such as the radio or television send waves into the atmosphere to be picked up by any of a number of receivers. Modern audio and visual communication systems include the use of satellites that are in synchronous orbit around the earth. Events happening on one part of earth can be seen and heard on any part of the globe almost instantly.

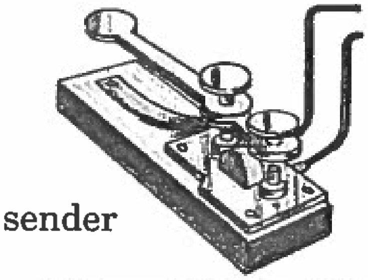


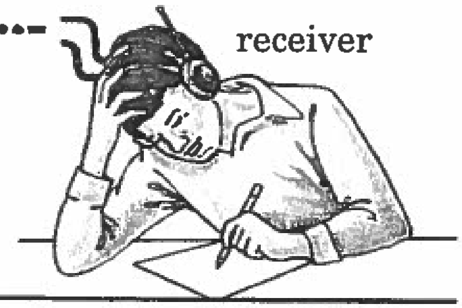
Development of Communications Systems



Sending Messages with Sound

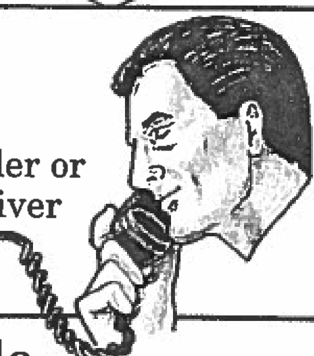
Sending Messages with Electricity





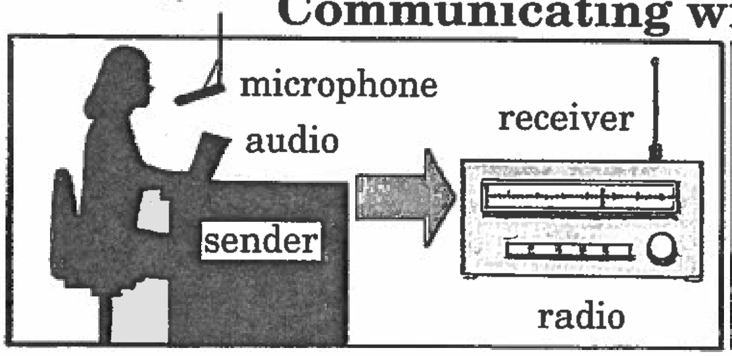
Person receiving signal changes dot and dash sounds into the alphabet.

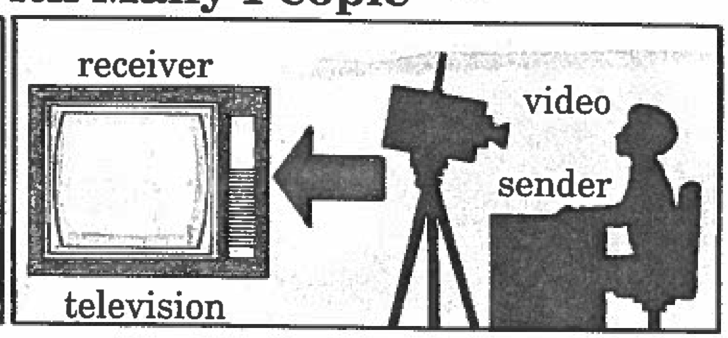
Sending Messages with Voice and Electricity



Sound energy changes to electrical energy.

Communicating with Many People





1. What energy source is most often used for communications?
2. How are telephone and radio communication different?

STUDY QUESTION: Research various communication systems used by animals.

How does the ear

1

The ear is made up of **three** sections

- the outer ear
- the middle ear
- the inner ear

2

The **outer ear** is made up of the **pinna** and the **ear canal**. The entrance of the ear canal is lined with **hairs** and **wax**, which help to keep it **clean**. **Wax** is a sign of a **healthy, functioning ear.**

3

The **ear canal** leads to a **flexible, circular membrane,** called the **eardrum.** The **sound waves** pass down the **ear canal,** causing the **eardrum to vibrate.** These vibrations then pass into the **middle ear.**

4

The **middle ear** contains **three** tiny bones, namely the **Hammer, Anvil** and **Stirrup**. These bones **increase** and **strengthen** the vibrations and pass them onto the **inner ear**.

5

The **inner ear** contains a system of tubes, which are filled with a **watery liquid.** This is called the **cochlea.** As **sound waves** pass from the **middle ear** through the **oval window** into the **inner ear,** this liquid moves and **sensitive nerve endings** change this movement into **electrical signals.** These **electrical signals** are sent to the **brain** along the **nerve of hearing,** known as the **auditory nerve.**

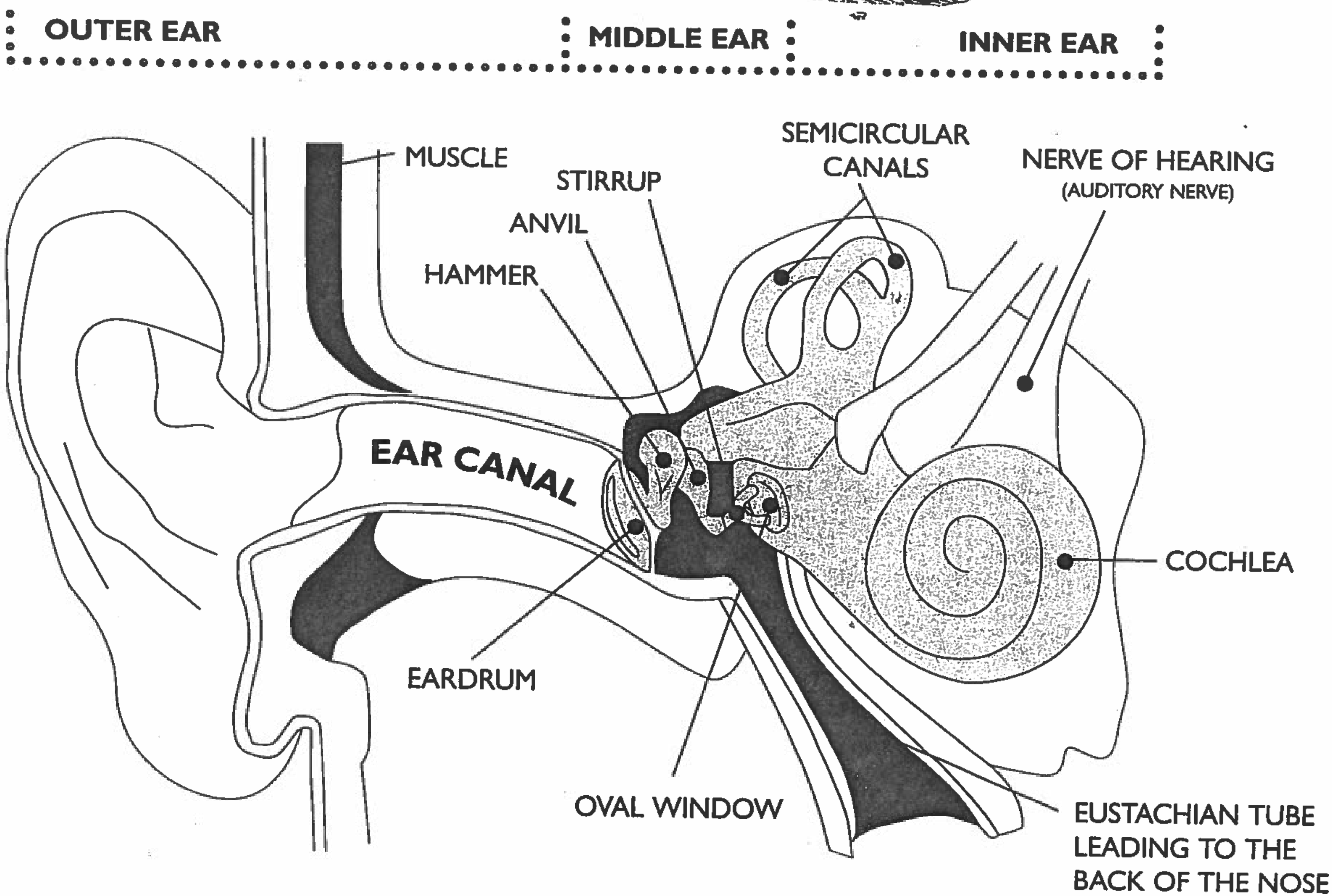
6

To summarize, **vibrations** from the **air (sounds)** are **collected** by the ear and changed into **nerve impulses**, which the **brain 'translates.'**

It is not yet clearly understood how the electrical signals are interpreted by the brain.

The anatomy of the human ear

2

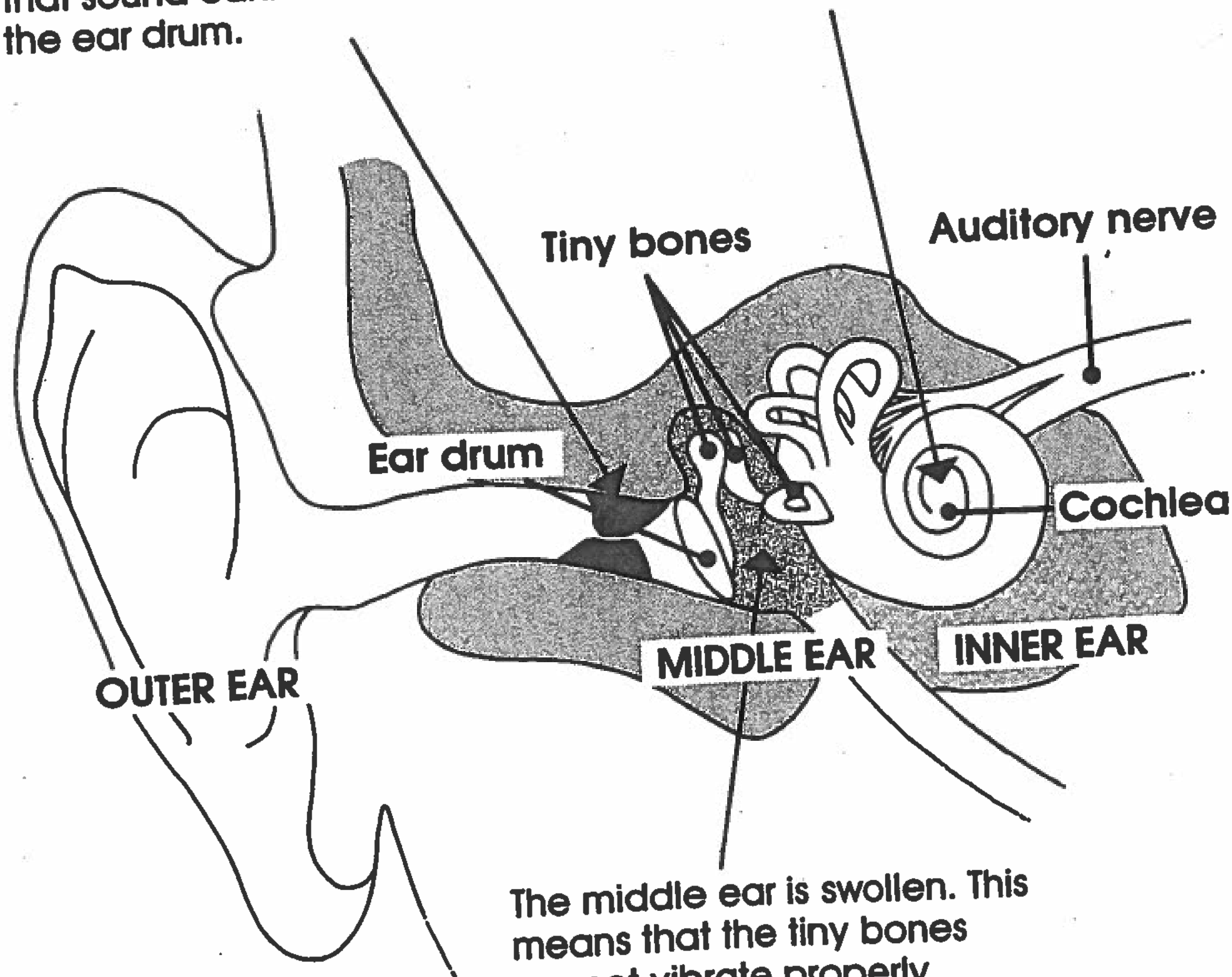


15

Some causes of deafness

The passage leading to the ear drum is blocked — perhaps by wax. This means that sound cannot travel to the ear drum.

There is an infection in the cochlea. This means that "sound" messages will not be passed to the brain.



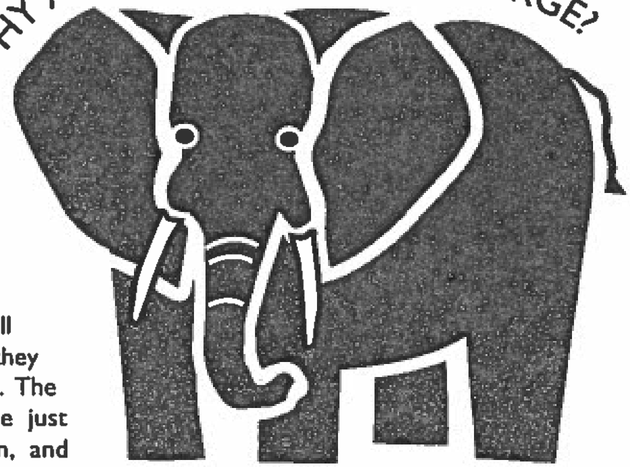
The middle ear is swollen. This means that the tiny bones cannot vibrate properly.

8

DID YOU KNOW ?

FACTS ABOUT ANIMALS' HEARING

WHY ARE ELEPHANTS' EARS LARGE?



Elephants have very good hearing, but that is not all they use their ears for - they also use their ears for cooling. The blood vessels in their ears lie just under the surface of the skin, and when the elephant flaps its ears, the blood loses heat, cooling down the elephant's body. Elephants' ears also make great fans to fan cool air over themselves!

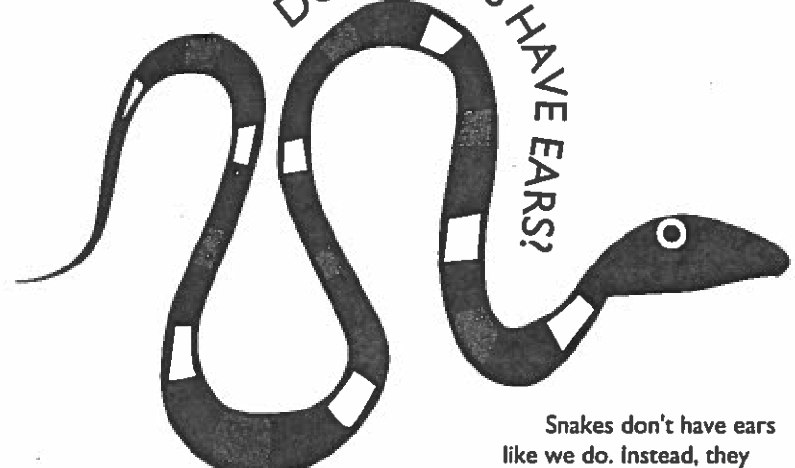
HOW DO CATS TURN THEIR EARS?

Cats also have excellent hearing. When we look at our own ears, we have only 6 muscles, whereas cats have 30 muscles in their ears. This allows cats to turn their ears very quickly and accurately to determine where a sound is coming from. A cat can turn its ears far more quickly than a dog can.

DOES A VAMPIRE BAT HAVE GOOD HEARING?

Vampire bats can hear very high-pitched sounds that humans cannot hear. These bats can hear sounds up to 150,000 cycles per second, which is more than seven times as high as the highest sounds people can hear. As a bat flies, it constantly sends out very high-pitched sounds. The sound waves bounce off objects and echo back towards the bat. The bat's large, pointed ears are like sound funnels. They collect the sounds and send messages to the bat's brain.

DO SNAKES HAVE EARS?

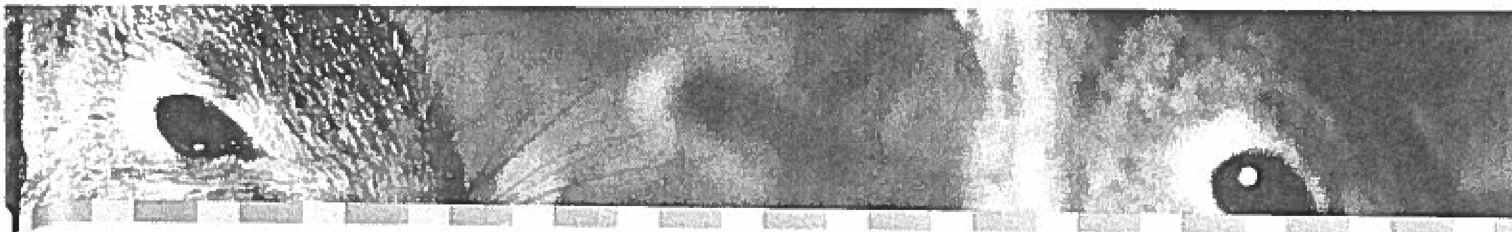


Snakes don't have ears like we do. Instead, they "feel" sounds by picking up vibrations in the ground.

Show What You Know

1. List five ways sound is used in your home and in your community.
2. How does each of these items produce sound: an alarm clock, a flute, and a bouncing ball? What is the purpose of each sound?
3. How does science explain what sound is and how it travels?
4. What is pitch and how does it change?
5. What is sound volume and how is it measured?
6. How does sound travel differently through solids, liquids, and gases?

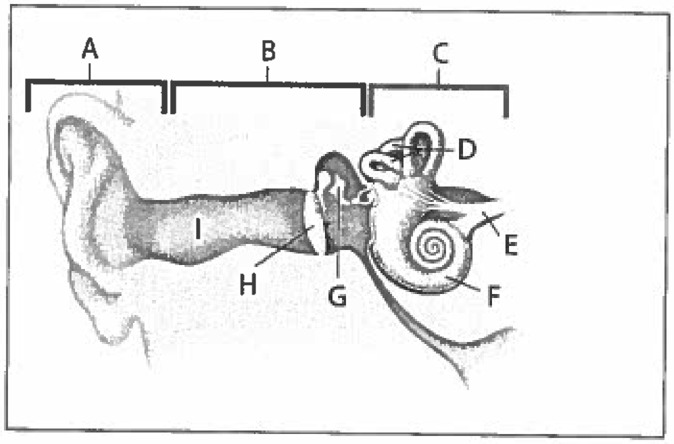
7. Describe ways that sound is important in First Nations and Métis cultures.
8. Musical instruments can be grouped as string, wind, percussion, or brass.
   - **a)** How does each type of instrument make sound?
   - **b)** How does each type of instrument change pitch? How does it change volume?
9. Choose an animal. Describe what and how this animal hears, then compare that with human hearing.
10. **a)** When can sound be dangerous?
    b) What can you do to protect your hearing?



11. Describe a method or device you could use to reduce noise pollution at school.

12. **a)** Label each part of the ear shown in the diagram.

    b) How does each part of the ear help us hear?

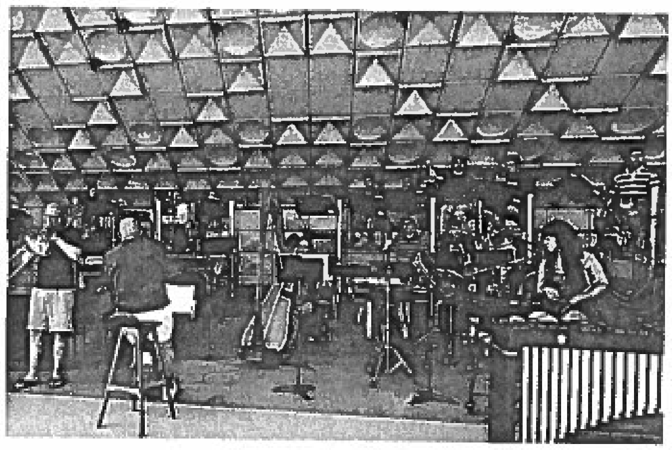


13. **a)** List three situations in which you would need to amplify sound.

    b) How would you amplify the sound in each situation?

14. Think about designing a music recording studio and a theatre. How would sound be treated differently in each?

15. What negative consequences can sound have for animals? Are there positive consequences? Describe one.



Looking Back

16. List three things you did not know before this unit started. What new questions do you have?

17. What sound device would you like to learn more about?

18. Write a short letter to your mayor suggesting ways to reduce noise pollution in your community and why it is important.