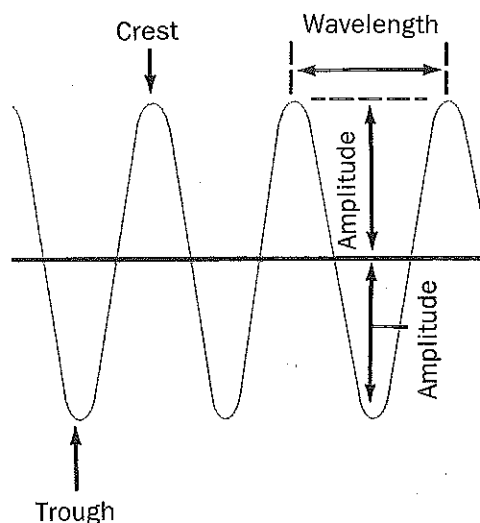


UNIT 4 - Sound and Light

How Sound Travels



Sound Waves

Have you ever thrown a rock into a lake or pond? Small waves move outward in a circle away from the place where the rock hit the water. Some kinds of energy move in waves like these. Sound is a kind of energy that moves in waves. Sound waves can move through all kinds of matter. You cannot see sound waves. But you know they are there because you can hear the sound.

All sounds are made by vibrating objects. To vibrate means to move quickly back and forth. When a vibrating object moves outward, it pushes the air molecules close together. Then they spread out again and push the molecules next to them. This movement of molecules is a sound wave. Sound waves, like waves in a pond, move outward in circles from their source.

Sound waves move more quickly through dense matter. The molecules of dense matter are close together. Sound travels faster through water than through air. This is because the molecules in water are much closer than the molecules in air.

Scientists use special words to describe waves. The highest part of a wave is called the **crest**. The lowest part of a wave is the **trough**. One half the distance between a wave's crest and its trough is the wave's **amplitude**. The **wavelength** of a sound is the distance between the crests of two of its waves. The number of waves that move past one spot in a second is the sound's **frequency**.

A. Underline the correct words.

1. Sound is a kind of energy that moves in (waves, space).
2. Sound waves (cannot, can) move through all kinds of matter.
3. All sounds are made by (still, vibrating) objects.
4. Sound waves, like waves in a pond, move (inward, outward) in circles from their source.
5. Sound waves move more quickly through (dense, light) matter.
6. The lowest part of a wave is the (crest, trough).

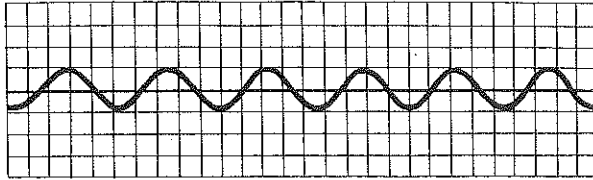
B. Draw lines to match the parts of waves with their descriptions.

- | | |
|---------------|---------------------------------------------------------|
| 1. crest | half the distance between a wave's crest and its trough |
| 2. trough | the highest part of a wave |
| 3. amplitude | number of waves that move past one spot in a second |
| 4. wavelength | the lowest part of a wave |
| 5. frequency | the distance between two crests |

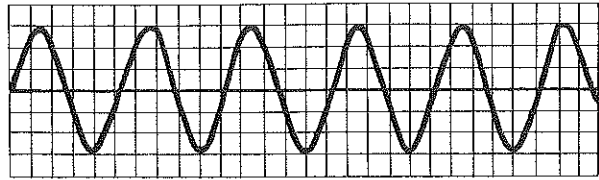
C. Answer True or False.

1. Energy does not move in waves. _____
2. Sound waves cannot move through matter. _____
3. You cannot see sound waves. _____
4. All sounds are made by vibrating objects. _____
5. Sound waves move outward in circles from the person hearing the sound. _____
6. Sound waves move more quickly through dense matter. _____
7. The molecules of dense matter are far apart. _____
8. The wavelength of a sound is the distance between the crests of two of its waves. _____

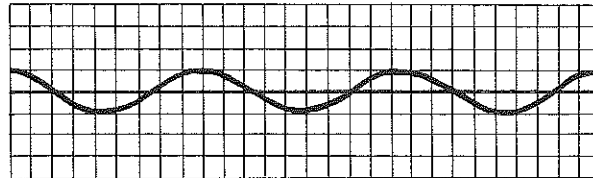
Pitch and Loudness



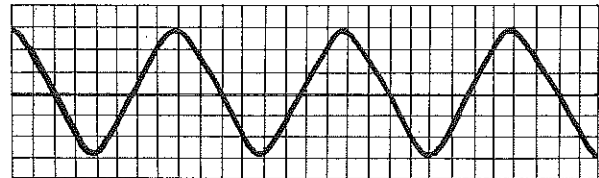
High-Pitched Soft Sound



High-Pitched Loud Sound



Low-Pitched Soft Sound



Low-Pitched Loud Sound

You have learned that all sounds are waves that move through the air. But not all sounds are alike. Some sounds, such as a bird singing, are high sounds. Other sounds, such as a frog croaking, are low sounds. Some sounds are so quiet you can barely hear them. Other sounds are very loud. What makes these sounds different?

The quality of being high or low is a sound's **pitch**. A sound's pitch is the same as the frequency of its sound waves. You have learned that a sound's frequency is the number of waves that move past one spot in a second.

Waves with a high frequency have a high sound. These waves have short wavelengths. Waves with a low frequency have a low sound. These waves have long wavelengths.

A sound's loudness is different from its pitch. A high-pitched sound can be loud or soft. So can a low-pitched sound.

A sound's loudness is the same as the amplitude of its sound waves. You have learned that a wave's amplitude is one half the distance between its crest and its trough. Soft sounds have a low amplitude. Loud sounds have a high amplitude. Look at the pictures on this page to see the difference between high, low, loud, and soft sound waves.

A. Use the words below to complete the sentences.

amplitude	Loud	pitch
frequency	loudness	Soft
high	low	

1. The quality of being high or low is a sound's _____.
2. A sound's pitch is the same as the _____ of its sound waves.
3. Waves with a high frequency have a _____ sound.
4. Waves with a low frequency have a _____ sound.
5. A sound's _____ is different from its pitch.
6. A sound's loudness is the same as the _____ of its sound waves.
7. _____ sounds have a low amplitude.
8. _____ sounds have a high amplitude.

B. Answer the questions.

1. What is a sound's pitch? _____

2. What is a sound's frequency? _____

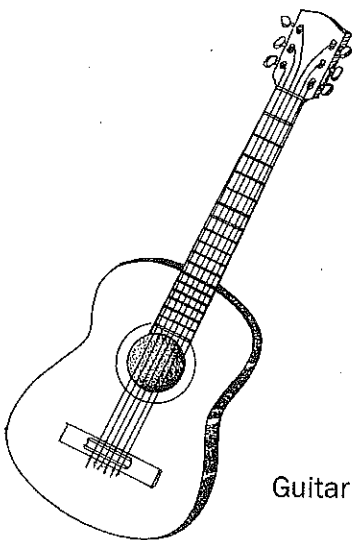
C. Answer True or False.

1. All sounds are waves that move through the air. _____
2. Waves with a high frequency have a high sound. _____
3. A sound's loudness is the same as its pitch. _____

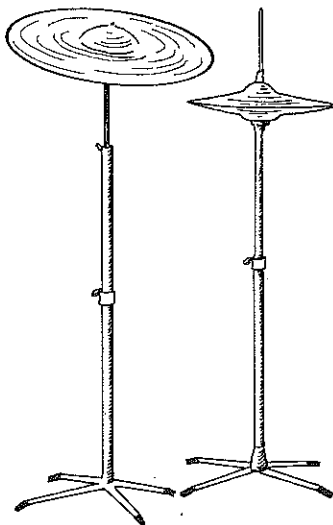
Music



Saxophone



Guitar



Cymbals

The sounds that you hear can be divided into music and noise. What is the difference? Music is pleasant to listen to. Noise is not. Music is made of notes, or sounds with a certain pitch. These sounds have certain frequencies. Noise is made of sounds with different frequencies.

In music, each note lasts for a certain amount of time. The times that the different notes last make up a pattern. This pattern is the music's rhythm. Noise does not have rhythm.

When people sing, they make music with their voices. People also make music with instruments. The three main kinds are **wind**, **stringed**, and **percussion** instruments.

One kind of wind instrument, such as the saxophone, has a thin piece of wood called a reed that vibrates. The person playing the instrument blows into the mouthpiece, which has the reed attached to it. The vibrating reed makes the column of air inside the instrument vibrate.

The piano, the guitar, and the violin are stringed instruments. They make sounds by vibrating strings. The strings are hit by tiny hammers, plucked with the fingers, or moved with a bow. The vibrating strings cause the air around them to vibrate.

Percussion instruments, such as drums and cymbals, make sounds by being struck. When the instrument is struck, it vibrates and causes the air around it to vibrate. Most percussion instruments do not have any certain pitch. Instead, they mark the beat of the music.

A. Answer True or False.

1. Music is pleasant to listen to. _____
2. Music is made of notes. _____
3. Noise is made of sounds with the same frequencies. _____
4. Noise is rhythm. _____
5. When people sing, they make music with their voices. _____
6. The piano is a wind instrument. _____
7. Percussion instruments make sounds by vibrating strings. _____
8. Stringed instruments make sounds by vibrating strings. _____
9. Stringed instruments can make only noise. _____

B. Choose the instrument that matches the type of instrument and write its name in the blank.

drums

guitar

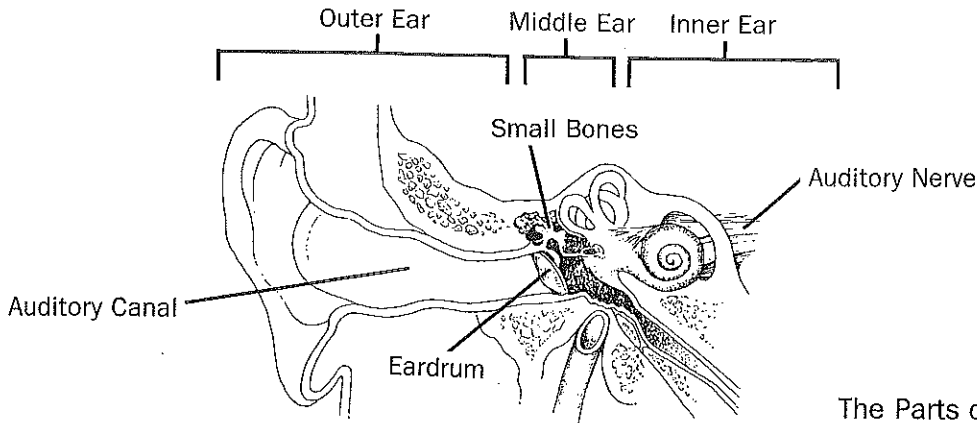
saxophone

1. stringed instrument _____
2. wind instrument _____
3. percussion instrument _____

C. Answer the question.

What are two reasons why music is different from noise? _____

How You Hear



The Parts of the Ear

You hear many different sounds every day. You hear people talking. You hear music and the sounds of cars. You have learned that sound is caused by vibrations. Vibrations send sound waves through the air. But how do your ears turn these sound waves into the sounds you hear?

Your ear has three main parts. They are the outer ear, the middle ear, and the inner ear. The outside part of your ear catches sound waves moving through the air. Then the waves move down the **auditory canal**. You can see the opening of the auditory canal in the middle of your outer ear. The outside part of your ear and the auditory canal are both part of the outer ear.

Sound waves move down the auditory canal to the **eardrum**. The eardrum is a thin piece of skin across the auditory canal. Sound waves make the eardrum vibrate. The vibrations from the eardrum are passed on to three small bones in the middle ear. The bones make the vibrations larger.

The inner ear is filled with liquid. The vibrations from the bones in the middle ear make the liquid move. The moving liquid bends tiny hairs in your inner ear. Your **auditory nerves** feel these hairs move. The auditory nerves turn these movements into signals and send them to the brain. These signals are the sounds you hear.

A. The steps below describe how you hear. Number the steps in the correct order. The first one is done for you.

- _____ The sound waves make the eardrum vibrate.
- _____ The moving liquid bends tiny hairs in your inner ear.
- _____ The outside part of your ear catches the sound waves moving through the air.
- _____ The auditory nerves turn the movements of the tiny hairs into signals and send them to the brain.
- _____ The sound waves move down the auditory canal.
- _____ The vibrations from the small bones in your middle ear make the liquid in your inner ear move.
- _____ Vibrations from the eardrum are passed to small bones.

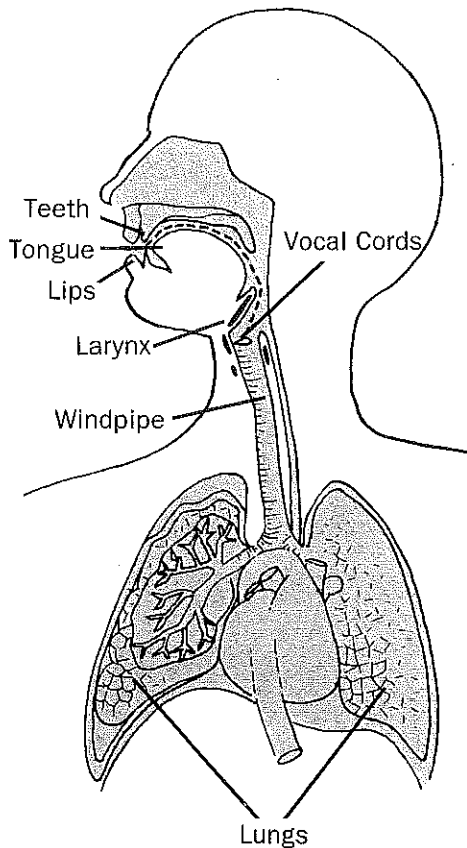
B. Underline the correct words.

1. The outside part of your ear and the auditory canal are both part of the (outer, inner) ear.
2. The three small bones in the middle ear make the vibrations (smaller, larger).
3. The inner ear is filled with (liquid, air).
4. Sound waves move down the auditory canal to the (eardrum, outer ear).
5. The auditory nerves send signals to the (brain, eardrum).
6. Your (inner, middle) ear has three small bones.
7. Your ear has (six, three) main parts.

C. Name the three parts of the ear.

1. _____
2. _____
3. _____

How You Talk



Parts of the Mouth and Throat

You have learned that all sounds are vibrations. When you speak, you send vibrations out into the air. Where do these vibrations come from?

Your voice begins in your **larynx**, or voice box. The voice box is the top part of your **windpipe**. Your **vocal cords** are small bands of tissue on either side of your voice box.

When you breathe, the vocal cords are relaxed. Your windpipe is completely open. When you talk, the muscles in your larynx pull on your vocal cords. The muscles pull the vocal cords over your windpipe. Only a narrow opening is left. The air coming up through your windpipe makes the vocal cords vibrate. These vibrations are sounds. When you talk, you use your mouth, tongue, teeth, and lips to shape these sounds into words.

Everyone talks the same way. But you can recognize the voices of people you know. This is because no two people have voices that sound exactly alike. Everyone's voice has its own pitch and its own sound.

The pitch of a person's voice depends on how large his or her voice box is. The larger a person's voice box is, the longer his or her vocal cords are. People with high voices have small voice boxes and short vocal cords. People with deep voices have large voice boxes and long vocal cords. People use their teeth, tongue, and lips differently when they talk. This is another reason why no two human voices sound exactly alike.

A. Fill in the missing words.

1. Your voice begins in your _____. (larynx, mouth)
2. Your vocal cords are small bands of tissue on either side of your _____. (voice box, mouth)
3. Air coming up through your windpipe makes your vocal cords _____. (relax, vibrate)
4. People with high voices have _____ vocal cords. (short, long)
5. People with low voices have _____ vocal cords. (short, long)

B. Answer True or False.

1. Your vocal cords are small bands of tissue on either side of your voice box. _____
2. When you breathe, your vocal cords are tight. _____
3. When you talk, your vocal cords are relaxed. _____
4. No two human voices sound exactly alike. _____
5. Everyone's voice has the same pitch and the same sound.

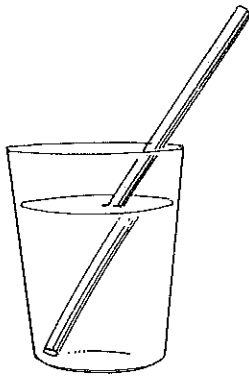
6. People with deep voices have large voice boxes and long vocal cords. _____
7. People use their teeth, tongue, and lips differently when they talk. _____
8. Your voice begins in your tongue. _____

C. Use each word to write a sentence about how you talk.

1. larynx _____

2. vocal cords _____

How Light Travels



How Light Rays Bend



This girl can see her reflection in the mirror.

Light is a kind of energy. Light is given off in tiny particles called **photons**. Photons have no mass. They are not matter. Photons travel in waves. Most light waves have so many photons that the separate photons cannot be seen. They look like solid waves of light.

Sound waves are movements of the matter through which they travel. So sound waves can travel only through matter. But light waves are waves of photons. So light waves can travel through empty space.

Light travels very quickly. It goes through 186,225 miles of air in 1 second. Light travels much faster than sound. Sound goes only about one fifth of a mile in a second. Have you ever been in a thunderstorm? If you have, you may remember that you saw lightning a moment before you heard the thunder. The light from the lightning reached you more quickly than the sound did.

Light travels in straight lines called **rays**. When light rays hit a smooth, shiny surface such as a mirror, they bounce back. You see whatever is in front of the surface. This is called **reflection**.

Light rays cannot turn corners. But they can be bent by things in their path. When a light ray goes through a different substance, such as glass or water, it changes direction. Then the ray comes out on the other side and goes straight on. This is called **refraction**. Look at the picture of a straw in a glass of water. The straw is not really bent. The light rays that your eyes see are bent.

A. Use the words below to complete the sentences.

energy
mass

matter
photons

space
wave

Light is a kind of _____. Light is given off in tiny particles called _____. Photons have no _____. They are not _____. Photons travel in _____.

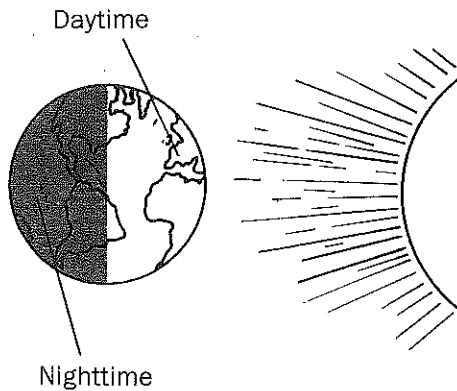
B. Write the letter for the correct answer.

1. Sound waves can travel only through _____.
(a) space (b) water (c) matter
2. Light travels much _____ than sound.
(a) faster (b) more slowly (c) more loudly
3. Light travels in straight lines called _____.
(a) particles (b) rays (c) photons
4. The bending of light rays by things in their path is called _____.
(a) refraction (b) reflection (c) transmission
5. When light rays hit a smooth, shiny surface and bounce back, it is called _____.
(a) transmission (b) refraction (c) reflection
6. Light is given off in tiny particles called _____.
(a) electrons (b) photons (c) straws

C. Answer True or False.

1. Photons have mass. _____
2. Photons travel in waves. _____
3. Light goes only about one mile in a second. _____
4. Light is much faster than sound. _____
5. Light rays cannot turn corners. _____

Sources of Light



How the Sun Lights Earth

Most of the light on Earth comes from the sun. The sun shines during the daytime. At night, the sun sets and it is dark. Why does the sun shine only during the day?

The sun is always shining. But because Earth **rotates**, or spins around, you see the sun's light only during the day. When the part of Earth where you are is facing the sun, sunlight falls on it. But as Earth spins, your part of Earth moves and faces away from the sun. Then it is night. Your nighttime is daytime for the people on the other side of Earth.

At night, some light comes from the moon. The moon does not really give off its own light. It just reflects light from the sun. So moonlight is very dim.

Most of the people in the world use electric light bulbs to see at night. The light from a light bulb comes from the **filament**. The filament is a small piece of tungsten wire. Electricity passes through the wire and makes it very hot. The hot wire gives off light.

Fill in the missing words.

1. Most of the light on Earth comes from the _____. (sun, moon)
2. Because Earth _____, you see the sun's light only during the day. (is round, rotates)
3. Your nighttime is _____ for the people on the other side of Earth. (twilight, daytime)
4. The moon reflects light from _____. (the sun, Earth)
5. Moonlight is very _____. (bright, dim)

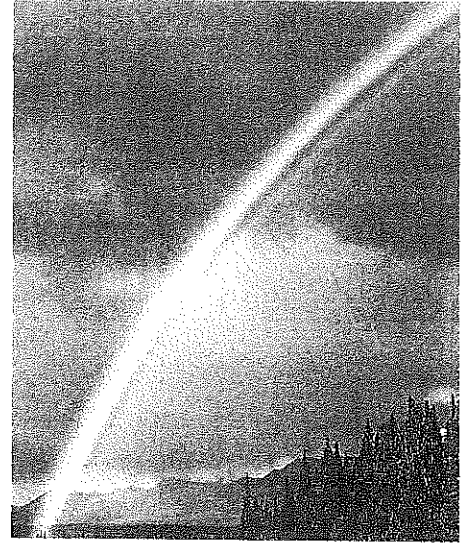
Color

Every day, you see objects of many different colors. The objects do not really have colors. The colors come from light. An object has a certain color because of the way it absorbs light.

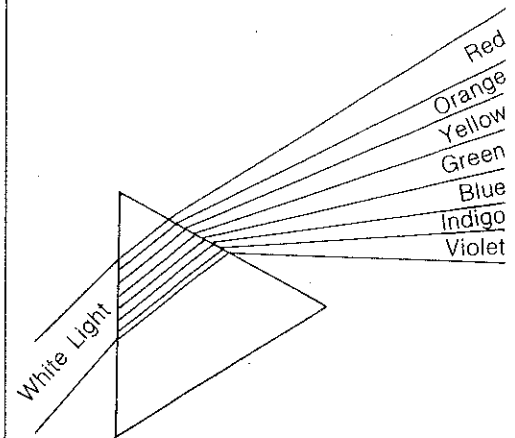
Sunlight is a mixture of light of all colors. Each color of light has a different wavelength. The photons of different colors have different energies. Red light has a long wavelength and low-energy photons. Violet light has a short wavelength and high-energy photons.

A red object, such as an apple, absorbs all colors of light except red. The red light is reflected. You see a red apple. White objects reflect all colors of light. Black objects absorb all colors of light.

The **spectrum** is all the colors of light. You can see the spectrum by using a **prism**. A prism is a piece of glass shaped like a triangle. When light passes through the prism, it is separated into all its different colors. The spectrum can also be seen in a rainbow. Rainbows happen when the sun shines after it has been raining. The drops of water in the sky act like tiny prisms to separate out the different colors of sunlight.



The different colors of light can be seen in a rainbow.

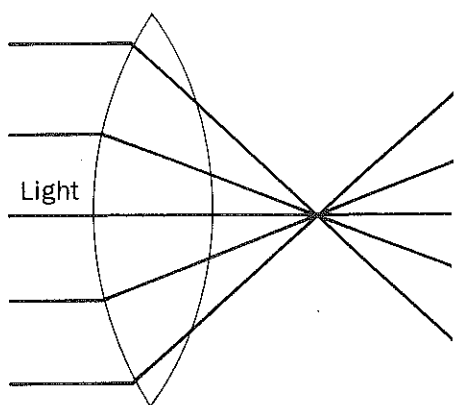


When light passes through a prism, it is separated into its different colors.

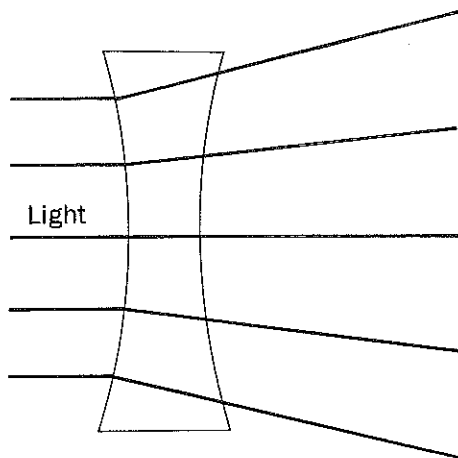
Answer True or False.

1. An object has a certain color because of the way it absorbs light. _____
2. Sunlight is made of only one color of light. _____
3. A red object reflects all colors of light except red. _____

Lenses



Convex Lens



Concave Lens

You know that light can be refracted, or bent. **Lenses** are used for bending light. They can make objects look smaller or larger. They can make things that are far away look close. How do lenses work?

Lenses are made of glass or other materials that light can pass through. The two main kinds of lenses are **concave** lenses and **convex** lenses. A concave lens is thinner in the middle than it is at the edges. A concave lens bends light rays so that they spread apart. A convex lens is thicker in the middle than it is at the edges. A convex lens bends light rays so that they come together.

Lenses have many different uses. People who have trouble seeing wear eyeglasses or contact lenses. Eyeglasses are lenses worn in front of the eyes. Contact lenses are lenses worn on the eye. Contact lenses are made of plastic. Concave lenses help people who have trouble seeing objects in the distance. Convex lenses help people who have trouble seeing objects close to them.

Scientists use lenses in microscopes. The lenses in microscopes make very tiny objects look larger. Scientists use microscopes to study things that are normally too small to see. Scientists also use lenses in telescopes. Telescopes make faraway objects look as if they are closer. Scientists use telescopes to study stars and planets.

Lenses are used in cameras. They **focus** light on the film. Without lenses, there would not be photographs or movies!

A. Use the words below to complete the sentences.

closer
concave

convex
focus

light
microscopes

1. Lenses are used for bending _____.
2. A _____ lens is thinner in the middle than it is at the edges.
3. A _____ lens is thicker in the middle than it is at the edges.
4. The lenses in _____ make very tiny objects look larger.
5. Telescopes make objects that are very far away look _____.
6. Lenses used in cameras _____ light on the film.

B. Answer True or False.

1. The main kinds of lenses are concave lenses and convex lenses.

2. A concave lens bends light rays so that they come together.

3. A convex lens bends light rays so that they come together.

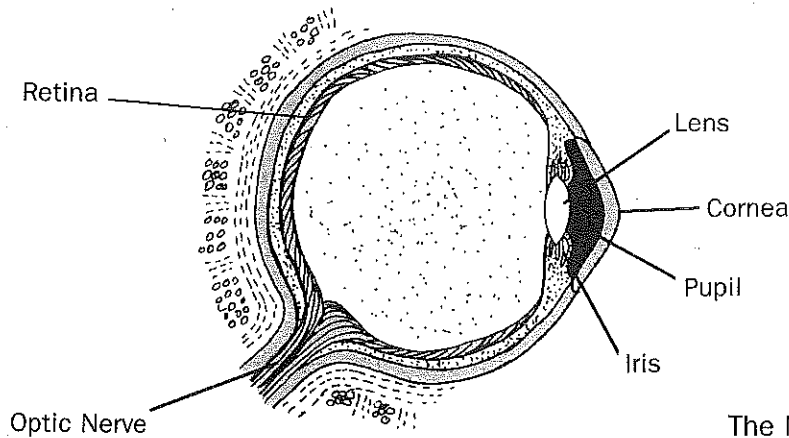
4. Lenses are used in cameras. _____
5. Lenses are not used in telescopes. _____

C. Answer the questions.

1. What do telescopes do? _____

2. What do scientists use telescopes for? _____

How You See



The Main Parts of the Eye

How do your eyes turn light into what you see? Your **eyeballs** are almost round. They have a thin covering called the **cornea**. The cornea helps to protect your eyes. The black circle in the middle of each of your eyes is the **pupil**. The pupil is a hole. Light goes through the pupil.

The colored part of your eye around the pupil is the **iris**. The iris changes the size of the pupil to let in the right amount of light. When the light is bright, the iris makes the pupil small. When the light is dim, it makes the pupil large.

Light enters the pupil and goes through the lens. The lens bends light rays so they hit the **retina** at the back of the eye. The retina is attached to the **optic nerve**. The optic nerve sends messages to your brain. Your brain sees these messages as pictures.

Draw lines to match each part of the eye with its description.

- | | |
|----------------|-----------------------------------|
| 1. pupil | attached to the optic nerve |
| 2. iris | a hole in the center of the eye |
| 3. lens | sends messages to the brain |
| 4. retina | the colored part around the pupil |
| 5. optic nerve | bends light rays |

Review

Part A

Underline the correct words.

1. Sound is a kind of energy that moves in (rays, waves).
2. All sounds are made by (vibrating, colored) objects.
3. The lowest part of a wave is called the (crest, trough).
4. The (wavelength, amplitude) of a sound is the distance between the crests of two of its waves.
5. A sound's pitch is the same as the (amplitude, frequency) of its sound waves.
6. Your voice begins in your (larynx, eardrum).
7. Light is given off in tiny particles called (electrons, photons).
8. Light travels much (more slowly, faster) than sound.
9. Light travels in straight lines called (rays, refractions).
10. Because Earth (reflects, rotates), you see the sun's light only during the day.

Part B

Read each sentence. Write True if the sentence is true. Write False if the sentence is false.

1. Sound waves can move through all kinds of matter. _____
2. Sound waves move outward in squares from their source. _____
3. A sound's loudness is the same as the amplitude of its sound waves.

4. Noise is made of notes. _____
5. The moon gives off its own light. _____
6. The light from a bulb comes from the filament. _____
7. An object that absorbs all colors of light is red. _____

Test

Fill in the
spaces.

Choose the phrase that best completes the
sentence.

1. Sound waves move more quickly through matter that is
 colored.
 dense.
 light.
2. Sound waves with a high frequency have a
 loud sound.
 low sound.
 high sound.
3. Most percussion instruments do not have any certain
 pitch.
 beat.
 vibration.
4. The inner ear is filled with
 air.
 liquid.
 gas.
5. The auditory nerves send signals to the
 eardrum.
 voice box.
 brain.
6. Your voice begins in your
 larynx.
 brain.
 auditory canal.
7. When light waves hit a smooth, shiny surface and bounce back, it is called
 reflection.
 concave.
 amplitude.
8. Each color of light has a different
 frequency.
 wavelength.
 cornea.
9. A concave lens bends light rays so that they
 change color.
 bounce back.
 spread apart.
10. The black circle in the middle of your eye is the
 pupil.
 cornea.
 retina.

Just for Fun

Use the words below:

bend
crest
eardrum

energy
iris
lenses

music
pitch
trough

vocal
waves

1. What part of your ear vibrates?
2. What kind of sound is made of notes?
3. What is the lowest part of a wave?
4. What is the colored part of your eye?
5. What is the same as the frequency of a sound's waves?
6. How do sound and light move?
7. What do lenses do to light rays?
8. What cords vibrate when you talk?
9. What are used in microscopes?
10. What is light, music or energy?

_____ 8 _____

_____ 3 _____

_____ 13 2 _____

_____ 10 1 _____

_____ 12 _____

_____ 6 _____

_____ 4 5 _____

_____ 9 _____

_____ 7 _____

_____ 11 _____

Now find the letters that begin each word in the words below. Write them in the spaces below. When you are finished, you will have a surprise.

Riddle: What kinds of energy move in waves?

1 2 3 4 5

6 7 8

9 10 11 12 13