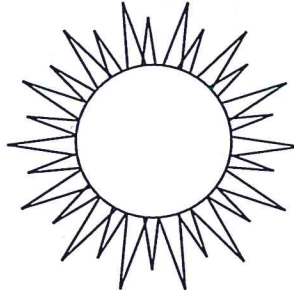
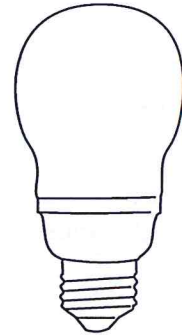


## Sources of Light

Where does light come from? Light comes from two sources. One source is natural light. This means that the light comes from nature. Light from the Sun is natural because the Sun makes its own light.



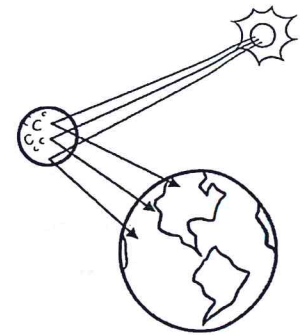
natural light



artificial light

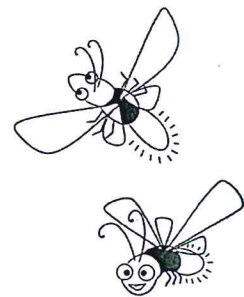
The other source of light is artificial. This means that the light is made by people. Light bulbs are artificial because people made them.

Most light sources give off their own light. Our Sun and other stars make their own light. Candles and light bulbs also make their own light. But what about the Moon? We can see light from the Moon, but it does not make light because it is not a star. The light we see from the Moon is reflected sunlight. Reflected light is important in other ways. Reflectors on a bicycle bounce light from car headlights so drivers can see the bicycle.



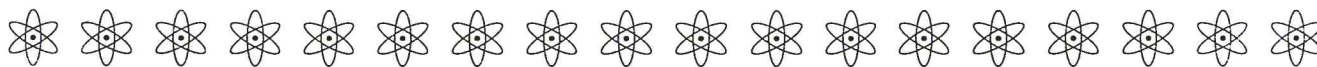
## Unusual Sources of Natural Light

Many animals and plants can make their own light. This is called bioluminescence (buy-oh-loo-muh-NESS-ens). You may have seen a firefly at night. Fireflies produce light at the ends of their bodies. They flash the light to communicate with other fireflies. Some mushrooms can make their own light. If you walk in the forest in the dark, you may see some. Most of the animals that make light live in the oceans and seas. One example is the Anglerfish. This fish has a long, thin fin that grows out of the top of its head. The tip of the fin gives off light to attract prey.



## Light Is Important

Both natural and artificial light are very important. Light from the Sun is needed for plants to grow. This light also helps keep animals and people healthy. Most things people do require light. We do many activities during daylight. We can also do many things at night because of artificial light. Think about how different your life would be if we only had light from the Sun.



## "Sources of Light"—Think About It!

1. Write the following sources of light in the correct column of the chart below.

- neon lights
- falling meteors
- lightning
- Northern lights
- sparklers
- traffic lights
- fireflies
- kerosene lamps

| Natural Light Sources                                        | Artificial Light Sources                                     |
|--------------------------------------------------------------|--------------------------------------------------------------|
| falling meteors<br>lightning<br>fireflies<br>Northern lights | neon lights<br>sparklers<br>traffic lights<br>kerosene lamps |

2. Fireflies and some algae make their own light. Is that light natural or artificial?

Explain your thinking.

Natural → not produced by humans

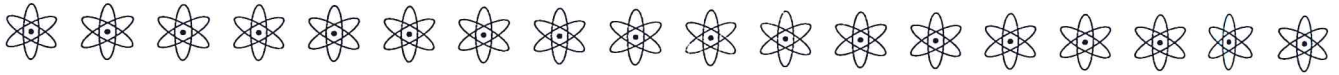
3. What is one advantage of sunlight compared to a light bulb? What is one advantage of a light bulb?

Sunlight is free      light bulb works anytime

4. How would your life be different if you had no artificial light?

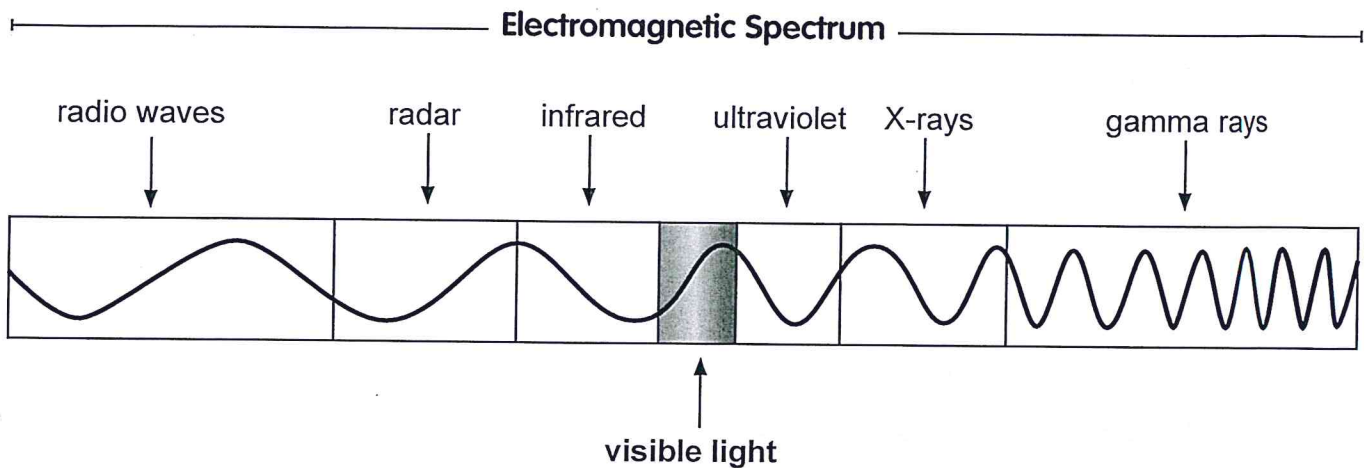
Would only be able to see things when the sun is shining

Candle light would be limiting things you could do



## Light and Energy

Light is a form of energy. It comes from the Sun. Light that we can see is called visible light. Light travels in waves from the Sun. Visible light is only one part of a family of waves that scientists call electromagnetic energy. Our eyes can see the waves of visible light, but cannot see the other waves of energy. They are invisible to our eyes. Below is a diagram of the electromagnetic spectrum that shows the different families of waves. You can see that visible light is a very small part of this spectrum.

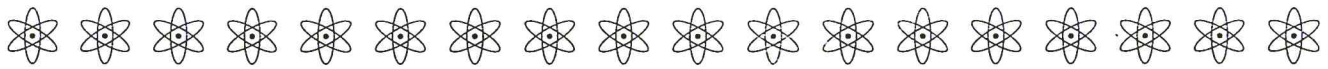


## Visible Light and Colour

Visible light from the Sun looks like white light. This light is made up of colours that mix together to make white light. White light can be split up to form a spectrum of its colours. A rainbow shows the spectrum of colours of visible light. The seven colours in visible light are violet, indigo, blue, green, yellow, orange, and red. Whenever visible light is split, these colours appear in the same order. Some scientists think that indigo and violet are the same colour. They say there are only six colours in the spectrum.

People with normal vision can see all the colours of visible light in the spectrum. Some people have colour blindness. This means they have difficulty seeing certain colours such as red and green. Dogs, cats, mice, and rabbits have poor colour vision. They see mostly greys and some blues and yellows. Bees and butterflies have super colour vision. They can even see some ultraviolet parts of the spectrum.





## "Light and Energy"—Think About It!

1. How is all light energy the same? How is it different?

All energy can come from the sun. Different types of light energy can be used for different tasks. Only part of the sun's light energy can be seen by humans.

2. How can you tell that radio waves and infrared light exist if you cannot see them?

A radio can be used to sense radio waves. You can feel the heat of infrared light or take a picture with an infrared camera.

3. X-rays are one type of light energy. How are X-rays useful to doctors?

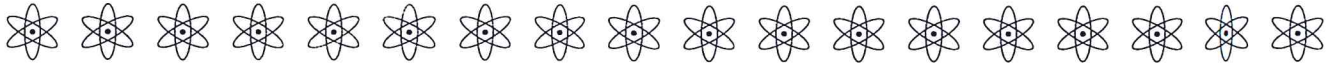
Useful because they can take pictures of bones inside a body.

4. Imagine that the only colours you could see were black, white, and shades of grey. A dark-red book and a dark-green book would both look dark grey to you. What everyday activities would be difficult for you to do? Give at least three examples.

It would be difficult to tell the difference between red and green, peppers, apples, or wires.

Would not be able to watch 3D movies or pick matching clothes

\* Many answers are acceptable



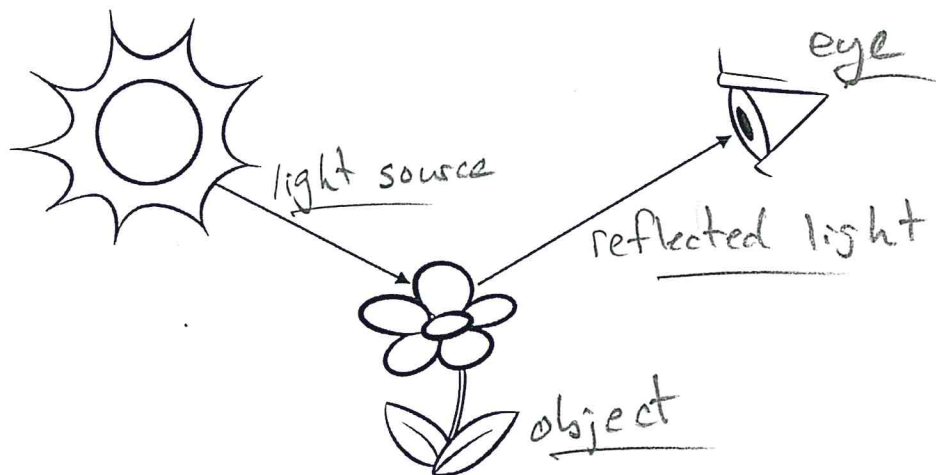
## Reflected Light

We can see light from things that produce light, such as the Sun and fire. But how do we see objects that do not produce light? Light travels in a straight line and it bounces off objects. Light that bounces off an object is called reflected light. Moonlight is reflected sunlight. Light from reflective clothing is light that bounces off the clothing. Reflected light also travels in a straight line.

How do we see objects? Light from a light source reflects off an object. Then the reflected light travels in a straight line into our eyes. We cannot see objects when it is completely dark because there is no light to reflect off them.

### Think About It!

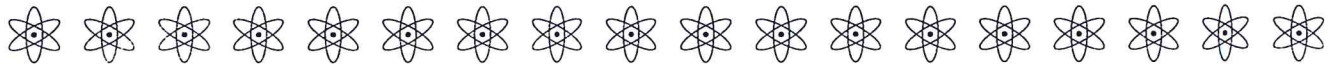
1. Label the following diagrams with these words: light source, object, reflected light, light, eye.



2. You go into a dark room. At first, you cannot see anything. Slowly you begin to see the outlines of objects in the room. Is there any light in the room? How do you know?

there must be light in the room because the objects are reflecting light, that's why I can see the outline.





## Light Technology

The Sun was the first light source used by people. Later in history, people started to burn fuels to make light. First they burned animal fat in hollow objects. Over time, people designed new containers for burning fats. They added wicks to make the fire in the lamps burn more evenly. They started to use other fuels such as olive oil, beeswax, fish oil, whale oil, and nut oils. In the 1700s and 1800s, new lamps were designed. These used fuels that came from the ground, such as kerosene and coal. But the world was still a dark place for many people. Good fuels and lamps were expensive. Gas street lamps lit up only the area around each lamp.

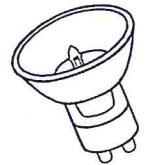
### Light Bulbs Today

Today most lighting depends on electricity. These are some different light sources used in homes, schools, and stores.

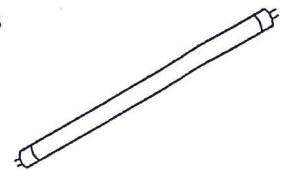
**Incandescent:** Inside these light bulbs is a thin wire that is heated by electricity. When the wire gets very hot, it gives off a visible light. It also gives off a lot of wasted heat. Incandescent bulbs do not last very long. They also use a lot of electricity to produce a bright light. These bulbs are not expensive.



**Halogen:** Halogen light bulbs work in the same way as incandescent bulbs. A wire inside the bulb is heated to produce light. The light from halogen bulbs is much brighter than the light from incandescent bulbs. Halogen bulbs also last longer, but they are more expensive. They also get very hot. They give off a lot of wasted heat.



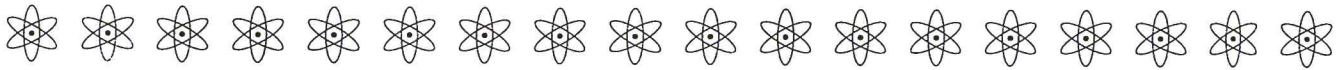
**Fluorescent:** These are tubes filled with gas. Some bulbs are long, straight tubes, and others are spiral tubes. When electricity passes through the tubes, ultraviolet light is produced. This ultraviolet light causes other chemicals in the bulb to give off visible light. Fluorescent bulbs are more expensive than incandescent bulbs, but they use less electricity. They also give off much less heat.



**Light-emitting Diode (LED):** These are very different from other lights because they have a special material inside. The material produces light when electricity passes through the bulb. Different colours of light can be produced with different materials. LED lights last a very long time. They use very little electricity and do not get hot. LED lights are very expensive.







# What Can You See Through?

## Transparent Objects

When you look through a clear glass window, you can see what is on the other side. This happens because light can pass right through the glass. Another way to say this is that clear glass transmits light. Materials or objects that transmit light are called transparent.

## Translucent Objects

What happens when you look through a frosted glass window? You can see a little bit through the window, but you cannot clearly see what is on the other side. This happens because only a small amount of light is transmitted through the glass. Materials or objects that transmit only a little light are called translucent.

## Opaque Objects

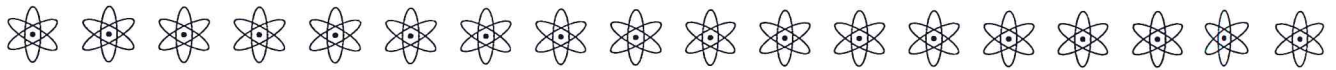
Can you see through a wooden door? No, the door does not let any light through. The wood absorbs the light instead of transmitting it. Materials or objects that absorb light are called opaque.

### Think About It!

1. In the chart below, list examples of materials and objects that are transparent, translucent, and opaque. List at least three examples in each column.

| Transparent                                                                                                                          | Translucent                                                                                                                                       | Opaque                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• eyeglass lenses</li><li>• clear plastic wrap</li><li>• house windows</li><li>• air</li></ul> | <ul style="list-style-type: none"><li>• plastic milk jug</li><li>• waxed paper</li><li>• stained glass window</li><li>• nylon stockings</li></ul> | <ul style="list-style-type: none"><li>• cement</li><li>• wood</li><li>• stone</li><li>• desk</li></ul> |
| Many correct answers                                                                                                                 |                                                                                                                                                   |                                                                                                        |



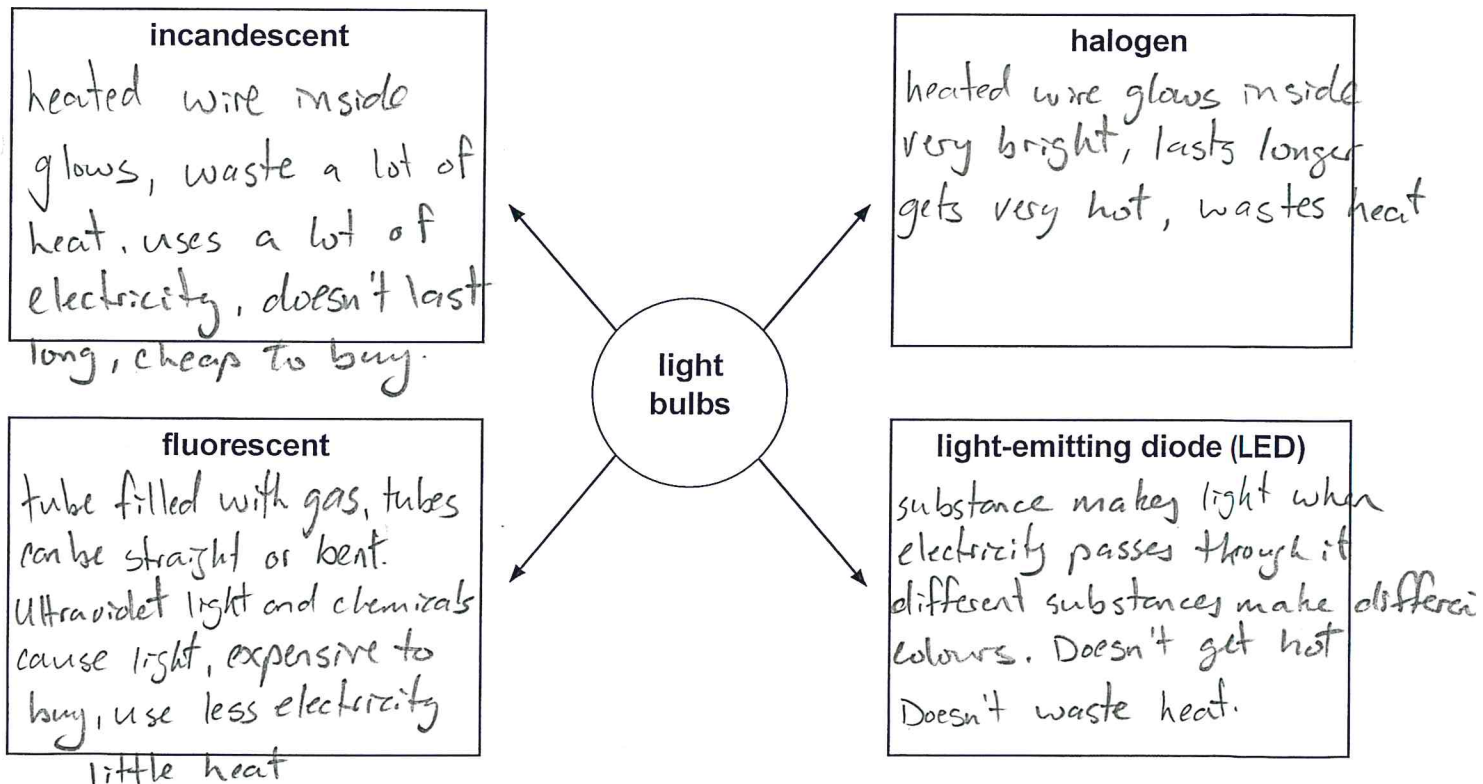


## "Light Technology"—Think About It!

1. Street lights provide light at night. Lights are also used in parks, playing fields, and many other places. What is one advantage of having these lights? What is one disadvantage of having these lights?

- street lights make it safer at night - advantage  
- can't see as many stars because city is bright - disadvantage

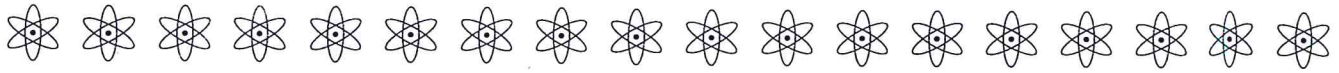
2. In the web below, summarize important points about each type of lighting.



3. Which light or lights do you think are the best for your home? Why?

Answers will be different but need a good reason  
Ex. Fluorescent bulbs because they use less electricity  
because we have a lot of lights that are on a lot.



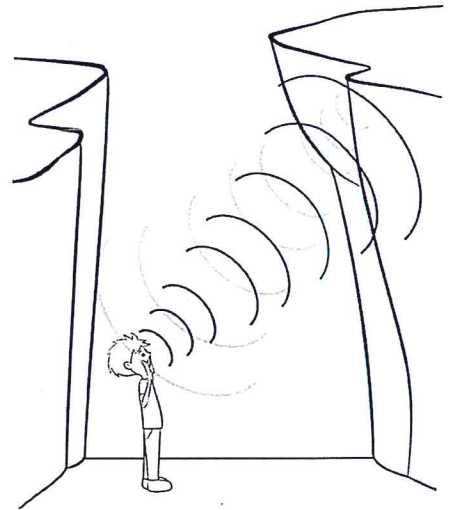


# Changing How Sound Travels

## Reflected Sound

Have you ever heard an echo? An echo is sound reflecting, or bouncing off, a surface. Light will reflect off a mirror. Sound will reflect off a surface, too. Sound will keep bouncing around until it loses its energy.

Some animals use sound in a special way. Bats and whales send out sounds that bounce off surfaces. The echoes tell them where the objects are. Using sound in this way is called echolocation.



## Absorbed Sound

Can you stop sound from travelling far? Can you stop sound from reflecting? Can you make sound quieter? Materials that are not smooth or hard can help you do these things.

Have you ever been in an empty house that no one lives in? You probably noticed a lot of echoes. Soft materials absorb sound. They stop echoes. An empty house has no soft materials to absorb the sound. Adding carpets, furniture, and drapes helps quiet the sound.

## Think About It!

1. Would hard or soft materials be best for a room in which you watch television or listen to music? Why?

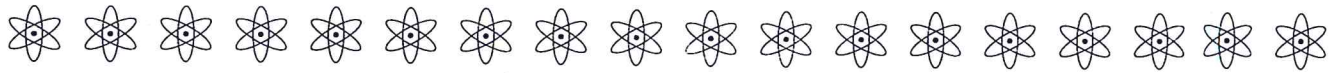
*Soft materials would be best because they absorb sound, reducing the echo.*

2. Many large concert halls contain some hard materials and some soft materials. Why do you think they do?

*Soft materials help reduce echoes and hard materials are needed to support the structure and direct sound to the audience.*







## Hearing Sounds

We hear with our ears. Our ears are special organs that pick up vibrations made by sound. The ear is made up of three different sections: the outer ear, the middle ear, and the inner ear. These parts all work together with our brain so we can hear and understand sounds.



Most animals have ears that help them hear sounds. Animal ears come in many shapes and sizes. Most of the time, ears are found on an animal's head. Some animals have hearing organs that do not look like ears. For example, crickets have small, pale spots on their front legs that sense sound. Snakes do not have an outer ear, but they do have an inner ear. Snakes also feel vibrations through the ground. These vibrations travel through a snake's lower jaw, and into the inner ear.

## Measuring Volume

Sounds can be loud or soft. This is called the volume of sound. Sounds that have more energy are louder. Sounds with less energy are softer. Decibels (dB) are used to measure how much energy is in sound. If you have good hearing, the softest sound you can hear is 0 dB. One of the loudest sounds ever heard was the eruption of a volcano in 1883. Scientists estimate that the sound was 180 dB. People 3000 km away from the volcano heard the eruption.

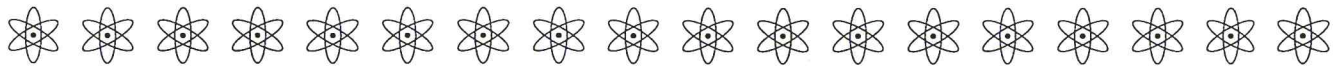
## Measuring Hearing Range

People and animals can hear a range of sounds, from low-pitched sounds to high-pitched sounds. The pitch of sounds is measured in Hertz (Hz). One vibration per second is one Hertz. Low-pitched sounds have lower values of Hertz. High-pitched sounds have higher values of Hertz.

People can hear sounds that range from 20 Hz to 20 000 Hz. Dogs can hear sounds that range from 40 Hz to 45 000 Hz. This means that dogs can hear sounds at a higher pitch than people can. Have you ever heard a dog whistle? The whistle makes a sound with a pitch that is too high for you to hear, but dogs can hear it.

This chart shows the lowest-pitched and highest-pitched sounds that people and various animals can hear.

| Animal      | Range of Hearing in Hz |
|-------------|------------------------|
| People      | 20 to 20 000           |
| Dogs        | 40 to 45 000           |
| Cats        | 45 to 65 000           |
| Bats        | 2000 to 120 000        |
| Blue Whales | 5 to 120 000           |
| Giraffes    | 5 to 120 000           |
| Mice        | 2300 to 85 000         |
| Tuna        | 50 to 1100             |



## "Hearing Sounds"—Think About It!

1. Rank the following sounds from softest to loudest. Write each sound where you think it belongs in the chart.

- normal conversation
- loud thunder
- power lawn mower
- a whisper
- car horn
- vacuum cleaner

| Sound               | Decibels |
|---------------------|----------|
| whisper             | 20 dB    |
| normal conversation | 50 dB    |
| vacuum cleaner      | 70 dB    |
| power lawn mower    | 100 dB   |
| car horn            | 110 dB   |
| loud thunder        | 120 dB   |

2. Scientists sometimes disagree on the hearing range of some animals. Why do you think this happens?

different individuals within different species can have different hearing abilities. Hard to measure in animals and would have to watch their reactions. Reactions would vary.

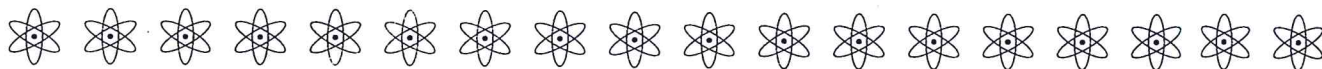
3. Which animals can hear sounds that are lower in pitch than sounds people can hear?

blue whales and giraffes

4. Can bats and tuna hear the same sounds? How do you know?

No, because the highest frequency tuna can hear is lower than the lowest frequency bats can hear.





# The History of Hearing Aids

Some people find that they do not hear as well as they used to. This problem is called hearing loss. Many people over the age of 60 have hearing loss, but sometimes younger people have to cope with this problem.

Throughout history, scientists and inventors have developed different types of hearing aids to help people hear better. Let's take a look at how hearing aids have changed over time.

## The Ear Trumpet

One of the first hearing aids was called an ear trumpet. It was a tube that was narrow at one end and wide at the other end. A person put the narrow end against one ear, and people spoke into the wide end.

Ear trumpets started to become popular in the late 1700s. People were still using them in the early 1900s. Ear trumpets did help people hear a little better, but new inventions that worked much better would soon come along.

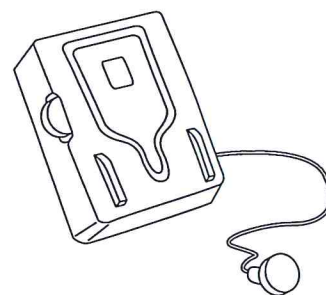


Ear trumpet

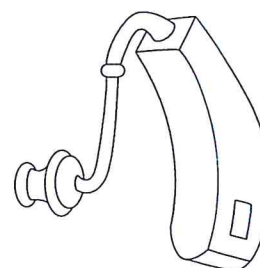
## Electronic Hearing Aids

The first electronic hearing aids were invented at the beginning of the 1900s. They were large boxes that weighed several pounds, with an earpiece that was connected to the box by a wire. These hearing aids were too large and heavy for people to carry around with them.

In the 1950s, scientists created much smaller hearing aids that could fit in a shirt pocket. These hearing aids still used a wire to connect the box to the earpiece. Before long, scientists invented hearing aids small enough to fit behind the ear. The invention of very small batteries helped make behind-the-ear hearing aids possible.



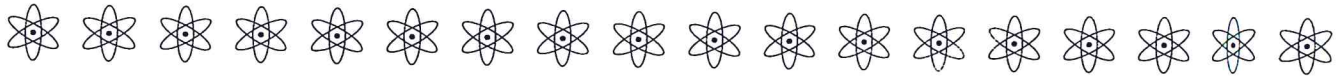
Electronic hearing aid from the early 1950s



Behind-the-ear hearing aid from the 1960s

continued next page





## Digital Hearing Aids

The newest hearing aids use digital technology. That is the same technology used in computers and cell phones. Digital technology allowed scientists to create hearing aids that are small enough to fit inside the ear. Some hearing aids are small enough to fit deep inside the ear so they are almost impossible to see.

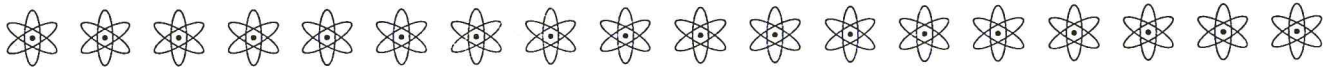


In-the-ear hearing aid

Today's digital hearing aids can do some remarkable things:

- **Adjust to changes in volume:** The hearing aid automatically adjusts itself so loud sounds are not made too loud, but soft sounds are made louder.
- **Adapt to background noise:** Imagine your friend is speaking to you in a crowded, noisy room. If your hearing aid makes your friend's voice *and* all the background noise louder, you might still have trouble hearing your friend.  
Today's hearing aids can make your friend's voice louder without making the background noise louder.
- **Help people with different types of hearing loss:** Some people have problems hearing low tones such as the sound of tuba, or high tones such as the sound of a flute. Today's hearing aids can be adjusted so they only make the tones louder that a person has trouble hearing.





## "The History of Hearing Aids"—Think About It!

1. Look at the picture of the ear trumpet. How do you think this hearing aid got its name?

It looks like a musical trumpet. Both are tubes that are wide on one end and narrow at the other end.

2. In the 1950s, scientists started created hearing aids that people could wear on their bodies.

Why would this type of hearing aid be more useful than one with a large, heavy box?

A hearing aid that people wear on their bodies can easily go wherever a person goes. A large device would be difficult to carry around.

3. Why do you think scientists invented hearing aids that fit deep inside the ear so they are almost impossible to see?

- make them smaller and easier to wear
- sends sound straight to the ear drum
- more difficult to notice and see

4. There have been many improvements to the hearing aid. What invention that we use today would you like to improve? Tell one way that you would improve it.

- easily make adjustments in volume
- eliminate background noise
- help with different types of hearing loss.

I would improve the size and consider an implant.

\* answers may vary.