EASY SCIENCE

GOOD VIBRATIONS

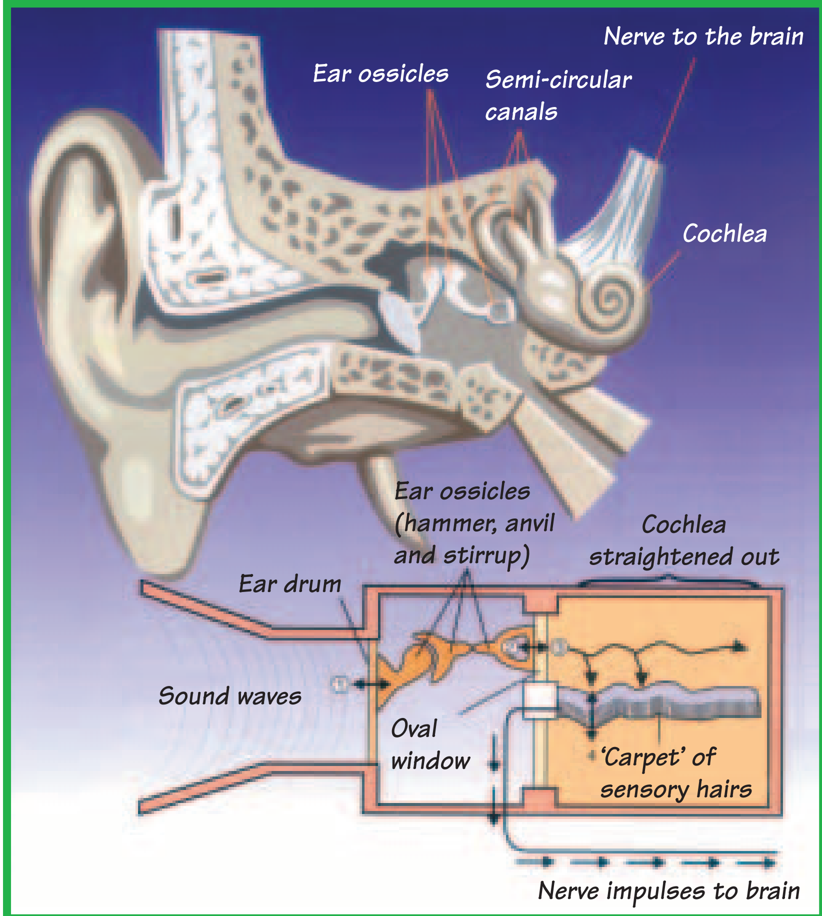
You may think those two things sticking out on the sides of your head are what let you hear sounds. But your outer ears don't really hear at all. They are just "sound catchers". Your hearing organs are located inside your head.

In fact, you hear through a system made up of two ears, two paths to the brain, and two brain halves. This "double" system lets you tell the direction a sound is coming from and how far away it is. It also lets you hear stereo sound. Just as sound from a stereo system comes from two speakers, sound comes to your brain from your two ears.

Your two ears are almost identical. The picture shows what one of your ears looks like.

Sound collected by the **outer ear** travels through the air in your **ear canal** to your **ear drum**. Three small bones are connected to the ear drum. These bones are called the **hammer**, **anvil**, and **stirrup** because of their shapes. Next to these bones is a large snail-like shell called the **cochlea**. The stirrup touches the cochlea at a small membrane-covered opening called the **oval window**. The space inside the cochlea is filled with a thick fluid. Along the inside wall of the cochlea are more than 10 000 very sensitive hair cells that stick into the fluid. Attached to these hair cells are nerves that come together at the back of the cochlea and go to the brain stem.

Here is how it all works: Sound makes the ear drum vibrate. The vibrating ear drum makes the hammer, anvil and stirrup vibrate. The vibrating oval window causes the fluid in the cochlea to vibrate. The hair cells sense the vibrating fluid and send nerve signals to the brain stem. The nerve signals from both ears are combined in the brain stem and sent up to the brain, which interprets the signals as sound.



EASY SCIENCE

EasyScience is produced by the South African Agency for Science and Technology Advancement (SAASTA), an operational unit of the National Research Foundation. SAASTA's mission is to promote the public understanding, appreciation and engagement with science and technology among all South Africans.
Visit the website: www.saasta.ac.za for more information.

SAASTA

SEE FOR YOURSELF

Here is a cool activity you can do to help you better understand sound and hearing.

You will need:

- A metal coat hanger
- Two pieces of string, each 50 cm long
- Pencil
- Keys, metal spoons and an oven rack

Hold the coat hanger upside down. Tie a piece of string to each end of the bottom of the coat hanger. Wrap the other ends of the strings a couple of times around the ends of your index fingers. Place your index fingers in your ears.

Ask a friend to use a pencil to lightly tap the hanger. Describe the sound you hear. Try it again, but this time, after your friend taps the hanger, he or she should very gently touch the string. Can your friend feel the string vibrate?

As other sound sources, instead of the hanger, use other metal objects like spoons of different sizes, or keys, and hear how they sound. One thing that really works well is an oven rack. Be sure that the oven has not been used for several hours and that the rack is not hot! Have your partner tap the oven rack with a pencil. Describe the sounds you hear.

Once the sound reaches your ear, it makes your ear drum and other parts of your ear vibrate. The vibrations cause nerve messages to go to your brain. Your brain interprets these messages as sounds.

There must always be some material for a sound to travel through to get to your ear. Here the material is the string and your finger. Usually the material is air.

If you touch the string very gently, you can feel it vibrating as sound travels through it. When sound travels through air, it makes particles of the air vibrate, but they are too small for you to see or feel.

All sounds you hear are produced by vibrating object like this vibrating coat hanger. The coat hanger is the sound source.

LOOK AFTER YOUR EARS

The ear is such a complicated mechanism that it is not surprising problems can occur, causing deafness or hearing problems. If the eardrum is broken, you will be deaf for a while until it has re-grown. Defects can also occur in the bones of the middle ear and the sensitive cochlea. As long as some hearing remains, a hearing aid can help a lot to make the person hear sounds.

BALANCE

The inner ear contains three semicircular canals that help us keep our balance. Each canal is filled with fluid and as you move your head the fluid moves. If you spin around and around or knock your head, the delicate balance of the fluid in the canals is disturbed and you will feel dizzy.

EARDRUMS

Frogs and many lizards have their eardrums on the surface of the head and have no outer ear. Fish have no eardrums at all, and no middle ear. They can, however, pick up sounds or vibrations in the water through another organ, called the lateral line.

HEARING IN 3-D

You are riding your bike down a busy street. A motorcycle roars up behind you. A bus honks it hooter. A man coughs. A radio blares from somewhere nearby. A trash can lid bangs on the sidewalk. A bird sings. You have the amazing ability to hear all of these sounds at the same time. You can also tell, without looking, where each sound is coming from. You can do all this because you have two ears. This activity will help you figure out why two ears work better than one.

Stand in the middle of the room surrounded by your classmates. Close your eyes and plug up one ear. Your teacher (or someone else) should silently point to one of your classmates. This person should clap once. Listen carefully for the sound and point your finger in the direction it seemed to come from. Your teacher then silently points to another classmate in another part of the room. This new classmate claps once, and you try to point towards the sound. Your teacher continues to point to other classmates to make sounds for you to try to locate. Keep your eyes closed, but unplug your ear. Your teacher will repeat the activity, but this time you will use both ears to locate the sound. Are you more successful?

THE KEY TO HEARING IN 3-D:

Your brain can tell which direction a sound is coming from in two ways:

1. By which ear hears the loudest sound: Your ear that is closest to the sound source will hear the sound a little louder than the other ear. Your brain interprets the extra loudness to mean that the sound source must be in the direction of the ear that hears it the loudest.
2. By the difference in the time that the sound reaches each ear: Sounds coming from the side will reach your closest ear a tiny fraction of a second before they reach your other ear. Your brain interprets this time difference to mean that the sound source must be in the direction of the ear which heard the sound slightly sooner.

EASY SCIENCE

PITCH SWITCHER

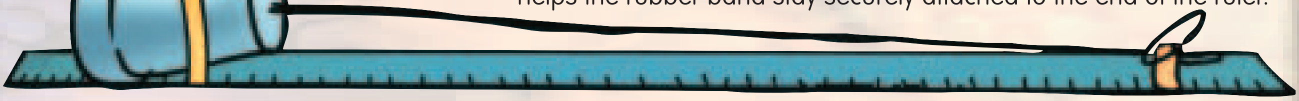
Human ears can hear a wide range of loudness, from the very quiet sounds of a whisper to the loud roar of a jet engine. We can also hear extremely small differences in the highness and lowness of sounds. This characteristic of sound is called **pitch**. Some musical instruments, such as a piano or harp, have strings, each of which plays a different pitch. Try the activity below to see what makes some strings produce a high-pitched sound and others a low-pitched sound.

You will need:

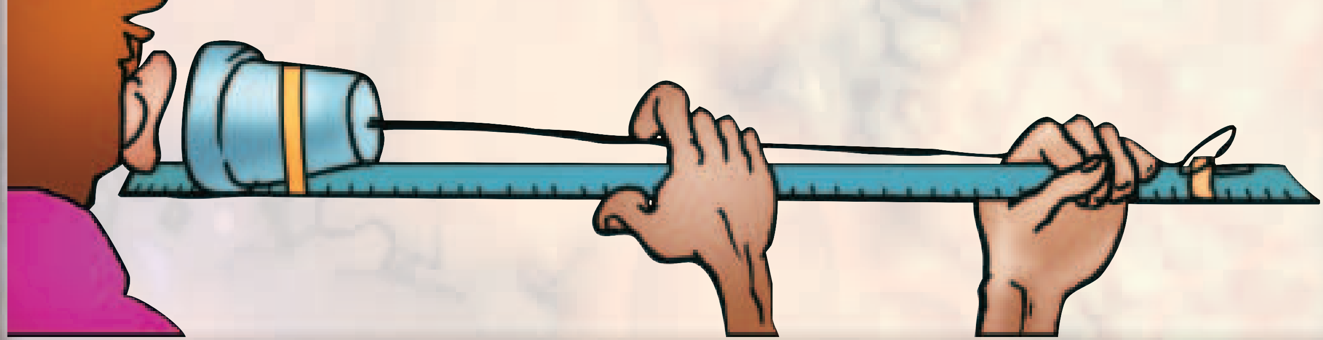
- A paper cup
- A thumb tack
- A long rubber band
- Paper clip
- Stiff plastic or wooden ruler
- Tape
- Scissors

Use your thumb tack to carefully poke a hole in the centre of the bottom of a paper cup. Cut a rubber band. Thread one end through the cup and out the hole. Tie two or three knots in the end of the rubber band inside the cup as shown.

Tape the cup to the ruler so that the bottom of the cup is on about the 2 centimetre line. Tie a paper clip to the free end of the rubber band. Stretch the rubber band to the end of the ruler. Tape the rubber band down as shown so that the paper clip helps the rubber band stay securely attached to the end of the ruler.



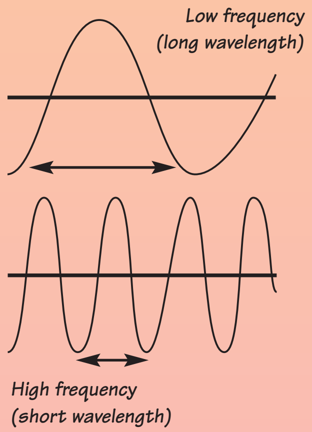
Hold the cup to your ear as shown. Pluck the rubber band once. Press the rubber band down onto the ruler near the end opposite the cup. Pluck the rubber band again. Was the sound different than before?



Press the rubber band down as you move your finger closer and closer to the cup. Pluck the rubber band each time you press it down. How does changing the length of the vibrating part of the rubber band change the pitch of the sound? How do you think the sound will change if, instead of pressing the rubber band down closer and closer to the cup, you press it down further away from the cup? Try it and see! How is this similar to the way a guitar player can change the pitch of a string on a guitar? Can you use this idea to make a homemade guitar?

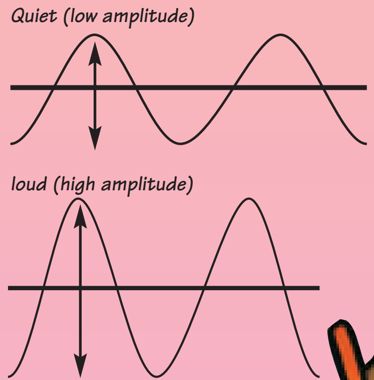
Increasing the length of the vibrating part of the rubber band causes it to make a lower-pitched sound. Decreasing the length of the vibrating part of the rubber band causes it to make a higher-pitched sound.

Two important characteristics of a sound that help us recognise and describe it are pitch and loudness. The pitch of a sound – whether it is high or low – depends on the number of vibrations per second, called its frequency. The faster something vibrates (the higher the frequency), the higher the pitch of the sound it makes. The higher the sound, the shorter the length of the sound wave.



The pitch of a sound – whether it is high or low – depends on its frequency or wavelength. Long waves have a lower frequency and pitch than short waves.

The loudness of a sound is related to how large the vibrations are, or the height of the sound waves. This is called the amplitude. Larger vibrations produce louder sounds and quiet sounds have a small amplitude.



The loudness of a sound depends upon the height of its waves, called the amplitude. Quiet sounds have small amplitude; loud sounds have a large amplitude.

SOUND TRAVELS

Have you seen an old cowboy movie where someone puts an ear on the ground to tell if buffalo or horses are coming? Looks silly, doesn't it? But those old cowboys were actually quite clever.

To reach your ear, sound usually travels through the air. But sound can also travel through other things. Try this activity to see how well sound travels through the different states of matter: liquids, gases and solids.

You will need:

- Three zip-closing plastic bags
- Water
- Sand or dirt
- Pencil

Put sand in one plastic bag so that it is about half full. Push the extra air out and then seal it to no sand will leak out. Lay the bag on its side.

Fill another plastic bag with water so that it is as full as the bag of sand. Push the extra air out and then seal it so that no water will leak out. Lay the bag on its side.

Blow into one of your plastic bags so that it is inflated. Let some air out so that the bag is as full as the bags of sand and water. Seal it so that no air will leak out. Lay the bag on its side.

Clear off the table and place one of the bags on the table. Put your one ear gently on the bag and put your finger in your other ear. Lightly tap on the table with the eraser end of the pencil about an arm's length away. How well can you hear the sound? Lift your ear off the bag and tap the pencil again. Do you hear better with or without the bag?

Repeat this experiment with the other two bags. Through which bag did you hear the sound best? Through which bag was the sound hardest to hear?

Dolphins and whales communicate through great distances under water. Do you think they could communicate from so far away if they lived on land?