PRIMARY + STEM

Teaching Resource

ACTIVITY: Sound Vibrations

ACTIVITY OVERVIEW

Sound is one of the most common ways that we use to communicate with each other. We are always alert for voices and sounds in the environment around us. Sounds are very important in our lives. This activity helps students understand how sound, as a form of energy, is sensed by our bodies and how it travels as vibrations in the air and other different materials.

The science of sound can be easily integrated into a music class, while students explore different sounds made by musical instruments.

SYNOPSIS

Sound is one of the most common ways that we use to communicate with each other. We are always alert for voices and sounds in the environment around us. Sounds are very important in our lives. This activity helps students understand how sound, as a form of energy, is sensed by our bodies and how it travels as vibrations in the air and other different materials.

The science of sound can be easily integrated into a music class, while students explore different sounds made by musical instruments.

Foundation – Year 2

- Light and sound are produced by a range of sources and can be sensed. (VCSSU049)

Year 3 – 4

- Natural and processed materials have a range of physical properties; these properties can influence their use. (VCSSU060)

Year 5 - 6

- Energy from a variety of sources can be used to generate electricity; electric circuits enable this energy to be transferred to another place and then to be transformed into another form of energy. (VCSSU081)

ACTIVITY, MATERIALS AND INSTRUCTIONS

Activity – Ear drum dancing salt

Make a model of an ear drum, sprinkle it with salt and use sound vibrations to make the salt dance.

Materials for 30 students (working in 10 groups)

- 10 x round plastic takeaway containers (no lids required)
- 10 x elastic bands (big enough to fit around the container)
- Roll of cling film
- Table salt
- Assorted objects that can be hit together (we suggest putting together a box/bag for each table containing at least 12 items, such as metal spoons, plastic cups, cream containers, wooden blocks, foam pieces)

Instructions

1. Teacher to prepare 'ear drums' for younger children. Place a piece of cling film over the top of the plastic container.
   Secure with elastic band. Repeat for 10 ear drums.
2. Distribute ear drums to groups around the classroom.
3. When ear drums are placed securely on the table or floor, sprinkle a pinch of salt on the cling film.
4. Students bang different objects directly above the ear drum. The sound vibrations through the air make the salt dance. (Note – this is quite a noisy activity!)
5. Students investigate which objects make the salt jump up and down the most and how the movement of salt is affected by the energy used to bang objects. The more energy we hit the objects with, the higher the salt jumps.

Can we hear in space? No, we cannot hear in space because there is no air! Sound vibrations need something to bump to be able to move from one place to another.

Can students make predictions about other materials? Share observations with others. Do students have further questions about sound to investigate? Can I hear sounds underwater? Can we design a fair test to work out which material makes the most sound vibrations?

HOW TO USE THIS ACTIVITY WITH YOUR STUDENTS

Foundation - Year 2

Sound travels as vibrations in the air. When we are talking to each other sounds come from my voicebox, these vibrations are shaped by my tongue, teeth, and lips, bumping the air molecules as they exit my mouth.

The sounds which leave the mouth transfer as vibrations through the air and some of the vibrations enter the air that is inside your ear canal. The parts of the ear that make up the eardrum (the mallet, hammer and cochlear) continue to transmit the vibrations until the sound is received by the fine hairs in the cochlear that pass along the information to our brain.

By observing the salt on the model ear drum moving due to sounds they create, students can understand this movement of sound in their environment. Unlike light, sound can travel around corners and through opaque objects!

We use our ears to receive sounds but it is our brain that helps us to identify them. Time permitting, challenge students to identify the contents of sealed containers by the sounds they make? Fill a number of opaque containers with various objects (e.g. marbles, sand, coins, foam balls, beans), secure lids. Shake containers, listening carefully to the sounds being produced. Can students guess what is inside? What is different about these sounds? What happens when students shake the contents more vigorously? When students put in more energy, the sounds become louder.

Years 3/4

When conducting this activity with Year 3 and 4 students, we need to shift the emphasis from the way that sound travels, to the way it is created by and travels through different materials. In younger years, students will have learnt about sound travelling through vibrations and they are now ready to extend this knowledge.

Focus the children's learning on the different materials that are being used to make the sound vibrations that make the salt move. You may wish to be more selective about the types of materials used, with students being directed to test wood, plastic, metal, foam, rather than just concentrating on making noises. Students can rank the materials according to loudness (which ones produce the largest vibrations), or pitch (number of vibrations).

What materials are used to make musical instruments? What materials could be used to build a sound-proof room with? Can students link this knowledge to the results of their sound activity?

Further investigate sound travelling through materials using a spoon and string. Tie a metal spoon in the centre of a 1m piece of string (cotton cooking twine works well). First, strike the spoon against a hard surface (e.g. a table, or a chair). Students already know how the sound travels through air, and into their ears. Next, twist the string around your pointer fingers and poke your fingers into your ears. Strike the spoon on a hard surface again (this time with the string connected to the ear). Yes, you will look strange, but the sound we hear is louder, and much richer – like the tolling of church bells. This is because the sound energy that was produced by the striking of the spoon travels better through solids like the string and into our ears. When conducted through air, a lot of the energy is lost in the transmission.

Years 5/6

This activity will be a reminder about the fundamentals of sound for Year 5 and 6 students. They are learning more about energy and can now put sound energy into context with other types of energy (e.g. heat, light, electrical). Students can use activities involving sound (such as the ear drum dancing salt) to help understand energy transformations. In this case, we have our bodies (powered by the chemical energy of food) moving objects to make sound energy.

If your school has circuit kits (wires, buzzers, battery packs), extend students' understanding of energy transformations using a simple circuit that includes a buzzer. We use electrical energy to help us with a lot of functions, including making sound. Students assemble a circuit using wires, batteries (or solar panel) and a simple buzzer.

Can students explain the energy transformations involved in making the buzzer sound? The chemical energy in the battery is transformed into electrical energy in the wires, and then transformed into sound energy in the buzzer. Energy cannot be created or destroyed; it is just transformed.

DISCUSSION SECTION AND KEY THEMES

KEY THEMES

Sound waves

Sound waves (vibrations) travel into our ears – outer ear (ear lobe, ear canal), middle ear (ear drum, hammer, anvil, stirrup), inner ear (cochlea – shaped like a snail), and finally into our brain. The bing-e-ty, bang-e-ty sound vibrations make the ear drum go bing-e-ty bang-e-ty, which makes the hammer, anvil, and stirrup go bing-e-ty, bang-e-ty. These waves are sent to the cochlea where special cells transmit the information to the brain where sounds are distinguished. The three bones in the middle ear are incidentally the smallest bones in our bodies.

Sound waves are longitudinal waves. Their vibrations occur in the same direction as the direction of travel. They are produced by vibrating sources, such as speakers. A vibrating object transfers kinetic (movement) energy to the particles surrounding it through an alternating series of pushing and pulling on the particles. The continuous forward and backward bumping of particles results in transferring of energy to neighbouring particles. Sound waves can only travel through a medium. It cannot travel through vacuum. The medium can be in a solid, liquid, or gas state. They travel fastest in solids, then liquids, and slowest in gases. A slinky is often used to model sound travelling.

Hearing

Humans have evolved to gain information about the environment through our sense of hearing.

We have two ears to hear sounds (biaural hearing) to help us locate the origin of sound. The shape of our ears – from the ear lobe, to the ear canal - are shaped so that we are able to collect and magnify vibrations. This helps us hear even the softest whispers.

Sound waves travel into the ear canal until they reach the eardrum. The eardrum passes the vibrations through the middle ear bones (hammer, anvil, stirrups) into the inner ear. The inner ear is shaped like a snail and is also called the cochlea. Inside the cochlea, there are thousands of tiny hair cells. These hair cells change the vibrations into electrical signals that are sent the brain through the hearing nerve.

The brain processes the vibrations into what we recognise as sound.

Measuring sound

The number of sound waves per second (frequency) is measured in Hertz (Hz). Sounds in the normal range of human hearing are between about 20Hz and 20,000Hz (20kHz), but the range becomes more limited as we get older. Sounds with frequencies above this range are called ultrasound.

We cannot hear many animals communicate with one another. Dogs and bats can make and hear sounds at much higher frequencies (ultrasonic). On the contrary, elephants communicate over long distances using very low frequency sounds (subsonic).

What is energy?

Energy is everywhere around us and takes many forms. It is contained in every atom of matter, runs through our bodies, powers our electric devices and transportation systems, and is present across the universe.

In physics, energy is often defined as the ability to do work. Work is, in turn, a movement of an object caused by a force. Energy can therefore be seen as the ability to move.

Scientists love to measure things. Measurements allow us to compare and group things. For example, we can measure time, mass, temperature and distance. We measure things in units. For example, the unit of distance is a metre (m), the unit of force is Newton (N) and the unit of energy is Joule (J).

Types of energy

There are many types of energy. This makes sense because energy is about movement - and there are many ways things can move. Broadly speaking, however, energy can fall into two main groups: KINETIC or POTENTIAL energy.

Kinetic energy refers to the energy possessed by an object, due to its motion or movement. All moving things, whether they are large like a bus or as small as an atom, have kinetic energy. Potential energy is energy that is stored in an object because of its position (e.g. above the ground) or state (e.g. stretched). Objects with potential energy can move if they are not already doing so.

Actions often involve more than one energy. A good example that involves both kinetic and potential energy is inflating a balloon. Blow up a balloon and pinch the end of it between your fingers.

The balloon has potential energy because it could move, even though it is not. Release the balloon and see how the balloon starts flying around the room. The balloon's potential energy is being transformed into kinetic energy once it starts moving.

Kinetic energy (movement energy) – electrical, heat, sound, light

Potential energy (stored energy) – chemical, gravity, magnetic, elastic, nuclear

Energy transformation

The conversion of energy is commonly referred to as energy transformation. Energy can neither be created nor destroyed, but it can be converted from one form into another. It transforms, or changes, from one form to another - over and over again. The amount of energy present in the universe is always the same. This concept is referred to as conservation of energy.

For example, the energy transferred by a cricket batsman to the ball includes the ball displacement, the noise of the impact, and a slight temperature increase of the ball.

QUESTIONS AND ANSWERS

Can we ever see sound waves?

We can't see sound making air molecules vibrate, or bump around, because we can't see air. But, in this activity we saw sound vibrations in air make the cling-film vibrate and move the salt. Things in the air can be moved by sounds, though – have you ever seen an "airzooka" or rubbish bin cannon? Sometimes we see sound moving through clouds or debris in the sky during a volcanic eruption. In this clip of Mount Tavurvur erupting in Papua New Guinea, you can see the sound waves move out through the clouds, then shortly after the huge sound of the eruption (or shockwave) reaches the observer on the boat. https://www.youtube.com/watch?v=BUREX8aFbMs

How fast does sound travel?

Sound travels at 330 metres per second (m/s) in dry air. The example of thunder and lightning helps us make sense of the different speeds of light and sound. We see the lightning with our eyes (light travels much faster than sound, at 300,000,000 metres per second), but it takes longer for us to hear the sound it makes (the thunder).

If you watched the volcano erupting in the above link, this difference is also clear - we can see the volcano erupt well before the sound reaches the man filming on the boat.

Sound moves faster in liquids and solids, as the molecules are closer together and the vibrations can transfer more easily.

The speed of sound is also known as Mach 1 (named after an Austrian physicist). Anything moving faster than this is supersonic.

What sound did a Tyrannosaurus rex make?

Movies like Jurassic Park show dinosaurs roaring with their huge mouths wide open. Is this really how scientists think dinosaurs made noises? The study of sound associated with fossils is called paleoacoustics. Some scientists think that many dinosaurs produced sounds with their mouths closed. Scientists have scanned fossil skulls to learn about what might have been inside their heads. T-rex may have produced a low frequency sound without its mouth opening. Other animals would have been familiar with this low sound and known to be alert – and run away - when it was heard.

We can compare these suggested sounds with those made by elephants of the present day. Elephants communicate with low frequency sounds over long distances.

Humans cannot hear these sounds because they are too low to make our ear drums vibrate in a way that sends a signal to our brain. Scientist, Katy Payne, describes the feeling when elephants make these low sounds as being like when you have your window down in the car and your ears feel strange. You can learn about her elephant research in this clip - https://www.youtube.com/watch?v=YfHO6bM6V8k

Maybe this is what we would feel like if a T-rex was roaring in our neighbourhood!

What happens inside my ear when I hear things that are really loud?

Sound is measured in units called decibels (dB), a scale that goes from 0 up to around 200dB. For example, normal breathing is around 10dB, vacuum cleaners are around 70 dB, lawnmowers 90 dB, car horns 110dB. The loudest recorded sound, 204 dB, was the launch of the Saturn V rocket, used in the USA's Apollo missions in the 1960s and 70s. So loud!

The ear drum and the parts of our inner ear experience much bigger vibrations when a sound is louder. Inside our cochlea are thousands of hair cells that detect sound vibrations. These sensitive hairs can be damaged by excessive noise.

The hairs bend more when a sound is louder and then straighten again after a period of recovery. This is why your hearing can be a bit muffled after hearing loud noises, while the cochlea hairs are straightening out again. If the vibrations are too loud or quite loud for an extended period (over 80 dB), the hairs can be damaged and even die.

If you know that you are going to be exposed to loud noises that you can't control (e.g. concerts, sporting events, power tools, firearms) you should wear ear protectionsuch as ear plugs or ear muffs.

What sound does a giraffe make?

Students may ask you about all sorts of animal sounds, but here's one that we find interesting (in addition to the elephant sound information given above).

We used to think that giraffes made no sounds (or vocalisations), apart from snorts and grunts. However, scientists recording giraffe sounds (in three zoos) over an eight-year period found that giraffes made a low humming sound at night. The sounds are right near the edge of what humans can hear. You can hear them here - https://www.youtube.com/watch?v=tx8XtPBOGlU

What are the highest/lowest notes that people can sing?

Everyone has a unique vocal range – the name for all the notes, from the lowest to the highest, that a person can sing comfortably (that means not grunting, growling, screeching, or squeaking). Different people have different vocal ranges, we are not all the same. The notes you can sing are determined by the length of your vocal cords (folds of tissue found in your voice box).

Usually, women's voices are higher than men's. Singing voices are sorted into categories so that music can be written for different types of voices. The highest singing voice is called a soprano and reaches up to the second C note above middle C (C6). The lowest singing voice is called a bass and reaches down to the second E note on a piano (E2).

The Guinness World Records website is a great place to look for information on highest/lowest/most/least categories. The lowest recorded vocal note by a human is a G -7, sung by Tim Storms. This is 7 octaves below the lowest G note on a piano!

The greatest vocal range of a female singer has been recorded by Georgia Brown, who can sing from G2 (the second G note on a piano) up to G10 (which is higher than a piano and had to be recorded with special equipment!).

Is it possible to break glass with the sound of your voice?

Yes, it is possible. You have to sing the right note and sing it loudly (about 105 dB). This experiment was done in an episode of the great TV show, Mythbusters (Season 3, Episode 11). You can see a clip here, showing the singer who is able to break glass with his voice, Jamie Vendera - https://www.youtube.com/watch?v=QGk8nXs6Aao

How does a hearing aid work?

Hearing aids fit into the wearer's ear canal (the hole that leads down to your ear drum). A hearing aid is made up of three parts; a microphone, a processor and a speaker.

The microphone picks up the sound vibrations heading into the ear, the processor transforms the sound energy into electrical energy. The processor is a tiny computer and can be set to operate in different environments, for example a noisy restaurant or listening to music. The electrical energy from the processor is then transformed back into sound energy in the speaker and is played more loudly into the wearer's ear.

Why do I have two ears?

The main advantage to having two ears is that we can locate the direction of sounds. For example, when we hear a friend call out to us, we can turn and face their direction. Sounds will arrive at our ears at slightly different times, depending on the direction the sounds come from. Our brain can distinguish these tiny timing differences and use this information to help us determine the location of a sound.

How do our bodies make so many different sounds?

Inside our voice box (or larynx) are our vocal cords. The vocal cords are moved by small muscles that contract or relax. When we speak, the muscles bring the vocal cords close together and air (from our lungs) is pushed out through this small gap. It's a bit like when you pinch the mouth of a balloon and air squeaks out. This is where the sound vibrations begin. The vibrations travel through the rest of our throat, into the nose and mouth, where they can be shaped by our lips, teeth, and tongue into an endless number of words, in a multitude of languages. Speaking is a very important method of communication between humans.

OUTSIDE OR SUPPLEMENTARY READING

Hearing damage and loud noises (useful websites)

- https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/ears-ways-to-protect-your-hearing
- https://www.cdc.gov/nceh/hearing_loss/how_does_loud_noise_cause_hearing_loss.html
- https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hearing_loss.html

Sound Science activities from Science Buddies

- https://www.sciencebuddies.org/blog/sound-science-lessons

Children can be interested in sounds that animals make.

This is a fun list of the words used in many different languages to describe animal sounds. For example, in English we say that a chicken says cluck-cluck, but the Dutch say tok-tok, Swedish people say ock-ock, and Hungarian people say kot-kot.

- http://www.eleceng.adelaide.edu.au/Personal/dabbott/animal.html

TOPIC WORDS

- sound
- vibration
- energy
- eardrum
- cochlear
- energy transformation
- waves
- hearing
- communicate
- vocal cord
- voice box
- larynx

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