Science

SOUND

Student Handbook

CONNECTED LEARNING INITIATIVE

An initiative seeded by

TATA TRUSTS

CLIx (2018)

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The **Connected Learning Initiative (CLIx)** is a technology enabled initiative at scale for high school students. The initiative was seeded by Tata Trusts, Mumbai and is led by Tata Institute of Social Sciences, Mumbai and Massachusetts Institute of Technology, Cambridge, MA USA. CLIx offers a scalable and sustainable model of open education, to meet the educational needs of students and teachers. The initiative has won UNESCO's prestigious 2017 King Hamad Bin Isa Al-Khalifa Prize, for the Use of Information and Communication Technology (ICT) in the field of Education.

CLIx incorporates thoughtful pedagogical design and leverages contemporary technology and online capabilities. Resources for students are in the areas of Mathematics, Sciences, Communicative English and Digital Literacy, designed to be interactive, foster collaboration and integrate values and 21st century skills. These are being offered to students of government secondary schools in Chhattisgarh, Mizoram, Rajasthan and Telangana in their regional languages and also released as Open Educational Resources (OERs).

Teacher Professional Development is available through professional communities of practice and the blended Post Graduate Certificate in Reflective Teaching with ICT. Through research and collaborations, CLIx seeks to nurture a vibrant ecosystem of partnerships and innovation to improve schooling for underserved communities.

Collaborators:
Centre for Education Research & Practice – Jaipur, Department of Education, Mizoram University – Aizawl, Eklavya – Bhopal, Homi Bhabha Centre for Science Education, TIFR – Mumbai, National Institute of Advanced Studies – Bengaluru, State Council of Educational Research and Training (SCERT) of Telangana – Hyderabad, Tata Class Edge – Mumbai, Inter-University Centre for Astronomy and Astrophysics – Pune, Govt. of Chhattisgarh, Govt. of Mizoram, Govt. of Rajasthan and Govt. of Telangana.

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CLIx/Eklavya Team
Version 2017-PE01

Notion of sound is prevalent around us so to laid foundation of sound is important. Hearing, speaking or producing sound is more familiar to us but do we really know what is sound, how is this produced, how does it propagate. Sound is intangible and could only be indirectly perceived/felt. Sound is common but physics of sound is not trivial.

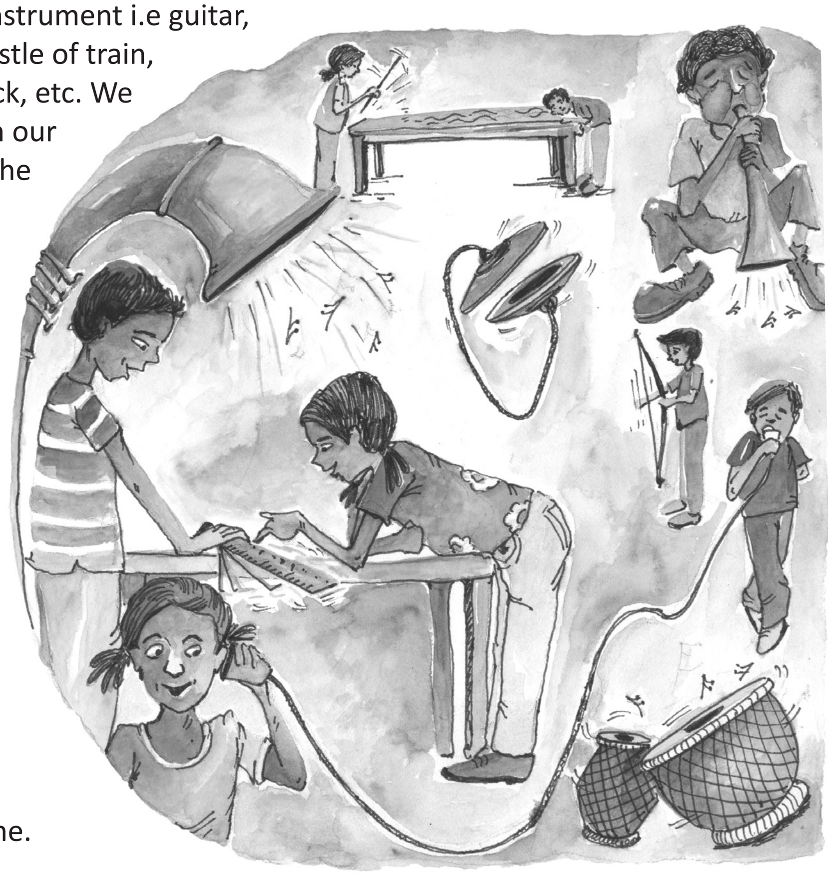
Content

Sounds Around us

1.1 Introduction

All of you are familiar with the term ‘sound’, right!

You might have heard the chirping of birds, the rustling of leaves, the honking of vehicles, the melody of flute or any musical instrument i.e guitar, harmonium, tabla, dhol, the whistle of train, the bell of a cycle, the alarm clock, etc. We perceive all such sounds through our hearing sense, with the help of the organ-ear.



Let us explore and understand the sounds that we hear. What is sound? How is it produced? How does it travel?

Lesson 1: Sounds Around us

1.1 Where are these sounds coming from?

Here we have a sound clip. Play it and identify the different sources of sound and list them down in your notebook.

Try the following exercise at home.

You will need –

- a notebook or a piece of paper,
- a pen or pencil.

Exercise

Find a corner or a spot to sit down. For about two minutes, close your eyes and listen to the different sounds that you can hear. Open your eyes. Now draw a map of the room or the area around you on the paper or the notebook. Mark the different sources of the sounds that you heard. Please mark the sequence of these sounds if possible.

1.2 A science classroom like yours

Here is a video that shows the teacher teaching the concept 'Sound' to the class. To start with, she writes on the blackboard 'What do you want to know about sound?'.

Watch the video below to see what happens after that.

Just like the students in the video, you may also have questions/queries regarding sound. Write them below.

Exercise

Your questions/queries regarding sound

1.3 Creating sound(s)

(i) Make sound(s) with things around you

1. Make a group of 5 members.
2. Create a sound(s) using things around you. For example, you may pick a pencil, or a coin. You have 1 minute to do this. It should be different from other groups.

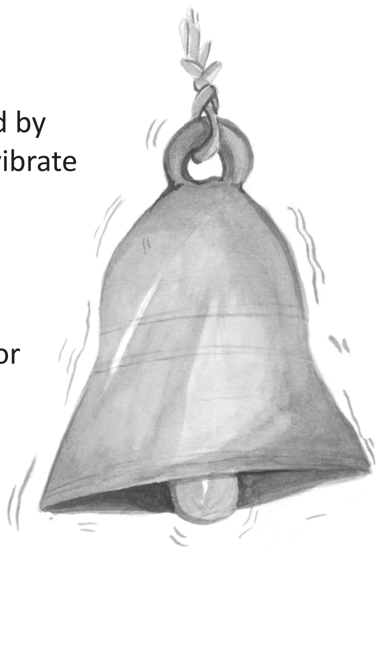
(ii) Make sound(s) with things given to you

1.1. Work in the same group.

2. Make a sound(s) using the thing(s) given to you. You can combine two or more things or you can also use them separately. You have 5 minutes for doing this.
3. You can also use things other than those that are given to you.
4. Make the sounds in front of the class and explain the following:

(a) How is the sound produced in the design that you made? Is it by blowing, hitting, plucking or in some other way?
(b) Identify which part of the design is making the sound?

1.4 Sound is vibration



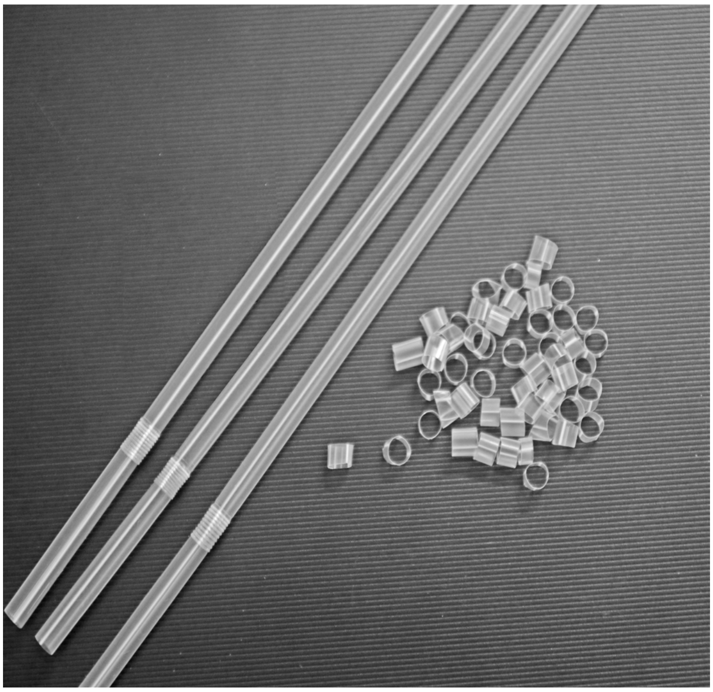
You noticed that sound, in most of the designs, is generally produced by blowing, hitting or plucking. When two objects hit each other, they vibrate and the vibrations produce sound.

For further exploration
Some vibrations stay for a longer time, that is why we are able to listen to the sound for a longer time. Example- vibrations of a bell or a steel plate. Other vibrations die out quickly and their sound stops immediately like the banging of the table, the stamping of your foot on the ground, the splashing of water on the floor. What other examples can you think of? Are they lasting an instant

or are they long?
Try it out *Ring a bicycle bell and cover it by putting your palm on it, the vibrations stop immediately. Why do you think this happens?*

1.5 Seeing vibrations

We can directly see things vibrating or we can feel the vibrations by touching things. Let's do an activity to see vibrations when we make a sound.



Activity: Dancing rings on the base of the cup

Dancing rings on the base of the cup

1. Hold a paper cup in an inverted position.

2. Cut a straw to get rings (as shown in the figure).

3. Now put the rings on the base of the paper cup.

4. Hold the cup with both hands close to the mouth and shout into it.

Why do the straw rings jump around?

You can feel vibrations by touching.
You can do this using the paper cup. Hold the paper cup with the open end close to your mouth. Ask your friend to touch the base of the cup. Now shout into the cup.

You can also feel the vibration of your voice. Place your fingers gently against your throat and say 'aaaahhh' or 'hmmmm' or 'hooooo' or any sound- and say it a little loudly.

Where are the vibrations?

You may have experienced sound produced by moving a palm of your hand briskly near your ear, by moving a long stick briskly, by whipping a towel, by waving a flag, by clapping, by hitting of a stone on the ground etc. In these examples, you can hear the sound but it's hard to see the vibrations. So, it is possible that sound is produced but you cannot see the vibrations or vice versa.
Think of such examples where we do not see two things hitting each other but they produce sound and write about them here.

For further exploration:
Hold a bottle opening near your ear and listen. Now fill some water in it and listen. Does the sound change? Now hold a glass or a vessel to your ear. What do you notice? How is the sound produced?

Knowing more about sound

2.1 Loudness

Loudness of the sound corresponds to its amplitude.
In the ***computer lab***, you can watch a video to see the amplitude of three balls moving to and fro from their mean position.

Amplitude is the maximum displacement of the vibrating particle from its mean position.

2.1 Loudness (continued)
Amplitude using Audacity.

Now we will use a tool to “see” sound on the computer screen. There are several buttons at the top left corner of the tool. We are going to use the “record” and “stop” button in the tool. Keep the microphone close to the source of sound.

Suppose you choose to snap your fingers. Now press the “record” button. Snap your fingers gently at first and then snap them hard. Click on the “stop” button.
You will see that the louder sound has a bigger wiggle and the lower sound has a smaller wiggle. You can say that the louder sound has higher amplitude than the lower sound.
<u>To open the Audacity, use the following directions:</u>

1. Go to Start (windows icon)

2. Type Audacity in search tab

3. From the result shown, click on Audacity

Here is a tutorial video to know how to use Audacity.

Now choose the sounds that you want to “see”. For e.g. you can clap your hands or hit the table or say “aaa” - change the volume of the sound and observe the amplitude of higher and lower volume. You can also look at the wiggle for the sound made by your design in section 1.4.

Changing the volume means you are changing the amplitude.
Take a screenshot of the wiggle of your recorded sound sample on Audacity and upload the image in gallery on platform.

To take a screenshot, press the ‘window’ button + PrtScr button. Image will be saved in Pictures (in “screenshots” folder)

To save your recorded sound sample (audio file), first create a new folder of your name or your group’s name on Desktop. For this-

Go to Desktop-->right click-->click on New-->click on Folder-->type the name that you want to give your folder.

Now follow the directions given below:
1. Go to the File tab
2. Click on the option- Save Project As
3. You will get a warning. Select ok
4. Save in - Desktop

5. Select the folder that you created on Desktop
6. File name- Type your file name.
You need to give different name for each file. For example- aud1, aud2, etc.
To open the saved file, use the following directions:

1. Close Audacity Software (click on x sign on the top right corner)

2. Go to Desktop

3. Click on the folder that you created, select the file (with Audacity icon) that you want to play.

For Further exploration

What does the wiggle stand for? It shows the electrical signal that the microphone sends to the computer through the wires. But how does a microphone work?

Are the ears our body's microphones? Do they also send a wiggle to our brain through the nerves?

2.2 Pitch

A shrill or piercing sound is also called a high-pitch sound.

We use one more term for shrillness - that is pitch. Shriller the sound higher the pitch. For example compare the sound of buffalo and of goat. Goat's sound is shriller than buffalo's sound. So, we can say that the goat has a high pitched voice and the buffalo has a low pitched voice.

In the computer lab, watch a video in which you can see the difference between a less shrill and a more shrill sound.

We saw that sound is vibrations. The number of times a particle/object vibrates in a second is called frequency. If it vibrates more number of times in a given time, we say that its frequency is higher. Frequency of vibrations decides the pitch of the sound. Higher the frequency higher the pitch, lower the frequency lower the pitch.

For further exploration

What is the frequency of the rotation of the ceiling fan?

As a ceiling fan speeds up, beyond a point we are not able to see its blades. This is a limitation of our eyes - we can't see things that move too quickly. The sound vibrations also occur too rapidly for us to observe them. For example, if we look at a speaker (watch the video in 4.1), we can see that it vibrates but we are not able to count the number of times it vibrates in a given time.

2.3 World of music

Music is the combination of different sounds i.e. sounds of different frequencies and amplitudes.

Sing a song that you like or speak something into the microphone and record it. Look at the wiggles on Audacity. What do the shapes of the wiggles tell us? Compare the wiggles of loud and low voice.

Project: Making your own music

Now you will create a small 10 second music track of your own by recording sounds on Audacity. You have played around with different objects in Section 1.4 to make various kinds of sounds. You can also create newer sounds by clapping or whistling or some other action. Decide the rhythm and the tempo. A group of sounds (For example, snapping fingers and hitting a plate with a spoon) can be your drum or tabla. A tune that fits in that rhythm will complete the music track - you can hum, sing, whistle, or make music using a design that you made in section 1.4.

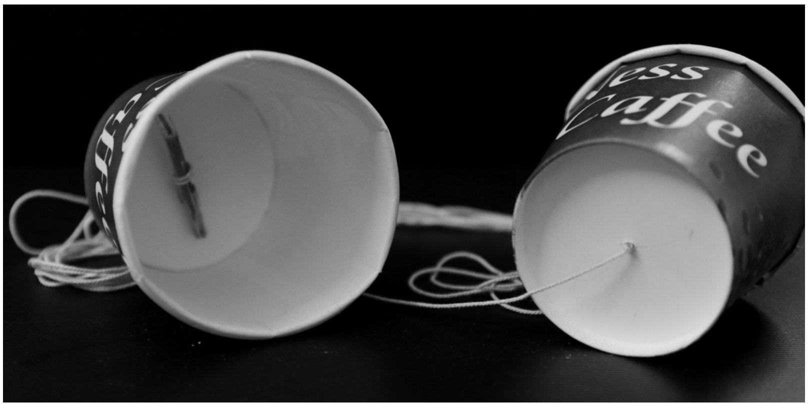
In the music track that you have just recorded on Audacity, identify the wiggles corresponding to each sound that you used.

Sound Travels

3.1 Paper cup telephone

We will make a paper cup telephone using two paper cups and a thread (at least 10 meters long). We will work in a group of 4.

Hold the cups with thread stretched taut between them. Ask your friend to speak softly in one paper cup and listen to it at the other end by putting the second cup on your ear.



The end of the thread is passed through a hole and tied to a small ball of paper or a matchstick. This way the paper cup will not tear.

Can you hear your friend's voice?

Does your friend's voice change when you listen through the cup?

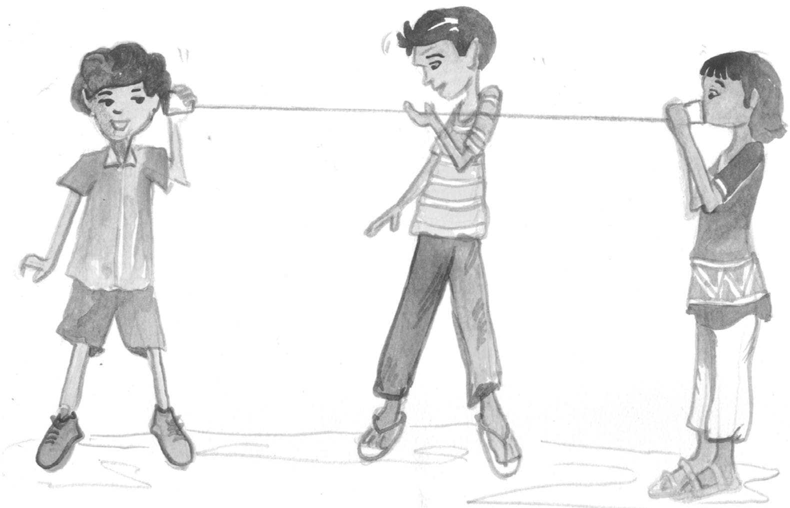
Can you still hear your friend's voice if the string is not taut?

Can you hear even if the thread is wet?

Is the sound different if you use cups of different sizes?

3.1 (A) Paper cup telephone

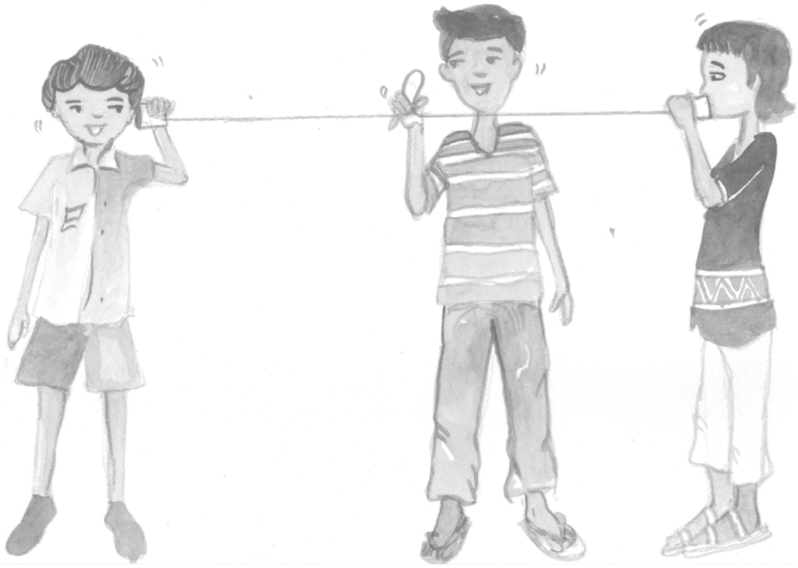
Now ask a member of your group to touch the thread gently while the person who is holding the cup near his/her mouth is speaking. Keep the thread stretched taut.



Ask your friend to touch the thread at different places on the string - close to the speaker and far away.

What did he/she feel on touching the thread while a person is speaking through the cup?

Members can change their role so that each member of the group get the chance to explore all the situations.

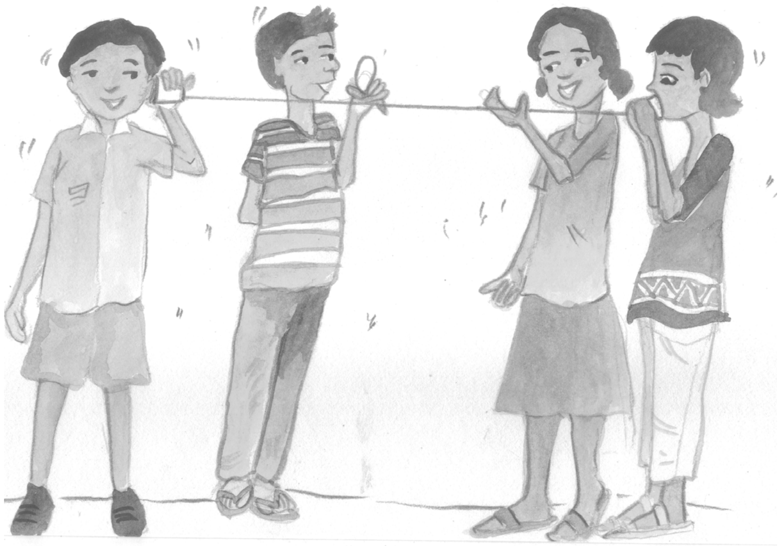


3.1 (B) Paper cup telephone

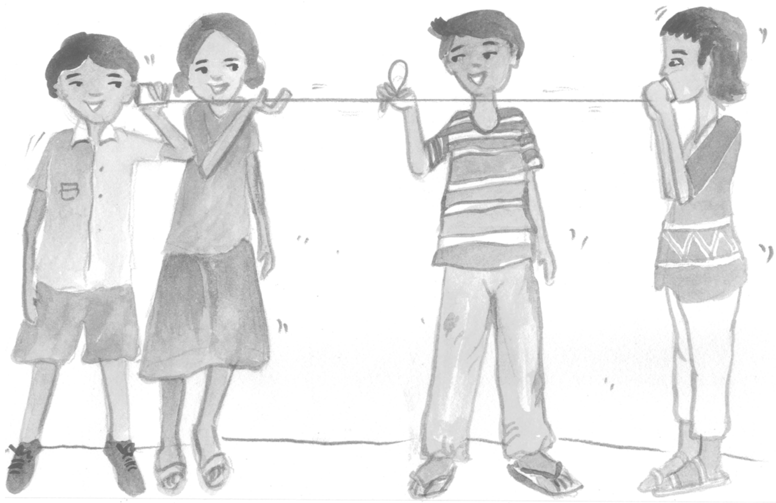
Now ask a member of your group to hold the thread firmly somewhere in the middle. Ask another member to touch the thread gently first at the speaking end and then at the hearing end.

Note that one person should be speaking into the cup while another person holds the thread.

Please keep changing the roles within the group so that every member of the group gets the chance to explore.



What did you feel when you touched at the speaking side and when you touched at the listening side?
Can you explain why?



Can you explain why?

Bring your ear near the string (while someone is speaking into the cup). Do you hear anything? How does the string help to make the sound audible?

> **For further exploration**
>
> What is the role of the cup?

3.2 Singing spoon

1. Take a spoon and a thread (long enough).
2. Tie a spoon's handle with one end of the thread.
3. Wrap the other end of the thread in the index finger and insert this in the ear.
4. Let the spoon hang down freely.
5. Let the spoon hit the table/wall or ask your friend to hit the spoon gently with another spoon (or pen/pencil) and listen carefully.

Touch at various places along the thread. **Do you feel the vibrations in the thread?**

Keeping the finger in ear, hit the spoon and lift the thread from somewhere in the middle and release it quickly. **What did you feel?**

3.3 Do walls have ears?

1. Put a mark on the same spot on one of the walls of your classroom, both inside and outside.
2. Put your ear against the mark on the wall from the inside of the classroom.
3. Ask your friend to go outside the classroom and hit the wall at the mark with a small pebble.
4. The person hitting with a pebble should do so gently so that the person behind the wall cannot hear the sound directly.
5. Now change the roles and try again. Were you able to listen through the wall?

3.4 Hitting spoon inside the bucket

1. Fill up a bucket with water.
2. 2. Hold a spoon in each hand. Lower your hands into the water and hit the spoons against each other inside the water.
3. 3. Listen to the sounds coming out of the water. Is it like the sound of coins striking each other

Will sound be audible if we use oil or any other liquid instead of water?

3.5 Vibrating balloon

1. Hold a balloon in front of your friend's face and ask your friend to shout "ouuu" in a loud voice. What happens? Why do you think it happens? Is it due to the air that comes from your friend's mouth?
2. 2. Hold a paper or a notebook between the balloon and your friend's mouth to block the air. Now ask your friend to shout again. Do you still feel the vibrations?
3. 3. Take two steps away from your friend. Ask him to shout. Does the balloon still vibrate?

3.6 Sound travels: as vibrations through different media

In all the above activities, you noticed that there are vibrations in different places. For instance, in the paper cup activity, your friend feels the vibrations along the string when you speak. The same is true for the singing spoon activity, where you feel vibrations in the string attached to the spoon. Not only that, you also feel the vibrations in the balloon when you stand near your friend making "ouuu" sound. These instances show that sound travels in the form of vibrations from one place to another. We perceive sound only in the form of vibrations. The vibrations could travel through any medium (solid, liquid or gas).

How does sound travel?

4.1 A speaker

We use speakers to listen to music. Speakers are used in mobile phones and in televisions too. Have you ever observed or touched a speaker while it is producing sound? Does its diaphragm vibrate? (Is a speaker related to a microphone?)

Let us watch a video of a speaker producing sound.

Sometimes speakers can create a nuisance, especially when someone plays loud music. But how does the sound go forth from a speaker?

4.2 A slinky spring

We will try to see if a slinky spring could provide us clues about how sound travels. Consider a slinky spring kept on a table. We can compress it by giving it a sudden jerk from one side. Watch the slow motion video given below. You can also try this in your classroom.

Now let us move our hand back and forth.

You can see that there are alternate regions where the slinky spring is compressed and where it is elongated.

The diaphragm of a speaker also moves back and forth. It compresses the air when it moves forward and makes the air rarer/sparser/less dense when it moves back. Just as these successive compressions and rarefactions travel along the slinky spring, sound travels away from a speaker through air. Sound travels in the same way through liquids and solids too.

4.3 Is air like a spring?

When we pull a spring, it gets elongated and if we push it, it is compressed. A spring always tries to get back to its original position. It does not stay in an elongated or a compressed position once we remove the force. On the other hand, a piece of clay or dough cannot completely regain its original shape once we deform it. Let us try to see if air behaves like a spring or like a piece of clay.

Take a plastic syringe without the needle. Insert the piston completely into the syringe. Now block the opening with your finger. Pull back the piston fully and release it. What do you see?

Now take off the finger from the hole and pull back the piston completely. Again block the hole firmly with your finger. Push the piston as much as you can and release it. What happens?

Can we say that air is somewhat similar to a spring?

4.4 Does the medium move with the sound?

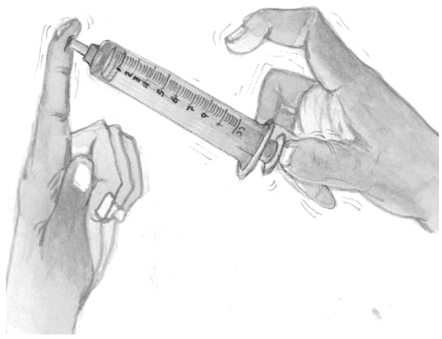
Every medium consists of some tiny particles that vibrate when sound travels through the medium.

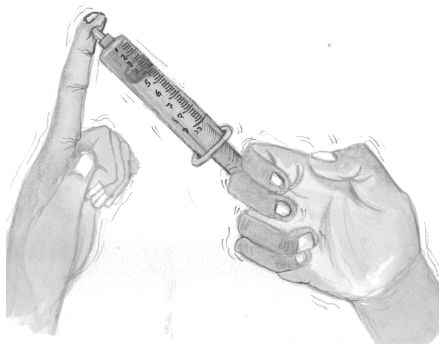
When sound goes from one place to another, do the particles of the medium also travel with it?

Consider the paper cup telephone activity, in which the vibrations are felt everywhere on the string. The string particles are at the same place but the vibrations travel.

4.5 Is this true in other cases too?

Let us do some activities.





<u>Activity: 1</u>

Materials required

1.A 10 meters long string

2.Sketch pen

Procedure

1. *Hold one end of a long string (10 meters) in your hand and ask your friend to hold the other end.*
2. *Mark a small portion on the string with a color.*
3. *Now give a sudden jerk to the string.*

Did the coloured mark change its position along the string? (Could you feel light and frequent tugs in your hand? Why does this happen?)

<u>Activity: 2</u>

You must have floated a paper boat on water. What happens when there are waves on the water surface?

Friends discussing a question; help them

Kanchan was playing with a string. She held the string taut, plucked it with a finger and listened to the sound. She heard a low-pitched sound. She decreased the length of the string and plucked it again. This time, she heard a higher-pitched sound.

She was so excited that she shared this with her friends in the class.

Sonu, one of her friends, found a rubber band in his pocket. He tried the same with the rubber band. But he found the opposite of what Kanchan saw with the string. As he elongated the rubber band by stretching it, the sound became higher pitched.

Listen to their conversation and help them solve this puzzle.

Perform the experiments that Kanchan and Sonu did. You can do your own experiments as well

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