Discovering STEM Program

Sounds Like Fun!

Description: In this activity students will explore musical sounds using tuning forks, wooden rulers, boom-whackers, and saxoflute toys. Students practice science and engineering practices by finding patterns, generalizing patterns, and applying patterns to design an instrument.

Age Group: Elementary

Estimated Time: Approximately 20 minutes

Key Questions: What physical properties of an instrument determine pitch and loudness of the notes produced?

Teacher Background:

- Sound is a wave that is a repetitive longitudinal vibration, in air.
- Sound waves can be characterized by amplitude and either wavelength or frequency.
- Typically sounds are made up of many different frequencies, although a single frequency sound can be made. Musical sounds are made up of frequencies that are typically related to each other by integer multiples. (In this activity students will not be able to explore the relation of different frequencies within a sound).
- Amplitude is the measurement of the maximum displacement of air particles in wave. In terms of waves at the beach, it is how big the waves are.
- Wavelength describes the length between successive repetitions of the wave. In terms of waves at the beach, it is how far apart the waves are.
- Frequency is the time the wave takes to repeat itself. In terms of waves at the beach it is the time between waves.
- Wavelength and Frequency are related to each other via the wave Speed.
    - **Speed = Wavelength × Frequency**
- Our perception of sound is based on three characteristics; pitch, volume (loudness), and timbre. Timbre of a sound describes the quality of the sound; it is related to the relative strengths of different frequencies of vibration within a sound. (Timbre is not accessible within this activity).
- Pitch is physically related to the frequency and wavelength. Higher frequencies (which have shorter wavelengths) produce higher pitches.

- Volume (loudness) is physically related to the amplitude of the wave. Larger amplitudes produce louder sounds.
- The frequency, therefore pitch, of sound produced by musical instruments depends on the size and stiffness of the vibrating object. In this experiment we ask students to compare pitch of larger and smaller vibrating objects. Students will find longer objects have lower pitch. If students compare different types of objects in size and pitch, they will find the rule will break down because the stiffness is different between the different objects. We do not intend for students to compare rulers to boom-whackers or tuning forks.

Additional helpful information for teachers/parents/volunteers as student's progress through stations.

The event is designed to work for all four stations. Students start with Station 1 and work through in order. Each station can support 4-8 students at a time.

1. Station 1 = Tuning forks

Students will be looking for evidence that sound is produced by vibrating objects. They may also see that larger objects tend to make lower sounds.

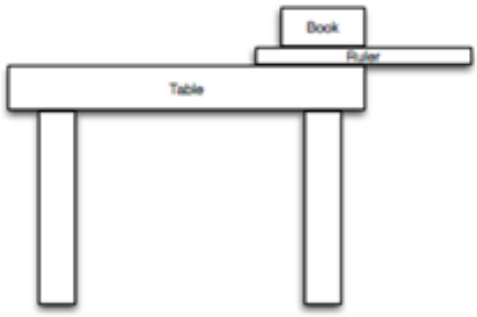
Students should have a chance to strike several tuning forks and listen to the sound each fork makes. They should strike a fork and look closely to see vibrations. This works best with a larger tuning fork. They should strike a fork and place the end in a bowl of water to see the surface of the water vibrate. Finally they should strike a fork and gently touch the end of the fork to feel the vibrations. This will be easier to do with the larger tuning forks.

From this evidence they should be able to conclude that vibrating things make sound. They may also begin to make the connection between the length of the object and the pitch of the sound. They will have more direct evidence at the next station.

2. Station 2 = Rulers

Students will be examining the sound made by the ruler when they hold it off the desk and pluck the free end. They do not need to hit the ruler very hard; one tendency will be to hit the ruler very hard to make a loud sound. When testing the volume, we have asked the students, "What do you need to do to make the sound quieter, instead of louder?"

The ruler will work best if it is held firmly against the table. Smaller children may want to use a book to help steady the end of the ruler against the table.



The students should explore what it takes to make different sounds. The **length** of the ruler hanging off the edge determines the **pitch** of the note produced. The **force** of the plucking action determines the **loudness** of the note produced.

3. Station 3= Boom-wacker station

The sound of the boom-whacker depends on what it is hit against. If a surface is too hard or too soft the boom-whacker will not sound as well. Try out different surfaces to find a good one. They work well when hit against each other. Experiment with different surfaces and find something that works well in your classroom. At this station students should verify the pattern that they found while exploring with the rulers. Longer tubes will make a lower sound. Hitting the tube more softly will make a softer sound.

4. Station 4 = Saxoflute station

At this station there are parts to make a flute. There are mouthpieces, bells, straight sections, Straight sections with holes, T junctions, and +junctions. The students can make any combination.

- Everything will make a sound except for blowing backwards through the mouthpiece.
- The sound of the flute will depend on the length of the tubing used.
- A hole in the hole piece acts as the end of the pipe if it is uncovered.
- If there are two paths, with two endings the pitch will be somewhere between the pitch of the long pipe and the short pipe.
- If there are loops that combine back on themselves the length is the shorter path, unless the child can very carefully blow softly to make a lower sound.
- **Clean the mouthpiece by dipping in rubbing alcohol and drying between each child.** This is an extremely important part of the cleaning process. Rubbing alcohol is the best way to disinfect and keep germs from spreading. Please be sure to submerse the mouthpiece completely and allow to dry before allowing another child to use.

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Instructions (place at stations)

1. Tuning Fork Station

Making Observations

At this station you will find a tuning fork and a mallet. Use the mallet to hit the tuning forks. **Don't hit the fork against the desk or another hard object. You might damage them.** You don't have to hit the tuning fork very hard, the sound is quiet until you bring the fork right up near your ear.

- Strike a tuning fork; hold it near your ear. What do you hear?
- Try listening to several different tuning forks. Do all the forks make the same sound? Which ones sound higher and which ones sound lower?
- Strike the tuning fork and look closely at the tips of the prongs. What do you see? (Try using one of the larger forks). You can also try striking the tuning fork and **dipping the tips** of the prongs in a calm bowl of water. What happens to the surface of the water when you dip the fork in?
- Strike the tuning fork again and **gently** touch the tips of the prongs. What do you feel? You can touch the prongs gently to your cheek if you can't feel anything with your fingers. Try one of the larger forks.

Drawing Conclusions

- What do you learn about sound from these observations?
- What can you say about an object that makes sounds?
- What is the object doing when it makes sound?

2. Ruler Station

Making Observations

At this station you will find a wooden ruler. Hold the ruler so that it hangs off the edge of the table about halfway. Hold the part of the ruler on the table firmly against the table. Pluck the end of the ruler. You should hear a boing sort of sound. That is what we will explore at this section. **You don't have to hit the ruler very hard; we don't want to break the rulers.**

- Explore what happens as you change the length of the ruler hanging off the table. What happens to the sound? Does this have anything in common with the sound from the tuning forks?
- What do you have to do to make the sound quieter? Does this have anything in common with the sound from the tuning forks?

Drawing Conclusions

- What do you learn about sound from these observations?
- Do your conclusions agree with what you found with the tuning forks?

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3. Boom-Whacker Station

Testing your ideas

At this station you will find a bunch of colorful plastic tubes. When you bump the tube against something hard like the floor it makes a boom sound. Each tube makes a different sound. **You don't have to hit too hard, and don't hit people with the tubes.** By now you should have some idea about sound, use your idea to predict what will happen and then do a test to see if you are right.

Make these predictions first, and then test them;

- Which tube will make the lowest sound?
- Which tube will make the highest sound?
- What do you do to make a quiet sound with the tube?

4. Saxoflute Station

Applying your ideas

Now that you have an idea about sound and you have tested it out you are ready to put it to work. Use your ideas to make a flute from the pieces in the bins.

- What do you think the job of the mouthpiece is? Why does it go first?
- How long did you make your flute? Why did you choose that length?
- Did you use a piece with a hole in it? What does the hole do when it is covered? What does the hole do when you uncover it?
- Did you use a junction like the T or the +? What does the junction do?