



Musical Instruments: Part II

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Students experiment with various sounds sources, including their voice, cup instruments, string, and guitars, to gain an understanding of the connection between sound and vibration.

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This lesson was designed for use after the sound and music introductory lesson and Musical Instruments Part 1.

Science Topics	Process Skills	Subject Integration	Grade Level
Sound	Observing	Physical Science	6-12
Sound wave	Scientific Inquiry	Musical Acoustics	
Vibrations	Comparing		
Resonance	Measuring		
Resonance Chamber	Predicting		
Sympathetic vibration			
Frequency			

Time Required

Advanced Preparation	Set-Up	Activity	Clean-Up
Gather materials	5 minutes	40-50 minutes	5 minutes

Learning Goals

Students will be able to describe how string instruments require a source of vibration a way to change pitch and a way to amplify the sound.

Students will be able to define frequency and vibration in terms of a sound wave and what we hear.

Students can describe how vocalizing and music both require a source of vibration, a way to change pitch and a way to amplify the sounds.

Students will be able to describe some of the difference between resonance and sympathetic vibration.

Materials

- Packets -- 1 per student (see pages 5-9)
- 3 foot piece of string -- 1 per pair
- Cup Instrument -- 1 per pair
 - Plastic Cup -- 3 different kinds of cups divided among the groups
 - String -- two different kinds, divided randomly amongst the groups
 - One smooth/shiny and one rough cotton/twine make good comparisons
 - Big paperclip

Please forward any questions or comments to:

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- Scissors
- Wet paper towels – 1 or 2 per group
- Acoustic Guitar*
- Electric Guitar*

*Guitars can be easily accessible to teachers. Try asking the music department in your school or local music stores. Most are perfectly happy to lend instruments for learning experiences.

Advanced Preparations

- Complete the sound and music introductory lesson and the Musical Instruments Part I lesson.
- Gather supplies (see materials list).

Set Up

- Prepare stations for each group of students with each of the following:
 - A 3 foot piece of string
 - Plastic cups (1 per pair)
 - String (1 piece per pair)
 - Paper clip (1 per pair)
 - Scissors
 - Paper towels
- Set up the guitars in one area of the room

Introducing the Activity

Explain that all the required materials for the lesson are together before the students divide into groups for the activity.

Tell the class they will be exploring musical instruments by using their voice, a string, and a cup instrument.



Begin the lesson by introducing the idea of a voice being a musical instrument. Ask the students questions about their voice, such as:

- **How can we feel the movement made by our voices?**
 - If the students struggle to find an answer to this question, ask a leading question such as:
- **Where on our bodies can we feel our voices vibrating?**

Students should experiment with this idea for a short period of time. Have the students hold their fingers against the front of their throat and say *Aaaaah*, and to notice the vibration against their fingers.

Hand out a packet to each student.

Doing the Activity



Your Voice

Students will work together in small groups to try out different sounds with their voice, including Aaaaah, Ooooh, Eeeee, Ssss, and Ffffff. They will hold their hands to their throats while speaking, and answer questions 1-5 in their packet.

Explain that pitch varies with the emphasis given to different words. The last words of a question, for example is at a higher pitch.



String Activity

The students will tie a three-foot piece of string to a table leg, pull it tight, and pluck it. After plucking the string they try sliding the string between their thumb and index fingers. They will answer questions 6-7 in their group.



Cup Instruments

Students will create a cup instrument by:

- Poking a hole in the bottom of the cup carefully with scissors
- Threading the string through the hole
- Attaching the paper clip to the string inside the cup
- Pulling the extra string out of the cup so the paper clip is on the bottom of the cup

As the students work, walk around the room to assist as needed.

Students will hold the cup so the string is loose and slide the string between their thumb and index finger, then answer questions 8-9.

Students will attach the string of the cup instrument to a table leg. They will pull the cup so that the string pulls tightly against the table leg, and pluck the string. One partner holds the string at different lengths from the cup while the other plucks it (still tied to the table leg). Students will work through questions 10-15.

Students will wet their paper towels and pinch the string very tightly as they slide the towel down the string. If they do it correctly, they'll get a very loud sound. They will answer questions 16-17.



Electric vs. Acoustic Guitars

The students will compare the two types of guitars. Pluck a string on each one and compare the sounds, answering questions 18-21.



Compare Cup Instruments

Students will find at least two other groups that used different cups but the same string and compare and contrast the two on question 22.

Students will find another group that used the same cup but different string, then answer questions 23-24

The students will try to make a chicken sound (quick short slides) and a whale sound (long smooth slides) with the cup instruments.

Explanation

In-depth background information for teachers and interested students

The various letters have different sources for the sound. For example ssss is a vibration caused by air being forced between the tongue and the roof of the mouth. Ffff is similar but between the teeth and the lower lip.

Sound is made if a simple string is plucked or you run your fingers along it; however, this sound is not very loud. If the cup is attached to the string, then plucking or sliding your fingers is amplified. The cup vibrates a lot more air than the string does! The length of the string or the tension in the string determines the pitch of the sound when plucking it. When you use the wet paper towel, this causes a “slipstick” interaction. The friction between the wet towel and the string cause it to stick and then slip creating a vibration that is magnified by the cup. It’s horribly loud and irritating. This is similar to a violin except those sounds are much more soothing.

The electric guitar and the acoustic guitar are very similar. Both have the same source of sound, plucking the string to create vibrations. Both have the same mechanism for changing pitch either the length of the string or the tension in the string. However, they differ in amplification. The hollow body of the acoustic guitar makes it loud. The electric guitar does not have a hollow body so it does a poor job of amplifying the sound and needs to be plugged into an external electric amp.

Key Terms:

- Sound wave – Vibrations of air molecules that travel through air carrying energy with them.
- Vibrations – a shaking back and forth movement
- Natural frequency – the frequency at which an object likes to vibrate.
- Resonance – When one object is vibrating and it is put in contact with another object, if the frequency of the first object is at the natural frequency for the second object, the second object will start vibrating vigorously at its natural frequency. (pasta demo is an nice clean example of resonance)
- Frequency (rate) – wiggles per second (moves back and forth)
- Sympathetic vibration – When a vibrating object causes another object to vibrate at the same frequency, which may or may not be a resonance frequency. For example, if you

place the handle of a vibrating *tuning fork* onto a table it becomes a *soundboard* and will vibrate at the same frequency. The table top moves more air than the tuning fork so the sound is louder. A piano string causes the *soundboard* of a piano to vibrate at the same *frequency* as the string.

- Pitch - how high or low a tone sounds to a person – it is how a person perceives the *frequency* of a sound. High *frequency* sound has a high pitch or tone (treble notes), but low *frequency* has a low/deep pitch or tone (bass notes). High sounds are usually above 2000 Hertz and low below 200 Hertz.

Optional Extensions /Modifications

Modifications:

- Hard of hearing students can feel vibrations through speakers by touching them, or by touching the instrument itself.

Extensions:

- Students could add to a vocabulary sheet.
- Students can complete the Generalizing how Instruments Work activity.
 - Students who play a stringed instrument can bring their instrument to class to show how their homemade instruments compare to more commonly used and played instruments.

5. How about *Ffffff*? What is vibrating?

6. Hold your hand to your throat while speaking. Pitch varies with the emphasis given to different words. The last words of a question, for example are at a higher pitch.

7. Tie a 3 foot piece of string to a table leg. Pull it tight and pluck it. Does it make a sound? Would you say it is a musical sound? What does it sound like to you?

8. What if you slide the string between your thumb and index finger? Does it make a sound? Is it quiet or loud? How would you describe the sound?

Cup Instrument:

You will need:

- Plastic cup
- String
- Paper clip

Take the cup and poke a hole in the bottom. Put the loose end of your string through the hole from the bottom, tie the end of the string that is inside the cup to the paper clip and then pull all the extra string out of the cup so the paper clip is on the bottom of the cup.

1. Hold the cup so the string is loose and slide the string between your thumb and index finger. How does the sound compare to what you heard with just the string and no cup?



8. How about your straw instrument from the previous activity? What were the three important features to make it play sound, makes it loud and changes pitch?

9. Get a wet paper towel and pinch the string *very* tightly as you slide the towel down it. If you do it right, you'll get a *very loud* sound. What instrument does this remind you of?

10. What is creating the vibration in this case?

Electric vs. Acoustic Guitars

11. Compare the two types of guitars. Pluck a string on each one and compare the sounds.

12. Why is the acoustic guitar so much louder? What is the difference between the two that causes the acoustic guitar to be loud?

13. What happens if you press your finger on the string on one of the frets along the neck of the guitar? What happens if you hold the string down closer to the body (basically shortening the length of the string that can vibrate)?

14. Name three string instruments that are “plucked” and three that use slip stick vibrations.

Compare cup instruments

15. Find at least two other groups that have different cups than you used but the same string. How do their cup sounds compare to yours. What seems to be the cause of the differences, if any?
16. Find one other group that has the same cup but used different string than you did. How do their cup sounds compare to yours? What seems to be the cause of the differences, if any?
17. Did you hear any animal sounds? What sounded like what? Try to make a chicken (quick short slides), or a whale sound (long smooth slide) with the cup instrument.