BOTTLE MUSIC (1 Hour)

Addresses NGSS
Level of Difficulty: 2
Grade Range: 3-5

OVERVIEW

In this activity, students will make sound three ways: by blowing across the top of a bottle, tapping a glass, and running a finger around the rim of a glass. Students will make predictions and test how the level of water in the bottle/glass affects pitch. Students will "tune" their instruments and play a simple song.

Topic: Vibrations and Sound

Real-World Science Topics:

- An introduction to how instruments make different sounds.
- An exploration of the relationship between pitch and the physical characteristics of an instrument.

Objective

By making sounds with bottles and glasses, students will gain an understanding that vibrating objects make sound, the speed of the vibrations determines the pitch of the sound, and the mass of the object determines the speed of the vibrations.

NGSS Three-Dimensions:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (4-PS3-3) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide	**PS4.A Wave Properties** • Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; it does not move in the direction of the wave except when the water meets the beach. Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	**Patterns** • Similarities and differences in patterns can be used to sort and classify natural phenomena. Similarities and differences in patterns can be used to sort and classify designed products.

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evidence to support explanations or design solutions.
- Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Scientific Knowledge is Based on Empirical Evidence
- Science findings are based on recognizing patterns.

Background Information

When an object vibrates in air, it causes air molecules to squeeze together (compression) and then spread apart (rarefaction). These changes in air pressure travel in a compressional wave that carries the sound energy away from the vibrating object. When these compressional waves reach your ear, it causes your eardrum to vibrate. Three tiny bones in your ear (hammer, anvil, and stirrup) amplify this vibration and transmit the vibration to the fluid in the cochlea. The tiny hair cells that line the cochlea vibrate and stimulate nerve cells that send electrical signals to the brain. The brain interprets these signals as sound.

The more mass an object has, the more inertia it has. Inertia is an object's resistance to changes in its motion. The more mass an object has, the less willing it is to vibrate quickly.

Key Vocabulary

Sound – a form of energy that travels in waves referred to as compressional waves

Compressional waves – waves that carry sound energy and require a medium through which to travel. Matter vibrates in the same direction as the wave is traveling, and waves travel slower than light (transverse waves)

Pitch – what note the sound is; determined by the frequency of the sound, the higher the frequency of the sound, the higher the pitch

Hertz – the unit for frequency; one hertz = 1 complete wave cycle per second

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Materials Needed for Activity

- 3 Tuning forks of three different lengths (check the music department at your school or borrow them from the local high school science department)
- Strobe light
- Glass or plastic single serving soda bottles
- Drinking glasses
- Wine glasses
- Water
- Beans
- Tuners or instrument such as a recorder (the band and orchestra at your school should have tuners that students use before practice; students that play instruments may have small pocket tuners that they can bring to class)

*Discuss with the students how to use the glasses in a safe manner.
Also review your safety procedure regarding broken glass.

Teacher Preparation

Before students arrive, shine the strobe light on a tuning fork in a dark classroom. Adjust the frequency of the strobe light until you can clearly see the tuning fork vibrate.

Set up three stations in the classroom and place the following objects at each station.

Station 1 – 1 drinking glass
a pitcher of water (if there is not a sink nearby)
a metal object to strike the glasses (such as a spoon or fork)
beans
a tuner

Station 2 – 1 wine glass
a pitcher of water (if there is not a sink nearby)
beans
a tuner

Station 3 – 1 soda bottle
a pitcher of water (if there is not a sink nearby)
a tuner

Position the stations as far away from each other as possible so they can hear what they are doing.
For a large class, increase the number of items at each station or create six stations (two of each type).

Grade 4 – You may choose to omit station 2 due to safety concerns.

STEPS FOR *BOTTLE MUSIC*

1. **Warm-up Activity:** Open the class by striking a tuning fork on a desk. This will quickly gain everyone's attention!
   Ask the class the following questions:
   - What does the tuning fork do when I strike it? It begins to vibrate.
   - Why can't you see it vibrating? It is vibrating very fast. (Read the frequency printed on the tuning fork. A frequency of 480 Hertz means it makes 480 complete vibrations every second.)
   - How can we prove it is vibrating? If a student has the idea to touch it, go over and lightly touch his/her ear with the tuning fork. They will be able to feel that it is vibrating.

   Tell the class that you can appear to "slow down" the vibrations so they can see the tuning fork vibrate. Darken the room as much as possible. Shine a strobe light on the tuning of fork while it is vibrating. You are not actually slowing down the tuning fork, but you are showing little snapshots of the tuning of fork in different stages of its vibration. The faster the tuning fork vibrates, the higher the pitch sound it makes.

2. Stress to the class that vibrating objects make sound. Distribute the Bottle Ballads handout. Tell the class whenever they hear a sound, they should stop and think: What vibrating object is making that sound? Start with musical instruments. Have students fill out the chart on the handout relating musical instruments and how they make sound.

3. Explain to the class that they will be rotating between three stations. At station 1, they will gently tap glasses with a metal utensil (demonstrate). At station 2, they will run a moist finger around the rim of a wine glass (demonstrate). At station 3, they will blow across the top of a bottle (demonstrate). Have them follow the instructions on the handout, and record their observations. When they hear the tuning fork ring, it is time to move to the next station.

4. **Wrap-Up Activity:** Discuss results with the class and check for understanding. Be sure students recognize that the more massive an object is, the slower it will vibrate, thus creating a lower pitch sound.

   Reinforce the idea by striking the tuning fork again. Ask the class the following questions:
   - Will a longer tuning fork have a higher or lower pitch?
     Lower, it is more massive, so it will vibrate more slowly (demonstrate by striking a longer tuning fork)
   - Will a shorter tuning fork have a higher or lower pitch?
     Higher, it is less massive, so it will vibrate more quickly (demonstrate by striking a shorter tuning fork)

   Assign each group a note to play:

   Station 1 – D
   Station 2 – C
   Station 3 – B flat

   Groups can use a tuner to "tune" their cup or bottle to the note. (Playing the note on an instrument can take the place of the tuner.) Simply add or remove water until they have achieved the note. The class can then play hot cross buns. You are the conductor!

   Have the students play in the following order:

   D, C, B flat, pause, D, C, B flat, pause, B flat, B flat, C, C, D, C, B flat

   Grade 6 – Have each station tune three notes and play the whole song for the rest of the class.

STEPS FOR *BOTTLE MUSIC*

Bottle Ballads Extension Activity

Ask the class:

- How do I make a louder sound with the tuning fork? Strike it harder. (demonstrate)
  Point out that the tuning fork is still playing the same note, but it is louder.
- How do I make a: quiet high pitch? Lightly tap short tuning fork
  loud high pitch? Strike short tuning fork forcefully
  quiet low pitch? Lightly tap long tuning fork
  loud low pitch? Strike long tuning fork forcefully

Explain that striking the tuning fork harder, does not change the pitch (it still vibrates at the same frequency). It vibrates more forcefully, creating a bigger pressure wave in the air.

Sources

http://www.discoveryeducation.com

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STUDENT HANDOUT

Name:

Date:

For each instrument, determine what vibrates to make the sound.

INSTRUMENT	WHAT IS VIBRATING?
cymbals	
drum	
guitar	
clarinet	
flute	
your voice	

Visit stations 1, 2, and 3. Follow the instructions for each station. The stations can be visited in any order.

Station 1:
Gently tap an empty glass with a metal utensil. You are causing the glass to vibrate and therefore make sound. Listen to the resulting sound.

Fill the glass 1/4 full with water. Tap the glass. Compare the sound to the sound of the empty glass.

Fill the glass 1/2 full with water. Tap the glass. How has the sound changed?

Fill the glass 3/4 full with water. Tap the glass. How has the sound changed?

Predict how the sound will change if you add beans to the water.

Fill the cup 1/3 full with beans. Tap the glass. How did the sound change? Was your prediction correct?

As you added mass (water and beans) to the glass, did the pitch of the sound go up or down?

When you add mass to the glass, do you think it will vibrate faster or slower?

Station 2:
Moisten your finger with water. Run your finger around the rim of the glass until the glass makes a ringing sound. Your finger is causing the glass to vibrate.

Fill the glass 1/4 full with water. Run your finger around the rim again. How has the sound changed?

Fill the glass 1/2 full with water. Run your finger around the rim again. How has the sound changed?

Fill the glass 3/4 full with water. Run your finger around the rim again. How has the sound changed?

As you added mass (water) to the glass, did the pitch of the sound go up or down?

When you add mass to the glass, do you think it vibrates faster or slower?

Station 3:
Blow across the top of the bottle in order to make a sound. You are causing the air inside the bottle to vibrate, much like the air inside a flute.

Fill the bottle 1/4 full with water. Now there is less air in the bottle to vibrate. Blow across the bottle again. How has the sound changed?

Fill the bottle 1/2 full with water. Now there is even less air in the bottle to vibrate. Blow across the bottle again. How has the sound changed?

As you added more water to the bottle and there was less air to vibrate, did the pitch of the sound go up or down?'

Does that mean the air vibrated faster or slower?

Complete the following sentences:

The more massive an object is, the _____ it will vibrate.

The _____ an object vibrates, the lower the pitch sound it will make.

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TEACHER HANDOUT

For each instrument, determine what vibrates to make the sound.

INSTRUMENT	WHAT IS VIBRATING?
cymbals	the cymbals
drum	the drumhead
guitar	the strings
clarinet	the reed
flute	column of air
your voice	your vocal chords

Visit stations 1, 2, and 3. Follow the instructions for each station. The stations can be visited in any order.

Station 1:
Gently tap an empty glass with a metal utensil. You are causing the glass to vibrate and therefore make sound. Listen to the resulting sound.

Fill the glass 1/4 full with water. Tap the glass. Compare the sound to the sound of the empty glass.
lower pitch or lower note

Fill the glass 1/2 full with water. Tap the glass. How has the sound changed?
lower pitch or lower note

Fill the glass 3/4 full with water. Tap the glass. How has the sound changed?
lower pitch or lower note

Predict how the sound will change if you add beans to the water.
answers will vary

Fill the cup 1/3 full with beans. Tap the glass. How did the sound change? Was your prediction correct?
lower pitch or lower note

As you added mass (water and beans) to the glass, did the pitch of the sound go up or down?
down

When you add mass to the glass, do you think it will vibrate faster or slower?
slower

Station 2:
Moisten your finger with water. Run your finger around the rim of the glass until the glass makes a ringing sound. Your finger is causing the glass to vibrate.

Fill the glass 1/4 full with water. Run your finger around the rim again. How has the sound changed?
lower pitch or lower note

Fill the glass 1/2 full with water. Run your finger around the rim again. How has the sound changed?
lower pitch or lower note

Fill the glass 3/4 full with water. Run your finger around the rim again. How has the sound changed?
lower pitch or lower note

As you added mass (water) to the glass, did the pitch of the sound go up or down?
down

When you add mass to the glass, do you think it vibrates faster or slower?
slower

Station 3:
Blow across the top of the bottle in order to make a sound. You are causing the air inside the bottle to vibrate, much like the air inside a flute.

Fill the bottle 1/4 full with water. Now there is less air in the bottle to vibrate. Blow across the bottle again. How has the sound changed?
higher pitch or higher note

Fill the bottle 1/2 full with water. Now there is even less air in the bottle to vibrate. Blow across the bottle again. How has the sound changed?
higher pitch or higher note

As you added more water to the bottle and there was less air to vibrate, did the pitch of the sound go up or down?'
up

Does that mean the air vibrated faster or slower?
faster

Complete the following sentences:

The more massive an object is, the [faster or slower] it will vibrate.

The [faster or slower] an object vibrates, the lower the pitch sound it will make.