

“RIDE THE WAVES”

Incorporating Sound Energy Experiments into the General Music Class

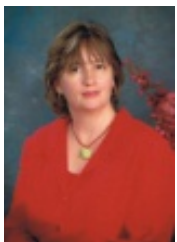
PRESENTERS



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Graduated from Berklee College of Music in Boston with a B.M. Degree and earned a Masters Degree in Music Therapy from Florida State University. Mr. McLaughlin began teaching music in 1984 at the Alternative Ed Center in Ocala, Florida where he created the first music program at the school. In 1987 Mr. McLaughlin began teaching elementary music at Deltona Lakes Elementary in Volusia County. In 1989 Mr. McLaughlin joined the inaugural faculty of Timbercrest elementary where he taught music until 2000 when he returned to Deltona Lakes Elementary to team teach music with his wife Lorraine.

Awards: FUTURES Grant Recipient for Adaptive Instruments/ ESE Teacher of the Year/ FUTURES Grant for Ride the Waves – A Sound Energy Experience \$1,391.00/ FUTURES Creative Award – Ride the Waves – A Sound Energy Experience/ Fender Music Foundation Grant – 25 Guitars, strings, capos, and books/ Mockingbird Foundation Grant of \$4,997 for band instruments/ FUTURES Grant Recipient – Integrating Music with Reading/ Middle School Clinician Preparing for Solo Competition/ Clinical Ed Certification/ 2007-2008 Council for Exceptional Children Auxiliary Staff Member of the Year/ Featured on FOX 35 What’s Right in Education



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Graduated from Illinois State University with a B.A. degree in Music Therapy. She began her career as a music therapist at South Florida State Hospital in Ft. Lauderdale. In 1986 Mrs. McLaughlin joined Volusia County Schools starting the music therapy program at Boston Avenue School, a school for special needs students. Mrs. McLaughlin currently team teaches music with her husband Paul at Deltona Lakes Elementary where she has taught since 1997.

Awards: Deltona Lakes Elementary Teacher of the Year/ FUTURES Grant Recipient – Integrating Music with Reading / FUTURES Grant for Ride the Waves – A Sound Energy Experience \$1,391.00/ FUTURES Creative Award – Ride the Waves – A Sound Energy Experience/ Fender Music Foundation Grant – 25 Guitars, strings, capos, and books/ Mockingbird Foundation Grant of \$4,997 for band instruments/ Clinical Ed Certification/ Presenter at FMEA Conference

MUSIC & SCIENCE NGSSS

MUSIC STANDARDS

MU.K.F.1.1; MU.1.C.1.2; MU.1.H.3.1; MU.1.F.1.1; MU.2.C.1.3; MU.2.F.1.1; MU.3.H.3.1; MU.4.C.1.1;
MU.4.C.1.3; MU.4.H.3.1; MU.5.F.1.1; MU.5.H.3.1

SCIENCE STANDARDS

Kindergarten: SC.K.L.14.1; SC.K.N.1.1; SC.K.N.1.2; SC.K.N.1.3; SC.K.N.1.4; SC.K.N.1.5; **SC.K.P.10.1;**
SC.K.P.12.1; S.C.K.P.13.1; SC.K.P.8.1:

1st Grade: SC.1.L.14.1; SC.1.N.1.2; SC.1.N.1.3; SC.1.P.12; SC.1.P.13.1; SC.1.P.8.1

2nd Grade: SC.2.N.1.2; SC.2.N.1.3; SC.2.N.1.4; SC.2.P.13.1;

3rd Grade: SC.3.N.1.2; SC.3.N.1.3; SC.3.N.1.4; SC.3.N.1.5; SC.3.N.1.6; SC.3.P.10.1; SC.3.P.10.2;
SC.3.P.8.3

4th Grade: SC.4.N.1.2; SC.4.N.1.4; SC.4.N.1.5; SC.4.N.1.6; SC.4.N.1.8; SC.4.P.10.1; SC.4.P.10.2;
SC.4.P.10.3; SC.4.P.9.1

5th Grade: SC.5.N.1.1; SC.5.N.1.2; SC.5.N.1.3; SC.5.N.1.4; SC.5.N.2.1; SC.5.N.2.2; SC.5.P.10.2;
SC.5.P.10.4; SC.5.P.13.1

PHYSICS OF SOUND WAVES

• PHYSICS OF SOUND WAVES – Use of End Caps with Boomwhackers

○ Purpose:

- Demonstrate inverse relationship between wavelength and pitch.
- Conceptualize the connection between wavelengths and corresponding pitch.

○ Materials: Boomwhackers, Boomwhacker End Caps, Rulers, Science Notebooks

○ Procedure:

- Show students a variety of Boomwhackers
- Introduce vocabulary
 - “Nodes”: Points in a sound wave that appear to not move i.e. no vibration.
 - “Antinodes”: Points of vibration between nodes.
- Explain there is an inverse relationship between the wavelength and pitch. i.e. When wavelength increases, frequency goes down (lower pitch); When wavelength decreases, frequency goes up (higher pitch)
- Show a video of the **Tacoma Narrows Bridge Destruction**. Ask students to identify the “nodes” and “antinodes” in the bridge’s movement.

Part 1

- Introduce the formula to calculate wavelength for an open tube as $2L$ or 2 times the Length of the Tube.
- Working in small groups, students measure tubes using the formula $2L$ and record calculations for the wavelength of each in a chart.
- Using knowledge learned about the inverse relationship between wavelength and pitch, hypothesize which tube’s pitch will be lowest and highest. Arrange the tubes in order from lowest to highest according to their calculations and mark them in the chart (see below). Obviously, students could simply arrange the tubes by their length; however, it is beneficial to learn the formula and practice the math calculations then a comparison between their observations and the numbers in the chart can be made.

Tube Letter	Length	Wavelength = $2L$	Rank from Lowest to Highest with 1 being the lowest
C1	24.5	49	1
A	14.5	29	3
E	19.5	39	2

- Test findings by playing each of the tubes and record all conclusions.

Part 2

- Introduce the formula to calculate wavelength for a closed tube as $4L$ or 4 times the Length of the Tube.
- Give each student 1 Boomwhacker and 1 End Cap.
- Working independently or with partners, measure tubes without the end cap, calculate the wavelength using the formula $2L$ and record findings.

Tube Letter	Length	Wavelength = $2L$ No End Cap	Wavelength = $4L$ With End Cap	Lowest Sound With or Without the End Cap?
C	24.5	49	98	<i>With</i>

- Place the end cap on the tube, measure the tube and end cap, use the formula $4L$ to determine the wavelength and record.
- Using only their calculations, students predict if the tube’s pitch will sound higher or lower with the end cap in place. (hypothesis)
- Test the hypothesis by playing tube with and without the end caps and record conclusions.

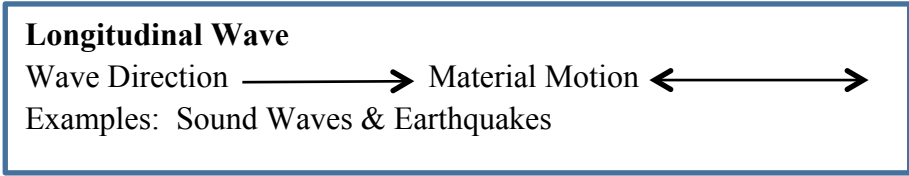
Part 3

- Using the high C and low C Boomwhackers you can easily show how placing the end cap on the high C tube lowers the pitch to match the low C tube which is twice as long. Students can prove this through the calculations as well.

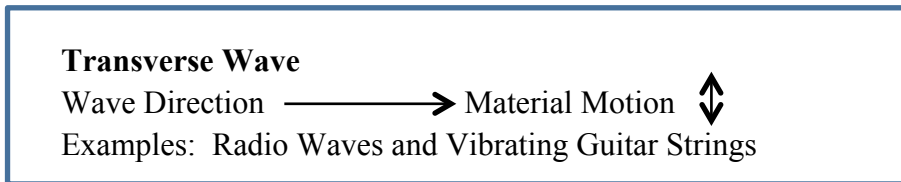
Tube Letter	Length	Wavelength = 2L		Wavelength = 4L	
		No End Cap	End	With End Cap	End
C	24.5	49		98	
C	12.25	24.5		49	

• **PHYSICS OF SOUND WAVES – Compression Waves v. Transverse Waves**

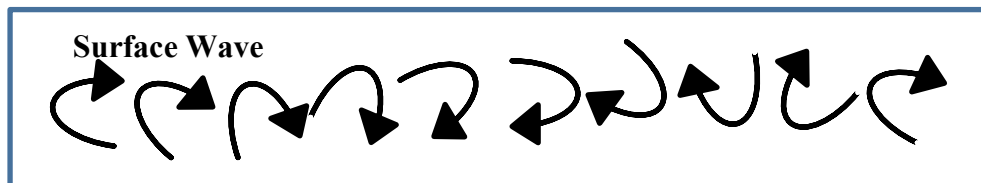
- **Purpose:**
 - Visualizing compression/longitudinal waves
 - Understanding differences in Longitudinal Waves; Transverse Waves; and Surface Waves
- **Materials:** Slinkys of various sizes and composition; Long Table or Hard Floor; Guitar; Document Camera; Computer; Screen; Tuning Fork(s); Bowl of Water; Science Notebooks
- **Procedure:**
 - Discuss the definition of a compression/longitudinal wave. Explain that sound waves are longitudinal; they transfer energy in the same direction as the initial disturbance. Discuss how longitudinal waves can transfer through any material state.
 - Draw the following diagram.



- Define a transverse wave as a sound wave that transfers energy perpendicular to the direction of the initial disturbance.
- Draw the following diagram.



- Define surface waves as waves that travel at the surface of a material with the particles moving in elliptical orbits. Surface waves are slower than transverse waves.
- Draw the following diagram.



Part 1

- Observe a variety of Slinkys and discuss the similarities and differences they exhibit.
- Separate students into pairs and distribute 1 slinky to each pair.
- One student holds the slinky and gently moves it up and down as his partner holds the other end. The slinky should begin to undulate (move perpendicular to the wave direction).
- Students identify the wave form based on the drawings. This is called a **Transverse Wave**.
- **Additional Observations.**
 - Experimenting with faster and slower movements causes changes in the slinky. As the slinky is shaken faster the wavelength decreases, when shaken slower wavelength increases. (Shorter Wavelength = Higher Pitch; Longer Wavelength = Lower Pitch).
 - A transverse wave can also be demonstrated and viewed by holding a guitar under a document camera and plucking a string.

Part 2

- Holding a slinky, stretch it up and down perpendicular to your hand.
- Identify the wave form based on the drawings they made. Is this a **Longitudinal or Compression Wave**.
- Using the table or floor work in pairs with a slinky.
- Stretch the slinky out along the table/floor with one person acting as an anchor point.
- The other student releases the slinky creating a longitudinal/compression wave.

- Students can have “Slinky Races.” Predict the winner based on size and composition of the Slinkys (metal or plastic).

Part 3

- Prepare a bowl or glass of water and 1 or more tuning forks.
- Strike the tuning fork with a rubber mallet and place it in the water. Observe the water’s surface.
- Identify the wave form. This is a **Surface Wave**.

• **PHYSICS OF SOUND WAVES – Longitudinal Waves**

- **Purpose:** Demonstrate Longitudinal Waves
- **Materials:** Singing Rods; Rosin
- **Procedure:**
 - Present the singing rods to the students.
 - Hypothesize how sound can be generated using the rods.
 - Predict if the sound of the two rods will be the same or different and theorize how the sound is made (Consider what is vibrating?).
 - Working in small groups each student takes turns holding the rod in the center (this creates a Node). Spread rosin along half of the rod and on index finger and thumb of other hand.
 - Firmly rub along the sticky end of the rod with their rosined hand. Continue rubbing in one direction until the rod begins to “sing.”
 - Vary the speed and grip pressure. Note the changes in sound.

Note: These are longitudinal waves. If the rod is rubbed slowly lower pitched notes result. Faster motions produce higher pitched sounds.

• **PHYSICS OF SOUND WAVES – Speed of Sound**

- **Purpose:** Demonstrate how slowly sound travels through air.
- **Materials:** Metal Pipe suspended by nylon fishing line, mallet/hammer, rolling tape measure
- **Procedure:**
 - Discuss observations students have made about sound when watching a roof being built on a nearby building or some other construction type project. Describe what they saw and what they heard. Did they notice a delay between a person swinging a hammer and the corresponding sound? Other scenarios that can be investigated are airplanes overhead and thunder vs. lightning. Is there a noticeable difference between seeing a plane overhead or lightning in a storm and when they hear the corresponding sound?
 - Sound travels much slower than light. Sound travels at approximately 345 m/s (meters per second) in normal atmospheric pressure and 20 degrees Celsius or 750 mph. Compare this to a runner – 11 m/s or highway speeds – 30 m/s.

- For intermediate students introduce the following formula to calculate the distance a lightning strike is from their home based on the time between observing the strike or flash and hearing the thunder.

FORMULA: Distance = Speed x Time.

For purposes of these simple calculations assume approximate speed as 345 m/s and time is the interval between the lightning strike and hearing the thunder. If we use a scenario assuming a 3 second gap the formula will look like this:

$$d = 345\text{m/s} \times 3\text{s} = 1035\text{m} \text{ (to convert to miles divide the result by 1600)}$$

- Go to a large open area outside.
- Teacher stands in a spot a few feet away from the students and strikes the suspended pipe with a hammer or mallet.
- Students raise the left hand when they see the strike and the right hand when they hear the sound.
- Seeing and hearing should be almost simultaneous for the first few short distances.
- Predict how far away the visual strike and sound heard will stay together.
- Repeat the procedure moving farther from the students until a delay between seeing the strike and hearing the sound occurs.
- Using a rolling measuring wheel, determine the distance when a delay becomes noticeable. The distance may not be as far as expected. Sound is discovered to be quite slow.

- **PHYSICS OF SOUND – Measuring dB**

- **Purpose:** Understanding how sound level is measured.
- **Materials:** Sound Level Meter (Extech 07730); Notebooks
- **Procedure:**
 - Sound level is measured in decibels (dB) – A unit of intensity.
 - Discuss common sounds and their corresponding dB level.
(see *Decibel Comparison Chart below*)
 - Students construct a list of areas around the school to measure with the dB Meter. Predict what sound levels may be encountered and compare to the chart of common known levels.
 - What is the loudest and softest location?
 - Using the sound level meters, chart various parts of the campus and record the findings.
 - Compare the results with known sound levels and discuss.

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DECIBEL COMPARISON CHART	
Weakest Sound Heard	0 Db
Whisper (library)	30dB
Normal Conversation	60-70dB
Normal piano practice	60-70dB
Telephone Dial Tone	80dB
Violin	82dB
Piano Fortissimo	84-103dB
Truck Traffic	90dB
Flute	92-103dB
Trombone	85-114 dB
Bass Drum	106 dB
Level at which sustained exposure may result in hearing loss	
Power Mower at 3 feet	107dB
Motorcycle	100 dB
Loud Rock Concert	115 dB
Symphonic Music Peak	102-137 dB
Short term exposure can cause damage. Loudest recommended exposure <u>with</u> hearing protection	
Jet Engine at 100'	140dB
Rock Music Peak	150 dB
Loudest Sound Possible	195Db

- **PHYSICS OF SOUND – Sound Waves Move Through the Air**

- **Purpose:** Background activity – All About Air
- **Materials:** Windbags, Elastic Band
- **Procedure:**
 - Unroll the windbag and measure it.
 - Describe everything noticed about the geometric shape, length, and width of the bag.
 - Fluff the bag:
 - Open one end of the bag and gather it as if blowing up a paper bag.
 - Put mouth directly on the bag and blow 3 big breaths of air into it.
 - Grab the bag with one hand and use the other hand to slide the air all the way to the other end and out.
 - Tie a simple knot in one end of the bag as close to the end as possible so the air will be trapped inside.
 - To prepare the bag for the test, slide a hand from the knot to the open end to empty all the air from the bag.
 - Hold the bag to mouth and blow 3 breaths of air into the bag again.
 - Slide hand down the bag and see how much air was trapped inside.
 - Allow each student to try. Empty the bag between each attempt, measure the filled portion and record the results.
 - Estimate how many breaths it might take to fill the bag completely.
 - Take turns blowing 3-4 times into the bag until the bag is full. The number of breaths needed is recorded and compared to their estimates.
- **Follow Up Activity**
 - Explain that the bag can be filled using one breath.
 - Allow students to attempt it then demonstrate the procedure as follows:
 - Have a second person hold the closed end of the bag parallel to the floor.
 - Open the mouth of the bag widely and shape it into a square.
 - Hold the opening of the bag at eye level and keep it 8-10 inches away from your mouth.
 - Blow a long steady breath of air into the center of the opening of the bag. (think of blowing out a candle)
 - The bag should inflate in less than 2 seconds.
 - When you feel the air returning in your face close the opening and compress the air in the bag by sliding your closed hand forward and the bag will take shape.
 - Close with an elastic band (optional)

Note: This is the Bernoulli Principle which states fast moving air creates an area of low pressure and the surrounding air (higher pressure air) moves into the lower pressure space only to be pushed into the bag inflating it easily.

- **PHYSICS OF SOUND WAVES – Oscilloscope**

- **Purpose:**

- Exploring different types of sound waves.
- Compare and contrast sound waves of different voices and music instruments.

- **Materials:** Oscilloscope; computer with projector; various music instruments; microphone; tone generator.

- **Procedure:**

- Connect a tone generator to the oscilloscope. Tone generator apps can be found on-line.
- Display a sine wave, square wave, saw tooth wave, and triangle wave.
- Compare and contrast the wave forms.
- Ask students to describe what the different waves might sound like.
- Repeat the wave forms again and listen to them. Discuss differences heard.

- **Part 1**

- Generate a sine wave on Channel 1, play an instrument on Channel 2 simultaneously.
- Describe the differences and similarities in the wave forms.
- Repeat with a variety of music instruments.

- **Part 2**

- Connect a microphone and have a student speak into it creating a sound wave.
- Using Channel 2 and an additional microphone compare a second student’s voice to the first.
- Students predict what if any changes will take place if they alter their speaking patterns. Students can vary their speaking patterns using different pitches and tempos and record all observations. A printer can be used to print a copy of the wave form generated by their voice. Very Cool!

- **Part 3**

- Play various music instruments and compare and contrast the sound waves they produce.
- Which ones are similar? Which ones are very different? This is what is responsible for the different timbres of sound.

RESONANCE

- **RESONANCE – Boomwhackers**

- **Purpose:** Demonstrate Resonance.

- **Materials:** Variety of Boomwhackers; 2 Gallon Bucket; Water; Tuning Forks

- **Procedure:**

- Enter a noise rich environment such as a hallway or school cafeteria.
- Listen carefully to the surrounding sounds and try to isolate a particular pitch.

Explain that resonance is one object’s vibrations setting a second object vibrating at the same frequency. This is what happens in a seashell. The seashell picks up matching resonant frequencies. These frequencies in the environment are amplified and you can hear this in the shell.

Part 1

- Give each student 1 Boomwhacker.
- In a noisy environment, hold the Boomwhacker slightly away from your ear and concentrate on the sound. Hear how the tube filters and amplifies the same tone it produces when struck.
- Confirm this by alternately listening through the tube and playing the tube.
- Hold the tube tightly against your head and describe the difference in the sound. (Should be 1 octave lower).
- Hold 2 tubes, one to each ear and discuss the differences heard.
- Select the “E” and “F” Boomwhackers and hold one against each ear at the same time.
- Remove the “E” then “F” Boomwhacker from the ear alternating between the two. Gradually increase the tempo. (E F E F) Can you name the famous movie theme from “Jaws?”

Part 2

- Fill a 2 gallon bucket with water
- Immerse the G Boomwhacker perpendicular to the bottom of the bucket and hold it in place.
- A second student strikes the F tuning fork with a rubber hammer and holds it above the Boomwhacker tube.
- Coordinate moving up and down so the tuning fork and tube never touch each other until the sound becomes louder.
- Experiment with various combinations of tuning forks and Boomwhacker tubes and record all findings regarding resonance in a notebook.

Note: The vibrating fork makes the air in the tube vibrate. When the air in the tube vibrates at exactly the same frequency as the tuning fork, they are in resonance and amplitude is increased (sound louder). Other pitch combinations we have discovered work are BW D/High C Fork; BWG/D Fork; BW B/E Fork.

SOUND ENERGY TRANSFER

SOUND ENERGY TRANSFER – Paper on a String

- **Purpose:** Visualize vibration/ sound wave
- **Materials:** Long nylon string; small strips of paper
- **Procedure:**
 - Attach one end of the string to a solid object i.e. door handle while a second person holds the other end of the string and pulls tightly.
 - Cut strips of paper ½” wide by 2 ½” Long
 - Distribute small colored pieces of paper along the string.

- Pluck the string at one end.
- Discuss your observations.
 - What happened to the pieces of paper?
 - What made the paper move?
 - What direction did the paper move?
 - Did the papers move in any particular order?

- **SOUND ENERGY TRANSFER – Tuning Forks**
 - **Purpose:** Discover how sound is transmitted through a variety of mediums.
 - **Materials:** Tuning Forks; Bowl/Glass; Water (enough to fill bowl or glass); Rice (enough to fill bowl or glass)
 - **Procedure:**
 - Form groups of 2 – 4 students.
 - Take turns holding the empty glass/bowl up to your ear while a partner strikes a tuning fork and holds it against the glass/bowl.
 - Repeat with rice then water in the bowl.
 - Document findings in student science notebooks. (Describe sound changes when heard through air, rice, and water mediums.)

- **SOUND ENERGY TRANSFER – Talking Cups**
 - **Purpose:** How sound is transmitted through a variety of mediums.
 - **Materials:** Plastic Cup; Nylon String; Rosin or Candle Wax
 - **Procedure:**
 - Drill a hole in the bottom of plastic cups just large enough for the nylon string to pass through.
 - Tie a knot in one end of the nylon string
 - Rub rosin or candle wax along the string.
 - Students pinch the string with their index finger and thumb and slide down the string. Note any findings in their science notebook. (i.e. sound/no sound)
 - Feed the string through the bottom of the cup. The knot should be flush against the inside bottom of the cup.
 - Students slide their index finger and thumb along the string and document their findings.
 - Experimenting with speed and tension of the string produces a variety of sounds.

- **SOUND ENERGY TRANSFER – Spoons**
 - **Purpose:** Examine how sound is transmitted through a variety of mediums.
 - **Materials:** Metal Spoons; Yarn
 - **Procedure:**
 - Students work in pairs.
 - In the center of a 25” piece of yarn, tie 1 spoon so the spoon can dangle like a pendant.
 - Wrap the two ends of the yarn around each of index finger and hold the strings up to their ears. They will need to lean forward so the spoon does not touch their clothing.

- Their partner lightly taps the spoon with a second spoon.
- Take turns tapping and listening.
- Record what you hear through the yarn.

- **SOUND ENERGY TRANSFER – Talking Strips**

- **Purpose:** Examine how sound is transmitted through a variety of mediums.
- **Materials:** Plastic Cup; Purchased Talking Strips, Tape
- **Procedure:**
 - Distribute one plastic cup, a piece of tape and one Talking Strip to each student group.
 - Demonstrate how to hold the talking strip in one hand and run a thumbnail down the length of the entire strip.
 - Students record what they hear.
 - Attach the **pointed** end of the Talking Strip to the bottom of the plastic cup with tape.
 - Each student takes turns holding the cup to their ear while they or a partner run their thumbnail lightly down the entire length of the Talking Strip.
 - Listen for and record the message they hear.
 - Answer the following questions:
 - What is acting as the amplifier?
 - What is vibrating?
 - Was the sound louder with or without the cup?

Note: The grooves in the Talking Strips act like the grooves in a vinyl record. In this activity the student’s thumbnail takes the place of the needle or stylus and the cup serves as an amplifier. You can also use a balloon or piece of paper. The vibrating surface moves the air molecules that carry the sound to the ear. You can also bite the end of the talking strip and your head will act as a sound box. Each student will need their own disposable talking strip.

VIBRATION

- **VIBRATION – Exploring Pitch: Talking Balloons**

- **Purpose:** Explore the relationship between speed of a sound wave and pitch
- **Materials:** Latex Balloons, Hex Nut, Plastic Bead, Washer, Balloon Clips
- **Procedure:**
 - Show students the bead, hex nut, washer, and balloon.
 - Place one item in the balloon and inflate.
 - Predict how each item will sound when the balloon is moved in a clockwise motion at different speeds.
 - Predict if there will be a difference in the sound generated when the balloon is shaken at various speeds.
 - How will the sound be different i.e. pitch or volume?

- Place a bead in the balloon, inflate, and clip with a balloon clip.
 - Rotate the balloon in a clockwise motion first slowly then increasingly faster.
 - Repeat process for the hex nut and washer.
 - Record the results and draw some conclusions.
-
- **VIBRATION – Exploring Pitch: Boomwhackers**
 - **Purpose:** Explore the relationship between size of vibrating tube and pitch
 - **Materials:** Assortment of Boomwhackers, Poster board or large paper and markers (for primary grades), Notebooks and pencils (for intermediate students)
 - **Procedure:**
 - Primary Students
 - Select 2 or more different Boomwhackers
 - Examine the tubes. Record observations.
 - Demonstrate methods to make a sound with the Boomwhackers.
 - Create a hypothesis about the Boomwhackers’ pitch. Do all tubes produce the same sound? Explore different methods of producing sound using different parts of the body (leg/hand). Is the sound produced different based on the force of the tap? Does the length of the tube have an effect on the pitch?
 - Each student group records a hypothesis.
 - Distribute at least 2 Boomwhackers to each student group.
 - Students take turns playing the Boomwhackers to test their hypothesis. More than one hypothesis can be tested by each group.
 - Regroup and discuss all conclusions.
 - Encourage students to discuss the similarities or differences in their findings.
 - Intermediate Students
 - Students can do the same experiment as the primary students then expand to include the scientific method design i.e. hypothesis, experiment, results, and conclusions.

- **VIBRATION - Exploring Pitch: Straws**

- **Purpose:**

- Explore how a vibrating material can produce sound and recognizable pitches.

- **Materials:** Plastic Drinking Straws; Scissors; Oboe Reeds; Clarinet/Saxophone Mouthpieces with Reeds; Sterisol

- **Procedure:**

- Prepare the plastic drinking straws by cutting them as shown in Figure “A”
In the elementary school setting the teacher may have to prepare the straws.
- Distribute one straw to each student instructing them not to blow into them yet.
- Measure the straw and record its length.
- Discuss the effect, if any, the length of the straws will have on the pitch.
- Predict if there is a way to change the pitch.
- Document hypotheses.
- Flatten out the pointed tip of the straw (see dotted line) by drawing it between teeth repeatedly to soften straw tip.
- Place the straw in mouth with lips at the dotted line.
- Blow into the straw to create a sound. This may take some trial and error.
- If necessary, move straw in and out of mouth while blowing to start the sound.
- Adjust blowing effort to change the air pressure and document any change in the sound.
- Students compare straws of different sizes to determine if the pitch is different.
- Document all findings.
- Demonstrate how changing the length of the straw changes the pitch. This can be done by cutting the straw while playing.
- Describe the relationship between length of the straw and corresponding pitch.
- Demonstrate the correlation between straws and various instrument reeds.
- If available, allow students to try different single and double reeds.
- Consider the relationship to music instrument families and sizes.

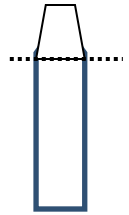


Figure “A”

- **VIBRATION – Tuning Forks**

- **Purpose:** Observe Vibrations and explore how vibrating materials produce sound and different pitches.

- **Materials:** Tuning Forks; Rubber Mallet; Suspended Ping Pong Balls; Plastic Cups; String; Tape

- **Procedure:**

- **Part 1**

- Display tuning forks of different pitches.
- Record observations about the tuning forks i.e. size and shape
- Direct students to hold out a hand palm up.
- Strike a tuning fork with a rubber mallet and hold the handle against the center of their palm.
- Students describe what they feel.
- Strike a tuning fork with a rubber mallet and hold the handle against a desk or hard surface.
- Repeat with at least 3 different tuning forks.

- Describe the different pitches produced and correlate the pitch with the size of the tuning fork.

Part 2

- Make a classic string telephone by poking a small hole in the bottom of two cups with a pencil then passing a 2-3 meter long string through the holes. Tie a knot on the inside of each cup and stretch the string out between the two cups.
- Work in groups of 3. Two students hold the cups to their ears while a 3rd student strikes a tuning fork with a rubber mallet and touches the handle to the string.
- Students describe what they hear.

Part 3

- Using fishing line and tape suspend ping pong balls from the ceiling or fixed object so they are free to swing.
- Strike the tuning fork with a rubber hammer and touch the ping pong ball. Experiment with different parts of the tuning fork touching the ball.
- Record all observations.

• **EXPLORING PITCH - Singing Balloons**

- **Purpose:**
 - Explore the relationship between air pressure and pitch
- **Materials:** Singing Balloon
- **Procedure:**
 - Show students the balloon and describe it as a singing balloon.
 - Ask the students to predict how/if the sound will change as the air leaves the balloon.
 - Inflate the balloon and release it.
 - Students describe what they hear.
 - Repeat the process and ask students to specifically notice how the pitch changes as the air pressure in the balloon decreases.
 - Inflate and release the balloons using different amounts of air.
 - Measure the length of the inflated balloons. Determine if the amount of air in the balloon makes a difference in the pitch.

• **EXPLORING PITCH – Slide Whistle**

- **Purpose:**
 - Explore the relationship between length of a closed tube and pitch.
- **Materials:** Slide Whistle; Alcohol Pads or Sterisol
- **Procedure:**
 - Introduce the slide whistle explaining how it works. (plunger inside moving up and down shortens and lengthens the tube of air)
 - Demonstrate high and low sounds on the slide whistle.
 - Have a group of students stand up and down as the pitch changes.

• **EXPLORING PITCH – Bottles**

- **Purpose:** Explore the relationship between pitch and the vibrating medium (what is vibrating to produce the sound).
- **Materials:** Glass Bottles (*Coke* and *Yoo-Hoo* bottles work best); Small Wooden Mallet; Water
- **Procedure:**
 - Part 1**
 - Fill one bottle with water and predict if the sound will be low or high when struck.
 - Strike the bottle and have students record their findings.
 - Pour some of the water out of the bottle and predict if the pitch will be lower or higher than the first trial.
 - Strike the bottle and note any change in pitch.
 - Complete 2-3 trials.
 - Separate students into small groups and supply each group a set of 3 bottles.
 - Experiment with the bottles by adding/reducing the water to make different pitches.
 - Fill and empty the three bottles until they are able to approximate the 1st three notes of “*Three Blind Mice*”. **Note:** They will not all be in the same key.
 - Each group plays their 3 note pattern. Compare pitches heard.
 - For each group measure the amount of water in each bottle and record it on a chart.
 - Questions:
 - Were all of the measurements of liquid the same?
 - If not, did the high/middle/low pitches all sound the same? (different starting notes produce different keys)
 - Did more water equal a lower or higher pitch?
 - What was vibrating to make the sound?

Part 2

- Fill one bottle three quarters full with water and predict if the pitch will be low or high when **blown** across the top.
- **Blow** across the bottle top (like a flute) and have students record their findings.
- Pour some of the water out of the bottle and predict if the pitch will be lower or higher than the first trial.
- **Blow** again and record the results.
- Complete 2-3 trials.
- Separate students into small groups and supply each group a set of 3 bottles.
- Allow students to experiment with the bottles by adding/reducing the water to make different pitches **blowing** rather than **striking** the bottles as in Part 1 above.
- Have students fill and empty the three bottles until they are able to approximate the 1st three notes of “*Three Blind Mice*”.
- Each group plays their 3 notes.
- Measure the amount of water in each bottle and record it on a chart.
- Questions:
 - Were all of the measurements of liquid the same?
 - If not did the high/middle/low pitches all sound the same? (different notes different keys)
 - Did more water equal a lower or higher pitch?

- What was vibrating to make the sound?
- How was the pitch affected by the two different methods? First when the bottles were struck and then blown across. Why? (*Blowing – The column of air is vibrating so less water = longer column of air = lower note. Striking – Glass and water are vibrating so less water = shorter “bar” = higher note*)

Part 3

- Distribute guitar tuners to student groups.
- Fill a bottle part way with water.
- Tap or blow across the top of the bottle. Try to match a predetermined pitch. Add or remove water until the predetermined pitch is achieved.
- Measure the amount of water in each bottle and record.

Explain this is called tuning. This activity can be used for increasing ear training skills.

RESOURCES

- SteveSpanglerScience.com
- Ward’s Natural Science – Wardsci.com
- Video: Tacoma Narrows Bridge (Use for Physics of Sound Waves and Resonance Examples)