# Science Notebook

Sound Energy
Grade 4

Name: ___________________________

My Science Notebook

# Grade 4
# Sound Energy

# Table of Contents

# How did the singer shatter the glass?

## 1. Watch the videos.

Jaime Vendera shatters a glass http://bit.ly/SingerBreaksGlass

Slow motion glass breaking http://bit.ly/SlowMotionGlassBreak

2. What do you notice?

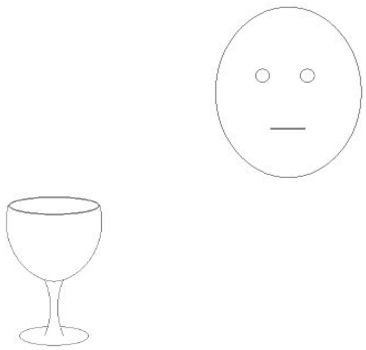
3. What do you wonder?

4. What information do you need to figure out what caused the glass to break?

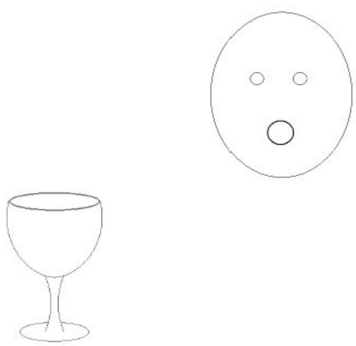
## How did the singer break the glass?

Draw and write about what caused the glass to break. Remember models use labels, arrows, zoom-ins, and symbols to communicate your thinking.

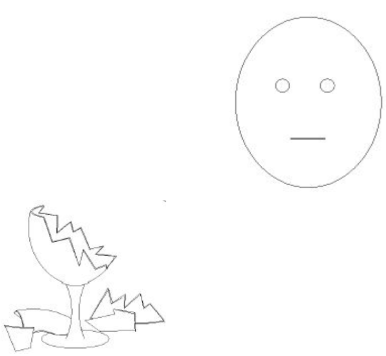
Before sound



During sound



After sound



Did you….?

- ❏ Draw sound using a symbol or representation
- ❏ Show how or where sound travels
- ❏ Explain or show more than one observation

# Human Voices Investigation

## 1.Making Observations

*Directions*: Put one hand on your diaphragm and one hand on your throat to feel your vocal cords. For each volume, use the phrase "Go Seahawks!" and take notes about what you notice about force, vibrations, and volume.

Whisper

Hum

Talk

Yell

## 2. Develop models of sounds

After observing each sound, draw a model of what you think sound looks like for each: whisper, hum, talk, yell. How are you showing different volumes?

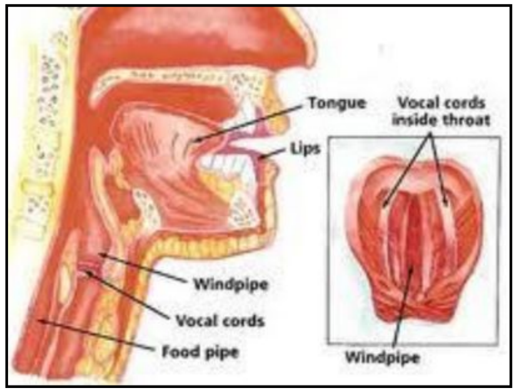
Whisper

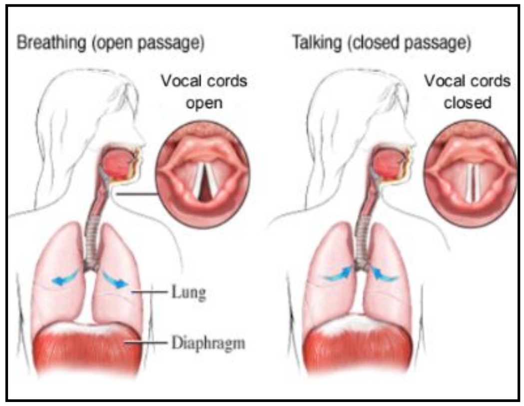
Hum

Talk

Yell

## Human Voices

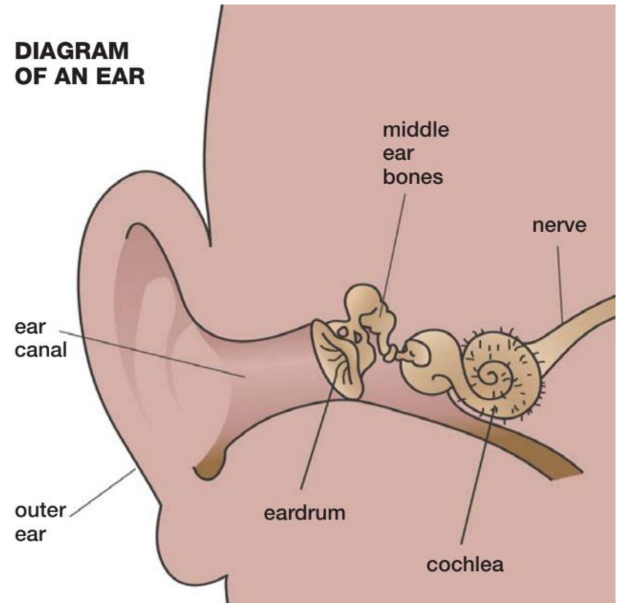



There are parts inside your body which work together to help you make sounds like talking, yelling, and singing. The main parts are the diaphragm muscle, lungs, windpipe, vocal cords, and mouth. The diaphragm is a muscle below your lungs. You can control your diaphragm muscle. To make loud sounds, you can feel your diaphragm pushing hard. The diaphragm muscle pushes on your lungs. Your lungs are kind of like balloons. Your diaphragm muscle helps move air in and out of your lungs. The windpipe connects to your mouth and nose to your lungs. When you breathe in, air goes in your mouth or nose, through the windpipe, and fills up your lungs. Your vocal cords are inside your windpipe. When you talk, you exhale. The muscles in your neck control your vocal chords. When you talk, your vocal cords get closer together than when you are just breathing. Lungs are also important. You breathe in just before you talk or sing. While you are talking or singing, you are slowly breathing out. As air leaves your lungs, it moves up, out, and passes through your vocal cords. As the moving air passes over your vocal cords and gets vibrated when you hum, talk, or yell. The sounds we make with our mouths travels out into the air for other people to hear and feel.

## How We Hear

Your ears are shaped to gather sound waves and move the sound into your ears. The part of your ear on the outside of your head is called the outer ear. A tube inside the ear, called the ear canal, carries sound from the outer ear to the eardrum. The eardrum is a tightly stretched patch of thin skin. It is like a tiny drum. When sound waves from the outer ear hit the eardrum, it vibrates. The eardrum passes vibrations into the middle ear, which has three tiny bones. When the eardrum vibrates, the bones vibrate. These bones pass the sound vibrations to the deepest part of each ear—the inner ear. The most important part of the inner ear is the cochlea. The cochlea looks like a tiny snail shell. It is filled with liquid that vibrates when the bones of the middle ear vibrate. Tiny hairs lining the inside of the cochlea change the vibrations to signals. Each sound causes different vibrations that then make different signals. The hairs inside the cochlea connect to nerves. The thin, threadlike nerves carry messages from the ear to the brain. The brain interprets the signals. If the sound of an alarm clock buzzing reaches your ear, the vibrations in your ear send a signal to your brain. Your brain interprets the signal and tells you to get out of bed.



## Hearing Loss

The many parts of the ear must work together for good hearing. If any part stops working properly, hearing will be affected. Hearing loss can happen because a person was born with parts of the ear that didn't form correctly or don't work well. Other hearing loss can happen later in life because of an injury or illness. Some people need a hearing aid to make sounds louder. Hearing aids are like tiny amplifiers. They make sounds louder and clearer. Hearing aids deliver amplified sounds from the eardrum and middle ear to the inner ear or cochlea. Hearing aid technology can adjust the volume of sounds automatically.

People use the words deaf, deafness, hearing impaired, or hard of hearing when they're talking about hearing loss. Someone who has hearing loss might be able to hear some sounds or nothing at all. Some people can't hear sounds even with a hearing aid. People who cannot hear learn to use their sight, touch, and other senses in place of hearing. Some use sign language to communicate. Others learn to read lips and feel vibrations.

**The Most Frequent Causes of Hearing Loss:**


*Source: Mayo Clinic*

**American Sign Language: Example Words**

# Build & Compare Eardrum Models

*Create these models if you have these materials available to you.*

1. **Build** each model and test them. Sketch them.
2. **Similarities**: What do these models have in common?
3. **Differences**: What are some differences between these two models?
4. **Improvements**: What would you add or change about the model to make it better?

### Kids Health Eardrum Model

https://kidshealth.org/en/kids/experiment-eardrum.html

Materials
- Glass bowl
- Plastic wrap
- 20 grains of uncooked rice
- Cookie sheet

Directions
1. Stretch a piece of plastic wrap over your bowl. Make sure the wrap is on there tight. The plastic wrap represents the eardrum.
2. Place about 20 grains of uncooked rice on the top of the plastic wrap.
3. Now you need some noise. Hold the cookie sheet close to the plastic wrap. Hit the cookie sheet to create a "big bang" noise and watch the rice grains jump. Now you know how sound causes your eardrum to vibrate, sending messages to your brain about the sounds you're hearing!

## Sketch & Label

### Science Friday Eardrum Model

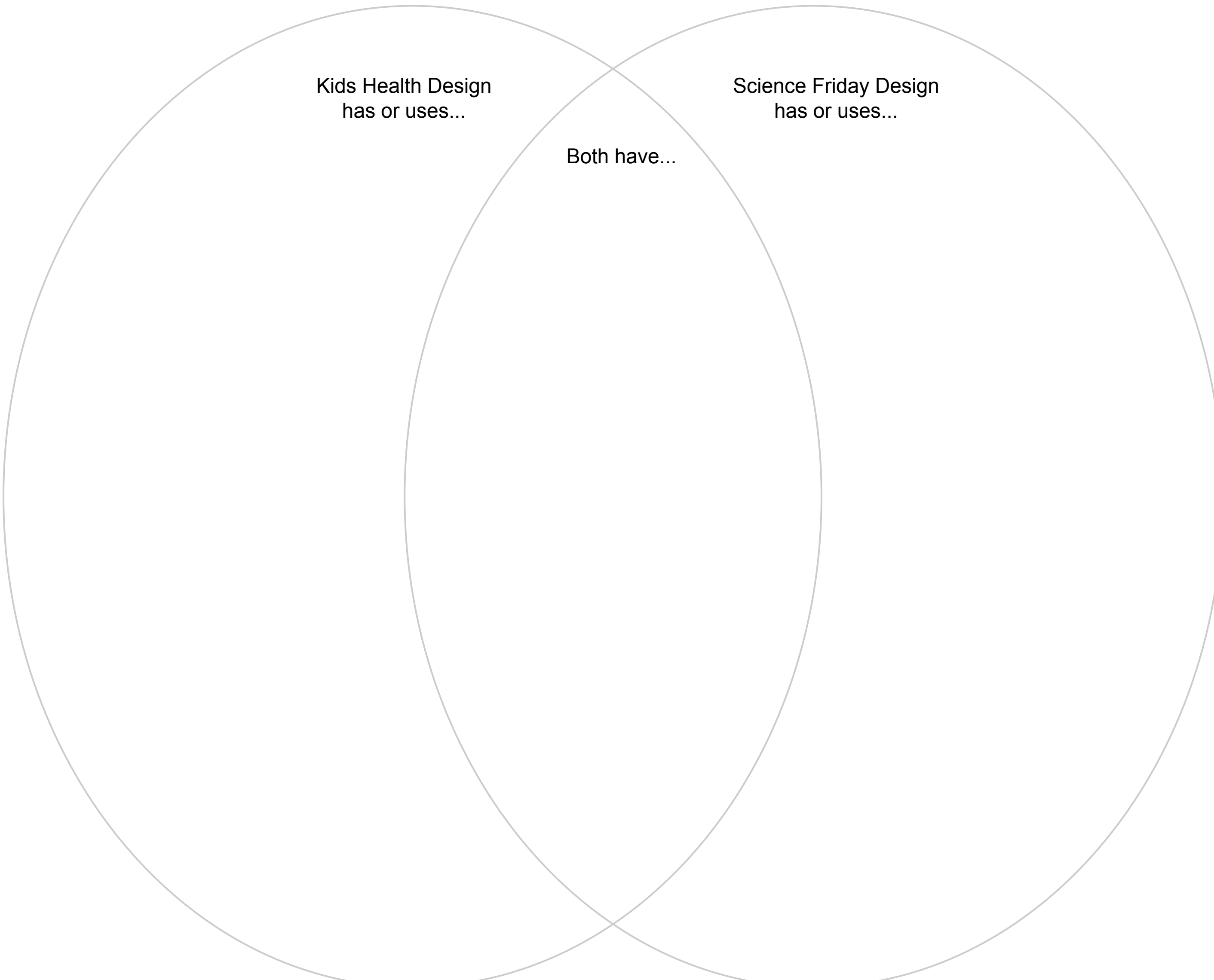
https://www.sciencefriday.com/educational-resources/make-a-model-eardrum-to-detect-sound-waves/

Materials
- Plastic soda bottle or rigid plastic cup
- Rubber band
- Balloon or plastic wrap
- Sugar, salt, sand, or other sand-like substance
- Scissors
- Smartphone, small speakers or earbud headphones

Directions
1. Carefully cut the bottle or cup to make 5 centimeter ring cylinder shape.
2. Stretch the balloon or plastic wrap over one end of the ring. Make sure it is pulled tightly. Secure with rubber band.
3. Sprinkle the salt, sand, or sand-like substance on top of the plastic wrap or balloon.
4. Place the eardrum model near speakers or headphones and play loud music. You should be able to see the salt or sand jump and vibrate. Does some music work better than others to vibrate this eardrum model?

## Sketch & Label

**Compare:** How are these eardrum models similar and different?




**Improve**: What would you change to improve one or both models?

## Summarize new learning:

How do humans make and detect sounds? What parts help us do this?

## Make a Connection:

How does information about how we produce and detect sounds help explain how the singer shattered the glass? How did the singer make such a powerful sound?

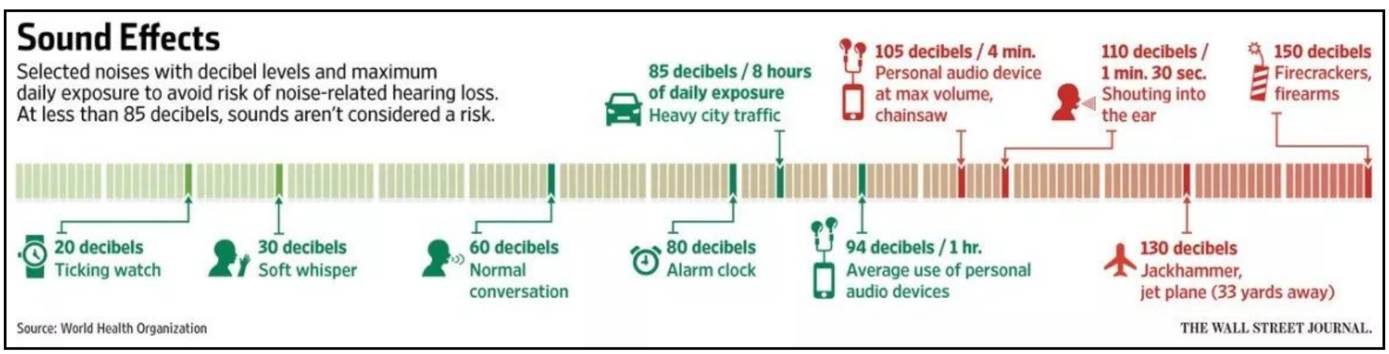
# Decibels at a Distance

**1. Think & Write:** What happens to the volume of a sound as we increase our distance from it?

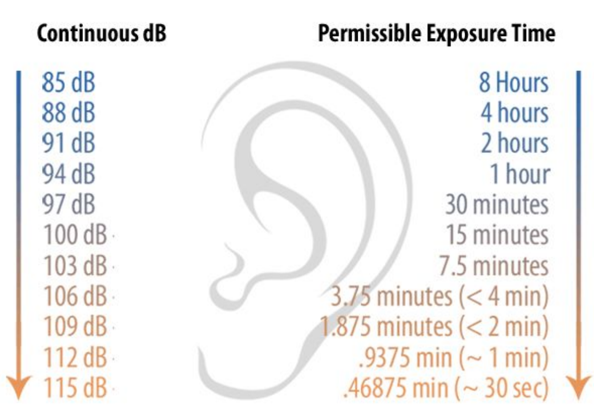
**2. Read:** How do scientists measure sound? What is a decibel? What do the images teach us about?

## Measuring Sound

We can measure the intensity or loudness of sound by using a tool that measures **decibels**. Decibels measure the pressure or forcefulness of a sound wave. The more pressure a sound has, the louder the sound is. The decibel measurement works on a power of ten. This means that a sound at 100 dB is not just ten decibels louder but *ten times louder* than a sound at 90 dB.




Whether a loud sound will damage your hearing or cause hearing loss depends on two factors: (1) how loud the sound is, and (2) how long the loud sound lasts. Any sound around 85 decibels can cause hearing loss after several hours. For example, working an eight hour shift in a noisy environment at 90 dB can cause permanent damage. Sounds at 140 decibels, like standing next to a jet airplane taking off, can instantly cause damage. Blasting really loud music into your headphones is a fast way to damage your hearing. It might not happen right away, but over time, you may notice changes to your hearing.



**3. Investigate:** Collect data a different distances from a source of sound. Sketch a map of where the source of the sound is and where the decibel meter is. Include decibel measurements to show how loud or intense the sound is at each distance.

**4. Analyze:** What patterns do you notice in your data?
Use your data as evidence to make a claim about volume and distance.

**5. Model-to-Explain:** Use symbols, arrows, labels, colors, and captions to model and explain why or how the volume of a sound decreases over a distance. You could use a birds eye view (top down) or a side view.

### 6. Summarize new learning:

What are decibels? What does it mean if a sound is 90 dB compared to 80dB? Why is it important to know about decibels?

### 7. Make a Connection:

How does information about decibels and distance help explain or understand how the singer shattered the glass?

# Seeing Sound Waves

**1. Think & Write:** What does *sound wave* mean to you? What does drawing sound waves in a model help to communicate about a sound even though we can't see sound?

**2. Observe:** Make observations of a vibrating tuning fork on the surface of water. What changes when the tuning fork is hit with less force compared to more force?

less force

more force

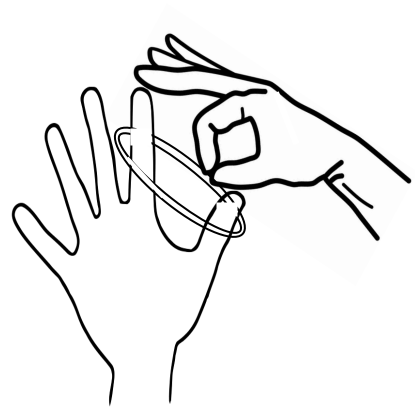
### 3. Read & Investigate: Amplitude

Read to learn about the term *amplitude*. What does *amplitude* describe about a sound? Try the investigation with the rubber band described in the text. How does force relate to amplitude?

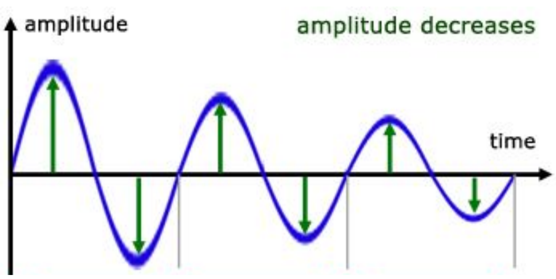
## What is amplitude?

Strum one guitar string or hit a piano key one time and listen as the sound fades away. You will hear the volume sounds louder at first and gets less and less over time.

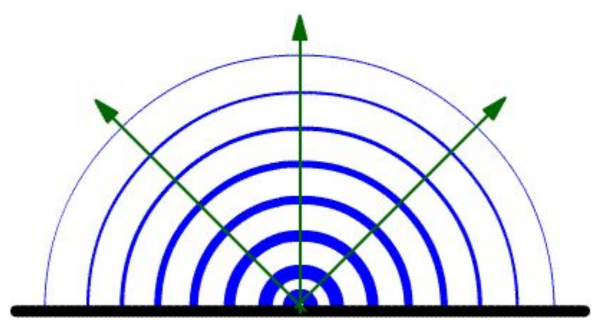
***Try this:*** Stretch a rubber band between your finger and thumb. Pluck the rubber band gently. What do you hear? What do you see? Now pluck with more force. What do you notice? What does force have to do with amplitude or volume of a sound?



Amplitude is a description of the sound wave's strength. Amplitude is often drawn as the height of the sound wave. Amplitude, or wave height, decreases over time if no more energy or force is put back into the system. As the amplitude of a sound wave decreases, the volume of the sound decreases. One way computers represent sound waves is shown below. Over time, the amplitude, or wave height, decreases if no more energy is put into the system. This results in less and less volume over time.




*In this model, amplitude is shown as the height of the sound wave. A louder sound has more amplitude so it has a taller or higher wave. This wave shows a sound that is fading over time as the sound energy spreads out into a room.*



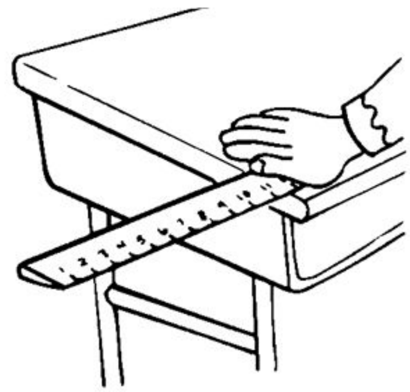
*In this model, the illustrator is showing amplitude with the thickness of the line. The source of the sound is the origin and as the sound wave moves away in all directions, the sound intensity decreases which is shown by thinner and thinner lines.*

## 4. Read & Investigate: Pitch

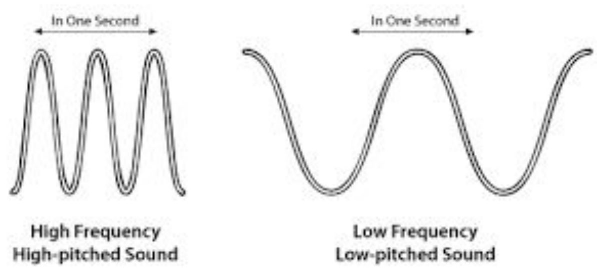
Read to learn about the term *pitch*. What does *pitch* describe about a sound or sound wave? Try the investigation with the ruler described in the text. What do you hear? What do you feel?

### What is pitch?

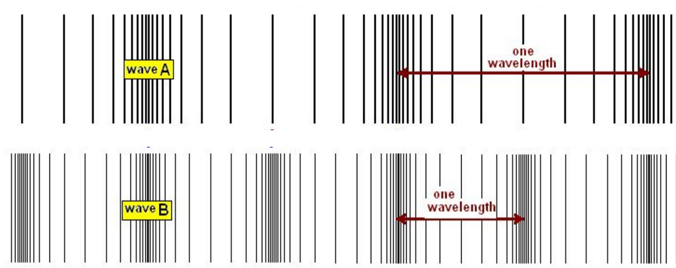
Pitch is a quality of sound that refers to how high or low the sound is. A sports whistle or bird song has a higher pitch than a bass drum. We already know that to make sound there must be a vibration. The speed of vibration relates to the pitch of the sound. The faster the vibration, the higher the pitch. And, conversely, the slower the vibration, the lower the pitch.



***Try this:*** Extend a plastic ruler over the edge of a table so that 8 inches of the ruler extends off the table into the air. Give it a push down with your finger. What do you notice? Now pull back the ruler so only 4 inches extend off the table. Give it a push down with your finger with the same pressure or force you used before. How is the sound different? What do you notice about the vibrations?




*In this model, the high pitched sound has two wavelengths in one second whereas the low pitched sound only one wavelength in one second.. Using a wave representation, pitch is shown by the horizontal (side-to-side) size. High pitched sounds have shorter wavelengths than lower pitched sounds.*
*Image source: Open School BC*




*In this model, the illustrator shows pitch with the distance between lines. Wave A (top) has a longer wavelength and a lower pitch sound than Wave B which has a shorter wavelength and higher pitch sound. Image source: [http://www.docbrown.info/ephysics/wavesound.htm](http://www.docbrown.info/ephysics/wavesound.htm) .*

## 5. Model-to-Explain:

Choose and circle an item: ruler rubber band tuning fork

Use symbols, arrows, labels, colors, and captions to model and explain how you can use that item to make a different pitch or amplitude in the sounds it can make.

## 6. Summarize new learning:

What is amplitude? What is pitch? How is it important or helpful to know about pitch and amplitudes properties of sound?

## 7. Make a Connection:

How does information about *amplitude* and *pitch* help explain or understand how the singer shattered the glass?

# Knock, knock!

## Energy Moves through Matter

**1. Think & Write:** Imagine a teacher is talking to a room full of students. How do you think the sound from their voice is traveling so the students can hear the teacher?

**2. Observe:** Place your ear on your desk. Knock softly on the top of your desk. Now lift your head so there is air between your ear and the table. Knock again with the same amount of force. Repeat using more force.

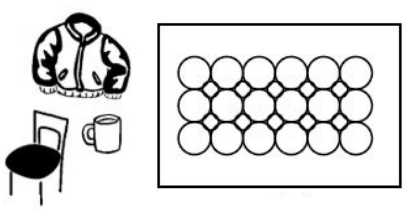
| | **Ear on table** | **Ear in air** |
|---|---|---|
| **Hard knock** on table | Observations: | Observations: |
| **Soft knock** on table | Observations: | Observations: |

## 3. Read to learn about: Matter

Read to learn about the term *matter*. What do you think *matter* or *molecules* could have to do with sound?

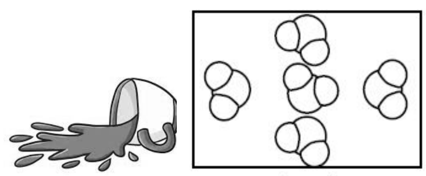
### The "Stuff" in our World: What is matter?

Things in our world take up space and have some weight. We most commonly encounter three forms the stuff, or matter, on Earth: solids, liquids, and gases. A jacket, chair, and cup are all examples of solids. You can't put your hand through a solid. If you had microscope eyes, you would see tiny molecules in solids are packed together tightly. Water, juice, and oil are all examples of liquids. We can move our hands through liquids, like swimming in a pool. Tiny molecules in liquids are not packed as tightly as solids so we can move in between them. Two examples of gases are the air that we breathe and helium in birthday balloons. We can also move through gases. Molecules in gases are not close together. Consider $H_2O$ (water), for example, each molecule is the same; however, depending on how fast they move or how close together they are, we might see the water as a solid ice cube, a liquid puddle, or water vapor going into the air.



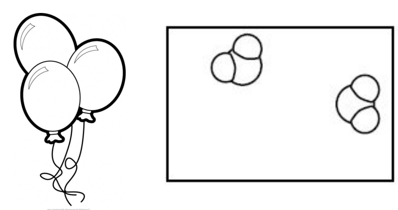
***Solid***

When molecules have less and less energy and slow down enough, they get closer together. Eventually, the molecules connect together to form a solid material.



***Liquid***

Molecules that have some energy but not too much or not too little can move around each other. We see liquid. Liquids can pour and flow and take the shape of the container.



***Gas***

When liquid water gets enough energy like from the hot sun or stove, liquid water can change and move into the air as a gas. Molecules move farther apart and zoom around very quickly.

## 4. Model-to-Explain:

Use symbols, arrows, labels, colors, and captions to model and explain the difference in the knocking sound between listening through the SOLID table compared to the GASEOUS air.

**5. Summarize new learning:**

What are molecules? What is matter? How is it important or helpful to know about molecules or matter to understand how sound travels?

**6. Make a Connection:**

How does information about *molecules* and *matter* help explain or understand how the singer shattered the glass?

# What do we know so far?

**1. Think & Write:** Flip back through your notebook. What is one of your favorite activities or new words you've learned about. Name it and jot a note about why you like it.

**2. Reflect:** What is one thing you know now that you didn't know about, or that much about, before we started studying sound? Elaborate by telling what it is or why it's important.

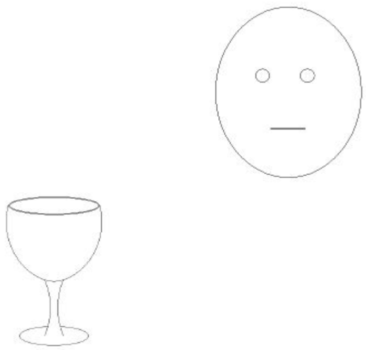
**3. New answers:** Go back to the questions from day 1. Choose one question you can answer fully or partially and jot the question and your answer here.

| Helpful words | |
|---|---|
| sound wave | diaphragm |
| vibration | vocal cords |
| volume | pitch |
| amplitude | molecules |
| force | |

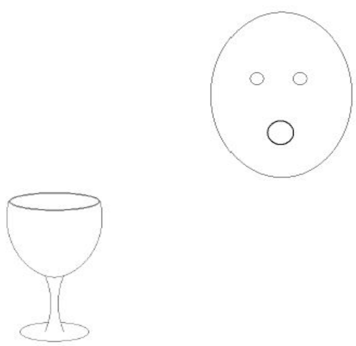
## 4. Now, how do you think the singer was able to break the glass?

Draw and write about what caused the glass to break. Remember models use labels, arrows, zoom-ins, and symbols to communicate your thinking.

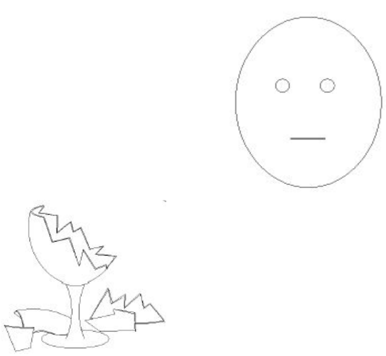
Before sound



During sound



After sound



## Sound Energy Unit Explanation Checklist

Did you show and write about...?

- ❏ How sound travels
  - *Where does sound come from?*
  - *Where does sound go?*
- ❏ How or why distance matters
  - *What happens to sound as it goes farther from the source?*
  - *Why does the singer need to be close to the glass?*
- ❏ Why volume is important
  - *Where does he volume of a sound come from?*
  - *Why does the singer have to be loud?*

# Stop that sound!

**1. Watch & Observe:** Watch the video of a drummer playing a snare drum. Describe the sound in each condition. How does the sound change as more insulation is added to the walls?

**Empty Room**

**Corners added**

**Corners + Ceiling**

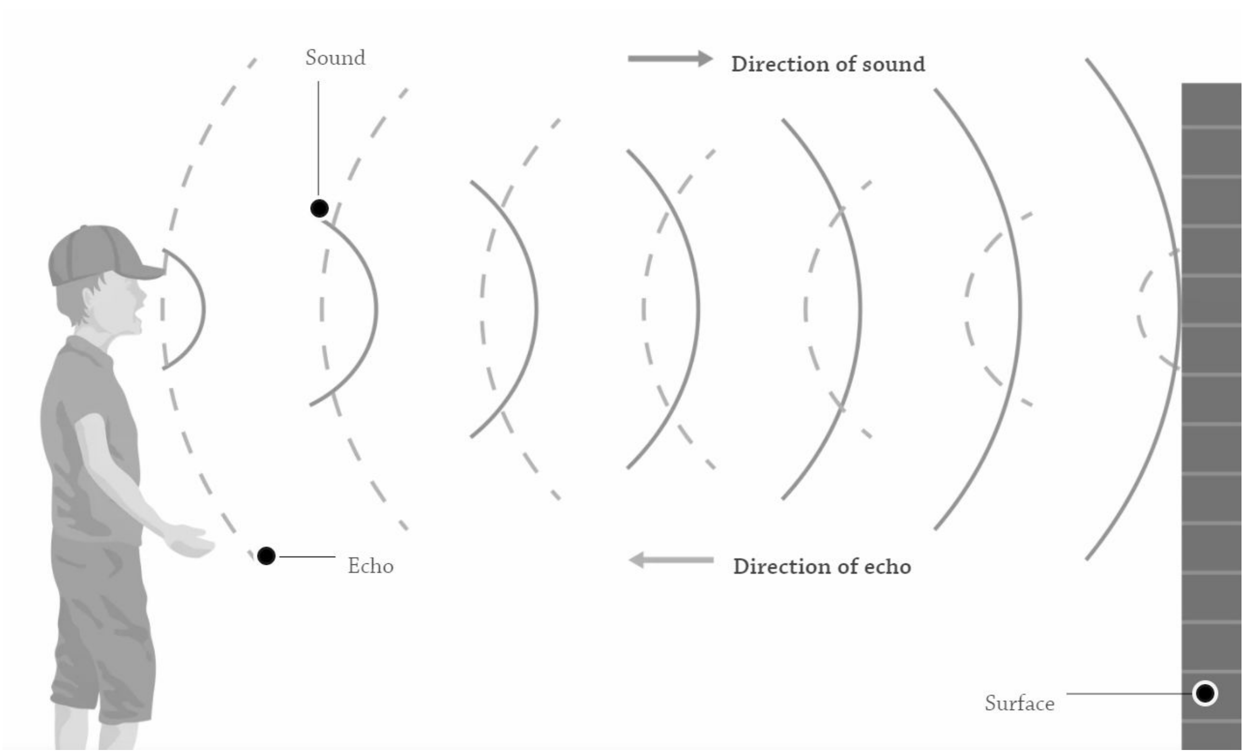
**Corners + Ceiling + walls**

**2. Read about sound:** How does knowing about *echoes* and materials that *absorb* sound help explain the drummer's room?

## Echos: A Reflection of Sound

An echo is a sound that is repeated because the sound waves are reflected back. Sound waves can bounce off smooth, hard objects in the same way as a rubber ball bounces off the ground. Although the direction of the sound changes, the echo sounds the same as the original sound. Echoes can be heard in small spaces with hard walls, like wells, or where there are lots of hard surfaces all around. That is why echoes can be heard in a canyon, cave, or mountain range. But sounds are not always reflected. If they meet a soft surface, such as a cushion, they will be absorbed and will not bounce back.

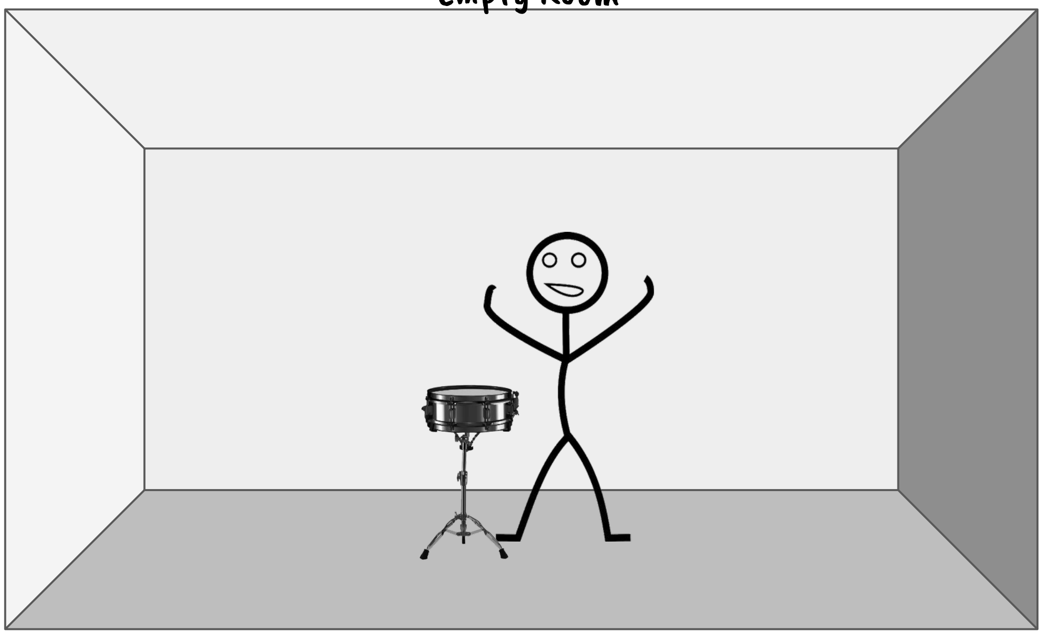
Hard objects reflect sounds, but soft materials absorb sounds and silence them. When sound waves reach a soft material, their energy is soaked up and they cannot travel further. In an echo-free chamber, where sound equipment is tested, all the surfaces are lined with soft foam shapes that absorb sound.



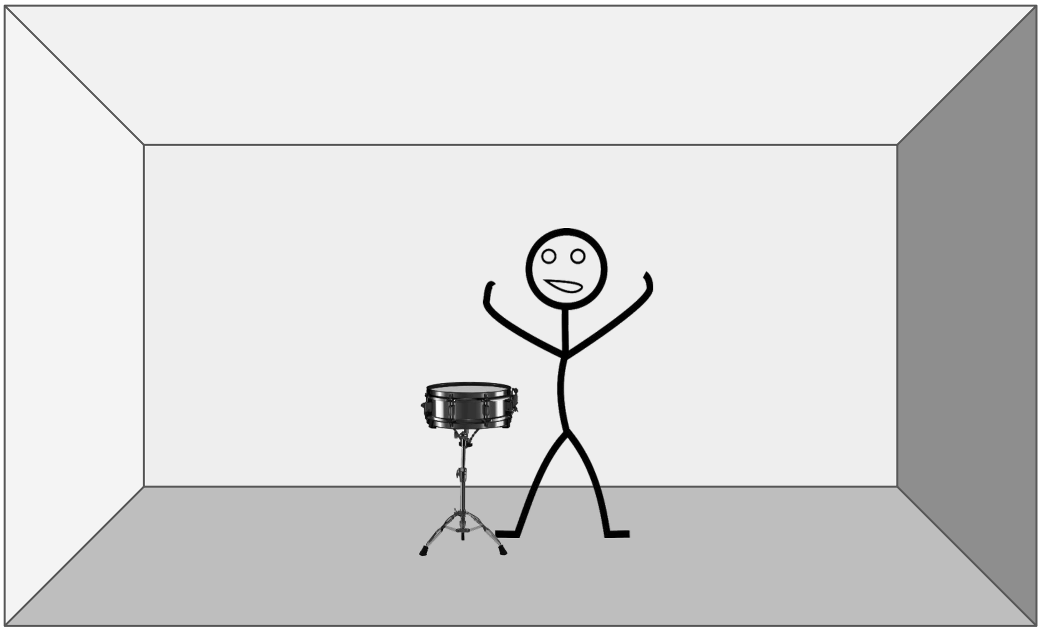
### 3 Model to Explain: Compare the empty room with the most insulated room.

- How does the insulation in different places change the sound? Use what you know about molecules!
- What would the drummer have to do so no one outside the room could hear the drum?
- Do you think he could block or stop all the sound so we could not hear the drum in the room?

**Empty Room**



Corners + Ceiling + walls



# Stop that sound!
# Buzzer Box Challenge

**Challenge!**

Use available materials to make a plan to reduce the sound from a buzzer inside a pencil box.

What materials will you use?

Why do you think those materials will reduce of stop the sound the best?

**Test**: Use a decibel meter to test your buzzer blocker design.
How many decibels did you measure?

**Improve**: What change could you make to improve your design?

**Model-to-explain:** How does your buzzer box design work to block the sound?

# Find the Right Pitch

**1. Think & Write:** Rewatch the beginning of the video of the singer shattering the glass.
*Why do you think the singer flicked the glass?*

**2. Make Observations:** Stretch plastic wrap over a glass bowl. Shake on some salt. Then, hum close to the bowl at different pitches or tones. Do NOT blow, just hum.
*What happens when you hit the 'right pitch'?*

**3. Make Observations:** Observe the teacher or a video of a pair of resonance boxes. Resonance boxes come in pairs with a wooden box base and a tuning fork on top. Both tuning forks are the same size or pitch. *What happens?*

## 4. Summarize new learning:

Can we make something vibrate without touching it? If so, how? What does it mean to find the 'right pitch'?

## 5. Make a Connection:

How does information about finding the *right pitch* or *resonant frequency* help explain or understand how the singer shattered the glass?

# What is sound?

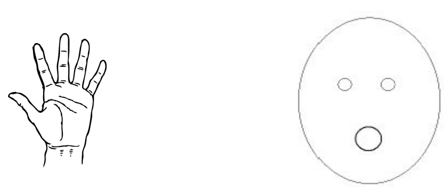
## Comparing energy transfer and moving wind

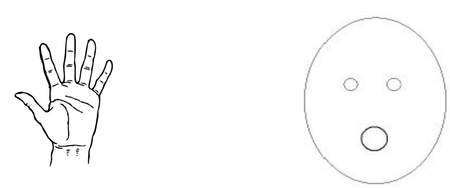
**1. Think & Write:** Think about spraying room freshener spray or perfume where your friend is sitting across the room. *Why can your friend hear the spray sound before they can smell the fragrance?*

**2. Make Observations:** Hold your hand a few inches from your face.

Blow at your hand without making sound. Can you feel air on your hand?

Next, go "Ahhhhhh" making a sound without blowing. Can you feel air on your hand?.





**3. Explain your observations:** How is blowing air different than making sound? How does sound travel through air?

## 4. Make a Connection:

What do you think is making the singer's straw move? Why do you think he has a straw in his glass?

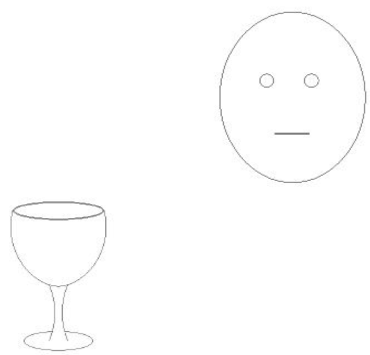
## Now, how do you think the singer was able to break the glass?

Draw and write about what caused the glass to break. Remember models use labels, arrows, zoom-ins, and symbols to communicate your thinking. Use evidence from investigations and readings to justify your explanation.

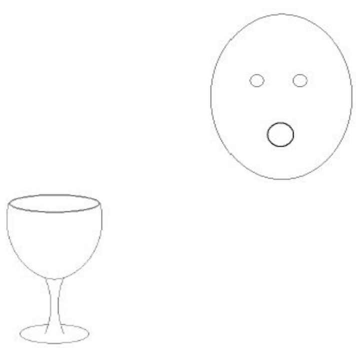
Helpful words

| | |
|---|---|
| sound wave | diaphragm |
| vibration | vocal cords |
| volume | pitch |
| amplitude | molecules |
| force | |

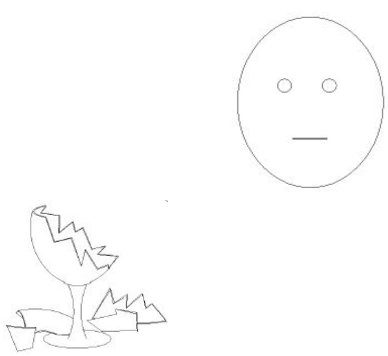
Before sound



During sound



After sound



**Sound Energy Unit Explanation Checklist**

Did you show and write about…?

- ❏ How sound travels
  - *Where does sound come from?*
  - *Where does sound go?*
- ❏ How or why distance matters
  - *What happens to sound as it goes farther from the source?*
  - *Why does the singer need to be close to the glass?*
- ❏ Why volume is important
  - *Where does he volume of a sound come from?*
  - *Why does the singer have to be loud?*

# Summary Table

| **Activity**<br>What did we do? | **Data & Observations**<br>What did we observe? | **New Learning**<br>In general,what did we learn? | **Connections/So, what?**<br>Explain the glass breaking |
|---|---|---|---|
| | | | |
| | | | |

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| | | | |

# Important Words

Word: ____________________

Definition:

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Picture or sketch:

Sentence:

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Word: ____________________

Definition:

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Picture or sketch:

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