Compression Waves

Name: Joe

Lab Partner: Corey Coleman

Science Lab Report • MCS Adolescents • May 30, 2022

INTRODUCTION:

Our current topic of study is the latest thermobaric bomb developed and tested by Russia. According to their press release, it has a similar effect on the ground to that of a small nuclear device, but does not release environmentally harmful radiation. The term thermobaric derives from two Greek words: thermos (hot) and baros (pressure), so we can infer that this device combines pressure and heat to damage its surroundings. This device triggers a small primary explosion that disperses a cloud of highly explosive material. A second detonation then ignites the cloud causing a massive and rapid release of heat that in turn creates a powerful and destructive compression wave. Today we are going to study compression waves by using a model system – sound waves.

PURPOSE:

To answer the following questions:

1. *What is a compression wave?*
2. *How can a compression wave transfer energy?*
3. *How do compression waves travel?*
4. *How do they differ from other types of waves?*

HYPOTHESIS:

What is a compression wave?

I hypothesize that a compression wave is compressed air. An example of compressed air is when a bomb explodes, it moves the air that was once in the place of the explosion outward, the air that is moving hits the air around the bomb that is still, and presses against it.

How does a compression wave transfer energy?

I hypothesize that when the bomb moves the air in the place of it outward the air compacts, and pushes the atoms closer together (atoms are mostly empty space) the atoms repel each other but this force is greater than the force pushing the atoms apart. This gives the air potential energy, once the compressed air hits something it transfers the energy into the thing it hit.

How do compression waves travel?

I hypothesize that the force given from the explosion moves the atoms away, and they begin to build as they go.

How do they differ from other types of waves?

I hypothesize that the compression waves are different from sound waves, and water waves because they atoms are not condensing.

MATERIALS & EQUIPMENT:

- ❑ *Tuning Fork*
- ❑ *Wave Tank*
- ❑ *Drum*
- ❑ *Paperclips*
- ❑ *Metal fork*
- ❑ *Metal Knife*
- ❑ *Balloon*
- ❑ *Pin*

PROCEDURE:

Your lab today consists of five short procedures. For each procedure, answer the following questions:

What do you see? Draw it.
What do you hear?
What do you feel? (get very close)
What is the source of the vibration?
What type of medium is the vibration traveling through?
What direction is it traveling in?

While carrying out each one, note all of your observations in detail, paying careful attention to those things that you think might help you answer the questions in the purpose. Repeat the procedure if necessary.

1. *Gently strike the tuning fork on your knee and place on the surface of the water.*
2. *Place a few paperclips on the drum-head and strike the drum with you hand.*
3. *Strike the tines of the metal form with the knife.*
4. *DO THIS ONE OUTSIDE - Blow up the balloon and tie a knot in it. Pop it with a pin.*
5. *Stretch a rubber band across two thumbtacks pressed into a wooden block roughly 3 inches apart. Pluck the rubber band. Watch carefully.*

DATA TABLES:

Questions	Tuning Fork	Drum & Paper Clip	Fork and Knife	Balloon	Rubber Band Jazz
What did you see?	Small ripples in the water, moving upward but then falling. Small lines move away from where the tongs touch the water.	The paper clip moving up and back down as the drum vibrates.	The tines moving.	The Balloon pop.	The rubber band vibrating the most at the middle but not at all close to the pin.
What did you hear?	When I put the tuning fork up to my ear hear a slight tone. When I put the tongs in my teeth I could hear a tone much louder at the top of my head.	The paper clips rattling on the drum. And the sound of the drum.	Tiny vibrations.	The sound waves and compressed air waves bounced back and forth off different obstacles until they had no force.	A plucking.

Questions	Tuning Fork	Drum & Paper Clip	Fork and Knife	Balloon	Rubber Band Jazz
What did you feel?	I felt a vibration in my ear when I put it in my mouth, I also could feel my ear vibrating when I put it in my mouth.	The drum vibrating.	The fork was also vibrating traveling up the fork but losing the power after the vibration reaches my hand.	The air wave hit my body.	The block vibrating, anything the block touches vibrating.
What is the source of the vibration?	It is the tongs moving back and forth, after they come into contact with my knee.	The animal skin moving up and down.	The vibration is in the tines.	The air escaping from the balloon.	The movement of the rubber band.
What type of medium is the vibration traveling through?	The Metal Tongs.	The animals skin is vibrating and transfer its vibration to the paper clips.	The Metal tines.	The Air.	The pin, the wood the air and anything that the wood is touching.
What direction is the vibration traveling in?	Down from the tongs.	Up and Down.	Down from the tines.	Outward.	Downward into the block.

DATA ANALYSIS AND RESULTS:

In this lab I observed many types of waves created by different sources. I recorded what I saw, what I heard, what I felt, what I thought was causing the vibration, the direction I thought the vibration was traveling and what it was traveling through. Observing these stations allowed me to better understand how waves travel, and how waves are created. It also allowed me to understand the characteristics of different waves. I also learned how they waves will move inside a medium.

In the first station I observed that directly around the tuner fork ripples were being created, this is because the tuner fork was vibrating after being struck, and pushing the water around it back and forth, the water that was being pushed hit the water around it that was still and because it was easier for the water to go through the air than to push the water the water was forced upward and created ripples. The lifted water then came back down under the force of gravity. This is an example of a circular wave, because the particles in the water are moving both back and forth and up and down.

I also noticed what looked like indents in the water around the ripples, which actually indicated the direction the energy in the wave was traveling, because the wave itself does not move but the energy does. And if I were to magnify this process I would see all of the water particles vibrating back and forth from the force of the tuner fork, and up and down from the collision of the particles. When looking at a pure longitudinal wave you can see dense spots that are called compressions and the open spots are called rarefaction's.

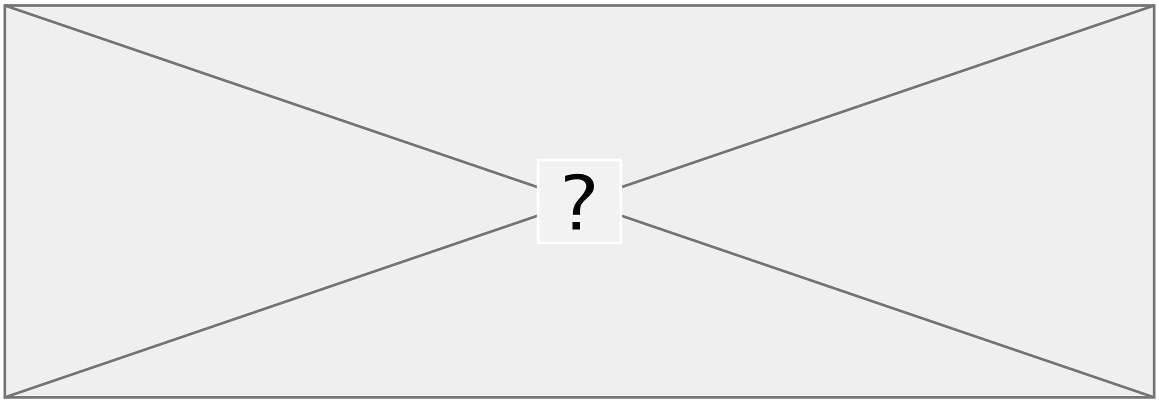
When the tuner fork was vibrating in the air the medium has changed from the water, to the air. So the tuner fork is still vibrating but instead of the water particles vibrating with it, the air particles are vibrating. And this would create a longitudinal wave because the particles in the air are moving back and forth. And every noise we hear is the particles in the medium vibrating and all compression waves make sound.

Also in the first station I found the noise amplified greatly when I put the vibrating tuner fork in between my teeth. This is because the medium that the vibration was traveling through was my head. Also in my observational data I recorded that I felt my ear vibrating when I put the tuner fork in between my teeth. This is because my entire head was vibrating and thus my ear was too.

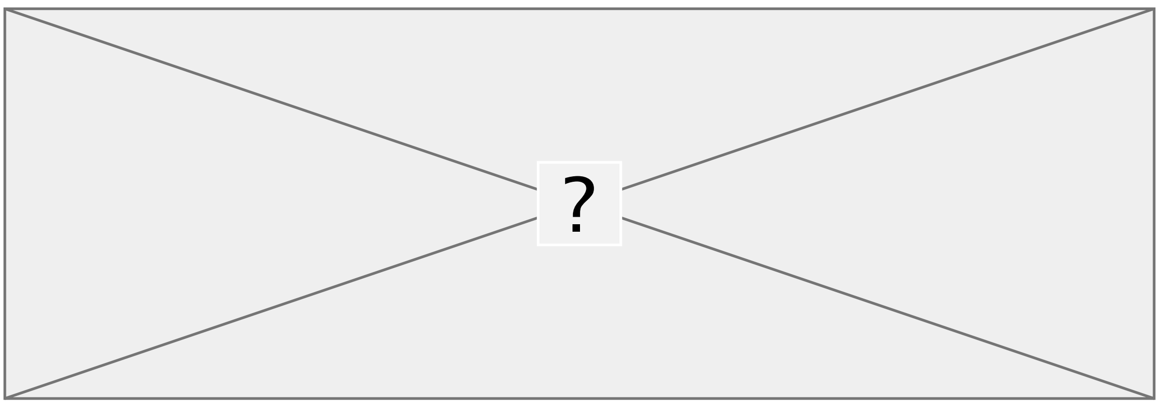
In the second station when I would strike the drum with the paper clips on it and watch it vibrate this is also a longitudinal wave because the drum is vibrating the particles around it back and forth. Creating a longitudinal wave. This vibration is transferring into anything the drum is touching. So the vibration is transferring into the paperclips causing them to rattle on the surface of the drum. All of these waves that are created are longitudinal, some are lower and higher pitch than others but they are all longitudinal waves.

As some extra work I decided to make graphs of waves that have higher and lower pitch, and low volume and high volume:

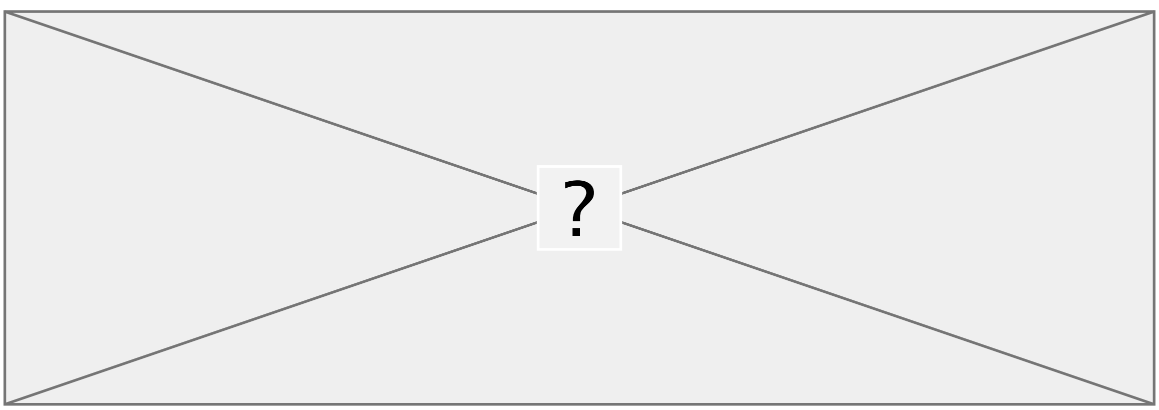
High Pitch, Low Volume:



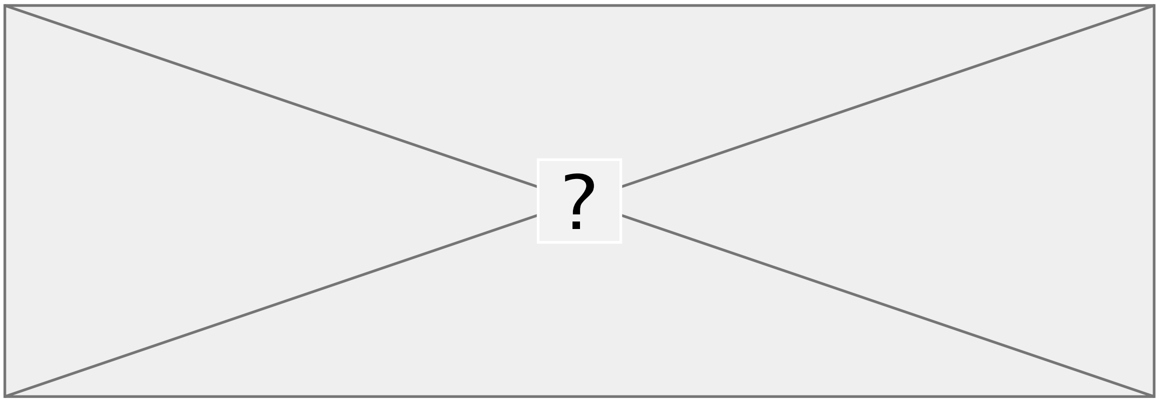
High Pitch, High Volume:



Low Pitch, Low Volume:



Low Pitch, High Volume:



As you can see the low volume waves have a low amplitude and the high volume waves have a higher amplitude, and the high pitch waves have a short wavelength and the low pitch waves have a long wavelength.

If an object is vibrating very fast it will have a high pitch and if it is vibrating many particles it will have a high volume, if you have an object that is vibrating very slow it will have a low pitch and if it is not vibrating many particles it will have a low volume. So in the case of the drum experiment it had a low pitch because it was not vibrating very fast and a higher volume than the paper clips because it was vibrating more particles.

In the third station where I would strike a fork with a knife and watch and listen to the vibrations, this is also an example of a longitudinal wave because when the tines on the fork are stuck by the knife they vibrate back and forth, and because the air particles around them to vibrate back and forth creating a longitudinal wave.

In the fourth station we blew up a balloon with air, as a tendency the air does not want to compress, so it creates tension on the balloon. So inside the balloon the air is compressed, and wants to get out. When we popped the balloon the air was released from the compression and ran into the still air directly around the balloon. This vibrated the particles in the air creating sound, this expansion of the air was large enough for us to feel. This was also an example of a compression wave.

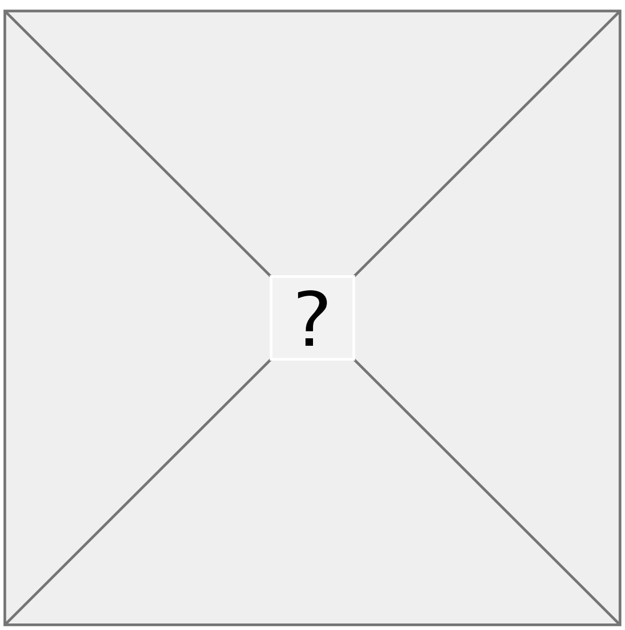
I also recorded that after popping the balloon we heard an echo, I later learned in a lesson that an echo is a reflection of a sound wave.

In the last station where we would pluck a rubber band stretched by two thumb tacks on a piece of wood when we plucked one of the two sides of the rubber band it would vibrate back and forth causing *the air around it to vibrate back and forth. When the rubber band was stretched away from the other side of the rubber band it would be the rarefaction, and when it would come close to the other side of the rubber band this would be the compression. If you were to pluck both of the sides when they came together the particles in the air would be more compressed than if you were plucking one side of the rubber band. And if you were to pluck both sides of the rubber band when they were apart it would be a larger rarefaction than if you were to pluck on of the sides.*

This is because the space between them is smaller and then larger when you pluck them simultaneously. In this lab there was not an example of a transverse wave, a transverse waves are those with vibrations perpendicular to the source of the wave. Note: all waves of any type can undergo the following:

- *Reflection: A change in the direction a wave is traveling from hitting a reflective surface, and the reflected wave will always reflect at the same angle relative to the wall as it hit. And example of a reflected wave is a light wave hitting a wall*
- *Refraction: A change in the direction of a wave due to entering a new medium (the amount of refraction depends on the structure of the new medium and speed of the wave)*
- *Interference: Two waves colliding with each other*
- *Dispersion: A wave splitting up by frequency (such as white light entering a prism)*

This is a diagram I made using a program that gives an example of a wave undergoing reflection and refraction:



The dark blue line indicates the initial wave before it inters the new medium, the light blue indicates the wave after it reflects off the new medium and the red line indicates the refracted wave. The light gray area indicates the initial medium that the wave is traveling through and the dark gray area indicates the new medium. The angle that this particular wave hits the new medium is 45 degrees exactly and the substance that it reflects and refracts off of.

Another obstacle that a wave can undergo is absorption, when a wave hits an object the object can absorb some of the energy of the wave. The remaining energy will be reflected or refracted. The shape of the wave does not matter when dealing with obstacles. In the case of a wave hitting a wall generally the wall will vibrate to give off the extra energy it gained, this will be heat.

One possible source of error may be that the pins in the wood were not three inches apart, or after vibrating the pins it created a hole wider than the pin head and did not transfer the complete vibration to the wood. Another possible source of error could be that I closed my eyes when the balloon popped and did not record my observations as accurately as I could have.

QUESTIONS TO CONSIDER:

In the case of a sound wave traveling through the air, what is being compressed?

Sound is a series of compression waves that move through the air or another object. The sound waves are created by the vibration of particles. Therefore, when a sound wave is traveling through air it is compressing the particles in the air.

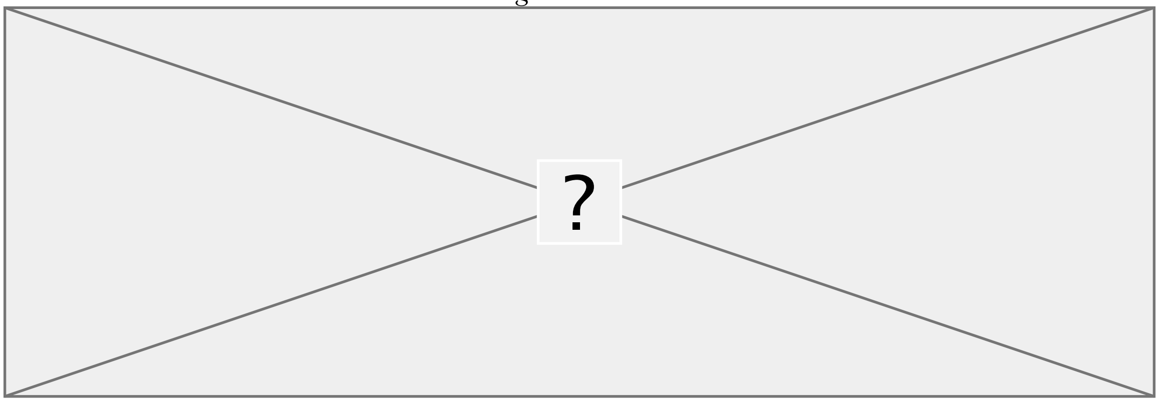
Given your answer to question #1, what would happen to a sound wave in deep space?

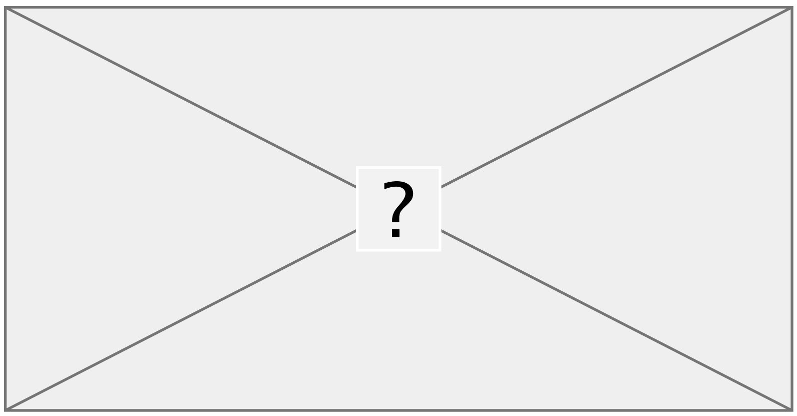
An explosion in space would give force to make a vibration, however because there is no particles in the vacuum of space there would be nothing to vibrate. Thus there would be no sound.

What is the difference between a longitudinal wave and a transverse wave? Give an example of each. Draw a diagram of each labeling the amplitude and wavelength.

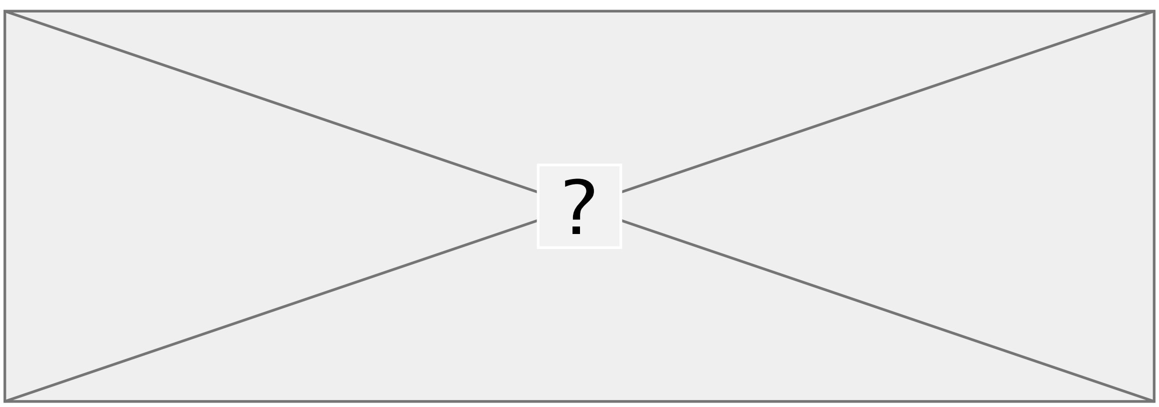
A longitudinal wave (also known as a compression wave) is where the particles move back and forth. The particles don't actually move with the wave, but back in forth in their individual positions. A transverse wave is where the particles move up and down. Much like the longitudinal wave the particles don't actually move with the motion of the wave, but up and down in their individual positions.

Longitudinal Wave





Transverse Wave



Are compression waves longitudinal or transverse? Why?

Compression waves are longitudinal waves because at a certain point in the wave the particles come together and compress, these points in the wave are called compressions. At other points in the wave the particles move apart these points in the wave are called refraction's. The reason that transverse waves do not compress is because if you look at a certain section in a transverse wave all of the particles move up and down simultaneously, thus not getting and closer to each other and not compressing.

Additional Wave Handout Questions Attached

CONCLUSION:

I learned the difference between a Longitudinal Wave and a Transverse Wave. I learned what a mechanical wave is and the characteristics of one. I learned what waves actually were, and what they look like on graphs. I learned that longitudinal and compression waves are the same thing. I learned why they gave that certain kind of wave the name longitudinal and why you can call it a compression wave too. I learned how to label a wave graph. And how to calculate the wavelength of a wave. I learned how waves are destructive and how they transfer energy. I learned how to recognize a longitudinal wave, and a transverse wave. I learned that an echo is actually a sound wave reflecting off of an object or objects.

I learned how prisms split light, and how white light is broken up the way it is when it enters a prism. I learned why an object moves when it is hit by a wave. I learned why you can't hear anything in space. And finally I learned how waves are created and how you hear. This lab did not trigger any additional questions.

The first hypothesis question was partially correct, a compression wave is particles vibrating in a certain way that creates compression areas and rarefaction areas, however a compression wave can be found in other mediums besides air. My second hypothesis question was correct. My hypothesis for the third purpose question was not correct. A compression wave does not travel neither do the particles it encounters, the energy in a compression wave is the only thing that travels, the particles in the medium that the wave is traveling through vibrate back and forth, which transfers the energy.

My hypothesis for the last purpose question was also incorrect, compression waves differ from any other waves because the vibration of the particles in the medium, are different than that of any other wave.

WEB LINKS:

http://www.school-for-champions.com/science/waves.htm

http://www.glenbrook.k12.il.us/gbssci/Phys/Class/waves/u10l1a.html