Full STEAM Ahead: Waves

Version 1

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Full STEAM Ahead!

Welcome to Full STEAM Ahead! Today you will be experimenting with the physics of waves. This is a directed and self-directed, self-paced program, but if you need any help, we are here to assist! For Home School we will be performing experiments on how waves are formed in the world around us and how this is important to the Navy and the world at large. The Navy has one of the largest fleets in the world and needs to know not only how the ships will react but how to use waves to their advantage.

With the idea of testing please keep your sheets with you; this will give you information and writing area for your experiment. We have added a large amount of data which you may not want to read at this time, you can read it once you get home if you so desire. The experiments are at the end of each reading section.

There are three types of waves you will be learning about:

- **Physical Waves**
- **Sound Waves**
- **Ocean Waves**

All students are welcome to participate in all activities, if you need additional material, just ask! Have fun today!

WAVES

WAVES

In physics, a wave is a motion that transfers energy through space or matter. Frequency refers to how quickly energy is being transferred through a given point

Wave motion transfers energy from one point to another, which displace particles of the transmission medium—that is, with little or no associated mass transport.

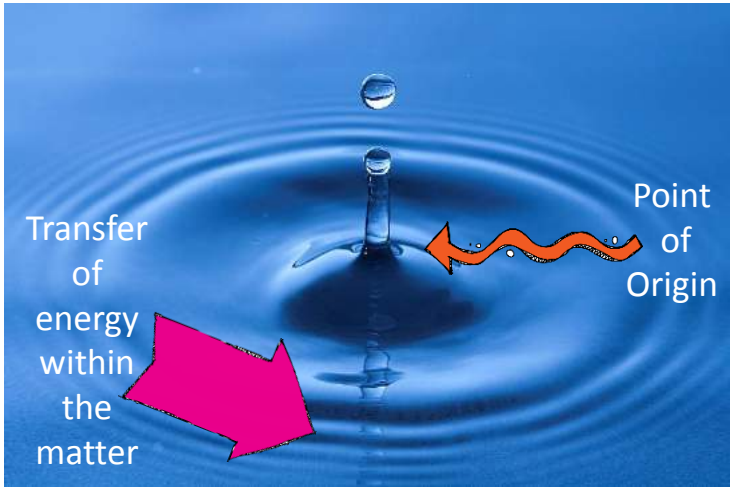


Figure 1: A water drop exerts a force at the point of origin and then transfers the energy through matter by means of physical waves

Wave Theory:

The theory that energy is spread through matter by a wave motion that is transferred to the matter by the molecular vibrations from a point of origin. See figure 1.

Vocabulary *Sound OFF*

Medium: Any substance that a wave moves through.

Physical Waves: Waves that transfer energy through matter.

Wave: a disturbance that transfers energy from one place to another.

Frequency: The rate at which waves pass through a fixed point.

Did You know?!

Particles vibrate at a specific frequency, or natural frequency, in different materials like steel, wood, or glass. Resonance is when objects with the same natural frequency as the vibrating source also begin to vibrate.

INVESTIGATING WAVES:

Investigative question: How can you change the reaction of the medium to the tuning forks waves?

Research: Take a tuning fork and tap the side of the tuning fork with the mallet then hold it close to your ear.

What did you hear? _____

How long did it last? _____

How can you change the sound? _____

In order to see the sound waves you must tap the tuning fork with the mallet then place the fork tip in the water.

What happened when you put the tip of the fork in the water? _____

_____

Hypothesis: If I tap the tuning fork in this way: _____
describe how you will tap it differently

Then I expect the tuning fork to react in this way: _____
describe what you expect to happen because you tapped it differently

_____

Data: Take notes or draw a diagram of what you did to test your hypothesis below

Conclusion: What can you conclude from your investigation? (Summarize what you learned)

_____

_____

_____

_____

_____

_____

_____

_____

PHYSICAL WAVES

Physical Waves

There are two types of physical waves longitudinal and transverse waves.

In a **longitudinal (LAHN-jih-TOOD-n-uhl) wave,** the wave travels in the same direction as the disturbance. A longitudinal wave can be started in a spring by moving it forward and backward. The coils of the spring move forward and bunch up and then move backward and spread out. This forward and backward motion is the disturbance. Longitudinal waves are sometimes called compressional waves because the bunched-up area is known as a compression.

In a transverse wave the direction in which the wave travels is perpendicular, or at right angles, to the direction of the disturbance. Transverse means “across” or “crosswise.

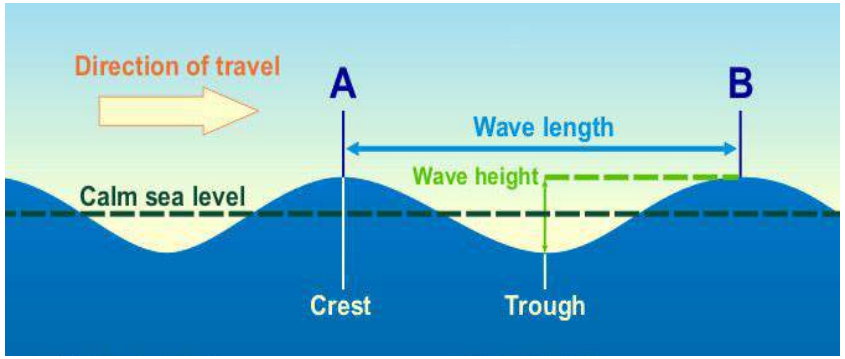


Figure 1: Parts of a physical wave traveling through the sea as the medium.

Parts of a Wave:

Waves have **crests** (the peak of the wave) and **troughs** (the lowest point on the wave). The **wavelength**, or horizontal size of the wave, is determined by the horizontal distance between two crests or two troughs. The vertical size of the wave is determined by the vertical distance between the two and is known as the wave height or **amplitude**. See figure 1.

Vocabulary *Sound OFF*

Longitudinal Waves: the wave travels in the same direction as the disturbance.

Transverse Waves: the direction in which the wave travels is up and down.

Trough: Lowest point of a wave

Peak: Highest point of a wave

Wavelength: Distance between two peaks

Amplitude: Height of the wave

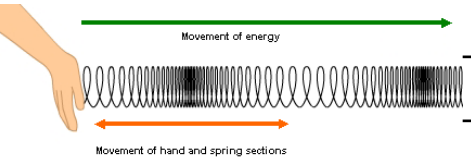
Making a Wave

Directions: *Take the long coil and with a partner and step back to stretch the coil and try to make waves but, don't hit the floor. While going back and forth try different things.*

Can you send and receive waves? YES or NO

How can you change the wave? _____

1. **Hold** the end of the slinky still and have your partner hold and pull the slinky toward them, and then let go of the coils. See figure below. **What did you observe?**



_____

_____

_____

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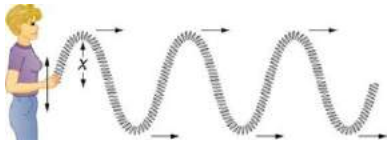
2. **Hold** the end of the slinky still on the table and have your partner move the slinky back and forth very quickly, perpendicular to its stretched length. See figure below **What did you observe?**



_____

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3. **Hold** the end of the slinky still on the table and have your partner constantly change the rate they move it back and forth. **What did you observe?**

_____

_____

_____

_____

SCIENCE CHALLENGE:

Try some of your own experiments with the slinky, what can you discover?

Did You know?!

Standing waves, or stationary waves, occur when waves that move through a medium are reflected back upon themselves. Two waves with the same **frequency**, **wavelength**, and **amplitude** traveling in opposite directions will interfere and produce a standing wave.

SOUND WAVES

Sound Waves

Sound travels in **mechanical waves**. A mechanical wave is a disturbance that moves and transports energy from one place to another through a **medium**. In sound, the disturbance is a vibrating object. And the medium can be any series of interconnected and interactive particles. This means that sound can travel through gases, liquids and solids.

How does Sound Travel?

Imagine a church bell. When a bell rings, it vibrates, which means the bell itself flexes inward and outward very rapidly. As the bell moves outward, it pushes against particles of air. Those air particles then push against other adjacent air particles, and so on. As the bell flexes inward, it pulls against the adjacent air particles, and they, in turn, pull against other air particles. This push and pull pattern is a sound wave. The vibrating bell is the original disturbance, and the air particles are the medium.

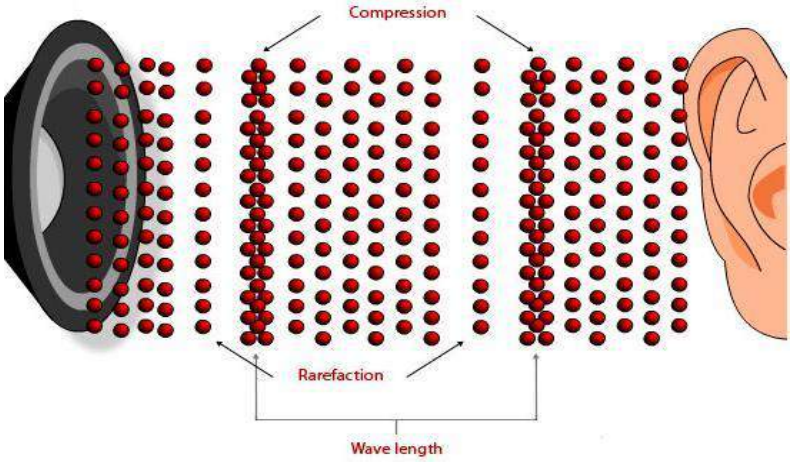


Figure 1: Compression Wave.

Vocabulary *Sound OFF*

Mechanical Waves: a disturbance that moves and transports energy from one place to another through a **medium.**

Compression Waves- Also called mechanical longitudinal waves are called so because they cause atoms to compress and refract as the waves travels through matter. See figure 1.

Compression- When matter becomes slightly more dense with a reduced volume.

Rarefaction- When matter becomes less dense with increased volume.

SOUND WAVES

Sound Waves and Hearing

The outer part of the ear (called the *pinna*) channels sound travelling in the air into the *ear canal*. As Sound reaches the *ear drum* it is transformed into a mechanical vibration.

The eardrum is attached to three hearing bones that transfer the vibration through the middle ear to the inner ear.

The last of these middle ear bones (the *stapes*), is attached to the *oval window*, a thin tissue covering and entry point to the fluid-filled inner ear known as the *cochlea*.

The *cochlea* is a snail-shaped tube that contains hearing cells and fluid. When the oval window vibrates the hearing cells are displaced by the vibrating fluid.

The hearing cells then transfer the sound information to the auditory nerve.

Finally, the auditory nerve transfers sound information to *auditory* regions of the brain so that information can be processed and meaning interpreted.

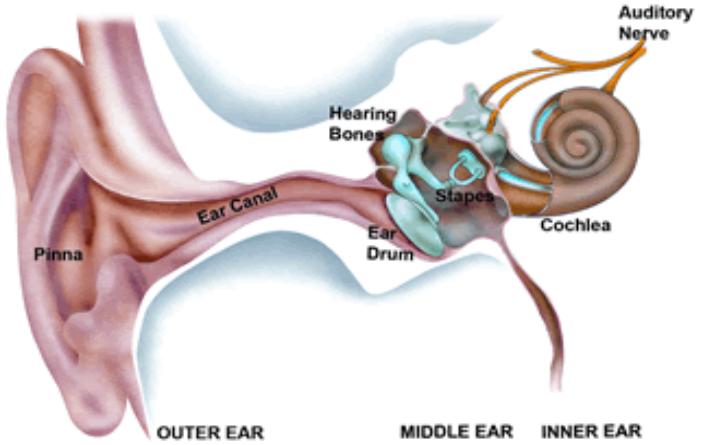
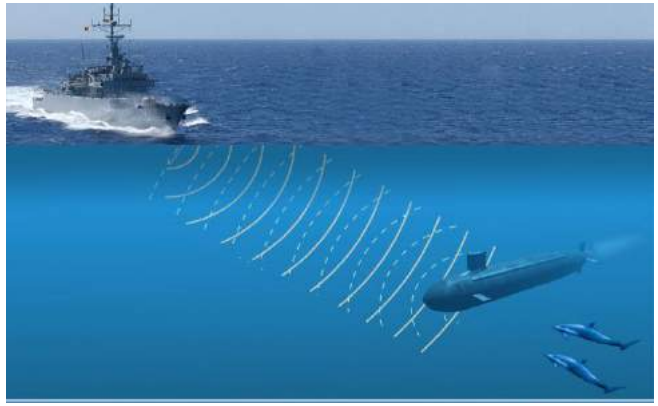


Figure 1: Anatomy of the ear.

NAVY NOTES:

When traveling in a submarine, you do not want the enemy to know your location. Navy Ships survey the ocean floor using SONAR (Sound Navigation and Ranging). Compression waves are sent out from the ship, to navigate and detect other vessels in the water. When a compression waves hits an object it reverses the waves direction and sends SONAR information back to the submarine. See figure below



Experiment:

Part 1: How does a compression wave work?

Place 5 marbles along the groove of a 12 inch ruler. Take a 6th marble and gently flick it against the end of the row of marbles.

What happened?

_____

_____

How does this represent how sound waves travel?

_____

_____

_____

Part 2: How does the material that the sound waves travel through change the sound?

There are three bags that are filed with different materials, one represent a solid, another liquid, and another gas.

Procedure:

1) place the bags on the table.

2) Have one member from your group tap on the desk with his or her hand while the other three students place their ears to one of the bags.

3) You will rotate the bags among your group and take turns tapping on the desk.

4) Allow time for each member of the team to listen for the tapping sound on each bag.

Write your observations about each bag in the box provided:

Observations for Solid:

Observations for Liquid:

Observations for Gas:

Discuss the following with your group:

How did the sound travel through the solid, liquid and gases?

Were you able to hear the sound clearer through the solid, liquid or gas?

Part 3: Does the size of the string matter in the type of sound produced?
Pluck or strum the first material. Now do the next and so on through all four.
What sound did the first instrument you plucked make ? Is it deep, is it vivid, is it sharp, is it flat, did it make a long note or a short?_____

_____

What sound did the second instrument you plucked make ? Is it deep, is it vivid, is it sharp, is it flat, did it make a long note or a short?_____

_____

What sound did the third instrument you plucked make ? Is it deep, is it vivid, is it sharp, is it flat, did it make a long note or a short?_____

_____

What sound did the fourth instrument you plucked make ? Is it deep, is it vivid, is it sharp, is it flat, did it make a long note or a short?_____

_____

What do you think makes the sound different for each string and why does this difference affect the sound it makes?

_____

_____

_____

Part 4 (if there is time):
The Navy has hired your group to teach the new naval recruits how sound waves work and travel. Use the space below to draw detailed diagrams and describe what you would say to the new recruits to help them learn.

WAVES

Ocean Waves and the Coast

The wind creates waves by transferring energy to the water, through the friction between the air and the water molecules. Stronger winds (like storm surges) cause larger waves. Waves of water do not move horizontally, they only move up and down. You can see a demonstration of this by watching a floating buoy bob up and down with a wave.

Waves can vary in size and strength based on wind speed or outside factors such as boats. The small wave trains created by a boat's movement on the water are called **wake**. In addition, undersea earthquakes or other sharp motions in the seafloor can sometimes generate enormous waves, called **tsunamis** (inappropriately known as tidal waves) that can devastate entire coastlines.

Vocabulary *Sound OFF*

Wake small wave trains created by a boat's movement on the water

Tsunamis: a series of waves caused by the displacement of a large volume of water, generally in an ocean.

Fetch: Distance of open water the wind is blown over

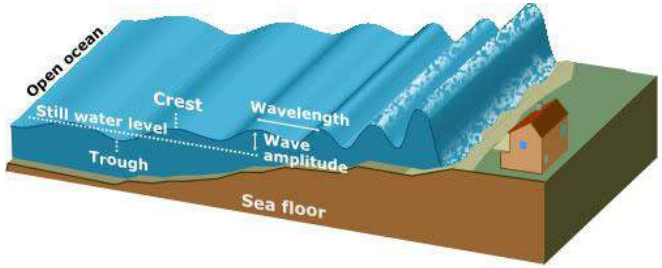


Figure 1: Parts of a Tsunami wave

ANATOMY OF A WAVE

There are three basic factors that make up waves:

-Wind speed

-Length of time the wind has blown

-Distance of open water that the wind blows over; called *fetch*

Waves are measured by:

Height (from trough to crest)

Length (from crest to crest)

Steepness (angle between crest and trough)

Period (length of time between crests)

Did You know?!

Since ocean waves are one of the most powerful natural phenomena on Earth, they have a significant impact on the shape of the Earth's coastlines. Generally, they straighten coastlines. Sometimes though, points composed of rocks that are resistant to erosion extend into the ocean and force waves to bend around them. When this happens different sections of the coastline receive different amounts of energy and are therefore shaped differently by waves.

Experiment:

Now we can make a wave! On the side away from the ship use your hands to make a small wave.

What would happen if the waves were larger than the vessel? _____

_____

What happens at depth when the surface is heavy with waves? _____

_____

Why? _____

Make one ripple (pulse) with a finger, and start another ripple from another place some distance away. Watch the two ripples carefully as they pass through each other.

What happens when one ripple crosses another? Do they upset each other? Are they changed by the encounter?

_____

_____

Now we also need to know how we become closer with waves by becoming the wave ourselves. We have two boards with rope. You and at least two other people need to attach them to your feet and walk keeping the board even.

How hard is it and why? _____

_____

How does this relate to creating an ocean wave?_____

_____

WAVES STATION

PHYSICAL WAVES STATION

SOUND WAVES STATION

OCEAN WAVES STATION