The Energy of Sound

Apr 12-1:04 PM

In this lab, you will perform several activities that will show that the properties and interactions of sound all depend on one thing - the energy carried by sound waves.

Materials:

- 2 tuning forks of same frequency and one of a different frequency
- Pink rubber eraser
- Small plastic cup filled with water
- Rubber Band
- Piece of string 50 cm

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Part A - Sound Vibrations

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Vibration

A vibration is the complete back-and-forth motion of an object

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A **sound wave** is a longitudinal wave caused by vibrations. Sound waves travel through material mediums such as air, water, glass and metal.

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In a **vacuum**, there are no particles to vibrate, so no sound can be made in a vacuum.

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Sounds travels quickly through air, but it travels even faster in liquids and even faster in solids.

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Temperature also affects the speed of sound. The cooler the medium is, the slower the speed of sound.

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1. Lightly strike a tuning fork with the eraser. Slowly place the prongs of the tuning fork in the plastic cup of water. Record your observations.

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1. The water begins to move when the tuning fork is placed in water.

Apr 14-8:39 AM

1. Strike the tuning fork again and slowly place the prongs on the edge of the cup. Record your observations.

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1. You can feel the vibrations when the tuning fork is placed on the edge of the cup.

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2. How do your observations show that sound waves are carried through vibrations?

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2. Vibrations from the tuning fork caused the water's movement.

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Pitch

a measure of how high or low a sound is perceived to be, depending on the frequency of the sound wave

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Frequency

the number of waves produced in a given amount of time

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Frequency is expressed in units of Hertz (Hz) which is equivalent to waves per second.

The pitch of sound becomes higher as the frequency of the sound wave becomes higher.

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Part B - Resonance

Apr 12-1:11 PM

A **standing wave** is a pattern of vibration that simulates a wave that is standing still. The frequencies at which standing waves are made are called **resonant frequencies**.

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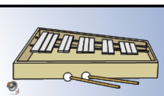

Resonance - happens when an object vibrating at or near a resonant frequency of a second object causes the second object to vibrate.

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3. Strike a tuning fork with the eraser. Quickly pick up a second tuning fork in your other hand and hold it about 30 cm from the first tuning fork. Place the first tuning fork against your leg to stop the vibration. Listen closely to the second tuning fork. Record your observations, as well as the frequencies of the two tuning forks.

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4. Repeat step 3 using the remaining tuning fork as the second tuning fork. Record your observations.

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5. Explain why you can hear a sound from the second tuning fork when the frequencies of the tuning forks used are the same.

Apr 12-1:13 PM

5. The vibrating tuning fork causes the air to vibrate at a certain frequency. The energy of the vibrations is transferred through the air to the second tuning fork, which starts to resonate (vibrate at the same frequency).

Apr 14-8:45 AM

6. When using tuning forks of different frequencies, would you hear a sound from the second tuning fork if you strike the first tuning fork harder? Explain you reasoning.

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6. Hitting the tuning fork harder causes a larger amount of energy to be transferred from the tuning fork to the air. However, the vibration of the air particles is not at the same frequency as the second tuning fork and will therefore not cause the second tuning fork to make a sound.

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http://techtv.mit.edu/collections/physicsdemos/videos/19356-tuning-forks-resonance-beat-frequency

Tuning Forks and Resonance

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Part C - Interference

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Interference happens when two or more waves overlap.

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Constructive Interference- compressions of one wave overlap the compressions of another wave and the sound becomes louder because the amplitude is increased.

Destructive Interference- the compressions of one wave overlap the rarefactions of another wave and the sound becomes softer because the amplitude is decreased.

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7. Using the two tuning forks with the same frequency, place a rubber band tightly over the prongs near the base of one tuning fork. Strike both tuning forks at the same time against the eraser. Hold a tuning fork 3 to 5 cm from each ear. If you cannot hear any differences move the rubber band down further on the prongs. Strike again. Record what you hear.

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8. Did you notice the sound changing back and forth between loud and soft? A steady pattern like this is called a beat frequency. Infer how this changing pattern of loudness and softness is related to interference (both constructive and destructive).

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8. The loudness corresponds to constructive interference (when the compressions of the sound waves overlap, increasing the amplitude), and the softness corresponds to destructive interference (when the compressions and rarefactio of sound waves overlap, decreasing the amplitude).

Apr 14-9:02 AM

Part D - The Doppler Effect

Apr 12-1:15 PM

The **Doppler Effect** is the apparent change in the frequency of a sound caused by the motion of either the listener or the source of the sound.

Apr 12-1:15 PM

Your teacher will tie the piece of string securely to the base of one tuning fork. Your teacher will then strike the tuning fork and carefully swing the tuning fork in a circle overhead. Record your observations.

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9. Did the tuning fork make a different sound when your teacher was swinging it compared to when he or she was holding it? Explain why or why not.

Apr 12-1:15 PM

9. Yes, as the tuning fork swings towards you, the pitch is higher because the sound waves in front of it are closer together and therefore have a higher frequency. As the tuning fork swings away from you, the pitch is lower because the sound waves are farther apart and therefore have a lower frequency.

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10. Is the actual frequency of the tuning fork changing? Explain.

Apr 12-1:16 PM

10. The pitch you hear changes because of the Doppler Effect, but the actual frequency of the tuning forks does not change.

Apr 14-9:18 AM

11. Explain how your observations from each part of this lab show that sound waves carry energy from one point to another through a vibrating medium.

Apr 12-1:16 PM

Part A

The vibrations of the tuning fork have energy that does work on water.

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Part B

The energy from one vibrating tuning fork can be passed by vibrations through the air to cause another tuning fork to vibrate.

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Part C

The energy from each vibrating tuning fork can travel through the air as waves that can interfere with each other.

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Part D

The vibrations from a tuning fork travel through the air to your ears, and the amount of energy being carried by the vibration determines what is heard (higher pitch = higher frequency = higher energy).

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http://www.npr.org/2014/04/09/300563606/what-does-sound-look-like

What does sound look like?

May 12-8:16 AM

12. Particularly loud thunder can cause the windows of a room to rattle. How is this evidence that sound waves carry energy?

Apr 14-9:28 AM

12. It takes energy to move the windows to cause them to rattle. Therefore, energy from the thunder's sound waves must be transferred through the air to the windows

Apr 14-9:30 AM

TUNING FORK SONG

EDCDEEE
DDD
EGG
EDCDEEE
EDDEDC

Apr 12-2:23 PM

May 12-8:23 AM