Introduction to Properties of Waves

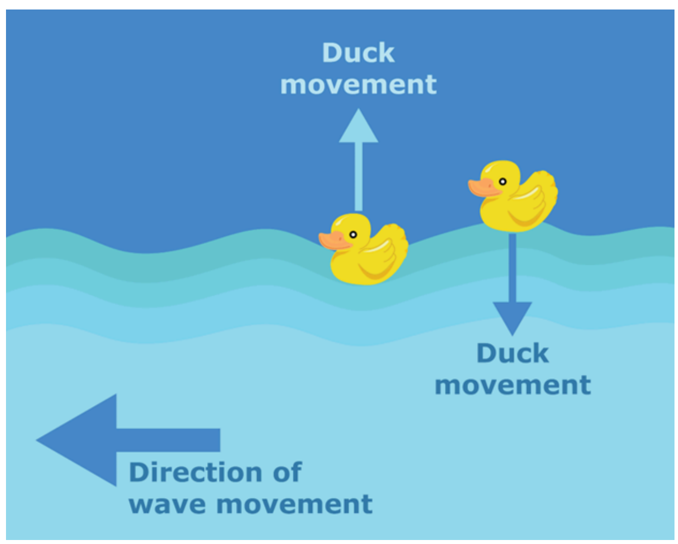
What Do You Think?

Water waves crash onto beaches, earthquakes shake buildings, the Sun's light travels to Earth, and sound waves boom from speakers. Have you ever thought about how this happens? We know that waves carry energy; however, let's think about how that happens.

Water itself does not move toward the beach through ocean waves, but energy is transferred from deeper to shallower water. How is this possible?

Reflect

If you have ever watched a floating toy on the surface of a lake, you may have noticed that the toy does not change position much except to float up and down. However, there is energy in the wave that makes the toy move, and this energy moves horizontally. This is because the energy that makes the duck move is traveling underneath it within a wave, and you see the duck as it rides the wave while the energy passes underneath. Waves transfer energy through matter.



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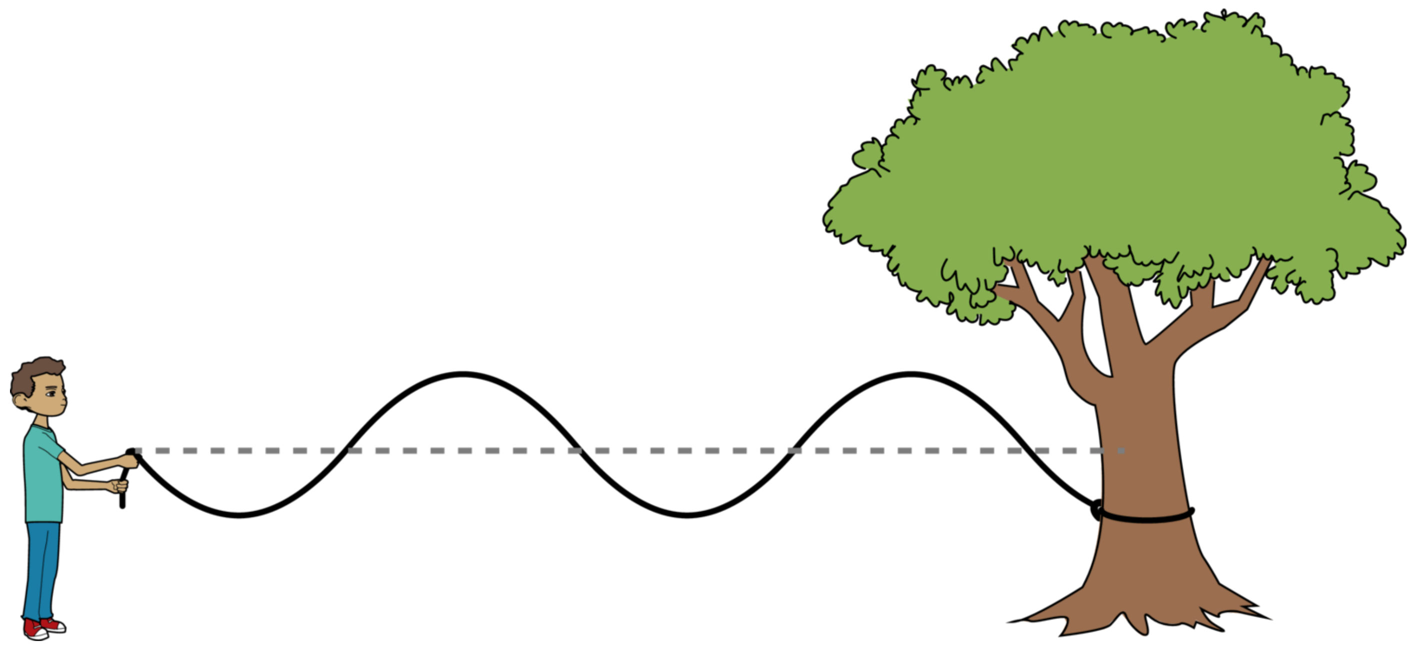
Look Out!

Waves travel through materials as vibrations and transmit energy. Though nearly all waves travel through matter, they never transmit matter. **Waves** are created when a source material sets up wavelike disturbances that spread away from the source of the disturbance. This means that every wave starts somewhere.

Waves are grouped by how they behave. All waves have repeating patterns that give them each a shape and length, which we use to describe wave behavior and therefore categorize waves according to these descriptions. Waves change their behavior as they travel through different types of matter. To apply these wave properties, we must first understand how each wave is measured. Do you see any characteristics in the waving rope below that might help us describe a wave?



Wave behavior is measured by the distance between peaks (wavelength), the size of the peak (amplitude), and the **speed** of the peaks (frequency).

Let's refer to a sound wave to help explain a wave's behavior. A wave's **amplitude** is the height of the wave from the midpoint, called the origin, to the crest. The **crest** of a wave is its highest part. The **trough**, on the other hand, is the lowest part of a wave. Higher-amplitude waves have a higher-pitched sound and more energy than low-amplitude waves.

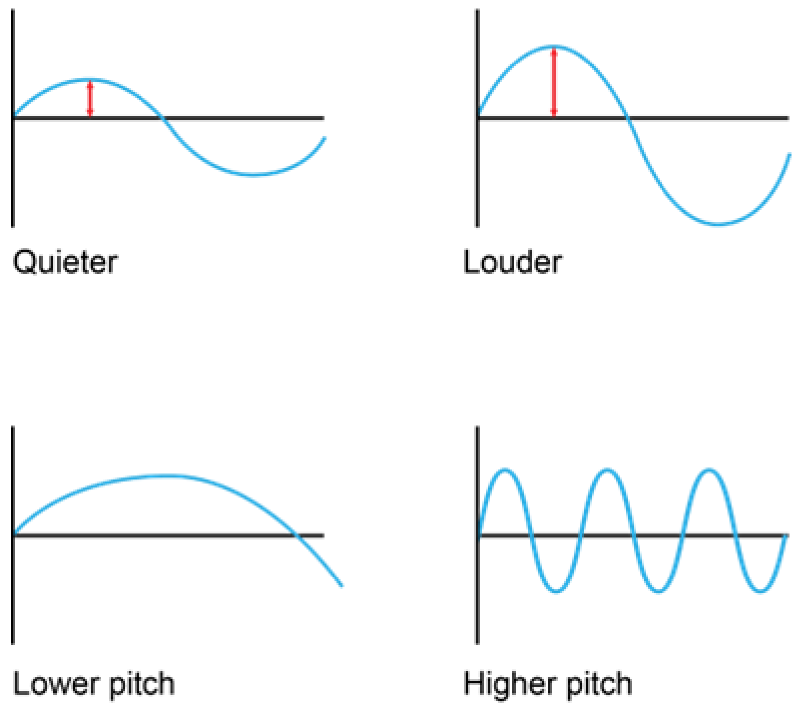
The **frequency** of a wave refers to how many complete wave cycles pass a given point in a set time. The more waves that pass through a certain point, the higher the frequency. The frequency of a sound wave is measured in hertz. For example, if 100 complete waves pass by a given point in one second, the frequency is 100 cycles per second, or 100 hertz (Hz).

Light waves travel much faster than sound waves. This is why you see lightning before you hear thunder during a storm. Both are created within the storm at the same time but take varying amounts of time to reach you if you are not located in the center of the storm. Light travels at 186,000 miles per second, and sound travels only at 1,100 feet per second.

If the amplitude of two waves is the same, the one with the higher frequency carries more energy and has a higher pitch.

Wavelength is the distance between any two corresponding points on a wave, such as crest to crest or trough to trough. The difference in wavelength between waves is how scientists can identify the type of energy the wave is transporting. Wavelength is measured in nanometers, abbreviated nm. Wavelength is related to frequency; the longer the wavelength of a wave, the lower the frequency of the wave. Low-frequency waves are perceived to have a lower pitch.

Comparing Amplitudes in Sound Waves



Reflect

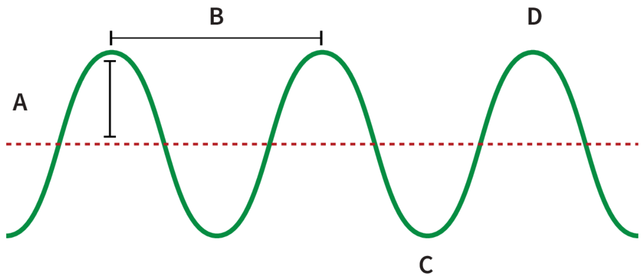
Waves transfer energy through matter. When matter travels through a medium, such as a solid, liquid, or gas, it disturbs it or makes it vibrate. We can describe and compare waves in terms of amplitude, frequency, and wavelength. A wave's amplitude is the height of the wave from the midpoint, called the origin, to the crest. Higher-amplitude waves have a higher-pitched sound and more energy than low-amplitude waves. The frequency of a wave refers to how many complete wave cycles pass a given point in a set time. The more waves that pass through a certain point, the higher the frequency. Wavelength is the distance between any two corresponding points on a wave, such as crest to crest or trough to trough. Wavelength is related to frequency—the longer the wavelength of a wave, the lower the frequency of the wave.

Try Now

1. Fill in the blank.

   Waves transfer energy but not ___________ from one particle or molecule to another.

2. Using this wave diagram, what characteristic is represented by each letter?

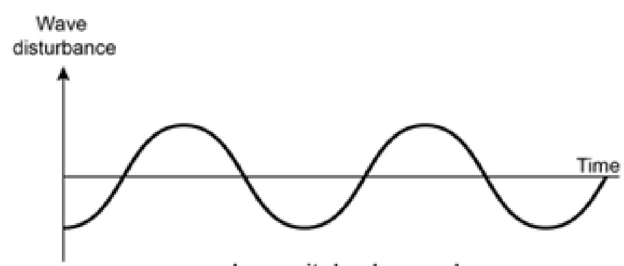


A. ________________________ B. ________________________

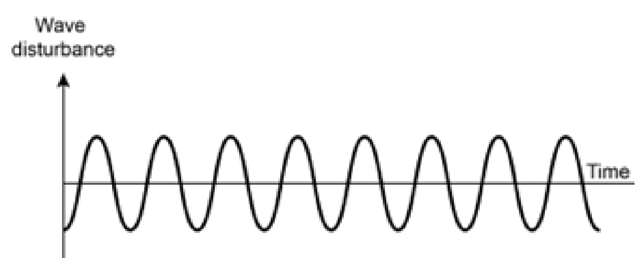
C. ________________________ D. ________________________

3. Look at the following images of high-pitched and low-pitched sound waves.

   How do the frequencies of high-pitched sound waves and low-pitched sound waves compare?
   A. Low-pitched sound waves have a higher frequency and more energy than high-pitched sound waves.
   B. High-pitched sound waves have a higher frequency and more energy than low-pitched waves.
   C. High-pitched sound waves have a higher frequency and less energy than low-pitched waves.
   D. Low-pitched sound waves have a higher frequency and less energy than high-pitched sound waves.



Low-pitched sound

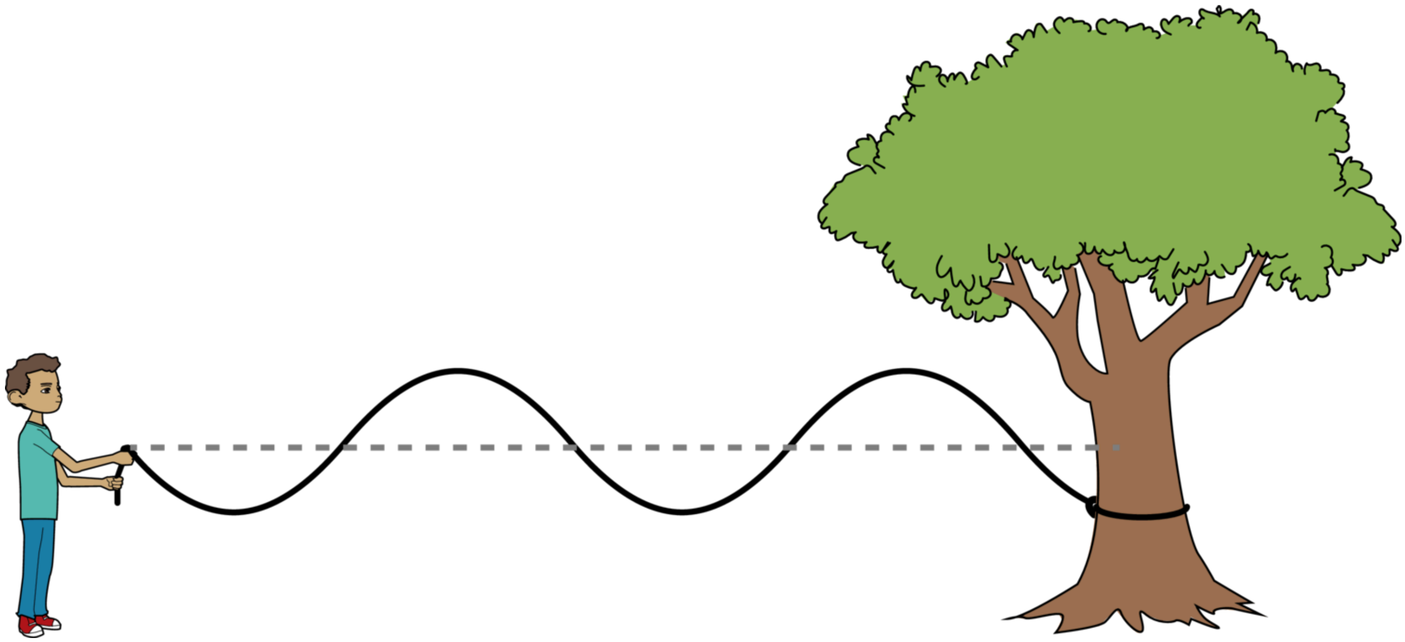


High-pitched sound

Introduction to Properties of Waves

Connecting With Your Child

This activity requires a rope or string and a stationary object like a tree or doorknob. Have students tie the string or rope to the stationary object and move it up and down to create a wave.



The students' task is to vary the movement of their arms to create different waves of amplitude, wavelength, and frequency.

Here are some questions to discuss with students:

What did you have to do to change the amplitude?
I needed to move the rope further up and down.

What did you have to do to change the wavelength and frequency?
I needed to move the rope up and down faster or slower.