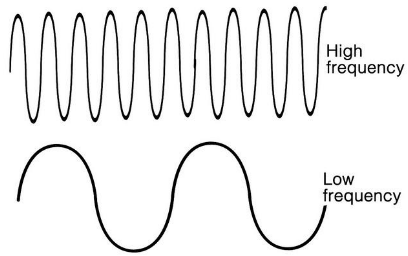
Modeling Waves Through Various Mediums

Reflect

Sound waves require mediums to travel through.
All waves transmit energy, not matter. However, nearly all waves travel through matter. Waves are created when a source (force) creates a vibration. A vibration in a material sets off wavelike disturbances that spread away from the source of the disturbance. This means, of course, that every wave starts somewhere.

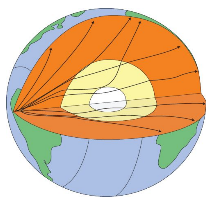


Waves can be compared by the ways that they behave. Waves have a repeating pattern that gives them a shape and length. This pattern has characteristics that allow us to describe wave behavior and therefore categorize waves with our descriptions.

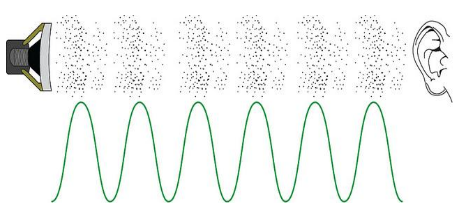
Waves are moving energy. The type of matter that the wave travels through will determine the **frequency** (speed) of the wave. As a source of energy begins the vibration of the wave, the matter around it, is disturbed. Each disturbance passes the disturbance to the matter next to it, and thus energy flows away from the source in a wave. Waves change their behavior as they travel through different types of matter.

Frequency: The rate at which a vibration occurs that constitutes a wave.

When a wave is created in a solid, like in Earth's crust, the matter is already so tightly packed that the energy doesn't have to move very far to travel. More compact matter, which has smaller distances between particle disturbances, allows waves of energy to move more quickly through the matter.



The picture of Earth to the left shows the occurrence of an earthquake and the path that the seismic waves took as they traveled away from the epicenter, or origin, of the earthquake. Since the waves are traveling through a solid, they are traveling quickly. Each of these waves changes its speed due to the changes in the layers of Earth that it travels through. Do you think the waves that travel nearest to the core travel faster or slower than the waves that stay nearer to the crust?



Waves that travel through air are compression waves. The atoms in the air compress together and push away from their source. Because the particles in the air are gas, they have longer distances to travel. The longer distances give the particles more time before they bump into each other, and that is why sound waves are the slowest traveling waves. Look at the picture above. Can you see how the particles are compressed?

Compression: The act of being shortened or squeezed, decreasing its volume.

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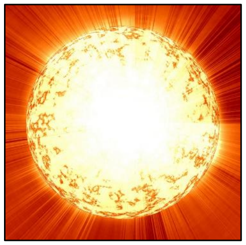
Surface waves are made from the combination of transverse and longitudinal waves (also called compression waves). Waves across water are a good example of a surface wave. Can you see the wave characteristics in the waves made by a water drop in the picture to the left? The disturbance of the water is evidence of the transverse wave traveling through the water.

We also know what directions the longitudinal wave is traveling by examining the frequency we can see made by the droplet. As the longitudinal wave moves the liquid particles away from the source of the wave, the transverse wave moves the liquid at a right angle (up and down) from the longitudinal wave. The energy spreads from particle to particle (horizontally) through the liquid less rapidly than would occur when it travels through a solid.

Look Out!



Many people refer to all waves as being the same. But waves change their behavior as they travel through different mediums. They also change the way the matter that they pass through behaves. Because of the relationship between the wave and the particles it is disturbing, you will find that wave rarefaction, compression, frequency, and amplitude all change as the matter types change from solid to liquid to gas. This is one of the reasons why waves have different names, such as compression, longitudinal, and transverse.

There is also one special type of wave: a light wave. Light waves are a type of transverse wave. They are unique because they do not need mediums (materials) to travel through, and because they have the ability to travel through a vacuum (space). This is how we receive light from the Sun, in waves that do not travel through a medium.

Try Now

Sound waves also travel at different rates as they pass through different mediums. The disturbances the particles transfer in the wave can be felt and heard. You can experience these waves for yourself by creating waves from sounds you make. You will need a friend, a solid door, a swimming pool or bathtub, and a balloon that is filled with air. Choose a material like the solid door, and have your friend stand on one side of the closed door while you stand on the other. You and your friend then take turns tapping the beat of your favorite song while the other presses their ear to the door. Next, go outside and jump into a pool. (Remember to be safe, and always have adult permission and supervision!) Now take turns singing your favorite song under water. Last, blow up a balloon and tie it shut. Take turns with your friend as one of you sings your favorite song and the other one listens through the balloon. Notice the qualities of the sound as the material you are singing through changes, and you will experience the differences in sound waves as they travel through different mediums.



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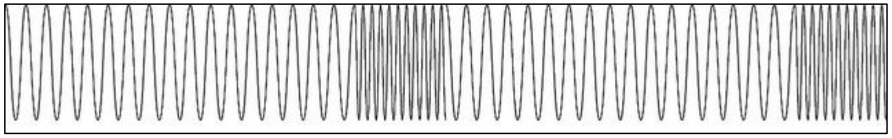
What Do You Think?

What Do You Know?

Imagine that the waveform below has been sent to you for analysis. You have been asked to decide the types of materials that the wave is traveling through. The picture below shows the compression and rarefaction of your wave.

The wave source and terminating point are marked on your diagram. Describe the mediums that this wave may be traveling through. Give your specific reasons why you believe this to be so. What could you tell about the medium(s) by examining just the wave form diagram?



Wave source

Wave terminating point

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Connecting With Your Child

Surface Waves at Home

This activity will help you explore the nature of waves passing through liquids.

The only materials you will need are a toy that floats and a clear container that holds approximately 2–5 gallons of water, as well as a location outside where you don't mind spilled water. You may use any size container; however, the larger the tub, the easier it will be to see the results.

1. Fill the tub about ¾ full. Be careful to not overfill the tub because the larger your waves, the more likely the water is to spill out.
2. Let the water calm to a complete stillness and place the floating toy on top of the water near the middle of the tub. Let the water settle again.
3. Tap the outside of the tub on only one side to initiate the wave.
4. Place your other hand on the opposite side of the tub (parallel) to where you tapped the container and observe the wave properties that you can feel.
5. Observe the floating toy and how it moves in the container as the wave travels through the water.
6. Can you create any other kinds of wave patterns in this experiment? Play around, noting the disturbances you create with each try. What happens to the floating toy each time?

What did you feel with your hand on the opposite side from the wave initiation point? Did the waves propel the floating toy? (The wave will take a few seconds to cross the tub and then the compressions will be felt with your opposite hand. The toy will move up and down on the waves but it will not be propelled across the water.)

Here are some questions to discuss with your child:

- Which forces are creating the waves?
- Why is there a thumping feeling across from where we tapped?
- Why did the toy not go shooting across the water?
- How do waves differ in the water (a liquid) versus in the air?
- How could you apply what you learned in this experiment to how sound waves travel through mediums?

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