

Big Picture

Waves transfer energy between two points in space without transferring any actual matter. For example, when a rock is dropped into a pond, the waves that emanate from the point of impact are transferring the rock's kinetic energy to the edge of the pond. All waves are the result of some sort of vibration. Sound waves result from the macroscopic vibrations of objects, and electromagnetic waves result from the vibrations of electrons in atoms. Similar to simple harmonic motion, the motion of waves can be mathematically modeled by sine and cosine curves.

Key Terms

Note: Some of the terms from the Simple Harmonic Motion study guide are also used in the description of waves. The explanations for period, frequency, and amplitude can be found there.

Mechanical Wave: Needs a medium to travel through.

Transverse Wave: Energy is transferred by particles vibrating perpendicular to the direction the wave is traveling.

Longitudinal Wave: Energy is transferred by particles vibrating in the same direction as the wave's motion.

Interference: When two waves of the same type meet, they combine to create a larger or smaller wave.

Destructive Interference: When two waves meet, if one is at the highest point in its vibration (crest) and another is at its lowest (trough), they cancel each other out so no wave appears at this point.

Constructive Interference: If the waves meet when they are both at their crests, their amplitudes will add together so that there appears to be a very large wave at that point.

Beat Frequency: The difference in frequencies when waves with two different frequencies interfere.

Standing Wave: A wave that stays in a constant position. They are the result of interference between two waves traveling in different directions.

Node: Location of complete destructive interference between the the incident (initial) wave and the reflected wave. The wave does not move at a node.

Antinode: Location of complete constructive interference. The wave will have the greatest displacement at an antinode.

Resonance: When an object is shaken or pushed at a frequency that matches its natural frequency.

Doppler Effect: When there is an apparent change in a wave's frequency due to the relative motion of either the source of the wave or the observer.

Mechanical Waves

Mechanical waves travel through a substance called a medium.

- Examples include sound waves (travel through air), and seismic waves (travel through the ground).
- Mechanical waves cannot transfer energy if there is no medium between the origin of the wave and its destination.
- Speed of a wave depends on the medium.

Two main types of mechanical waves are **transverse waves** and **longitudinal waves**.

Waves on the surface of water are an example of transverse waves. The water molecules move perpendicular to the surface of the water (up and down) to transfer the energy, while the wave itself moves along the surface.



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- **crest** - highest point of the wave
- **trough** - lowest point of the wave
- **amplitude** - distance between the equilibrium position and the crest (or trough)
- **wavelength** - distance between identical positions on two successive waves



Have you ever seen people in a stadium do the wave? The wave travels around the stadium, but the people do not.

We can visualize a longitudinal wave by laying a spring (such as a Slinky) on the ground, stretching it out, then pushing one end of the spring. The compression travels up the spring.

Sound waves are longitudinal mechanical waves that propagate through air. Sound waves are caused by vibrations in objects and exist as differences in pressure. They can be thought of as vibrations in the medium the sound waves are traveling through. The vibrations in air cause our ear drums to vibrate, which our brain interprets as sound. The speed at which sound waves travel depends on the medium which they're passing through. Sound travels fastest through solids, and slowest through gases, but it varies with each substance. Below is a diagram of a sound wave, where the dots represent air molecules.

Longitudinal wave
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Waves Study Guide Principles And Problems 14

Roman Wölfel



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