

## Video 1: Transverse and Longitudinal Waves

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Page #1

- Transverse waves - Oscillation is perpendicular to direction of motion
- Longitudinal waves - Oscillation is parallel to direction of motion
- Waves transfer energy through oscillations
- Mechanical waves require a medium (electromagnetic waves do not)
  - ↳ ocean, sound
  - ↳ light, radio

Examples of longitudinal waves = pressure waves, sound waves

Examples of transverse waves = rope wave, light

\* Transverse waves come in all different directions, so a polarizer only allows a certain direction through

## Video 2: Mechanical and Electromagnetic Waves

Mechanical waves need a medium, electromagnetic waves do not

↳ Explosions on the moon = See the light but don't hear the sound

↓  
electromagnetic

↓  
mechanical

Ocean waves: water is the medium

Sound waves: air molecules are the medium

Seismic waves: ground is the medium

## Video 3: Wave Amplitude

Amplitude - Maximum displacement of oscillations in a wave

↳ Longitudinal waves: measure density of compression

↳ Transverse waves: looks like a sine wave (maximum distance from equilibrium)

Amplitude determines amount of energy (greater amplitude = greater energy)

- Count the number of particles in the densest + least dense areas to find the amplitude of a longitudinal wave

## Video 4 - Wave Energy

Amplitude affects a wave's energy

Amplitude of a sound wave = volume

Frequency of a sound wave = pitch + musical note

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Page #2

## Video 5 - Wave Period and Frequency

Period - Time between oscillations (seconds)

Frequency - Number of oscillations per unit of time  $f = \frac{1}{T}$  ( $\text{Hz} = \text{s}^{-1}$ )

\* Check axes of the graph! (can't find period from a position vs. position graph)

## Video 6 - Wavelength

Wavelength - Distance between waves ( $\lambda$ )

↳ Longitudinal wave - Distance between compressions / rarefactions

↳ Transverse wave - Distance between crests / troughs

\* Measure wavelength in meters \*

## Video 7 - Wave Speed

$$\text{Wave Velocity} = \frac{\text{Wavelength}}{\text{Period}} = \frac{\lambda}{T} = \lambda \cdot f \quad * \text{Waves travel at a constant speed} *$$

Wave speed depends on the medium

Increase tension  $\rightarrow$  increase wave speed (v)

\* Sound moves faster in steel than water than air

## Video 8 - Doppler Effect

Kathleen Boyce  
Page #3

Doppler effect is about how an object that is moving while emitting sound waves sounds like the pitch is changing (pitch of a siren) (water ripples)

↳ Waves in front bunch up, waves behind spread out

\* Waves and their observed frequency change due to motion \*

Source moves towards observer / observer towards source = higher pitch (higher frequency)

Source moves away from observer / observer away from source = lower pitch (lower frequency)

## Video 9 - Wave Superposition

Waves move through each other (don't bounce off)

Waves interfere with each other

↳ Constructive: add amplitudes

↳ Destructive: amplitudes cancel

Standing wave = Superposition of several waves

## Video 10 - Traveling Waves

Traveling waves - Waves that move from one point to another

Ocean waves: Wind speed, wind duration, fetch

Standing waves - Appear to stand still but are actually moving

↳ Appear to stand still because of interference and reflection

\* Standing waves are made up of traveling waves interfering with each other

One dimension and two dimension wave interference

## Video #11 - Standing Waves

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Page #4

Standing waves - Waves that appear to stand still

↳ Made up of traveling waves with reflection + interference

Nodes - Areas that aren't moving (<sup>total</sup>destructive interference)

Antinodes - Areas that move the most (<sup>total</sup>constructive interference)

String instruments: Fixed at both ends

Tube: Open or closed

} Standing wave instruments

\* Sweet spot on a bat is on a node (very little vibration) → hitting on an antinode causes the buzz

↳ Bat and ball are in contact for a short amount of time → large force

Fixed on both ends: wave ends on nodes on both sides (string instrument)

One open end: one node, one antinode (tuba)

Two open ends: two antinodes (flute)

Ruben's tube - Sound is a longitudinal wave (high density vs. low density) and the areas of high pressure push the flammable gas out → looks like a transverse wave

## Video #12 - Harmonics

Harmonics - Integers of the fundamental frequency

Wavelength of a standing wave is determined by the boundary (L) and the frequency

Fundamental frequency - Frequency of the simplest possible standing wave = 1<sup>st</sup> harmonic

↳ Closed at both ends = half a wavelength is the fundamental frequency  $\lambda = 2L$

2<sup>nd</sup> harmonic:  $\lambda_2 = L$       3<sup>rd</sup> harmonic  $\lambda_3 = \frac{2}{3}L$



## Video 13 - Beats

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Page #5

Beats - Changes in amplitude when there are two waves with similar frequencies

\* Changing the tension will change the wave velocity and since the wavelength stays the same, the frequency will change

Waves with similar frequencies  $\rightarrow$  beats (amplitude changes) = change in volume

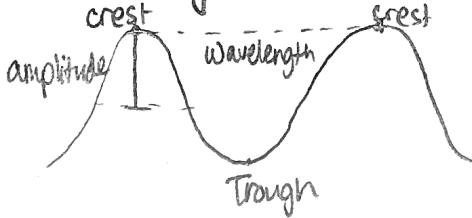
$$\text{Beat frequency} = |f_1 - f_2|$$

## Video 14 - Mechanical Waves Review

Wave: Disturbance of a medium which transfers energy

- Transverse: Disturbance of the medium is perpendicular to wave propagation
- Longitudinal: Disturbance is parallel to wave propagation

\* Electromagnetic waves don't require a medium  $\rightarrow$  always transverse waves



Longitudinal wave: density on the y-axis

- Compression: high density
- Rarefaction: low density

$$V = \frac{\Delta x}{\Delta t} = \frac{\lambda}{T} \quad V = f\lambda$$

A wave is not a physical object so two waves can occupy the same space

Constructive interference: add amplitudes      Destructive interference: subtract amplitudes

Nodes: Don't move

Antinodes: Maximum movement

$$1^{\text{st}} \text{ harmonic: } \frac{1}{2}\lambda = L \quad f = \frac{V}{\lambda} = \frac{V}{2L} \quad (\text{two fixed ends})$$

Equation for closed-closed is the same as open-open

$$\text{Open-closed: 1 node + 1 antinode} \quad \frac{1}{4}\lambda = L \quad \text{so} \quad \lambda = 4L \quad f = \frac{V}{4L}$$

$$\text{Beat frequency} = |f_1 - f_2|$$

Doppler Effect: Waves in front are closer (smaller  $\lambda$ , larger  $f$ , higher pitch) = going towards  
Waves behind are farther apart (larger  $\lambda$ , smaller  $f$ , lower pitch) = going away