Section 2: Characteristics of Waves

Preview

- Key Ideas
- Bellringer
- Wave Properties
- Wave Speed
- Math Skills
- The Doppler Effect

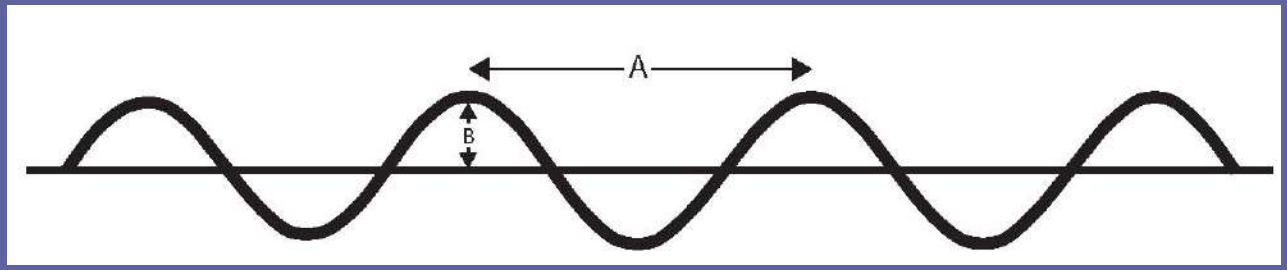
Key Ideas

- What are some ways to measure and compare waves?
- How can you calculate the speed of a wave?
- Why does the pitch of an ambulance siren change as the ambulance rushes past you?

Bellringer

In the diagram, A is the distance from a point on one wave to an identical point on the next wave. What might this distance be called?

- In the diagram, B is the *amplitude* of a wave. What do you think this is a measure of?
- Twenty waves pass by a point in a certain amount of time. Would this be a measure of a wave's speed or frequency?



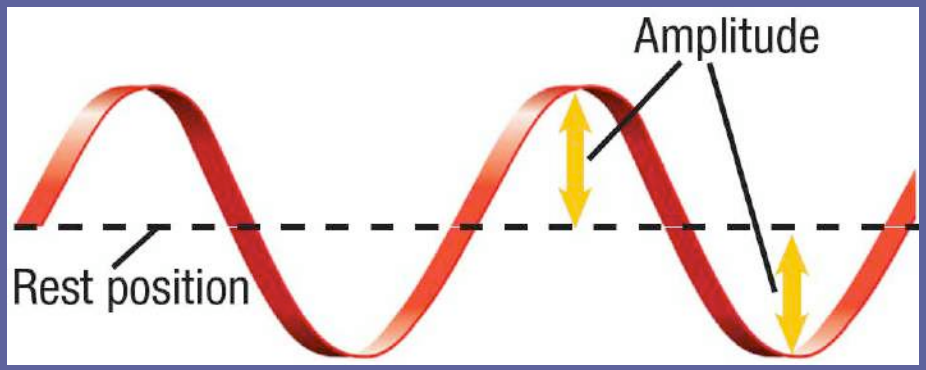
Wave Properties

- What are some ways to measure and compare waves?

- Amplitude and wavelength are measurements of distance. Period and frequency are measurements based on time.

Wave Properties, *continued*

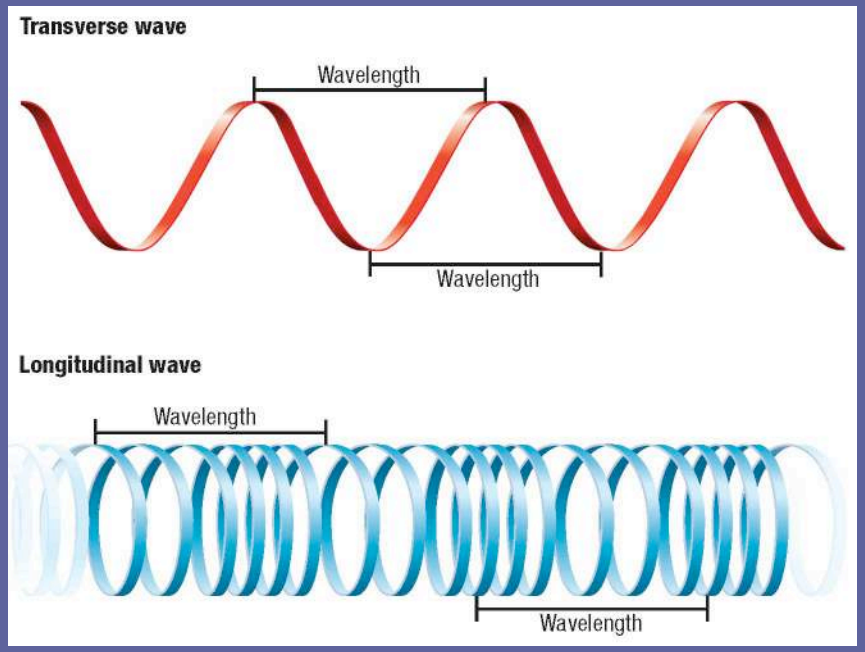
- Amplitude measures the amount of particle vibration.
  - **amplitude:** the maximum distance that the particles of a wave's medium vibrate from their rest position
  - for a transverse wave, measured from the rest position to the crest or the trough
  - expressed in the SI unit meters (m)



Wave Properties, *continued*

- Wavelength is the distance between two equivalent parts of a wave.

wavelength: the distance from any point on a wave to an identical point on the next wave
for a transverse wave, measured from crest to crest or trough to trough
represented by the symbol λ
expressed in the SI unit meters (m)



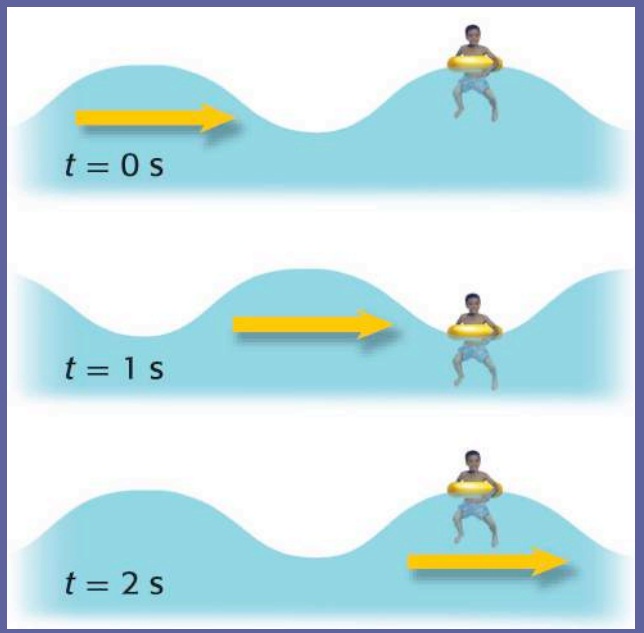
Wave Properties, *continued*

- Amplitude and wavelength tell you about energy.
  - larger amplitude = more energy
  - shorter wavelength = more energy

Wave Properties, *continued*

- The period is a measurement of the time it takes for a wave to pass a given point.

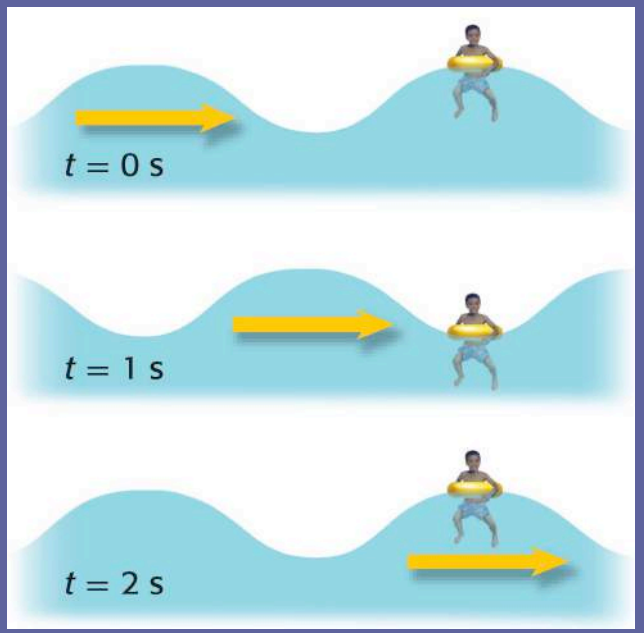
- **period:** in physics, the time that it takes a complete cycle or wave oscillation to occur
represented by the symbol T
expressed in the SI unit seconds (s)
in the diagram, $T = 2$ s



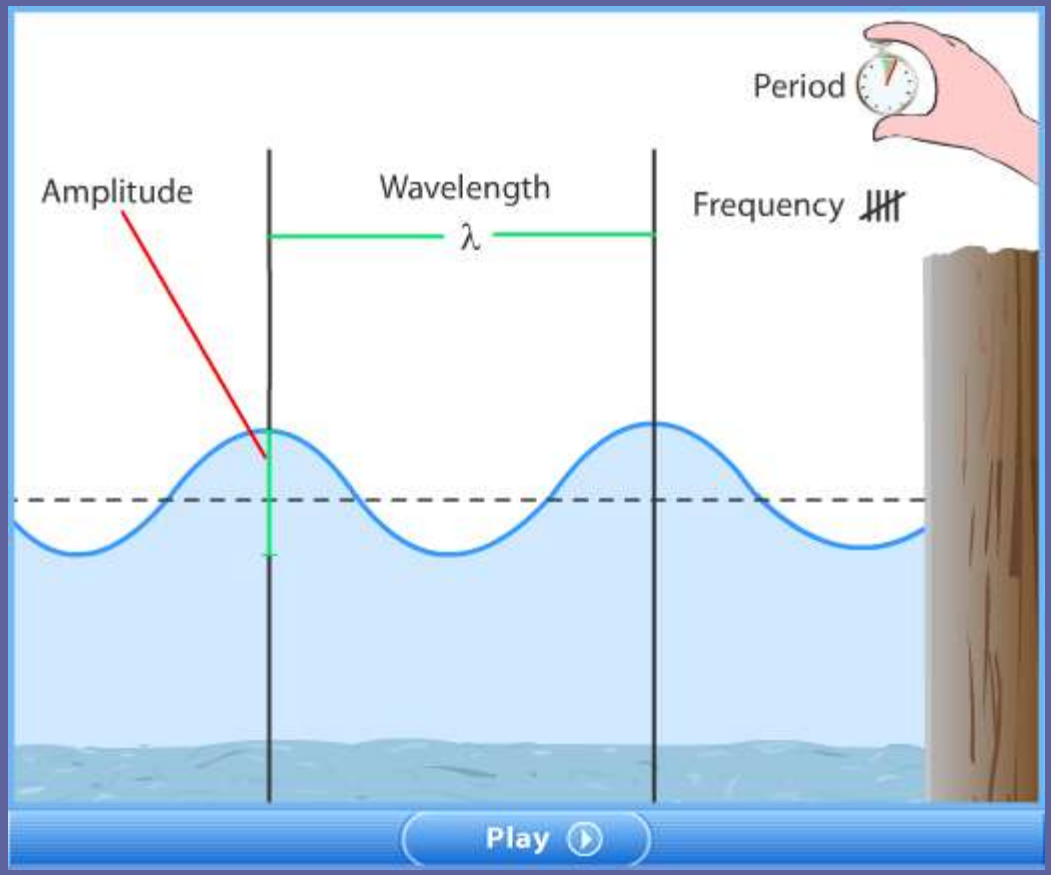
Wave Properties, *continued*

- Frequency is a measurement of the vibration rate.

- **frequency:** the number of cycles or vibrations per unit of time; also the number of waves produced in a given amount of time
represented by the symbol f
expressed in the SI unit hertz (Hz), which equals 1/s
in the diagram, $f = 0.5$ Hz



Visual Concept: Characteristics of a Wave



Wave Properties, *continued*

- The frequency and period of a wave are related.
  - The frequency is the inverse of the period.

$$\text{frequency} = \frac{1}{\text{period}}, \text{ or } f = 1/T$$

Wave Speed

- How can you calculate the speed of a wave?

- The speed of a wave is equal to wavelength divided by period, or to frequency multiplied by wavelength.

Wave Speed, *continued*

- Wave speed equals wavelength divided by period.

  speed = distance/time

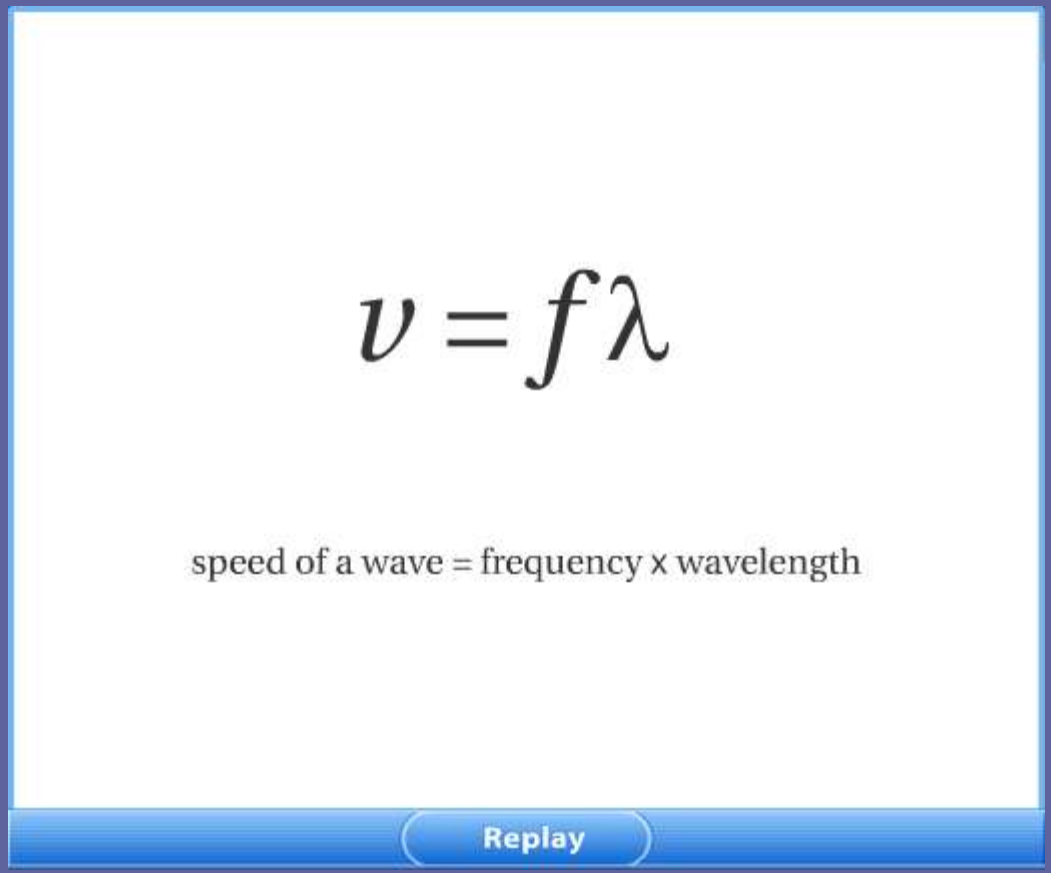
  wave speed = wavelength/period, or v=

- Wave speed equals frequency times wavelength.

$$\text{frequency} = \frac{1}{T}$$

wave speed = frequency × wavelength, or $v = f \times l$

Visual Concept: Equation for the Speed of a Wave



Math Skills

Wave Speed

The string of a piano that produces the note middle C vibrates with a frequency of 262 Hz. If the sound waves produced by this string have a wavelength in air of 1.30 m, what is the speed of the sound waves?

- **List the given and unknown values.**

Given: *frequency,* f = 262 Hz

wavelength, λ = 1.30 m

Unknown: *wave speed,* v = ? m/s

Math Skills, *continued*

- **Write the equation for wave speed.**

$v = f \times \lambda$

- **Insert the known values into the equation, and solve.**

$v = 262\ \text{Hz} \times 1.30\ \text{m}$

$v = 341\ \text{m/s}$

Wave Speed, *continued*

- The speed of a wave depends on the medium.
  - In general, wave speed is greatest in solids and least in gases.
  - In a given medium, the speed of waves is constant.

- Kinetic theory explains differences in wave speed.

- Light has a finite speed.
  - the speed of light (c) = 3.00×10^8 m/s
  - for electromagnetic waves, $c = f \times \lambda$

The Doppler Effect

- Why does the pitch of an ambulance siren change as the ambulance rushes past you?

- Motion between the source of waves and the observer creates a change in observed frequency.

The Doppler Effect, *continued*

- Pitch is determined by the frequency of sound waves.
  - The *pitch* of a sound (how high or low it is) is determined by the frequency at which sound waves strike the eardrum in your ear.
  - A higher-pitched sound is caused by sound waves of higher frequency.

The Doppler Effect, *continued*

- Frequency changes when the source of waves is moving.
  - **Doppler effect:** an observed change in the frequency of a wave when the source or observer is moving
  - The Doppler effect occurs for many types of waves, including sound waves and light waves.

Visual Concept: Doppler Effect and Sound