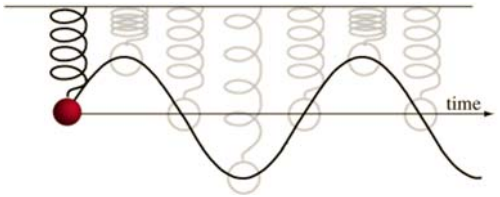
Periodic Motion

- Periodic Motion – motions that repeat on a regular cycle
  - Metal block on a spring
  - Pendulum
  - Guitar string



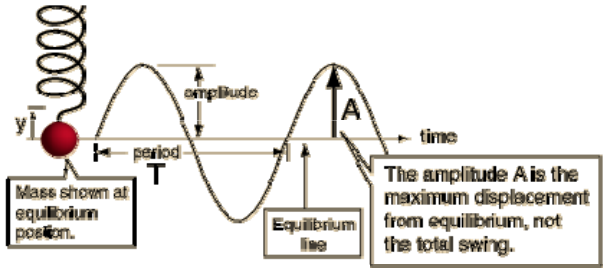
1

Periodic Motion Terms

- **Period (T)** – time needed for object to complete one whole cycle of motion
- **Equilibrium position** – resting position where net force is 0
- **Amplitude** – maximum distance object moves from equilibrium position

2

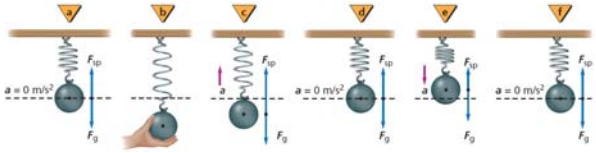
Parts of Simple Harmonic Motion



3

Simple Harmonic Motion

Periodic motion where force that restores object to equilibrium position is proportional to the object displacement

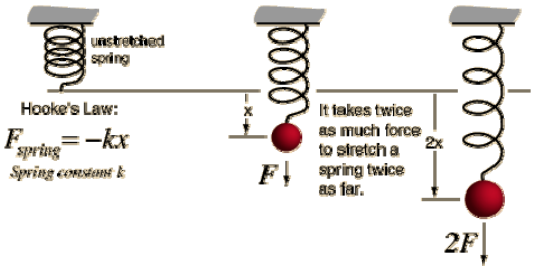


4

Hooke's Law

$F = -kx$

F = force (N)
k = spring constant (N/m)
x = displacement (m)

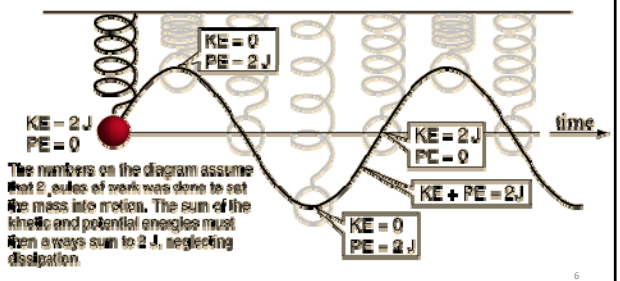


5

Potential Energy in a Spring

$PE_{sp} = ½kx^2$

k = spring constant x = displacement

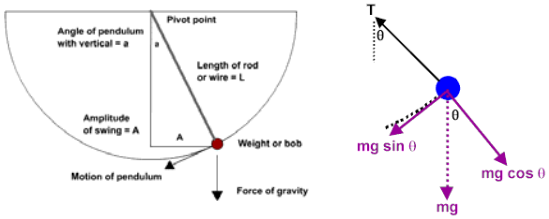


6

Pendulum Period

$$T = 2\pi\sqrt{\frac{l}{g}}$$

T = period
l = length
g = gravity acceleration



Wave Basics

- **Speed (v)** – how fast a wave moves
- **Pulse** – bump or disturbance that travels through a wave
- **Phase**– two points on a wave that are one or more exact wavelengths apart. Two points can be anywhere form 0° to 180° out of phase

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Wave Basics

- **Wavelength (λ)** – the shortest length of a wave pattern that begins to repeat itself
- **Frequency (f)** – The number of oscillations per second (In Chemistry the symbol was "υ")

$$f = \frac{1}{T} \qquad v = \lambda f$$

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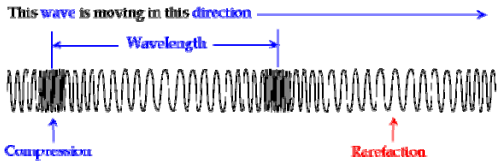
Longitudinal Wave



Vibrations are along or parallel to the direction of energy transfer

Fluids usually only transmit longitudinal waves

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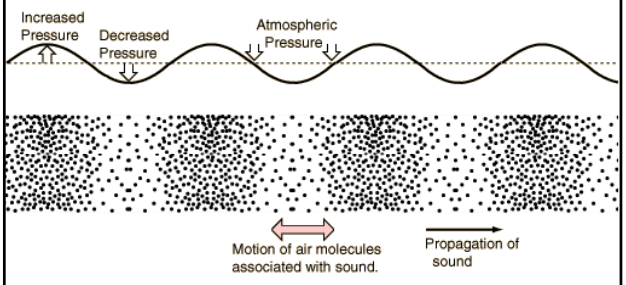
Longitudinal Wave



Sound is a longitudinal wave in air

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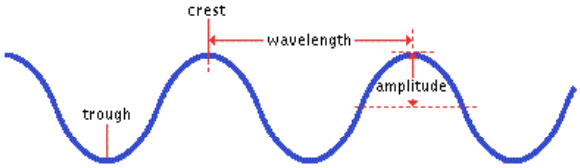
Transverse Wave



Oscillations are perpendicular to the direction of energy transfer

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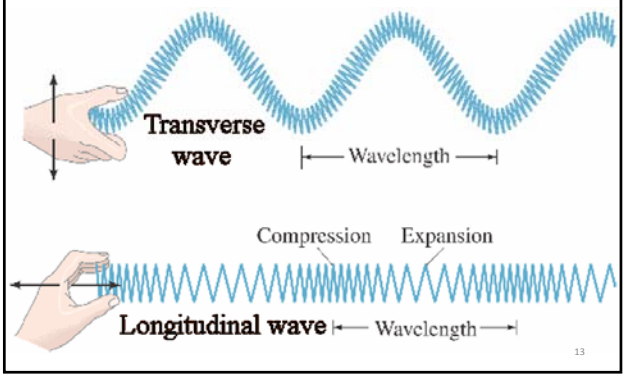
How Disturbances Make Waves



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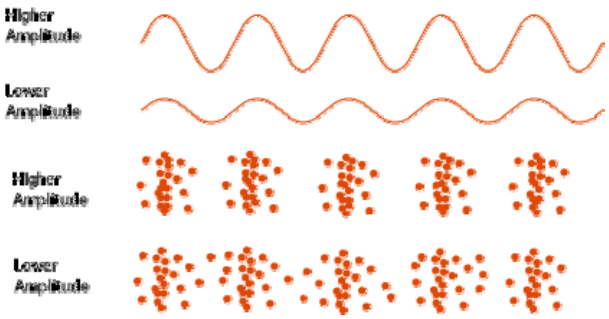
Comparing Amplitude



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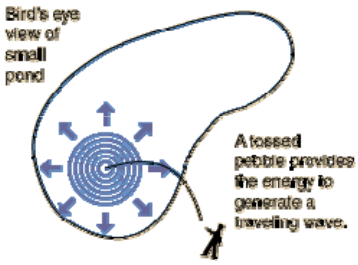
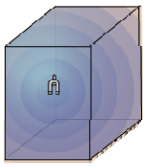
Waves Generation in Multiple Directions





Sound travels in all directions

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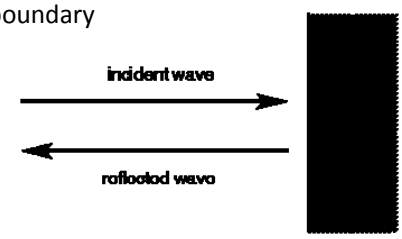
Wave Boundary Behavior

- **Incident Wave** – Wave that strikes a boundary
- **Reflected Wave** – returning wave from boundary



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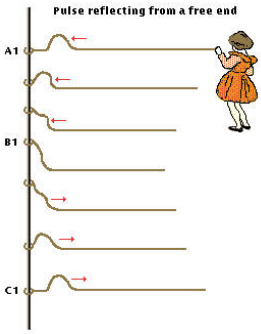
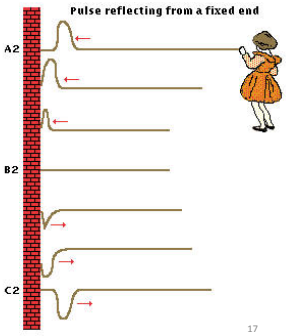
Boundary Behavior

Soft Boundary



Hard Boundary



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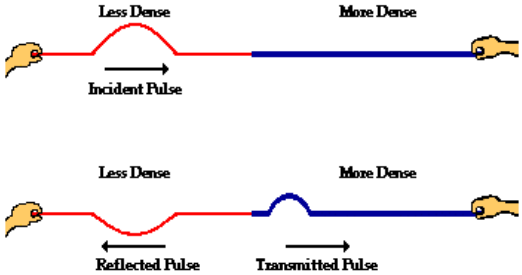
Wave from Low Density to High Density

A wave traveling from a less dense to a more dense medium…

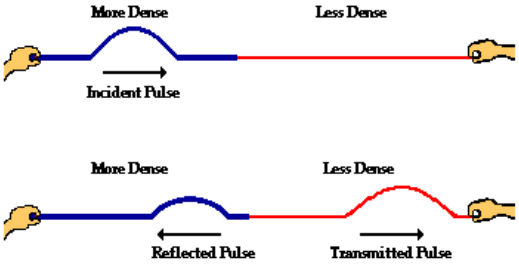


…will be reflected off the boundary and transmitted across the boundary into the new medium. The reflected pulse is inverted.

18

Waves from High Density to Low Density

A wave traveling from a more dense to a less dense medium…



…will be reflected off the boundary and transmitted across the boundary into the new medium. There is no inversion.

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Boundary Behavior on Speed

Low Density to High Density

This goes from high speed to low speed

High Density to Low Density

This goes from low speed to high speed

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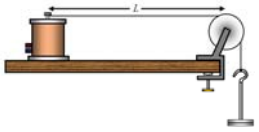
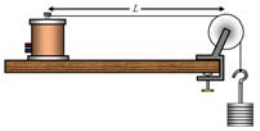
Tension Behavior on Speed

Waves will travel faster at greater tension.

Slower Wave Speed



Faster Wave Speed



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Superposition of Waves

The displacement of a medium caused by two waves will be the algebraic sum of the displacements of the individual waves

Constructive Interference – waves are in same direction and makes a larger amplitude wave

Destructive Interference – waves are in opposite direction and cancel partially or total

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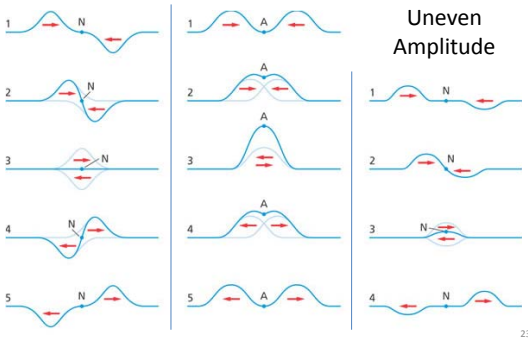
Superposition of Waves

Destructive | Constructive | Uneven Amplitude



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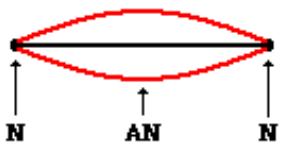
Interference of Waves

Node – Where the pulses meet in the same location and the displacement is 0. This point remains unmoved

Antinode – The point of largest displacement after two waves meet.



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Standing Waves

Standing Wave – Where the ends of waves are at fixed nodes and the antinode is in the middles. This is common for musical instruments

If you double the frequency of vibration you will produce one more node and antinode

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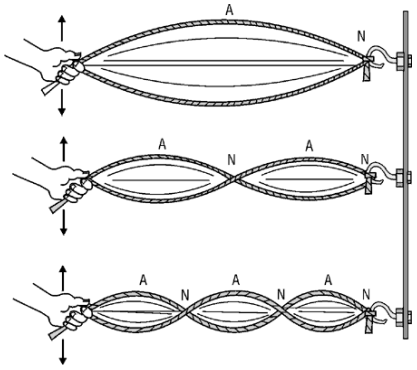
Standing Waves



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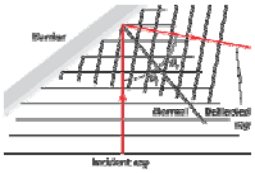
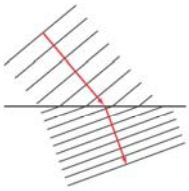
2D Wave Boundaries

Reflection



Refraction



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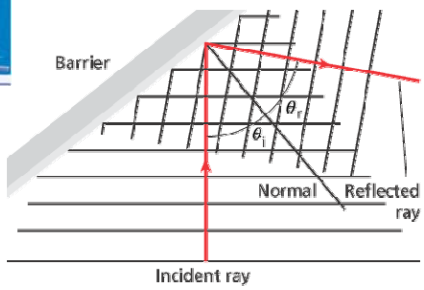
2D Wave Reflection



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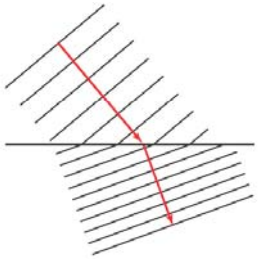
2D Wave Refraction

Less Dense



More Dense

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