

Phys 1402 2015-11-05 Lec 21

Oscillations: f T ω

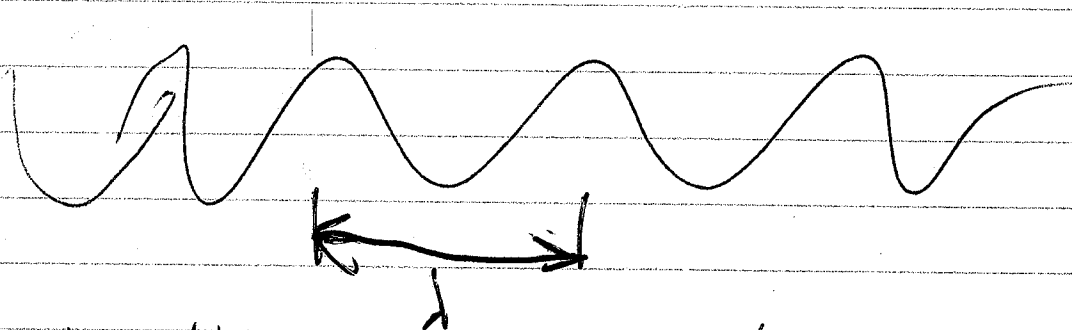
- Repeat in time $f = 1/T$
- Located in one place $\omega = 2\pi f$

Waves: Waves are sort-of moving oscillations.
In a wave, the oscillators don't move.
The wave comes from neighboring oscillators becoming excited.

PHET Normal Modes
Wave on a String

Waves have a propagation speed v .

Combined w/ repetition in time, we see repetition in space.



λ = wavelength = repeating distance

$$v = \frac{\text{Dist}}{\text{Time}} = \frac{\lambda}{T} = \underline{\lambda f}$$

1402 (2)

Sound Waves: oscillations of air molecules. Could measure

Displacement x_{max}

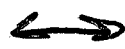
Speed v_{max}

Density N/V

Pressure P $PV = nRT$

How are air molecules coupled?

Disturbance



• Strong coupling

• Weak coupling

Conclusion: Sound only vibrates in the direction of propagation. Sound is a Longitudinal Wave.

Transverse and Longitudinal Wave Motion
(at psu.edu)

Speed of sound: $v \approx 340$ m/s room temp
Varies w/ temperature
 $v \approx 330$ m/s Freezing

Lowest Audible Frequency

$$f = 20 \text{ Hz}$$

$$v = f \lambda$$

$$\lambda = \frac{v}{f} = 17 \text{ m}$$

Highest Freq

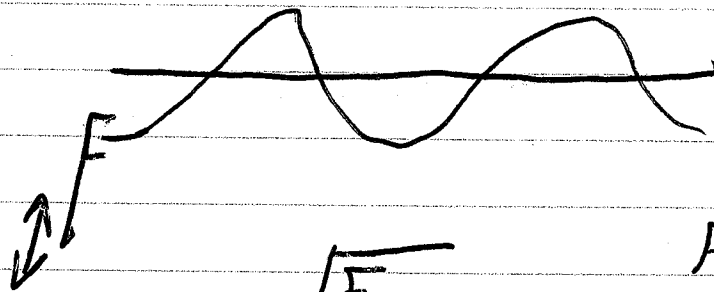
$$f = 20,000 \text{ Hz}$$

$$v = f \lambda$$

$$\lambda = 17 \text{ mm}$$

1402 (3)

Waves on Strings



$$v = \sqrt{F_T / \mu}$$

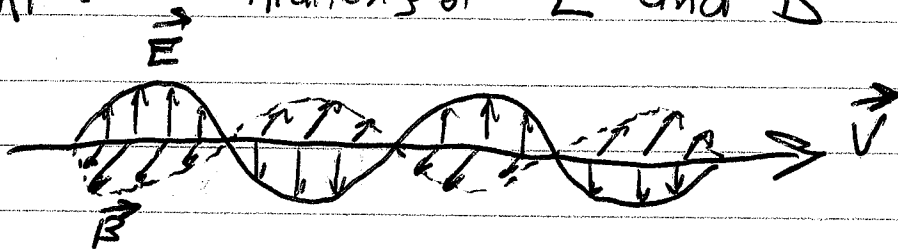
$F_T = \text{tension}$
 $\mu = \text{mass/length}$

Recall $f = \frac{1}{2\pi} \sqrt{k/m}$

Sound
~~Air~~

$$v = \sqrt{\frac{\text{force}}{\text{inertia}}}$$

Light: Oscillations of \vec{E} and \vec{B}



Speed of Light $v = c = 3 \times 10^8 \text{ m/s}$

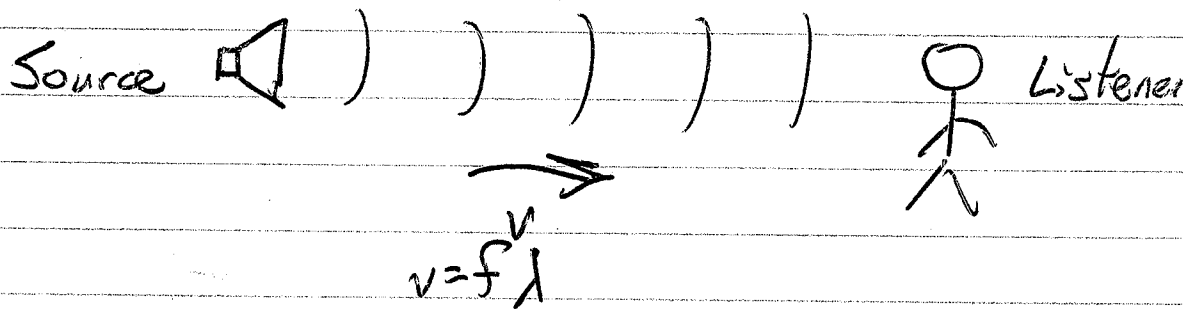
Water: v depends on freq & depth

Seismic:
 Longitudinal } Body (like sound)
 Transverse }
 Transverse } Surface (like water)
 Rayleigh }

1402 (4)

Coupled Oscillations always preserve
the frequency.

Except for the Doppler Effect.



Moving toward the source makes
the peaks arrive more rapidly.
They measure the frequency as
being higher.

$$f' = \frac{v_{\text{eff}}}{\lambda} = \frac{v + v_o}{v} \cdot f$$

Full:

$$f' = \frac{v + v_o}{v - v_s} f$$