Ch 16. Sound & Hearing

16-1. Sound Waves

Frequency: Pitch

Audible range: 20Hz - 20,000Hz

Ultrasonic: f > 20,000 Hz, Sonar

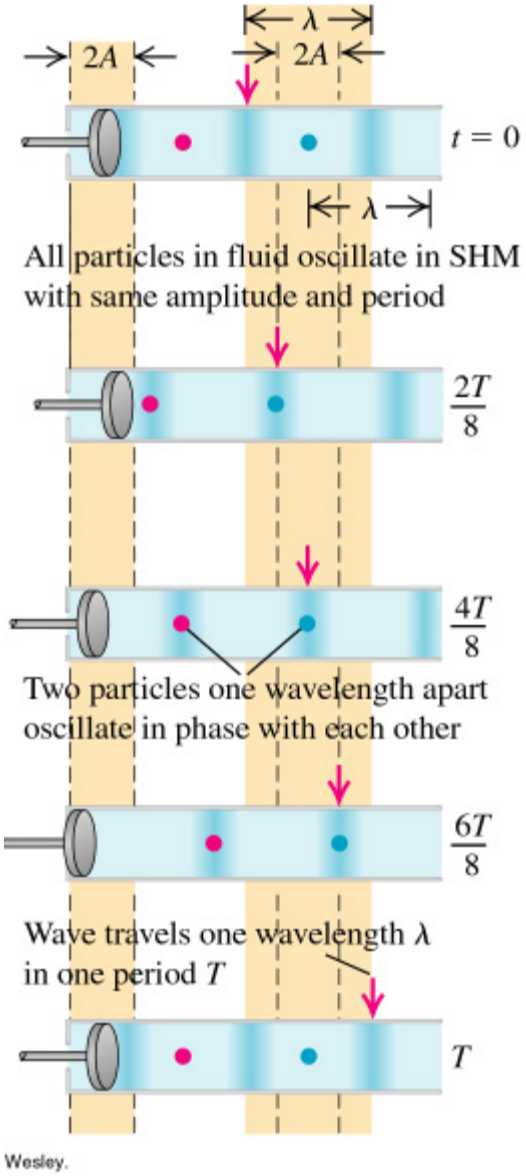
NOT

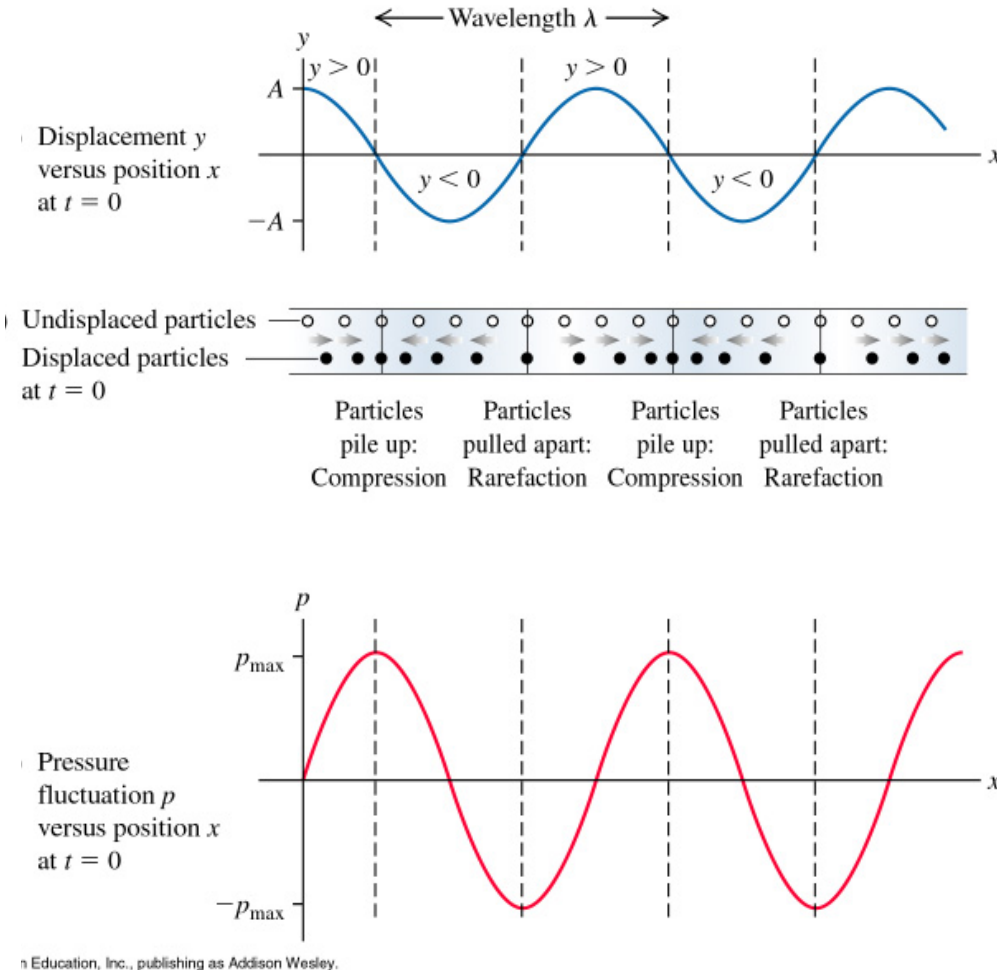
Supersonic (speed > sound speed)

Infrasonic: f< 20 Hz

Earthquake

Longitudinal Wave





Pressure fluctuation extremes ⟷ Zero displacement

Zero pressure fluctuation ⟷ Displacement extremes

16-2. Speed of Sound

Depends on Propagating material

Faster in solids than in liquids and gases

Temperature

Same for all frequencies, and $v=\lambda f$

In air, at 20ºC, v~340 m/s

SPEED OF SOUND IN VARIOUS BULK MATERIALS

MATERIAL	SPEED OF SOUND (m/s)
Gases	
Air (20°C)	344
Helium (20°C)	999
Hydrogen (20°C)	1330
Liquids	
Liquid helium (4 K)	211
Mercury (20°C)	1451
Water (0°C)	1402
Water (20°C)	1482
Water (100°C)	1543
Solids	
Aluminum	6420
Lead	1960
Steel	5941

Please read text on your own.

16-3. Sound Intensity (Loudness)

$$\text{Intensity I} = \frac{\text{energy/time}}{\text{area}} = \frac{\text{power}}{\text{area}}, \text{ in watts/meter}^2 \, (W / m^2)$$

Intensity level: β (in dB)=10 *log* (I/I_0)

I_0=1.0x10^{-12} W/m^2, β=0, Threshold of hearing

I=1W/m^2, β=120 dB, Threshold of pain

10 dB increase in intensity level ~ 10 times increase in intensity
doubling in loudness

Log Exercise

$\log a = \log_{10} a$

if $\log a = x$, then $a = 10^x$

$\log a^b = b \log a$

$\log a + \log b = \log ab$

$\log a - \log b = \log (a/b)$

$\log 1 = 0$

$\log 10 = 1$

$\log 100 = \log 10^2 = 2 \log 10 = 2$