Book Problem
16-9

$$y = A\sin(kx - \omega t)$$

$$k = \frac{2\pi}{\lambda}$$

$$\omega = 2\pi f = \frac{2\pi}{T}$$

$$v = \lambda f$$

$$y = 0.35 \sin\left(\underbrace{10\pi}_{\omega} t - \underbrace{3\pi}_{k} x + \frac{\pi}{4}\right)$$

a) speed

$$v = \lambda f = \left(\frac{\cancel{2\pi}}{k}\right)\left(\frac{\omega}{\cancel{2\pi}}\right) = \frac{\omega}{k} = \frac{10\pi}{3\pi} \approx 3\tfrac{1}{3}\ \frac{m}{s}$$

To the right

why:

$$y = A\sin(kx - \omega t + \phi)$$

or

$$y = A\cos(kx - \omega t + \phi)$$

wave traveling to the Right

For cos: $\cos(-\theta) = \cos\theta$

so, $\cos(kx - \omega t) = \cos(-kx + \omega t)$

For sin: $\sin(-\theta) = -\sin\theta = \sin(\theta + \pi)$

so, $\sin(kx - \omega t) = \sin(-kx + \omega t + \pi)$

So, anytime these signs are opposite the wave is moving to the right:

$$y = A\sin(\pm kx \pm \omega t)$$

Anytime these signs are the same the wave is moving to the left.

b) $y(\underset{x}{\underset{\uparrow}{0.1}}, \underset{t}{\underset{\uparrow}{0}}) = 0.35 \sin\left(\frac{\pi}{4} - 0.3\pi\right)$

$\uparrow \qquad \uparrow$

$x \qquad t$

$$y = -0.055 \text{ m}$$

c) $\lambda = \frac{2\pi}{K} = \frac{2\pi}{3\pi} = \frac{2}{3}$ m

d) $f = \frac{\omega}{2\pi} = \frac{10\pi}{2\pi} = 5$ Hz

e) $\frac{dy}{dt}$ is transverse speed

$$\frac{dy}{dt} = 0.35\left[\underbrace{\cos\left(10\pi t - 3\pi x + \frac{\pi}{4}\right)}_{=1 \text{ at max.}}\right](10\pi)$$

max speed $= 3.5\pi$

Worksheet p. 372 Top: $\underset{\text{longest } \lambda}{\underbrace{C = D}} > A > \underset{\text{shortest } \lambda}{\underbrace{B}}$

$$v = \lambda \underset{\text{same for all}}{\underset{\uparrow}{f}}$$

Bottom: same rope under same tension

→ all are the same

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p. 379 Top A) $\lambda = \frac{\text{length}}{1 \text{ cycle}} = \frac{25 \text{ cm}}{2.5 \text{ cycles}} = 10$ cm

B) $\lambda = \frac{28 \text{ cm}}{3.5 \text{ cycles}} = 8$ cm

C) $\lambda = \frac{20}{2} = 10$ cm

d) $\lambda = \frac{30}{1.5} = 20$ cm

bottom A) $\lambda = \frac{L}{5}$ $v = \lambda f = \frac{L}{5}(500) = 100\ L$

B) $\lambda = \frac{L}{3}$ $v = \lambda f = \frac{L}{3}(300) = 100\ L$

c) $\lambda = \frac{L}{2.5}$ $v = \frac{L}{2.5}(300) = 120\ L$

d) $\lambda = \frac{L}{5}$ $v = \frac{L}{5}(400) = 80\ L$

$C > A = B > D$

Ch 17 : Sound

Vibration causes longitudinal waves

Range of human hearing: 20 Hz to 20,000 Hz

Decibels (dB)

I = Intensity $\left(\frac{W}{m^2}\right)$

β = intensity level (in dB which is unitless)

$$\beta = (10\ dB) \log\left(\frac{I}{I_0}\right)$$

↑ base 10 log

I_0 = reference, threshold of hearing

$1 \times 10^{-12}\ \frac{W}{m^2}$

Zero dB → Not zero sound

$I = I_0$

1 dB → smallest change in loudness that the ave person can detect

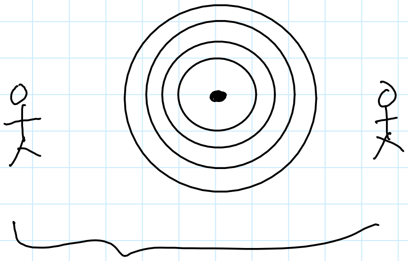
10 dB change → sound appears twice as loud

I must increase to $10I$ for sound to double

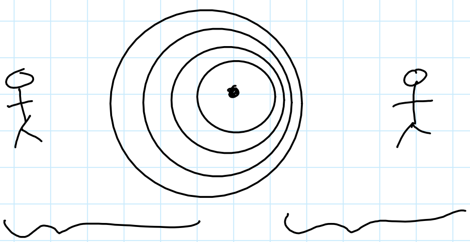
Doppler Shift:

Sound source at rest

moving sound source →



sound is same on both sides



f is lower

f is higher when source of sound moves toward you

$$f' = \left(\frac{v + v_0}{v - v_s}\right) f$$

f' = new or shifted freq

f = original freq at the source

v = speed of sound

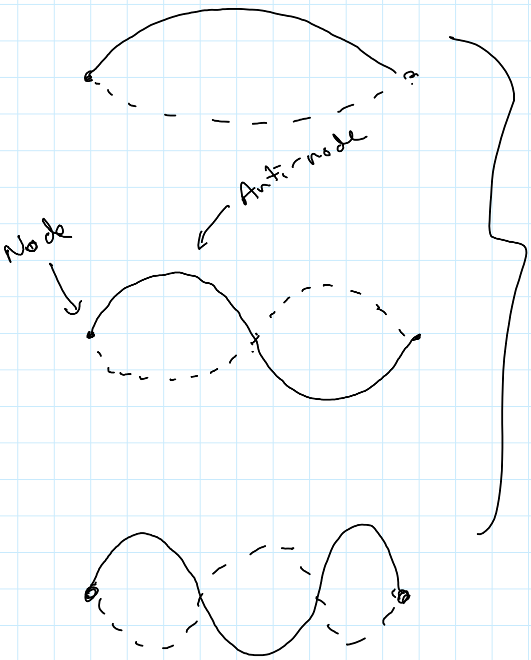
V_o = speed of observer
(WRT medium)

\+ toward source
\- away from source

V_s = speed of source
(WRT medium)

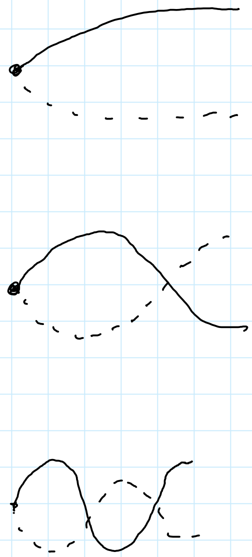
\+ toward observer
\- away

Standing Waves:



both ends fixed

(ends must be Nodes)



One end fixed

one end free

must have Node at fixed and anti-node at free end

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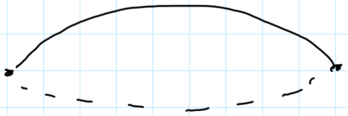
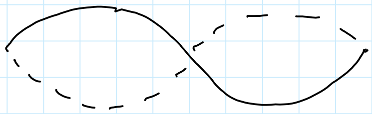
waves on a string

Fundamental
or
1st harmonic



$L = \frac{\lambda}{2}$

1st overtone
or
2nd harmonic



$L = \lambda$

2nd overtone
or
3rd harmonic

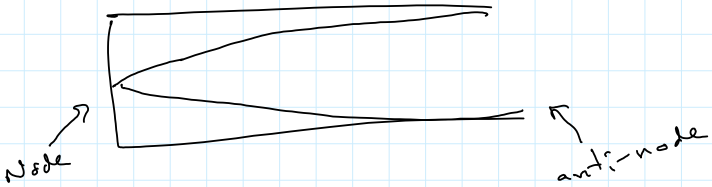
$L = 3\frac{\lambda}{2}$

given any two : v / f / L
solve for the 3rd

Sound waves :

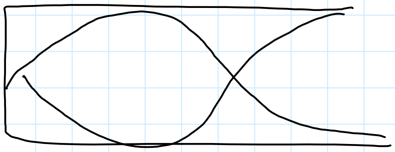
Pipe closed at one end

1st harmonic



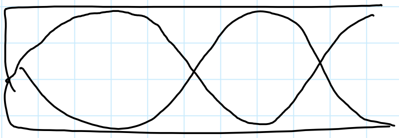
$L = \frac{\lambda}{4}$

3rd harmonic

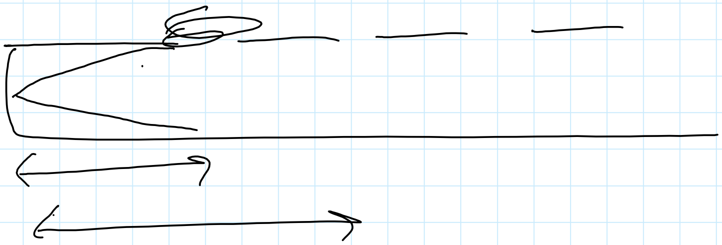


$L = \frac{3\lambda}{4}$

5th harmonic



$L = \frac{5}{4}\lambda$



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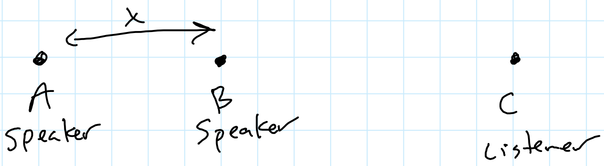
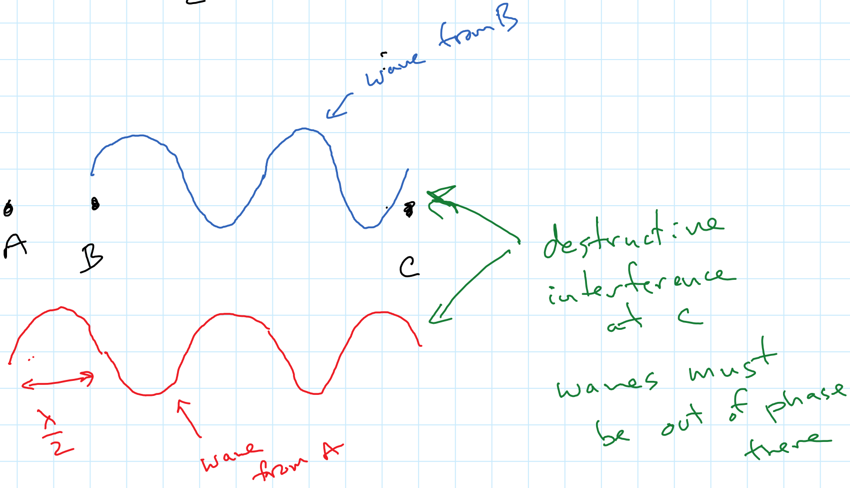
2 speakers

given: in phase
$f = 1000$ Hz
$v = 343\ \frac{m}{s}$



find x for destructive interference at point C

$x = n\frac{\lambda}{2}$ where n = odd integer



$\lambda = \frac{V}{f} = \frac{343}{1000} = 0.343$ m

$x = (1)\frac{\lambda}{2} = 0.17\ m$ min. distance x (n=1)

$x = (3)\frac{\lambda}{2} = 0.51\ m$ Next place for destructive (n=3)