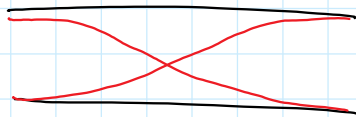


Draw the 1<sup>st</sup> 3 harmonics  
for sound waves in a  
pipe open at both ends

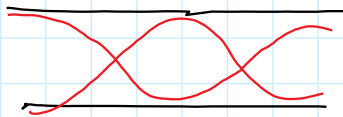
if  $L = 0.5 \text{ m}$  find the freq  
for each ( $v = 343 \frac{\text{m}}{\text{s}}$ )

1<sup>st</sup>

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

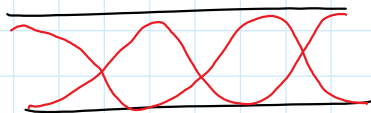
$$\frac{v}{2L} = f$$

$$f = \frac{343}{2(0.5)} = 343 \text{ Hz}$$

2<sup>nd</sup>

$$L = \lambda = \frac{v}{f}$$

$$f = \frac{v}{L} = \frac{343}{0.5} = 686 \text{ Hz}$$

3<sup>rd</sup>

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

$$f = \frac{3v}{2L} = 1029 \text{ Hz}$$

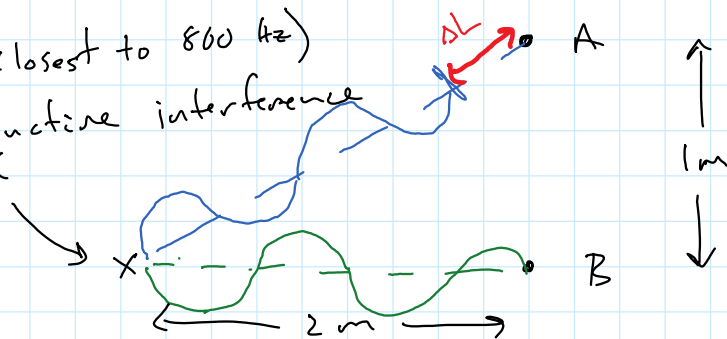


2 speakers (in phase)

find  $f$  (closest to 800 Hz)

for constructive interference at X

$v = 343 \frac{m}{s}$



$$L_B = 2 \text{ m}$$

$$L_A = \sqrt{2^2 + 1^2} = \sqrt{5}$$

Path difference:

$$\Delta L = \sqrt{5} - 2 = 0.236 \text{ m}$$

For constructive:

$$\Delta L = n \lambda = n \frac{v}{f}$$

$$f = \frac{n v}{\Delta L}$$

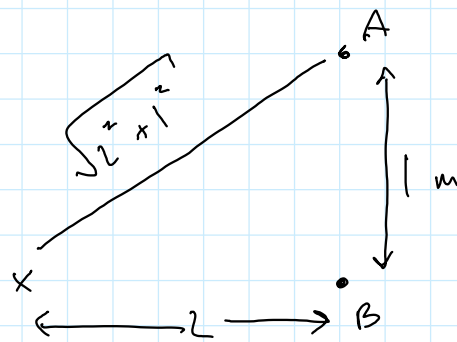
$n$	$f$
1	1453
2	2966
3	4360

Using

1453 Hz

How much does X need to move

closer to speaker B for destructive interference?



1st) find  $\Delta L$

$$\Delta L = \sqrt{L^2 + 1} - L$$

2nd)  $\Delta L = n \frac{\lambda}{2}$  where  $n = 1, 3, 5, \dots$   
 OR

$$\Delta L = \left(n + \frac{1}{2}\right) \lambda \quad \text{where } n = 0, 1, 2, 3, \dots$$

$$\left(n + \frac{1}{2}\right) \lambda = \sqrt{L^2 + 1} - L$$

$$\left(n + \frac{1}{2}\right) \frac{v}{f} = \sqrt{L^2 + 1} - L$$

Smallest distance for  $n=0$

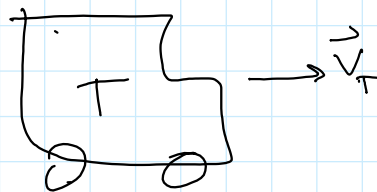
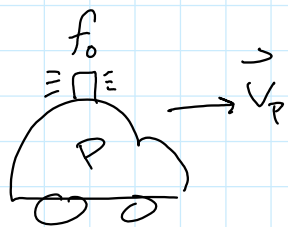
$$\frac{v}{2f} + L = \sqrt{L^2 + 1}$$

$$\left(\frac{v}{2f}\right)^2 + \frac{2vL}{2f} + \cancel{L^2} = \cancel{L^2} + 1$$

$$L = 4.18 \text{ m}$$

(move away by 2.18 m)

Doppler shift



2 Prob:

1<sup>st</sup>

Find the freq the truck hears ( $f_1$ )

2<sup>nd</sup>

Treat truck as a source of sound  
w/ freq  $f_1$

3<sup>rd</sup>

Find freq heard at police car ( $f_2$ )

$$f_1 = f_0 \left( \frac{v + v_o}{v - v_s} \right)$$

$$f_1 = f_0 \left( \frac{343 - v_T}{343 - v_p} \right)$$

$$f_2 = f_1 \left( \frac{343 + v_p}{343 + v_T} \right)$$