Physics 2C 1/17/20

1. Standing waves: sound
2. Beats
3. Practice Problem

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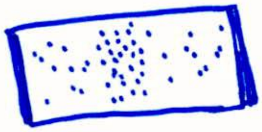
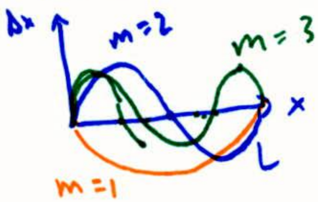
1. standing wave in (sound waves)

boundary condition:

closed end: displacement node

m = 2 



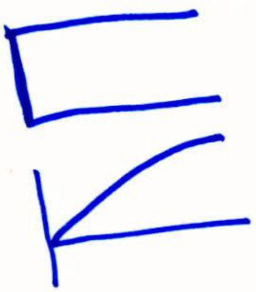
(1) $\lambda = 2L$

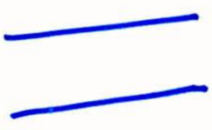
(2) $\lambda = L$

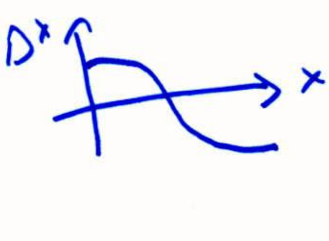
(3) $\lambda = \frac{2L}{3}$

pressure node

open end: displacement antinode

m = 1 



m = 1 

open-open / closed-closed

$$\lambda_m = \frac{2L}{m}, \quad m = 1, 2, 3, \ldots$$

open-closed

$$\lambda_m = \frac{4L}{m}, \quad m = 1, 3, 5, \ldots$$

not writing it yet...

could also write

$$\lambda_m = \frac{4L}{2m-1}, \quad m = 1, 2, 3, \ldots$$

Problem: An open-closed pipe is in its 3rd lowest harmonic frequency

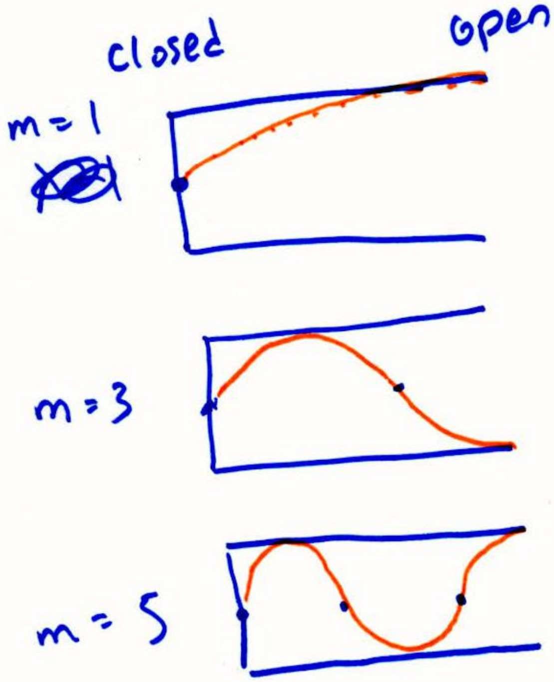
(a) Draw the standing wave

(b) Give an expression relating λ & L (length of pipe)

for (b) (A) $\lambda > L$

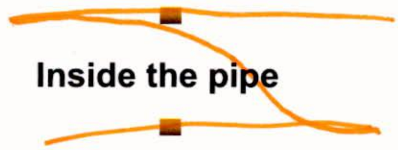
(B) $\lambda = L$

(C) $\lambda < L$



+ 2 clickers

A pipe with two open ends is shown below. The length of the pipe is 1m and the speed of sound is 343 m/s. What is the first harmonic frequency of the sound wave created in this pipe?



1. 343Hz
2. 172Hz
3. 686Hz
4. 1029Hz
5. None of the above

A pipe with two close ends is shown below. The length of the pipe is 1m and the speed of sound is 343 m/s. What is the first harmonic frequency of the sound wave created in this pipe?

1. 343Hz
2. 172Hz
3. 686Hz
4. 1029Hz
5. None of the above

find Δf, call it f^* (4)

$f^* = 171.5\ Hz$

A pipe with one closed end is shown below. 428.75 Hz, 600.25 Hz and 771.75 Hz are three adjacent harmonic frequencies of sound waves created in this pipe. What is the pipe's first harmonic (lowest) frequency?

$428.75\ Hz = 2.5 f^*$
$600.25\ Hz = 3.5 f^*$
$771.75\ Hz = 4.5 f^*$

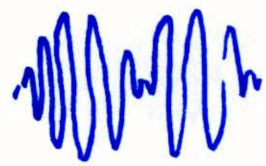
1. 86Hz
2. 172Hz
3. 343Hz
4. 257Hz
5. None of the above

$4.5 f^*$
$3.5 f^*$
$2.5 f^*$
$1.5 f^*$
$0.5 f^*$
~~0.5 ?~~

② Beats

* f_1 and f_2 "close"
* amplitudes "close"

eg. 400 Hz & 403 Hz



Online Demo & clicker

③ An open-closed pipe is exactly 1 m long. A second pipe, almost identical is a little bit longer. What's the length of the second pipe if the beat frequency between the two is 2 Hz (assume fundamental freq.)

* $v_{sound} = 343\, m/s$
* $|f_1 - f_2| = 2\, Hz$

* $f = \frac{v}{\lambda} =$ in terms of L

$L_1 = 1\, m$

$\Rightarrow \lambda_1 = 4\, m$

$f_1 = \frac{v}{\lambda_1} = 86\, Hz \Rightarrow f_2 = 84\, Hz$ (why not 88 Hz?)

$\Rightarrow \lambda_2 = \frac{v}{f_2} = 4.1\, m$

$\Rightarrow L_2 = 1.025\, m$

Question 14.10 Beats

The traces below show beats that occur when two different pairs of waves interfere. For which case is the *difference in frequency* of the original waves *greater*?

a) pair 1

b) pair 2

c) same for both pairs

d) impossible to tell by just looking

$f_{beat,1} > f_{beat,2}$

Pair 1

Pair 2