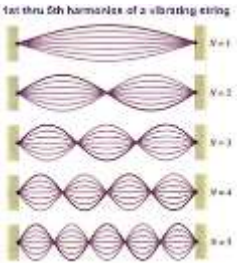
10 pts., due _____ **Name: _____ Hour:____**

The Physics of Instruments Lab

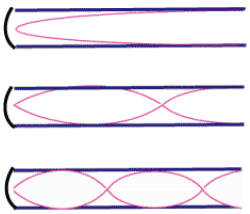
Harmonics- frequencies that create a standing wave



String instrument or **open at both ends** -A standing wave is created at every **1/2** of a wavelength.

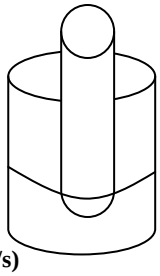
equation: $f_n = \frac{n\,(v)}{2L}$, **n =1,2,3,…**

Closed at one end - A standing wave is created at every **odd 1/4** of a wavelength.



equation: $f_n = \frac{n\,(v)}{4L}$, **n = 1,3,5, …**

Activity #1: PVC Pipe and Graduated Cylinder You need 3 different tuning forks and a PVC instrument.



Background Information

What type of instrument is this? *open at both ends or closed at one end (circle one)*

What fraction of the wave makes the first standing wave for this type of instrument? _____

Data:

found on the tuning fork **The distance is NOT the same as the wavelength.**

Frequency (Hz)	**Distance (m)**	**Wavelength (m)** *(distance x 4)*	**Speed of Sound (m/s) (Find using v=fλ)**
1. 320	**0.26**		
2. 288	**0.29**		
3. 341	**0.24**		
			Average experimental speed of sound:

1. Calculate the theoretical speed of sound in the room right now using v = 330 m/s+ 0.6 °C in m/s and in mph. **75 °F in room**

_____ m/s & _____ mph

2. Review from chemistry:
   a. Hotter molecules move faster / slower
   b. Hotter molecules will spread out / get closer together

3. If the water in the tube was hot, and that heated up the air in the tube, should it increase or decrease your wavelength measurement? **Explain why** using your answers to #7**!**

4. If your wavelength increases:
   a. What should happen to the frequency? Increase / decrease
   b. What should happen to the pitch? Increase / decrease
   c. Test this with the lab setup that is hot. Does it work? _____

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Activity #2: **Boomwhackers!** You need 3 different Boomwhackers and one of the caps. According to the **Boomwhacker** info sheet, **the actual frequencies are:** (Use for % error)

256Hz = C *(long red)*
288 Hz = D *(orange)*
320 Hz = E *(yellow)*
341.3 Hz = F *(light green)*
384 Hz = G *(dark green)*
426.7 Hz = A *(purple)*
480 Hz = B *(pink)*
512 Hz = C *(short red)*

Data and calculations:

	color	length (m)	note it plays	frequency of note	calculate the fundamental frequency (n = 1)	Calculate the % error for freq. (on eq. sheet)
1		0.495	E	320		
2		0.369	A	426.7		
3		0.41	G	384		

Activity #3: Tuning forks: Strike a tuning fork and hold it just inside the end of a Boomwhacker with a matching frequency. What happens? **Gets louder and vibrates**

What is this called? _____

Activity #4: **Capping a Boomwhacker**: Measure the length of 1 boomwhacker= __**0.495**___ m

- When a pipe is open on both ends, it contains ½ / ¼ of a wavelength? (when n=1)
- When a pipe is closed on one end, it contains ½ / ¼ of a wavelength? (when n=1)

According to your previous answers:

A **full wavelength** for a BW should be longer / shorter when it is closed on one end

The **frequency** of the BW should increase / decrease when closed on one end.

The **pitch** should be higher / lower when closed on one end.

Cap the boomwhacker and try it. Where you correct? __**Pitch was lower**___

Activity #5: **Dollar Store Toy** You need one dollar store toy.

Data: current temperature in the room: _**75 °F**___ and the length of a dollar store toy:__**0.74 m**___

1. Find the 1st, 2nd and 3rd, harmonic for one of the plastic spinning dollar store toy. Make sure you account for the temperature in the room.

fn_1 = _____
fn_2 = _____
fn_3 = _____

2. As you spin it around faster and faster, the frequency increases, what happens to the pitch? _____!