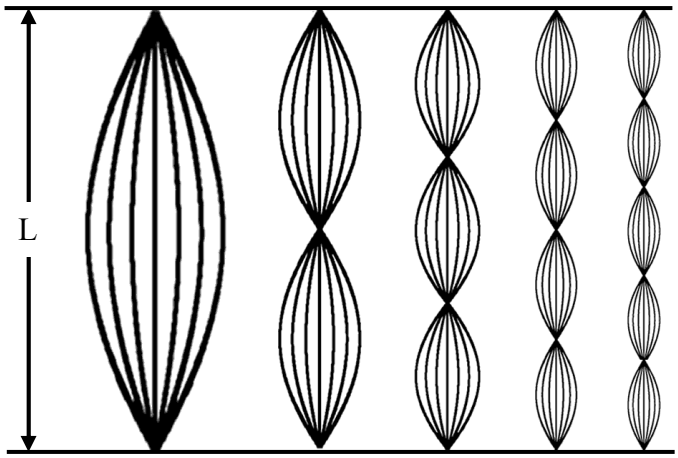
Questions for PreAP Physics Due Monday, Feb 11

Let's use the Socratic method to derive equations for harmonics on strings and in pipes. "Sit and learn, Aristotle."

1) How many antinodes (AN) equals 1 λ?
   (Circle this equation.)
2) How many AN does the fundamental have?
3) Using "L" as the length of a fixed string (shown) find and label the wavelengths for the harmonics shown on this graphic (*do it at the bottom of each harmonic*).
4) You probably have the fundamental as a whole number (not a fraction). Change it to a fraction: write it with its denominator (*all non-fraction numbers can be made a fraction if you put it over this number*).
5) Notice the denominators of harmonic 1, 3, and 5. You should see a pattern. Change the fractions of the other harmonics (2 and 4) so that the pattern is the same for all of them.
6) So, these changing denominators are the number of?
7) Let's call this "n". Now write a formula for finding the wavelength of a particular harmonic on a fixed string of length "L" (*Circle this equation*):



8) On a 2.5 m string, what is the wavelength of the 8th harmonic?

9) If a mechanical vibrator is vibrating 460 times per second to produce the 8th harmonic, find the speed of the wave in the string.

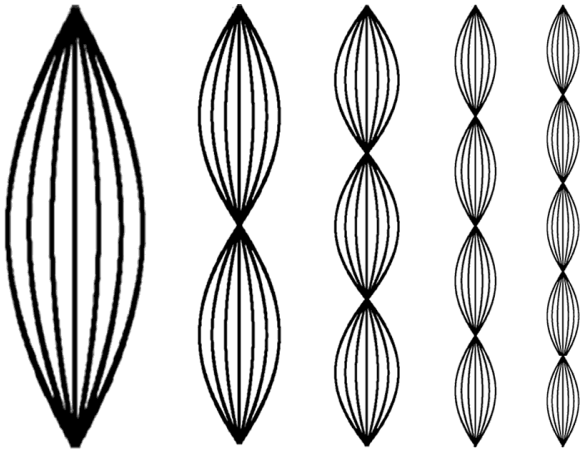
10) The speed of the wave is different in different mediums, so the speed of the wave is different in the string than in air. What is the speed of sound in air?

11) If you tighten the string, will the wavelength of the harmonics change?
12) When I tighten a string on my guitar what changes (music-wise)?
13) So, what is the same in air as in a fixed string: the wavelength of the vibration or the frequency of the vibration?
14) What frequency sound will we hear from the string in Q9?
15) Is this audible to us?
16) What would be the wavelength of that sound in air?

17) Using the equation for λ for a string and $v = f\lambda$, write an equation for f.

Let's switch now to pipes.

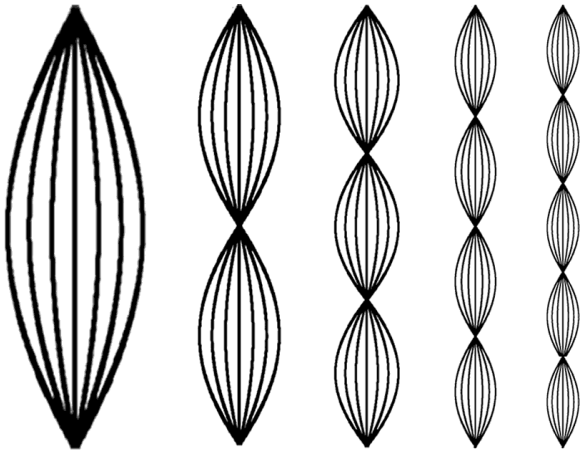
18) In an open end of a pipe is there a node or antinode?
19) At the closed end of a pipe is there a node or antinode?
20) On the graphic at the right, let's pretend we have a pipe with one end closed. We'll put that at the bottom of the graphic. For the fundamental draw a pipe that starts at the bottom. (*Don't be fancy, just use a rectangle with one side open, being sure to follow the rules in Q17 and 18.)*
21) Draw this same length pipe around each of the harmonics.
22) Which harmonics can be produced in this pipe?
23) So, for a pipe closed on one end (closed pipe), give the sequence of what harmonics can be present. n =

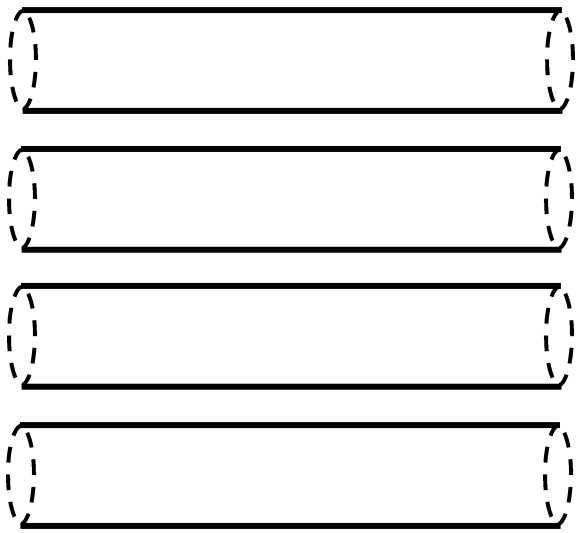


24) For the first harmonic, how many antinodes (AN) are present in the closed pipe you drew?
25) How many λ is that?
26) Write the wavelengths under the harmonics (even the ones that can't really exist).
    H_2 and H_4 should be obvious.
27) Remembering Q7: there must be a pattern that includes "n" sequentially. Find it.
28) But n can only =

Now, let's talk about open pipes (open at both ends).

29) Remembering the rule about open vs. closed pipes, what must be present at each end of a pipe open at both ends?
30) In order for a pipe to make a sound it must have a standing wave in it, meaning it must have at least one node.
31) Which of the harmonics at the right is the fundamental for an open pipe?
32) Draw the open pipe around the fundamental.
33) The size of pipe will change, but draw an open pipe around any of the given harmonics that will work. (*To show an OPEN pipe, use a rectangle with dotted lines for the open sides.)*
34) On a string you count the number of _____ to figure out which harmonic it is. For an open pipe, you count the number of _____ to figure out which harmonic it is.
35) So, draw and ***label*** the first three harmonics for the given open pipe below:





36) Which harmonics can be present in an open pipe (which "n's" are present)?

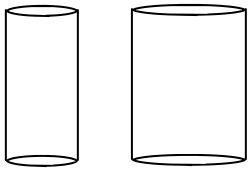
37) Using the same logic, figure out the sequence and give the equation for λ in an open pipe. *(Hint: use the drawing above to do this.)*

38) Now, go to the book (*for those of you that decided to really figure this out)* and write the equation for the frequency of a harmonic in an open pipe.

39) What velocity is in this equation?

40) Of the two pipes at the right, how will the sounds produced compare?

41) So (from the above equation in Q38) give all things that change in this equation between the two pipes.



42) If you know the length of a pipe, can you know the frequency of sound produced? Why or why not? Explain.

43) An open pipe 3 m long produces a 560 Hz sound. Find the speed of the wave in the pipe.