Resonance and Open-End Air Columns

Read from **Lesson 5** of the **Sound and Music** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/sound/u11l5a.html
http://www.physicsclassroom.com/Class/sound/u11l5c.html

MOP Connection: Sound and Music: sublevels 8 and 9

Review

1. Standing wave patterns consist of nodes and antinodes. The positions along a medium that appear to be stationary are known as ________________. They are points of **no di**splacement. The positions along a medium that are undergoing rapid motion between a maximum positive and maximum negative displacement are known as ________________. They are the **opposite of** the points of **no di**splacement. Each consecutive node is separated from each other by _____ λ.

2. Define fundamental frequency:

Resonance in Open-End Air Columns:

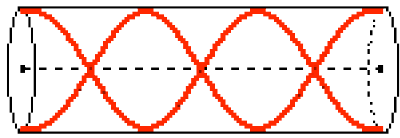
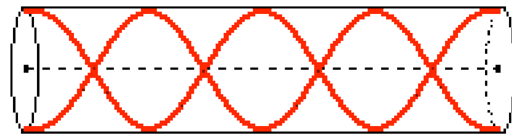
3. An open-end air column is a column of air (usually enclosed within a tube, pipe or other narrow cylinder) that is capable of being forced into vibrational resonance. Both ends of the column are open to the surrounding air. Air at the ends of the column is able to vibrate back and forth. Thus, these ends form vibrational ________________ (nodes, antinodes).

4. Draw the standing wave patterns for the first five harmonics and complete the equations.

Harmonic #	Standing Wave Pattern	λ ---> L	L ---> λ
1		L = _______ λ	λ = _______ L
2		L = _______ λ	λ = _______ L
3		L = _______ λ	λ = _______ L
4		L = _______ λ	λ = _______ L
5		L = _______ λ	λ = _______ L

5. Determine the frequency of the ....
   a. ... third harmonic for an air column whose first harmonic frequency is 384 Hz. ________________
   b. ... first harmonic for an air column whose fourth harmonic frequency is 1296 Hz. ______________
   c. ... third harmonic for an air column whose fourth harmonic frequency is 528 Hz. ______________

6. Determine the wavelength of the ...

a. ... wave in this 63-cm long air column. 	b. ... wave in this 85-cm long air column. 
c. ... first harmonic wave pattern for a 42.5-cm long air column.	d. ... fifth harmonic wave pattern for a 1.40-m long air column.

Use the wave equation and your standing wave patterns to solve the following problems. **PSYW**

7. Stan Dinghwaives is playing his open end pipe. The frequency of the second harmonic is 882 Hz (a pitch of A5). The speed of sound through the pipe is 345 m/sec. Find the frequency of the first harmonic and the length of the pipe. **PSYW**

8. A flute is played with a first harmonic of 196 Hz (a pitch of G3). The length of the open-end air column is 89.2 cm (quite a long flute). Find the speed of the wave resonating in the flute. **PSYW**

9. Find the length of a flute which would resonate at 262 Hz on a day when the speed of sound in air is 345 m/s. **PSYW**

10. Find the frequency of a 63.8-cm long open end air column that resonates as shown in the diagram at the right. The speed of sound in the air is 345 m/s.