

HARMONICS OF THIN PIPES

In wind instruments the air is oscillating in a tube. The sound waves are reflected on both ends, thereby producing a superposition of standing waves.

The harmonics can easily be found for thin pipes. At the mouth the air's oscillation has a maximum, i.e. there is an anti-node. The other end is either a node (closed pipe) or an anti-node (open pipe).

Draw the standing waves in the figure below, express their wavelength and frequency as a function of the pipe's length and the speed of sound and find a general expression for the i^{th} harmonic.

	open pipe	closed pipe
1 st harmonic (fundamental)	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>
λ_1		
f_1		
2 nd harmonic (1 st overtone)	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>
λ_2		
f_2		
3 rd harmonic (2 nd overtone)	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>
λ_3		
f_3		
4 th harmonic (3 rd overtone)	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>
λ_4		
f_4		
λ_i		
f_i		