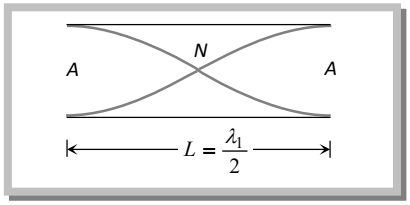
Standing Waves in Open Organ Pipes.

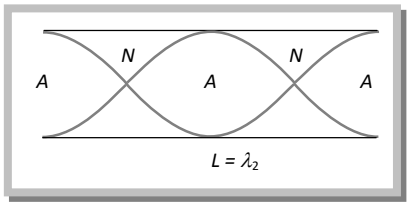
General formula for wavelength

$\lambda = \frac{2L}{n}$ Where n = 1,2,3 .....



(1) First normal mode of vibration: $n_1 = \frac{v}{\lambda_1} = \frac{v}{2L}$

This is called fundamental frequency and the note so produced is called fundamental note or first harmonic.

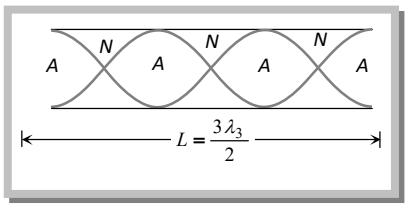


(2) Second normal mode of vibration $n_2 = \frac{v}{\lambda_2} = \frac{v}{L} = 2\left(\frac{v}{2L}\right) = 2n_1 \Rightarrow n_2 = 2n_1$

This is called second harmonic or first overtone.

(3) Third normal mode of vibration $n_3 = \frac{v}{\lambda_3} = \frac{3v}{2L}$, $n_3 = 3n_1$

This is called third harmonic or second overtone.



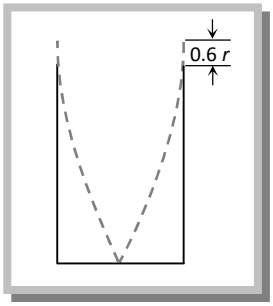
Important points

(i) Comparison of closed and open organ pipes shows that fundamental note in open organ pipe $\left(n_1 = \frac{v}{2L}\right)$ has double the frequency of the fundamental note in closed organ pipe $\left(n_1 = \frac{v}{4L}\right)$.

Further in an open organ pipe all harmonics are present whereas in a closed organ pipe, only alternate harmonics of frequencies $n_1, 3n_1, 5n_1, \ldots\ldots$ etc are present. The harmonics of frequencies 2n1, 4n1, 6n1 ..... are missing.

Hence musical sound produced by an open organ pipe is sweeter than that produced by a closed organ pipe.

(ii) Harmonics are the notes/sounds of frequency equal to or an integral multiple of fundamental frequency (n). Thus the first, second, third, harmonics have frequencies $n_1, 2n_1, 3n_1$, ...



(iii) Overtones are the notes/sounds of frequency twice/thrice/ four times the fundamental frequency (n) eg. $2^{n}, 3n, 4n$ ..... and so on.

(iv) In organ pipe an antinode is not formed exactly at the open end rather it is formed a little distance away from the open end outside it. The distance of antinode from the open end of the pipe is known as end correction.