

Q- an organ pipe is closed at one end and is 1.00 m long. Find the wavelength and frequency of the three lowest resonances which this pipe can produce. (speed of sound in air is 340 m/s)

In a closed organ pipe, there is a node at the closed end and an antinode at the open end. As the distance between consecutive node and antinode is one fourth of the wavelength, for the fundamental note we have

$$L = \lambda/4$$

Or $\lambda = 4L = 4 \times 1.00 = \mathbf{4.00 \text{ m}}$

And hence if the speed of sound in the air is 340 m/s the frequency of the fundamental note is given by

$$n = c/\lambda = 340/4.00 = \mathbf{85 \text{ Hz}}$$

Now for the second harmonic one more node and anti-node are added in between them and hence we have

$$3\lambda_2/4 = L$$

Or $\lambda_2 = 4L/3 = 4 \times 1.00/3 = \mathbf{1.333 \text{ m}}$.

And $n_2 = c/\lambda_2 = 340/1.333 = \mathbf{255 \text{ Hz}}$

And for the third harmonic one more node and anti-node is added and hence

$$5\lambda_3/4 = L$$

Or $\lambda_3 = 4L/5 = 4 \times 1.00/5 = \mathbf{0.8 \text{ m}}$.

And $n_3 = c/\lambda_3 = 340/0.8 = \mathbf{425 \text{ Hz}}$