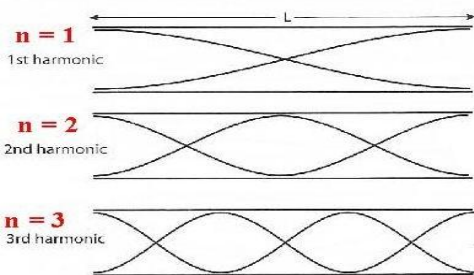


Q- The fundamental frequency of an open-open tube is 1500 Hz, when it is filled with helium at 0°C. What is the frequency when it is filled with air at 0°C?

As we know the $c = f \lambda$ and for fundamental frequency the length of the open-open tube L is equal to half of the wavelength i.e. $(\lambda/2) = L$ which is same for both the gases we get for air and helium

Standing wave in an open pipe

$$\lambda_n = \frac{2}{n}L \quad f_n = \frac{v}{\lambda_n} \quad \text{where the velocity (v) is the same for all n}$$



One half wave

$$\lambda_1 = \frac{2}{1}L \quad f_1 = \frac{v}{\lambda_1} = \frac{v}{2L}$$

Two half waves

$$\lambda_2 = \frac{2}{2}L \quad f_2 = \frac{v}{\lambda_2} = \frac{v}{L} = 2f_1$$

Three half wave

$$\lambda_3 = \frac{2}{3}L \quad f_3 = \frac{v}{\lambda_3} = \frac{v}{2/3L} = 3f_1$$

$$c_{He} = f_{He} * 2L$$

$$\text{And } c_{air} = f_{air} * 2L$$

Dividing the two equations we get

$$\frac{f_{He}}{f_{air}} = \frac{c_{He}}{c_{air}}$$

Now the speed of sound in air at 0°C is 331 m/s and that for helium is 972 m/s (<http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souspe.html#c5>)

Substituting in above equation we get

$$\frac{f_{He}}{1500} = \frac{972}{331}$$

$$\text{Or } f_{He} = 1500 * \frac{972}{331} = 4405 \text{ Hz}$$