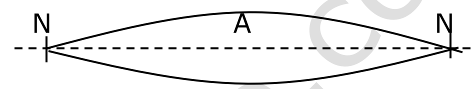
Q- A 78 cm long guitar string with a linear density of 1.0 g/m is under 225 N tension. It is plucked and vibrates at its fundamental frequency. What is the wavelength of the sound wave that reaches your ear in a 20°C room?

When the string vibrates in its fundamental frequency the two ends of the string are consecutive nodes (no vibration) and hence the length of the string is λ/2 gives the wavelength

λ = 2*length of the string = 2L= 2*78 = 156 cm.

The wave velocity c on a stretched string is given by

$$c = \sqrt{\frac{T}{\mu}}$$



where t is the tension in the string and μ is the mass per unit length.

Hence according to the relation c = n λ the frequency of the fundamental frequency is given by

$$n = \frac{c}{\lambda} = \frac{1}{2L}\sqrt{\frac{T}{\mu}} = \frac{1}{2*0.78}\sqrt{\frac{225}{1.0*10^{-3}}} = 304 \text{ Hz}$$

Now the frequency of the sound wave produced in the air will be same as that of the string and if the speed of sound in air (at 20^0C) is c′ (= 344 m/s) then the wavelength of the sound produced in air is given by

$$\lambda' = \frac{c'}{n} = \frac{344}{304} = 1.13 \text{ m.}$$