



A string of mass  $m$  and length  $L$  is positioned near a tube (open at one end) of length  $S$  and diameter  $D$ . When the string is excited in its fundamental mode, the tube experiences sympathetic vibrations in mode characterized by 6 intermediate nodes. At this particular moment, the speed of sound in air in the room happens to be  $v_{\text{air}}$ .

- a) (10 pts) What is the fundamental frequency for the tube? Which harmonic has been excited in the tube?
- b) (10 pts) What is the tension in the string? What is the fundamental frequency for the string?
- c) (5 pts) At what points could one lightly press on the string and generate sympathetic vibrations in the tube at new frequencies?

$$f_0 = \frac{15v_{\text{air}}}{4S} = \frac{v_{\text{air}}}{2L}$$

$$v_{\text{air}} = \frac{15v_{\text{air}}L}{2L}$$

$$v_{\text{air}} = \sqrt{\frac{T}{\mu}}$$

$$m \frac{15^2 v_{\text{air}}^2 L}{4 \cdot 2} = T$$

$$\frac{L}{2}$$

b) The tube has modes having lengths

$$\text{The tube fundamental frequency } f_0 = \frac{v_{\text{air}}}{4S}$$

| Mode | Nodes | Antinodes |
|------|-------|-----------|
|      | 1     | 0         |
|      | 3     | 1         |
|      | 5     | 2         |

Extrapolating, it would appear that the 15th harmonic has been excited in the tube.

The string has the following condition  $\Rightarrow \frac{P}{4L} = N \frac{v_{\text{air}}}{2L}$   
 $v_{\text{air}} = \sqrt{\frac{T}{\mu}}$

### EXTRA PAGE

b)  $f_{\text{string}} = f_{\text{tube}}$  we have some extra info  
 $f_{\text{string}} = 13 \frac{v_{\text{air}}}{4L}$

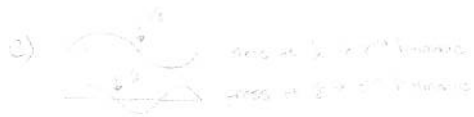
the string is vibrating in its fundamental mode  $\Rightarrow f_1 = \frac{13}{4} \frac{v_{\text{air}}}{L}$

$$\frac{v_{\text{air}}}{2L} = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

$$\frac{v_{\text{air}}}{L} = \frac{1}{L} \sqrt{\frac{T}{\mu}}$$

$$\frac{13}{4} \frac{v_{\text{air}}}{L} = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

$$T = mL \left( \frac{13}{2} \frac{v_{\text{air}}}{L} \right)^2$$



the case any resonance it can happen if is fundamental = 13S, 13S, 13S, 13S, ... we need to divide with number of the string.

$$\text{press at } \frac{L}{4}, \frac{L}{2}, \frac{3L}{4} \text{ ... } \text{Just in this.}$$