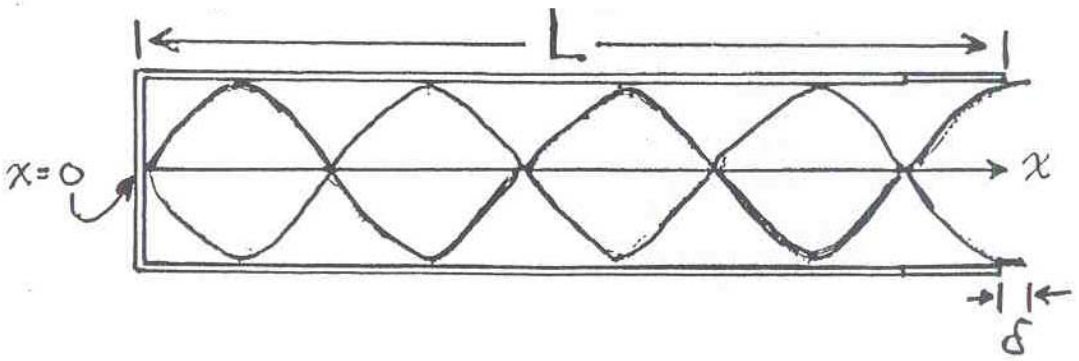
# Normal Modes & Standing Waves

## 1.) Standing Sound Waves in an Organ Pipe:

(a) Standing displacement wave:

$$y = A\sin\left(\frac{2\pi x}{\lambda}\right)\cos\left(\frac{2\pi t}{\tau}\right) \qquad \text{(Standing Wave)}$$

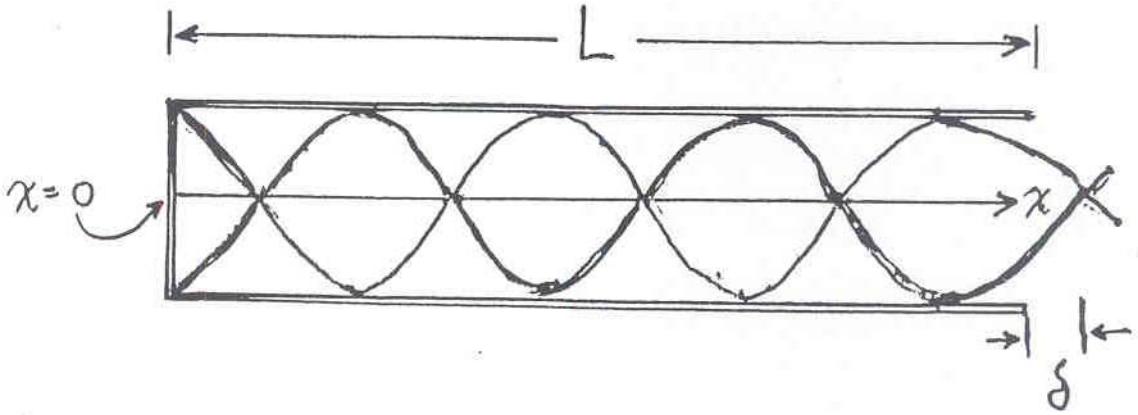
- Displacement ***node*** at $x = 0$




(b) Standing pressure wave:

$$\triangle P = -B\frac{\partial y}{\partial x} = -B\,A\left\{\frac{\partial}{\partial x}\sin\left(2\pi x/\lambda\right)\right\}\cos\left(\frac{2\pi t}{\tau}\right) = -\frac{2\pi\ B\,A}{\lambda}\cos\left(\frac{2\pi x}{\lambda}\right)\cos\left(\frac{2\pi t}{\tau}\right)$$

- Explains why **displacement ***nodes*** are **pressure ***anti*-*nodes***!




(c) Pressure ***node*** $\left(p = p_{\text{ambient}}\right)$ just ***beyond*** open end $x = L + \delta$ $\Leftarrow$ not precisely at $x = L$!

- so-called "end correction" $\delta \approx 0.6D$, where $D$ = diameter of pipe.