Last time:

$\mu_L, y_L \quad c_L \qquad \mu_R, y_R \quad c_R$

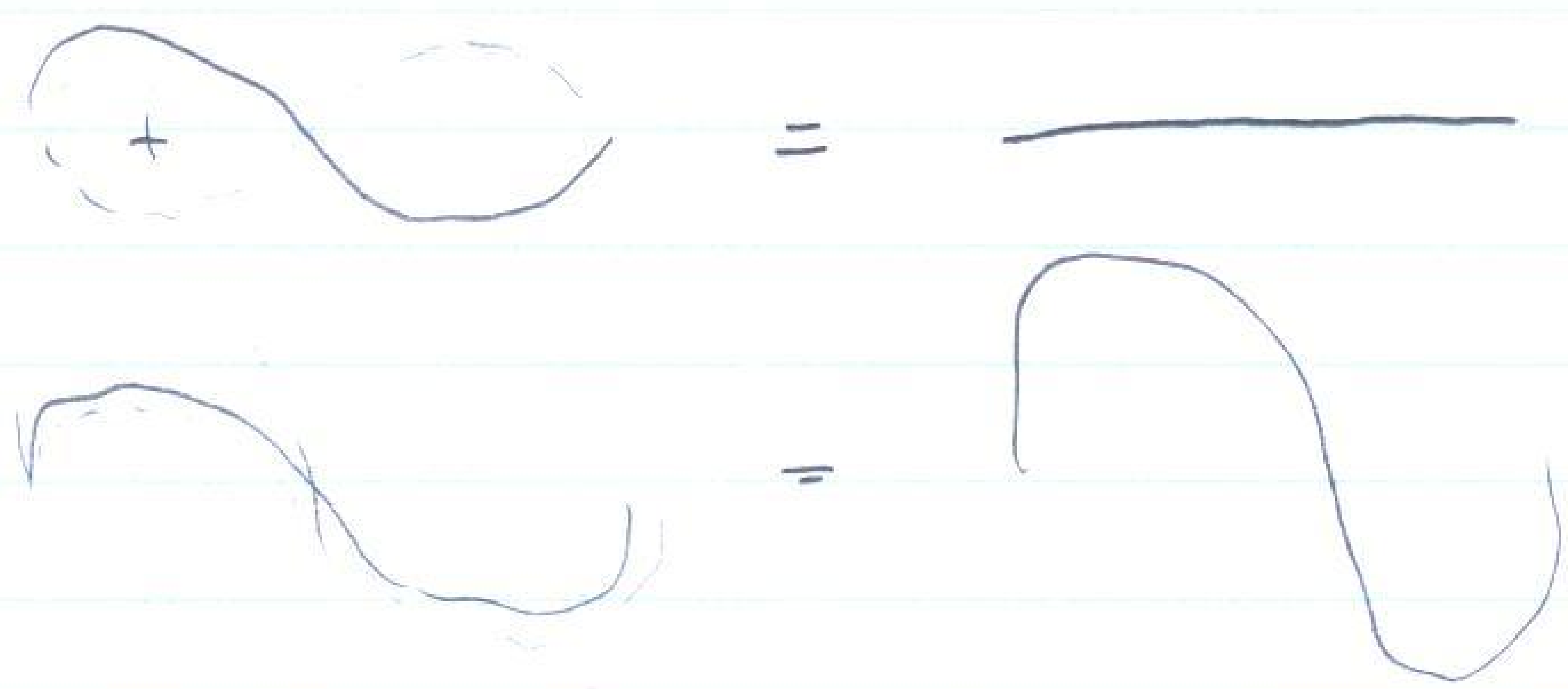
$$y_L = A\sin(kx-\omega t) + A_R\sin(-kx-\omega t) = A_T\sin(kx+\omega t)$$

$$\frac{A_R}{A} = \frac{\left(1 - c_L/c_R\right)}{\left(1 + \frac{c_L}{c_R}\right)} = \frac{\left(1 - \frac{\sqrt{\mu_R}}{\sqrt{\mu_L}}\right)}{\left(1 + \frac{\sqrt{\mu_R}}{\sqrt{\mu_L}}\right)}$$

$$c_L = \sqrt{\frac{T}{\mu_L}} \qquad c_R = \sqrt{\frac{T}{\mu_R}}$$

$$\frac{A_T}{A} = \frac{2}{1 + c_L/c_R} = \frac{2}{1 + \sqrt{\frac{\mu_R}{\mu_L}}} =$$

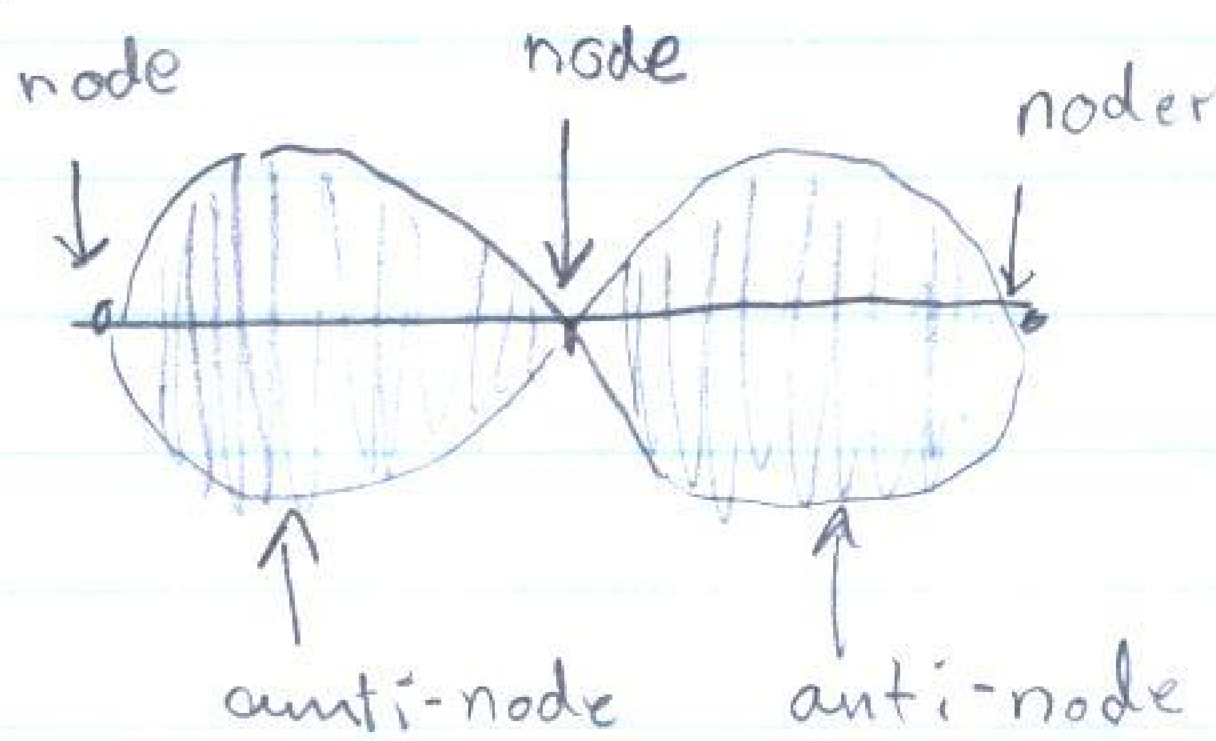
Superposition:



Finally we had Standing Waves:

$$y_{TOT} = A\sin(kx - \omega t) + A\sin(kx + \omega t)$$

$$y_{TOT} = 2A \sin kx \cos \omega t$$

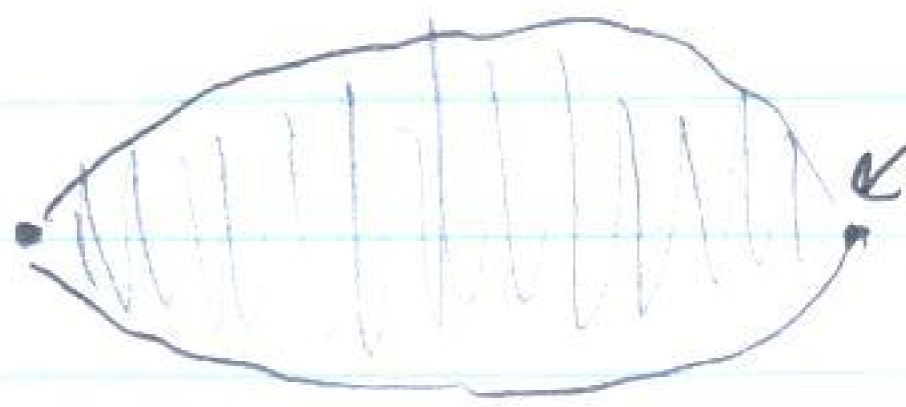


$$\langle P \rangle = \frac{1}{2}\mu^2 \omega^2 A v - \frac{1}{2}\mu \omega^2 A v = 0$$

right movin

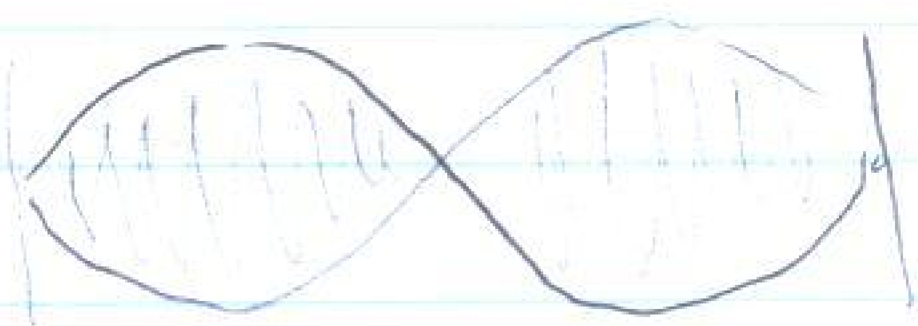
left moving

Only certain wavelengths are standing:

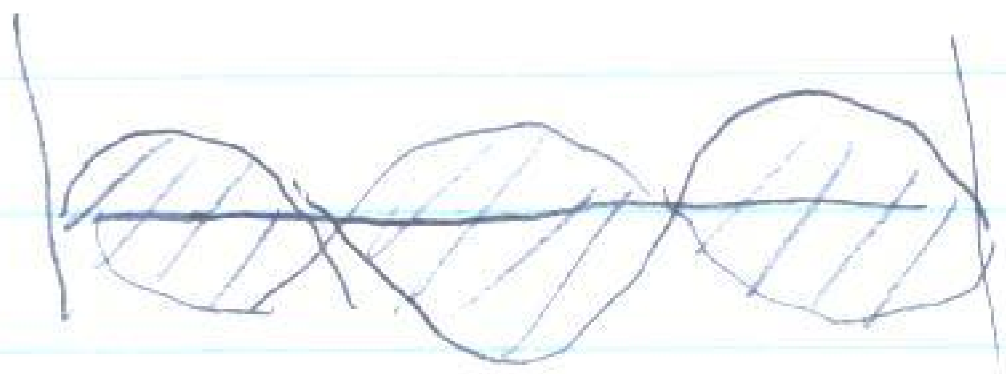


fixed end point

$$\lambda = 2L = \frac{2L}{1}$$



$$\lambda = L = \frac{2L}{2}$$



$$\lambda = \frac{2L}{3} \quad \ldots$$

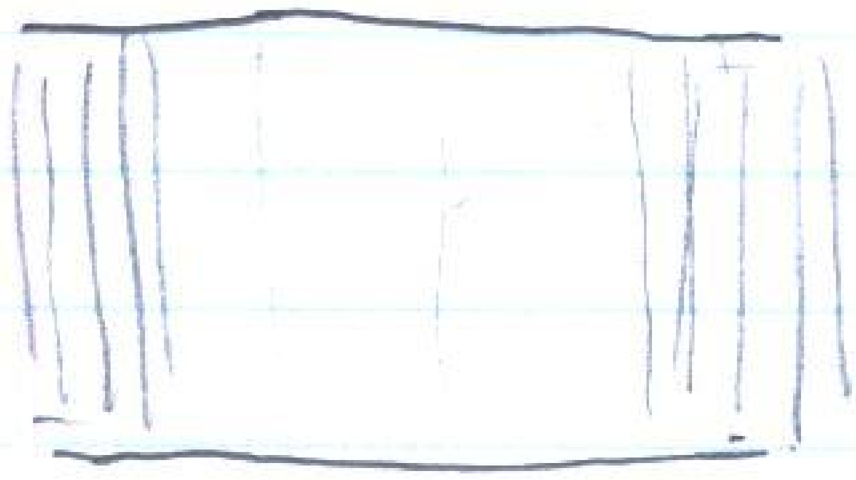
General:

$$\lambda_n = \frac{2L}{n} \qquad n = 1, 2, \ldots$$

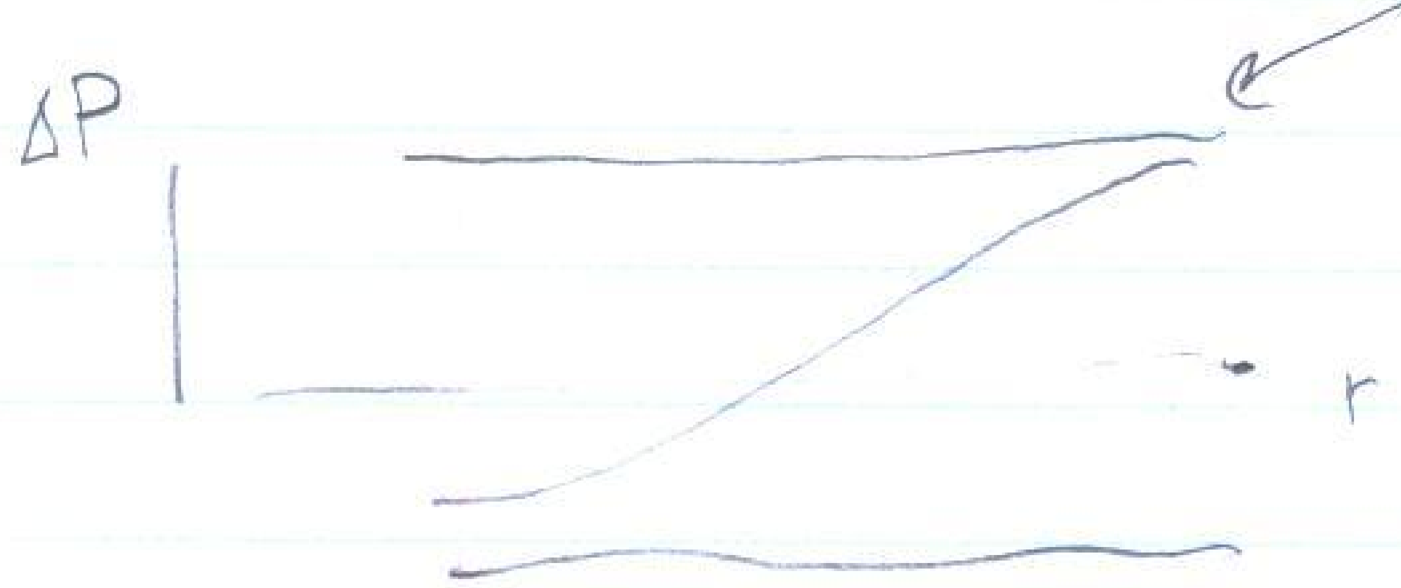
$$f_n = \frac{c_s}{\lambda_n} = \underbrace{\frac{c_s}{2L}}_{f_0 \,\leftarrow\, \text{fundamental}} n \qquad n = 1, 2, \ldots \infty$$

$$f_n = n\, f_0 \qquad f_0 = \frac{c}{2L} = \text{" the fundam}$$

Standing Waves in open Pipes: Trumpet

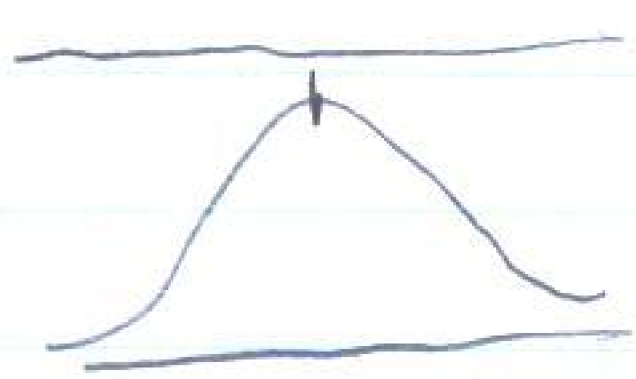


zero - derivative for open pipe

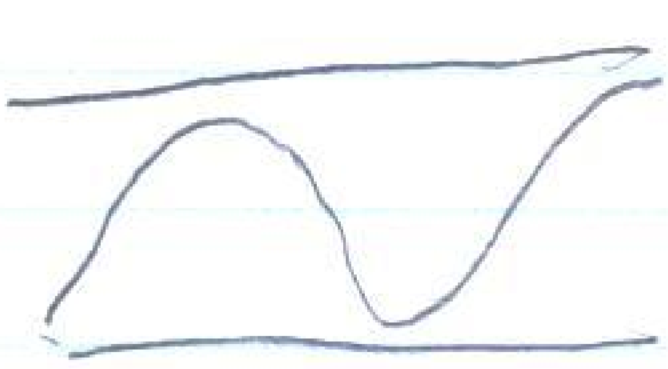


$$\left(1 \cdot \frac{\lambda}{2} = L\right)$$

$$\lambda_1 = \frac{2L}{1}$$



$$\lambda_2 = L = \frac{2L}{2} \qquad \left(2 \cdot \frac{\lambda}{2} = L\right)$$



$$\lambda = \frac{2L}{3} \qquad \left(3 \cdot \left(\frac{\lambda}{2}\right) = L\right)$$

General:

$$\lambda_n = \frac{2L}{n} \qquad f_n = \frac{c_s}{\lambda_n} = \left(\frac{c_s}{2L}\right) n$$

$$\boxed{f_n = f_0 \cdot n}$$

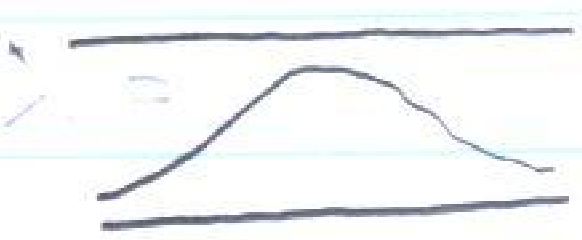
Problem:

Estimate the length of the first valve of the trumpet

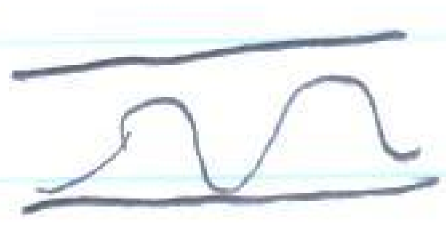
- Concert B^b is played @ no valves and has a frequency of 466 Hz

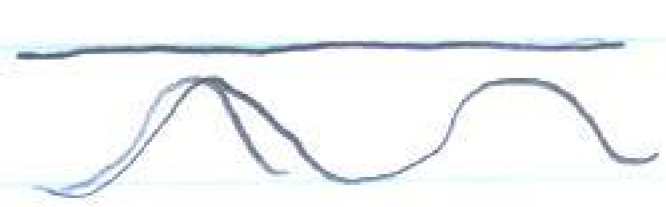
- By pressing the first valve the trumpet opens up some tubing goind then down to concert $A^b = 415.3\,Hz$

Determine the length of this valve

Low B^b  $n = 2$

F  $n = 3$

466 B^b  $n = 4$

415 A^b  $n = 4$

$$2\lambda_{B^b} = L_{B^b} \qquad 2\lambda_{A^b} = L_{A^b}$$

$$\frac{\lambda_{B^b}}{\lambda_{A^b}} = \frac{L_{B^b}}{L_{A^b}} \Longrightarrow \frac{f_{A^b}}{f_{B^b}} = \frac{L_{B^b}}{L_{A^b}}$$

First Estimate the Length of the trumpet

$$C_s = \lambda f \qquad \lambda_{B^b} = \frac{L_{B^b}}{2}$$

$$C_s = \frac{L_{B^b}}{2} f$$

$$\frac{2 C_s}{f} = L_{B^b}$$

$$\frac{2 \cdot 340\,m/s}{466\,Hz} = L_{B^b} \qquad \text{Then} \qquad L_{A^b} = \frac{f_{B^b}}{f_{A^b}} \cdot L_{B^b}$$

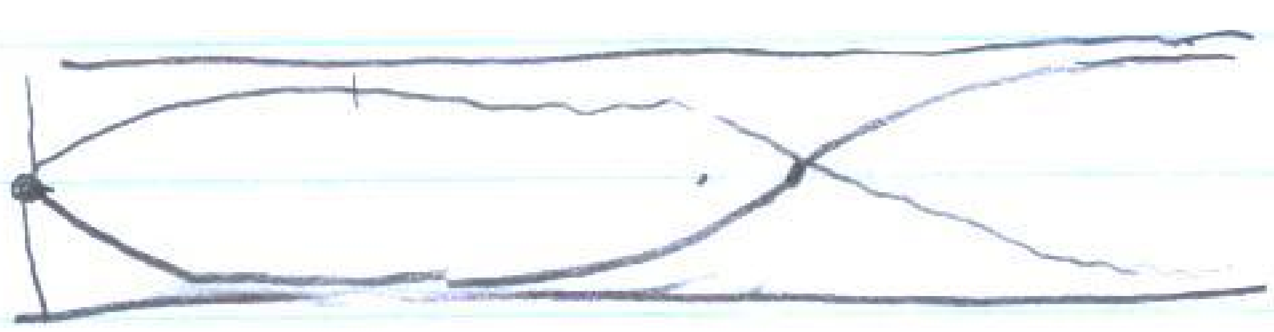
$$\boxed{146\,cm = L_{B^b}} \qquad L_{A^b} = 164\,cm$$

$$\Delta L = 164\,cm - 146\,cm = \boxed{18\,cm = \Delta L}$$

Then consider a Pipe with one end closed: Flute

$$\lambda_1 = \frac{L}{4}$$

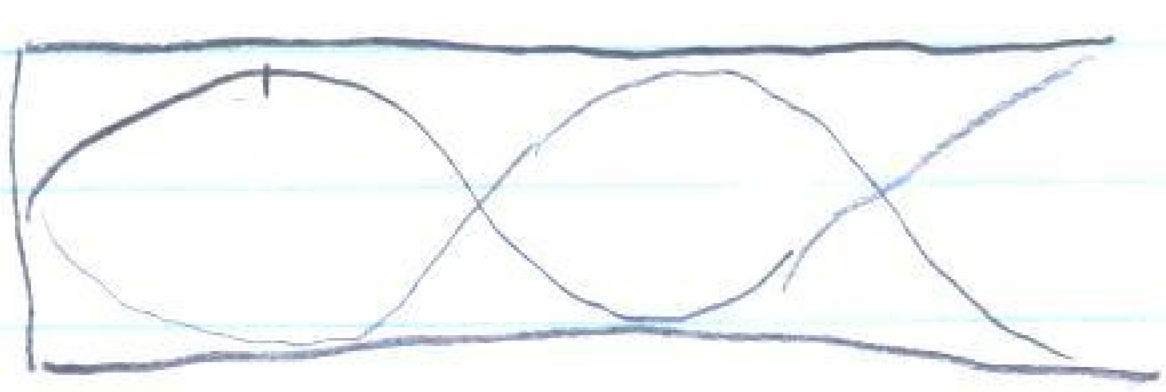
$$\lambda_n = \frac{4L}{n}$$



$n = 1, 3, 5, \ldots$

$$\lambda_3 = \frac{3L}{4}$$

$$f_n = \frac{c_s}{\lambda_n}$$



$$f_n = \underbrace{\left(\frac{c_s}{4L}\right)}_{f_0} \cdot n$$

$$\lambda_5 = \frac{4L}{5}$$

$n = 1, 3, 5, \ldots\ldots$

different from Last Time

Lab - Standing Waves

# nodes	λ	mass

Data Collection

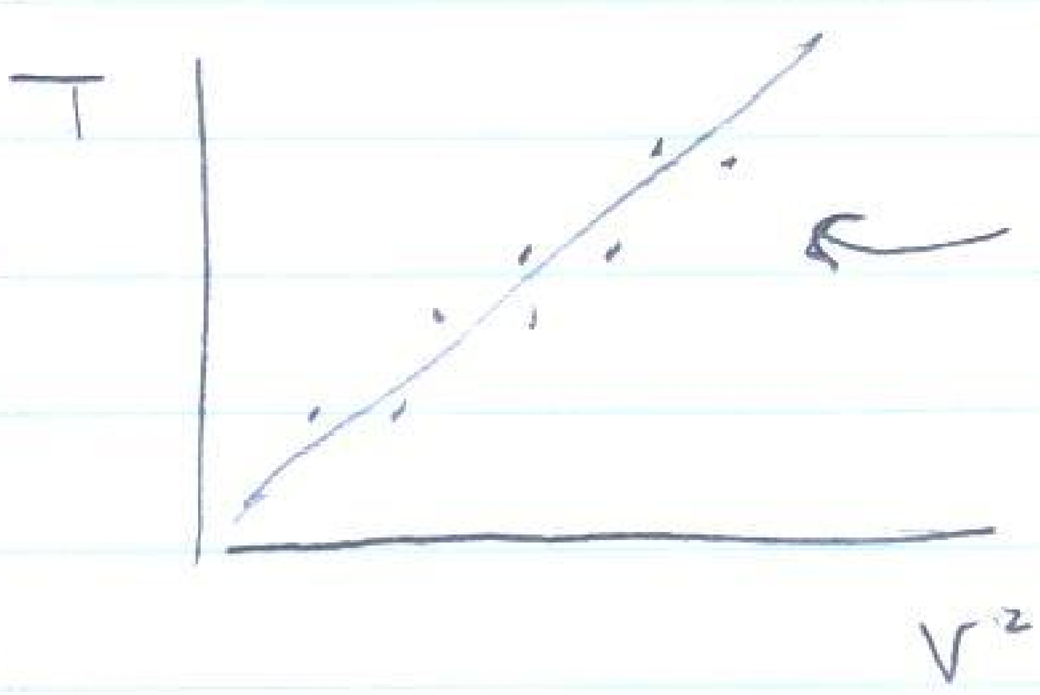
Then $v = \lambda f$ $T = mg$ Analysis

#	v^2	$T(N)$

Expectation :

$\mu v^2 = T$

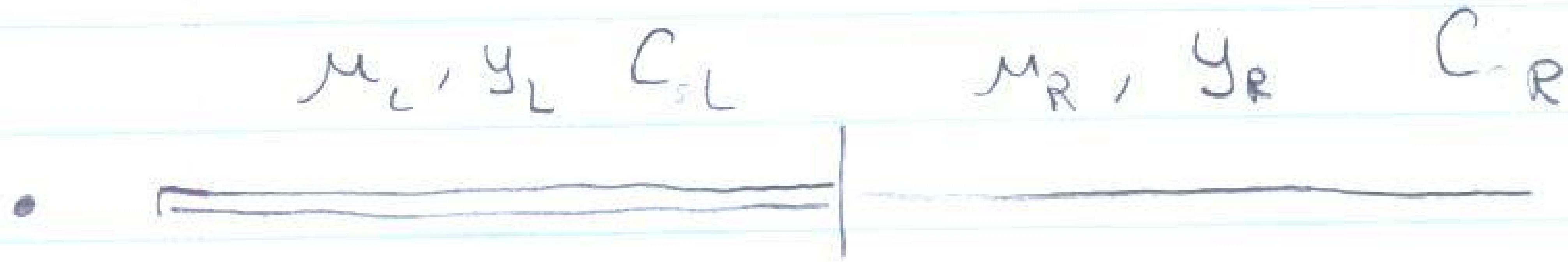
Summary



$\leftarrow$ slope $= \mu^2$

- Compare extracted

Last time:



$$y_L = A\sin(kx - \omega t) + A_R \sin(-kx - \omega t) = A_T \sin(kx + \omega t)$$

$$\frac{A_R}{A} = \frac{\left(1 - C_L/C_R\right)}{\left(1 + \frac{C_L}{C_R}\right)} = \frac{\left(1 - \frac{\sqrt{\mu_R}}{\sqrt{\mu_L}}\right)}{\left(1 + \frac{\sqrt{\mu_R}}{\sqrt{\mu_L}}\right)}$$

$$C_L = \sqrt{\frac{T}{\mu_L}} \qquad C_R = \sqrt{\frac{T}{\mu_R}}$$

$$\frac{A_T}{A} = \frac{2}{1 + C_L/C_R} = \frac{2}{1 + \sqrt{\frac{\mu_R}{\mu_L}}} =$$