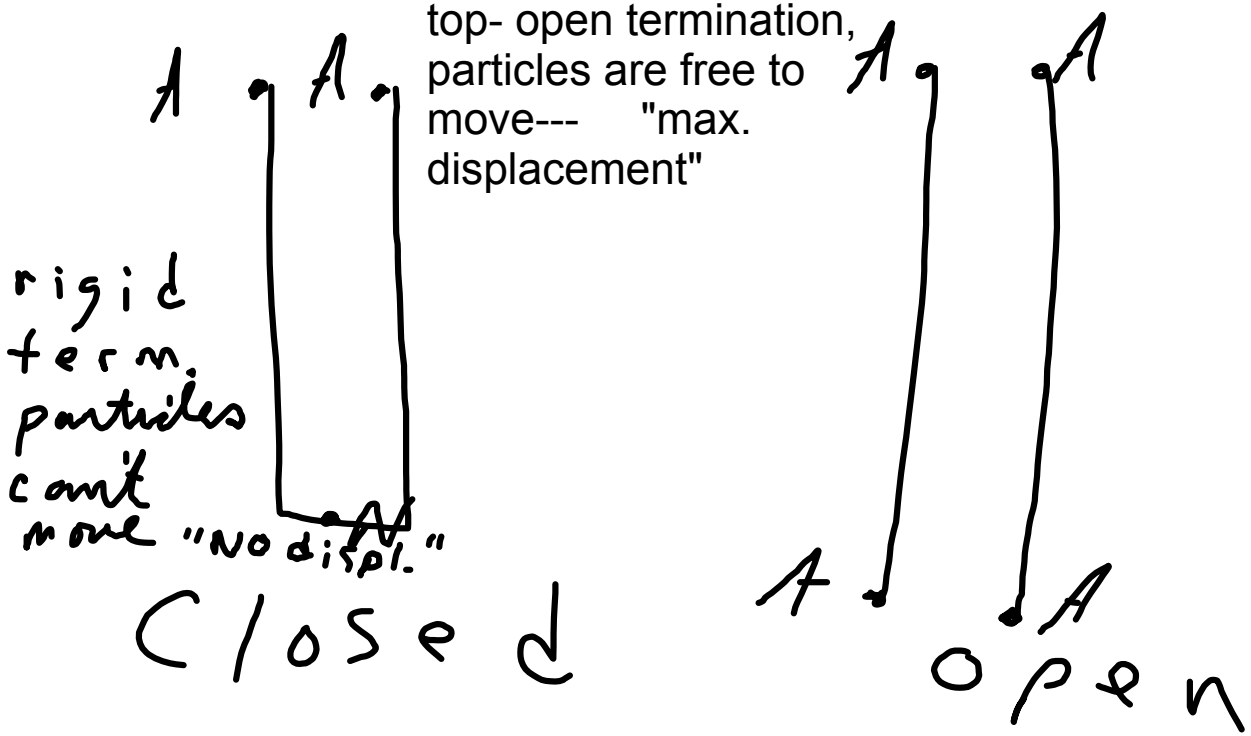
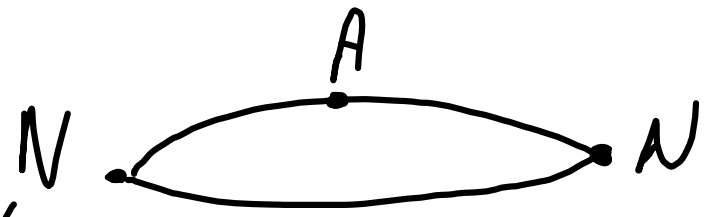
Tube Resonance

OPEN AND CLOSED TUBES

Tube Resonance





A = max. particle displacement

N = no part. displacement

Standing Waves

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

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$L = \frac{3}{2}\lambda$ algebra $\lambda = \frac{2}{3}L$

$\lambda_1 = \frac{2}{1}(1.0\,m)$ $\lambda_2 = \frac{2}{2}(1.0\,m)$ $\lambda_3 = \frac{2}{3}(1.0\,m)$

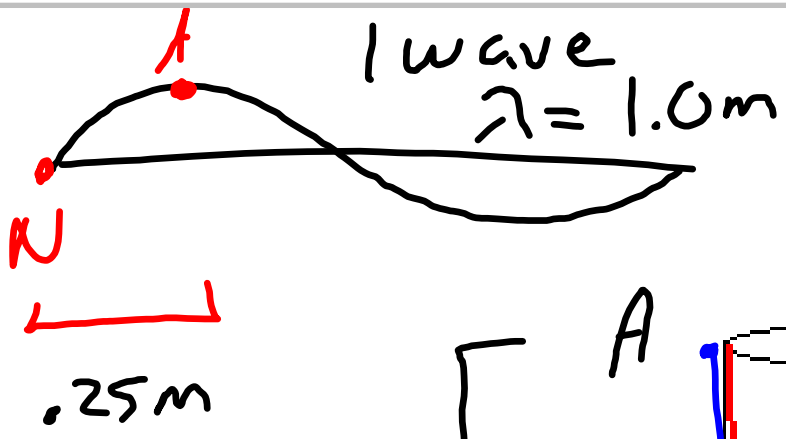
$\lambda_1 = 2.0\,m$ $\lambda_2 = 1.0\,m$ $\lambda = .66\,m$

$v_w = 160\,m/s$

$f_1 = \frac{v}{\lambda} = \frac{160\,m/s}{2m} = 80\,Hz$

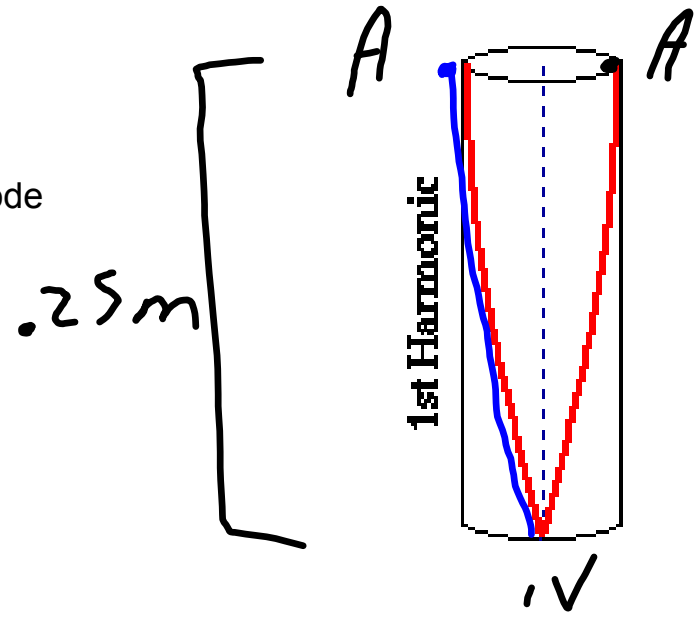
$f_2 = \frac{v}{\lambda_2} = \frac{160\,m/s}{1.0\,m} = 160\,Hz$

$f_3 = \frac{v}{\lambda_3} = \frac{160\,m/s}{.66\,m} = 240\,Hz$

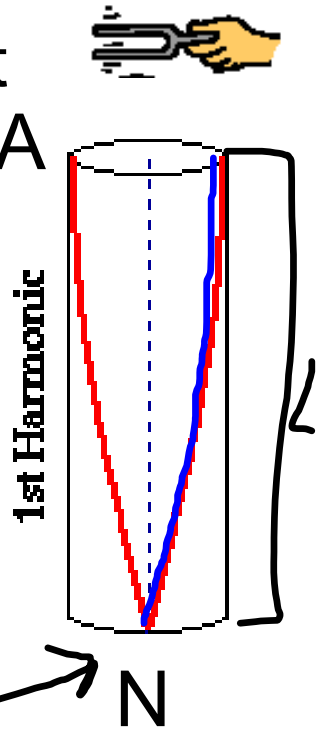


closed termination

.25 m from a node to an antinode



at *antinode* particles are free to move and have max. displacement



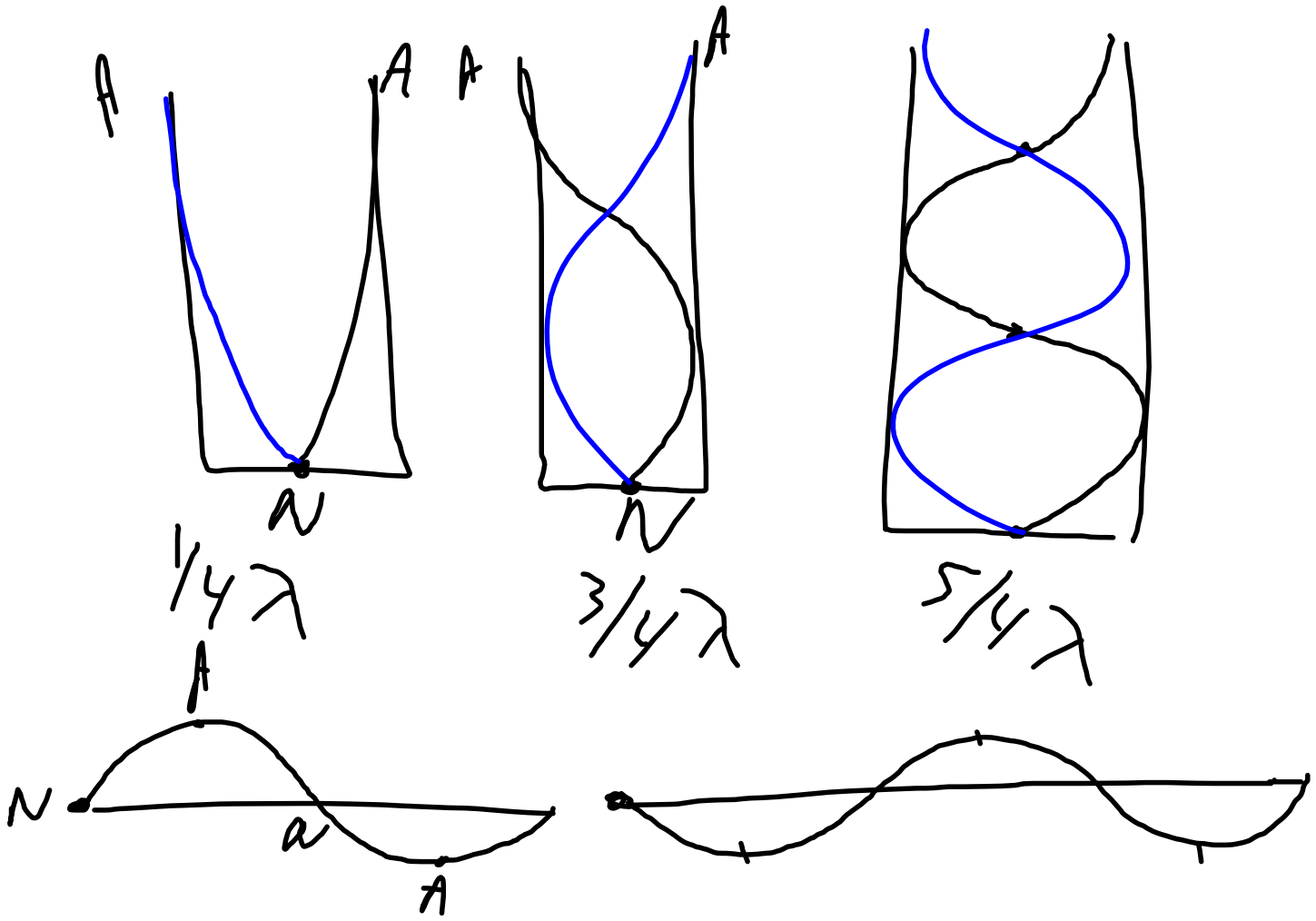
- incident pulse
- reflected pulse

$\frac{1}{4}\lambda = L$

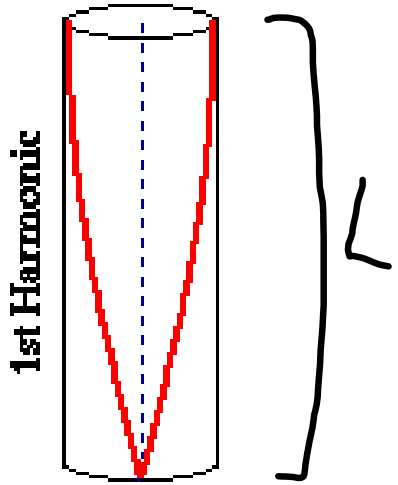
$\lambda = 4L$

because of rigid termination there is a *node* at the closed end of the tube

other possible arrangements of nodes and antinodes of waves that will resonate in the closed tube



$L = 30\,cm$



$v_s = 340\ m/s$

$\lambda_1 = 1.2\ m$

$\therefore f_1 = \frac{v}{\lambda} = \frac{340\ m/s}{1.2\ m}$

$f_1 = 283\ Hz$

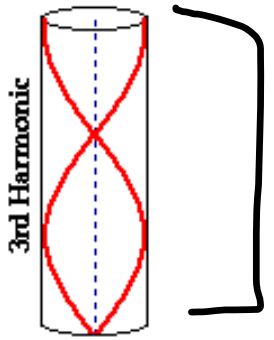
① $L = \frac{1}{4}\lambda_1$

$\lambda_1 = \frac{4}{1}L$

$\lambda_1 = \frac{4}{1}(.30\ m)$

$\lambda_1 = 1.2\ m$

L = 30 cm



30 cm

$L = 3/4\,\lambda$

$\lambda = 4/3\,L$

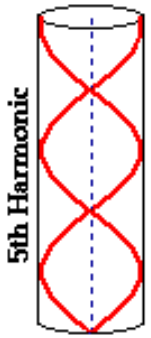
$\lambda = 4/3(.3m) = .4m$

$f = \frac{v}{\lambda_2}$

$f = \frac{340\,m/s}{.4m}$

$f = 850\,Hz$

L = 30 cm



.3m

$5/4\lambda = L$

$\lambda = 4/5\, L$

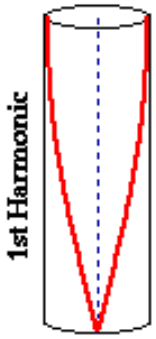
$\therefore \lambda = 4/5(.3m)$

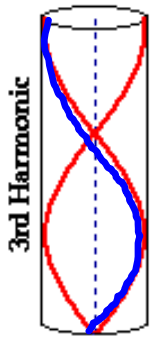
$\lambda = .24m$

$v = f\lambda$

$f = \frac{v}{\lambda} = \frac{340\,m/s}{.24m}$

$f = 1417\,Hz$





$\frac{1}{4}\lambda$ $\frac{3}{4}\lambda$ $\frac{5}{4}\lambda$

$\lambda = 4L$ $\lambda = \frac{3}{4}L$ $\lambda = \frac{4}{5}L$

$f_1 = 283\,Hz$ $f_3 = 850\,Hz$ $f_5 = 1417\,Hz$

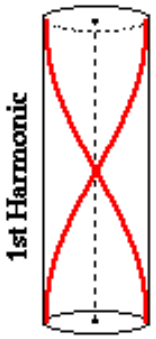
1st harmonic 3rd harmonic 5th harmonic

Closed Tubes:

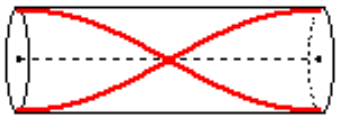
1) resonate at every odd $\frac{1}{4}\lambda$ ($\frac{1}{4}\lambda, \frac{3}{4}\lambda, \frac{5}{4}\lambda, \frac{7}{4}\lambda \ldots$)

2) resonates at every odd harmonic

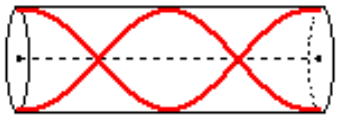
$1, 3\pm, 3, 5\pm, 5, 7\pm, \ldots$


1st Harmonic

1st Harmonic



2nd Harmonic



3rd Harmonic