Phys 2426 2016-11-10 Lec 23

Doppler Example

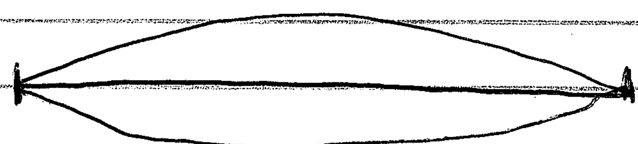
$$\frac{\Delta f}{f} = \frac{V_{rel}}{V_{wave}}$$

$$\frac{192 \text{ Hz}}{4703 \text{ Hz}} = \frac{V_{rel}}{340 \text{ m/s}}$$

$$V_{rel} = 13.9 \text{ m/s} = 31 \text{ MPH}$$

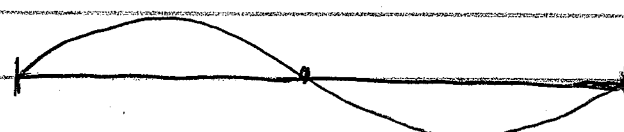
Standing Waves

$\boxed{\lambda_1 = 2L}$



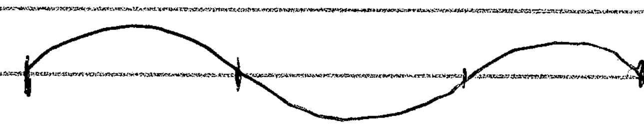
$v = f\lambda$ $\quad f_1 = \frac{v}{\lambda_1} = \frac{v}{2L}$ Fundamental

$\lambda_2 = L$



$f_2 = \frac{v}{\lambda_2} = \frac{v}{L} = \boxed{2} f_1$

$\lambda_3 = \frac{2L}{3}$



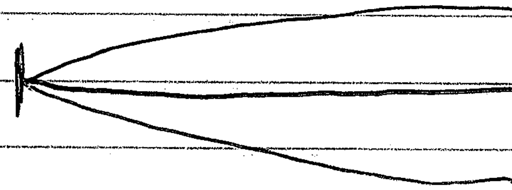
$f_3 = \frac{3v}{2L} = \boxed{3} f_1$

Harmonics

2

Standing Waves w/ different ends

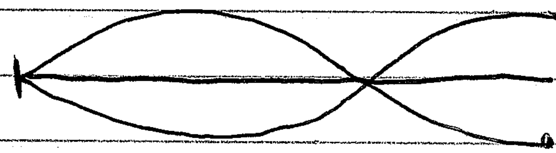
$$\boxed{L = \lambda_1/4}$$



$\lambda_1 = 4L$

$f_1 = \frac{v}{\lambda_1} = \frac{v}{4L}$

Next Harmonic



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

$\lambda = (4/3)L$

$f = \frac{v}{\lambda} = \frac{3v}{4L} = \boxed{3} f_1$

Different Ends: $L = \lambda_1/4$

odd harmonics

(3)

Ex: Speed of waves on slinky

$f_1 = 2$ Hz $\pm 20\%$

$L = 3.5$ m $\pm 20\%$

$\lambda_1 = 2L = 7.0$ m

$v = f\lambda = 14$ m/s

Tuning a string:

$v = \sqrt{F_T / \mu}$ $\mu =$ mass/length

Usually: Change F_T w/o changing L or μ.

Result: $f_1 \propto \sqrt{F_T}$

Ex: Increase F_T by 2%:

$F_T \Rightarrow 1.02\ F_T$

$f_1 \rightarrow \sqrt{1.02}\ f_1 = 1.00995\ f_1$

$\sim 1.01\ f_1$

Freq increases by 1%