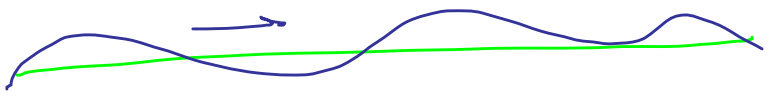
Phys 2110-4 4/16/12

Note Title 4/16/2012

Waves

Kinds of Waves

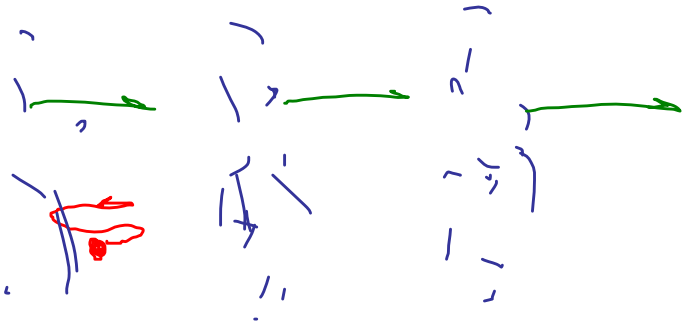


$$v = \sqrt{\frac{F}{\mu}} \qquad \lambda f = v$$

$$y(x,t) = A\cos(kx \mp \omega t + \phi)$$

$$k = \frac{2\pi}{\lambda} \qquad v = \frac{\omega}{k} \qquad \omega = 2\pi f$$

Sound Waves



Humans hear

$20Hz - 20,000Hz$

$v = \sqrt{\frac{\gamma P}{\rho}}$

Dogs $\rightarrow$ $30,000Hz$

Bat $\rightarrow$ $100,000Hz$

Loudness How to measure it.

Intensity:

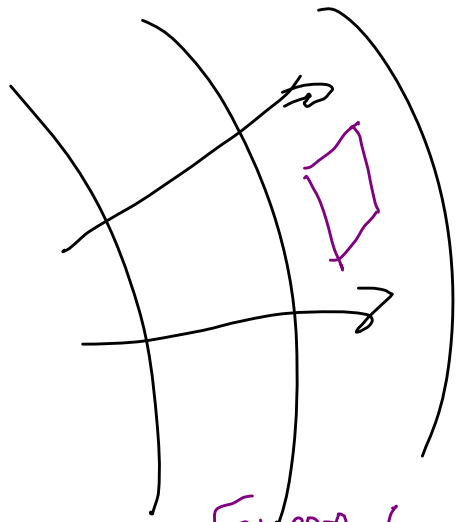
$I_0 = 10^{-12}\ W/m^2$

lowest intensity

$I_{conversation} \approx 10^{-6}\ W/m^2$

$I_{max\ (pain)} = 10^{0}\ W/m^2$

Take logarithm (base 10)



$I = \frac{Energy}{Area \cdot Time} = \frac{Power}{Area}$

Better $\log_{10}\left(\frac{I}{I_0}\right)$ $I_0 = 10^{-12}\ W/m^2$

Better still $\beta = 10 \log_{10}(I/I_0)$

β = sound intensity level

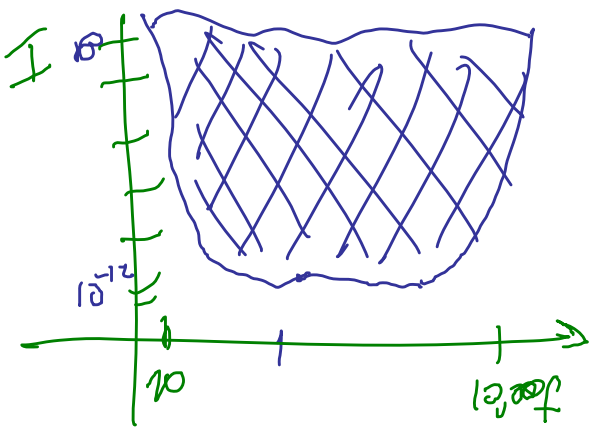
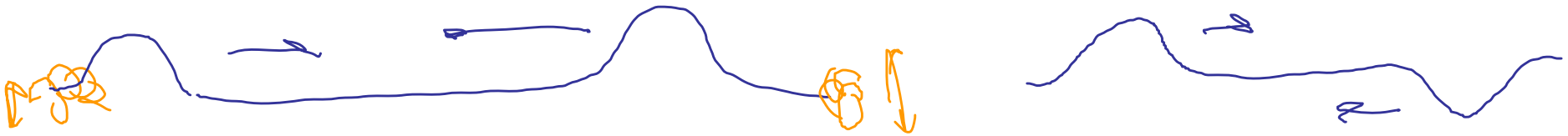
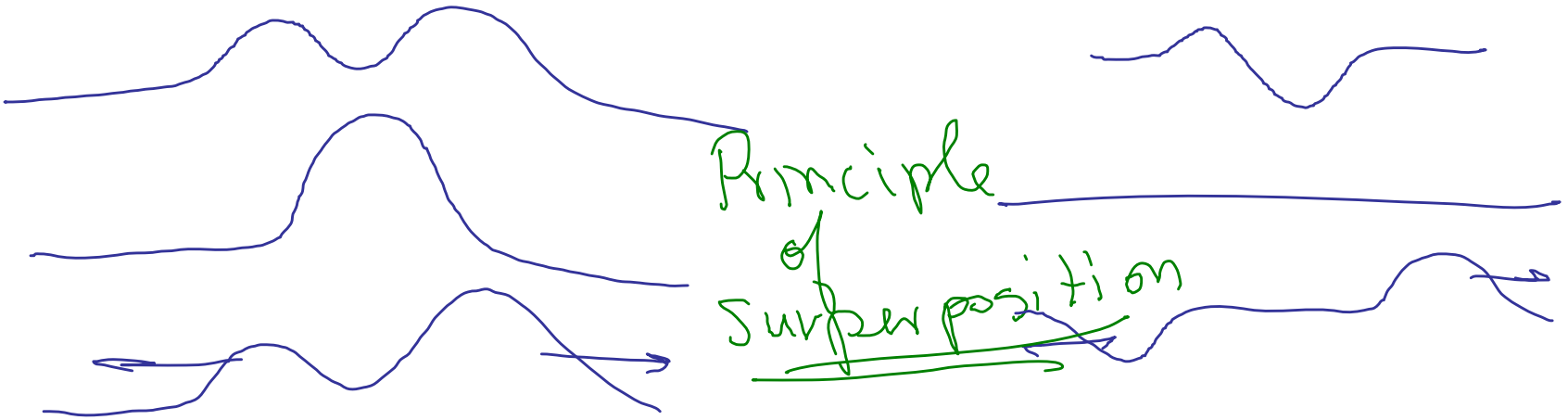


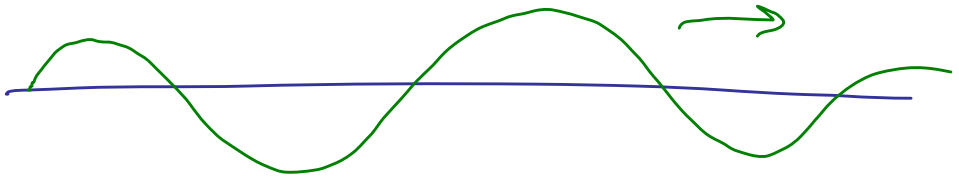
Fig 14.15

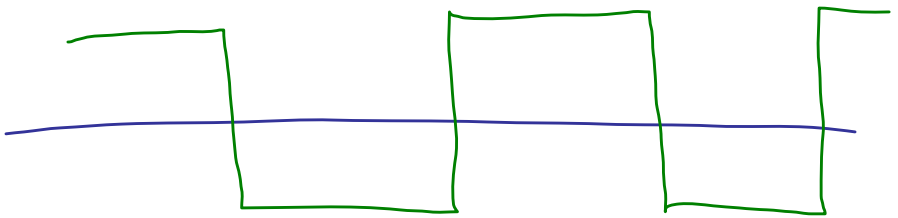
Waves are more interesting when they add together.

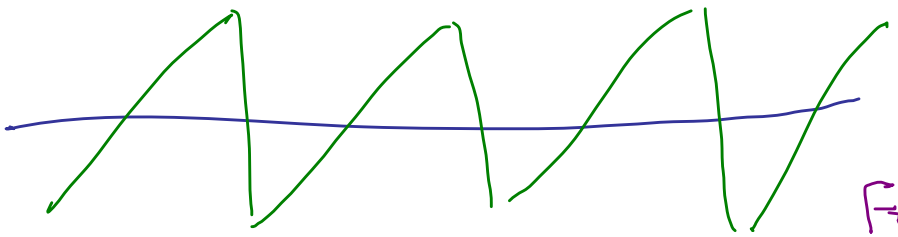




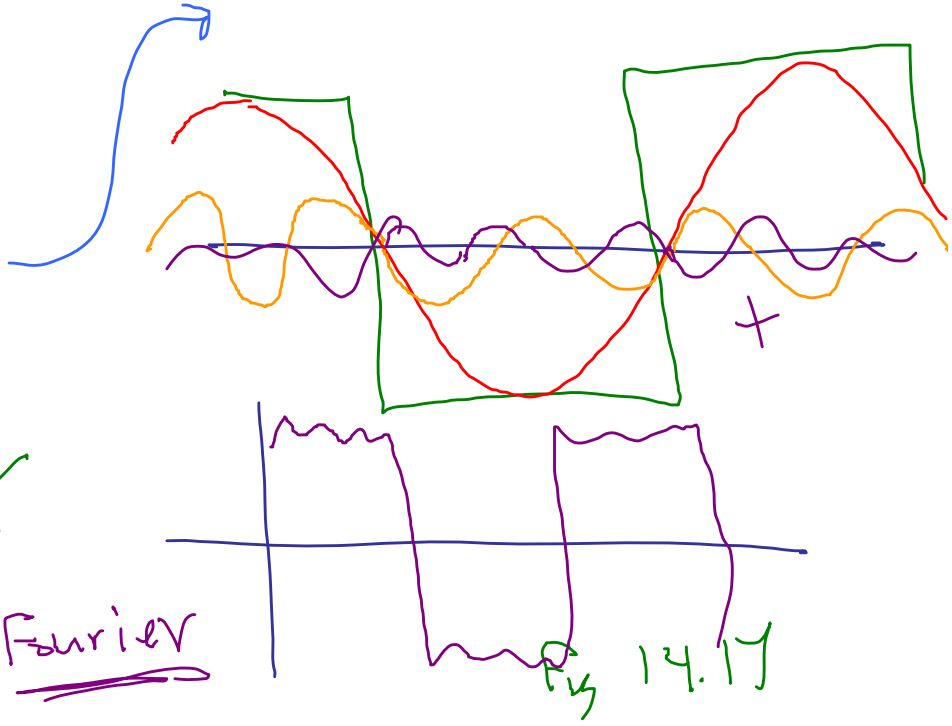
With harmonic waves one can form any wave by adding them





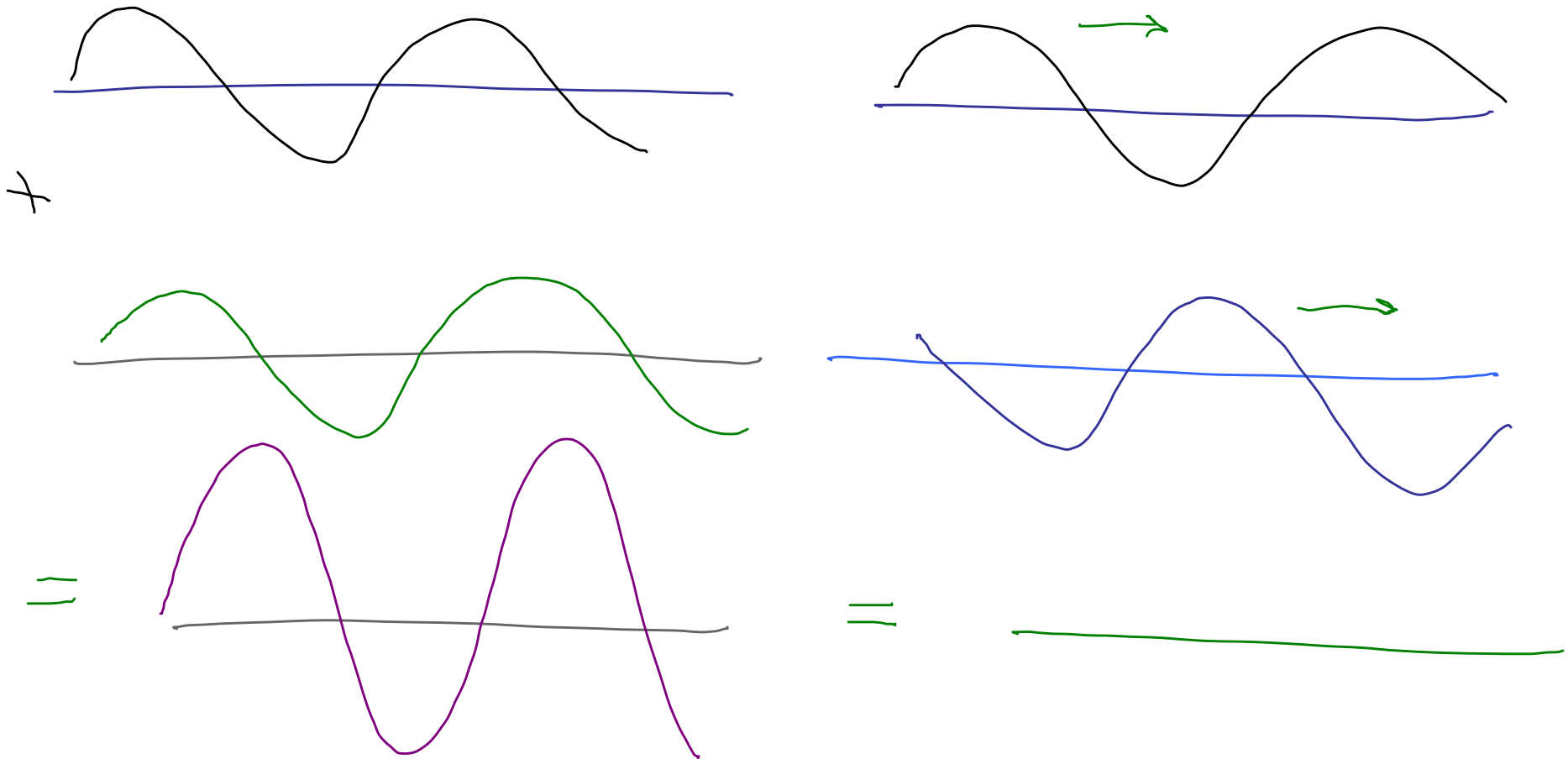


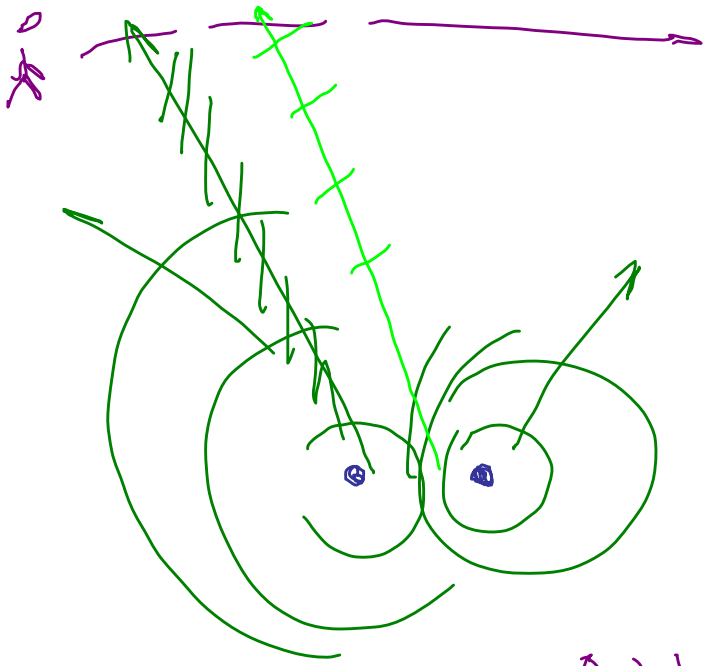
Make square wave by adding harmonic waves



Fourier

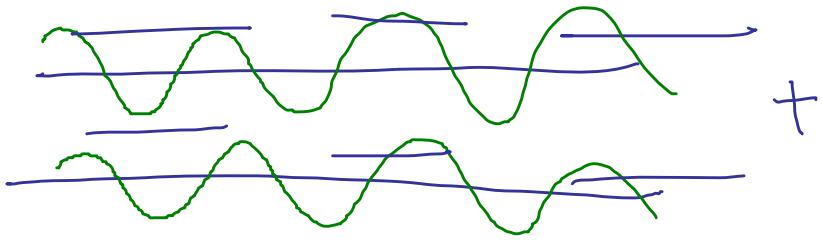
Fig 14.17





Beats

Add two waves, slightly different frequencies, diff wavelengths



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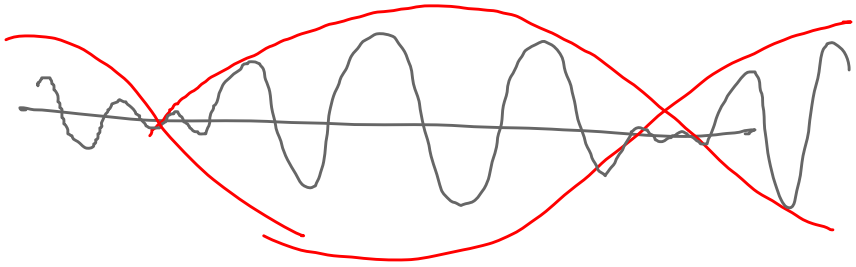
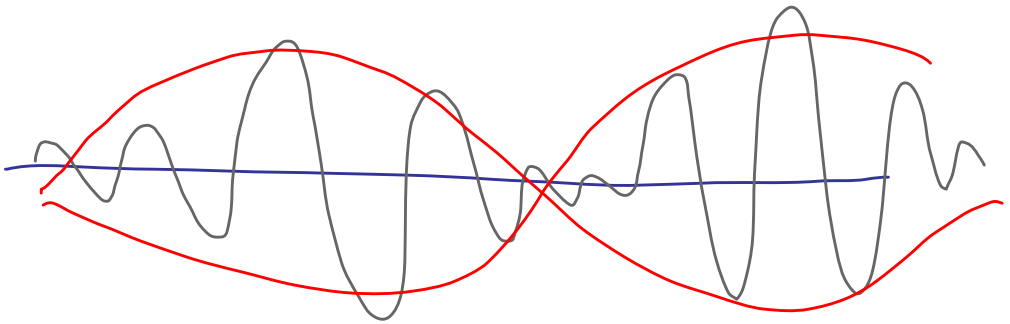


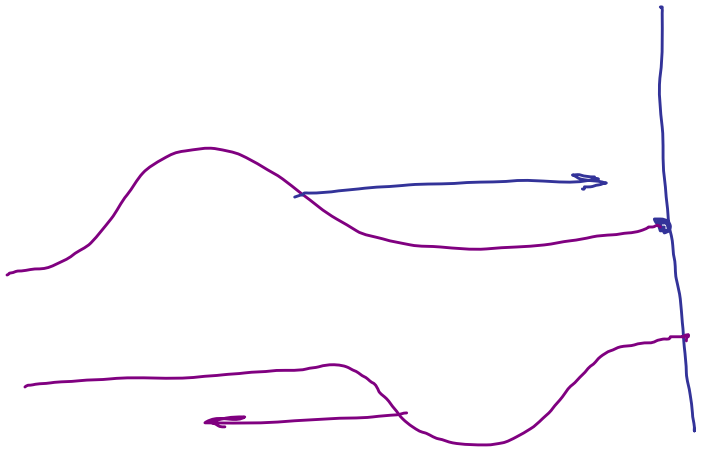
Beats

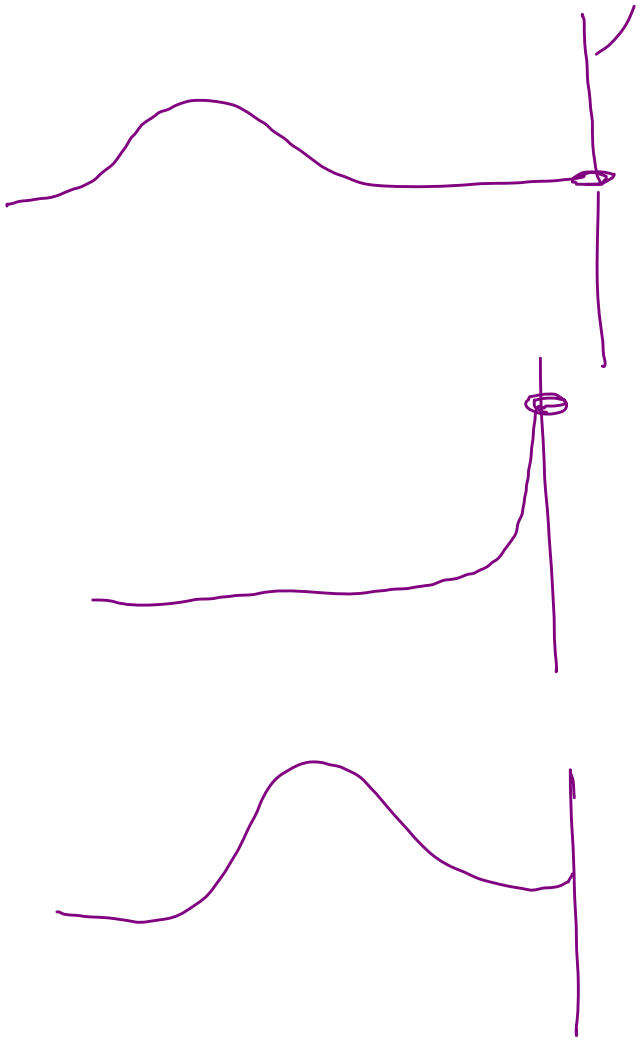


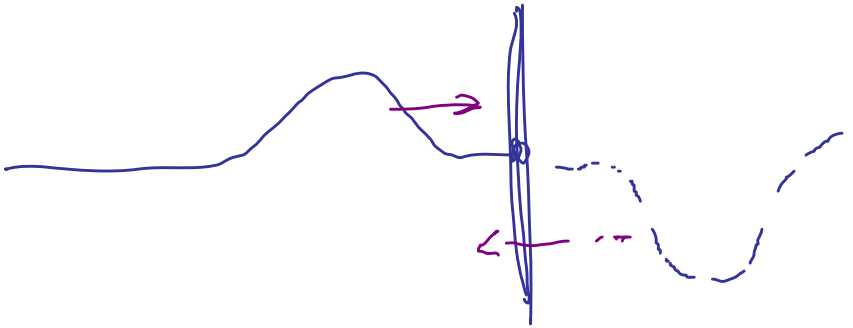
$f_{\text{Beats}} = |f_2 - f_1|$

(pulses)

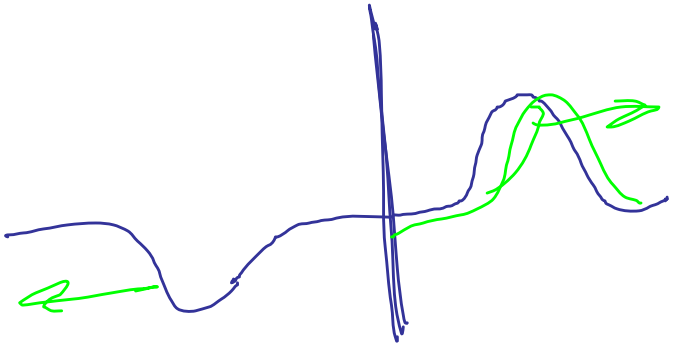
Reflections



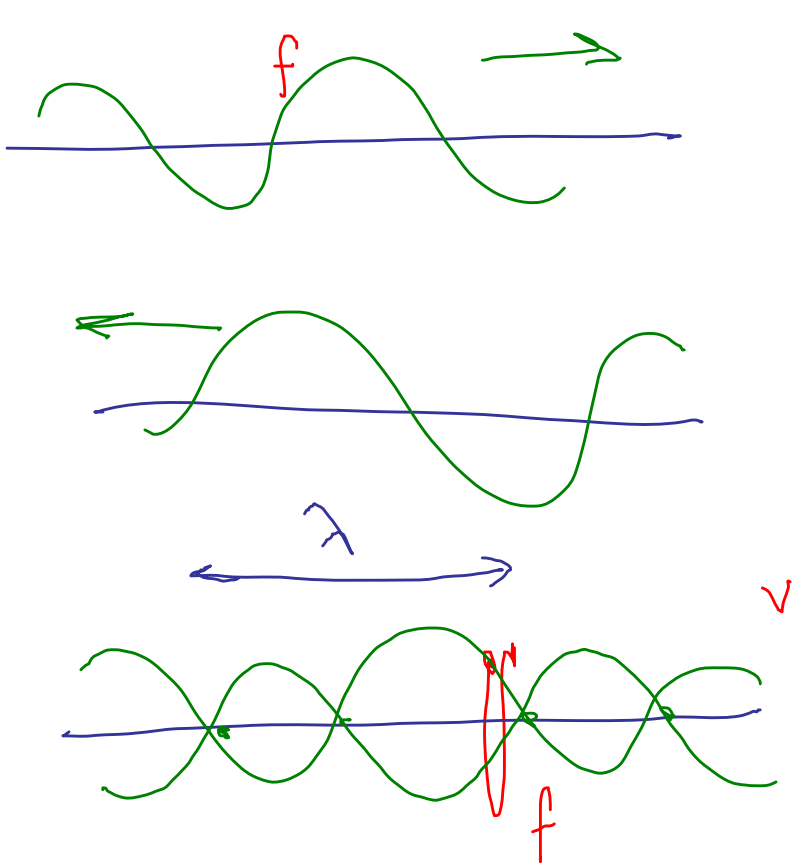




Soft boundary,
same sign.



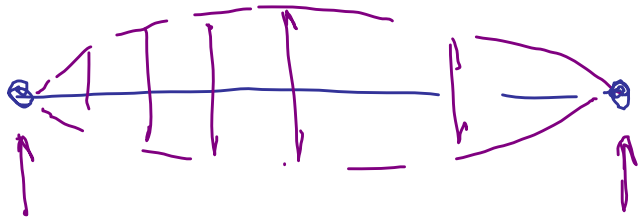
More fun w/ Waves

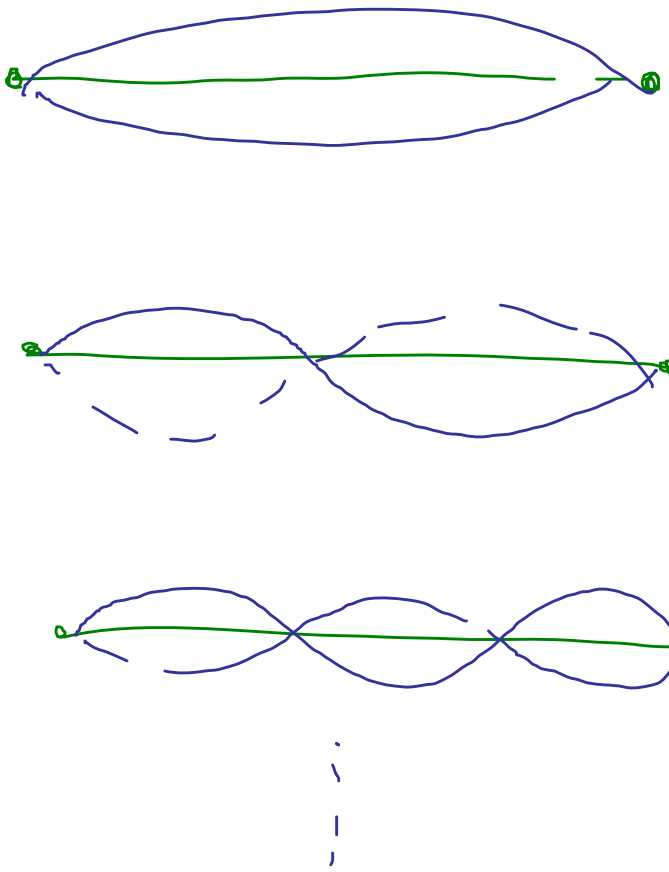


Same λ Same
same f v

opposite direction.

Gives standing wave





Harmonics

Overtones