Physics 113 - December 10, 2013

- Final Exam - Thurs. Dec 19, 7:15 pm, Hubbell
  - Both sides of 8.5×11 inch sheet
  - Cumulative
  - Thru chapter 15 - may refine this a little depending on where we get this week
- Prob set 11
- Q + A session TBA
- Regrades, P.S., etc.

Last Time

Simple Harmonic Motion

$$\frac{d^2x}{dt^2} + (\text{const})\,x = 0$$

$$x = \underbrace{A}_{\text{Amplitude}}\ \overset{\text{or cos}}{\sin}(\underbrace{\omega}_{\text{Frequency}} t + \phi) \qquad \text{where} \quad \omega^2 = \text{const}$$

initial phase Angle → defines starting point

Frequency $= \frac{2\pi}{T}$ — Period

Think of Springs

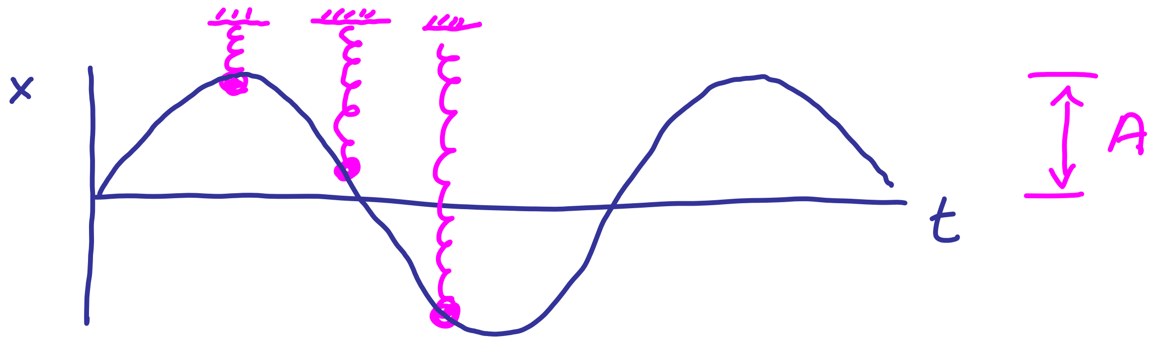
of This form

$F = -Kx$

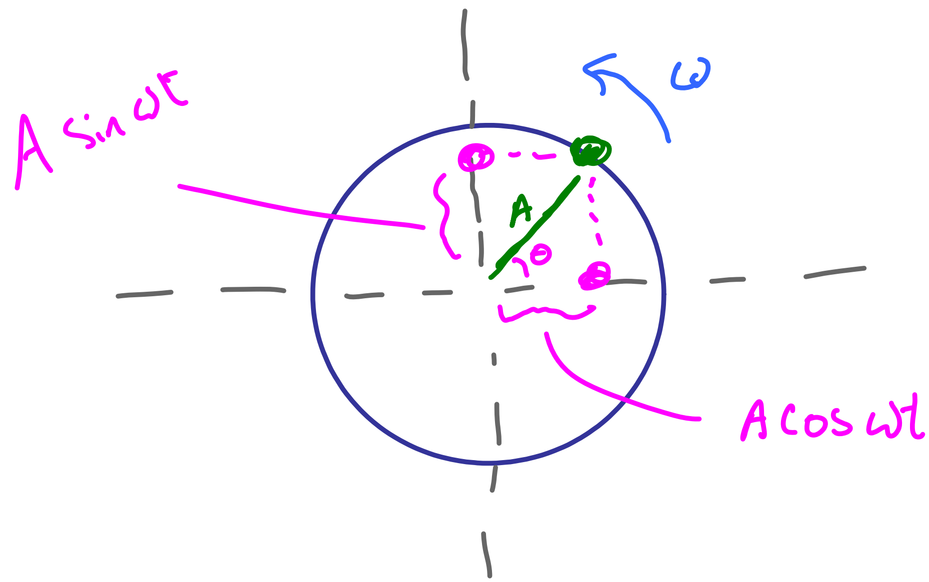
$$m\frac{d^2x}{dt^2} = -Kx$$

$$\frac{d^2x}{dt^2} + \frac{K}{m}x = 0$$

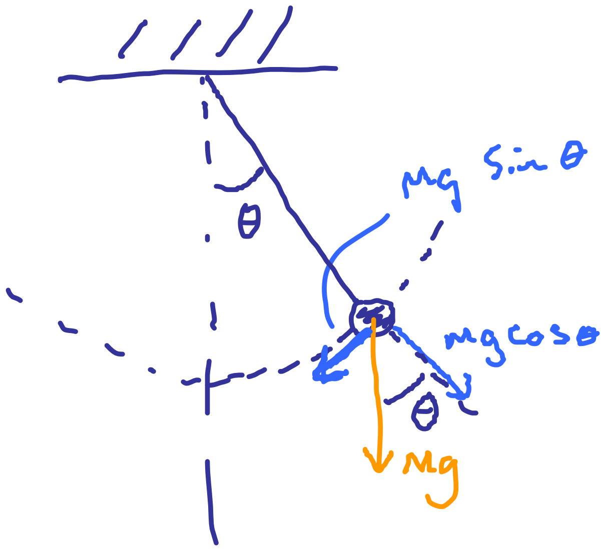
SHO
&
connection to
circular motion



one full cycle
of motion in
time of one
"period"

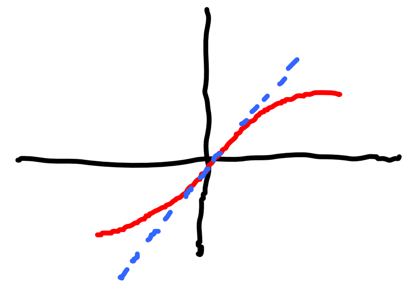


Simple Pendulum Example

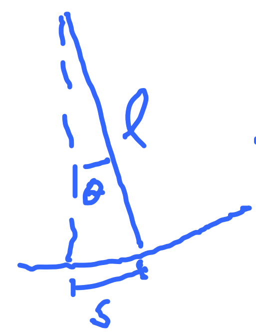


$$F_{\text{tangential}} = -mg\sin\theta$$

$$m\frac{d^2s}{dt^2} = -mg\underbrace{\sin\theta}_{\sim \underbrace{\theta}_{s/\ell}}$$



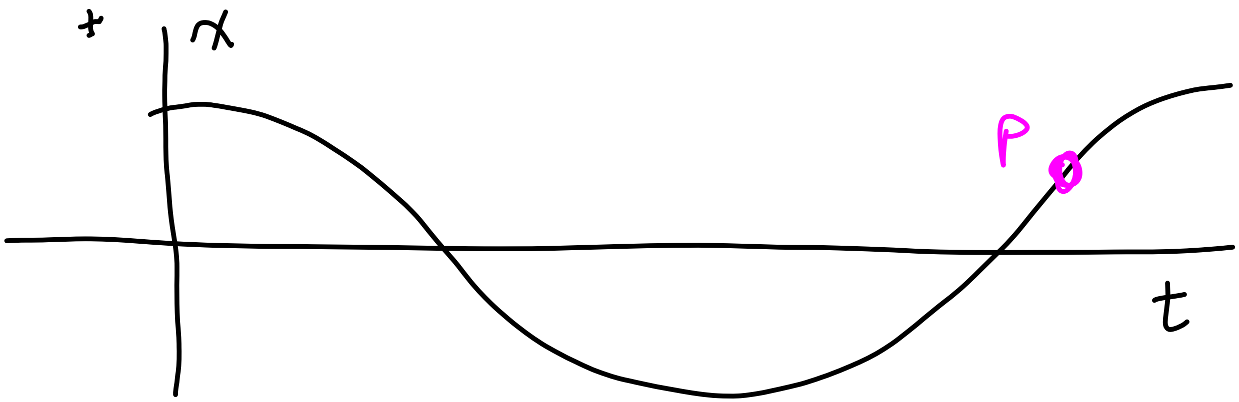
$\sin\theta \sim \theta$
for small θ



$s = \ell\theta$

$$\frac{d^2s}{dt^2} + \frac{g}{\ell}s = 0$$

SHM w/ $\omega^2 = g/\ell$



What can we say about v and a for P undergoing SHM

I   pos. velocity (+v), pos. Accel. (+a)

II   + v , − a

III   − v , − a

IV   − v , + a

V   0 v , 0 a

A simple pendulum has period T on Earth. What is the period of same pendulum if taken to the moon

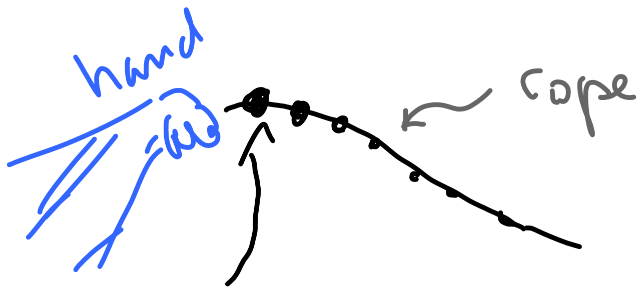
$\omega^2 = g/l$

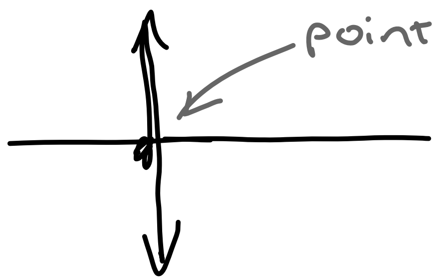
I $T_E > T_M$

II $T_E < T_M$

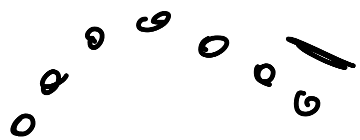
III $T_E = T_M$

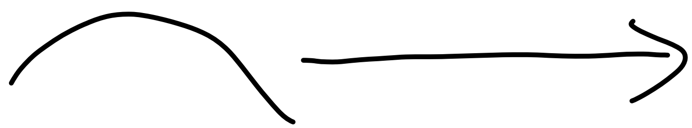
Waves

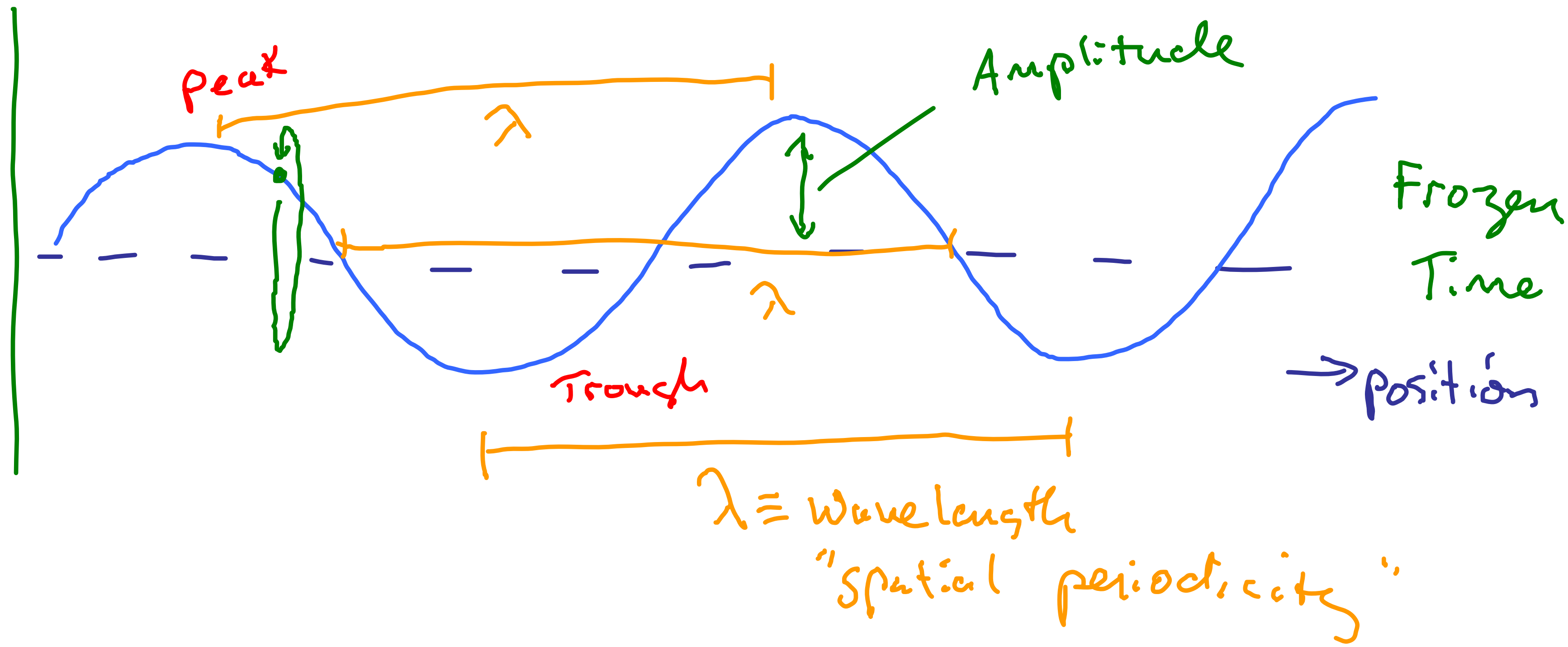




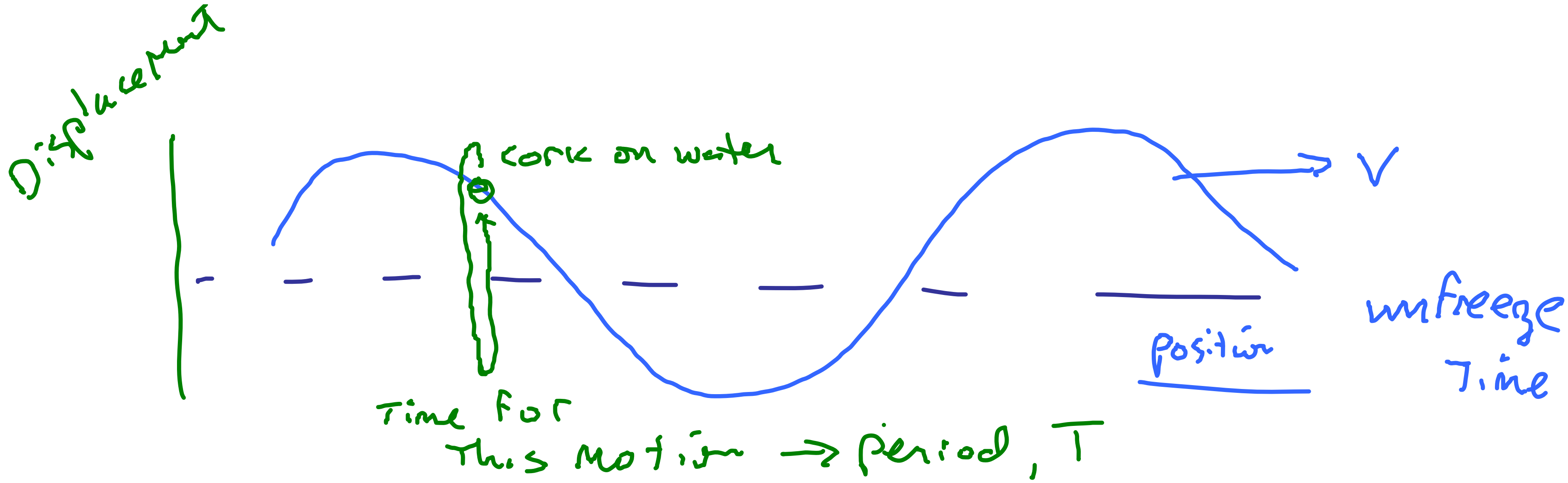
point on rope moves up + down in SHO







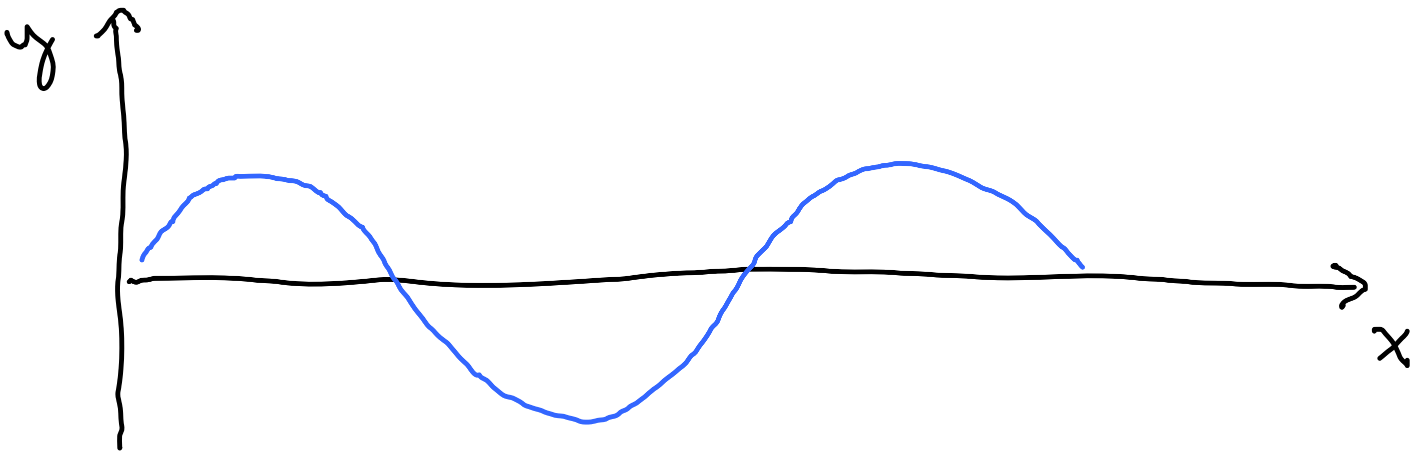
Peak
λ
Amplitude
Frozen Time
λ
Trough
→ position
$\lambda \equiv$ wavelength
"spatial periodicity"



Frequency $\equiv \frac{1}{T} = f$ (sound, strings)

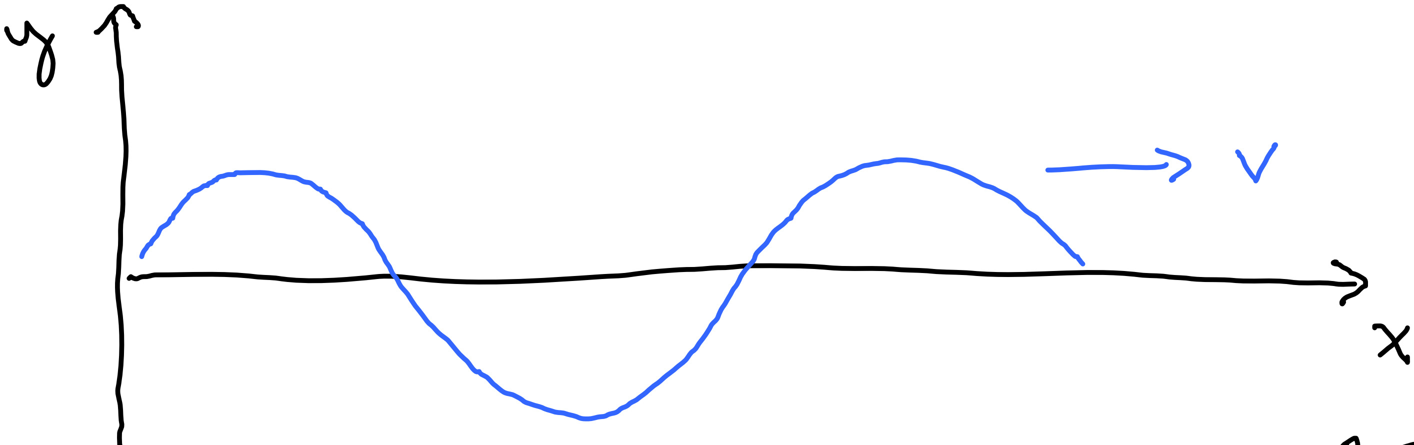
ν (light)

$$\boxed{v = \lambda / T = \lambda f \overset{\text{or}}{=} \lambda \nu}$$



$$y(x) = A \sin(kx)$$

$$\frac{2\pi}{\lambda}$$



$y = A \sin(\omega t)$

$\frac{2\pi}{T}$

$y(x,t) = A \sin(kx - \omega t)$ v to +x right

$y(x,t) = A \sin(kx + \omega t)$ v → left, −x

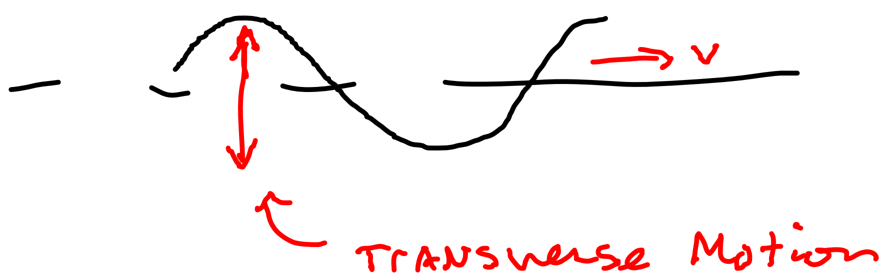
For CONSTANT "phase"

$$kx - \omega t = \text{CONSTANT}$$

$$\frac{d}{dt}(kx - \omega t) = 0$$

$$= k\frac{dx}{dt} - \omega = 0$$

$$\frac{dx}{dt} = +\frac{\omega}{k} = \frac{\frac{2\pi}{T}}{\frac{2\pi}{\lambda}} = \frac{\lambda}{T} = v$$



Transverse wave

longitudinal wave

"Slinky"

Sound

on string

$$v = \sqrt{\frac{T}{\mu}}$$

T ← Tension

μ ← linear mass density

λ

low pressure

→ v_{sound}

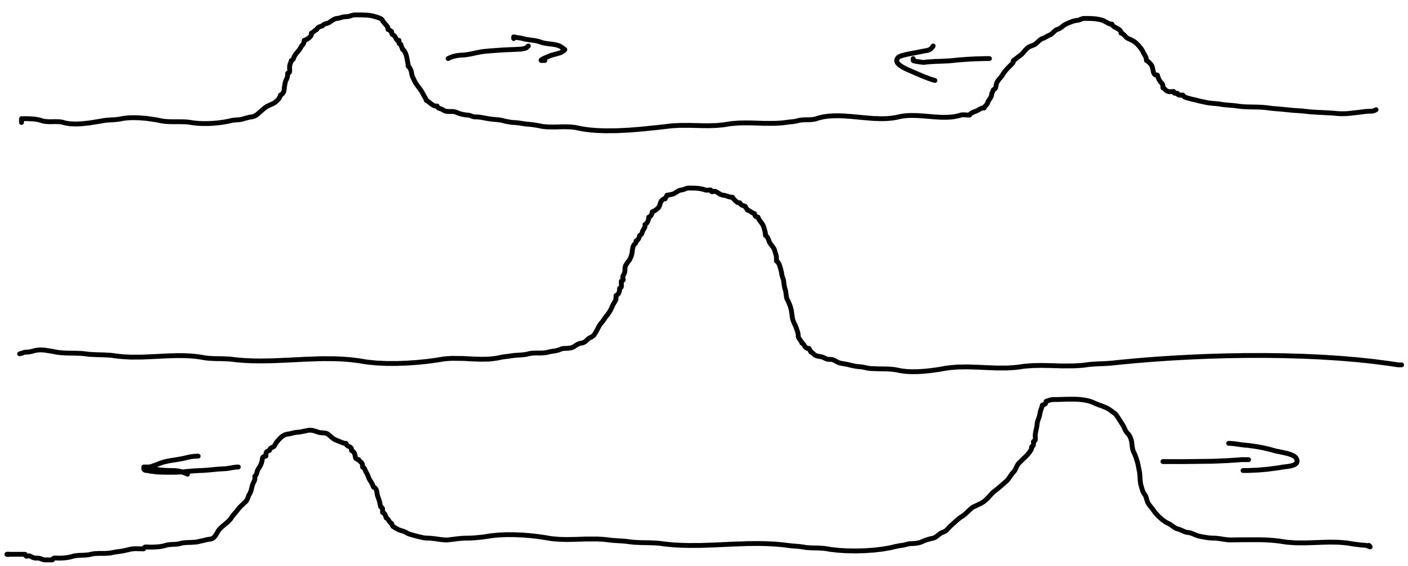
high pressure

$$v_{sound} = \sqrt{\frac{B}{\rho}}$$

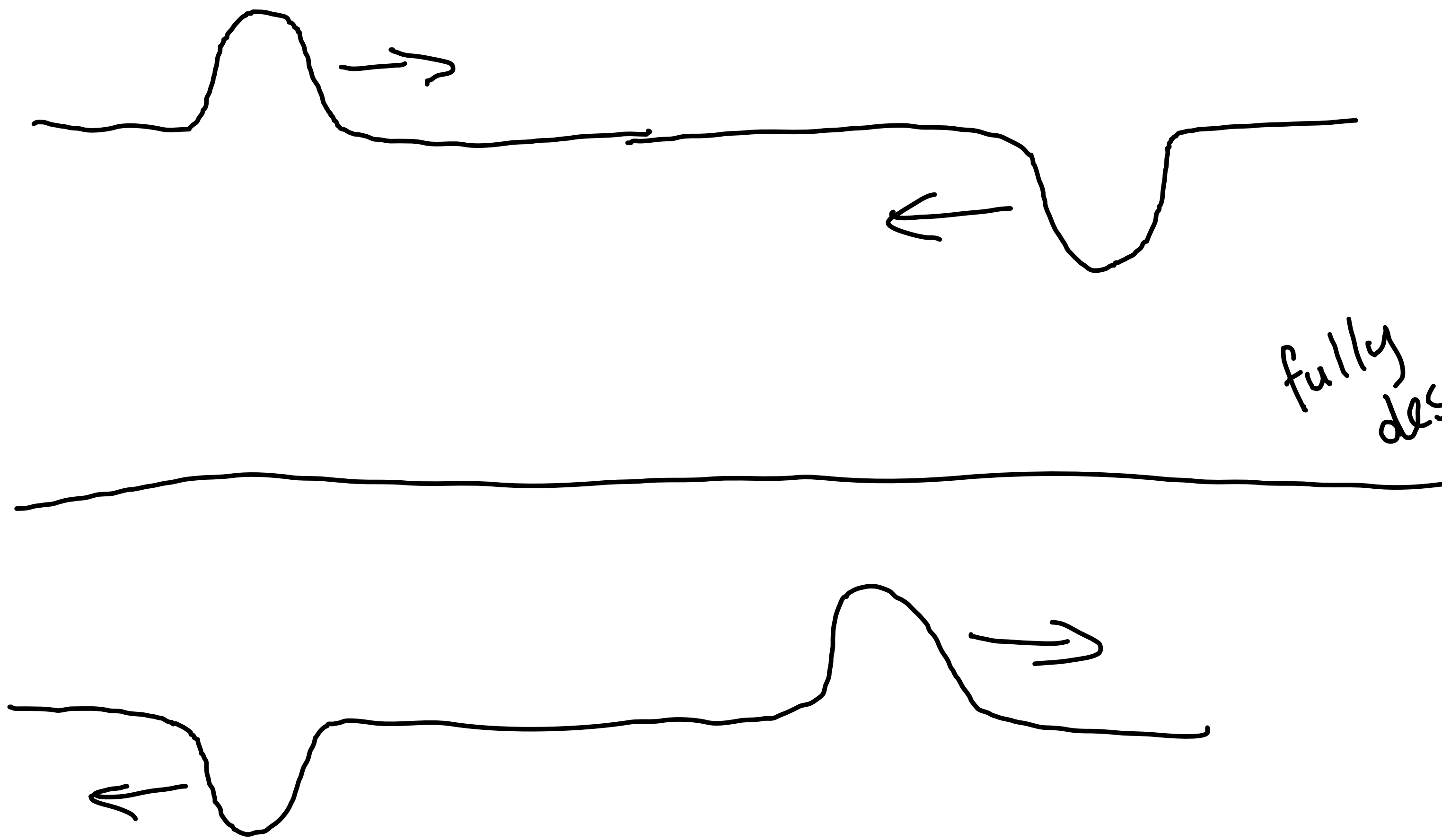
B ← Bulk modulus

ρ ← volume density

Waves exhibit Superposition

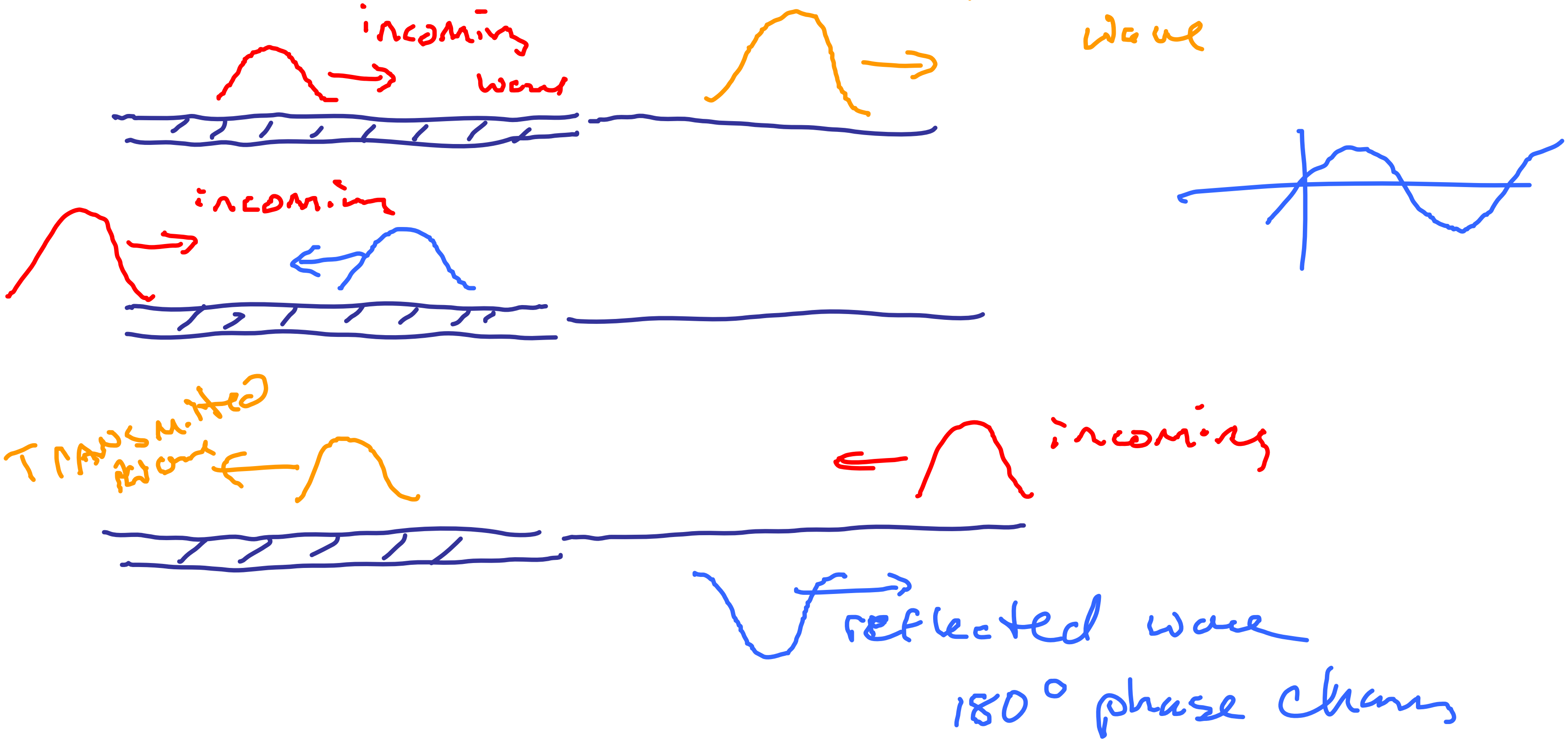


fully constructive inference



fully destructive interference

Waves + Boundaries



fast to slow

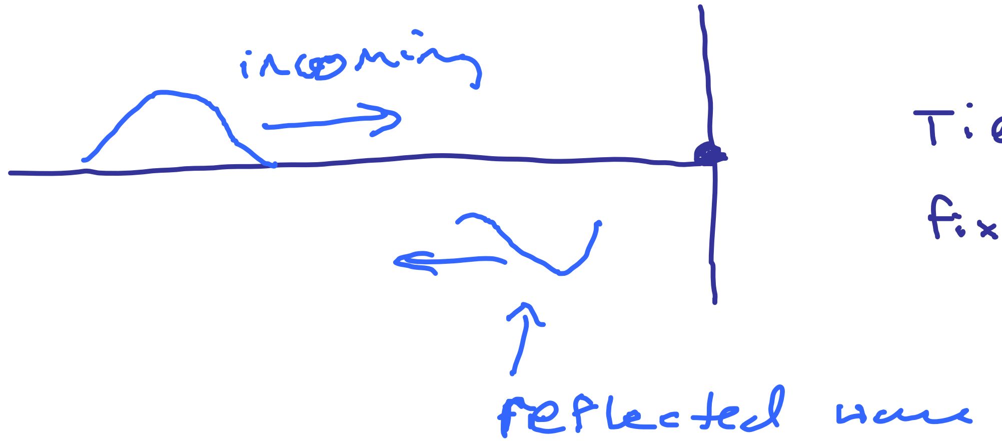
low μ to high μ

180° phase Δ for reflected wave

Slow to fast

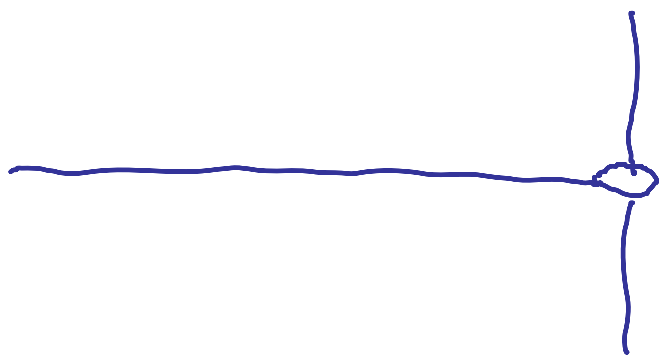
high μ to low μ

No phase change



Tie string fixed end

180° phase change



Free to move

No phase change