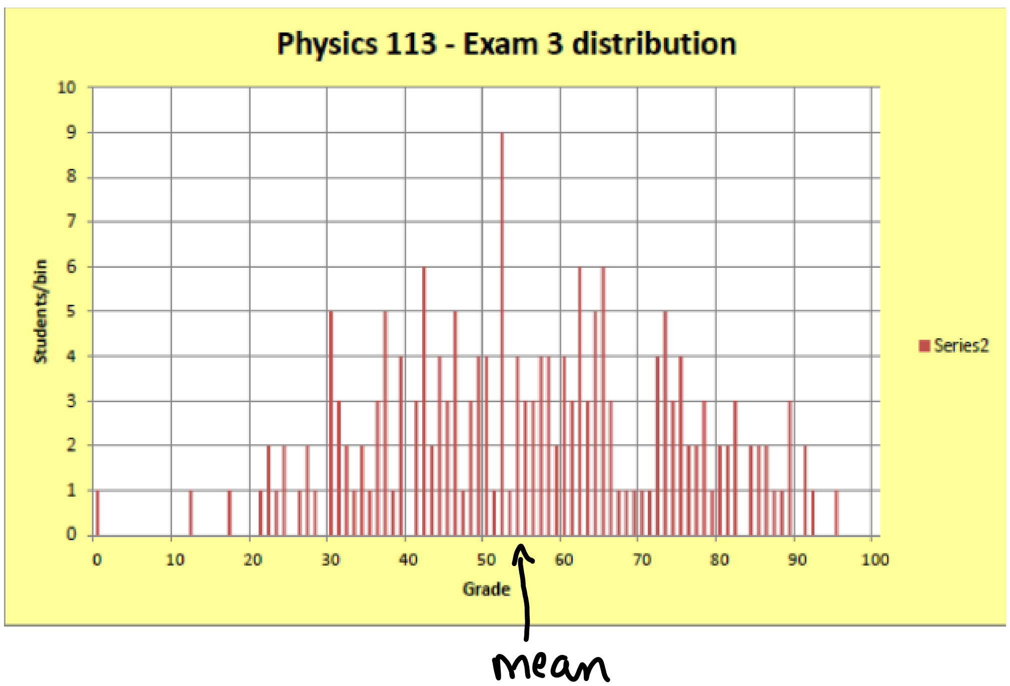
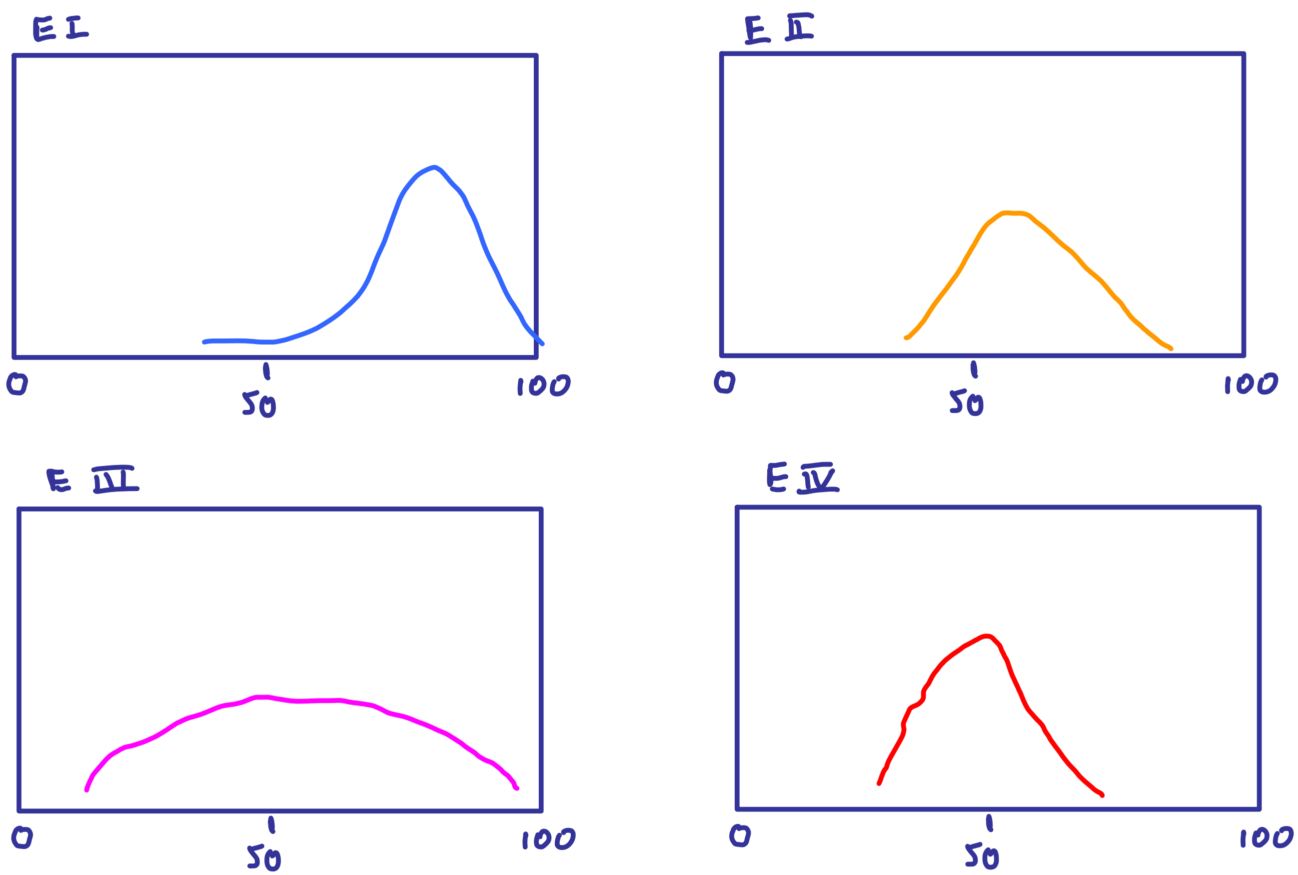
Physics 113 – December 11, 2012



Solutions are posted on class website

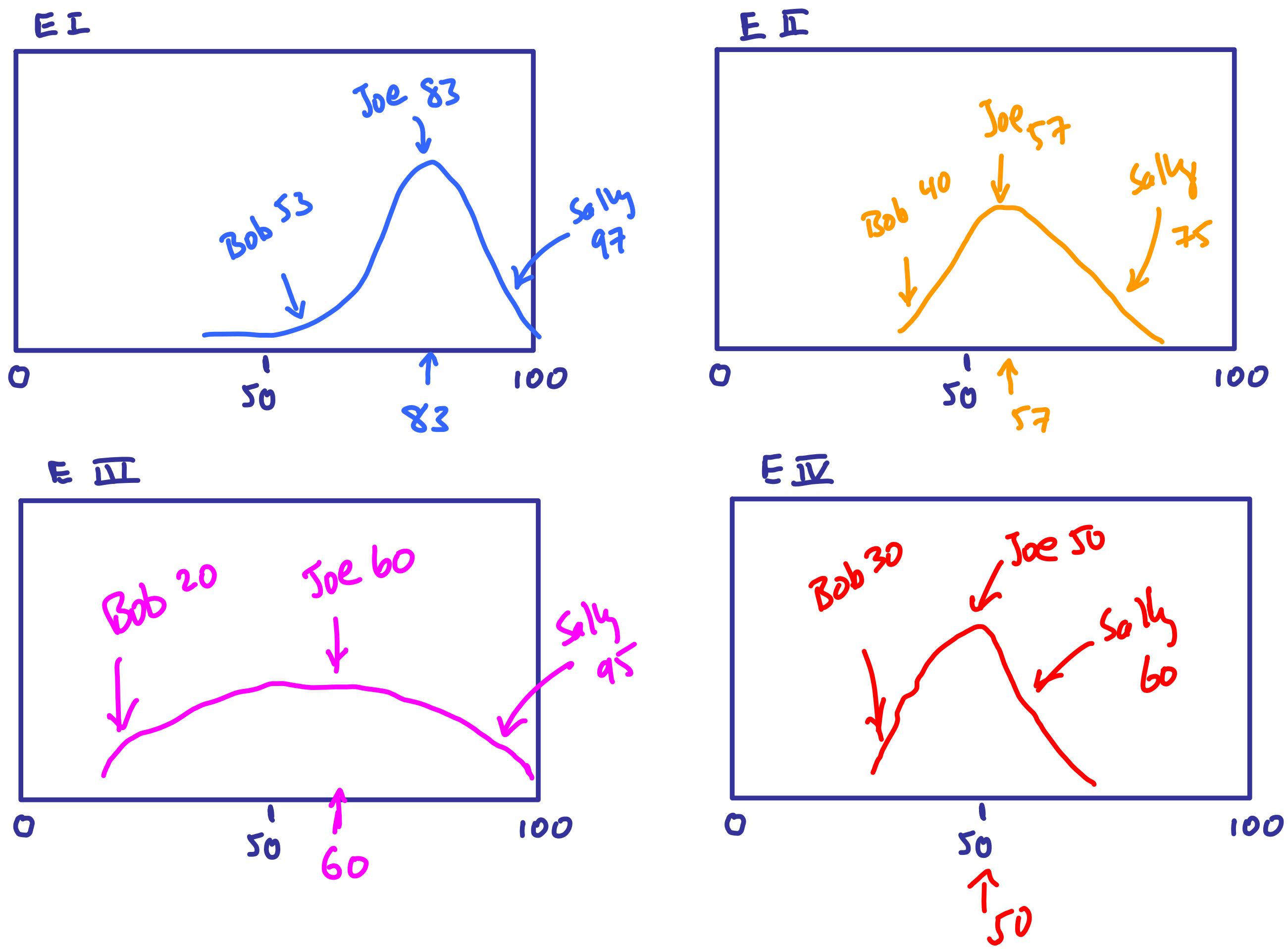
understanding normalization - Fictitious illustrative Example

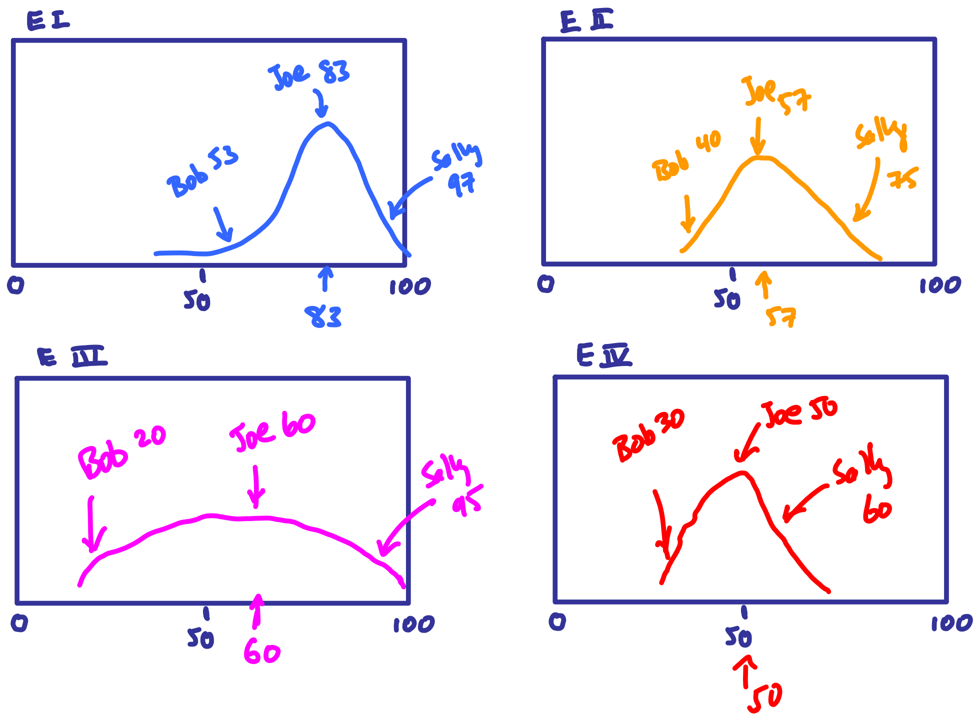


- 4 Exams
- You are allowed a "drop"
- I can't make all 4 Exams of equal difficulty

⇒ must do something to take into account the different difficulties

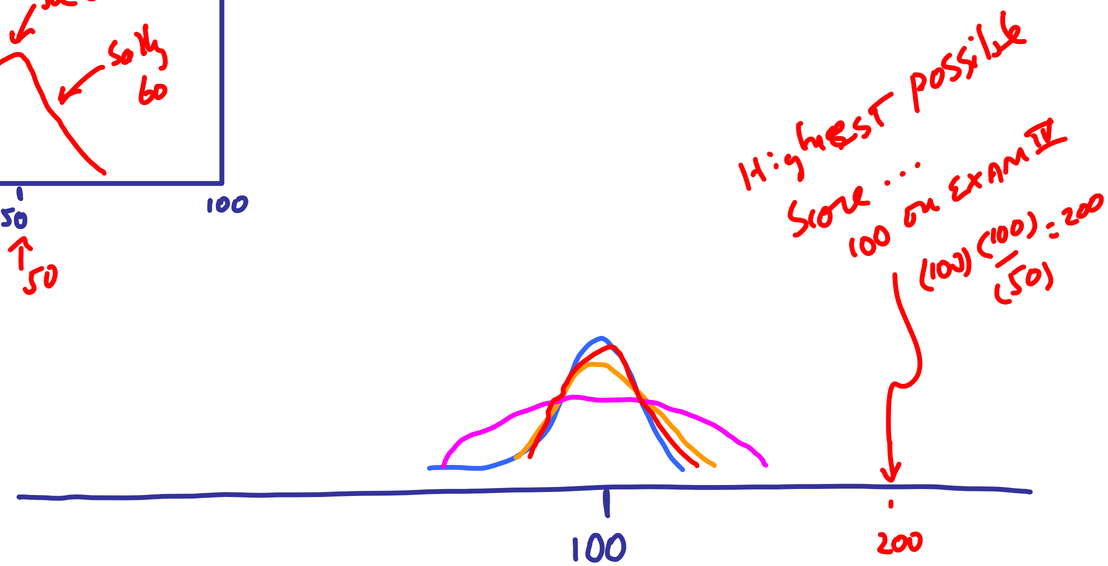
⇒ Suppose you were sick for exam I

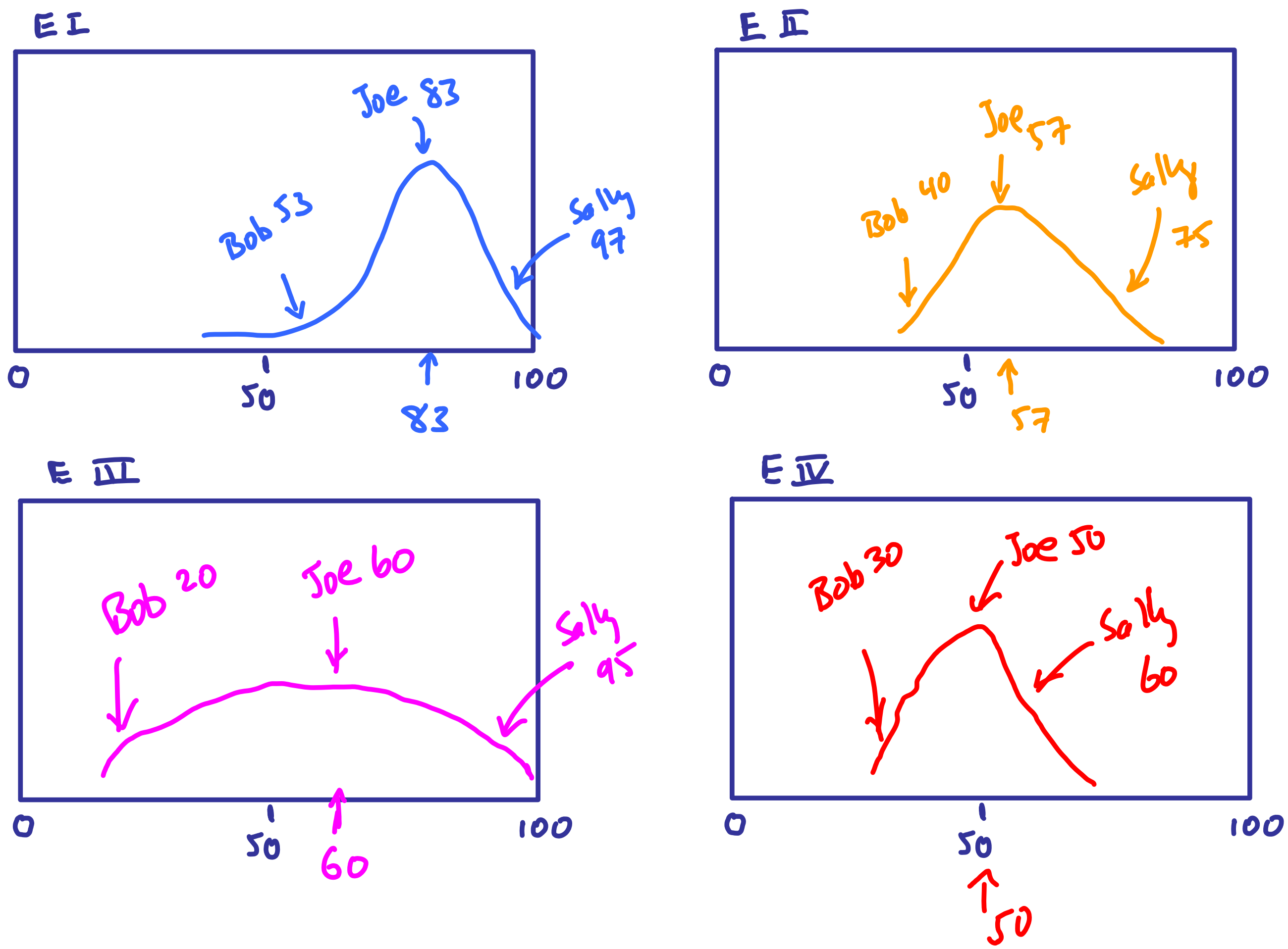

E I
Joe 83
Bob 53
Sally 97
0
50
83
100
E II
Joe 57
Bob 40
Sally 75
0
50
57
100
E III
Bob 20
Joe 60
Sally 95
0
50
60
100
E IV
Bob 30
Joe 50
Sally 60
0
50
50
100



Scale all exam grades for
Exam n

by $\left[\frac{100}{\text{Mean of Exam } n}\right]$





E1

Bob $(53)\frac{100}{83} = 64$

Joe $(83)\frac{100}{83} = 100$

Sally $(97)\frac{100}{83} = 117$

E2

Bob $(40)\frac{(100)}{57} = 70$

Joe $(57)\frac{100}{57} = 57$

Sally $(75)\frac{100}{57} = 132$

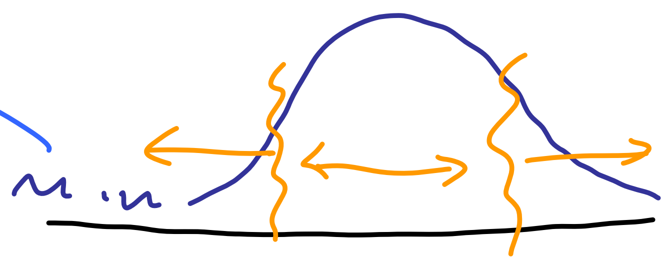
And so forth for Exams III + IV

I use the new normalized scores in the algorithm weighting components appropriately

Scheme	Exam 1	Exam 2	Exam 3	Final exam	Lab	Prob sets
1	---	20%	20%	35%	16%	9%
2	20%	---	20%	35%	16%	9%
3	20%	20%	---	35%	16%	9%
4	18%	18%	18%	21%	16%	9%

get a new distribution → call it Best numerical Average distribution (NOT necessarily a 0–100 scale)

I look at these cases individually



Typical forms

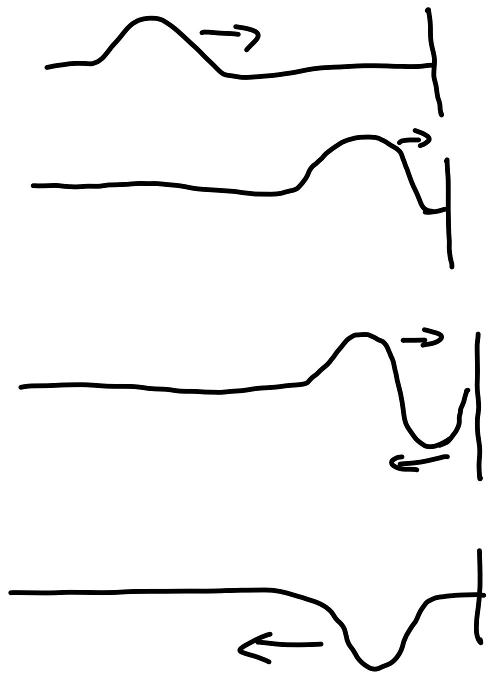
A range 20–25%

B range ~50%

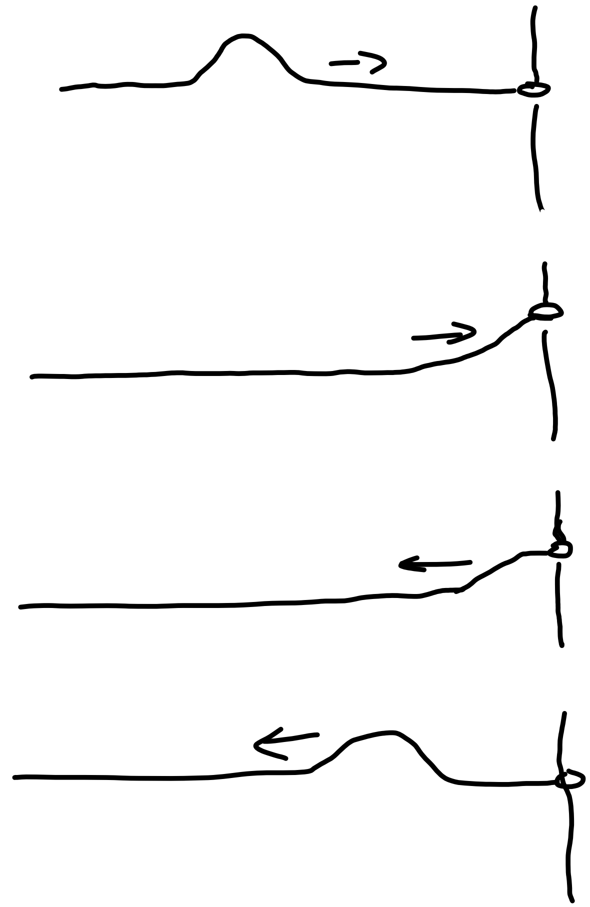
C range ~20–25%

last time

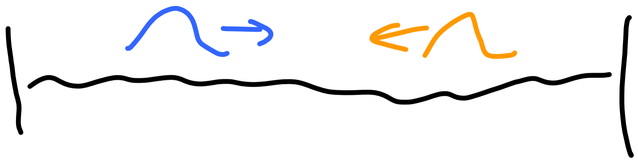
Waves on string – reflections



Fixed end ~ 180° phase change



loose end
No phase change



look at wave propagating on string
and Add together with reflected wave
(both have same frequency + Amplitude)
use principle of superposition
They "interfere"

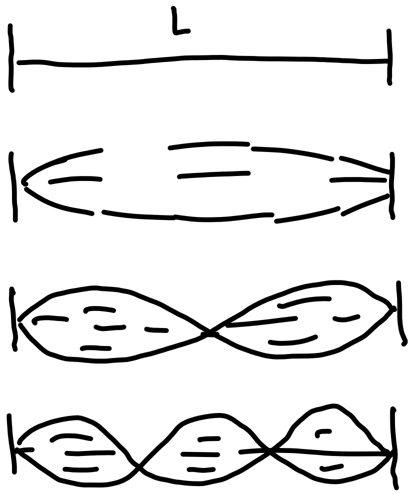
$$y(x,t) = (-2A)\sin(\omega t)\cos(kx)$$

2A = Amplitude of Superposition

Time Variation

fixed form in space
Periodic in λ

Standing Waves



Tension, T

Mass/length, μ

Fundamental $L = \lambda/2$ 1st harmonic

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

3rd harmonic $L = \frac{3\lambda}{2}$

⋮ higher harmonics → $L = n\frac{\lambda}{2}$ $n = 1, 2, 3 \ldots$

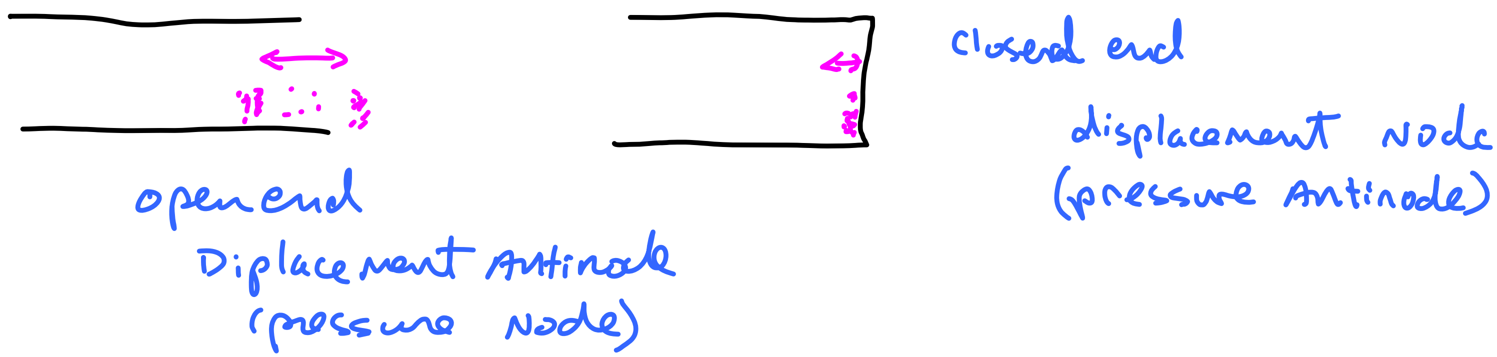
$v = f_n \lambda_n$ $v = \sqrt{T/\mu}$ on string

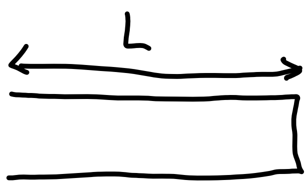
$f_n = v/\lambda_n$

$$f_n = \frac{n}{2L}\sqrt{T/\mu}$$

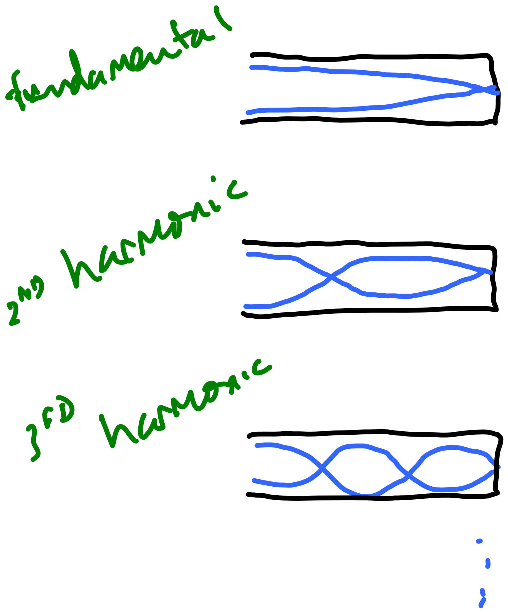
are frequencies that "resonate" on string

For Tubes/sound (wind instruments)





What are frequencies that resonate in Tube of length L that is closed at 1 end?



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

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

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

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

where $n = 1, 3, 5 \cdots$

$v = f\lambda$

$v_{sound} = 343\ m/s$ at $20°C$

$v = f_n \lambda_n$

$L = \frac{n}{4}\frac{v}{f_n}$

$f_n = \frac{nv}{4L}$ $\quad n = 1, 3, 5$

frequencies that resonate on this instrument

⟶ Tune + Warm up musical instruments

Beats

Two waves passing a fixed point $(x=0)$
Differ slightly in frequency
Equal amplitudes

Wave 1

$$x_1(x,t) = A\sin(k_1 x - \omega_1 t) = A\sin(\omega_1 t)$$

$$x_2(x,t) = A\sin(\omega_2 t)$$

use superposition $\quad x(x,t) = x_1(x,t) + x_2(x,t)$

$$x(x,t) = A\sin(\omega_1 t) + A\sin(\omega_2 t)$$

use Trig ID

$$\sin A + \sin B = 2\sin\left[\tfrac{1}{2}(A+B)\right]\cos\left[\tfrac{1}{2}(A-B)\right]$$

$$x(t) = 2A \sin\left[\left(\frac{\omega_1+\omega_2}{2}\right)t\right] \cos\left[\left(\frac{\omega_1-\omega_2}{2}\right)t\right]$$

Average frequency

Difference in frequency

Hear this sound

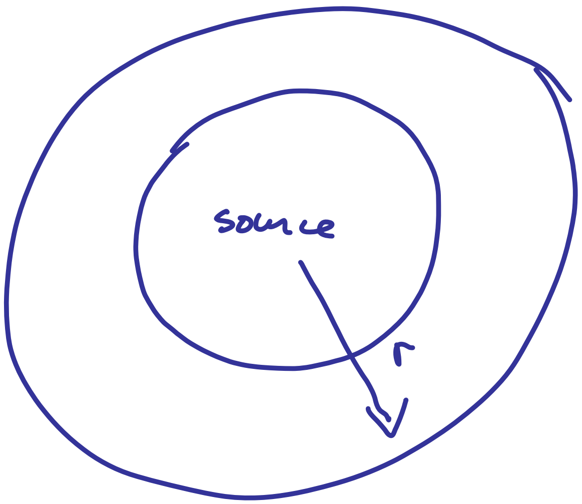
Think of this as Amplitude (intensity ~ Amplitude^2) that varies in time with frequency ~ $\frac{\Delta\omega}{2}$

Sensitive way to detect small frequency differences

Energy flow in waves

$$\frac{dE}{dt} \sim A^2 v$$

This is why I say intensity $\sim A^2$



← same Energy
larger Area → $4\pi r^2$

$\frac{\text{Energy flow}}{\text{Area}}$ (intensity)

drops as r^2

True for light, sound . . .

$$\text{Intensity} = \frac{\text{Power}}{\text{Area}} \qquad \frac{\text{Watts}}{m^2}$$

Intensity of sound

define I_0 as reference intensity

1×10^{-12} W/m^2

Threshold of hearing for average person

$$\beta \text{ (decibel)} = 10 \log \frac{I}{I_0}$$

dB

	dB
Threshold	0
Whisper	~20
Street Traffic	~70
Siren @ 30 m	~100
Rock concert at pain Threshold	~120
Jet engine at 30 m	~140

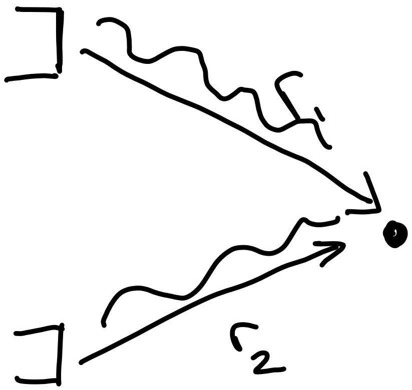
Example

Stereo Ad: Flat response ± 3 dB from 30 Hz to 18,000 Hz

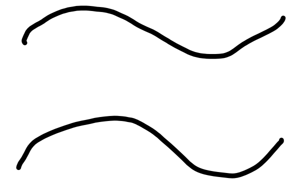
What does this mean for relative intensity variation?

$$\beta - \beta_1 = 10 \log \frac{I}{I_0} - 10 \log \frac{I_1}{I_0}$$

$$3\ dB = 10 \log \frac{I}{I_1} \rightsquigarrow \frac{I}{I_1} = 2$$

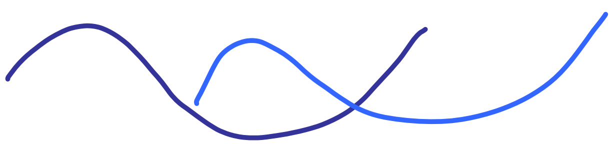


if $r_1 = r_2$



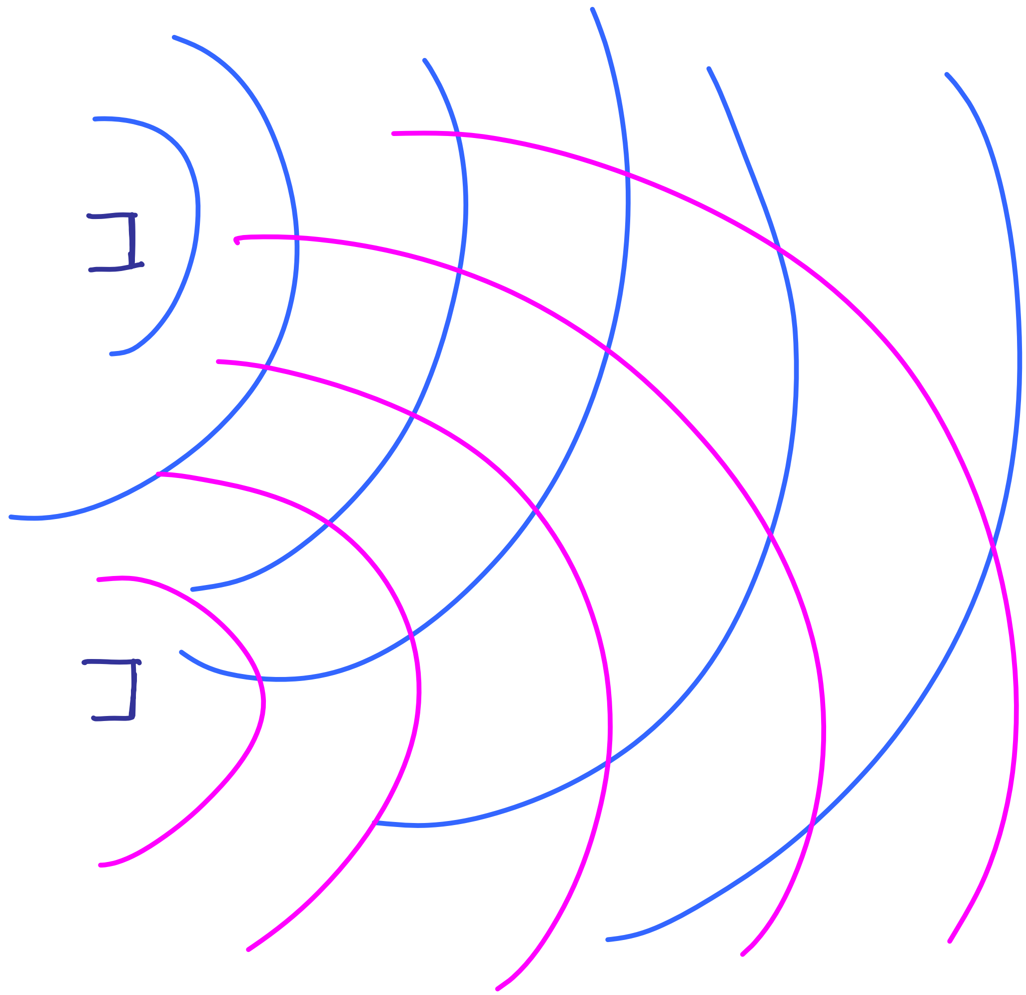
construct in interference

$$r_1 - r_2 = n\lambda$$



if $r_1 - r_2 = n\lambda - \frac{1}{2}$

Destructive



Doppler effect

Souce Moving toward you

$$f_{Hear} = \frac{f_{source}}{\left(1 - \frac{v_{source}}{V_{wave}}\right)}$$

Souce Moving Away

$$f_{Hear} = \frac{f_{source}}{\left(1 + \frac{v_{source}}{V_{wave}}\right)}$$