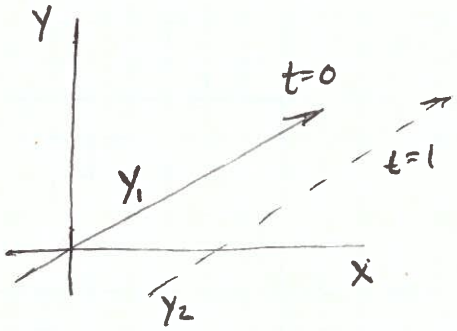
Travelling Waves, Standing Waves, Musical Instruments

$y_1 = \frac{1}{3}x$



If we want this line to move at 6m/s then we replace

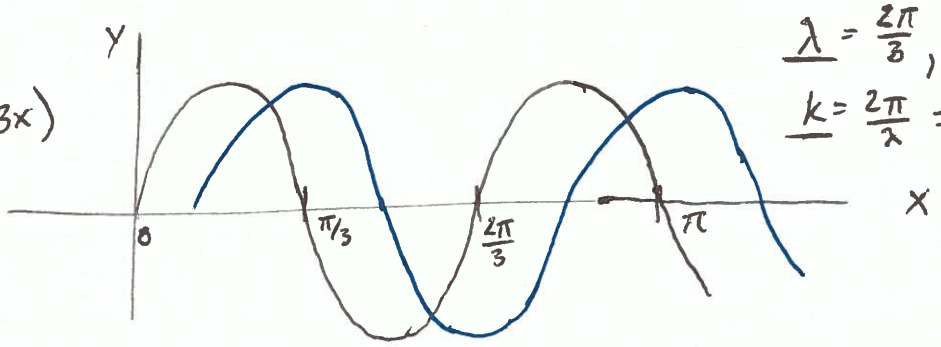
$x \rightarrow x-6t$

So that

$y_2 = \frac{1}{3}(x-6t)$

Wave

$y = 2\sin(3x)$



$\lambda = \frac{2\pi}{3}$,

$k = \frac{2\pi}{\lambda} = 3$

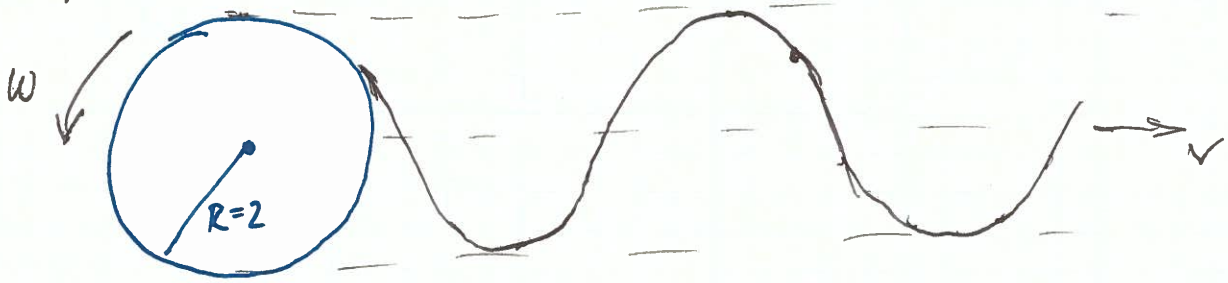
let's make the wave move!

$y = 2\sin(3(x-6t))$ → $y = 2\sin(3x - 18t)$

Amplitude, wavelength, speed

space info, time info

Spin w/ with yarn attached to generate wave...



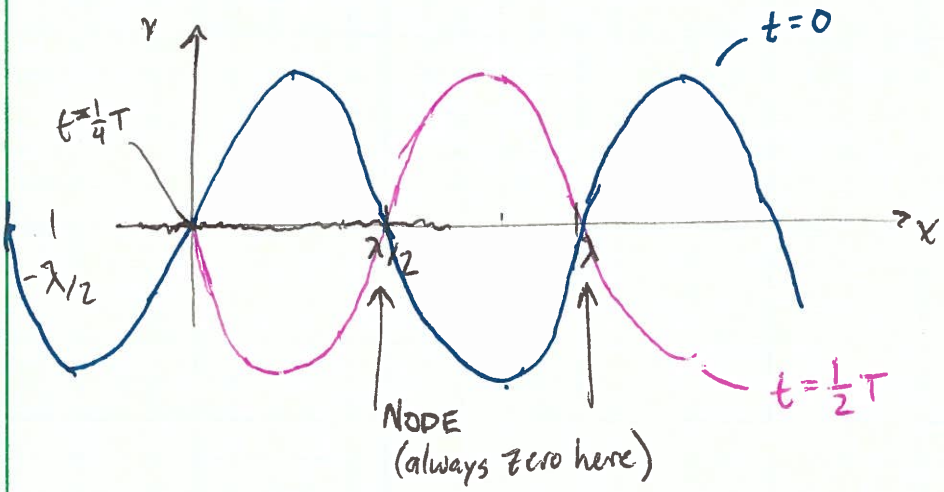
$T = \frac{2\pi}{\omega}$, $\lambda = vT$, $f = \frac{v}{\lambda}$, $v = \omega/k$

Standing Waves

$y_1 = y_0 \sin(kx - \omega t)$ →

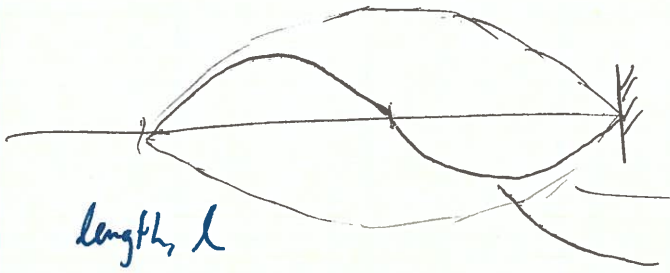
$y_2 = y_0 \sin(kx + \omega t)$ ←

$y = y_1 + y_2 = 2y_0 \sin(kx)\cos(\omega t)$



DEMO: Make a standing wave:

tie string to wall and wiggle at the "right" frequency (resonance)



f_0 - fundamental frequency $\lambda_0 = 2L, f_0 = \frac{v}{2L}$

f_1 - 1st harmonic $\lambda_1 = L, f_1 = 2f_0$

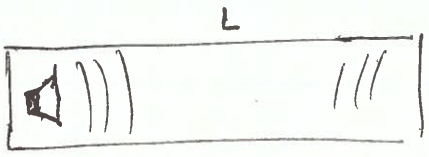
f_n - n^{th} harmonic $\lambda_n = \frac{2L}{n}, f_n = \frac{nv}{2L}$

Musical Instruments:

tight strings that are plucked are exposed to all freqs (impulse →) and the fundamental and harmonics become standing waves while other destructively interfere...

$$f_n = \frac{nv}{2L} \quad , \quad v = \sqrt{\frac{\text{tension}}{\text{mass/length}}}$$

Instruments w/ out strings

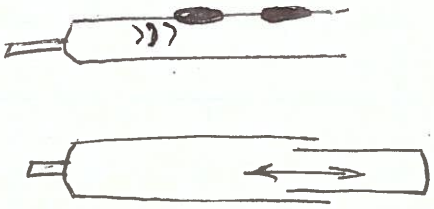


Velocity is fixed,

$V = 300$ m/s (speed of sound)

DEMO: FLUTE / TROMBONE

Blow through tube and change "length" of resonant cavity



Speed of sound $\propto \sqrt{\frac{\text{Temperature}}{\text{Molecular Weight}}}$