(1) Phys 2426 Lec 22

Exam 2 Mass Spec

$\underline{B} = 0.5\ T \qquad v = 3000\ m/s$

$$r = \frac{mv}{qB} = \frac{(7.64 \times 10^{-26})(3000)}{(1.6 \times 10^{-19})(0.5)}$$

$$= 0.0029\ m = 2.9\ mm$$

~~Falling Loop~~

Oscillations Time

Period T in s

Freq f in Hz

$f = 1/T$

Angular Freq $\omega = 2\pi f$

Displacement Amplitude

$$x = x_{max} \sin(2\pi f t)$$

Wave: Many coupled oscillators

Ex: "The Wave" in a stadium

Oscillators are individual people.

Amplitude is their hand height

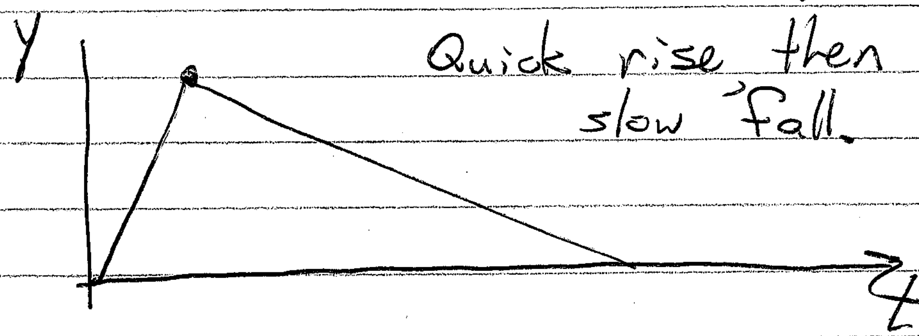
The disturbance moves; people stay @ seats

②

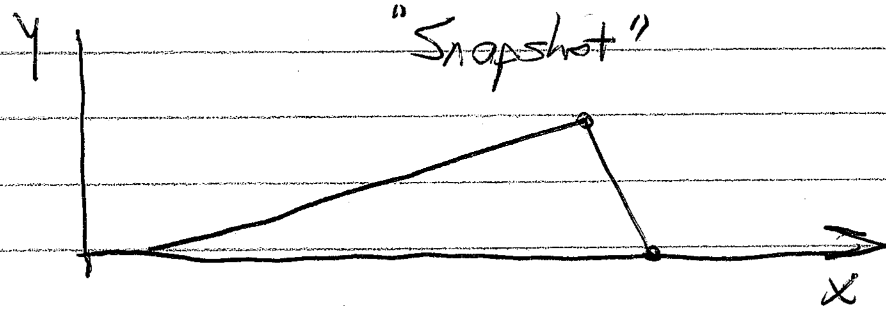
Wave-on-a-string

Disturbance travels with $V = \sqrt{\frac{F_T}{\mu}}$ Tension / Mass/L

Quick rise then slow fall.



"Snapshot"



Time and propagation distance are kind of opposite.

General form $y(x) = y(x - vt)$

-or- $y(t) = y\left(t - \frac{x}{v}\right)$

With oscillations $y(t) = A \sin(2\pi f t) = A \sin\left(\frac{2\pi}{T} t\right)$

~~Generic~~ Osc. waveform $y(x) = A \sin\left(\frac{2\pi}{\lambda} x\right)$

λ = wavelength

③

Oscillating Wave

$$y(x,t) = A\sin\left(\frac{2\pi}{\lambda}(x - vt)\right)$$
$$= A\sin\left(\frac{2\pi x}{\lambda} - \underbrace{\frac{2\pi v}{\lambda}t}_{2\pi f t}\right)$$

$$\frac{v}{\lambda} = f \Rightarrow v = f\lambda$$

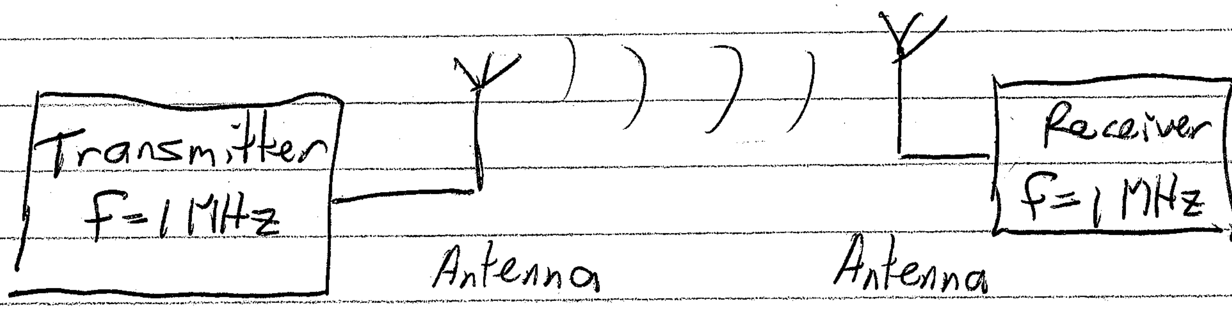
Ex: Sound $f = 1100$ Hz
$v = 340$ m/s (room temp)
($v = 330$ m/s @ Freezing)

$$v = f \cdot \lambda$$
$$(340\ \text{m/s}) = (1100\ \text{Hz})\,\lambda$$

$$\lambda = \frac{340}{1100} = 0.309\ \text{m}$$

Most wave-makers have a size of
$L = \frac{\lambda}{2}$ or $L = \frac{\lambda}{4}$

When oscillations couple, the frequency always stays constant.



Exception: Doppler Effect

$$f' = \frac{v+v_o}{v-v_s} f$$

v_o = v of observer
v_s = v of source
$\oplus$ = "toward"
f = orig freq
f' = observed f
v = v of wave

"toward" $\rightarrow$ f' bigger

Easier version $f' = f + \Delta f$

fractional shift $= \frac{\Delta f}{f} = \frac{V_{rel}}{V_{wave}}$ as long as $V_{rel}/V_{wave} < 0.1$

Doppler Radar – there are 2 doppler shifts!

$$\frac{\Delta f}{f} = 2\frac{V_{rel}}{c}$$

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Ex: $v = 30\ m/s$

$f = 1\,GHz$

$$\Delta f = \frac{30\ m/s}{3 \times 10^{8}\ m/s}\left(1 \times 10^{9}\ Hz\right) = 100\ Hz$$

$f' = 1{,}000{,}000{,}100\ Hz$