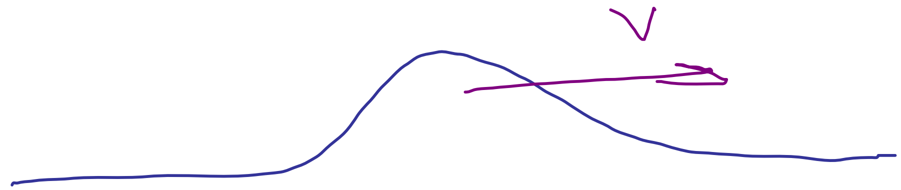
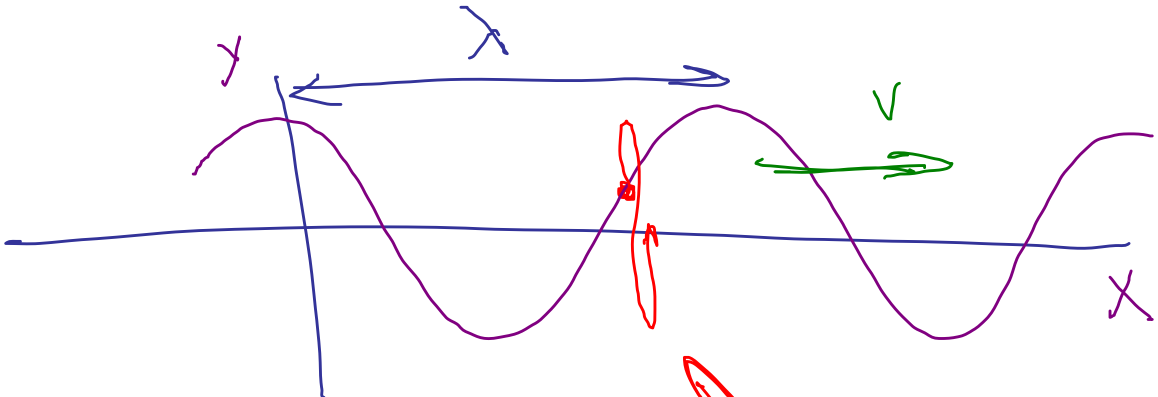
Phys 2110-4 4/22/13

Note Title 4/22/2013

Waves





snapshot

$y(x,t)$

freq $f = 1/T$

$\omega = 2\pi f$

In time of one period, T wave moves by λ

$\lambda = vT$

$\lambda = v \frac{1}{f}$

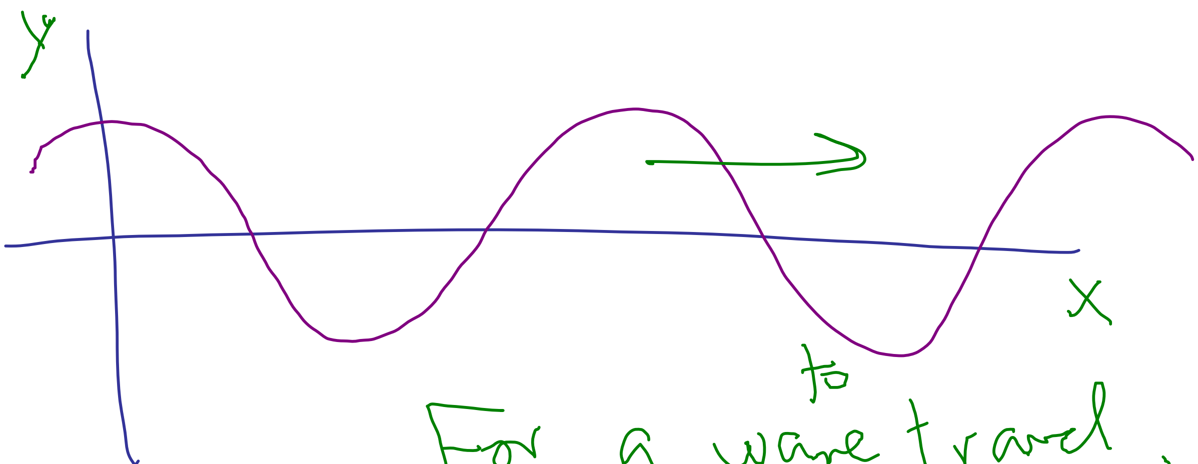
$$\boxed{\lambda f = v}$$

Light, radio are EM waves

Also follow $\boxed{\lambda f = v}$ where

$$v = c = 2.998 \times 10^8 \frac{m}{s}$$

Does not travel in medium. 2nd semester.



Mathematical form

$y(x, t)$

For a wave to travel, has math form

$$y = f(x \mp vt)$$

$-$ wave moves to right.

$+$ wave moves to left.

$$y = f(x \mp vt)\quad \begin{cases} - & \text{right} \\ + & \text{left} \end{cases}$$

$$y = A\cos\left(k(x \mp vt) + \phi\right)$$

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

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

Gen form for harmonic

Amplitude

(wave number)

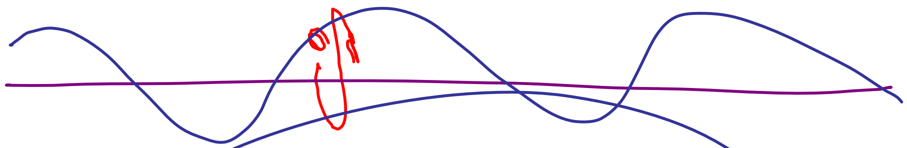
$k = \frac{2\pi}{\lambda}$

$\nu = \frac{1}{\lambda}$

ang. freq

$x \mp vt$

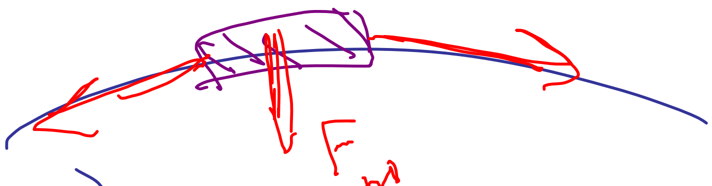
phase constant



$$v_y(x,t) = \frac{\partial y}{\partial t} = \pm A\omega \sin(kx \mp \omega t + \phi)$$

$$v = \omega / k \qquad (14.3)$$

why would string behave that way?



$f(x \pm vt)$

Wave

pos x

location y

t

$$\boxed{\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y}{\partial t^2}}$$

speed

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$x(x,t)$

Derivation gives expression for v speed of waves on string. (14.6)

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

Waves in water, solids

$$v = \sqrt{\frac{\text{Elastic property}}{\text{Mass property}}}$$

Mass density

$$\mu = \frac{M}{L}$$

$$= \text{kg}/\text{m}$$

Power, Intensity

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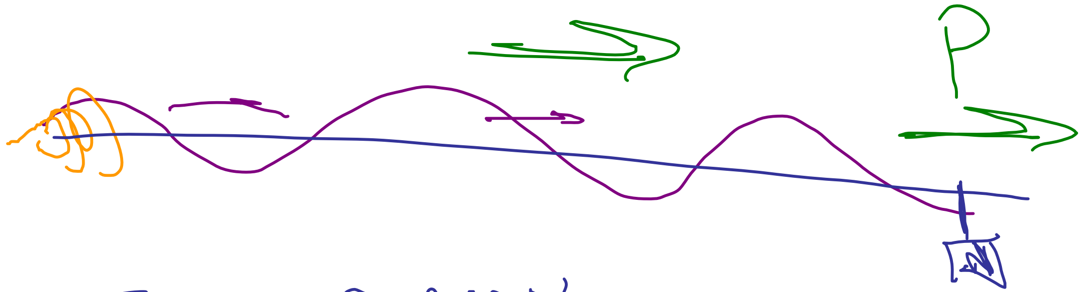

Carry energy

Vibrating string: Energy time, average.

Avg power
Harmonic wave
String:

$$\boxed{\bar{P} = \frac{1}{2}\mu\omega^2 A^2 v}$$

$\propto A^2$

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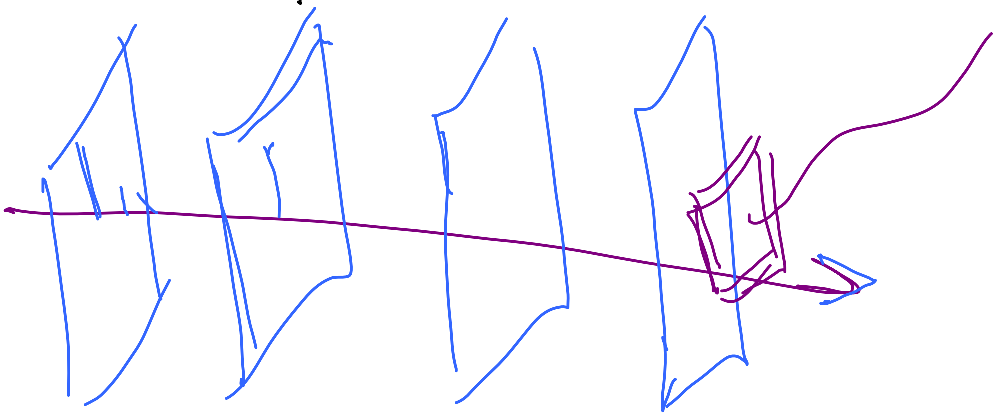
$$\frac{kg}{m}\left(\frac{1}{s}\right)^2 m^2 \frac{m}{s} = \frac{kg\, m^2}{s^3} = J/s$$

Generally, waves travel in 3-dims



"Plane wave"

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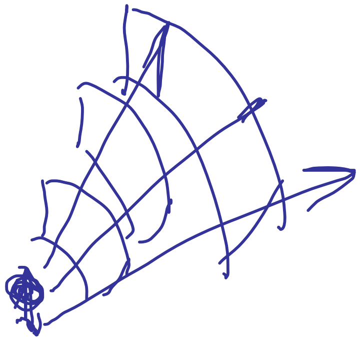
planes repr. regions in space where phase is same

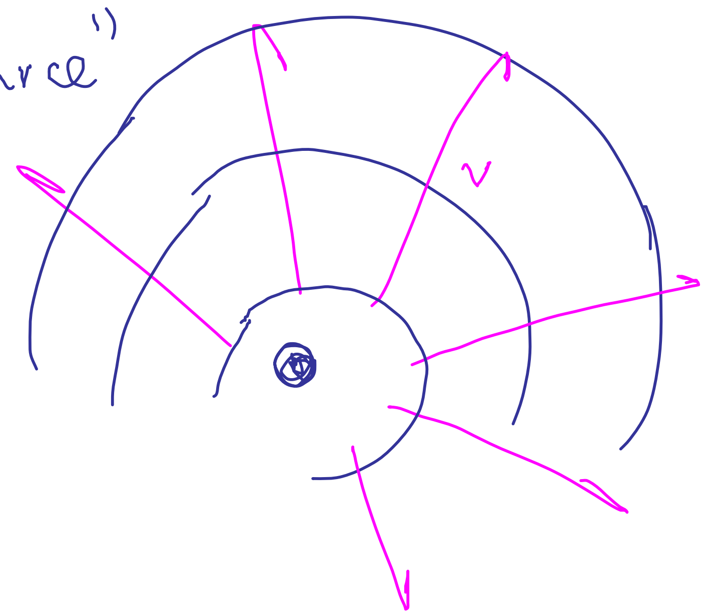
Carry energy.

$$\frac{\text{Energy}}{\text{Time} \cdot \text{Area}} = \frac{E/\text{time}}{\text{area}}$$

$= W/m^2$, Intensity.



"point source"



Isotropic source