Types of Waves

Transverse:
- Transmit energy, not necessarily water, but... (shift?
- Hand slice of mass moves up or transverse to axis.

Longitudinal (sound)
- Tube
- Diaphragm pushed in, makes a compression
- Drawn back, a "rarefaction"
- Slices of mass move parallel or longitudinal to axis.

Earthquakes: speed of longitudinal part ("P-wave") faster than transverse ("S-wave").
- P-wave wakes you, animals up.
Pulse: one segment
Periodic; keep doing it (sound)
Complication: both time and space.

Sinusoidal:

\[ y(t) = A \cos(\omega t) \]

what will that \( \omega \) turn out to be?

\( \omega \) will be related to the wavelength, and the speed \( v \).
On a string ....

→ Ideal, non-dispersive

\[ y(x,0) = f(x) \]

\[ \frac{dy}{dx} - v = 0, \quad \frac{dx}{dt} = v \]

Later... displaced in \( x \) by...

\( v^+ \) same shape

(Non dispersive)

\[ y(x,t) = f(x - v^+ t) \]

Think... + = 0

\( f(x) \)

+ > 0...

\( x - v^+ = \text{constant} \ 0, \text{ peak} \)
Generally, \( f(x + vt) \) would work too, how different?

\( \Rightarrow \) generally, wave equations give... \( \sqrt{v^2} \) for speed.

Dispersive

Later... non-ideal

"soggy" speed of propagation depends on frequency, light.
The wavelength $\lambda$ is related to the frequency $f$ by:

$$\lambda = f \cdot \frac{2\pi}{\omega}$$

where $\omega$ is the angular frequency, in radians per second. The wavelength $\lambda$ is the distance a wave travels in one period $T$.

The speed $v$ of the wave is given by:

$$v = \lambda \cdot \frac{2\pi}{\omega}$$

or

$$v = \lambda \cdot f$$

This equation shows that the speed of the wave is proportional to the wavelength and the frequency. The speed is also equal to the wavelength divided by the period, since $v = \frac{\lambda}{T}$.

The period $T$ is the time it takes for one complete cycle of the wave, and it is also related to the angular frequency by $T = \frac{2\pi}{\omega}$.

The wave travels a distance $\lambda$ in one period $T$.
Wave function: \( y(x, t) \)

\[ y(x, t=0) = A \cos \left( \pm \frac{2\pi x}{\lambda} \right) \]

why?

study particular \( x \)

\[ y(x=0, t) = A \cos \left( \pm \omega t \right) \]

combine

\[ y(x, t) = A \cos \left( \pm \left( \frac{2\pi x}{\lambda} \pm \omega t \right) \right) \]

"constant phase"

\[ \frac{2\pi x}{\lambda} \pm \omega t = \text{constant} \]
\[ x = \mp \frac{\omega \lambda}{2\pi} t + \text{constant} \]
\[ x = \mp vt + \text{constant} \]

\[ A \cos \left( \frac{2\pi x}{\lambda} + \omega t \right) \rightarrow \text{left moving wave} \]

\[ A \cos \left( \frac{2\pi x}{\lambda} - \omega t \right) \rightarrow \text{right moving wave} \]

Often: \[ \frac{2\pi}{\lambda} = k \text{ wave vector} \]

\[ v = \frac{\omega}{k} \]