Physics 5B - Waves I

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Disturbance can be perpendicular to the direction of the propation (*tranverse wave*).

OR it can be parallel (*logitudial wave*).

The material in the medium is NOT propagated; the Disturbance is!

Mathematical representation of Disturbant:

$$D(x,t)$$

Example:

A traveling, penedic wave. Has a sinsodial shape (also called a harmonic wave)

1. Freeze time. Take a snapshot at: t=0.

   A is from middle to top or bottom. And distance is 2A from trough to crest.

   λ is the wavelength, which is the length of one period.

2. $D(x,t=0) = \text{Asin}\left(2\pi\frac{x}{\lambda}\right)$

   Let k = $\frac{2\pi}{\lambda}$ Which is also called the wave number.

   $\text{dimension} = \frac{\text{radians}}{\text{meters}}$ $\qquad D(x,t=0) = \text{Asin(kx)}$

3. Now, let time move forward, but watch only 1 position.

4. Time to go through one full oscilliation, T (the period). This is also the time for λ to pass by!

5. Frequency $f = \frac{1}{T}$

   In 1 period (or T), the sine function argument moves through 2π

   $\frac{2\pi t}{T}$ OR 2πft

   NOTE: $\omega = 2\pi f$. So, ωt

6. want to have a fixed phrase (or arguement of sine function) move toward positive x-direction as time increases

   $$D(x,t) = \text{Asin(kx} - \omega t)$$

   As t increases, x also increases.

   $$D(x,t) = \text{Asin(kx} + \omega t)$$

   However, as t increases, x decreases!

7. What is the speed of some fixed phase?

"phase velocity" - v

$v = \frac{\lambda}{T}$ $\quad \frac{\text{disturbance travels}}{a\,\text{distance}\,\lambda\,\text{in time}\,T}$

$v = \frac{\omega}{k}$ OR $v = f\lambda$

8. soon, will want to add (AKA superpose) waves.

   Needs offsets! So....

$$D(x,t) = \text{Asin}(\text{kx} \pm \omega t + \phi)$$

9. EXAMPLE:

   Specific mdium: wave on a string:

   F_T restoring force

   $\mu = \frac{\text{mass}}{\text{length}}$

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