Physics 5B: Wave III

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- $D_1 = \text{Asin}(\text{kx} - \omega t + \phi_1)$ wave in the positive direction

  $D_2 = \text{Asin}(\text{kx} - \omega t + \phi_2)$

  $D = D_1 + D_2 = A[\sin(\text{kx} - \omega t + \phi_1) + \sin(\text{kx} - \omega t + \phi_2)]$

  $\sin\alpha + \sin\beta = 2\sin[\frac{1}{2}(\alpha + \beta]\cos\left[\frac{1}{2}(\alpha - \beta)\right]$

  $= \text{Acos}\left(\frac{1}{2}\Delta\phi\right)\sin(\text{kx-}\omega\text{t} + \phi)$

  where $A = \phi_2 - \phi_1$

  where $\phi = \frac{\phi_1 + \phi_2}{2}$

- Amplitude:

  $\phi_1 = \phi_2 \qquad (\Delta\phi = 0) \leftarrow$ constructive interference

  New Ampltitude is 2A

  when $\Delta\phi = \pi$, when Amplitude is 0 $\leftarrow$Destructive interference

- Another Case:

  $D_1 = \text{Asin}(\text{kx} - \omega t)$ Positive direction

  $D_2 = \text{Asin}(\text{kx} + \omega t)$ Negative direction

  $D = D_1 + D_2$

  $D = A[\sin(\text{kx} - \omega t) + \sin(\text{kx} + \omega t)]$

  $D = 2\text{Asin}(\text{kx})\cos(\omega t)$ STANDING WAVE

- The location where D is always 0 are always called NODES.

- ANTINODES are where D is at maxium displacement.

- The space between nodes is :$\frac{\lambda}{2}$

- $x_{\text{nodes}} = 0, \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2} = \frac{m\lambda}{2}$ m=0,1,2,3.....

- Antinodes: $x_{\text{antinodes}} = \left(m + \frac{1}{2}\right)\frac{\lambda}{2}$

- Standing waves on a string tied at both ends

  Boundary conditions: walls are nodes.

  λ=2L longest wavelength that can fit between walls of length L

- Next longest: L=λ

- $f\lambda = v = \sqrt{\frac{F_t}{\mu}}$
- $\lambda_n = \frac{2L}{n}$ n=1,2,3.....
- $f_n = n\frac{v}{2L} = n\, f_1$
- EXAMPLE

  f=441 Hz

  What is the frequency if you press down with your finger one third of the way from end?

  effectively shortens the part of the string there can be a wave.

  only $\frac{2}{3}$of the string now vibrtes. What is the new frequencya?

$$\underline{f_0 = \frac{v}{2L_o} = 441\mathrm{Hz}}$$

$$f_{\mathrm{new}} = \frac{v}{2\left(\frac{2}{3}L_0\right)} = \frac{3}{2}\frac{v}{2L_o} = \frac{3}{2}441\mathrm{Hz} = 662\mathrm{Hz}$$

- WAVES CHANGING MEDIA
- Boundaries

  Medium 1: $v_1 > v_2$ Refraction

  $\frac{\sin o_2}{\sin o_1} = \frac{v_2}{v_1}$ Wave is both refracted and refletced at the bounary in general.