University Physics 1A

Alvin Lin

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Waves

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

$$\text{speed of wave} = v = \sqrt{\frac{elastic\ property}{inertial\ property}}$$

$$\text{for a string(spring) v} = \sqrt{\frac{tension}{mass\ density}} = \sqrt{\frac{F_{tension}}{\lambda}}$$

$$\text{for air(sound) v} = \sqrt{\frac{bulk\ modulus\ of\ air}{volume\ mass\ density}} = \sqrt{\frac{B}{\rho}}$$

Principle of superposition: two waves at the same point just add their values. While this does not hold for other concepts, it holds for most of the mediums that we will work with.

Interference

Two waves going in the same direction with the same amplitude:

$$\begin{aligned} y &= y_{max}\sin(kx - \omega t) + y_{max}\sin(kx - \omega t + \phi) \\ &= 2y_{max}\cos(\frac{\phi}{2})\sin(kx - \omega t + \frac{\phi}{2}) \end{aligned}$$

If $\phi = \pi$ and the two waves are half a wavelength apart, then the two waves are destructive and cancel each other out. If $\phi = 0$, then the two are constructive and

amplify each other. Any other values of ϕ are partially constructive. This is an example of wave interference.

Two waves travelling in the opposite direction:

$$\begin{aligned} y &= y_{max} \sin(kx - \omega t) - y_{max} \sin(kx - \omega t) \\ &= 2y_{max} \cos(\omega t) \sin(kx) \end{aligned}$$

This forms a standing wave.