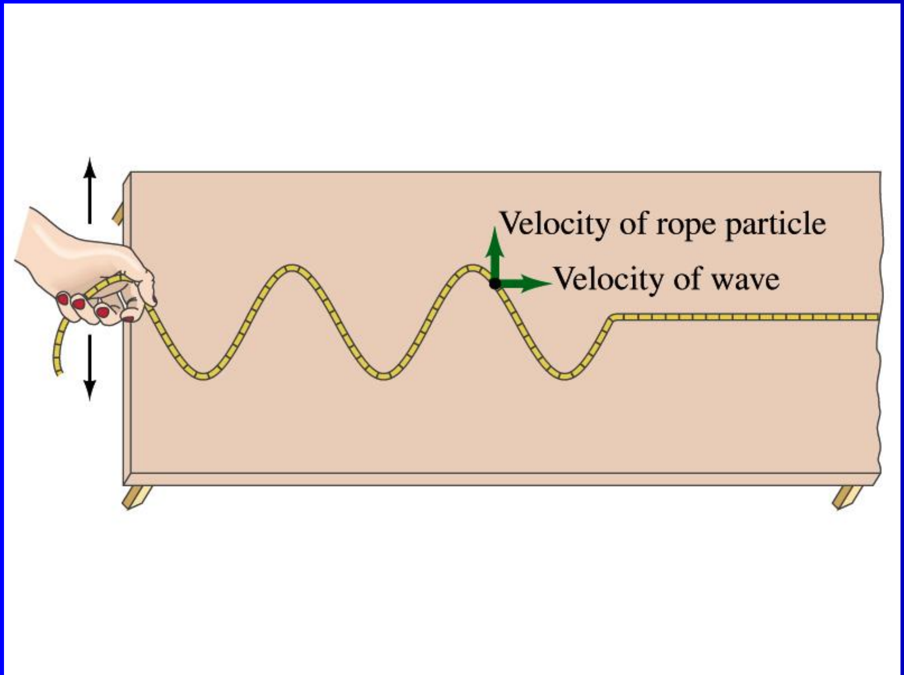
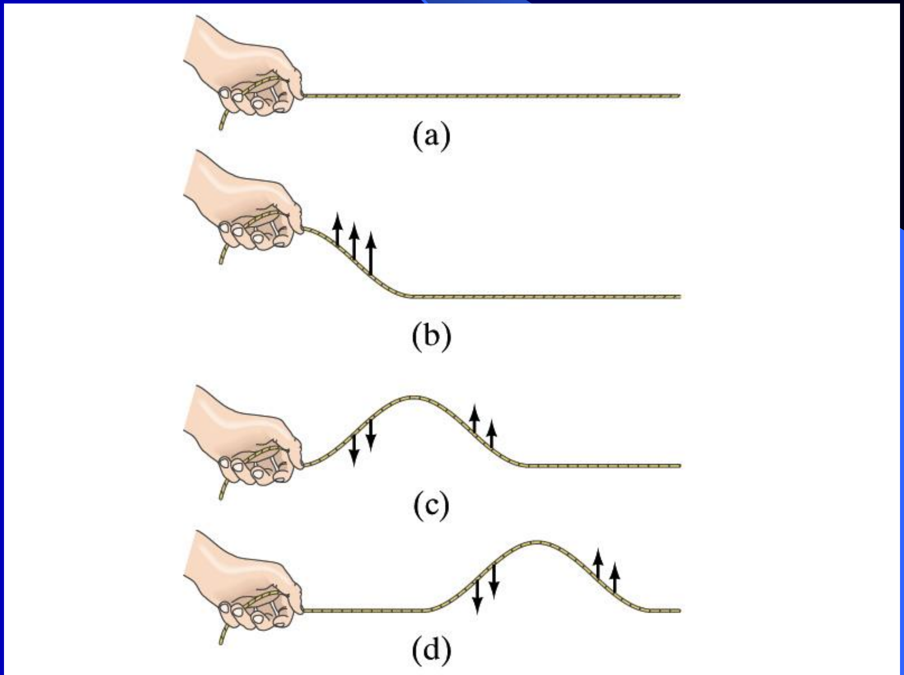
SHM leads to a sinusoidal wave

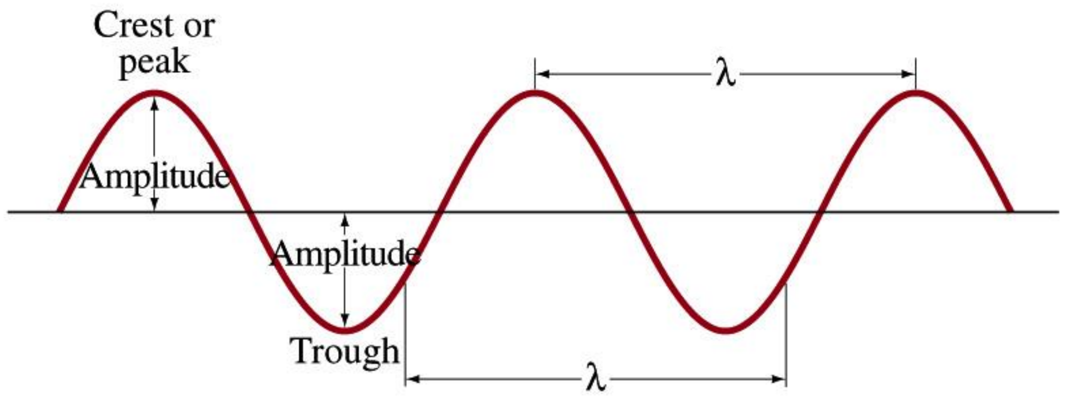




A Periodic Wave

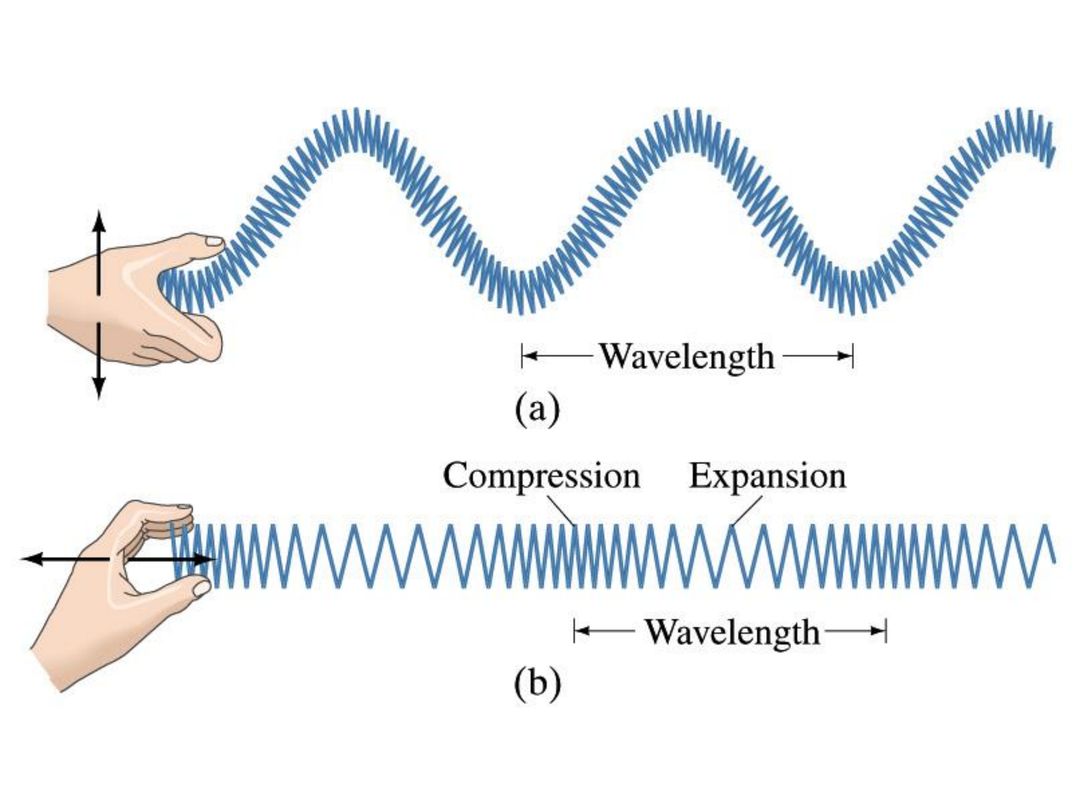
- Important Quantities
  - Amplitude D_M
  - Wavelength λ
  - Frequency f
  - Period T
  - Wave Velocity

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



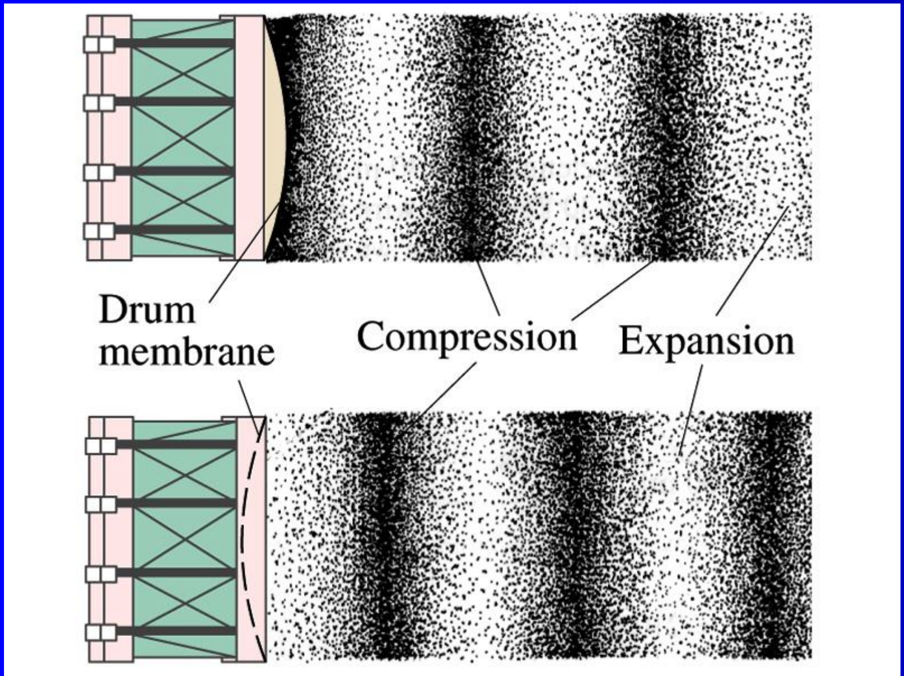
Transverse - Longitudinal Waves

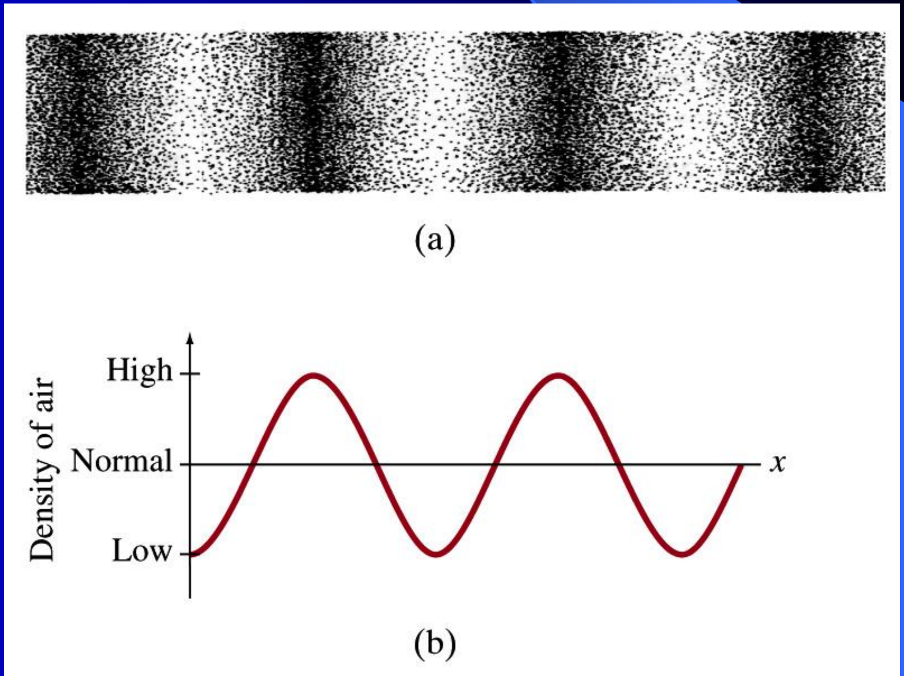
- Transverse Wave
  - Oscillation ⊥ Wave
- Longitudinal Wave
  - Oscillation || Wave



Representing a LW as a TW

- E.g. plot density of wave versus distance





Velocity of Transverse Waves

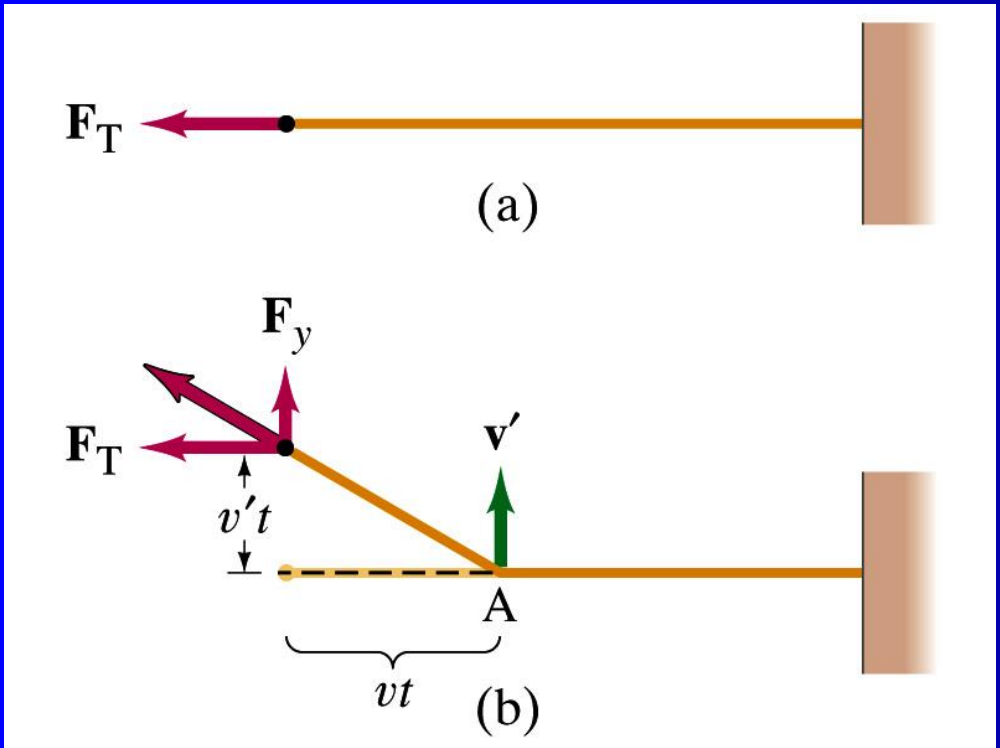
$$v = \sqrt{\frac{F_T}{\mu}}$$

- Derivation:

$$\frac{F_T}{F_y} = \frac{vt}{v't} = \frac{v}{v'} \Rightarrow F_y = \frac{v'}{v} F_T$$

$$\Delta p = F_y t$$

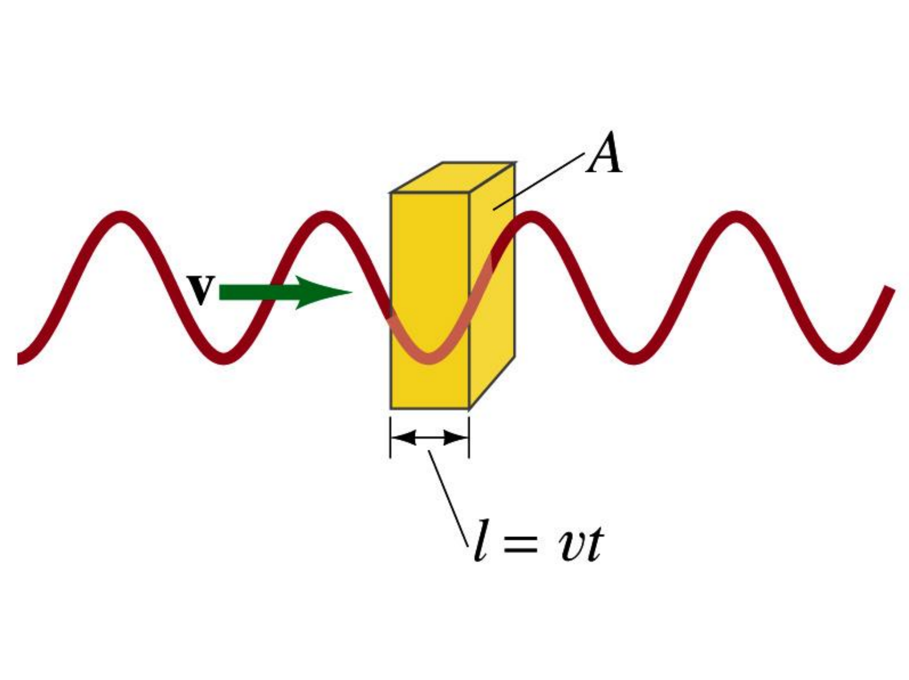
$$(\mu v t) v' = \frac{v'}{v} F_T t \Rightarrow v^2 = \frac{F_T}{\mu}$$



Energy in a Wave

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \Rightarrow k = 4\pi^2 m f^2$$

$$m = \rho V = \rho A l = \rho A v t$$



$$E = \tfrac{1}{2} k D_M^2 = 2\pi^2 m f^2 D_M^2$$

- Energy

$$E = 2\pi^2 \rho A v t f^2 D_M^2$$

- Average Power

$$\overline{P} = \frac{E}{t} = 2\pi^2 \rho A v f^2 D_M^2$$

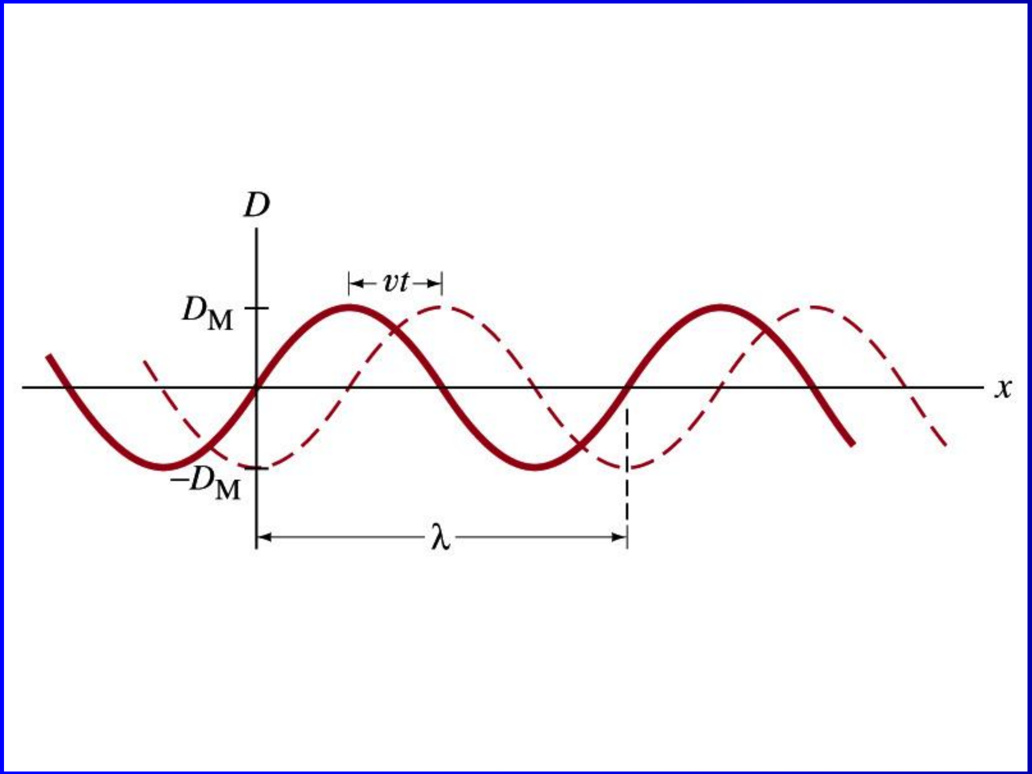
- Intensity

$$I = \frac{\overline{P}}{A} = 2\pi^2 \rho v f^2 D_M^2$$

- 3-d: $I = \frac{\overline{P}}{A} = \frac{\overline{P}}{4\pi r^2}$

Formalism of a Traveling Wave

- At t=0: $D(x) = D_M \sin \frac{2\pi}{\lambda} x$ At t≠0: $D(x,t) = D_M \sin\left[\frac{2\pi}{\lambda}(x - vt)\right]$



$$v = \frac{\lambda}{T}$$

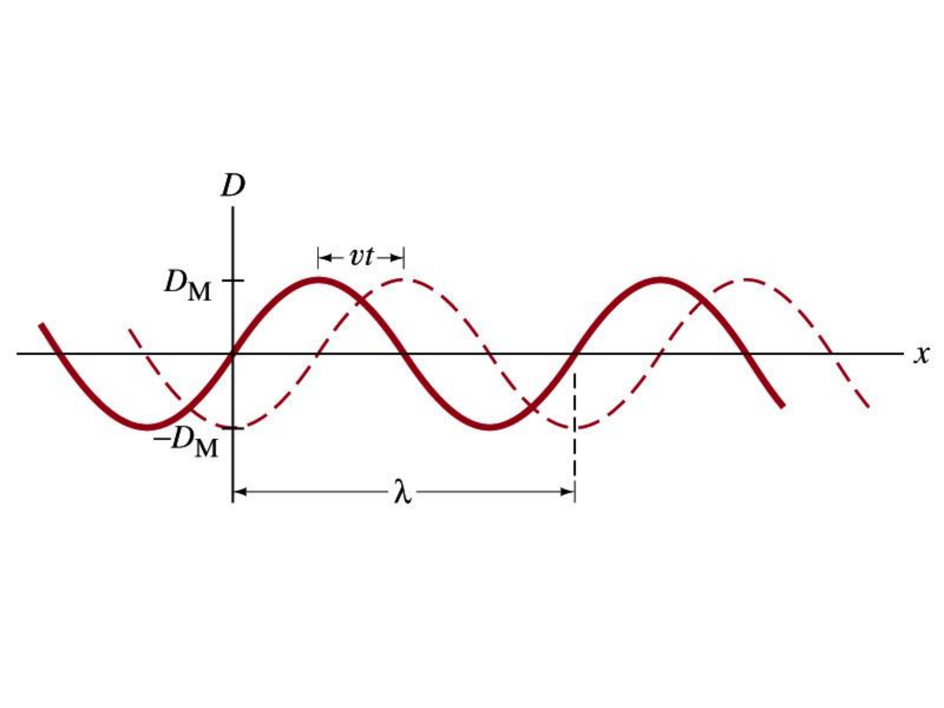
$$D(x,t) = D_M \sin\left[\frac{2\pi x}{\lambda} - \frac{2\pi t}{T}\right]$$

$$k = \frac{2\pi}{\lambda}, \omega = \frac{2\pi}{T}$$

$$D(x,t) = D_M \sin(kx - \omega t)$$

Formalism of a Traveling Wave

- Note: $k = \frac{2\pi}{\lambda}, \omega = \frac{2\pi}{T}$ $v = \frac{\lambda}{T} = \frac{2\pi}{k}\frac{\omega}{2\pi} = \frac{\omega}{k}$



$$D(x,0) = D_M \sin kx$$

$$D(0,t) = D_M \sin(-\omega t) = -D_M \sin \omega t$$

$$D(x,t) = D_M \sin(kx - \omega t + \phi)$$