

Traveling Waves

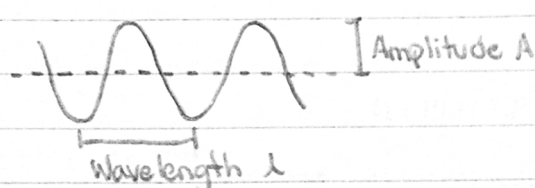
Wave - traveling disturbance that transports energy but not matter

Transverse - oscillates \perp to direction the wave is moving (electromagnetic)

Longitudinal - oscillates in the same direction as wave propagation (sound)

Wave front - boundary between region through which a wave has passed and has not yet passed

Continuous  Pulse  Pulse train 

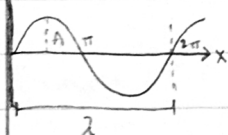


$$v = \lambda f = \frac{\lambda}{T} = \frac{\lambda \omega}{2\pi}$$

$$\omega = 2\pi f \quad f = \frac{\omega}{2\pi}$$

Example #1

$$\lambda = \frac{v}{f} \quad \frac{v_R}{f_R} = \frac{v_S}{f_S} \quad \frac{3 \times 10^8}{3 \times 10^2} = 10^6 \quad f_S = 100 \text{ Hz} \quad f_R = 100 \text{ MHz}$$



$$y(x, t) = A \sin(kx)$$

$$y(0, 0) = A \sin 0 = 0 \quad y\left(\frac{\lambda}{2}, 0\right) = A \sin\left(\frac{\lambda}{2} \cdot 0\right) = 0$$

$$k = \frac{2\pi}{\lambda} \quad y(x, t) = A \sin\left(\frac{2\pi x}{\lambda}\right) = A \sin\left(\frac{2\pi}{\lambda} (x - vt)\right)$$

$$y(x, t) = A \sin\left(\frac{2\pi x}{\lambda} - \omega t\right) = A \sin(kx - \omega t) \quad \phi = 0 \quad k = \frac{2\pi}{\lambda}$$

$$y(x, t) = A \sin(kx - \omega t + \phi)$$

Example #2

$$A = 15 \text{ cm} = 0.15 \text{ m}$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{.4} = 15.7 \text{ rad/m}$$

$$\phi = \frac{\pi}{2} \text{ rad}$$

$$\lambda = 40 \text{ cm} = 0.4 \text{ m}$$

$$T = \frac{1}{f} = \frac{1}{8} = 0.125 \text{ s}$$

$$y(x, t) = 0.15 \sin\left(15.7x - 50.3t \pm \frac{\pi}{2}\right)$$

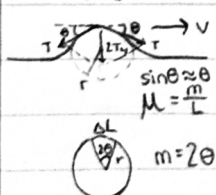
$$f = 8 \text{ Hz}$$

$$\omega = 2\pi f = 2\pi(8) = 50.3 \text{ rad/s}$$

$$k = ? \quad T = ? \quad \omega = ? \quad v = ? \quad y(x, t) = ?$$

$$v = \lambda f = .4(8) = 3.2 \text{ m/s}$$

Waves on a string



$$F_{\text{net}} = ma$$

$$2T\theta = ma_c = m \frac{v^2}{r}$$

$$T_y = T \sin \theta \approx T\theta$$

$$2T\theta = 2\theta \mu v^2$$

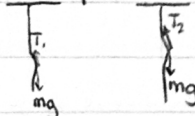
$$m = 2\theta \mu r$$

$$\frac{\Delta L}{r} = 2\theta \Rightarrow \Delta L = 2\theta r$$

$$T = \mu v^2$$

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

Example #3



$$T_2 > T_1$$