Standing waves.

$$y(x,t) = y(x \pm vt)$$

Periodic waves:

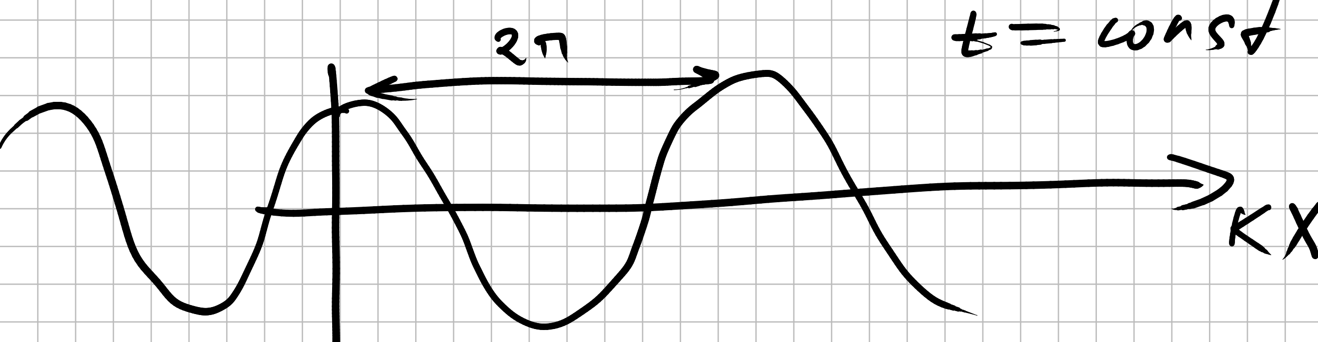
$$y(x,t) = A \cdot \cos(k(x \pm vt))$$

k ← makes proper units

$$= A \cdot \cos(kx \pm \omega t)$$

$\omega = k \cdot v$

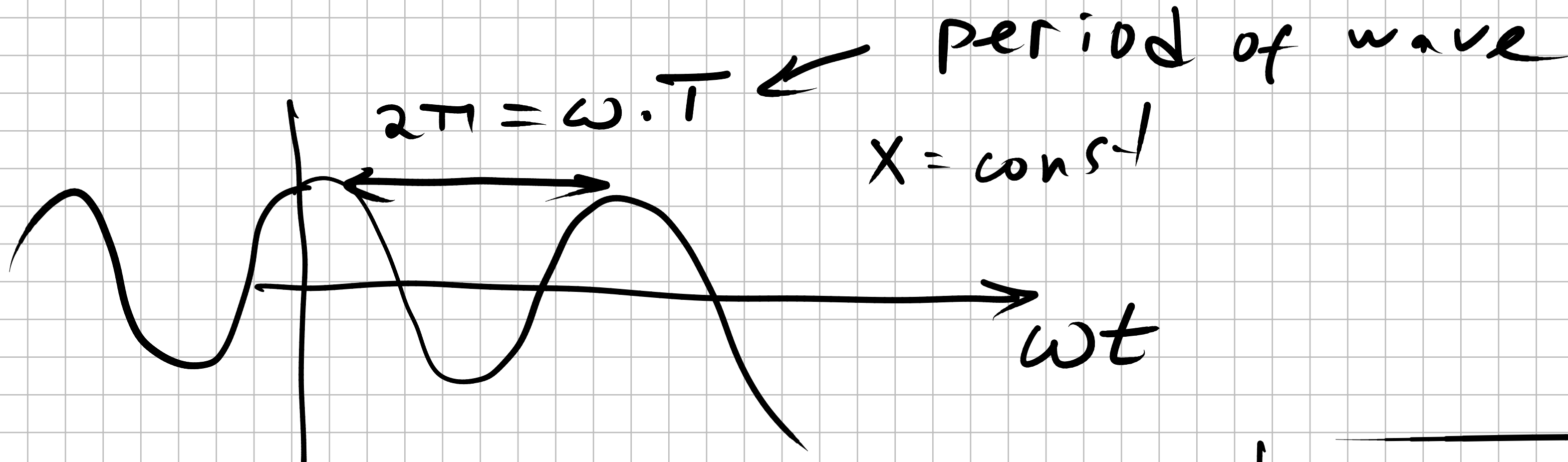
$t = \text{const}$



$$kx = 2\pi$$

$$k = \frac{2\pi}{\lambda}$$

λ ← wavelength



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

angular frequency

$$k = \frac{2\pi}{\lambda} \qquad f = \frac{v}{\lambda}$$

$$k v = \frac{2\pi}{\lambda} \cdot v = 2\pi \cdot f$$

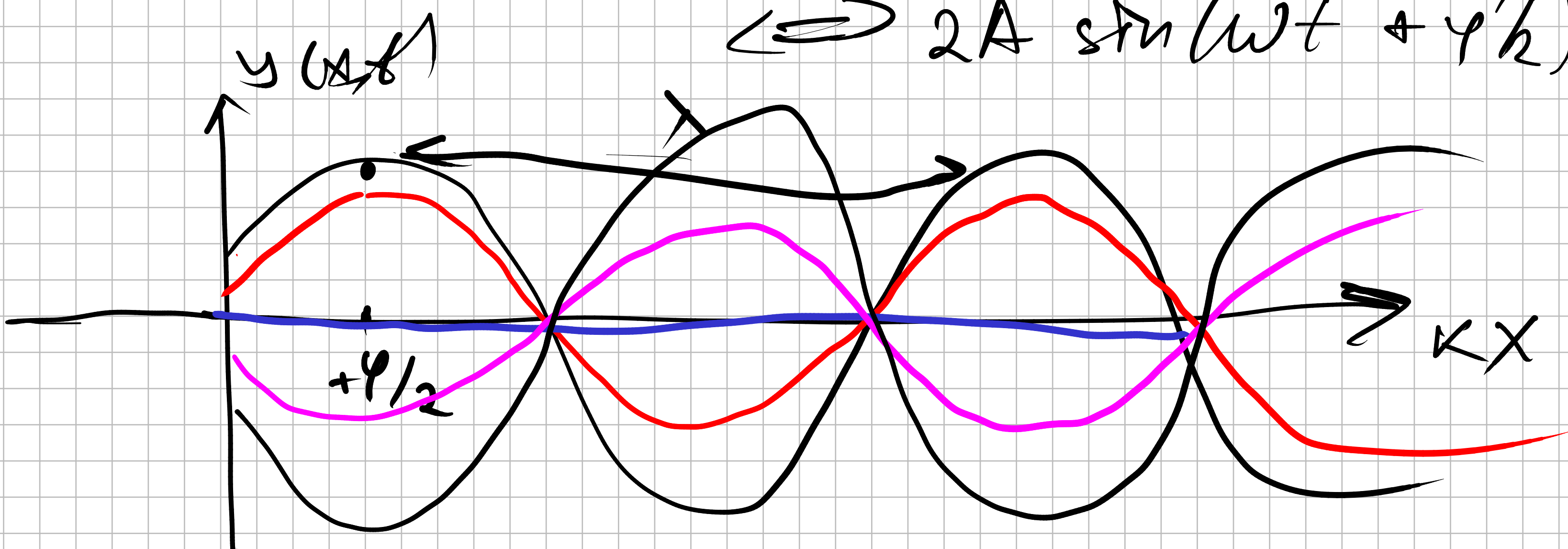
Two waves traveling towards each other

$$y(x,t) = A\cos(\overleftarrow{\omega t + kx}) + A\cos(\overrightarrow{\omega t - kx + \varphi})$$

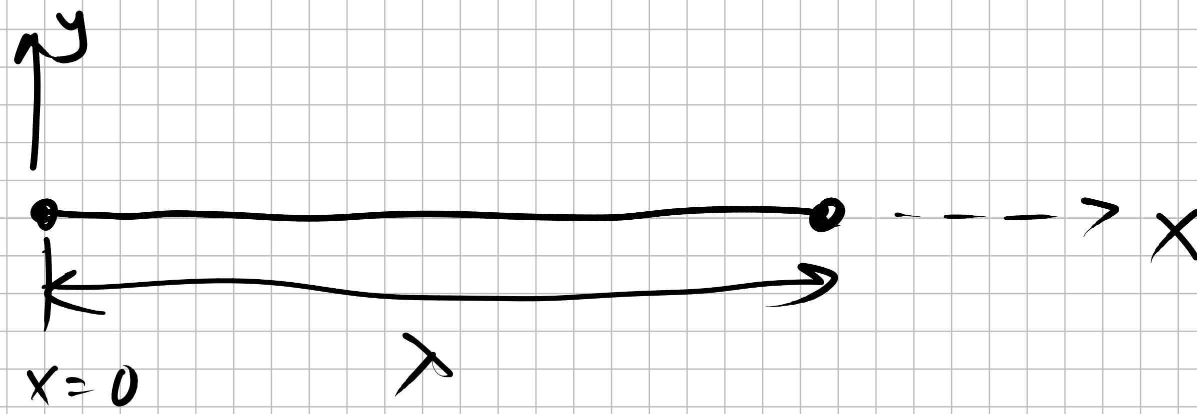
$$= 2A \cdot \cos\left(\frac{\omega t + kx + \omega t - kx + \varphi}{2}\right) \cdot \cos\left(\frac{\omega t + kx - \omega t + kx - \varphi}{2}\right)$$

$$= 2A\cos(\omega t + \varphi/2)\cos(kx - \varphi/2)$$

$$\Longleftrightarrow 2A\sin(\omega t + \varphi'/2)\sin(kx - \varphi'/2)$$



Strical Musical instruments



$$y(x=0,t) = 0$$

$$2A \sin(kx) \sin(\omega t)$$

$$y(x=L,t) = 0$$

$$\Downarrow$$

$$\sin(kL) = 0$$

$$kL = m\pi$$

$m = 1, 2, 3, 4, \ldots$

$$k = \frac{2\pi}{\lambda} = \frac{m\pi}{L}$$

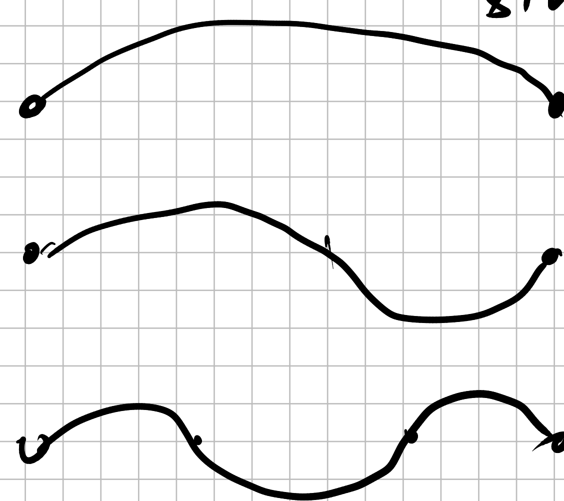
$$\boxed{\frac{\lambda}{2} = \frac{L}{m}}$$

$\sin(kx)$

$m = 1$

$m = 2$

$m = 3$



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

$$f = \frac{v}{\lambda} = \frac{v}{2L/m} = \frac{v}{2L} \cdot m$$