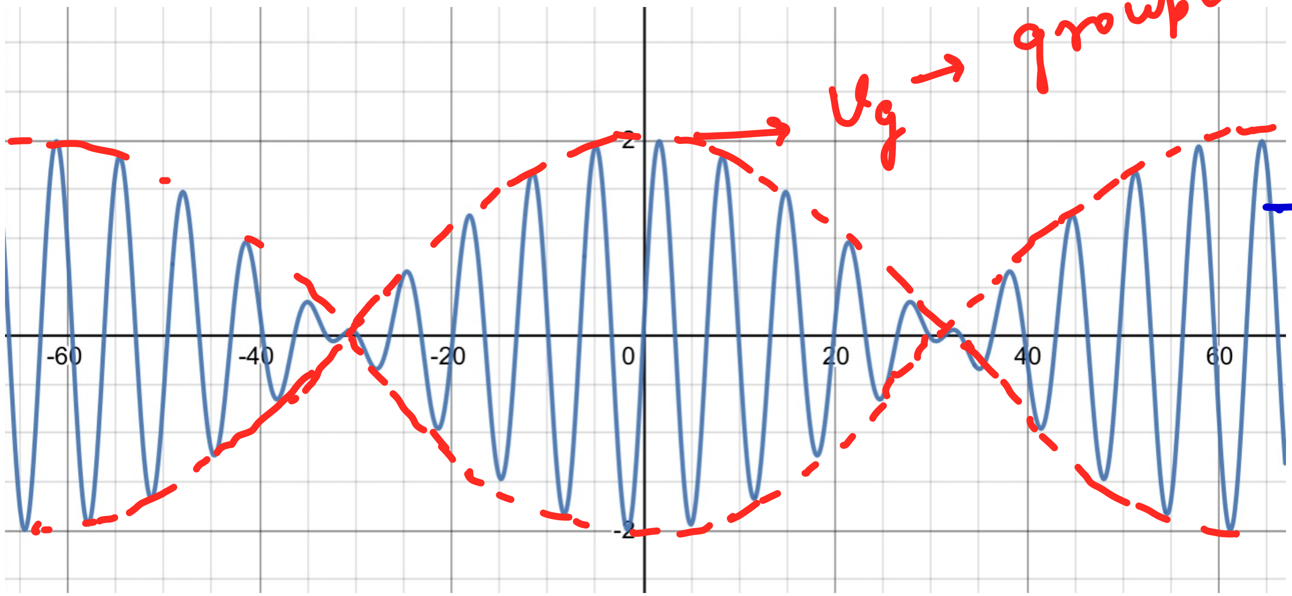
Harmonic wave

Feb. 22, 2022

$\omega \rightleftarrows \lambda$

$\omega = 2\pi\nu \; ; \; \nu = \frac{v}{\lambda}$



$v_g \rightarrow$ group velocity

$v_p \rightarrow$ phase velocity.

$$\omega = 2\pi\nu$$

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

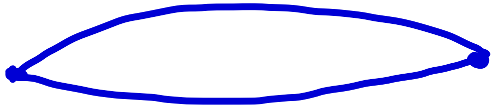
Periodic motion → Sine or cosine

Oscillatory motion →

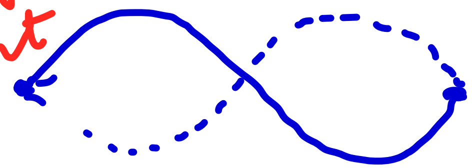
$= \omega t = \omega \cdot \frac{x}{v}$

$y = A \sin \omega t$ → Phase

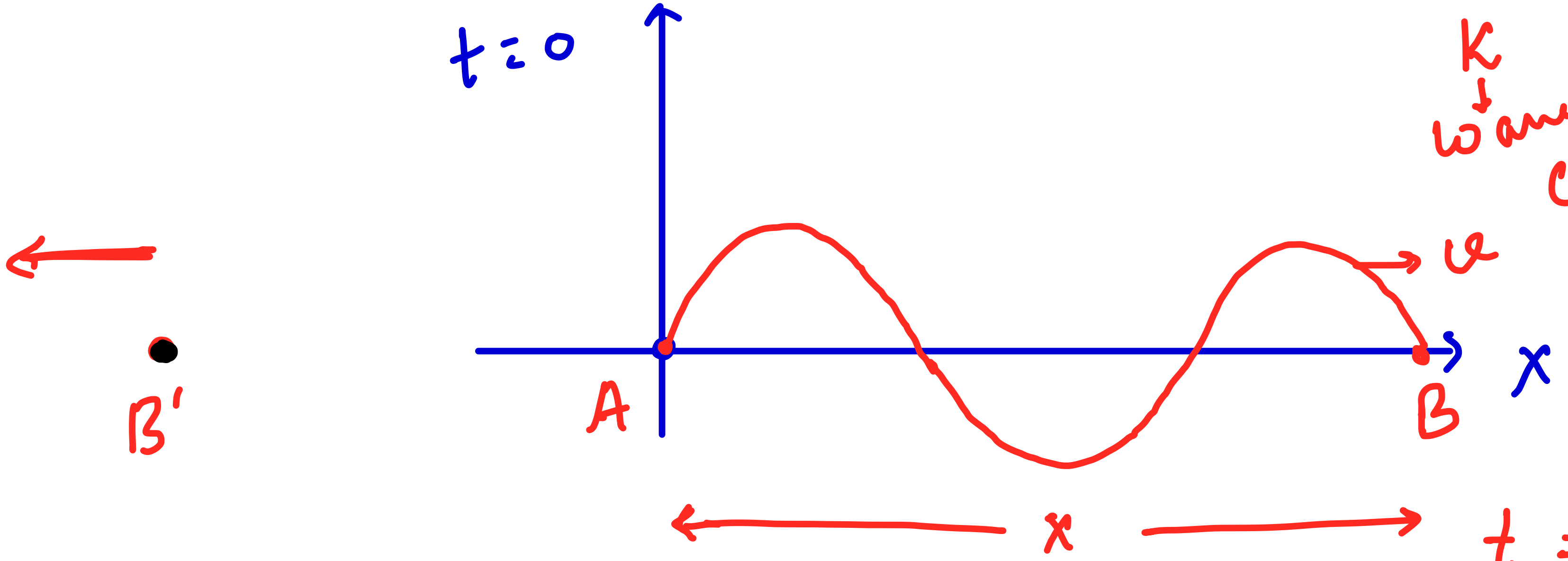
$= \left(\frac{\omega}{v}\right) x \pm x$



K
↓
wave propagation constant



$t = 0$



$t = \frac{x}{v}$

$\omega = 2\pi\nu$

$\frac{\omega}{v} = \frac{2\pi\nu}{v} = \frac{2\pi}{\lambda} = K$

$Y = A \sin(\omega t - \phi)$

$$y = A\sin\boxed{(\omega t - kx)}$$

2π

$n\pi$

$$y = f(vt - x)$$

$$= f\left(\omega \cdot t \cdot \frac{\lambda}{2\pi} - x\right)$$

$$= f\left[\frac{\lambda}{2\pi}\boxed{\left(\omega t - \frac{2\pi}{\lambda}x\right)}\right]$$

$$v = \nu \cdot \lambda$$

$$= \frac{2\pi\nu}{2\pi} \cdot \lambda$$

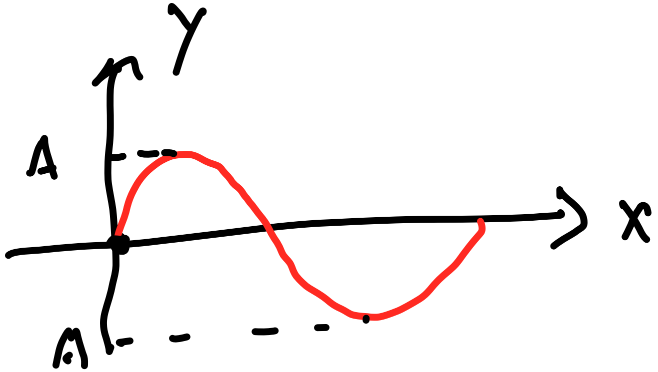
$$= \omega \cdot \frac{\lambda}{2\pi}$$

$$y = A\sin(\omega t + kx)$$

Cos

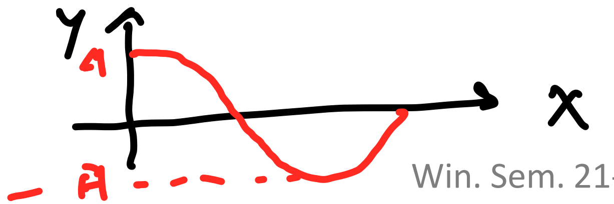
$t = 0,\ x = 0 \Rightarrow y = A\sin(\omega t - kx)$

$\rightarrow y = 0$



$t = 0,\ x = 0 \Rightarrow y = A\cos(\omega t - kx)$

$= A$



$Y_1 = A \sin \omega t$

$Y_2 = A \sin(n\pi + \omega t)$

$Y = Y_1 + Y_2$

$\frac{1}{c}$

→ Not a unique solution.

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

J, eV

cm^{-1}

$A \sin(\pi + \omega t) \rightarrow -A \sin \omega t$

$A \sin \omega t$

$y = \boxed{10} \sin(\boxed{10^5} t - \boxed{5} x)$

Find frequency and wavelength

$t = 0$

$t = 5$ sec

→ Plot the curve

$y = A \sin(\omega t - kx)$

$y = 10 \sin[-5x]$

$\omega = 2\pi\nu$

$v = \nu \cdot \lambda$

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

$y = A \sin\left[2\pi\nu t - kx\right]$

$\frac{2\pi v}{\lambda} t - \frac{2\pi}{\lambda} x$

$10^5 t$
$\parallel$
ω

$\frac{2\pi}{\lambda}(10^3 t - x)$

$\omega = \frac{2\pi 10^3}{\lambda}$

$y = A \sin \frac{2\pi}{\lambda}(vt - x)$

$y = A \sin(\omega t - kx)$

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

$$y(x,t) = A e^{i(\omega t - kx)} \rightarrow \text{Plane wave eq}^n$$

$$\cos(\omega t - kx) + i \sin(\omega t - kx)$$

$$\sin\theta = \frac{e^{i\theta} - e^{-i\theta}}{2i}$$

$$\cos\theta = \frac{e^{i\theta} + e^{-i\theta}}{2}$$

$$y = A \sin(\omega t - kx)$$

$$\frac{\partial y}{\partial t} = \text{Particle velocity} = A\omega \cos(\omega t - kx)$$

$$\frac{\partial y}{\partial x} = -AK\cos(\omega t - Kx) = -\frac{K}{\omega}\cdot\frac{\partial y}{\partial t}$$

$$\frac{\partial y}{\partial t} = -\underbrace{\boxed{\frac{\omega}{K}}}_{\text{phase velocity } = v_p}\frac{\partial y}{\partial x}$$

$$\underbrace{\frac{\partial x}{\partial t}}_{v_p}$$

$$Y = A\sin(\omega t \mp Kx)$$

$$Y = -A\sin Kx$$