UNIVERSITY OF CALGARY

Lecture 2.8
Sinusoidal waves example

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Example

A wave is represented as

$$y(x,t) = (2.0\ \text{m})\sin(kx - \omega t + \phi_0)$$

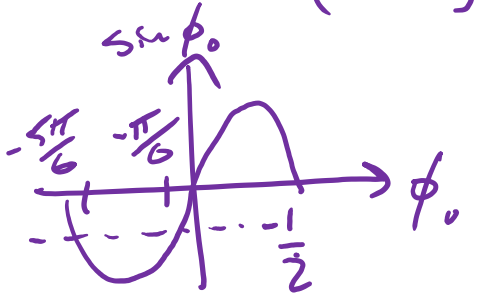
At {x=0, t=0}:

$$\begin{cases} y = -1\ \text{m} \\ v_y > 0 \end{cases}$$

Find ϕ_0

$$y(0,0) = (2.0\text{m})\sin(k\cdot 0 - \omega\cdot 0 + \phi_0)$$

$$= (2.0\text{m})\sin(\phi_0) = -1\text{m} \Rightarrow \sin\phi_0 = -\frac{1}{2}$$

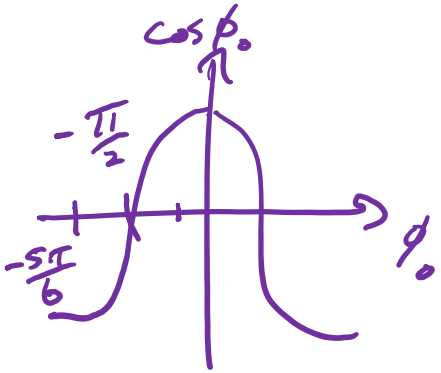


$$\Rightarrow \phi_0 = \begin{cases} -\pi/6 \\ -5\pi/6 \end{cases}$$ Which one?

$$y(x,t) = (2.0\text{m}) \sin(kx - \omega t + \phi_0)$$

$$v_y = \frac{\partial y}{\partial t} = (2.0\text{m})(-\omega)\cos(kx - \omega t + \phi_0)$$

$$v_y(0,0) = -\omega(2.0\text{m})\cos(\phi_0)$$



If $\phi_0 = \frac{-\pi}{6}$, $v_y(0,0) = -\omega(2.0\text{m})\cos\left(\frac{-\pi}{6}\right) < 0$ ✗

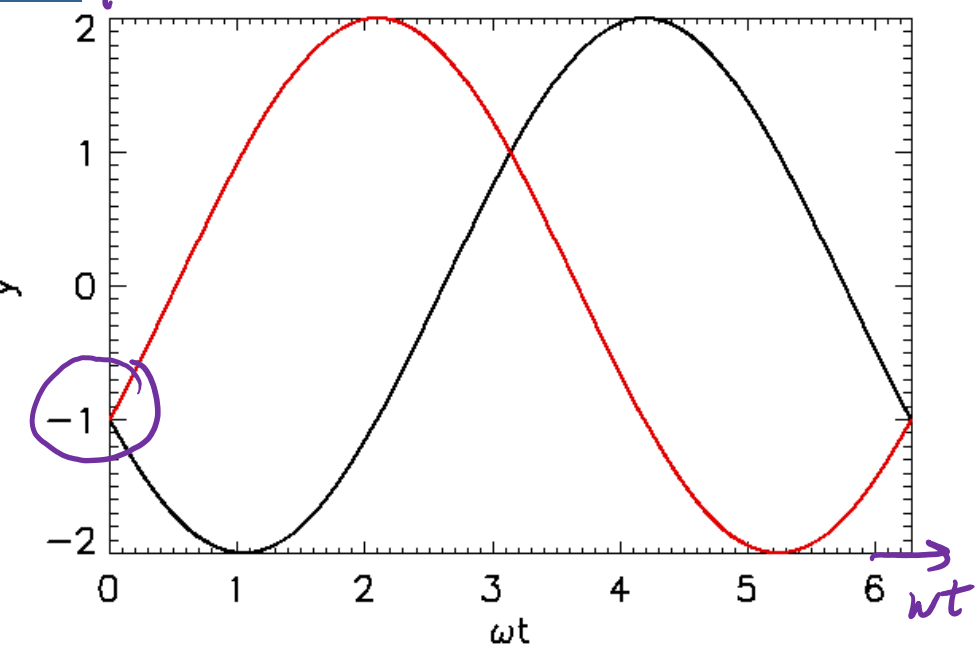
If $\phi_0 = \frac{-5\pi}{6}$, $v_y(0,0) = -\omega(2.0\text{m})\cos\left(\frac{-5\pi}{6}\right) > 0$ ✓

$\Rightarrow \phi_0 = -\frac{5\pi}{6}$ is our phase constant.

At x=0: at this point

$$y = 2\sin(-\omega t - \pi/6)$$

$$y = 2\sin(-\omega t - 5\pi/6)$$



BOTH solutions obey y=-1 at x=t=0.

However, only $\phi_0 = -5\pi/6$ is consistent with v_y>0 at x=t=0.

$\Rightarrow \phi_0 = -\frac{5\pi}{6}$