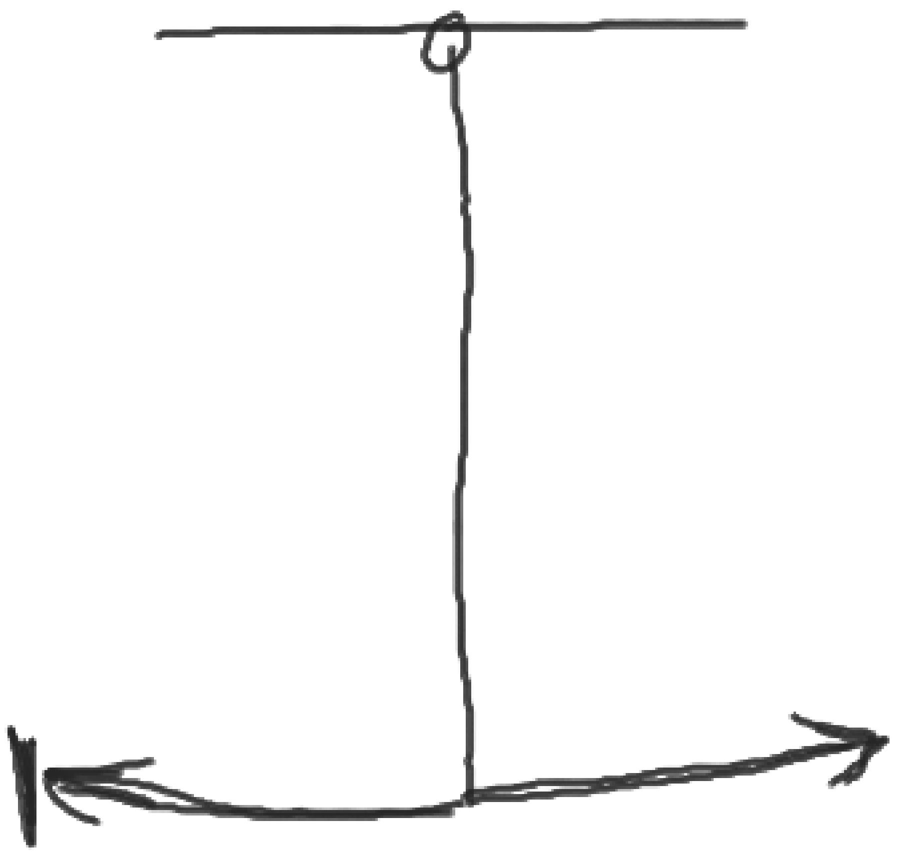

Pendulum.

Frictional force

Damping motion

Topic: Definition of a simple harmonic motion.

$$\vec{F} \propto -\vec{x}$$

$$\bar{F} = -k\,\bar{x}$$

$$F = -kx$$

Simple harmonic motion is such a motion where the displacement is proportional to the applied force and is negetively directed.

$$\bar{F} = -K\bar{x}$$

where, K is a constant, it is called spring constant.

Sine wave

Equation of motion for a SHO

We know that the motion of a harmonic oscillator can be written as

$$\boxed{\bar{F} = -k\bar{x}}$$

$$ma = -kx \quad \text{(using Newton's law)}$$

$$\underline{\underline{a}} = \frac{dv}{dt}$$

$$m\frac{dv}{dt} = -kx$$

$$\underline{\underline{v}} = \frac{dx}{dt}$$

$$m\frac{d}{dt}\left(\frac{dx}{dt}\right) = -kx$$

$$\frac{m}{m}\frac{d^2x}{dt^2} + \frac{k}{m}x = 0/m$$

$$\frac{d^2x}{dt^2} + \frac{k}{m}x = 0$$

Let us suppose $\frac{k}{m} = \omega^2$

$$\frac{d^2x}{dt^2} + \omega^2 x = 0 \quad \text{——} \quad (1)$$

So eq. (1) is a second order differential equation of a simple harmonic motion.

Find a solution of the eq. of motion of a SHO

We know that the equation of motion of a simple harmonic oscillator can be written as,

$$\frac{d^2 x}{dt^2} + \omega^2 x = 0 \qquad (1)$$

Let us consider a sinusoidal solution for equation (1)

$$x = \underline{\underline{A}} \sin(kx - \omega t)$$

$x \Rightarrow \sin(kx - \omega t)$

$y = \sin\theta$

$y = \cos\theta$

$\sin\omega t$

$\theta = 0^\circ \Rightarrow \sin\theta = 0$

$90^\circ \Rightarrow \quad = 1$

$\sin\theta = \dfrac{\text{লম্ব}}{\text{অতিভুজ}}$

$\cos\theta = \dfrac{\text{ভূমি}}{\text{অতিভুজ}}$

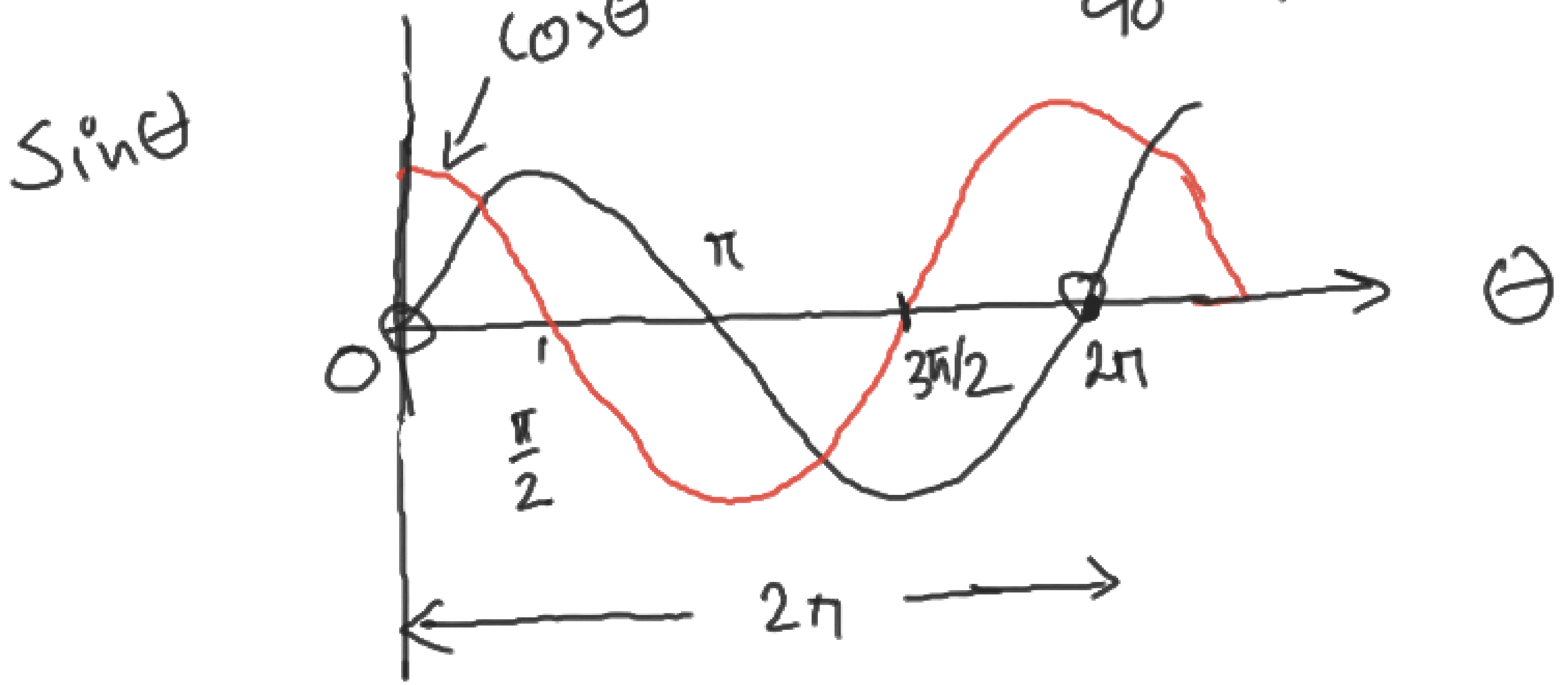

FIG. 4.

$0, 2\pi, 4\pi, 6\pi$

FIG. 5

We assume that the solution will be

$$x = A \sin(kx - \omega t) \longrightarrow (2)$$

where, $A =$ amplitude

$k =$ wave number

$\omega =$ angular frequency

L.H.S of eq. (1)

$$\frac{d^2}{dt^2}\left[A \sin(kx - \omega t)\right] + \omega^2 A \sin(kx - \omega t)$$

$$LHS = A \frac{d^2}{dt}\left[\sin\underbrace{(kx-\omega t)}_{\theta}\right] + \omega^2 A \sin(kx-\omega t)$$

$$= -\omega A \frac{d}{dt}\left[\cos(kx-\omega t)\right] +$$

$$= +\omega^2 A(-)\sin(kx-\omega t) +$$

$$= -\omega^2 A \sin(kx-\omega t) + \omega^2 A \sin(kx-\omega t)$$

$$= 0$$

$$LHS = RHS$$

$$\frac{d^2x}{dt^2}$$

$x = A \sin \omega t$

$$\frac{d^2}{dt^2}(A \sin \omega t)$$

$$\frac{d}{dt}\left[\frac{d}{dt}(A \sin \omega t)\right]$$

$$\omega A \frac{d}{dt}\left[\cos \omega t\right]$$

$$-\omega^2 A \sin \omega t = -\omega^2 x$$

What is the	definition of SHO?
Find the	equation of a SHO.
Find the	solution of a SHO