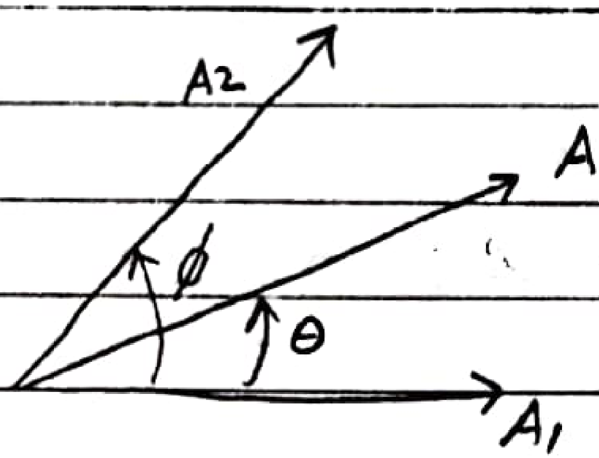
NOTES

1> SUPERPOSITION OF TWO SHM's.

$x_1 = A_1 \sin\omega t \qquad x_2 = A_2 \sin(\omega t + \phi)$

- same direction and same frequency



so, using Parallelogram Law,

$$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\theta}$$

and $$\tan\theta = \frac{A_2\sin\phi}{A_1 + A_2\cos\phi}$$

- same direction but different frequency

$x_1 = A_1 \sin\omega_1 t$ & $x_2 = A_2 \sin\omega_2 t$

so,

$$x = x_1 + x_2 = A_1\sin\omega_1 t + A_2\sin\omega_2 t$$

Not a SHM.

* DAMPED SIMPLE HARMONIC MOTION

if damping force is

$$F_d = -b\vec{v}.$$

so, our equation becomes

$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = 0$$

OR $$x(t) = Ae^{\frac{-bt}{2m}}\cos(\omega' t + \phi)$$

where,

$$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$$

Total Mechanical Energy

$$E(t) = \frac{1}{2}kA^2 e^{\frac{-bt}{m}}$$

* FORCED OSCILLATION (WITH DAMPING)

Taking force, $F = F_0 \cos\omega_d t$

$\omega_d \equiv$ driven frequency

Equation becomes-

$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = F_0\cos\omega_d t$$

so,

$$x = A\cos(\omega_d t + \phi)$$

$$A = \frac{F_0}{\{m^2(\omega^2 - \omega_d^2) + \omega_d^2 b^2\}^{1/2}}$$

and $\tan\phi = \frac{-v_0}{\omega_d x_0}$ v_0 & x_0 are at time $t=0$

(a) <u>Small Damping</u> (b is small)

$$A = \frac{F_0}{m(\omega^2 - \omega_d^2)}$$ i.e $\omega_d b$ is small.

(b) Driving frequency 'ω' closer to 'ω_d'

$$A = \frac{F_0}{\omega_d b}$$

<u>Resonance occurs when ($\omega = \omega_d$).</u>