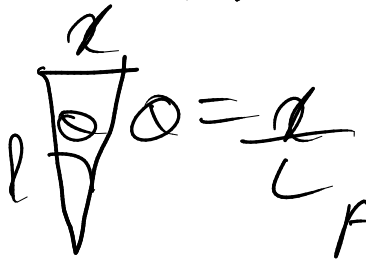
17 - oscillation

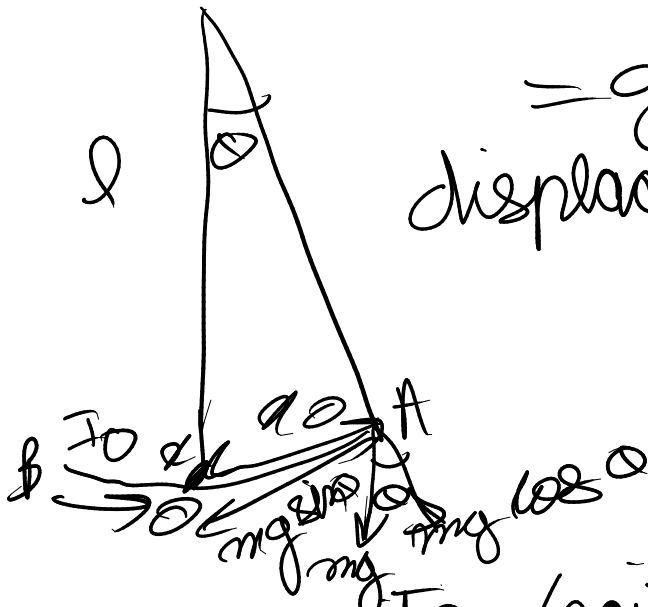
$-x_0 \Rightarrow$ Max displacement



$a = \frac{F}{m} = \frac{mg\sin\theta}{m}$

$= g\sin\theta$ directed towards O

displacement = x (opp to acceleration)



mean position / equilibrium

oscillation — one complete to & fro movement about a mean position.

- acceleration directed towards to mean position
- acceleration is directly ∝ to displacement
- acceleration is opposite to displacement

→ conditions for a body to perform simple Harmonic motion

Displacement is the distance of a body performing simple harmonic motion from its mean position. [x] [m]

Amplitude is the maximum displacement of the body from its mean position. [x_0] [m]

Time Period is the time taken by any body performing simple harmonic motion to complete one oscillation. [T] [s]

Frequency is the no. of oscillations made by the body in one second. [f] [Hz]

$f = \frac{1}{T}$ | $T = \frac{1}{f}$ for full circle

angular frequency $\omega = \frac{\theta}{t} = \frac{2\pi}{T} = 2\pi f$ (rad s^{-1})

$\omega = \frac{2\pi}{T}$

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equation of simple harmonic motion.

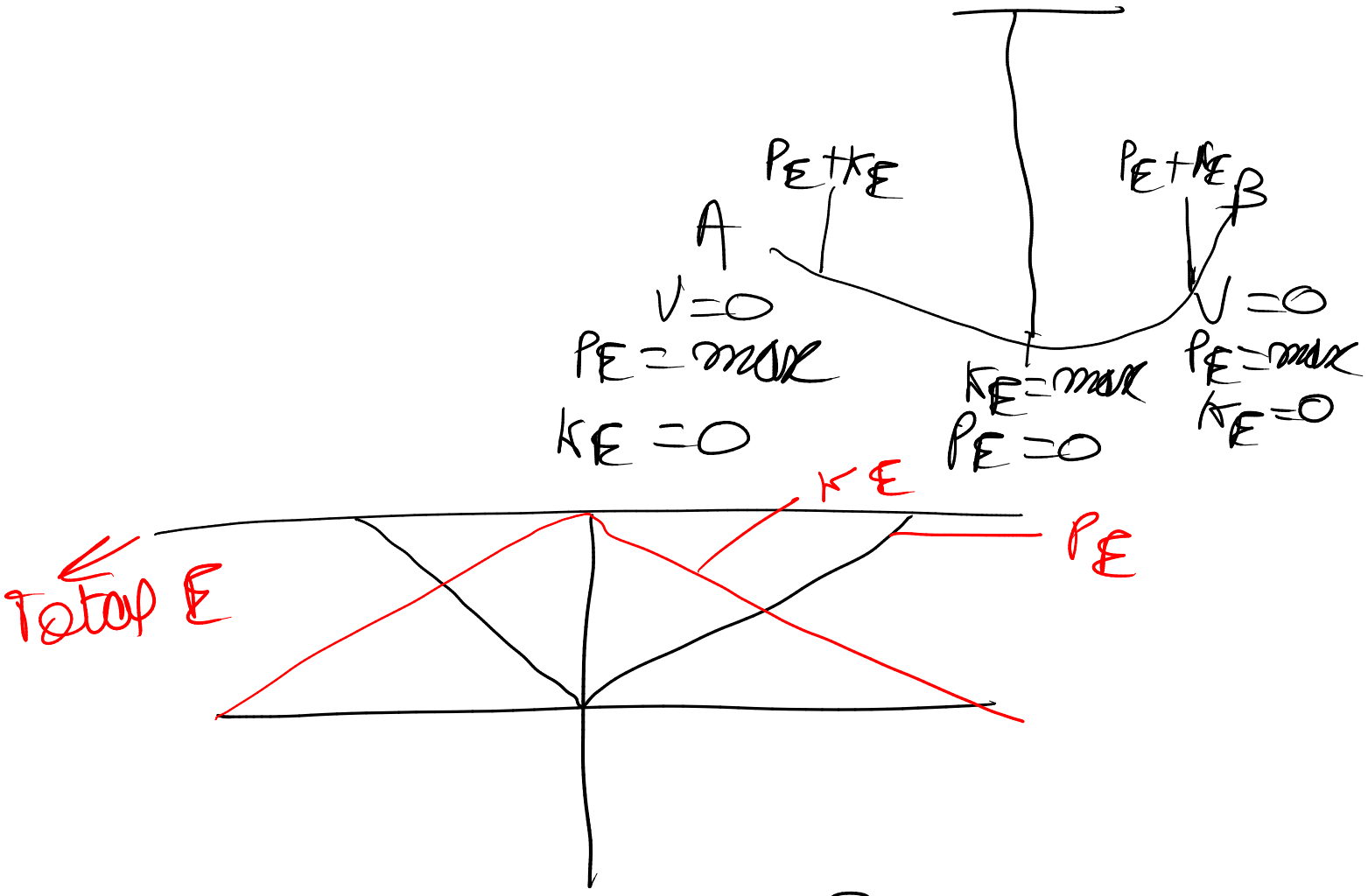
$a = -\omega^2 x$ displacement at time 't'

$x = x_0 \sin \omega t$ if body at mean from O.

Velocity at time (t).

$$V = \omega x_0 \cos \omega t$$

$$v = \pm \omega^2 (x_0^2 - x^2)$$



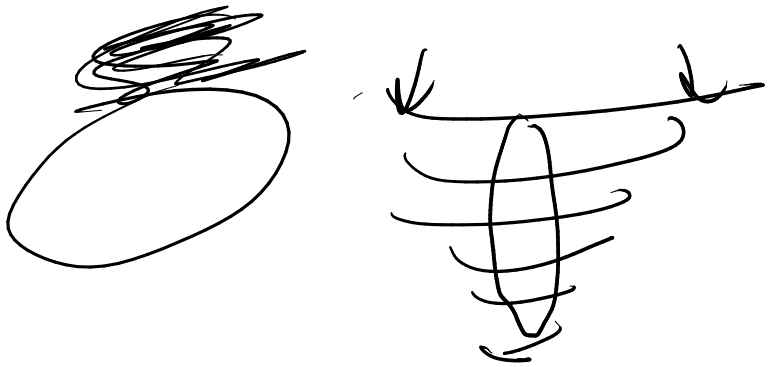
$$\text{Max } KE = \frac{1}{2} m (V_{max})^2$$

$$V = \omega \sqrt{x_0^2 - x^2}$$

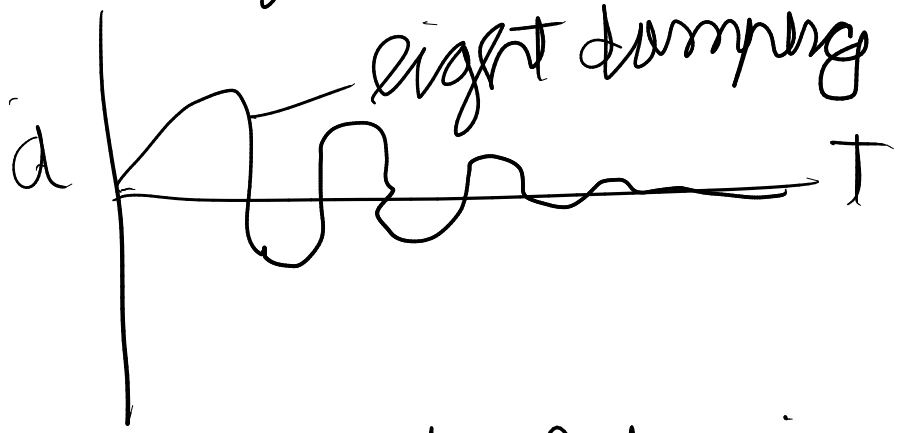
$$V_{max} = \omega x_0 \quad [\text{when } x = 0]$$

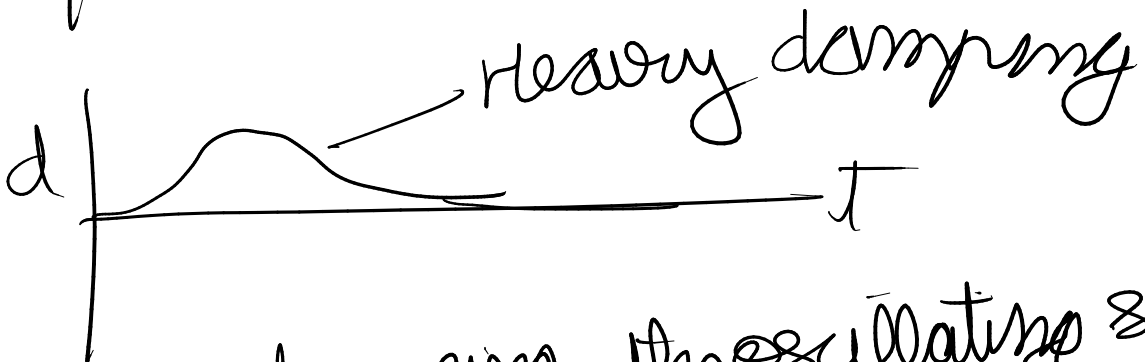
$$\rightarrow \frac{1}{2} m \omega^2 x_0^2 = \text{max } PE = \text{max } KE = \text{Total energy at any instant}$$

↓ amp will decrease due to air resistance → damping



light damping — when the oscillations continue for some time





critical damping, the oscillating system quickly returns to its ≡ position

In lighter damping, the system will oscillate one or more times before returning to its ⊜ position.

In critical damping the body will take a longer time to return to its ⊜ position as the oscillations continue for sometime

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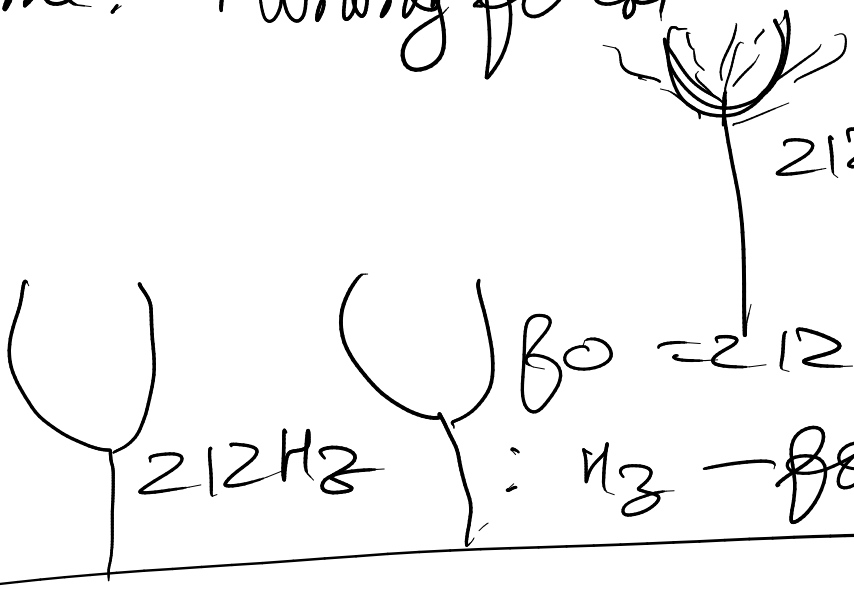
Resonance: Tuning fork



- When any object is forced to vibrate, it will vibrate with its own natural frequency. However if the body is forced to vibrate with a frequency equal to its natural frequency then it is said to be in resonance. When in resonance, it will have a maximum amplitude.