PRAYAS

JEE 2025

Lecture - 5

Physics

Oscillations

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Topics to be covered

1. spring block system (SHm)
2.
3.
4.

Q $v^2 = 108 - 9x^2$ (particle performing SHM.)

find A, T, w, V_{max}, a_{max}

Sol^n $v = \omega\sqrt{A^2 - x^2}$

$v^2 = \omega^2 A^2 - \omega^2 x^2$

$\omega^2 = 9$, $\omega = 3$ $\quad T = \frac{2\pi}{\omega} = \frac{2\pi}{3}$

$A^2\omega^2 = 108$

$A^2 \times 9 = 108$

$A^2 = 12$

$A = \sqrt{12}$

$V_{max} = A\omega = \sqrt{12} \times 3$

$v^2 = 108 - 9x^2$

diff wrt x

$2v\frac{dv}{dx} = 0 - 18x$

$a = -9x$

$a = -\omega^2 x$

$\omega = 3$

$V_{max}^2 = 108 - 0$

$V_{max} = \sqrt{108} = A\omega$

$A = \sqrt{12}$

SHM equation possible

- $\vec{F} = -k\vec{x}$ ✓
- $\vec{F} = +k\vec{x}$ X
- $F = -kx^2$ X
- $F = 10x + 20$ X
- $F = -10x + 20$ ✓ $\Rightarrow$ mp at $x = 2$

$x = A\sin\omega t$ ✓

$x = A\cos\omega t$ ✓

$x = A\cos\omega t = A\sin(\omega t + 90)$

Q $x = \sin\omega t + \sqrt{3}\cos\omega t$ SHM ✓

$= 2\left[\frac{1}{2}\sin\omega t + \frac{\sqrt{3}}{2}\cos\omega t\right] = 2\sin(\omega t + 60)$

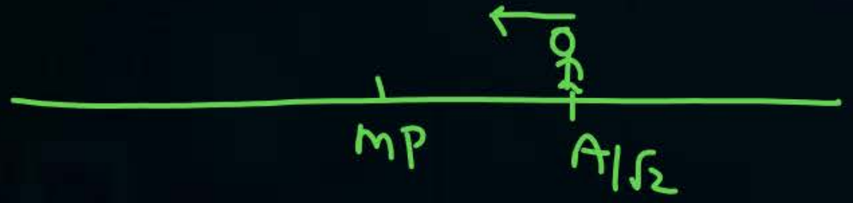
Amplitude $= 2 = \sqrt{1 + (\sqrt{3})^2}$

Q $x = \cos\omega t - \sin\omega t$

$= \sqrt{2}\left(\frac{1}{\sqrt{2}}\cos\omega t - \frac{1}{\sqrt{2}}\sin\omega t\right)$

$x = \sqrt{2}\cos(\omega t + 45^\circ)$

$x = \sqrt{2}\sin(\omega t + 45 + 90)$



Q $x = \sin^2\omega t$

$x = \frac{1-\cos 2\omega t}{2}$

$\cos 2\theta = \cos^2 - \sin^2\theta$
$= 2\cos^2\theta - 1$
$= 1 - 2\sin^2\theta$

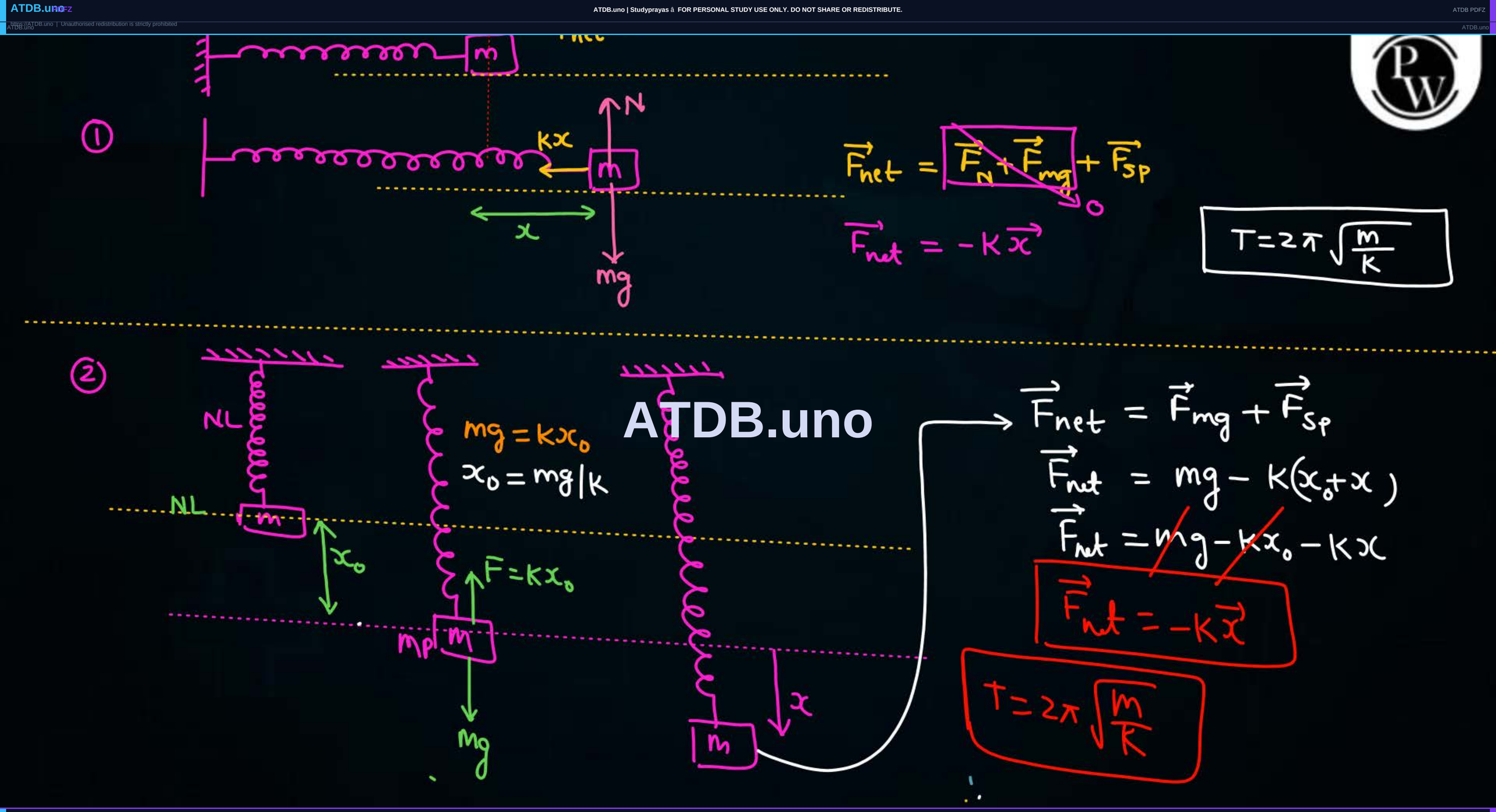
$x = \frac{1}{2} - \frac{1}{2}\sin(2\omega t + 90^\circ)$

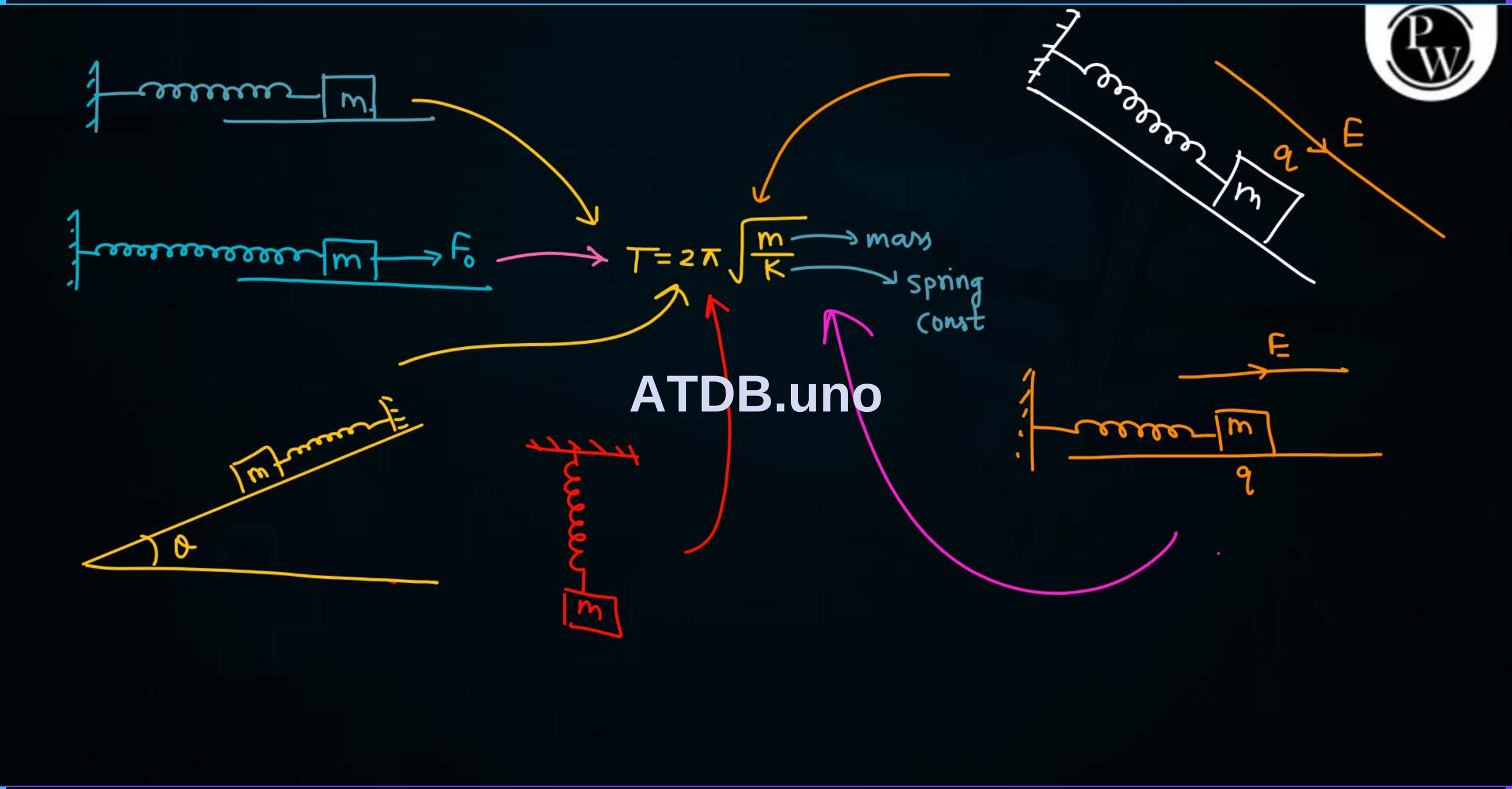
$x = \sqrt{2}\sin(45 - \omega t)$

$x = -\sqrt{2}\sin(\omega t - 45^\circ)$

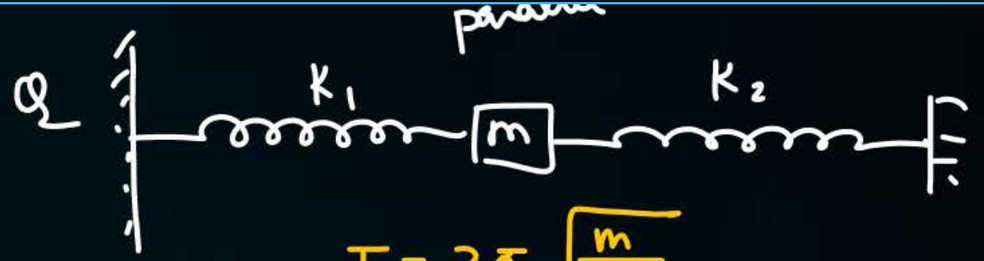
$x = \sqrt{2}\sin(\omega t - 45 + 180)$

$= \sqrt{2}\sin(\omega t + 135)$





$$T = 2\pi\sqrt{\frac{m}{K_{eq}}}$$

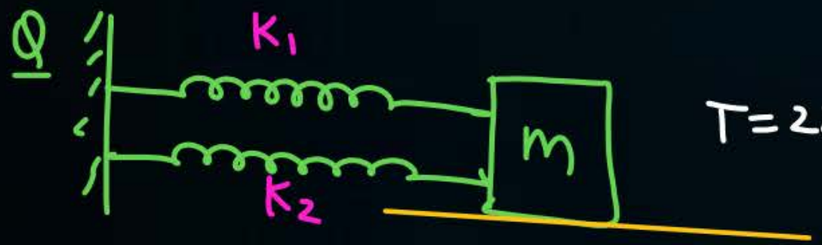


$$T = 2\pi\sqrt{\frac{m}{K_1+K_2}}$$

साथ-साथ SHM

$$T = 2\pi\sqrt{\frac{m_1+m_2}{K}}$$

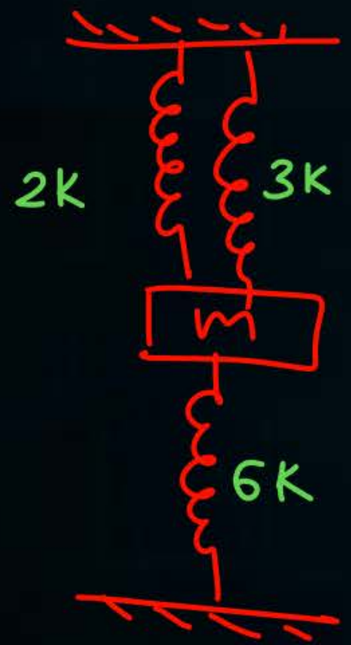
$$T = 2\pi\sqrt{\frac{m}{S_K}}$$



$$T = 2\pi\sqrt{\frac{m}{K_1+K_2}}$$

$$K_{eq} = K_1 + K_2$$

Q



$$T = 2\pi\sqrt{\frac{m}{2k+3K+6K}}$$

Q

$$T = 2\pi\sqrt{\frac{m}{10K}}$$

Q

$$T = 2\pi\sqrt{\frac{m}{K_{eq}}} \qquad K_{eq} = \frac{K_1 K_2}{K_1 + K_2}$$

$$\frac{1}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2}$$

① Spring block system

$$T = 2\pi\sqrt{\frac{m}{K_{eq}}}$$

②

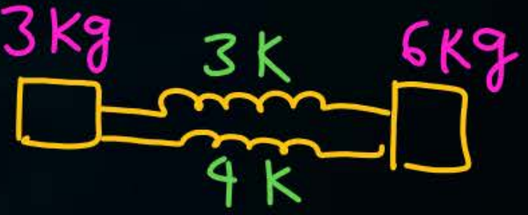
$$T = 2\pi\sqrt{\frac{\mu}{K}} \qquad \mu = \frac{m_1 m_2}{m_1 + m_2} = \text{Reduced mass}$$

③ Compound pendulum $T = 2\pi\sqrt{\frac{I}{mgd_c}}$

④ Simple pendulum $T = 2\pi\sqrt{\frac{l}{g_{eff}}}$

⑤ Torsional pendulum $T = 2\pi\sqrt{\frac{I}{C}}$ → torsional const

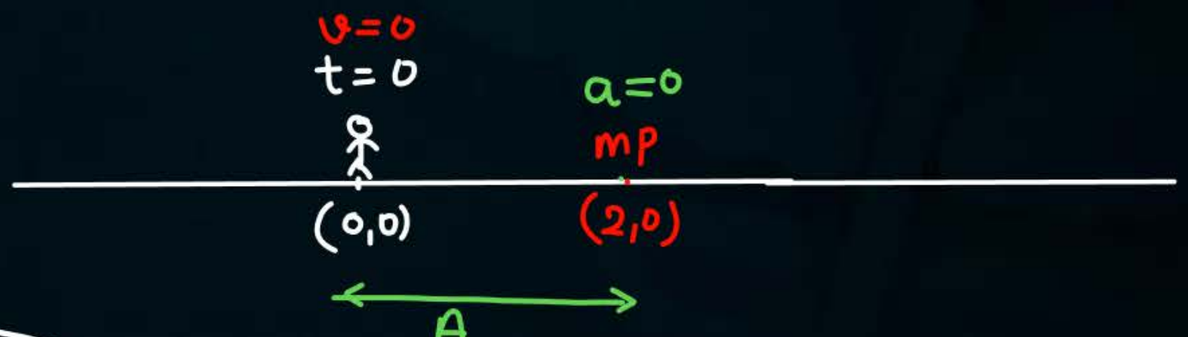
$K \longrightarrow K_{eq}$



$$T = 2\pi\sqrt{\frac{2}{7}}$$

Q A particle is moving on axis such that net force on the particle is given by $F = -10x + 20$. If at $t=0$, particle is at rest at origin $(m = 2.5\,kg)$.

Soln



$F = -10(x-2) = -10X$

x- co-ordinate

Displ. from mp

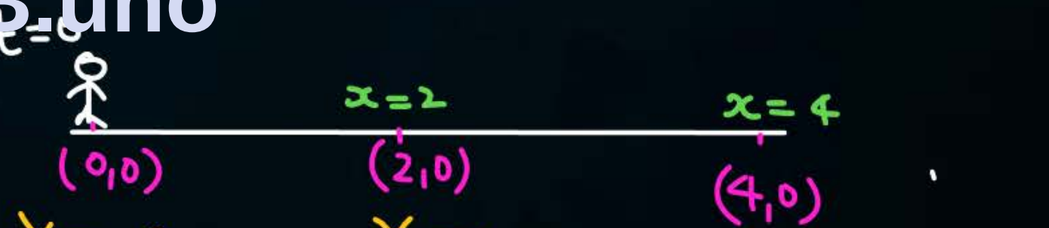
$A = 2$

$X = A\sin(\omega t + 3\pi/2)$

$K = 10 = m\omega^2$

$10 = 2.5\,\omega^2$

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



$X = -A$ EP

$X = 0$ mp

$X = +A = +2$ EP

$X = x - 2$

$m = 5kg$

Q A particle is performing SHM s.t. $F = -20x + 60$. At $t = 0$ particle is at rest at $x = +7$

find eqⁿ of SHM

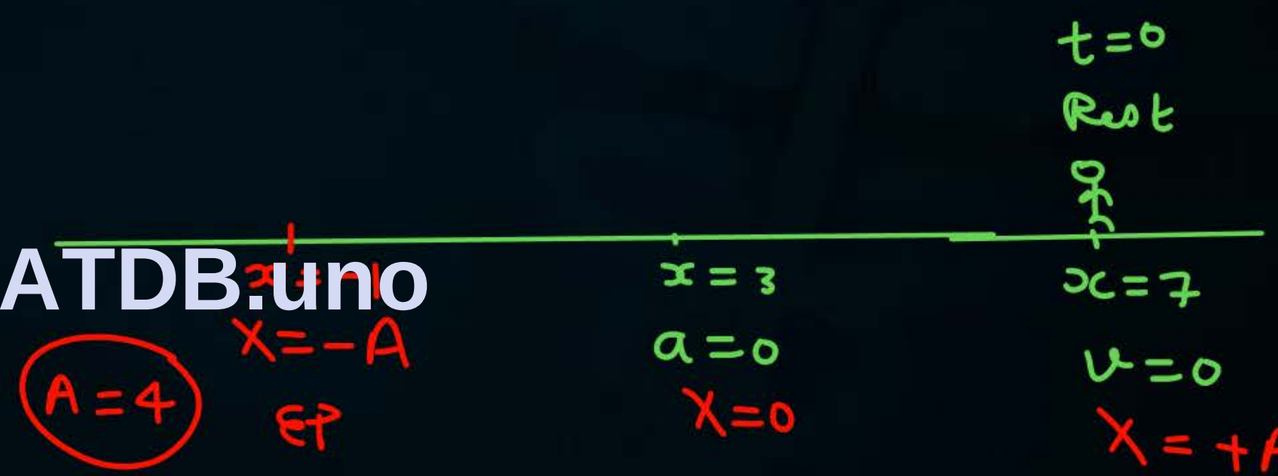
Soln

$F = -20x + 60$

$K = 20 = m\omega^2$

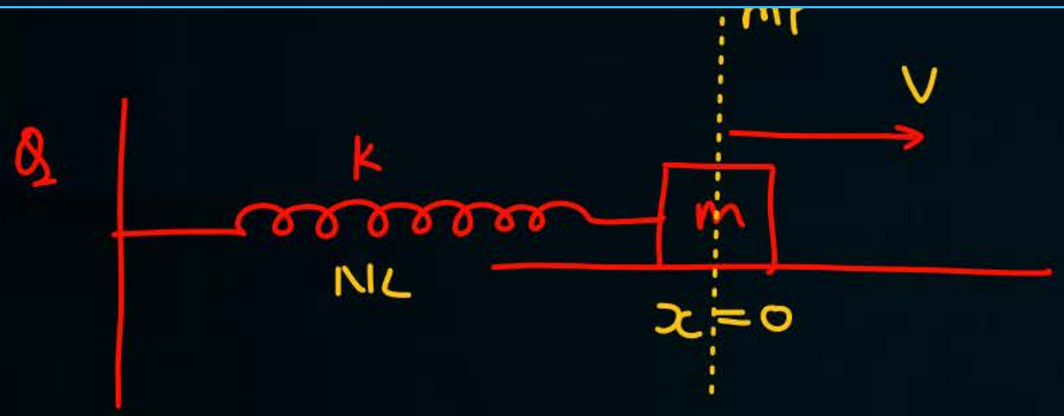
$20 = 5\omega^2$

$\boxed{\omega = 2}$



$X = 4\sin\left(2t + \pi/2\right) \Rightarrow x - 3$

$X + 3 = x$



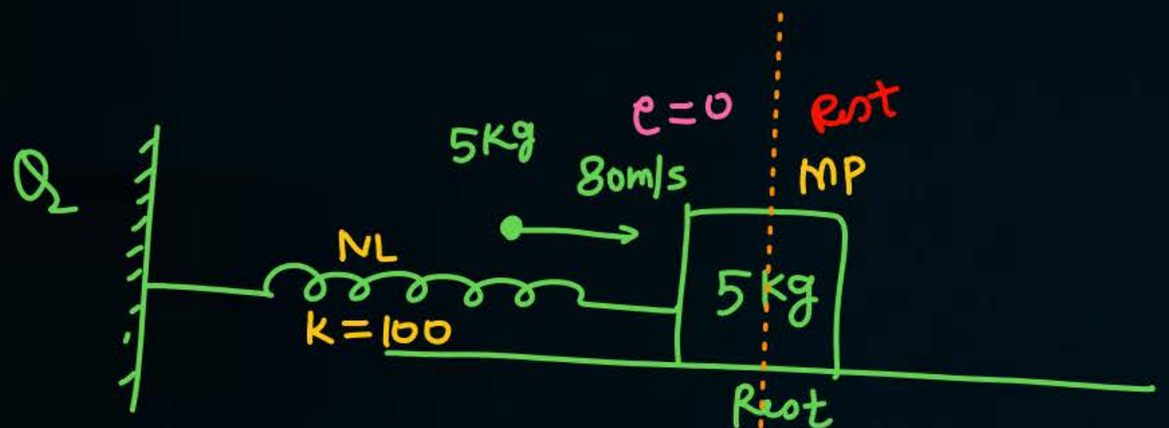
$$x = A\sin(\omega t + \upsilon)$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$v = A\omega$$

$$\omega = \sqrt{\frac{k}{m}}$$

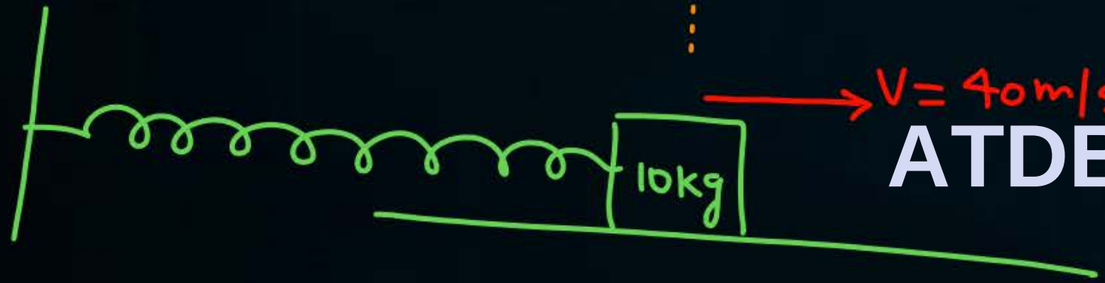
$$A = \frac{v}{\omega}$$



$$(P_i)_{jmt} = (P_f)_{jmt}$$

$$5\times80+0 = (5+5)V_f$$

$$\boxed{V_f = 40\ m/s}$$



$$x = A\sin(\omega t+\phi)$$

$$T = 2\pi\sqrt{\frac{10}{100}}$$

$$v = A\omega$$

$$40 = A\sqrt{10}$$

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{100}{10}} = \sqrt{10}$$

SKC SHM पता करना

① $mp \equiv F_{net} = 0$

② x displace. करो mp से FBD बनाओ

③ F_{net}

④ $\vec{F}_{net} = -k\vec{x}$ SHm

JEE Adv 2024

Q

A particle moving on x-axis s.t. at t=0 it is at rest at origin and net force acting on the particle is $F = -10x + 20$ (x-co-ordinate)

find. ① A, ω, T, f, ϕ, find x_{max}, $x = f(t)$, $v = f(t)$

② Eqⁿ of SHM.

Sol^n

$A = 2$, $\phi = 270°$

$k = 10 = m\omega^2$

$\omega = \sqrt{10}$

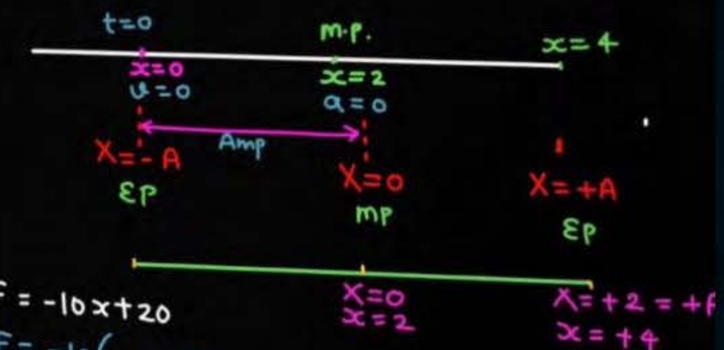
Displ. from m.p.

$X = A\sin(\omega t + \phi)$

$X = 2\sin(\sqrt{10}\,t + 270°)$

$x = X + 2$

$\boxed{x = 2\sin(\sqrt{10}\,t + 270°) + 2}$



$F = -10x + 20$

$F = -10(x - 2)$

$F = -20x + 10$

JA

ATDB.uno

Q

$m = 5\,kg$

A particle is moving on x-axis s.t. $F = -20x + 60$

and at t=0 particle is at $x = +7$ at rest.

$a = -4x + 12$

find A, ω, $x = f(t)$, $v = f(t)$, Eqⁿ of SHM.

Sol^n

$k = 20 = m\omega^2$

$20 = 5\omega^2$

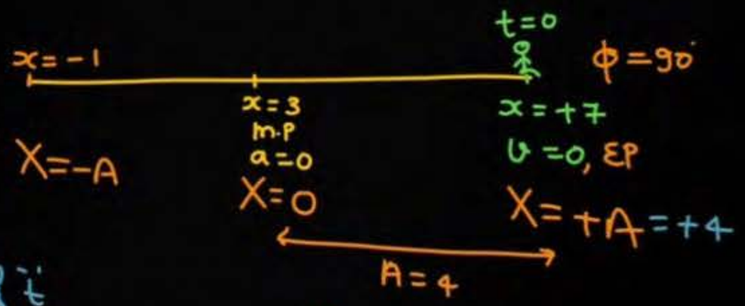
$\boxed{\omega = 2}$ $\omega = \frac{2\pi}{T}$

$A = 4$ $\boxed{T = \pi}$

$X = 4\sin(2t + 90°)$

x-co-ordinate as fxn of t

$x = X + 3 = 4\sin(2t + 90°) + 3$



$v_{max} = A\omega = 4 \times 2 = 8$

Home Work

- DPP -04
- HCV (SHM) → 11, 12, 15, 16, 17, 18, 21, 22, 23, 25, 28,
- module Next 3 days H.W ⇒ monday ⇒ Prarambh ⇒ (1-31)

  Twsday → Prabal → (1-13), (18, 19, 20)

  Wednesday → Pankhlit ⇒ (1-9), 23, 24,