
PRAYAS
JEE 2025
ATDB.uno
Lecture - 02
Physics
(SHM)
Oscillations
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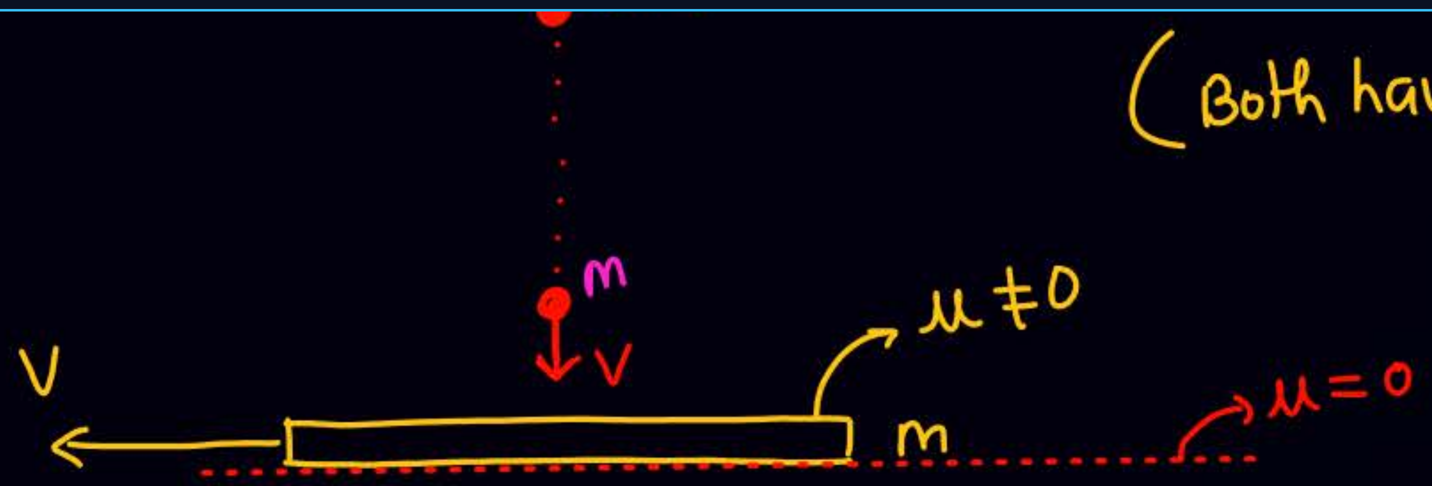
Physics Wall

Topics *to be covered*

1. Equation of SHM
2.
3.
4.

(Both have same mass)

Q



After collision platform (m) comes to at rest & vertical velocity of ball become $\frac{V_0}{2}$

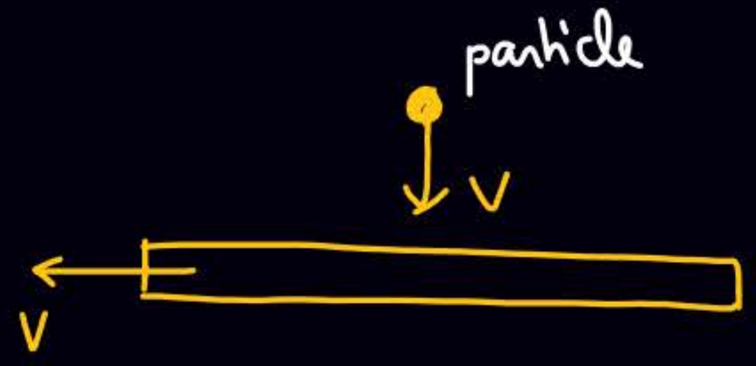
find

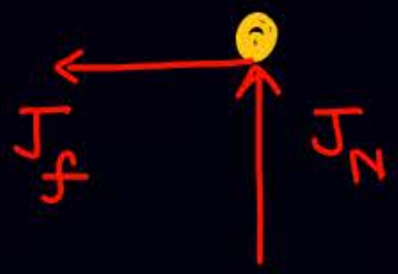
① $J_{\text{common normal}}$

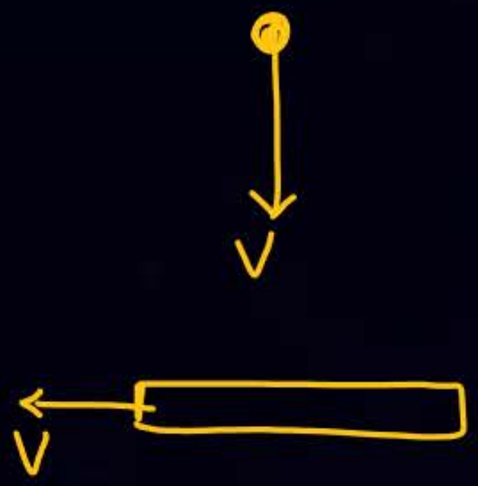
② J_{friction}

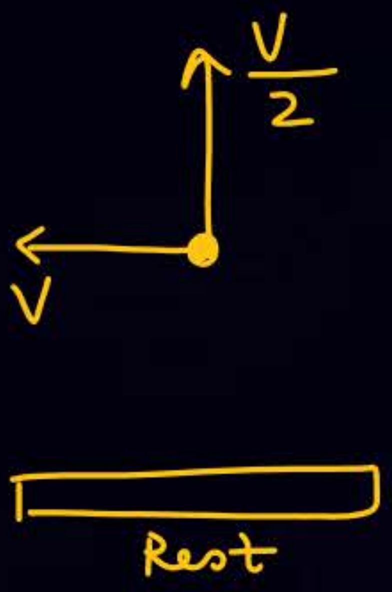
③ $(\vec{V}_f)$ ball just after collision

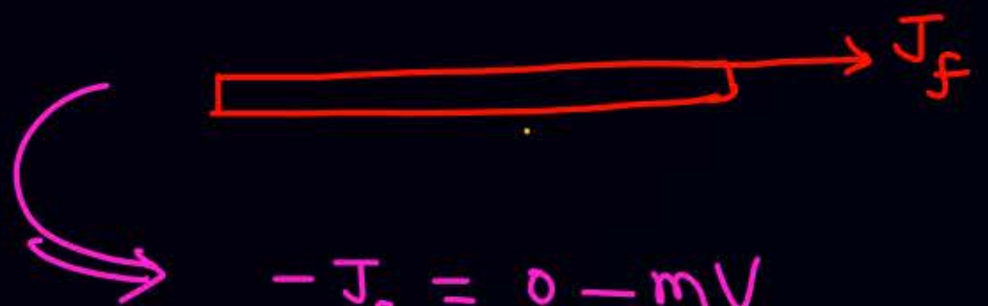
④ Coff of friction b/w ball & platform











$$-J_f = 0 - mV$$

$$J_f = mV$$

$$J_N = (\Delta P)_{ball} = m\frac{V}{2} - m(-V) = \frac{3mV}{2}$$

$$J_f = mV$$

4

$$J_N = \int N\,dt = \frac{3mV}{2}$$

$$J_f = \int f\,dt = \int \mu N\,dt = mV$$

$$\mu \int N\,dt = mV$$

$$\mu \frac{3mV}{2} = mV$$

$$\boxed{\mu = 2/3}$$

SHM

* $\vec{F} = -k\vec{x}$

Net ext- force

SHM वाला const

Displacement from M.P

Amplitude = A

a_{max}	V_{max}	a_{max}
$v = 0$	$a = 0$	$v = 0$
EP	mP	EP
	$F = 0$	
$x = -A$	$x = 0$	$x = +A$

$x \longrightarrow$ Displacement from M.P.

* acc is always towards the mp
* $\vec{a}, \vec{F}_{net}$ " " " "
* Amplitude $\longrightarrow$ max Displacement from M.P.

$F = -kx$ (Spring)

Spring force

Spring Const

Compression elongation

$$\vec{F} = -k\vec{x}$$

$$m\vec{a} = -k\vec{x}$$

$$\vec{a} = -\frac{k}{m}\vec{x}$$

$$\frac{d^2\vec{x}}{dt^2} = -\frac{k}{m}\vec{x}$$

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

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

$$v = A\omega\cos(\omega t + \phi)$$

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

$$a = -\omega^2[A\sin(\omega t + \phi)]$$

$$\boxed{a = -\omega^2 x}$$

$$\omega^2 = \frac{k}{m}$$

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

$$F = -kx^2 X$$

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

$\omega t + \phi \longrightarrow$ phase

$\phi \longrightarrow$ initial phase

$\vec{F} = -K\vec{x}$ (SHM)

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

$x \longrightarrow$ Displacement of particle from m.P.

$A \longrightarrow$ Amplitude

$\omega \longrightarrow$ Angular frequency

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

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

$T \longrightarrow$ time period

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

$f \longrightarrow$ frequency $= \frac{1}{T}$

Q $\quad x = 10\sin\left(\frac{\pi}{2}t\right)$

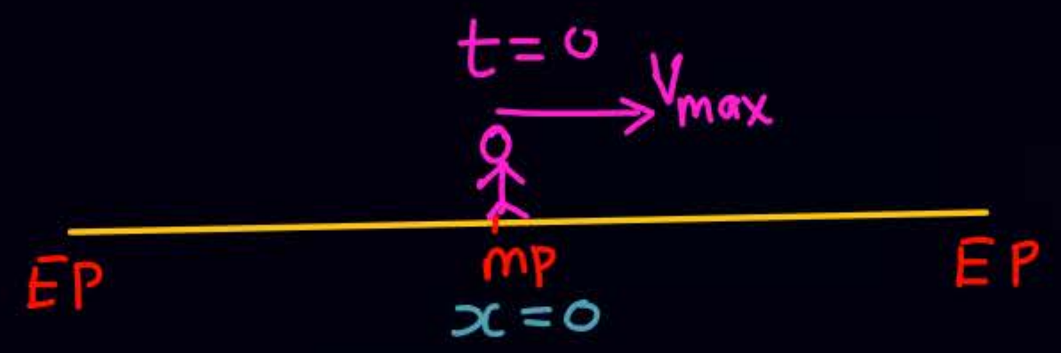
$$x = A\sin(\omega t + 0)$$

① $A = 10, \quad \omega = \frac{\pi}{2}, \quad T = ?$

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

$$\frac{\pi}{2} = \frac{2\pi}{T} \qquad \boxed{T = 4\,sec}$$

initial phase $= 0$



② $x = 10\sin\left(\frac{\pi t}{2}\right)$

$$v = \frac{dx}{dt} = 10\cdot\frac{\pi}{2}\cos\left(\frac{\pi}{2}t\right) \Rightarrow V_{max} = 10\pi/2$$

$$a = \frac{dv}{dt} = -10\frac{\pi}{2}\frac{\pi}{2}\sin\frac{\pi}{2}t$$

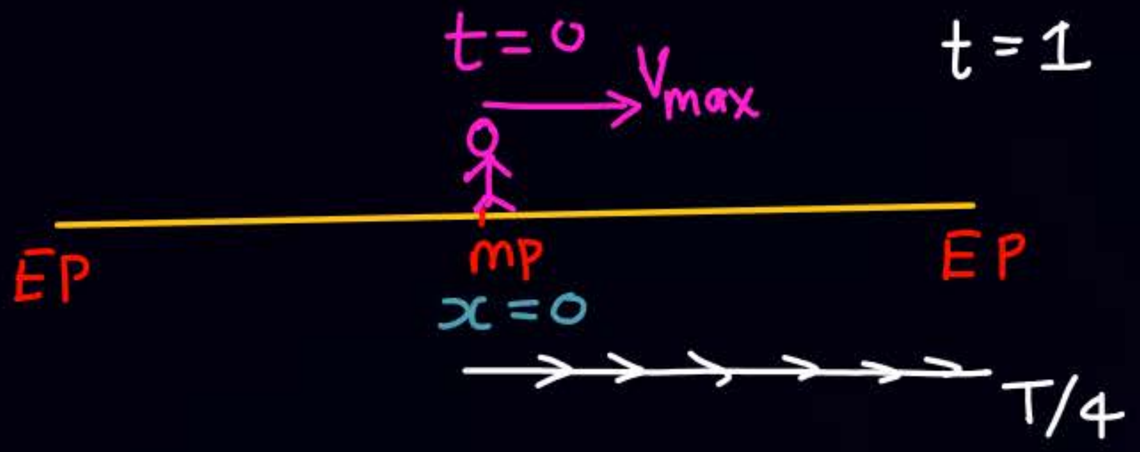
③ find x, v, a at $t = 0$

$t = 0, \quad x = 0, \quad v = 10\pi/2 = V_{max}$

$a = 0$

Q $x = 10\sin\left(\frac{\pi}{2}t\right)$

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



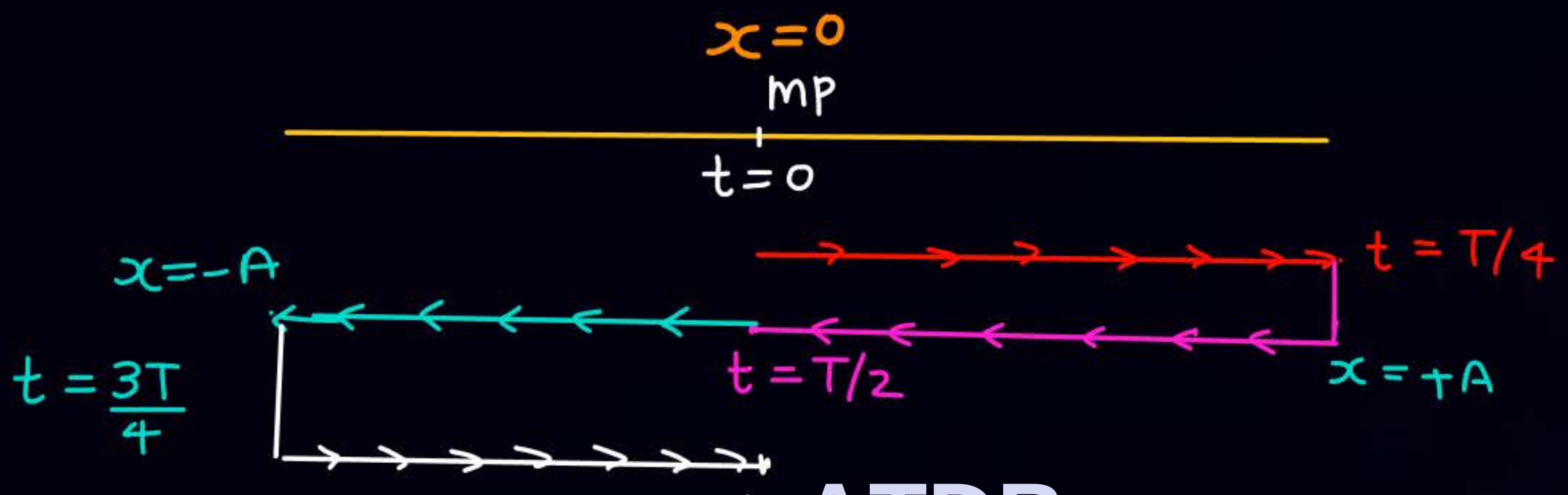
(4) find x, v at $t = 1$ sec

$x = 10\sin\frac{\pi}{2}t = 10\sin\pi/2 = 10$

$v = 10\frac{\pi}{2}\cos(\pi/2\, t) = 0$

$T = 4$ sec

$\frac{T}{4} = 1$ sec



$$x = A\sin(\omega t + 0)$$

$$v = A\omega\cos\omega t$$

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}mA^2\omega^2\cos^2\omega t$$

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

Q A particle is performing SHM on x-Axis s.t.

$$x = 10\sin\left(\frac{\pi t}{4} + \pi/6\right)$$

① $A = 10$

$\omega = \pi/4 = 2\pi/T$

$T = 8\text{ sec}$

initial phase $= \pi/6 = 30^\circ$

$v = f(t) = 10\cdot\frac{\pi}{4}\cos\left(\frac{\pi t}{4} + 30^\circ\right)$

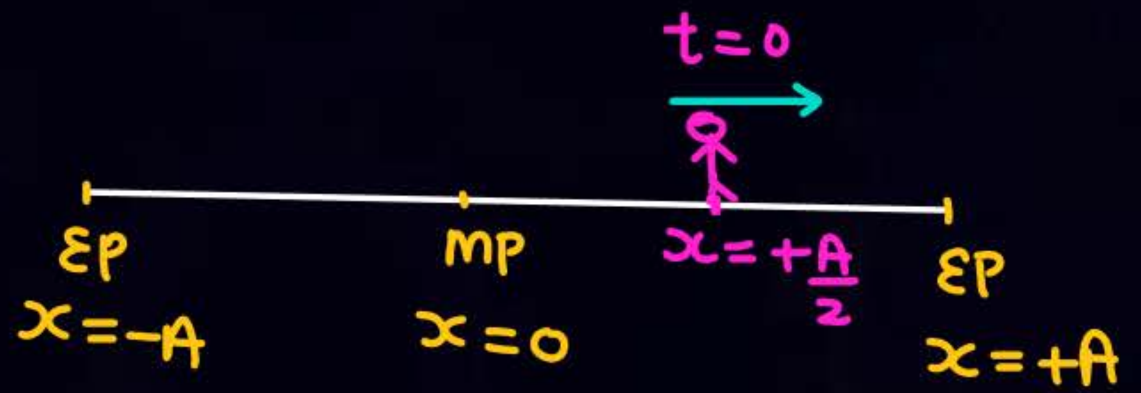
$a = f(t) = -10\left(\frac{\pi}{4}\right)^2 \sin\left(\frac{\pi t}{4} + 30\right)$

$v_{max} = 10\pi/4$

$a_{max} = 10\left(\frac{\pi}{4}\right)^2$

② Find location of particle, x, v at $t = 0$

$t = 0, \quad x = 10\sin(0 + 30^\circ) = \frac{10}{2} = \frac{A}{2} = 5$



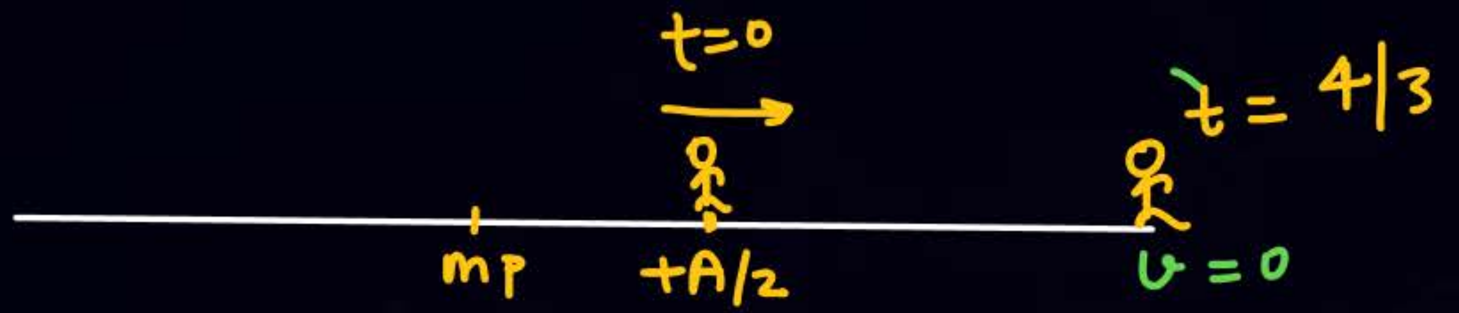
$v = 10\frac{\pi}{4}\cos\left(\frac{\pi t}{4} + 30^\circ\right)$

$t = 0, \quad v = 10\frac{\pi}{4}\cos(0 + 30^\circ)$

$v = \frac{10\pi}{4}\frac{\sqrt{3}}{2}$

③ $x = 10\sin\left(\frac{\pi t}{4} + \frac{\pi}{6}\right)$

find location & v at $t = \frac{4}{3}$



$$x = 10\sin\left(\frac{\pi}{4}\frac{4}{3} + \frac{\pi}{6}\right) = +10$$

$$v = 10\frac{\pi}{4}\cos\left(\frac{\pi t}{4} + \pi/6\right)$$

$t = 4/3$

$$v = 10\frac{\pi}{4}\cos\left(\frac{\pi}{4}\frac{4}{3} + \pi/6\right) = 0$$

(4) $x = 10\sin\left(\frac{\pi t}{4} + \pi/6\right)$

$v = \frac{10\pi}{4}\cos\left(\frac{\pi t}{4} + \frac{\pi}{6}\right)$

find the time when v become 0 $\Longrightarrow$ $\frac{\pi t}{4} + \frac{\pi}{6} = (2n+1)\frac{\pi}{2}$ $n = 0, 1, 2 \ldots$

" " " " " max $\Longrightarrow$ $\frac{\pi t}{4} + \frac{\pi}{6} = n\pi$

" " " a " 0

" " " a " max

" " " KE " max

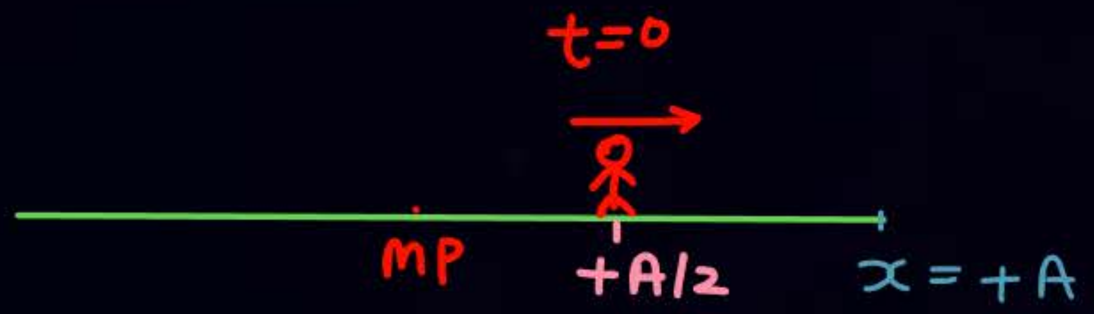
Maths

अगर आपको eq^n given है
या eq^n मिल गयी
} At any time कुछ भी निकाल सकते हैं।

?

Q A particle is performing SHM on x-Axis having amplitude A, time period T and angular freq. ω. Find eq^n of SHM if at $t=0$ particle is at $x = +\frac{A}{2}$ moving away from m.p.

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



$t=0,\ x = \frac{A}{2} = A\sin(0+\phi)$

$\sin\phi = A/2$

$\phi \rightarrow 30^\circ,\ 150^\circ$

$v = A\omega\cos(\omega t + \phi)$

At $t=0,\ v>0$

$v = A\omega\cos(0+\phi) > 0$

$\cos\phi > 0$

$\phi = 30^\circ$ ✓

$= 150^\circ$ ✗

$x = A\sin(\omega t + 30^\circ)$

(b)

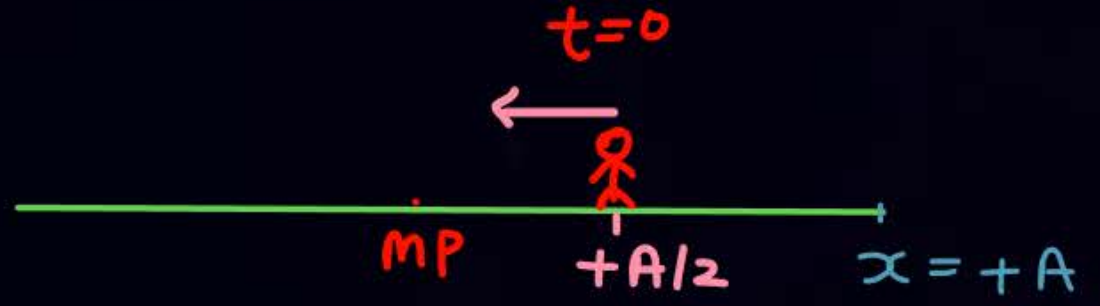
मजेदार shortcut तरीका

logical

(b) Repeat the above prob. if at $t=0$, $x = +\frac{A}{2}$ moving towards m.p

$$x = A\sin(\omega t + 150^\circ)$$

Q A particle is performing SHM on x-Axis having amplitude A, time period T and angular freq. ω. Find eqⁿ of SHM if at t=0 particle is at $x = +\frac{A}{2}$ moving Towards m.P.



Solⁿ $x = A\sin(\omega t + \phi)$

$t=0,\ x = \frac{A}{2} = A\sin(0+\phi)$

$\sin\phi = A/2$

$\phi \to 30^\circ,\ 150^\circ$

$v = A\omega\cos(\omega t + \phi)$

At $t=0,\ v<0$

$v = A\omega\cos(0+\phi) < 0$

$\cos\phi < 0$

$\phi = \cancel{30^\circ}$

$= 150^\circ$

$x = A\sin(\omega t + 150^\circ)$

Home Work

- DPP 01
- module → Prarambh ⇒ 2, 8, 10, 11, 18, 22,
- Start Rotation KPP & JA PYQ


THANK
YOU