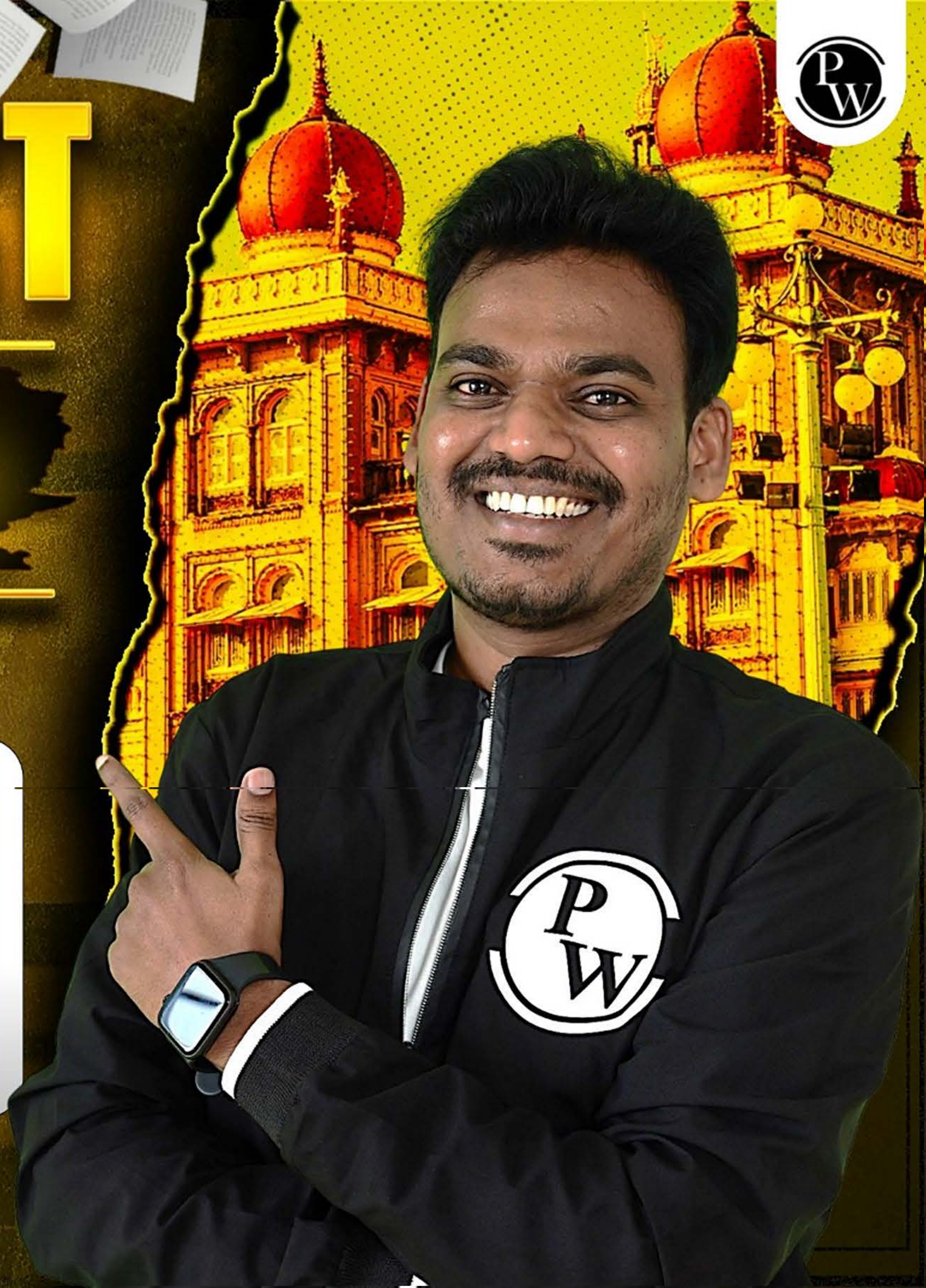
ULTIMATE KCET

CRASH COURSE 2026

PHYSICS | Lecture : 01

OSCILLATIONS

By: AK Sir



Recap

of previous lecture

1. THERMODYNAMICS
2. QUESTIONS ON THERMODYNAMICS
3. KINETIC THEORY
4. QUESTIONS ON KINETIC THEORY

Topics

to be covered

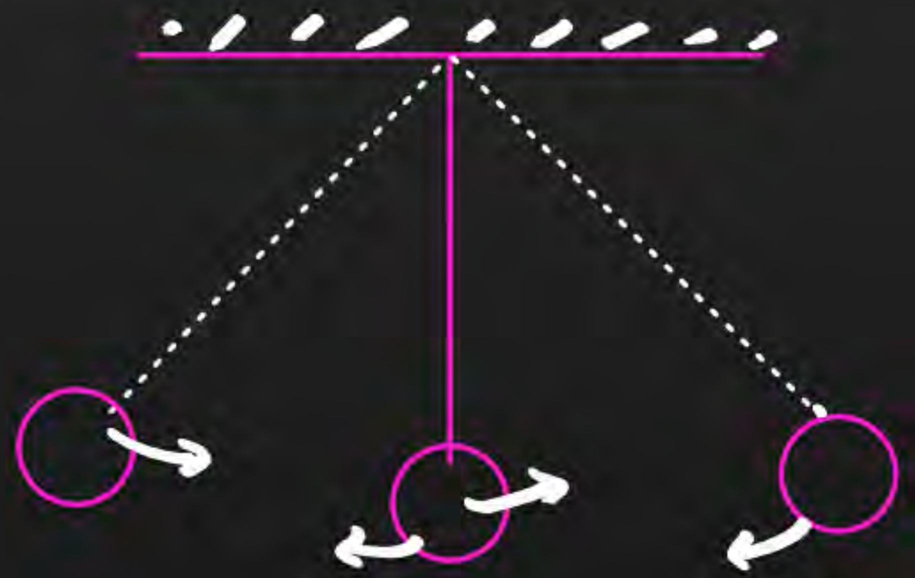
1. SIMPLE HARMONIC MOTION
2. EQUATION OF SIMPLE HARMONIC MOTION
3. POSITION, VELOCITY AND ACCELERATION IN SHM
4. QUESTIONS ON OSCILLATION

DIFFERENT TYPES OF MOTION

1. Oscillatory Motion

2. Vibratory Motion

3. Periodic Motion



1 → Every oscillatory motion is periodic motion.

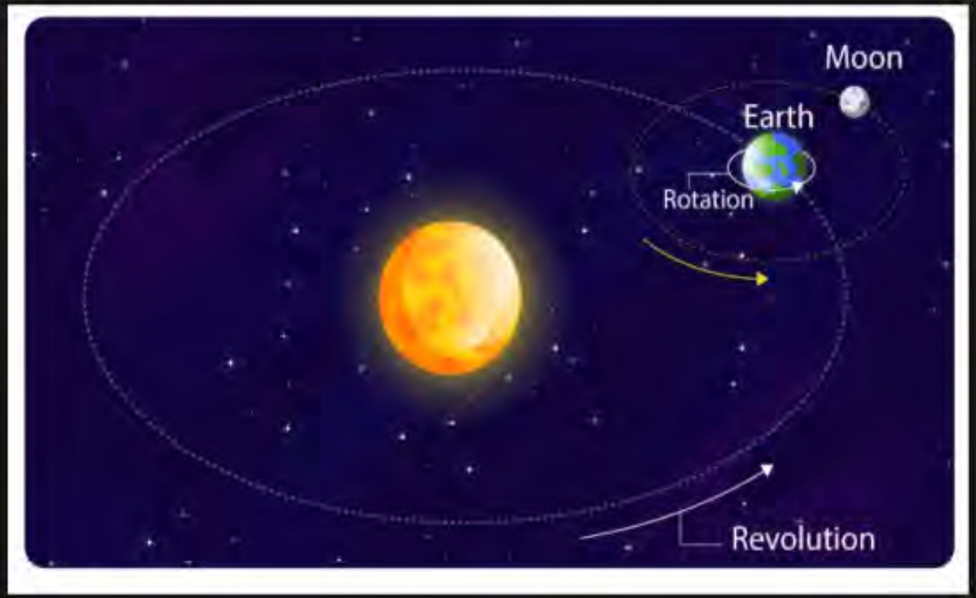
2 → Every periodic motion is a oscillatory -

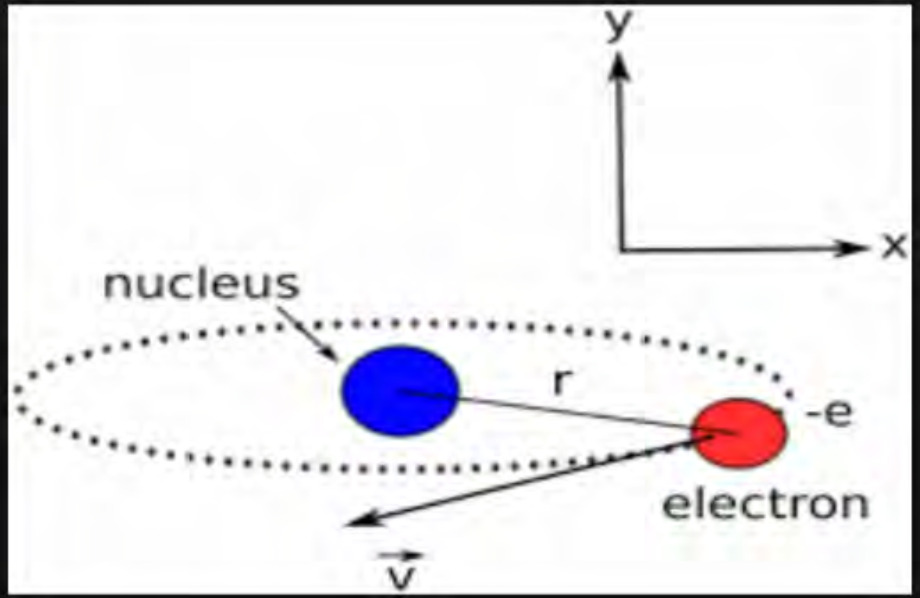
PERIODIC MOTION

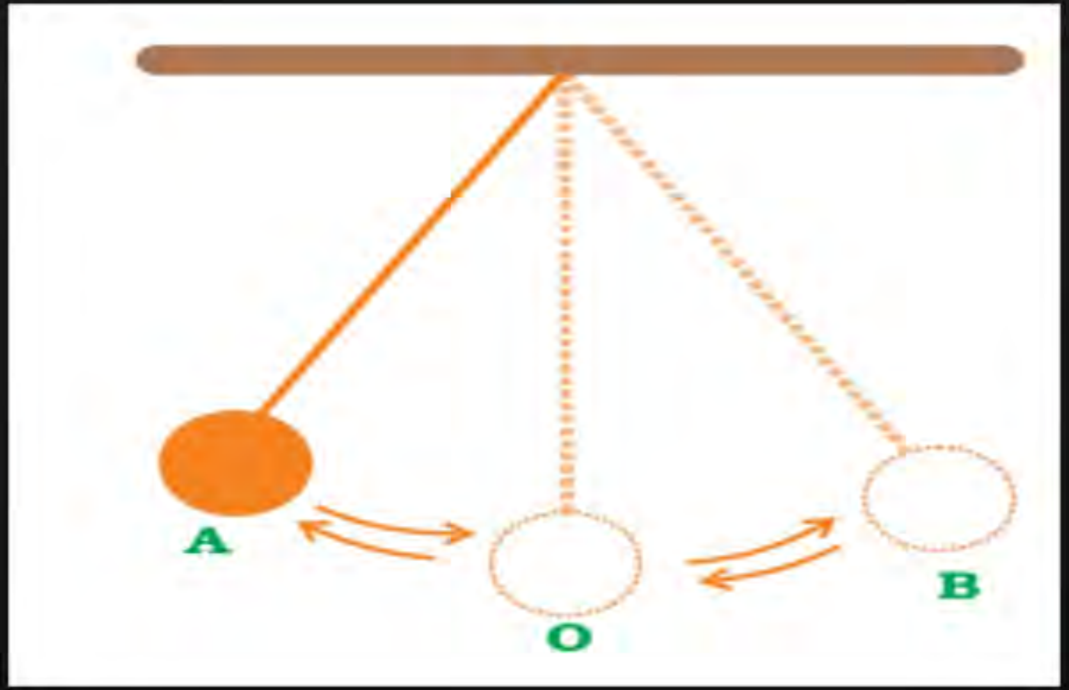
A motion which repeats itself at regular intervals of time along the same path is called periodic motion.

Ex:

1. Motion of earth around the sun.
2. Motion of an electron around the nucleus
3. Oscillating pendulum of a clock etc.





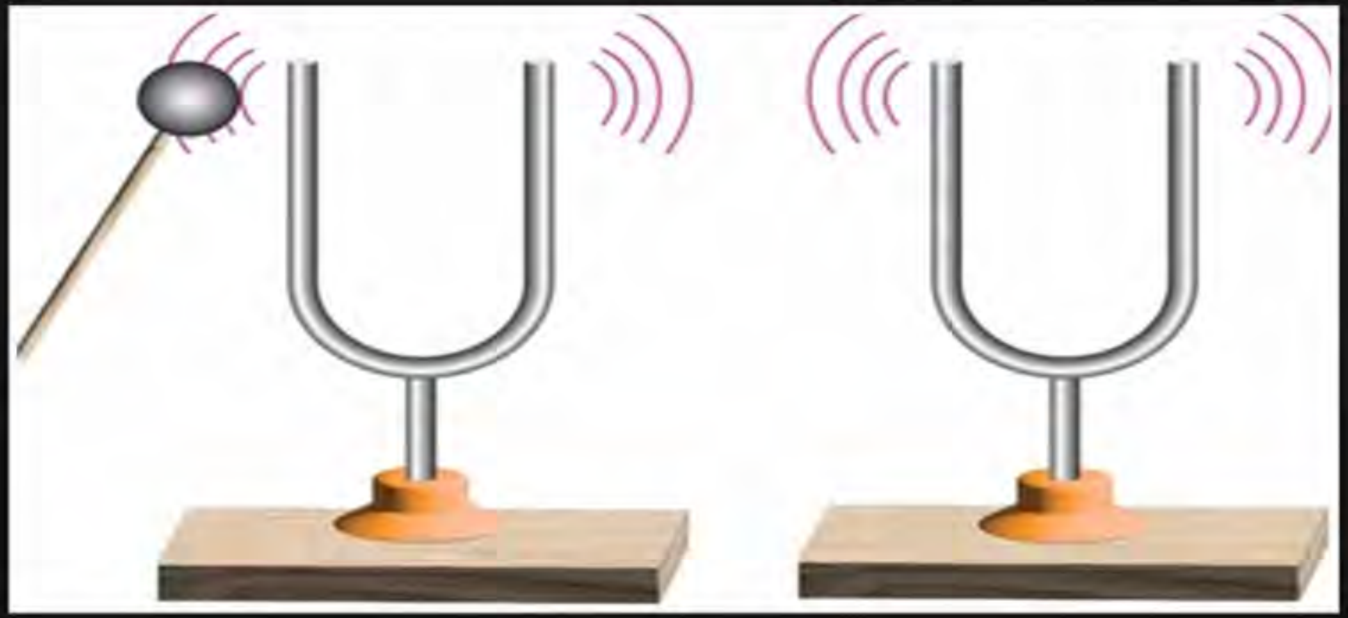


OSCILLATORY MOTION

If a body moves to and fro repeatedly about a mean position, then the motion is said to be oscillatory motion.

Ex:

1. Oscillations of a bob simple pendulum
2. Vibration of the wire of a musical instrument.
3. Motion of the prongs of an excited tuning fork etc.



IMPORTANT

Note: VVI

100%

1. All oscillatory motions are periodic but all periodic motions are not oscillatory.
Ex: motion of the earth around the sun is periodic but not oscillatory.

2. Periodic motion is often called as harmonic motion since the displacement of a particle executing periodic motion can always be expressed in terms of sine and cosine functions which are called harmonic functions.

SIMPLE HORMONIC MOTION

SHM is a simplest form of periodic motion. [Periodic Motion + Oscillatory Motion]

Ex: -

1. Swinging of a clock pendulum.
2. Vertical oscillation of a loaded spring.

Necessary Conditions :

1. Motion should be oscillatory.
2. Total Mechanical Energy of particle should be conserved [K.E+P.E=Constant]
3. Must be represented by sine or cosine function.
4. Extream Position must be defined [Amplitude should be small]

FORCE EQUATION OF SHM

Mathematical condition for motion to be SHM

$K = \text{const}$ $\quad F \propto -x$

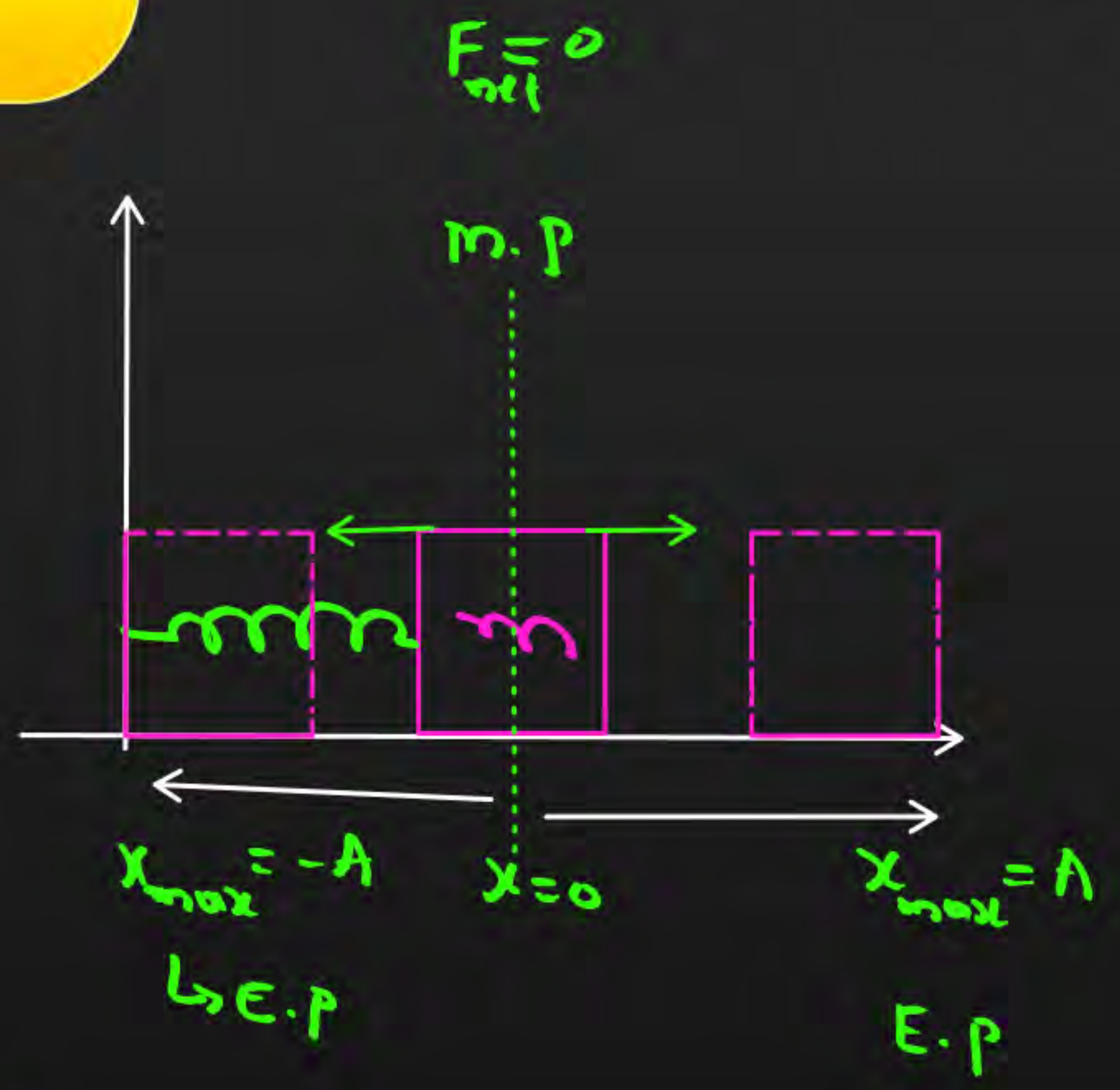
1. $\boxed{F = -Kx}$ → mean position

→ $F = -ve$

→ RHS terms power should be '1' *

2. $\boxed{F = -K(x^1 \pm a^1)}$ ↳ position of the particle

must



QUESTION

$F = -k(x \pm a)^1$

Identify weather given equation is SHM or not. If yeas then find Mean Position also.

A $F = -kx$ $\rightarrow$ yes, $a = 0$

B $F = -5(x^1 - 2)$ $\Rightarrow$ yes, $x - 2 = 0$ $\boxed{x = +2}$

C $F = -8(x^1 + 5)^1$ $\rightarrow$ yes, $x + 5 = 0$ $\boxed{x = -5}$

D $F = -2x + 4$

$\hookrightarrow F = -2(x - 2)$ $x - 2 = 0$ $\boxed{x = +2}$

QUESTION

Identify weather it is $\boxed{\text{SHM or not.}}$ $F = -K(x' \pm a)'$

1. $F = 10x$ ✗
2. $F = -10x'$ ✓
3. $F = -5x^{2}$ ✗
4. $F = -4x^{-1}$ ✗
5. $F = -2x + 5$ $\Rightarrow F = -2\left(x' - \frac{5}{2}\right)'$ ✓
6. $F = -2x - 4$ $\Rightarrow F = -2(x' + 2)'$ ✓
7. $F = 2x - 10$ ✗
8. $F = -2x^{2} + 5$ ✗

EQUATION OF SHM

Mathematical condition in terms of differential equation

$F = -Kx$

$ma = -Kx$

$a = \frac{dv}{dt}$ $\quad a = -\frac{K}{m}x$

$v = \frac{dx}{dt}$ $\quad \frac{dv}{dt} = -\frac{K}{m}x$

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

$\frac{d^2x}{dt^2} = -\frac{K}{m}\cdot x$

$\frac{d^2x}{dt^2} + \frac{K}{m}\cdot x = 0$ $\quad \omega^2 = \frac{K}{m}$.

$\boxed{\frac{d^2x}{dt^2} \boxed{+} \omega^2 x = 0}$ OR $\boxed{\frac{d^2y}{dt^2} + \omega^2 y = 0}$

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

$$\frac{d^2y}{dt^2} + \omega^2 y = 0$$

↳ solution of the Diff equn

*

$$\boxed{\begin{aligned} x &= A \sin\omega t \\ x &= A \sin(\omega t \pm \phi) \end{aligned}}$$

$y = A \sin\omega t$

↳ clockwise - Direction

$$\boxed{\begin{aligned} x &= A\cos\omega t \\ x &= A\cos(\omega t \pm \phi) \end{aligned}}$$

Anticlockwise.

$$\boxed{\frac{d^2x}{dt^2} + \omega^2 x = 0}$$ → Fundamental equation of SHM

On solving this differential equation

$$x = A\sin\underbrace{(\omega t + \emptyset)}$$

Phase of SHM

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

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

ω = angular frequency

ϕ = Initial phase (t = 0)

A = Amplitude (maximum displacement from mean position)

X = Position of any time t.

QUESTION

Identify weather given equation is SHM or not. If yes then find time period also.

$$\frac{d^2x}{dt^2}+\omega^2 x=0$$
↳ positive

(A) $\frac{d^2x}{dt^2}-10x=0$ ✗

(B) $\frac{5d^2x}{dt^2}+20x=0 \Rightarrow \boxed{\frac{d^2x}{dt^2}+4x=0}$ yes

(C) $\frac{2d^2x}{dt^2}+8x^2=0$ ✗

(D) $\frac{9d^2x}{dt^2}+16x=0 \Rightarrow \frac{d^2x}{dt^2}+\frac{16}{9}x=0$

$\omega^2=\frac{16}{9} \Rightarrow \omega=\frac{4}{3}$

$\boxed{T=\frac{2\pi}{\omega}=\frac{2\pi}{\frac{4}{3}}=\frac{3\pi}{2}}$

$\omega^2=4$

$\omega=2$ ✓

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

$\boxed{T=\pi=3.14\,s}$

QUESTION

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

Identify the equation of motion of a particle executing S.H.M. Find the time period Where symbols have usual meaning .

(A) $\frac{d^2x}{dt^2}=-\frac{k}{m}x$ $\Rightarrow \frac{d^2x}{dt^2}+\frac{k}{m}x=0$ ✓

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

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

(B) $\frac{d^2x}{dt^2}=+\omega^2x$ $\Rightarrow \frac{d^2x}{dt^2}-\omega^2x=0$ ✗

(C) $\frac{d^2x}{dt^2}=-\omega^2x$ $\Rightarrow \frac{d^2x}{dt^2}+\omega^2x=0$ ✓

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

(D) $\frac{d^2x}{dt^2}=-kmx$ $\Rightarrow \frac{d^2x}{dt^2}+(km)x=0$

$\omega^2=km$

$\omega=\sqrt{km}$

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

QUESTION

$\omega^2 = k \quad \omega = \sqrt{k}$

The equation of motion of particle executing SHM is $\left(\frac{d^2x}{dt^2}\right) + kx = 0$. The time period of the particle will be:

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

(A) $\boxed{2\pi / \sqrt{k}}$

(B) $2\pi / k$

(C) $2\pi k$

(D) $2\pi\sqrt{k}$

QUESTION

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

The displacement of a particle in S.H.M. is indicated by equation $y = 10 \sin (\underline{20}t + \pi/3)$ where y is in meters. The value of time period of vibration will be (in seconds)

$\omega = 20$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{20} = \frac{\pi}{10}$

A. $10/\pi$

B. $\boxed{\pi/10}$

C. $2\pi/10$

D. $10/2\pi$

Position, Velocity & Acceleration in SHM

$x = f(t)$

$x = f(x)$

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

$$v = \frac{dx}{dt} = A\omega\cos(\omega t + \phi)$$

$$a = \frac{dv}{dt} = -\omega^2 A\sin(\omega t + \phi)$$

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

$$a = -\omega^2 x$$

PHASE IN SHM

Phase difference between velocity, acceleration and position.

$$\begin{tikzcd}[column sep=huge]
\text{Position} \arrow[r, "\frac{\pi}{2}=90^\circ"] \arrow[rr, <->, bend right, "\pi=180^\circ"'] & \text{Velocity} \arrow[r, "\frac{\pi}{2}=90^\circ"] & \text{Acceleration}
\end{tikzcd}$$

GENERAL POINTS ABOUT SHM

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

$a = -\omega^2 x$

$x = f(t)$

NOTE:

1. At mean position : Speed- $v_{max} = \pm\omega A$ Acceleration- $a_{min} = 0$

$x = 0$

2. At Extreme position : Speed- $v_{min} = 0$ Acceleration- $a_{max} = -\omega^2 A$

$x_{max} = \pm A$

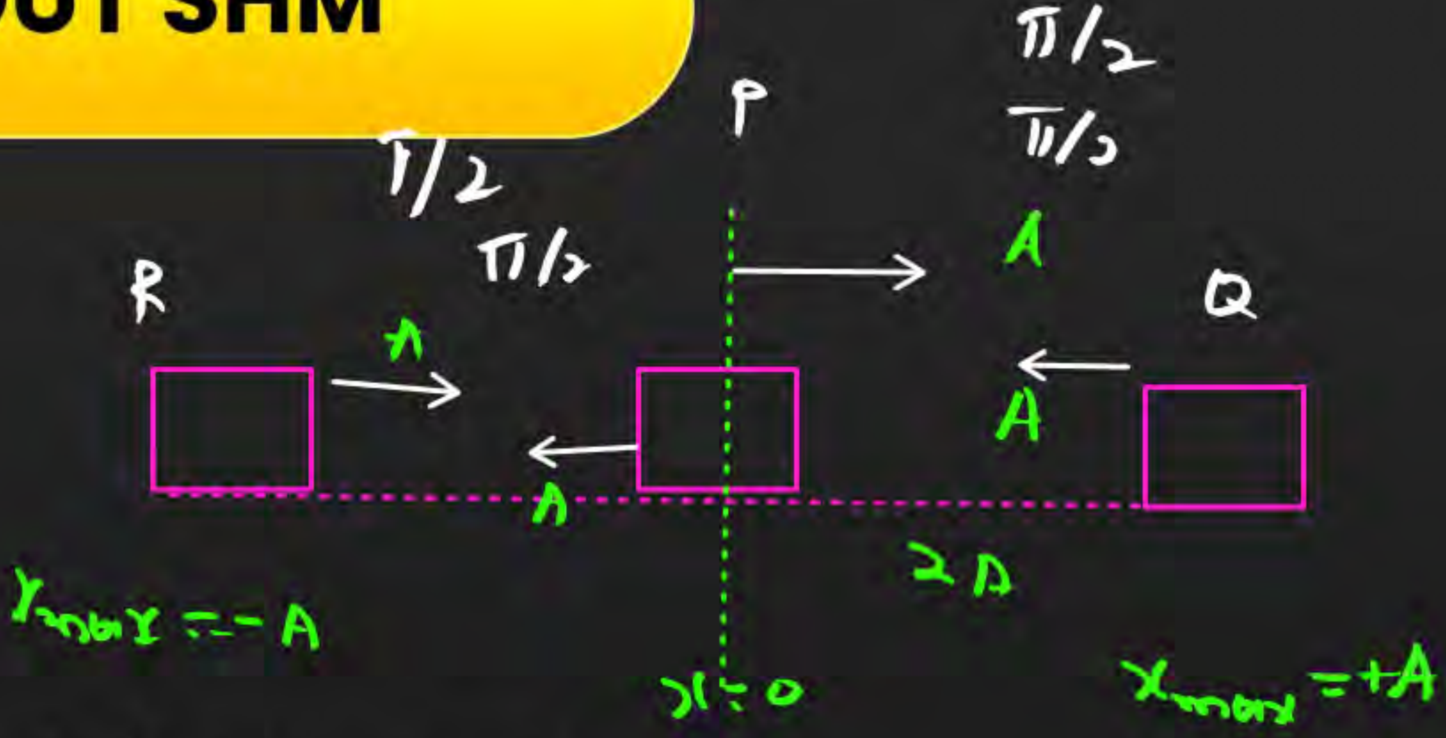
3. When a body moving from mean position to extreme position
   Speed - Decreases Acceleration- Increase

4. When a body moving from extreme position to mean position
   Speed - Increases Acceleration - Decreases

GENERAL POINTS ABOUT SHM

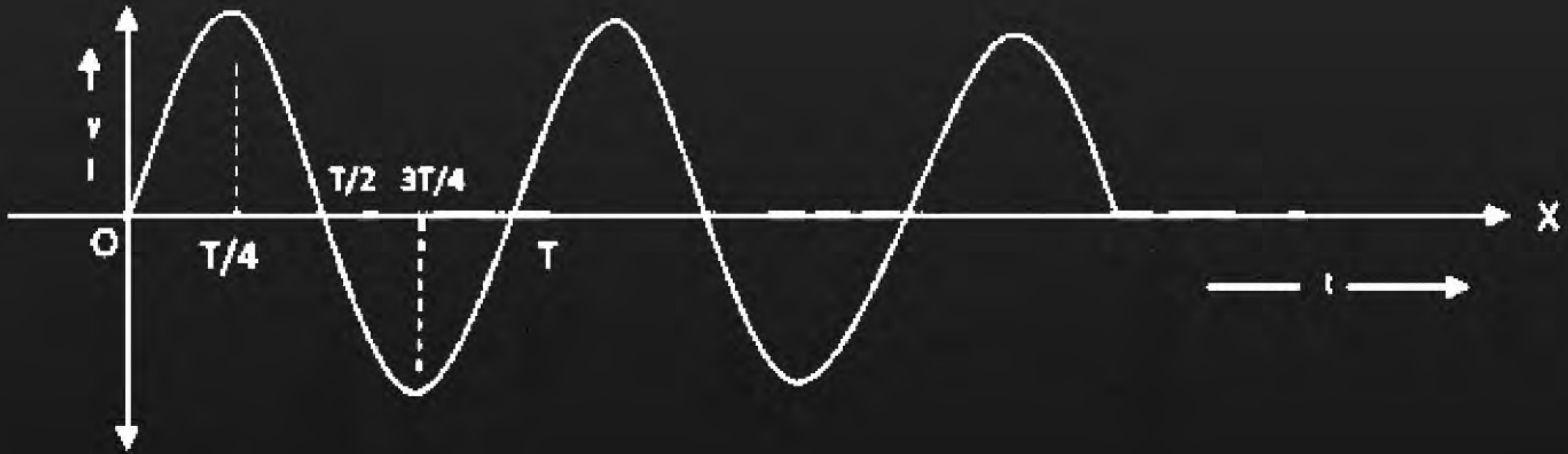
NOTE:

5. In one complete oscillation



- Distance = $PQ + QP + PR + RP = A + A + A + A = 4A$
- Displacement = 0
- Average Speed = $\frac{4A}{T}$
- Average Velocity = 0

GRAPHICAL REPRESENTATION OF SHM



T OR Radians	0 OR 0	$\frac{T}{4}$ OR $\frac{\pi}{2}$	$\frac{T}{2}$ OR π	$\frac{3T}{4}$ OR $\frac{3\pi}{2}$	T OR 2π
Displacement	0	A	0	-A	0

QUESTION

$x \xrightarrow{\pi/2} v \xrightarrow{\pi/2} a$

$x \xleftrightarrow{\pi} a$

The phase difference between the displacement and acceleration of particle executing S.H.M. in radian is:

A $\pi/2$

B $\pi/3$

C $\boxed{\pi}$

D 2π

QUESTION

The value of phase at maximum displacement from the mean position of a particle in S.H.M. is:

(A) $\boxed{\pi/2}$

(B) π

(C) Zero

(D) 2π

QUESTION

The phase difference in radians between displacement and velocity in S.H.M. is:

(A) $\pi/4$

(B) $\boxed{\pi/2}$

(C) π

(D) 2π

QUESTION

$\rightarrow$ E.P

The phase of a particle in S.H.M. is $\boxed{\pi/2,}$ then:

$x = \pm A$ ✓

v_{min}

a_{max}

F_{max}.

(A) Its velocity will be maximum ✗ v_{min}

(B) Its acceleration will be minimum ✗

(C) Restoring force on it will be minimum ✗

(D) Its displacement will be maximum

QUESTION

If the maximum velocity of a particle in SHM is vo. then its velocity at half the amplitude from position of rest will be

MP

(A) $v_0/2$

(B) v_0

(C) $\boxed{v_0\sqrt{3/2}}$ ✗

(D) $\boxed{v_0\sqrt{3}/2}$ ✓

$V_{max} = v_0 = \omega A$

$x = \frac{A}{2} \Rightarrow x^2 = \frac{A^2}{4}$

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

$v = \omega\sqrt{A^2 - \frac{A^2}{4}}$

$v = \omega\sqrt{\frac{3A^2}{4}}$

$v = \frac{\omega A}{2}\sqrt{3} \Rightarrow$

$v = \frac{\sqrt{3}}{2}\omega A$

$\boxed{v = \frac{\sqrt{3}}{2}v_0}$

QUESTION

At a particular position the velocity of a particle in SHM with amplitude a is $\frac{\sqrt{3}}{2}$ that at its mean position. In this position, its displacement is:

A $\boxed{a/2}$

B $\sqrt{3}\,a/2$

C $a\sqrt{2}$

D $\sqrt{2a}$

$$v = \frac{\sqrt{3}}{2} v_{max}$$

$$\cancel{\omega}\sqrt{A^2 - x^2} = \frac{\sqrt{3}}{2}\cancel{\omega} A$$

$$A^2 - x^2 = \frac{3}{4}A^2$$

$$x^2 = A^2 - \frac{3A^2}{4} = \frac{A^2}{4}$$

$$\boxed{\begin{array}{l} x = \pm \frac{A}{2} \\ x = \pm \frac{a}{2} \end{array}}$$

QUESTION

$\xrightarrow{} x$ a

The acceleration of a particle in SHM at 5 cm from its mean position is 20 cm/sec^2. The value of angular frequency in radians / sec will be:

ω

(A) $\boxed{2}$

(B) 4

(C) 10

(D) 14

$$v_{max} = \omega A$$

$$a = -\omega^2 x$$

$$\frac{\overset{4}{\cancel{20}}\ \cancel{cm}}{s^2} = -\omega^2\, \cancel{5} \times \cancel{cm}$$

$$\omega^2 = -4$$

$$\boxed{\omega = 2\ rad}$$

QUESTION

If the displacement, velocity and acceleration of a particle in SHM are 1 cm, 1 cm/sec, 1 cm/sec^2 respectively its time period will be (in seconds)

$\hookrightarrow T = \frac{2\pi}{\omega} = \frac{2\pi}{1}$

(A) π

(B) $0.5T\pi$

(C) $\boxed{2\pi}$

(D) 1.5π

$x = 1\,cm$

$v = 1\,cm/s$

$a = 1\,cm/s^2$

$\boxed{T = 2\pi\,s}$

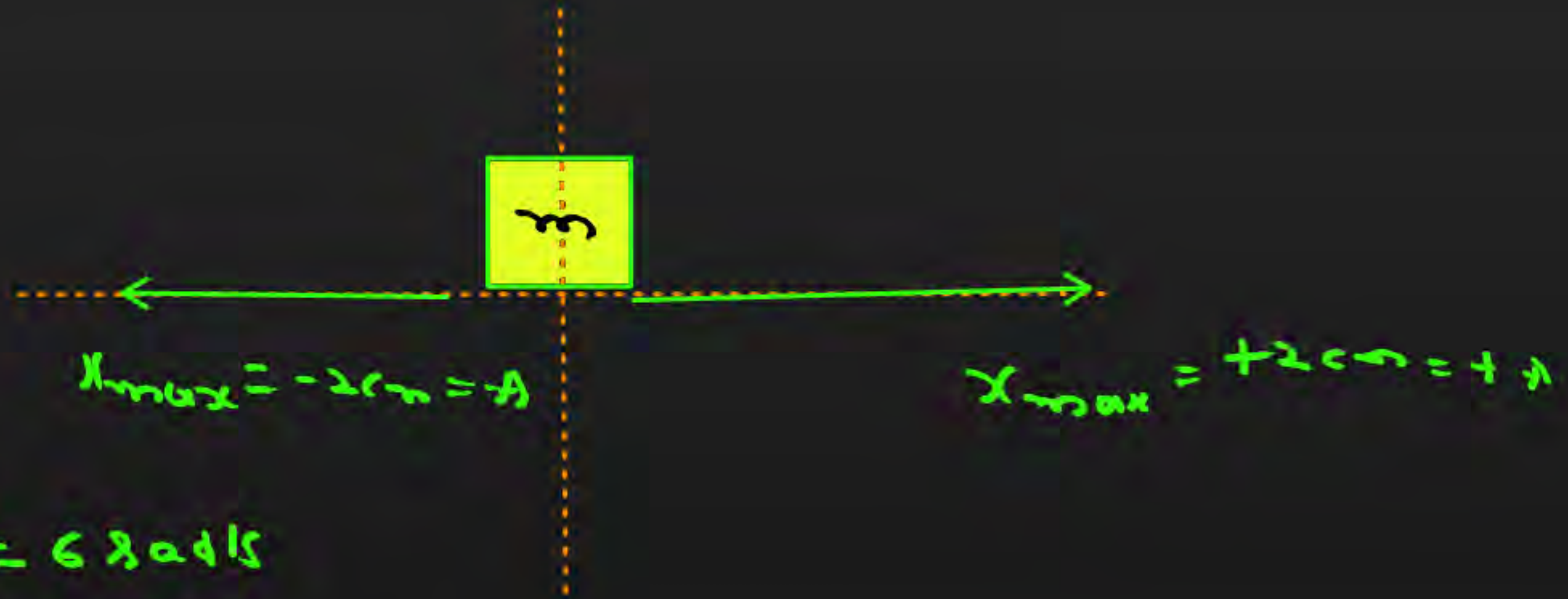
$a = -\omega^2 x$

$1 = -\omega^2 \times 1$

$\boxed{\omega = 1}$

QUESTION

The particle is executing S.H.M. on a line 4 cm long. If its velocity at mean position is 12 cm/sec, its frequency in Hertz will be:



(A) $2\pi/3$

(B) $3/2\pi$

(C) $\pi/3$

(D) $\boxed{3/\pi}$

$v_{max} = 12 cm/s$

$v_{max} = \omega A$

$\omega = \frac{v_{max}}{A} = \frac{12}{2} = 6 rad/s$

$\omega = 2\pi f \quad f = \frac{\omega}{2\pi} = \frac{6}{2\pi} = \frac{3}{\pi}$

$$\boxed{f = \frac{3}{\pi} Hz}$$

Energy in SHM

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

$K = \frac{1}{2}mv^2$

$K = \frac{1}{2}m\omega^2(A^2 - x^2)$

1. Total energy = K.E. + P.E. = $\frac{1}{2}KA^2 = E_0$ (constant)

$U = \frac{1}{2}Kx^2 = \frac{1}{2}m\omega^2x^2$

2. Kinetic energy = K.E. = $\frac{1}{2}mv^2 = \frac{1}{2}m\omega^2(A^2 - x^2)$

$T = K + U$

$\boxed{T = \frac{1}{2}m\omega^2A^2}$

3. Potential energy = P.E. = $\frac{1}{2}kx^2$

$$K = \frac{1}{2} m\omega^2 (A^2 - x^2)$$

$$U = \frac{1}{2} m\omega^2 x^2$$

$$U = K$$

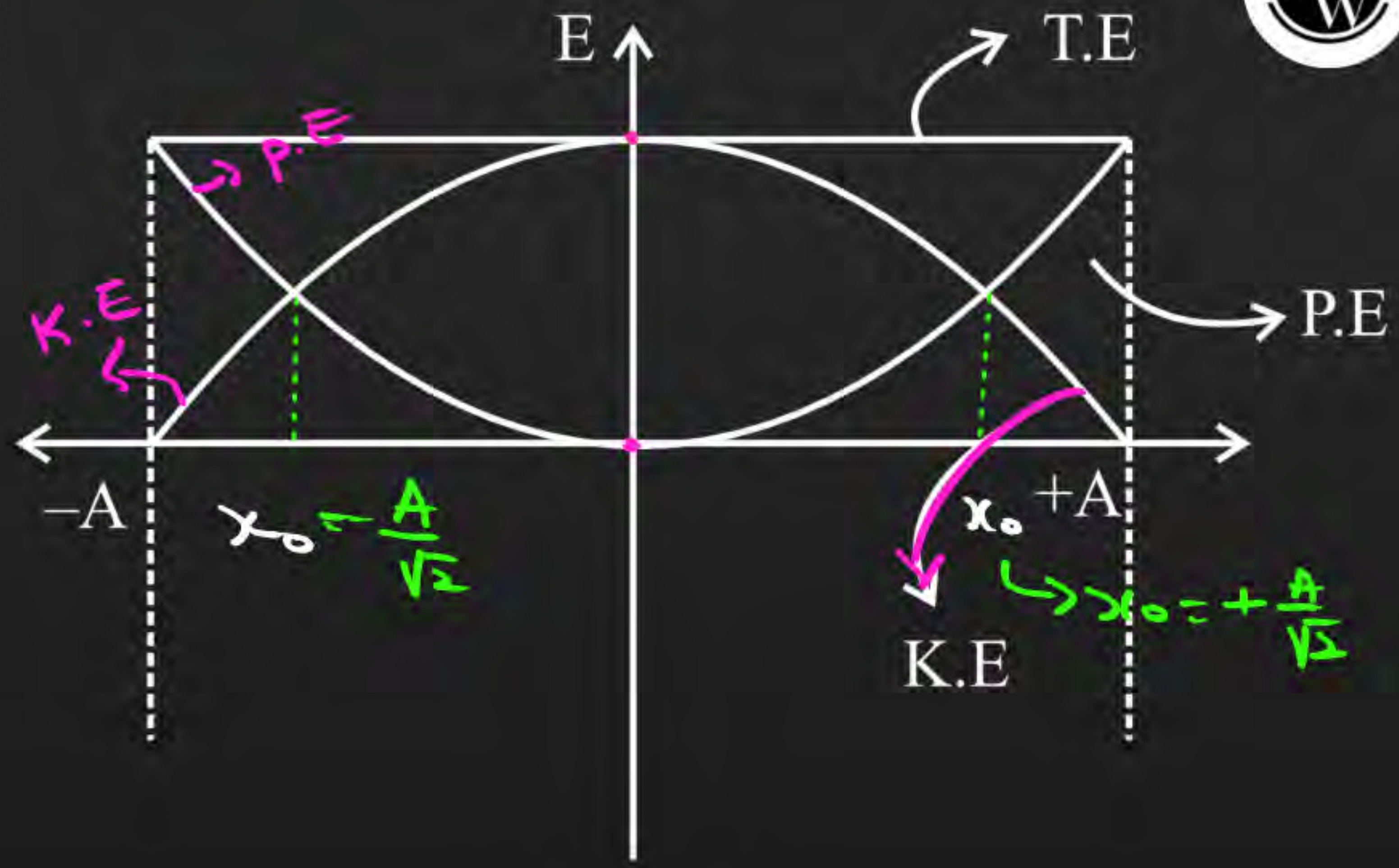
$$\cancel{\frac{1}{2}}\cancel{m\omega^2} x^2 = \cancel{\frac{1}{2}}\cancel{m\omega^2}(A^2 - x^2)$$

$$x^2 = A^2 - x^2$$

$$2x^2 = A^2$$

$$x^2 = \frac{A^2}{2}$$

$$\boxed{x = \pm \frac{A}{\sqrt{2}}}$$



QUESTION

$x=0$ $U=0$

$K=\frac{1}{2}m\omega^2 A$

The energy of SHM at the mean position of a pendulum will be:

A. Zero

B. Partial P.E and partial K.E.

C. $\boxed{\text{Totally K.E.}}$

D. Totally P.E.

QUESTION

The total energy of a vibrating particle in SHM is E. If its amplitude and time period are doubled, its total energy will be:

$$E = \frac{1}{2} m \omega^2 A^2$$

A) 16 E

$$\omega = \frac{2\pi}{T} \Rightarrow E = \frac{1}{2} m \frac{4\pi^2}{T^2} A^2$$

B) 8 E

$$E = \frac{2\pi^2 m A^2}{T^2}$$

C) 4 E

$T' = 2T$

$A' = 2A$

$$E' = \frac{2\pi^2 m (2A)^2}{(\cancel{2}T)^2} = \frac{2\pi^2 m A^2}{T^2}$$

D) $\boxed{E}$

$$\boxed{E' = E}$$

QUESTION

The total vibrational energy of a particle in S.H.M. is E. Its kinetic energy at half the amplitude from mean position will be:

$E = \frac{1}{2} m\omega^2 A^2$

$K = \frac{1}{2} m\omega^2 (A^2 - x^2)$

$x = \frac{A}{2}$

$K = \frac{1}{2} m\omega^2 \left(A^2 - \frac{A^2}{4}\right)$

$K = \frac{3}{4}\left(\frac{1}{2} m\omega^2 A^2\right)$

$\boxed{K = \frac{3}{4} E}$

(A) E/2

(B) E/3

(C) E/4

(D) $\boxed{3E/4}$

QUESTION

If total energy of a particle in SHM is E, then the potential energy of the particle at half the amplitude will be

$E = \frac{1}{2} m\omega^2 A^2$

$x = \frac{A}{2}$

$U = \frac{1}{2} m\omega^2 x^2$

$U = \frac{1}{2} m\omega^2 \frac{A^2}{4}$

$\boxed{U = \frac{E}{4}}$

(A) E/2

(B) $\boxed{E/4}$

(C) 3E/4

(D) E/8

QUESTION

A particle is describing SHM with amplitude 'a'. When the potential energy of particle is one fourth of the maximum energy during oscillation, then its displacement from mean position will be: [H.W]

A. a/4

B. a/3

C. a/2

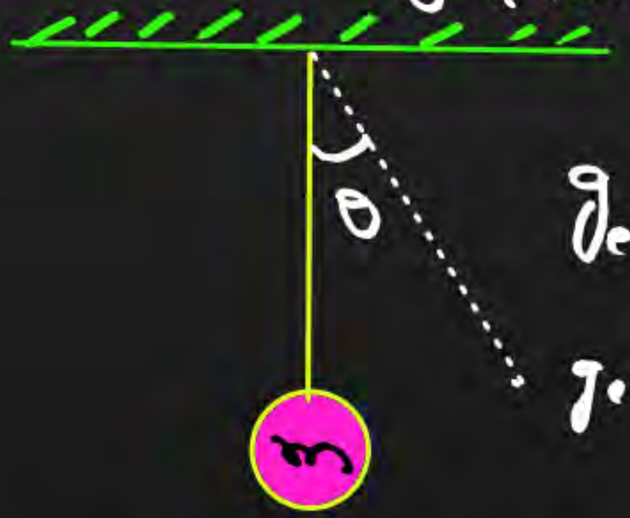
D. 2a/3

Time period of different oscillators

Simple Pendulum

$\theta = 10^\circ$

$\theta < 10\%$

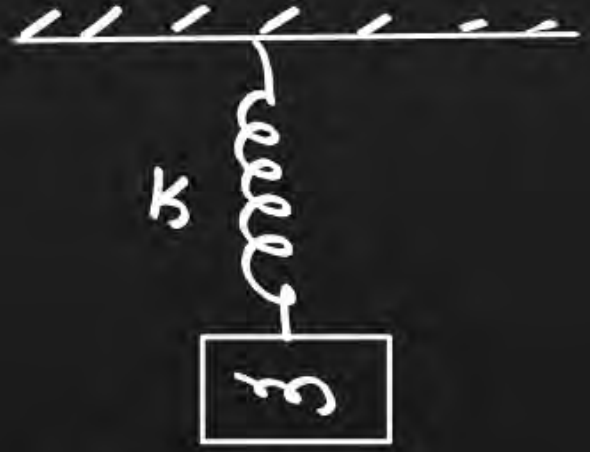


$g_e = g + a \rightarrow$ Upward

$g_e = g - a \rightarrow$ Downward

$$T = 2\pi\sqrt{\frac{l}{g_e}}$$

Spring Oscillator

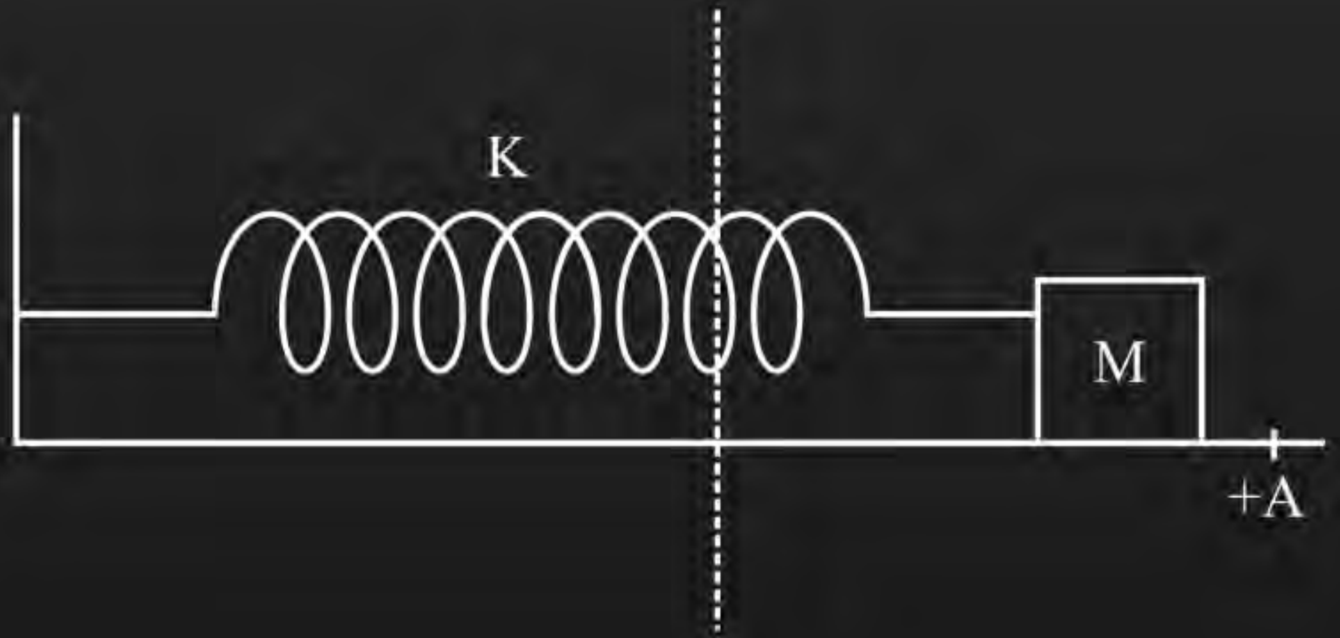


$$T = 2\pi\sqrt{\frac{m}{k_e}}$$

Series $k_e = \frac{k_1 k_2}{k_1 + k_2}$

Parallel $k_e = k_1 + k_2$

1. Spring block system



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

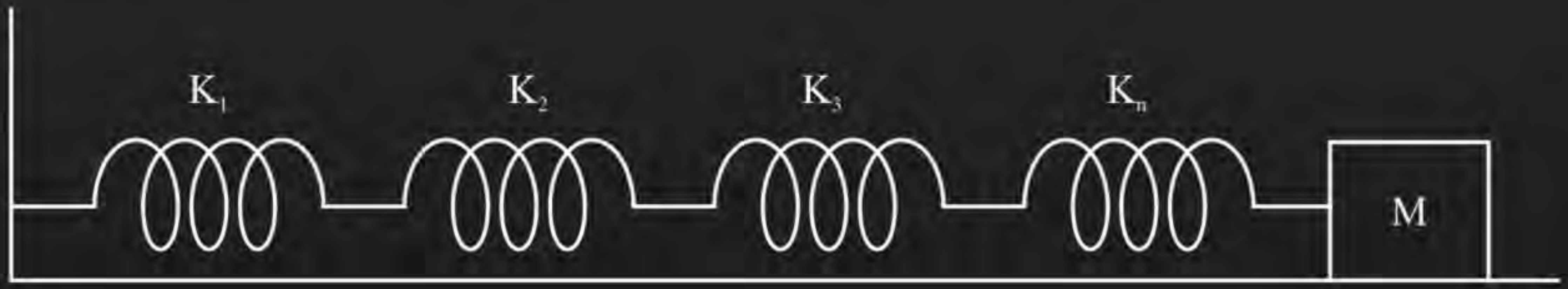
Note:

Time period of spring block oscillator is independent of gravity (g)

$$\boxed{T = 2\pi\sqrt{\frac{M}{K_{eff}}}}$$

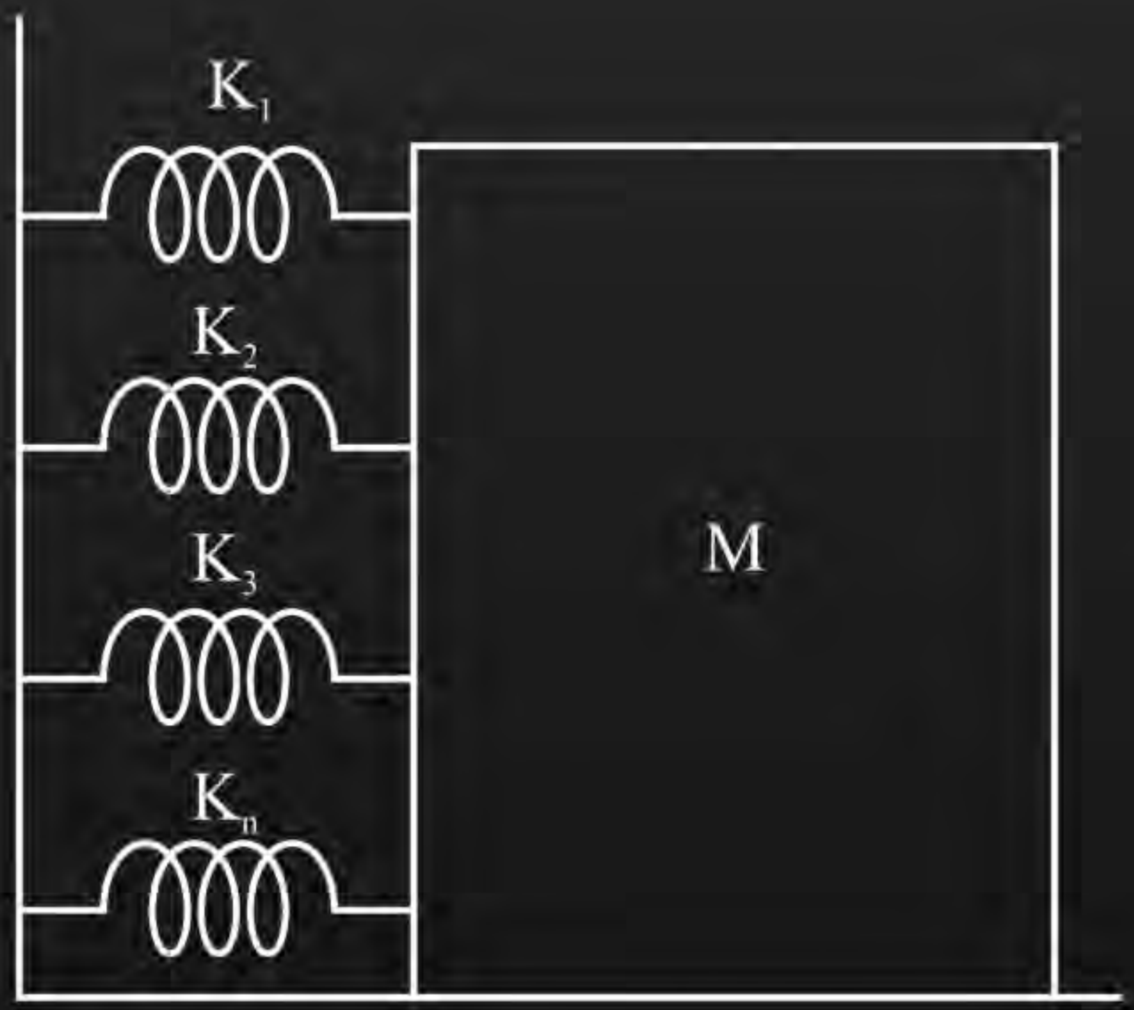
2. Combination of spring

(i) Series combination (tension in spring is same)



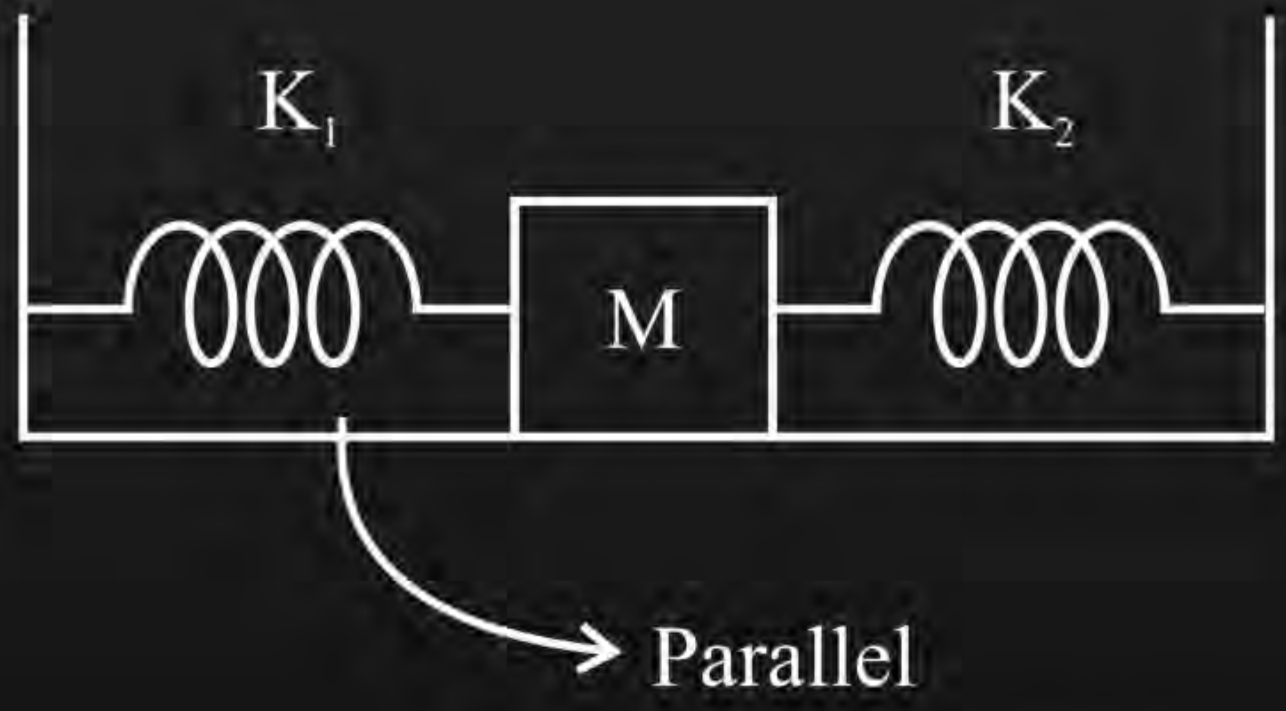
$$\boxed{\frac{1}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} \ldots . \frac{1}{K_n}}$$

(ii) $\boxed{\text{Parallel combination}}$ (elongation/compression)



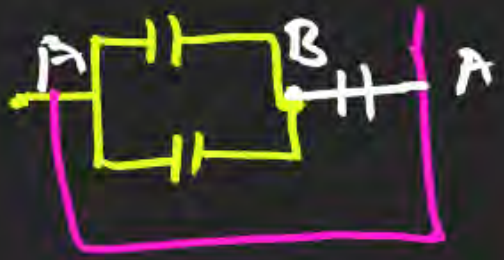
$$K_{eq} = K_1 + K_2 + K_3 \ldots\ldots K_n$$

Or



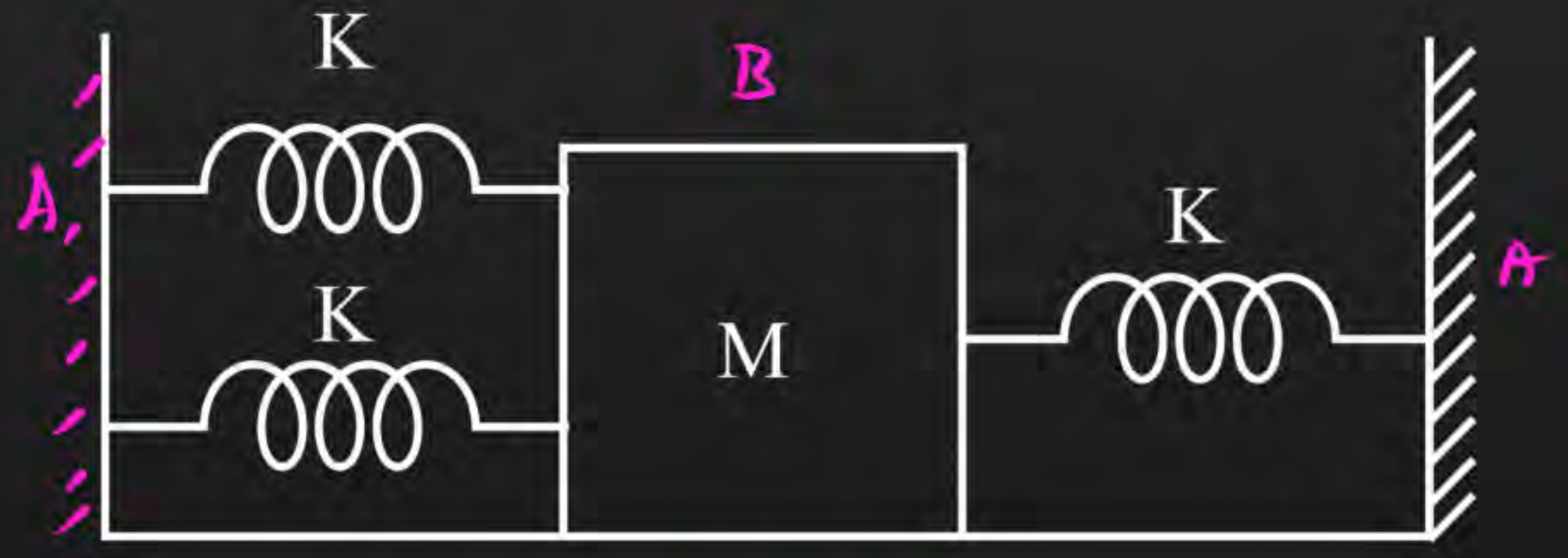
$$K_{eq} = K_1 + K_2$$

QUESTION



Find time period of following oscillator’s

(1)



$$T = 2\pi\sqrt{\frac{M}{K_e}}$$

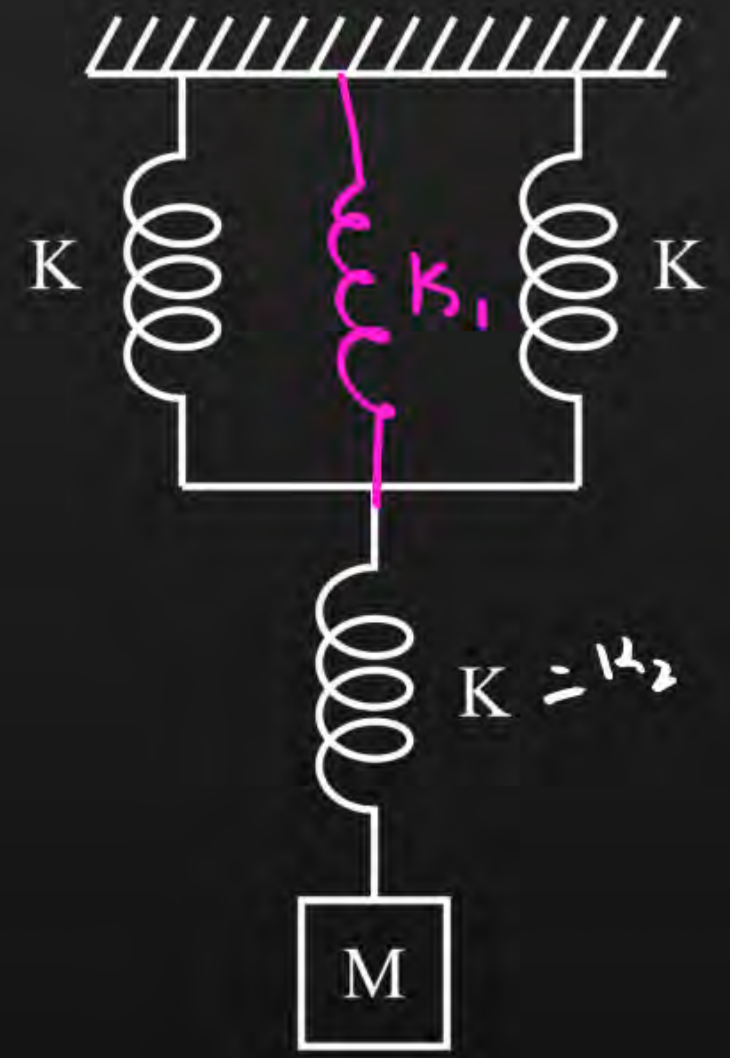
$$T = 2\pi\sqrt{\frac{M}{3K}}$$

$$K_{eff} = K_1 + K_2 + K_3$$
$$= 3K$$

QUESTION

Find time period of following oscillator's

(2)



$K_1 = K + K = 2K$

$K_{eq} = \frac{K_1 . K_2}{K_1 + K_2} = \frac{2K \times K}{2K + K} = \frac{2K . \cancel{K}}{3\cancel{K}} = \frac{2K}{3}$

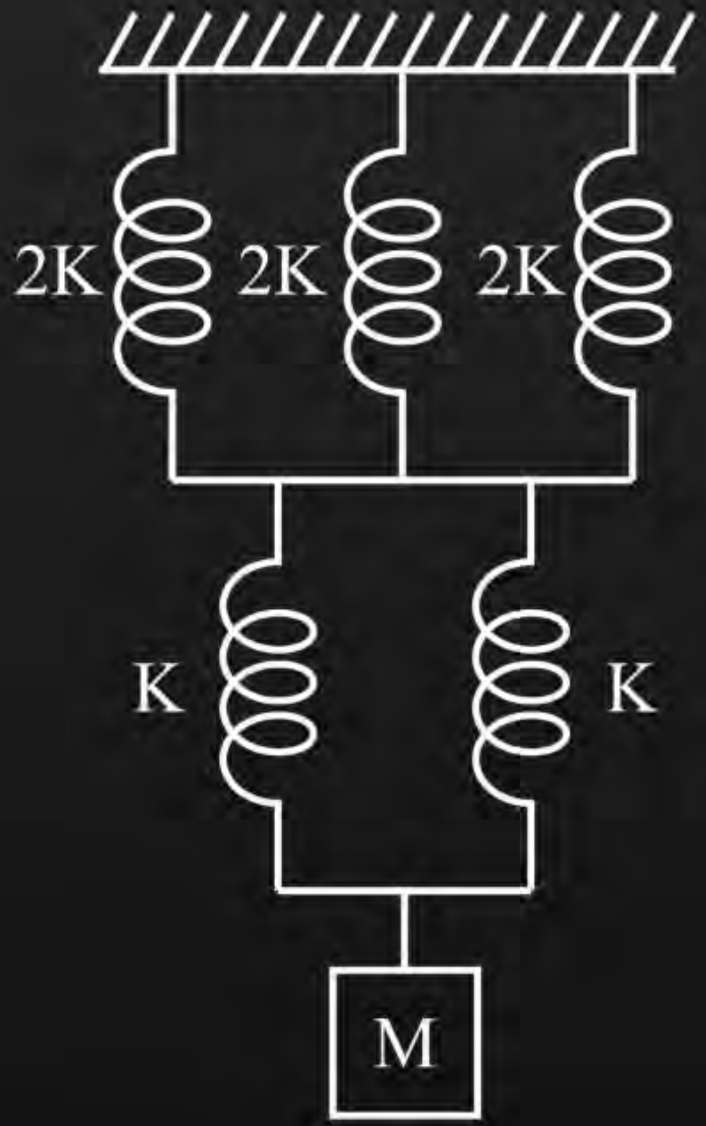
$T = 2\pi \sqrt{\frac{m}{K_{eq}}}$

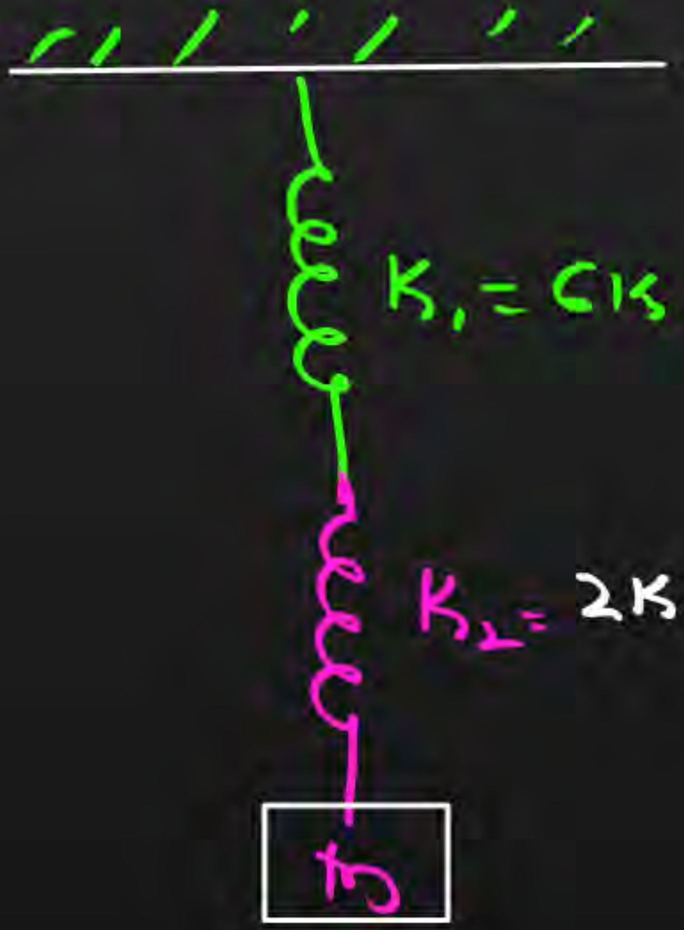
$T = 2\pi \sqrt{\frac{3m}{2K}}$

QUESTION

Find time period of following oscillator's

(3)





$$K_{eq} = \frac{6K \times 2K}{6K + 2K} = \frac{\overset{3}{\cancel{6}} K \times 2\cancel{K}}{\underset{2}{\cancel{4}}\,\cancel{8}\cancel{K}}$$

$$K_{eq} = \frac{3K}{2}$$

$$\boxed{T = 2\pi\sqrt{\frac{2M}{3K}}}$$

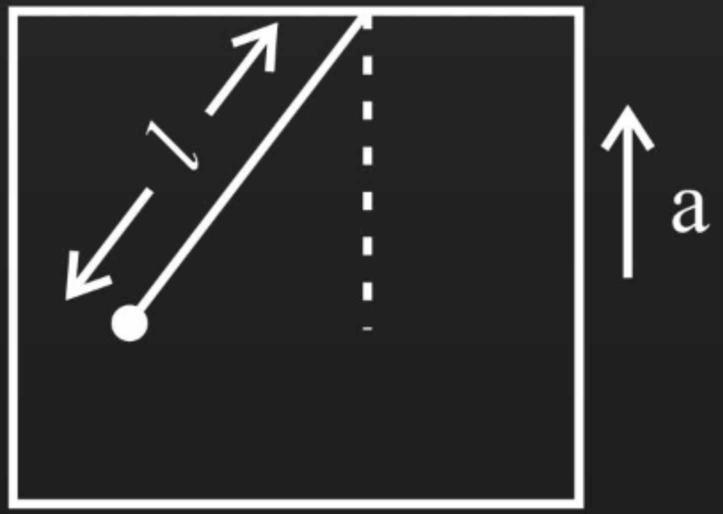
Time period of simple pendulum

$$T = 2\pi\sqrt{\frac{l}{geff}}$$

(1) On surface of earth geff = g

$$T = 2\pi\sqrt{\frac{l}{g}}$$

(2)

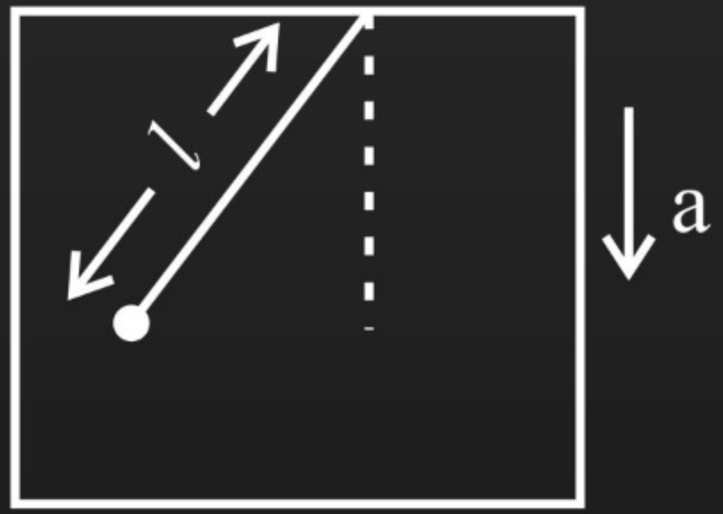


lift

$g_{eff} = (g + a)$

$$T = 2\pi\sqrt{\frac{l}{(g+a)}}$$

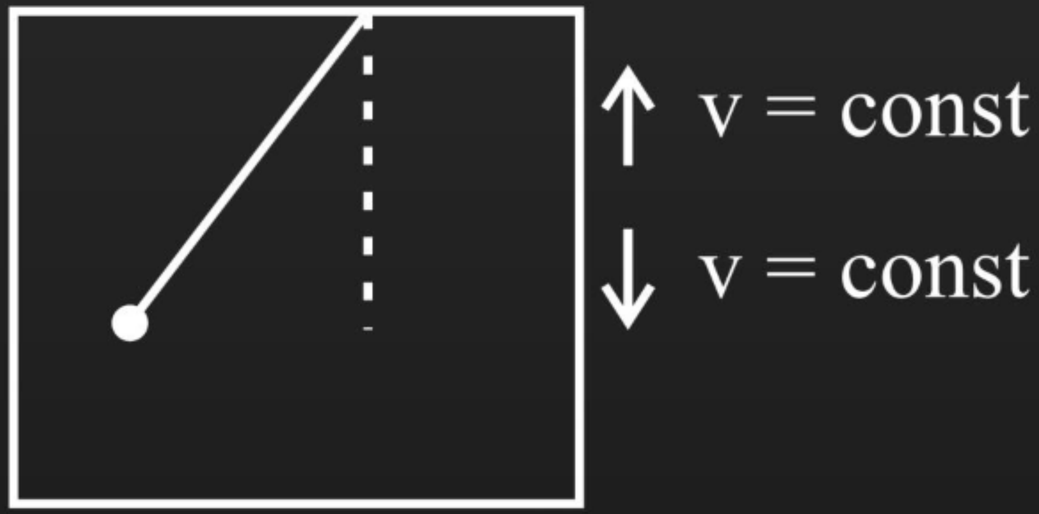
(3)



$g_{eff} = (g - a)$

$$T = 2\pi\sqrt{\frac{l}{(g-a)}}$$

(4)

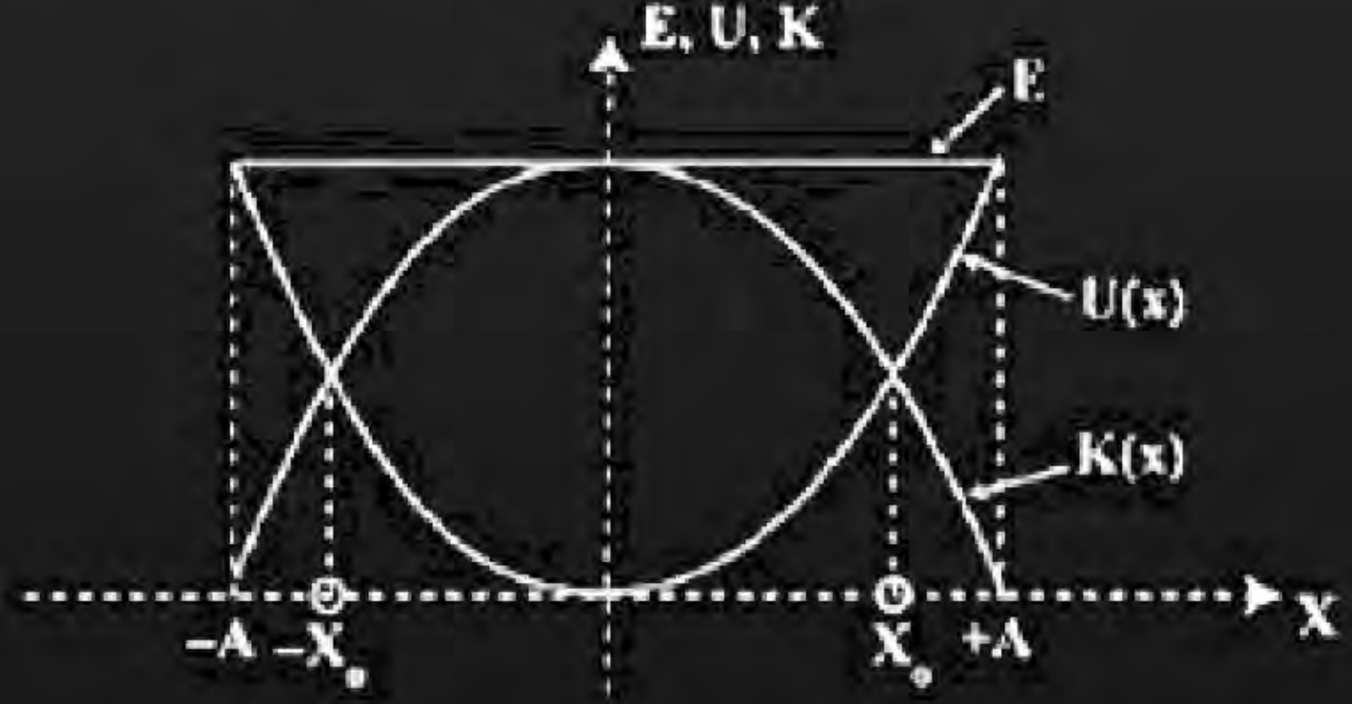


$g_{eff} = g$

$$T = 2\pi\sqrt{\frac{l}{g}}$$

QUESTION

The variations of kinetic energy K, potential energy U, and total energy E as a function of displacement of a particle in SHM is shown in the figure. The value of x_0 is



A) A/2

B) $\boxed{A/\sqrt{2}}$

C) A

D) A/3

QUESTION

For a particle executing simple harmonic motion (SHM), at its mean position

A. velocity is zero and acceleration is maximum

B. velocity is maximum and acceleration is zero

C. both velocity and acceleration are maximum

D. both velocity and acceleration are zero

QUESTION

$x = A\sin\left(\omega t + \frac{\pi}{4}\right)$

The displacement of a particle executing SHM is given by $x = 3\sin\left[2\pi t + \frac{\pi}{4}\right]$. Where x is in metre and t is in seconds. The amplitude and maximum speed of the particle

$\boxed{A = 3\,m}$

$\omega = 2\pi$

(A) $3m, 4\pi\, ms^{-1}$

$V_{max} = \omega A$

(B) $\boxed{3m, 6\pi\, ms^{-1}}$

$= 2\pi \times 3$

$\boxed{V_{max} = 6\pi}$

(C) $3m, 8\pi\, ms^{-1}$

(D) $3m, 2\pi\, ms^{-1}$

QUESTION

A pendulum oscillates simple harmonically and only if

I. the sizer of the bob of pendulum is negligible in comparison with the length of the pendulum.

II. The angular amplitude is less than $\boxed{10\%}$. Choose the correct option

(A) $\boxed{\text{Both I and II}}$

(B) Only I

(C) Only

(D) None of these

QUESTION

A tray of mass 12 kg is supported by two identical springs as shown in figure. When the tray is pressed down slightly and then released, it executes SHM with a time period of 1.5s. The spring constant of each spring is

(A) $50\ Nm^{-1}$

(B) 0

(C) $\boxed{105\ Nm^{-1}}$

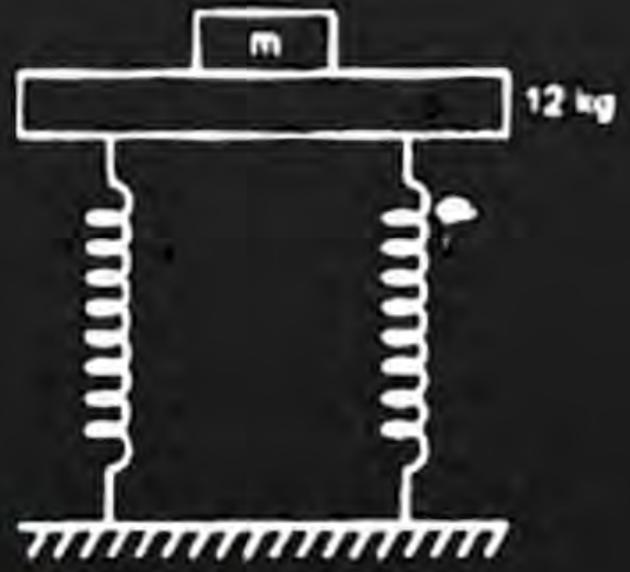
(D) ∞

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

$T^2 = 4\pi^2 \times \frac{m}{2K}$

$K = \frac{2\pi^2 \times m}{T^2} = \frac{2\pi^2 \times 12}{(1.5)^2}$

$\boxed{K = 105\ N/m}$



$K_{eq} = K + K = 2K$

QUESTION

f

A piston is performing S.H.M. in the vertical direction with a frequency of $\boxed{0.5\ \text{Hz}}$. A block of 10 kg is placed on the piston. The maximum amplitude of the system such that the block remains in contact with the piston is

(A) $\boxed{1\ m}$

(B) $0.5\ m$

(C) $1.5\ m$

(D) $0.1\ m$

$$F = mg$$

$$\cancel{m}a = \cancel{m}g$$

$$a = g$$

$$\omega^2 A = g$$

$$A = \frac{g}{\omega^2} = \frac{g}{(2\pi f)^2} = \frac{g}{(2\pi \times \frac{1}{2})^2} = \frac{g}{\pi^2} = \frac{9.8}{9.8} = 1\ m$$

$$\boxed{A = 1\ m}$$

QUESTION

Two simple pendulums A and B are made to oscillate simultaneously and it is found that A completes 10 oscillations in 20 sec and B completes 8 oscillations in 10 sec. The ratio of the length of A and B is

$T = 2\pi\sqrt{\frac{l}{g}}$

$T_A = \frac{20}{10} = 2\,s$

$T \propto \sqrt{l}$

$T_B = \frac{10}{8} = \frac{5}{4}\,s$

$T^2 \propto l$

$\frac{l_A}{l_B} = \left(\frac{T_A}{T_B}\right)^2 = \left(\frac{2\times 4}{5}\right)^2 = \left(\frac{8}{5}\right)^2 = \boxed{\frac{64}{25}}$

(A) $\frac{25}{64}$

(B) $\boxed{\frac{64}{25}}$

(C) $\frac{8}{5}$

(D) $\frac{5}{4}$

QUESTION

v_{max} a_{max}

A particle executing SHM has a maximum speed of 0.5 ms^{-1} and maximum acceleration of 1 ms^{-2} The angular frequency of oscillation is

$$\frac{v_{max} = \omega \cancel{A}}{a_{max} = \omega^2 \cancel{A}}$$

$$\frac{0.5}{1} = \frac{1}{\omega}$$

$$\frac{1}{2} = \frac{1}{\omega}$$

$$\boxed{\omega = 2 \text{ rad/s}}$$

A) $\boxed{2 \text{ rad } s^{-1}}$

B) 0.5 rad s^{-1}

C) 2π rad s^{-1}

D) $2\pi x$ rad s^{-1}

QUESTION

The ratio of kinetic energy to the potential energy of a particle executing SHM at a distance equal to half its amplitude, the distance being measured from its equilibrium position is

$$K = \frac{1}{2}m\omega^2\left(A^2 - \frac{A^2}{4}\right)$$

$$K = \frac{1}{2}m\omega^2\left(\frac{3A^2}{4}\right)$$

$$K = \frac{3}{4}\left(\frac{1}{2}\cancel{m\omega^2}A^2\right)$$

$$U = \frac{1}{2}m\omega^2x^2$$

$$U = \frac{1}{2}m\omega^2\left(\frac{A^2}{4}\right)$$

$$U = \frac{1}{4}\left[\frac{1}{2}\cancel{m\omega^2}A^2\right]$$

$$\boxed{\frac{K}{U} = \frac{3}{4 \times \frac{1}{4}} = \frac{3}{1}}$$

(A) 2:1

(B) $\boxed{3:1}$

(C) 8:1

(D) 4:1

Thank

You