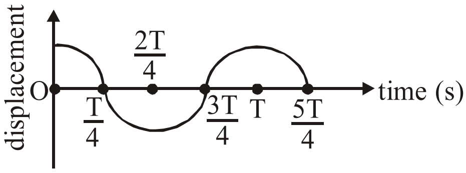
SIMPLE HARMONIC MOTION

1. The displacement time graph of a particle executing S.H.M. is given in figure :
(sketch is schematic and not to scale)



Which of the following statements is/are true for this motion ?

(A) The force is zero $t=\frac{3T}{4}$

(B) The acceleration is maximum at t = T

(C) The speed is maximum at $t=\frac{T}{4}$

(D) The P.E. is equal to K.E. of the oscillation at $t=\frac{T}{2}$

(1) (A), (B) and (D) (2) (B), (C) and (D)
(3) (A) and (D) (4) (A), (B) and (C)

2. A block of mass m attached to massless spring is performing oscillatory motion of amplitude 'A' on a frictionless horizontal plane. If half of the mass of the block breaks off when it is passing through its equilibrium point, the amplitude of oscillation for the remaining system become fA. The value of f is:

(1) $\frac{1}{2}$ (2) $\sqrt{2}$ (3) 1 (4) $\frac{1}{\sqrt{2}}$

3. A ring is hung on a nail. It can oscillate, without slipping or sliding (i) in its plane with a time period T_1 and, (ii) back and forth in a direction perpendicular to its plane, with a period T_2.

the ratio $\frac{T_1}{T_2}$ will be :

(1) $\frac{2}{\sqrt{3}}$ (2) $\frac{\sqrt{2}}{3}$ (3) $\frac{2}{3}$ (4) $\frac{3}{\sqrt{2}}$

4. When a particle of mass m is attached to a vertical spring of spring constant k and released, its motion is described by $y(t)=y_0\sin^2\omega t$, where 'y' is measured from the lower end of unstretched spring. Then ω is :

(1) $\sqrt{\frac{g}{y_0}}$ (2) $\sqrt{\frac{g}{2y_0}}$

(3) $\frac{1}{2}\sqrt{\frac{g}{y_0}}$ (4) $\sqrt{\frac{2g}{y_0}}$

SOLUTION

1. Official Ans. by NTA (4)

Sol. (A) F = ma $\qquad a = -\omega^2 x$

at $\frac{3T}{4}$ displacement zero (x = 0), so a = 0

F = 0

(B) at t = T $\qquad$ displacement (x) = A

x maximum, So acceleration is maximum.

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

V_{max} at x = 0

$V_{max} = A\omega$

at $t = \frac{T}{4}$, x = 0, So $V_{max.}$

(D) KE = PE

$\therefore$ at $x = \frac{A}{\sqrt{2}}$.

at $t = \frac{T}{2}$ $\quad x = -A$ $\quad$ (So not possible)

2. Official Ans. by NTA (4)

Sol. At equilibrium position

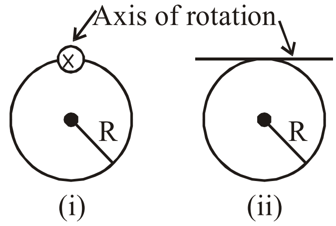
$$V_0 = \omega_0 A = \sqrt{\frac{K}{m}}A \qquad .....(i)$$

$$V = \omega A^1 = \sqrt{\frac{K}{\frac{m}{2}}}A^1 \qquad .....(ii)$$

$$\therefore \quad A^1 = \frac{A}{\sqrt{2}}$$

3. Official Ans. by NTA (1)

Sol.



Moment of inertia in case (i) is I_1

Moment of inertia in case (ii) is I_2

$I_1 = 2MR^2$

$I_2 = \frac{3}{2}MR^2$

$T_1 = 2\pi\sqrt{\frac{I_1}{Mgd}}$; $T_2 = 2\pi\sqrt{\frac{I_2}{Mgd}}$

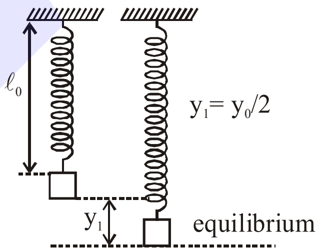
$$\frac{T_1}{T_2} = \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{2MR^2}{\frac{3}{2}MR^2}} = \frac{2}{\sqrt{3}}$$

4. Official Ans. by NTA (2)

Sol. $y = y_0 \sin^2\omega t$

$$y = \frac{y_0}{2}(1 - \cos 2\omega t) \Rightarrow y - \frac{y_0}{2} = -\frac{y_0}{2}\cos 2\omega t$$

Amplitude : $\frac{y_0}{2}$



$$\frac{y_0}{2} = \frac{mg}{K} \Rightarrow 2\omega = \sqrt{\frac{K}{m}} = \sqrt{\frac{2g}{y_0}}$$

$$\omega = \sqrt{\frac{g}{2y_0}}$$

Ans. (2)