

[SINGLE CORRECT CHOICE TYPE]

Q.1 A block is placed on a platform, which is making oscillations with amplitude of 10 cm along a vertical line. The least period of oscillation of platform so that block will not get separated from the platform is [3]

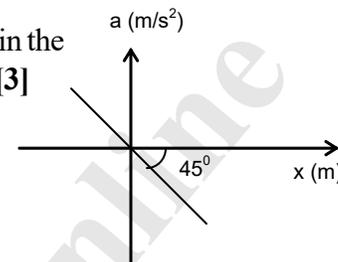
- (A) 2 sec. (B) 5π sec. (C) $5\sqrt{2}$ sec. (D) $\pi/5$ sec

Q.2 A simple harmonic motion is given by $y = 2(4\sin 3\pi t + 3\cos 3\pi t)$. What is the amplitude of motion if y is in meters [3]

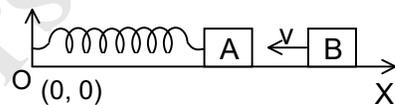
- (A) 200 cm (B) 5 cm (C) 500 cm (D) 1000 cm

Q.3 Acceleration - displacement graph of a particle executing SHM is shown in the figure. The time period of its oscillation is (in sec.) [3]

- (A) $\pi/2$
 (B) 2π
 (C) π
 (D) $\pi/4$

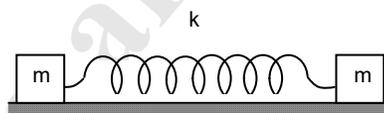


Q.4 A block 'A' of mass M connected with a spring of force constant k performing SHM. The equation of the position of the block in coordinate system shown in the figure is given by $X = X_0 + a \sin \omega t$. An identical block 'B' moving toward negative X-axis with velocity v collides elastically with the block 'A' at $t = 0$. The equation of position of A after collision will be [3]



- (A) $X = X_0 + 2a \sin \omega t$ (B) $X = X_0 + 2v \sqrt{\frac{m}{k}} \sin \omega t$
 (C) $X = X_0 + v \sqrt{\frac{m}{k}}$ (D) $X = X_0 - v \sqrt{\frac{m}{k}} \sin \omega t$

Q.5 Two identical blocks are attached by a light spring of constant k. The blocks are kept on a smooth horizontal surface. If the blocks are slightly displaced in opposite direction from equilibrium and released then, the time period of S.H.M. will be [3]

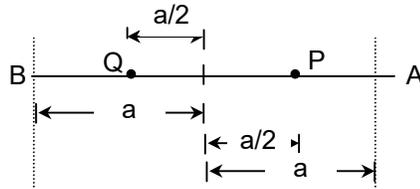


- (A) $2\pi \sqrt{\frac{m}{k}}$ (B) $2\pi \sqrt{\frac{m}{2k}}$ (C) $2\pi \sqrt{\frac{m}{4k}}$ (D) $2\pi \sqrt{\frac{m}{9k}}$

Q.6 Two linear simple harmonic motions of equal amplitudes A and frequency ω and 2ω are impressed on a particle along the x, y axis respectively. If the initial phase difference between them is $\pi/2$, the equation of the resultant path followed by the particle is [3]

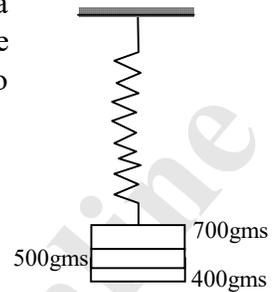
- (A) $x^2 + \frac{Ay}{2} - \frac{A^2}{2} = 0$ (B) $2x^2 + \frac{Ay}{2} - \frac{A^2}{2} = 0$ (C) $x^2 + Ay + A^2 = 0$ (D) $x^2 - \frac{Ay}{2} + \frac{A^2}{2} = 0$

- Q.7 Two particles P and Q are executing simple harmonic motions with equal amplitudes and frequencies. At a distance of half the amplitude one of them is moving away from the mean position while the other is at a distance half the amplitude and moving towards the mean position as shown in the figure. The phase difference between them is [3]



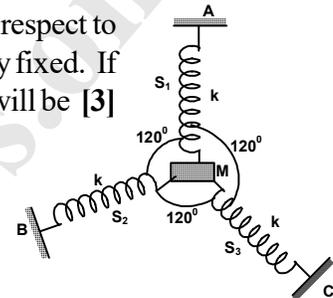
- (A) $\pi/2$ (B) $\pi/4$ (C) $4\pi/3$ (D) $5\pi/3$

- Q.8 Three masses 700gms, 500gms and 400gms are suspended at the end of a spring as shown and are in equilibrium. When the 700gms mass is removed, the system oscillates with a period of 3 seconds. When 500gms mass is also removed, it will oscillate with a period of [3]



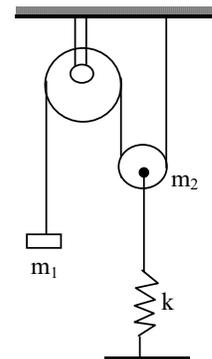
- (A) 1 sec.
(B) 1.55 sec.
(C) 3 sec.
(D) 2 sec.

- Q.9 Three springs each of force constant k are connected at equal angles with respect to each other to a common mass M. The other ends of the springs are rigidly fixed. If the mass is pulled along any of the springs, then the period of oscillation will be [3]



- (A) $2\pi \sqrt{\frac{M}{k}}$ (B) $2\pi \sqrt{\frac{2M}{3k}}$
(C) $2\pi \sqrt{\frac{2M}{k}}$ (D) $2\pi \sqrt{\frac{M}{k}}$

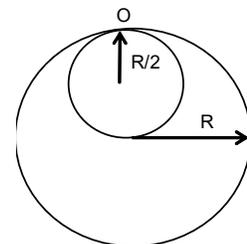
- Q.10 Find the period of the free oscillations of the system shown in the figure, if mass m_1 is pulled down a little & released. Force constant of the spring is k and mass of the fixed pulley is negligible and mass of movable pulley is m_2 . [3]



- (A) $T = 2\pi \sqrt{\frac{m_1 + m_2}{k}}$ (B) $T = 2\pi \sqrt{\frac{m_1 + 4m_2}{k}}$
(C) $T = 2\pi \sqrt{\frac{m_2 + 4m_1}{k}}$ (D) $T = 2\pi \sqrt{\frac{m_2 + 3m_1}{k}}$

- Q.11 A uniform disc of radius R and mass M has a hole of radius R/2 as shown in the figure. The disc with hole is suspended vertically through O. The time period of SHM for oscillation in plane of paper is [3]

- (A) $2\pi \sqrt{\frac{15R}{16g}}$ (B) $3\pi \sqrt{\frac{5R}{7g}}$
(C) $2\pi \sqrt{\frac{5R}{6g}}$ (D) $\frac{3\pi}{2} \sqrt{\frac{15R}{2g}}$



- Q.12 A particle of mass 1 gm lies in a potential field $v = 50x^2 + 100$. The value of frequency of oscillations in

Hz is

[3]

- (A) 502 MHz (B) $\frac{10}{2\pi}$ (C) $\frac{10\pi}{3}$ (D) none of these.

Q.13 A body is executing SHM. At a given moment, its displacement from the mean position is 5 m and its velocity is 5 m/s. Its maximum velocity is 10 m/s. When does it reach this point after passing through mean position? [3]

- (A) $\frac{\pi}{3\sqrt{3}}$ sec. (B) $\frac{\pi}{6}$ sec. (C) $\frac{\pi}{3\sqrt{2}}$ sec. (D) $\frac{\pi}{3}$ sec.

Q.14 A block is on a horizontal surface which makes oscillations horizontally with frequency 2 Hz. The coefficient of friction between the block and the surface is 0.4. What is the maximum amplitude so that the block does not slide? [3]

- (A) 2.5 cm (B) 0.8 cm (C) 0.2 cm (D) 0.4 cm

Q.15 A sphere of radius r is kept on a concave mirror of radius of curvature R . The arrangement is kept on a horizontal table. If the sphere is displaced from its equilibrium position and left, then it executes S.H.M. The period of oscillation will be (Assuming pure rolling) [3]

- (A) $2\pi\sqrt{\left(\frac{(R-r)1.4}{g}\right)}$ (B) $2\pi\sqrt{\left(\frac{(r-R)}{g}\right)}$ (C) $2\pi\sqrt{\left(\frac{(rR)}{a}\right)}$ (D) $2\pi\sqrt{\left(\frac{(R)}{gr}\right)}$

[SUBJECTIVE TYPE]

Q.16 Find the period of small oscillations for a 1 kg body disturbed from equilibrium positions in the potential energy field given by $U(x) = (5x^5 - 12x^3)$ J, where x is in m. [5]

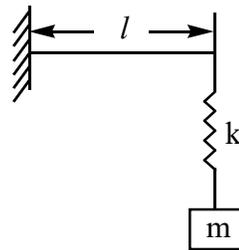
Q.17 A body performing SHM in a straight line OPQ has its velocity zero when at points P and Q. Its distances from O are b and c ($c > b$) and has a speed V when half-way between them. Find the time period of oscillation. [5]

Q.18 Suppose a particle is subjected to a force given by $F(x) = (-6x + 3x^2)$ N where x is in m. Find the maximum possible mechanical energy of the particle so that it executes oscillatory motion. [5]

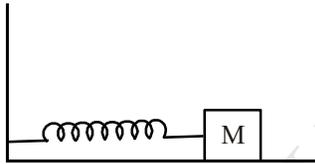
Q.19 A simple harmonic oscillator has a natural frequency of $(1/2)$ Hz. At time $t=0$, the oscillator is displaced to $x = +5$ cm and given an initial velocity $+5\pi\sqrt{3}$ cm/s. Write the expression for the displacement x as a function of time t . [5]

Q.20 A particle executes SHM and is located at $x = a, b$ and c at time $t_0, 2t_0$ and $3t_0$ respectively. Find the period of its oscillations. [5]

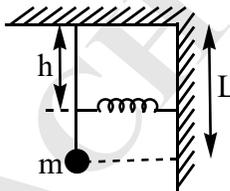
Q.21 Determine the time period of the system composed of a mass m suspended by a spring, whose constant is k , from the end of a massless cantilever beam of length l . If mass m is suspended from the free end of the cantilever, the depression produced is $\frac{mgl^3}{3YI}$, where I is a constant which depends on the dimensions of the crosssection of the beam and Y is Young's modulus of the material of the beam. [5]



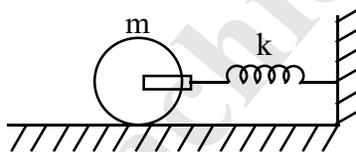
- Q.22 A horizontal spring - block system executes SHM $x = A \sin(\omega t)$. At time $t = t_1$, a blob of putty with a mass m is dropped straight down on the block, sticking to it. Find (a) the new amplitude of oscillation and (b) the new angular frequency. [5]



- Q.23 A simple pendulum of length L and mass m has a spring force constant k connected to it at a distance h below its point of suspension as shown. The spring is attached to the rod of negligible mass as shown in the figure. Find the frequency of vibrations of the system for small values of amplitude. [5]



- Q.24 A solid cylinder of mass m and uniform density is attached to a horizontal ideal spring of force constant k . The cylinder can roll without slipping along the horizontal plane. Find the time period of linear oscillations of the cylinder. [5]



- Q.25 The displacement of a particle executing periodic motion is given by $y(t) = 4 \cos^2(t/2) \sin(1000t)$. Find the frequencies of the independent constituent simple harmonic motions. [5]

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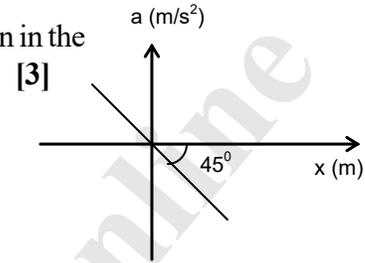
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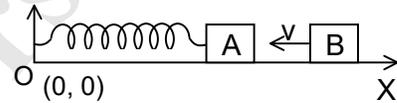
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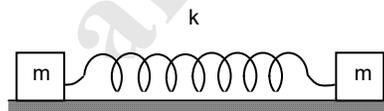


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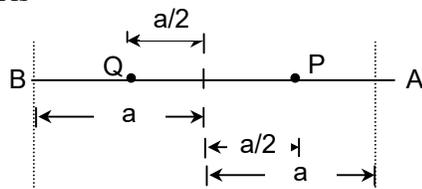


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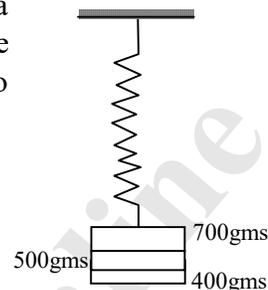
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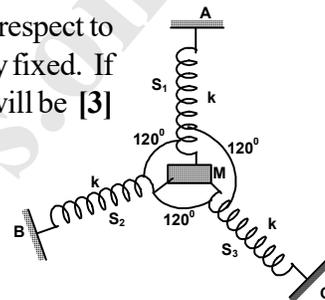
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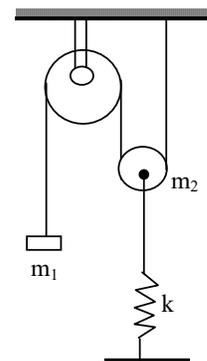
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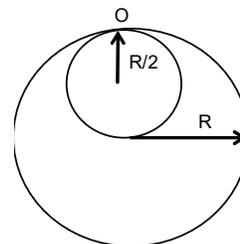
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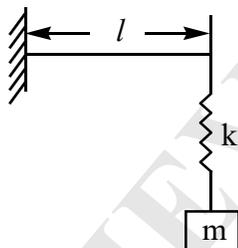
[SUBJECTIVE TYPE]

- Q.16 Find the period of small oscillations for a 1 kg body disturbed from equilibrium positions in the potential energy field given by $U(x) = (5x^5 - 12x^3)$ J, where x is in m. [5]
 [Ans : $\left\{ \frac{(\pi\sqrt{5})}{6\sqrt{3}} \right\}$ s]
- Q.17 A body performing SHM in a straight line OPQ has its velocity zero when at points P and Q. Its distances from O are b and c ($c > b$) and has a speed V when half-way between them. Find the time period of oscillation. [5]
 Ans: $\pi(c - b) / V$.
- Q.18 Suppose a particle is subjected to a force given by $F(x) = (-6x + 3x^2)$ N where x is in m. Find the maximum possible mechanical energy of the particle so that it executes oscillatory motion. [5]
 [Ans : 4 J]
- Q.19 A simple harmonic oscillator has a natural frequency of $(1/2)$ Hz. At time $t = 0$, the oscillator is displaced to $x = +5$ cm and given an initial velocity $+5\pi\sqrt{3}$ cm/s. Write the expression for the displacement x as a function of time t . [5]
 [Ans : $10 \sin(\pi t + \pi/6)$ cm]

- Q.20 A particle executes SHM and is located at $x = a, b$ and c at time $t_0, 2t_0$ and $3t_0$ respectively. Find the period of its oscillations. **[5]**

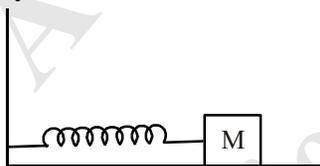
$$[\text{Ans : } 2\pi t_0 / \cos^{-1} \left(\frac{a+c}{2b} \right)]$$

- Q.21 Determine the time period of the system composed of a mass m suspended by a spring, whose constant is k , from the end of a massless cantilever beam of length l . If mass m is suspended from the free end of the cantilever, the depression produced is $\frac{mgl^3}{3YI}$, where I is a constant which depends on the dimensions of the crosssection of the beam and Y is Young's modulus of the material of the beam. **[5]**



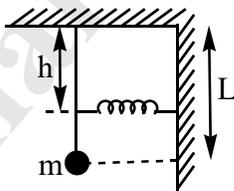
$$[\text{Ans : } 2\pi \sqrt{\frac{m(kl^3 + 3YI)}{3YIk}}]$$

- Q.22 A horizontal spring - block system executes SHM $x = A \sin(\omega t)$. At time $t = t_1$, a blob of putty with a mass m is dropped straight down on the block, sticking to it. Find (a) the new amplitude of oscillation and (b) the new angular frequency. **[5]**



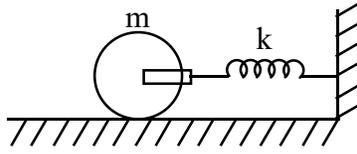
$$\left[\text{Ans : (a)} A \left[\sin^2(\omega t_1) + \frac{M}{M+m} \cos^2(\omega t_1) \right]^{1/2} \text{ (b)} \omega \sqrt{\frac{M}{M+m}} \right]$$

- Q.23 A simple pendulum of length L and mass m has a spring force constant k connected to it at a distance h below its point of suspension as shown. The spring is attached to the rod of negligible mass as shown in the figure. Find the frequency of vibrations of the system for small values of amplitude. **[5]**



$$\left[\text{Ans : } \frac{1}{2\pi} \sqrt{\frac{mgL + kh^2}{mL^2}} \right]$$

- Q.24 A solid cylinder of mass m and uniform density is attached to a horizontal ideal spring of force constant k . The cylinder can roll without slipping along the horizontal plane. Find the time period of linear oscillations of the cylinder. [5]



[Ans : $2\pi \sqrt{\frac{3m}{2k}}$]

- Q.25 The displacement of a particle executing periodic motion is given by $y(t) = 4 \cos^2(t/2) \sin(1000t)$. Find the frequencies of the independent constituent simple harmonic motions. [5]
[Ans : 999, 1000, 1001 rad/s]