# PHYSICS

# BOOKS - DC PANDEY ENGLISH

# SIMPLE HARMONIC MOTION

## Examples

**1.** Describe the motion of a particle acted upon by a force

(i) $F = -2(x-2)^3$

(ii) $F = -2(x-2)^2$

(iii) $F = -2(x-2)$

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2. Maximum acceleration of a particle in SHM is $16cm/s^2$ and maximum uelocity is $8cm/s$.Find time period and amplitude of oscillations.

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3. $F-x$ equation of a body in SHM is

$F+4x=0$

Here, $F$ is in newton and $x$ in meter. Mass of the body is $1kg$. Find time period of oscillations.

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**4.** A linear harmonic oscillator has a total mechanical energy of $200J$. Potential energy of it at mean position is $50J$. Find

(i) the maximum kinetic energy,

(ii)the minimum potential energy,

(iii) the potential energy at extreme positions.

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**5.** A particle executes SHM.

(a) What fraction of total energy is kinetic and what fraction is potential when displacement is one half of the amplitude?

(b) At what value of displacement are the kinetic and potential energies equal?

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6. The potential energy of a particle oscillating along x-axis is given as

$U = 20 + (x - 2)^2$

Here, $U$ is in joules and $x$ in meters. Total mechanical energy of the particle is $36J$.

(a) State whether the motion of the particle is simple harmonic or not.

(b) Find the mean position.

(c) Find the maximum kinetic energy of the particle.

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**7.** From the time equations of SHM, prove the relation, $v = \pm \omega \sqrt{A^2 - x^2}$

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**8.** If a SHM is represented by the equation $x = 10 \sin\left(\pi t + \frac{\pi}{6}\right)$ in Si units, then determine its amplitude, time period and maximum uelocity $v_{\max}$ ?

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**9.** A particle executes SHM with a time period of $4s$. Find the time taken by the particle to go directly from its mean position to half of its amplitude.

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**10.** A particle executes simple harmonic motion about the point $x = 0$. At time $t = 0$, it has displacement $x = 2cm$ and zero velocity. If the frequency of motion is $0.25s^{-1}$, find (a) the period, (b) angular frequency, ( c) the amplitude, (d) maximum speed, (e) the displacement from the mean position at $t = 3s$and (f) the velocity at $t = 3s$.

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**11.** Find time period of the function,

$y = \sin \omega t + \sin 2\omega t + \sin 3\omega t$

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**12.** $F - x$ equation of a body of mass $2kg$ in SHM is

$F + 8x = 0$

Here, $F$ is in newton and $x$ in meter.Find time period of oscillations.

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**13.** Acceleration of a particle in SHM at displacement $x = 10cm$ (from the mean position is $a = -2.5cm/s^2$ ). Find time period of oscillations.

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**14.** Find the period of a vertical spring - block system by both methods.

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**15.** A block with a mass of $3.00kg$ is suspended from an ideal spring having negligible mass and stretches the spring by $0.2m$.

(a) What is the force constant of the spring?

(b) What is the period of oscillation of the block if it is pulled down and released ?

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**16.** Find the displacement equation of the simple harmonic motion obtained by combining the motion.

$x_1 = 2\sin\omega t$, $x_2 = 4\sin\left(\omega t + \frac{\pi}{6}\right)$ and $x_3 = 6\sin\left(\omega t + \frac{\pi}{3}\right)$

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## Example Type 1

1. $x - t$ equation of a particle executing SHM is

$x = A\cos(\omega t - 45^\circ)$

Find the point from where particle starts its journey and the direction of its initial velocity.

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## Example Type 2

1. A particle in SHM starts its journey (at $t = 0$) from $x = -\frac{A}{2}$ in negative direction. Write $x - t$ equation corresponding to given condition. Angular frequency of oscillations is $\omega$.

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## Example Type 3

1. In terms of time period of oscillations T, find the shortest time in moving a particle from $+\frac{A}{2}$ to $-\frac{\sqrt{3}}{2}$.

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## Example Type 4

1. Two SHM particles $P_1$ and $p_2$ start from $+\frac{A}{2}$ and $-\frac{\sqrt{3A}}{2}$, both in negative directions. Find the time (in terms of T) when they collide. Both particles have same

omega, $A$ and $T$ and the execute SHM along the same line.

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## Example Type 5

**1.** A mass is suspended separately by two springs and the time periods in the two cases are $T_1$ and $T_2$. Now the same mass is connected in parallel $(K = K_1 + K_2)$ with the springs and the time is suppose $T_P$. Similarly time period in series is $T_S$, then find the relation between $T_1, T_2$ and $T_P$ in the first case and $T_1, T_2$ and $T_S$ in the second case.

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**2.** Time period of a block with a spring is $T_0$. Now ,the spring is cut in two parts in the ratio $2:3$. Now find the time period of same block with the smaller part of the spring.

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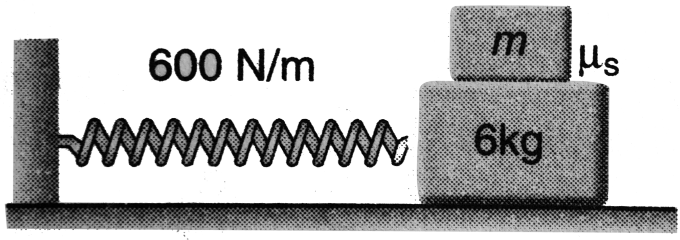
**3.** With the assumption of no slipping, determine the mass m of the block which must be placed on the top of a $6kg$ cart in order that the system period is $0.75s$. What is the minimum coefficient of static friction $\mu_s$ for which the block will not slip relative to the cart is displaced

$50mm$ from the equilibrium position and released? Take

$(g = 9.8m / s^2)$.

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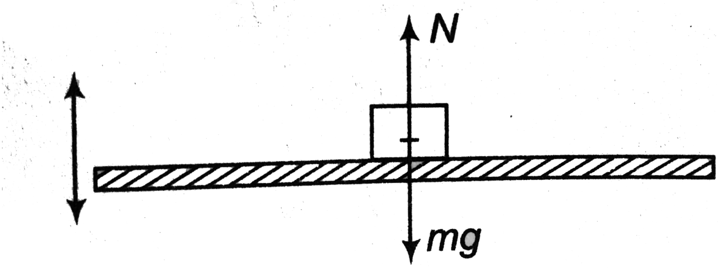
**4.** A block is kept is kept over a horizontal platform, executing vertical SHM of angular frequency $\omega$. Find maximum amplitude of oscillations, so that the block does not leave contact with the platform.

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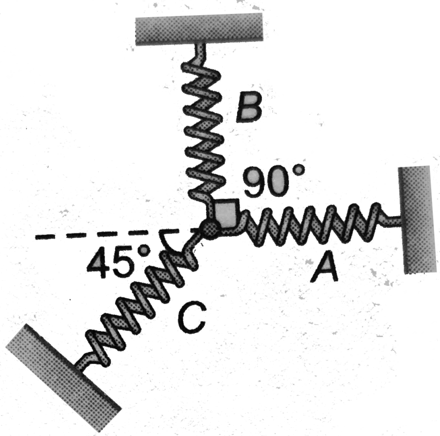
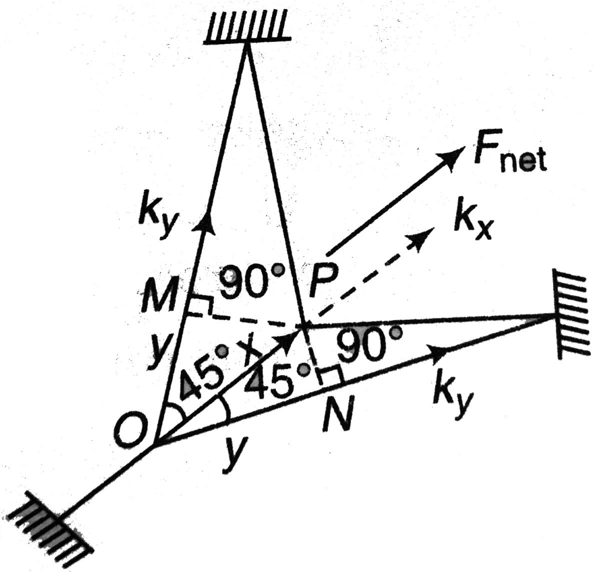
5. A particle of mass $m$ is attached with three springs $A, B$ and $C$ of equal force constants $k$ as shown in figure. The particle is pushed slightly against the spring

$C$ and released. Find the time period of oscillation.

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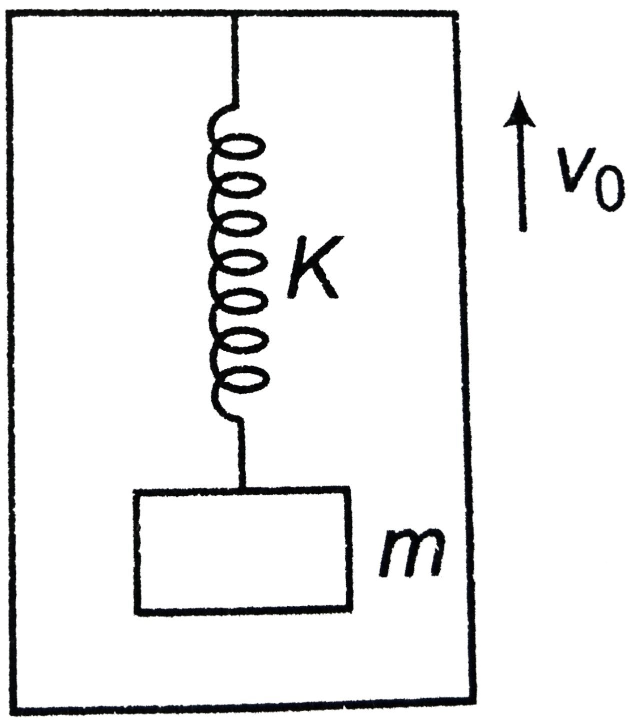
**6.** A spring block system is kept inside a lift moving with a constant velocity $v_0$ as shown in figure. Block is in equilibrium and at rest with respect to lift. The lift is suddenly stopped at time $t = 0$. Taking upward direction as the positive direction, write $x - t$ equation of the block.



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**7.** One end of an ideal spring is fixed to a wall at origin $O$ and axis of spring is parallel to x-axis. A block of mass $m = 1kg$ is attached to free end of the spring and it is performing SHM. Equation of position of the block in co-ordinate system shown in figure is $x = 10 + 3\sin(10t)$. Here, t is in second and $x$ in $cm$. Another block of mass $M = 3kg$, moving towards the origin with velocity $30cm/s$ collides with the block performing SHM at $t = 0$ and gets stuck to it. Calculate

(a) new amplitude of oscillations,

(b) newequtíon for position of the combined body,

( c) loss of energy during collision. Neglect friction.

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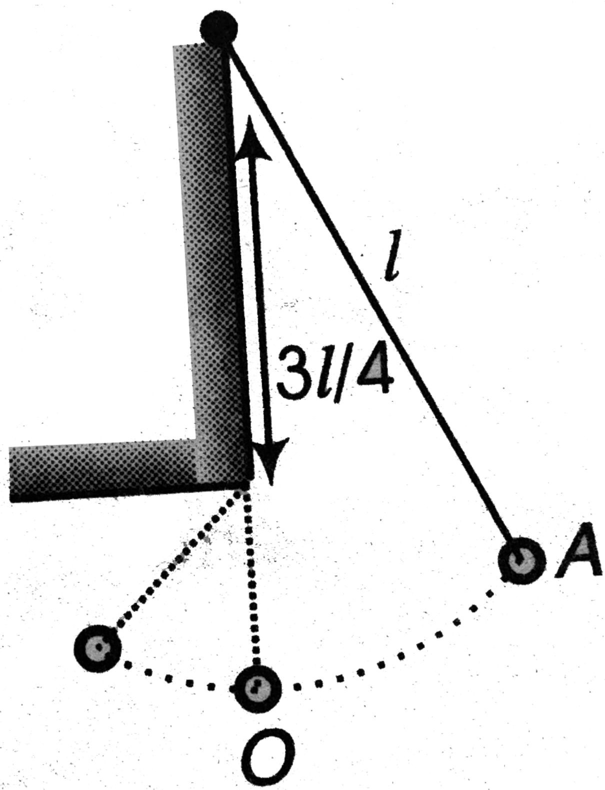
## Example Type 6

**1.** A pendulum has a period $T$ for small oscillations. An obstacle is placed directly beneath the pivot, so that only the lowest one - quarter of the string can follow the pendulum bob when it swings to the left of its resting position. The pendulum is released from rest at a certain point. How long will it take to return to that point again ? In answering this question, you may assume that the angle between the moving string and the vertical stays small throughout the motion.

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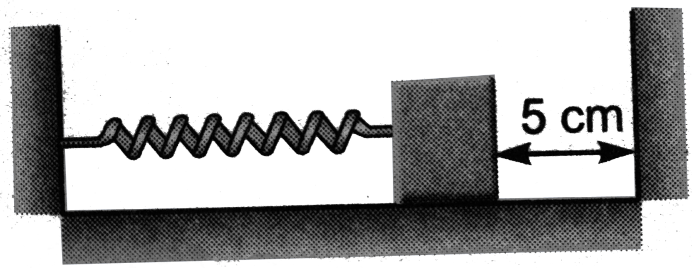
**2.** A block of mass $100g$ attached to a spring of stiffness $100N/m$ is lying on a frictionless floor as shown. The block is moved to compress the spring by $10cm$ and released. If the collision with the wall is elastic then find the time period of oscillations.

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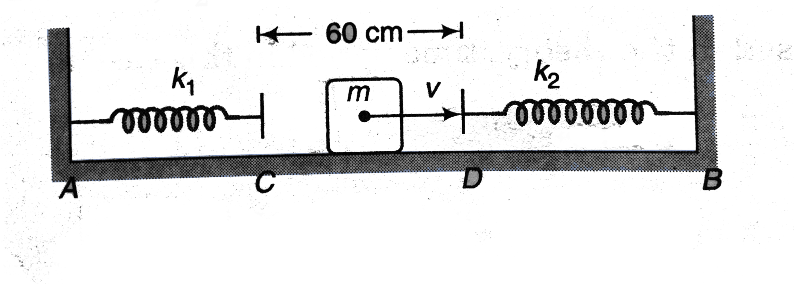
**3.** Two light spring of force constants $k_1$ and $k_2$ and a block of mass m are in one line $AB$ on a smooth horizontal table such that one end of each spring is fixed on rigid supports and the other end is free as shown in the figure. The distance $CD$ between the spring is $60cm$. If the block moves along $AB$ with a velocity $120cm/s$ in between the springs, calculate the period of oscillation of the block. (take $k_1 = 1.8N/m$, $k_2 = 3.2N/m, m = 200g$)

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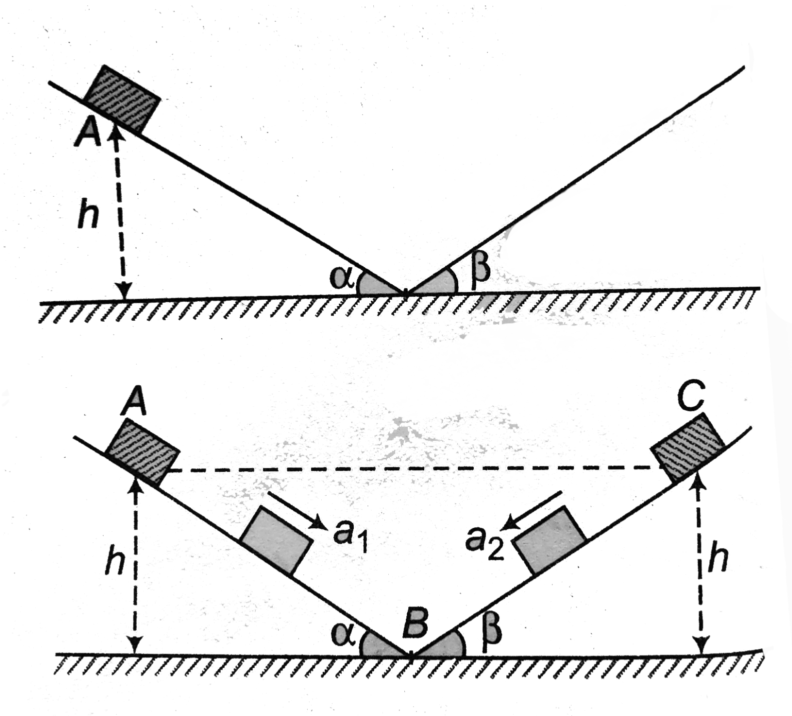
**4.** A block is released from point $A$ as shown in figure .All surfaces are smooth and there is no loss of mechnical energy anywhere. Find the time period of oscillation of block.

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## Example Type 7

**1.** A simple pendulum of length $l$ is suspended from the celing of a cart which is sliding without friction on as inclined plane of inclination theta . What will be the time period of the pendulum?

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## Example Type 8

**1.** A block in SHM starts from $+A$ position. Write $S-t$ equation of the block, if $S$ is measured from $-A$.

A. $S=A(1+\cos\omega t)$

B. $S=2A(1+\cos\omega t)$

C. $S = A(\cos \omega t)$

D. $S = A(1 + 2\cos \omega t)$

**Answer: A::C**

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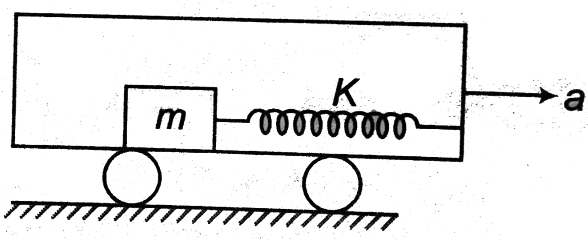
## Example Type 9

**1.** A spring block system is kept inside the smooth surface of a trolley as shown in figure.



At $t=0$ trolley is given an acceleration 'a' in the direction shown in figure. Write $S-t$ equation of the block

(a) with respect to trolley.

(b) with respect to ground.

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## Example Type 10

1. $x-t$ equation of a particle in SHM is

$$x=(4cm)\cos\left(\frac{\pi}{2}t\right)$$

Here ,$t$ is in seconds. Find the distance travelled by the particle in first three seconds.

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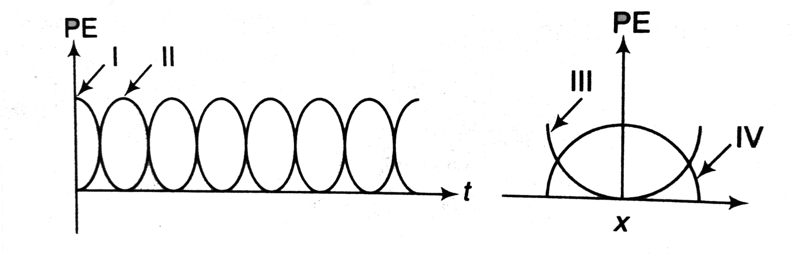
## Example Type 11

**1.** For a particle executing SHM, the displacement $x$ is given by $x = A\cos\omega t$. Identify the graph which represents the variation of potential energy $(PE)$ as a function of time $t$ and displacement $x$.




(a) $I, III$

(b) $II, IV$ (c ) $II, III$

(d) $I, IV$

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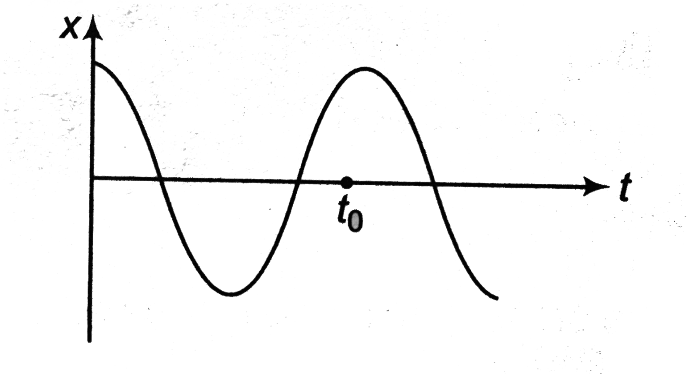
**2.** $x - t$ graph of a particle in SHM is




At time $t = t_0$, what are the signs of $v$ and $a$ of the particle?

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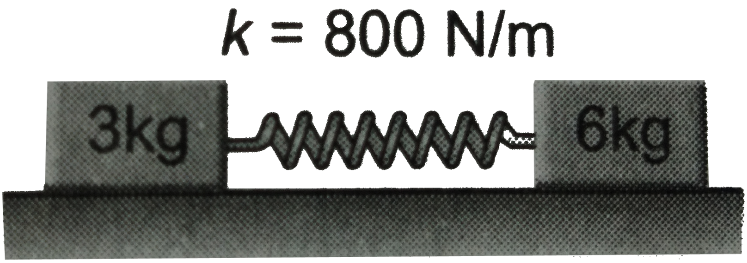
## Example Type 12

**1.** The system shown in the figure can move on a smooth surface. They are initially compressed by $6cm$ and then released, then choose the correct options.




(a) The system performs, SHM with time period $\frac{\pi}{10}s$

(b) The block of mass $3kg$ perform SHM with amplitude $4cm$

( c) The block of mass $6kg$ will have maximum momentum of $2.40kg - m / s$

(d) The time periods of two blocks are in the ratio of $1 : \sqrt{2}$

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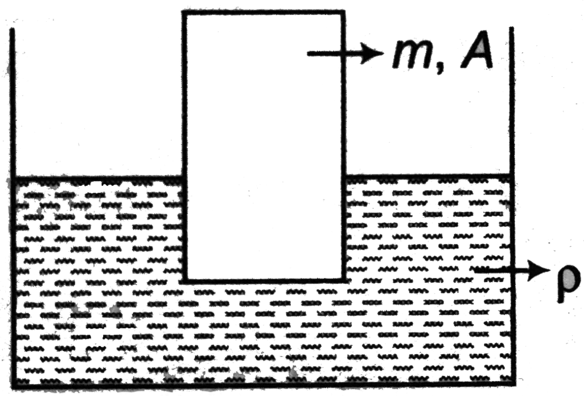
## Example Type 13

**1.** A plank of mass 'm' and area of cross - section $A$ is floating in a non - viscous liquid of desity $\rho$. When displaced slightly from the mean position, it starts oscillating. Prove that oscillations are simple harmonic and find its time period.

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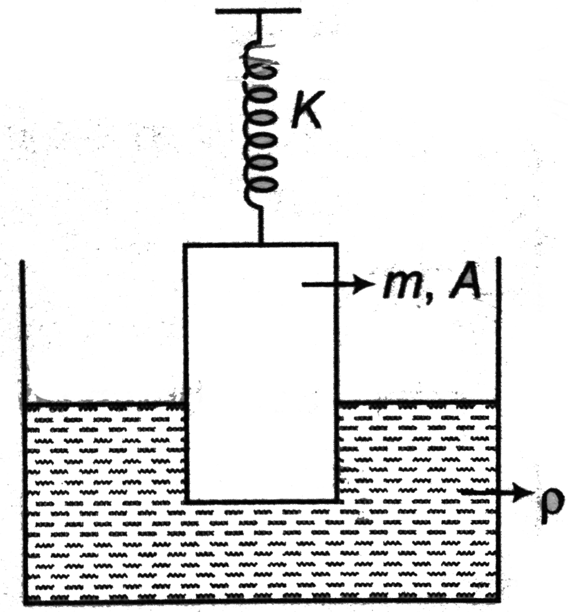
**2.** A plank of mass 'm' and area of cross - section $A$ is floating as shown in figure. When slightly displaced from mean position, plank starts oscillations. Find time period of these oscillations.

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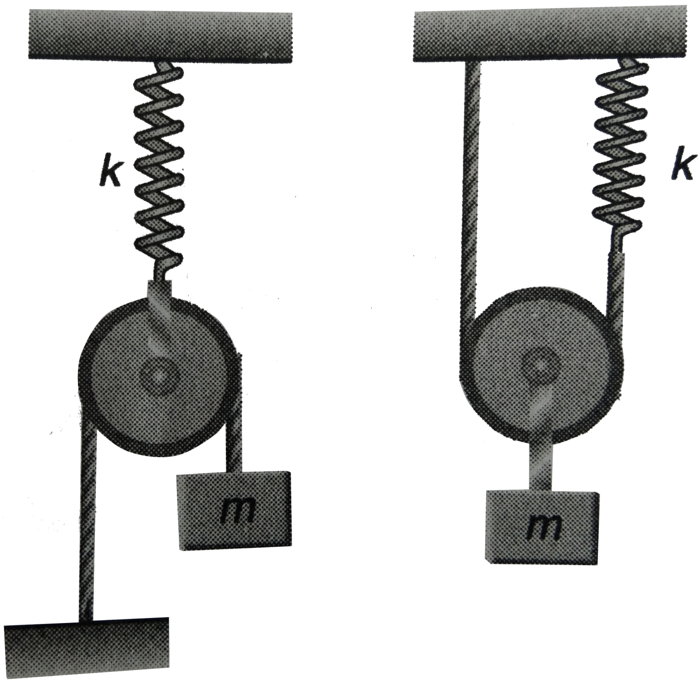
**3.** Figure shows a system consisting of a massles pulley, a spring of force constant $k$ and a block of mass $m$. If the block is sligthtly displaced vertically down from its equilibrium and released, find the period of its vertical oscillation in cases (a) and (b).

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## Miscellaneous Examples

**1.** For a two body oscillator system, prove the relation,

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

where, $\mu = \dfrac{m_1 m_2}{m_1 + (m_2)} =$ reduced mass.

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**2.** Two particles move parallel to $x -$ axis about the origin with same amplitude 'a' and frequency $\omega$. At a certain instant they are found at a distance $a/3$ from the origin on opposite sides but their velocities are in the same direction. What is the phase difference between the two?

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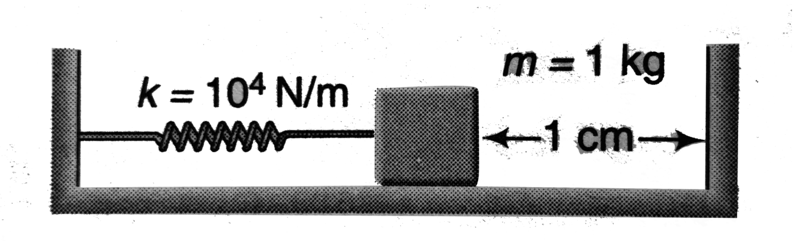
**3.** For the arrangement shown in figure, the spring is initially compressed by $3cm$. When the spring is released the block collides with the wall and rebounds to compress the spring again.




(a) If the coefficient of restitution is $\frac{1}{\sqrt{2}}$, find the maximum compression in the spring after collision.

(b) If the time starts at the instant when spring is released, find the minimum time after which the block becomes stationary.

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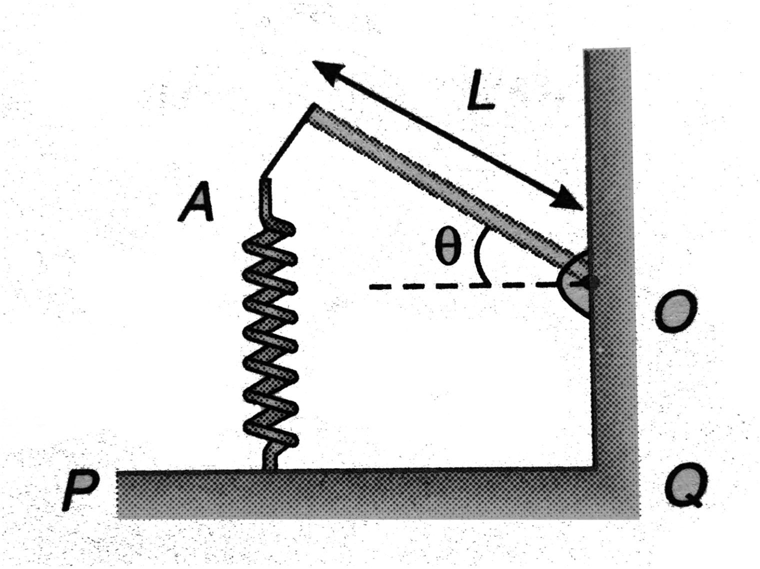
**4.** A long uniform rod of length $L$ and mass $M$ is free to rotate in a horizontal plane about a vertical axis through its one end 'O'. A spring of force constant $k$ is connected between one end of the rod and $PQ$. When the rod is in equilibrium it is parallel to $PQ$.




(a)What is the period of small oscillation that result when the rod is rotated slightly and released ?

(b) What will be the maximum speed of the displacement end of the rod, if the amplitude of motion is $\theta_0$?

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**5.** A block with a mass of $2kg$ hangs without vibrating at the end of a spring of spring constant $500N/m$, which is attached to the ceiling of an elevator. The elevator is moving upwards with an acceleration $\frac{g}{3}$. At time $t=0$, the acceleration suddenly ceases.

(a) What is the angular frequency of oscillation of the block after the acceleration ceases ?

(b) By what amount is the spring stretched during the time when the elevator is accelerating ?

(c )What is the amplitude of oscillation and initial phase angle observed by a rider in the elevator in the equation, $x = A \sin(\omega t + \phi)$ ? Take the upward direction to be positive. Take $g = 10.0 m / s^2$.

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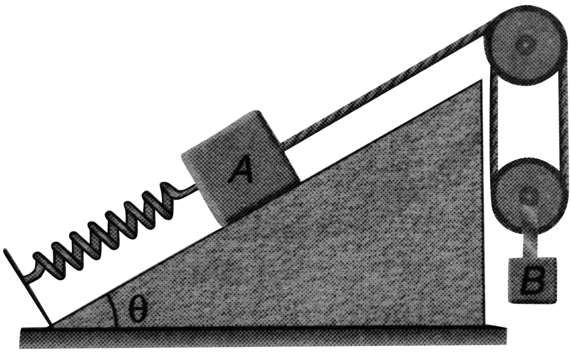
**6.** Calculate the angular frequency of the system shown in fingure. Friction is absent everywhere and the threads, spring and pulleys are massless. Given that

$m_A = m_B = m.$

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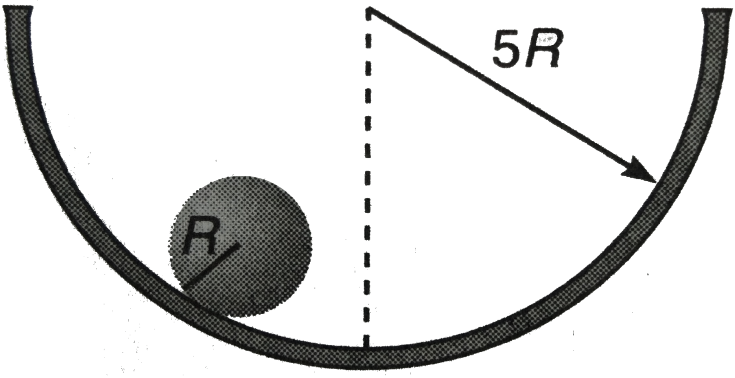
**7.** A solid sphere $(radius = R)$ rolls without slipping in a cylindrical throuh$(radius = 5R)$. Findthe time period of small oscillations.

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**8.** Consider the earth as a uniform sphere if mass $M$ and radius $R$. Imagine a straight smooth tunnel made through the earth which connects any two points on its surface. Show that the motion of a particle of mass m along this tunnel under the action of gravitation would be simple harmonic. Hence, determine the time that a particle would take to go from one end to the other through the tunnel.

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## Level 1 Assertion And Reason

**1.** Assertion : In $x = A\cos\omega t$, $x$ is the displacement measured from extreme position.

Reason : In the above equation $x = A$ at time $t = 0$.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: D**

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**2.** Assertion : A particle is under SHM along the x - axis. Its mean position is $x = 2$, amplitude is $A = 2$ and angular frequency $\omega$. At $t = 0$, particle is at origin, then $x$ - co-ordinate versus time equation of the particle will be $x = -2\cos\omega t + 2.$

Reason : At $t = 0$, particle is at rest.

A. Both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. Assertion is true, but the Reason is false.

D. Assertion is false but the Reason is true.

**Answer: B**

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**3.** Assertion : A spring block system is kept over a smooth surface as shown in figure. If a constant horizontal force $F$ is applied on the block it will start oscillating simple harmonically.

Reason : Time period of oscillation is less then $2\pi\sqrt{\frac{m}{k}}$.

A. Both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. Assertion is true, but the Reason is false.

D. Assertion is false but the Reason is true.

**Answer: C**

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4. Assertion : Time taken by a particle in SHM to move from $x = A$ to $x = \frac{\sqrt{3A}}{2}$ is same as the time taken by the particle to move from $x = \frac{\sqrt{3A}}{2}$ to $x = \frac{A}{2}$.

Reason : Corresponding angles rotated is the reference circle are same in the given time intervals.

A. (a)If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b)If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c)If Assertion is true, but the Reason is false.

D. (d)If Assertion is false but the Reason is true.

**Answer: A**

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**5.** Assertion : Path of a particle in SHM is always a straight line.

Reason : All straight line motions are not simple harmonic.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: D**

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**6.** Assertion : In spring block system if length of spring and mass of block both are halved, then angular frequency of oscillations will remain unchanged.

Reason : Angular frequency is given by $\omega = \sqrt{\frac{k}{m}}$.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: D**

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**7.** Assertion : All small oscillation are simple harmonic in nature.

Reason : Oscillation of spring block system are always simple harmonic whether amplitude is small or large.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: D**

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**8.** Assertion : In $x = A \cos \omega t$, the dot product of acceleration and velocity is positive for time interval $0 < t < \frac{\pi}{2\omega}$. Reason : Angle between them is $0^\circ$ .

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: A**

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**9.** Assertion : For a given simple harmonic motion displacement (from the mean position) and acceleration have a constant ratio.

Reason : $T = 2\pi\sqrt{\left|\frac{\text{displacement}}{\text{acceleration}}\right|}$.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: A**

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**10.** Assertion : We can call circular motion also as simple harmonic motion.

Reason : Angular velocity in uniform circular motion and angular frequency in simple harmonic motion have the same meanings.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: D**

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## Level 1 Single Correct

**1.** A simple harmonic oscillation has an amplitude $A$ and time period $T$. The time required to travel from $x = A$ to $x = \frac{A}{2}$ is

A. $\frac{T}{6}$

B. $\frac{T}{4}$

C. $\frac{T}{3}$

D. $\frac{T}{12}$

**Answer: A**

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**2.** The potential energy of a particle executing SHM varies sinusoidally with frequency $f$. The frequency of oscillation of the particle will be

A. $\frac{f}{2}$

B. $\frac{f}{\sqrt{2}}$

C. $f$

D. $2f$

**Answer: A**

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**3.** For a particle undergoing simple harmonic motion, the velocity is plotted against displacement. The curve will be

A. a straight line

B. a parabola

C. a circle

D. an ellipse

**Answer: D**

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**4.** A simple pendulum is made of bob which is a hollow sphere full of sand suspended by means of a wire. If all the sand is drained out, the period of the pendulum will

A. increase

B. decrease

C. remian same

D. become erratic

**Answer: C**

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**5.** Two simple harmonic motions are given by $y_1 = a\sin\left[\left(\frac{\pi}{2}\right)t + \phi\right]$ and $y_2 = b\sin\left[\left(\frac{2\pi}{3}\right)t + \phi\right]$. The phase difference between these after $1s$ is

A. (a)zero

B. $(b)\pi/2$

C. $(c)\pi/4$

D. $(d)\pi/6$

**Answer: D**

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**6.** A particle starts performing simple harmonic motion. Its amplitude is $A$. At one time its speed is half that of the maximum speed. At this moment the displacement is

A. $(a)\frac{\sqrt{2}A}{3}$

B. $(b)\frac{\sqrt{3}A}{2}$

C. $(c)\frac{2A}{\sqrt{3}}$

D. $(d)\frac{3A}{\sqrt{2}}$

**Answer: B**

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**7.** Which of the following is not simple harmonic function ?

A. $y = a \sin 2\omega t + b \cos^2 \omega t$

B. $y = a \sin \omega t + b \cos 2\omega t$

C. $y = 1 - 2 \sin^2 \omega t$

D. $y = \left(\sqrt{a^2 + b^2}\right) \sin \omega t \cos \omega t$

**Answer: B**

Watch Video Solution

**8.** The displacement of a particle varies according to the relation $x = 4(\cos \pi t + \sin \pi t)$. The amplitude of the particle is.

A. $8$ units

B. $2$ units

C. $4$sunits

D. $4\sqrt{2}$ units

**Answer: D**

Watch Video Solution

**9.** Two pendulums $X$ and $Y$ of time periods $4s$ and $4.2s$ are made to vibrate simultaneously. They are initially in same phase. After how many vibration of $X$, they will be in the same phase again ?

A. $30$

B. $25$

C. $21$

D. $26$

**Answer: C**

Watch Video Solution

**10.** A mass $M$ is suspended from a massless spring. An additional mass $m$ stretches the spring further by a distance $x$. The combined mass will oscillate with a period

A. $2\pi\sqrt{\left\{\frac{(M+m)x}{mg}\right\}}$

B. $2\pi\sqrt{\left\{\frac{mg}{(M+m)x}\right\}}$

C. $2\pi\sqrt{\left\{\frac{(M+m)}{mgx}\right\}}$

D. $\frac{\pi}{2}\sqrt{\left\{\frac{mg}{(M+m)x}\right\}}$

**Answer: A**

Watch Video Solution

**11.** Two bodies $P$ and $Q$ of equal masses are suspended from two separate massless springs of force constants $k_1$ and $k_2$ respectively. If the two bodies oscillate vertically such that their maximum velocities are equal. The ratio of the amplitude of $P$ to that of $Q$ is

A. $\sqrt{\dfrac{k_2}{k_1}}$

B. $\dfrac{k_1}{k_2}$

C. $\dfrac{\sqrt{k_2}}{k_1}$

D. $\dfrac{k_2}{k_1}$

**Answer: C**

Watch Video Solution

**12.** A disc of radius $R$ is pivoted at its rim. The period for small oscillations about an axis perpendicular to the plane of disc is

A. $2\pi\dfrac{\sqrt{R}}{g}$

B. $2\pi\sqrt{\frac{2R}{g}}$

C. $2\pi\sqrt{\frac{2\pi}{3g}}$

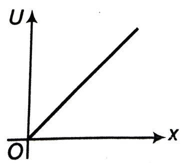
D. $2\pi\sqrt{\frac{3R}{2g}}$

**Answer: D**

Watch Video Solution

**13.** Identify the correct variation of potential energy $U$ as a function of displacement $x$ from mean position (or $x^2$) of a harmonic oscillator ($U$ at mean position $= 0$)

A. (a)



B.

C.

D. None of these

**Answer: C**

Watch Video Solution

**14.** If the length of a simple pendulum is equal to the radius of the earth, its time period will be

A. $2\pi\sqrt{R/g}$

B. $2\pi\sqrt{R/2g}$

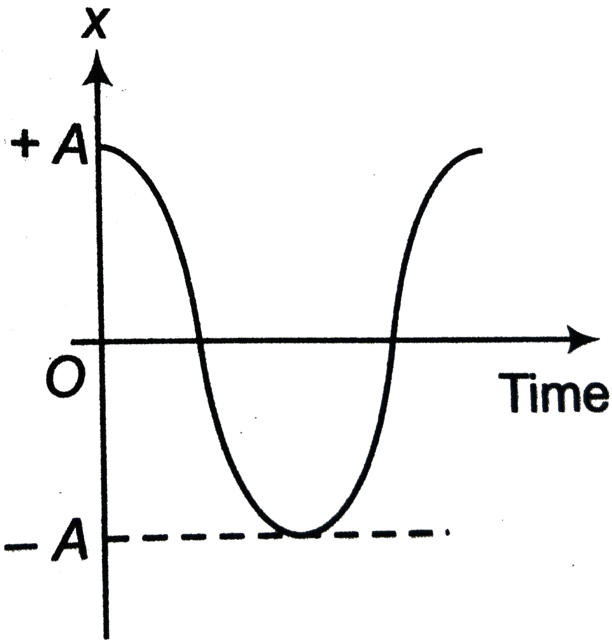
C. $2\pi\sqrt{2R/g}$

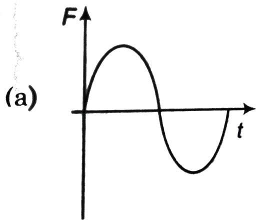
D. infinite

**Answer: B**

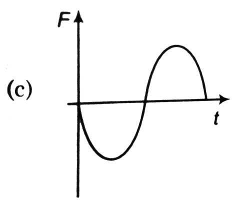
Watch Video Solution

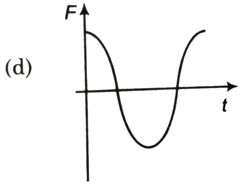
**15.** The displacement - time $(x - t)$ graph of a particle executing simple harmonic motion is shown in figure. The correct variation of net force F action on the particle as a function of time is




A. 


B.

C. 

D. 


**Answer: B**

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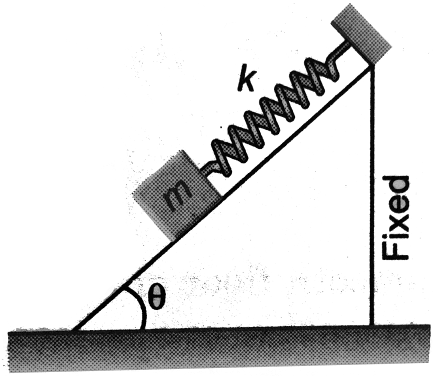
**16.** In the figure shown the time period and the amplitude respectively, when $m$ is left from rest when spring is relaxed are (the inclined plane is smooth)




A. $2\pi\sqrt{\frac{m}{k}}, \frac{mg\sin\theta}{k}$

B. $2\pi\sqrt{\frac{m\sin\theta}{k}}, \frac{2mg\sin\theta}{k}$

C. $2\pi\sqrt{\frac{m}{k}}, \frac{mg\cos\theta}{k}$

D. None of these

**Answer: A**

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**17.** The equation of motion of a particle of mass $1g$ is $\frac{d^2x}{dt^2} + \pi^2 x = 0$, where $x$ is displacement (in m) from mean position. The frequency of oscillation is (in Hz)

A. $1/2$

B. $2$

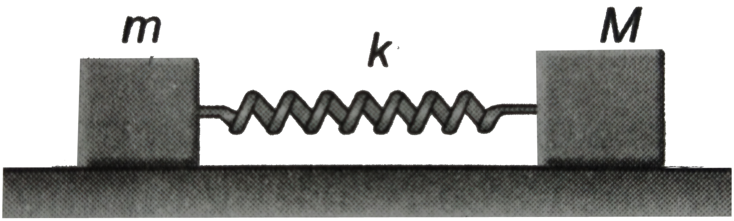
C. $5\sqrt{10}$

D. $1/5\sqrt{10}$

**Answer: A**

Watch Video Solution

**18.** The spring as shown in figure is kept in a stretched position with extension $x$ when the system is relesed. Assuming the horizontal surface to be frictionless, the frequency of oscillation is




A. $\frac{1}{2\pi}\sqrt{\left[\frac{k(M+m)}{Mm}\right]}$

B. $\frac{1}{2\pi}\sqrt{\left[\frac{mM}{k(M+m)}\right]}$

C. $\frac{1}{2\pi}\sqrt{\left[\frac{kM}{m+M}\right]}$

D. $\frac{1}{2\pi}\sqrt{\left[\frac{km}{M+m}\right]}$

**Answer: A**

Watch Video Solution

**19.** The mass and diameter of a planet are twice those of earth. What will be the period of oscillation of a pendulum on this plenet. If is a second's pendulum on earth?

A. $\sqrt{2}s$

B. $2\sqrt{2}s$

C. $\frac{1}{\sqrt{2}}s$

D. $\frac{1}{2\sqrt{2}}s$

**Answer: B**

Watch Video Solution

**20.** The resultant amplitude due to superposition of three simple harmonic motions $x_1 = 3\sin\omega t$, $x_2 = 5\sin(\omega t + 37^\circ)$ and $x_3 = -15\cos\omega t$ is

A. 18

B. 10

C. 12

D. None of these

**Answer: D**

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**21.** Two SHMs $s_1 = a \sin \omega t$ and $s_2 = b \sin \omega t$ are superimposed on a particle. The $s_1$ and $s_2$ are along the direction which makes $37^\circ$ to each other

A. the particle will perform SHM

B. the path of particle is straight line

C. Both (a) and (b) are correct

D. Both (a) and (b) are wrong

**Answer: C**

Watch Video Solution

**22.** The amplitude of a particle executing SHM about $O$ is $10 cm$. Then

A. a. when the $KE$ is $0.64$ times of its maximum$KE$, its displacement is $6 cm$ from $O$

B. b. its speed is half the maximum speed when its displacement is half the maximum displacement

C. c. Both (a) and (b) are correct

D. d. Both (a) and (b) are wrong

**Answer: A**

Watch Video Solution

**23.** A particle is attached to a vertical spring and is pulled down a distance $4cm$ below its equilibrium and is released from rest. The initial upward acceleration is $0.5ms^{-2}$. The angular frequency of oscillation is

A. $3.53rad/s$

B. $0.28rad/s$

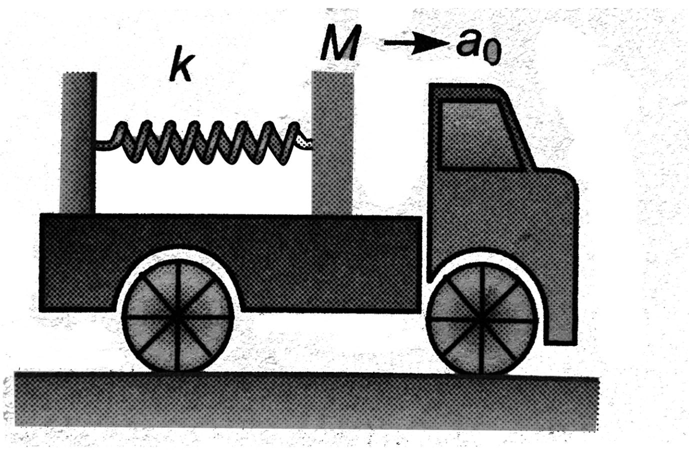
C. $1.25rad/s$

D. $0.08rad/s$

**Answer: A**

Watch Video Solution

**24.** A block of mass $1kg$ is kept on smooth floor of a truck. One end of a spring of force constant $100N/m$ is attached to the block and other end is attached to the body of truck as shown in the figure. At $t = 0$, truck begins to move with constant acceleration $2m/s^2$. The amplitude of oscillation of block relative to the floor of truck is




A. $(a)0.06m$

B. $(b) 0.02 m$

C. $(c) 0.04 m$

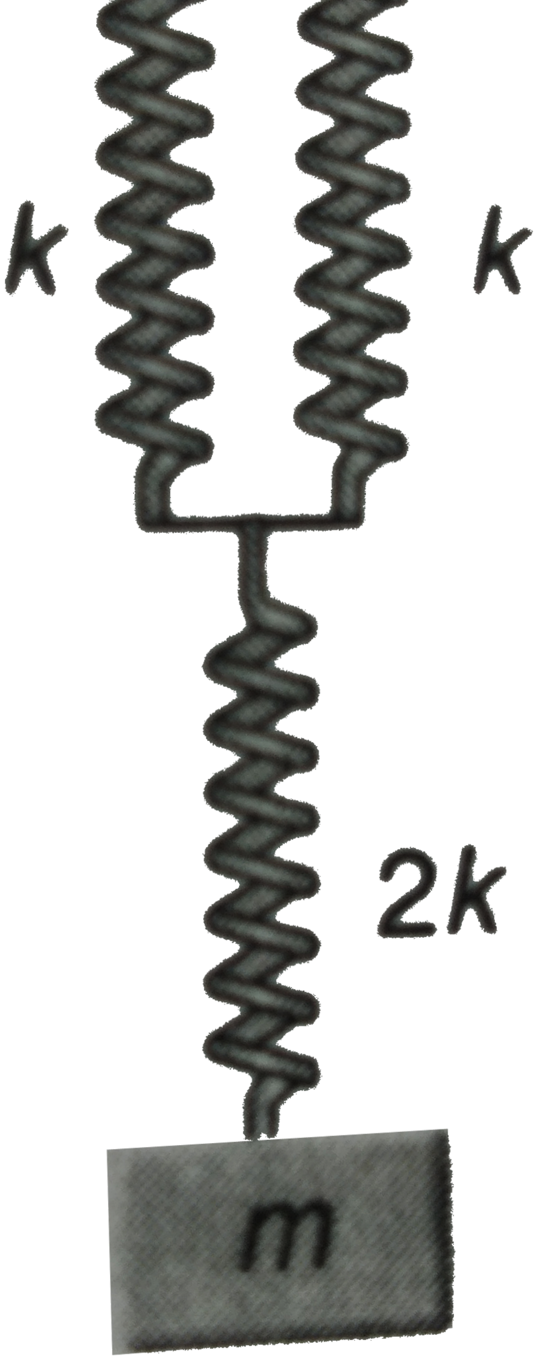
D. $(d) 0.03 m$

**Answer: B**

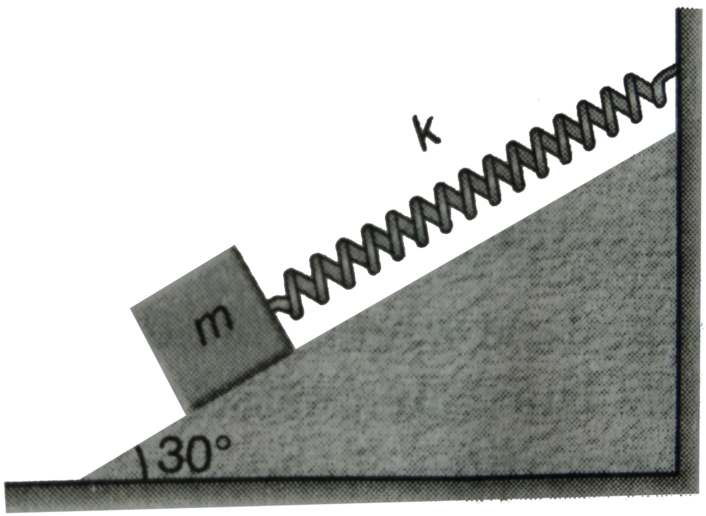
Watch Video Solution

## Level 1 Subjective

**1.** Find the period of oscillation of the system shown in figure.


k
k
2k
m

**2.** A block of mass 0.2 kg is attached to a mass less spring of force constant 80 N/m as shown in figure. Find the period of oscillation. Take $g = 10 m / s^2$. Neglect friction

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**3.** A body of weight $27N$ hangs on a long spring of such stiffness that an extra force of $9N$ stretches the spring by $0.05m$. If the body is pulled downward and released, what is the period ?

Watch Video Solution

**4.** A clock with an iron pendulum keeps correct time at $20^\circ C$. How much time will it lose or gain in a day if the temperature changes to $40^\circ C$. Thermal coefficient of liner expansion $\alpha = 0.000012 per ^\circ C$.

Watch Video Solution

**5.** A $50g$ mass hangs at the end of a massless spring. When $20g$ more are added to the end of the spring, it stretches $7.0cm$ more. (a) Find the spring constant. (b) If the $20g$ are now removed, what will be the period of the motion ?

Watch Video Solution

**6.** An object suspended from a spring exhibits oscillations of period $T$. Now ,the spring is cut in half and the two halves are used to support the same object, as shown in figure. The new period of oscillation is .

A. $T/2$

B. $T/4$

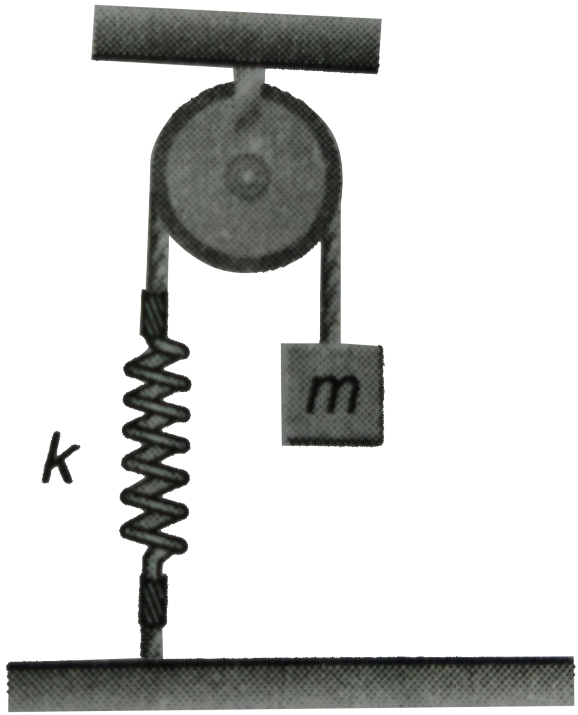
C. $2T$

D. $T$

**Answer: A**

Watch Video Solution

**7.** The string, spring and the pulley shown in figure are light. Find the time period of the mass $m$.

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**8.** A simple pendulum with a solid metal bob has a period $T$. What will be the period of the same pendulum if it is made to oscillate in a non - viscous liquid of density one - tenth of the of the metal of the bob ?

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**9.** A particle moves under the force $F(x) = (x^2 - 6x)N$, where $x$ is in metres. For small displacements from the origin what is the force constant in the simple harmonic motion approximation ?

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**10.** The initial position and velocity of a body moving in SHM with period $T = 0.25s$ are $x = 5.0cm$ and $v = 218cm/s$. What are the amplitude and phase constant of the motion ?

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**11.** A point particle if mass $0.1kg$ is executing SHM of amplitude $0.1m$. When the particle passes through the mean position, its kinetic energy is $8 \times 10^{-3}J$. Write down the equation of motion of this particle when the initial phase of oscillation is $45^{\circ}$.

Watch Video Solution

**12.** Potential energy of a particle in SHM along x - axis is gives by

$U = 10 + (x - 2)^2$

Here, $U$ is in joule and $x$ in metre. Total mechanical energy of the particle is $26J$. Mass of the particle is $2kg$.

Find

(a) angular frequency of SHM,

(b) potential energy and kinetic energy at mean position and extreme position,

(c ) amplitude of oscillation,

(d) x - coordinates between which particle oscillates.

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**13.** A simple pendulum is taken at a place where its separation from the earth's surface is equal to the radius of the earth. Calculate the time period of small oscillation if the length of the string is $1.0m$. Take $g = \pi^2 m / s^2$ at the surface of the earth.

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**14.** A solid cylinder of mass $M = 10kg$ and cross - sectional area $A = 20cm^2$ is suspended by a spring of force contant $k = 100N/m$ and hangs partically immersed in water. Calculate the period of small oscillation of the cylinder.

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**15.** A simple pendulum of length $l$ and mass $m$ is suspended in a car that is moving with constant speed $v$ around a circle of radius $r$. Find the period of oscillation and equilibrium position of the pendulum.

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**16.** A body of mass $0.10kg$ is attached to vertical massless spring with force constant $4.0 \times 10^3 N/m$. The body is displaced $10.0cm$ from its equilibrium position and released. How much time elapses as the body moves from a point $8.0cm$ on one side of the equilibrium position to a point $6.0cm$ on the same side of the equilibrium position ?

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**17.** A body of mass $200g$ is in equibrium at $x = 0$ under the influence of a force $F(x) = \left(-100x + 10x^2\right)N$.

(a) If the body is displacement a small distance from equilibrium, what is the period of its oscillations ?

(b) If the amplitude is $4.0cm$, by how much do we eror in assuming that $F(x) = -kx$ at the end points of the motion.

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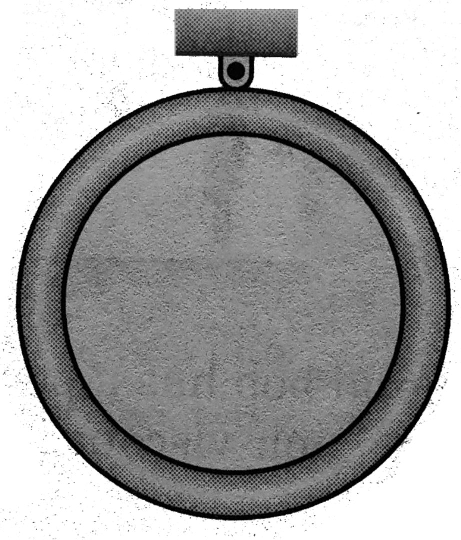
18. A ring of radius $r$ is suspended from a point on its circumference. Determine its angular frequency of small

oscillations.



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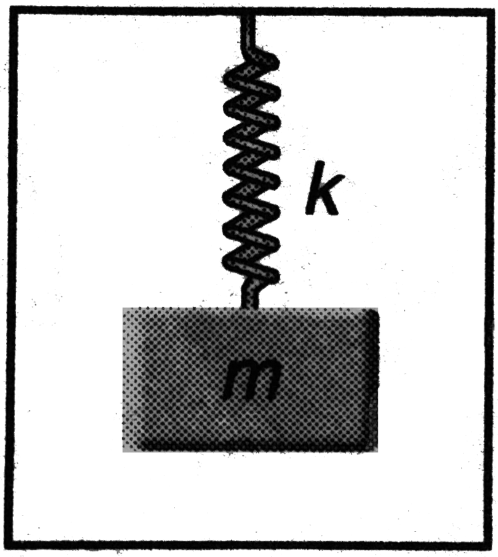
**19.** A spring mass system is hanging from the celling of an elevator in equilibrium. The elevator suddenly starts accelerating upwards with acceleration a. Find




(a) the frequency and

(b) the amplitude of the resulting SHM.

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**20.** A body makes angular simple harmonic motion of amplitude $\pi / 10 rad$ and time period $0.05 s$. If the body is at a displacement $\theta = \pi / 10 rad$ at $t = 0$, write the equation giving angular displacement as a function of time.

Watch Video Solution

**21.** A particle executes simple harmonic motion of period $16s$. Two seconds later after it passes through the center of oscillation its velocity is found to be $2m / s$. Find the amplitude.

Watch Video Solution

**22.** A simple pendulum consists of a small sphere of mass $m$ suspended by a thread of length $l$. the sphere carries a positive charge $q$. The pendulum is placed in a uniform electric field of strength $E$ directed vertically upwards. With what period will the pendulum oscillate if the electrostatic force acting on the sphere is less than the gravitational force?

A. $2\pi\sqrt{\dfrac{l}{g-\frac{qE}{m}}}$

B. $\pi\sqrt{\dfrac{l}{g-\frac{qE}{m}}}$

C. $2\pi\sqrt{\dfrac{l}{g-\frac{2qE}{m}}}$

D. $4\pi\sqrt{\dfrac{l}{g-\frac{qE}{m}}}$

**Answer: B**

Watch Video Solution

**23.** Find the period of oscillation of a pendulum of length $l$ if its point of suspension is

(a) moving vertically up with acceleration $a$

(b) moving vertically down with acceleration $a( < g)$

(c) failing freely under gravity

moving horizontal with acceleration $a$.

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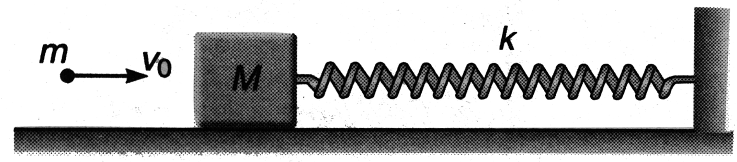
**24.** A block with mass $M$ attached to a horizontal spring with force constant $k$ is moving with simple harmonic motion having amplitude $A_1$. At the instant when the block passes through its equilibrium position a lump of putty with mass $m$ is dropped vertically on the block from a very small height and sticks to it.

(a) Find the new amplitude and period.

(b) Repeat part (a) for the case in which the putty is dropped on the block when it is at one end of its path.



**25.** A bullet of mass $m$ strikes a block of mass $M$. The bullet remains embedded in the block. Find the amplitude of the resulting SHM.

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26. An annular ring of internal and outer radii $r$ and $R$ respectively oscillates in a vertical plane about a horizontal axis perpendicular to its plane and passing through a point on its outer edge. Calculate its time period and show that the length of an equivalent simple pendulum is $\frac{3R}{2}$ as $r \rightarrow 0$ and $2R$ as $r \rightarrow R$.

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**27.** A body of mass $200g$ oscillates about a horizontal axis at a distance of $20cm$ from its centre of gravity . If the length of the equivalent simple pendulum is $35cm$, find its moment of inertia about the point of suspension.

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**28.** Show that the period of oscillation of simple pendulum at depth $h$ below earth's surface is inversely proportional to $\sqrt{R-h}$ , where $R$ is the radius of earth. Find out the time period of a second pendulum at a depth $R/2$ from the earth's surface ?

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29. The period of a particle in SHM is $8s$. At $t = 0$ it is in its equilibrium position.

(a) Compare the distance travelled in the first $4s$ and the second $4s$.

(b) Compare the distance travelled in the first $2s$ and the second $2s$.

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30. (a) The motion of the particle in simple harmonic motion is given by $x = a \sin \omega t$. If its speed is $u$, when the displacement is $x_1$ and speed is $v$, when the displacement is $x_2$, show that the amplitude of the

motion is

$$A = \left[\frac{v^2 x_1^2 - u^2 x_2^2}{v^2 - u^2}\right]^{1/2}$$

(b) A particle is moving with simple harmonic motion is a straight line. When the distance of the particle from the equilibrium position has the values $x_1$ and $x_2$ the corresponding values of velocity are $u_1$ and $u_2$, show that the period is

$$T = 2\pi\left[\frac{x_2^2 - x_1^2}{u_1^2 - u_2^2}\right]^{1/2}$$

Watch Video Solution

**31.** Show that the combined spring energy and gravitational energy for a mass $m$ hanging from a light spring of force constant $k$ can be expressed as

$U_0 + \frac{1}{2}ky^2$, where $y$ is the distance above or below the equilibrium position and $U_0$ is constant.

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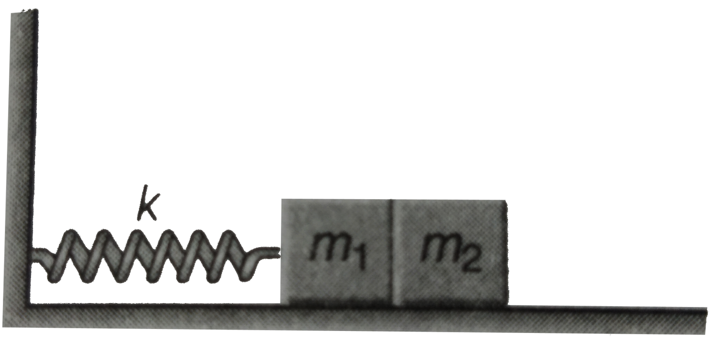
32. The masses in figure slide on a frictionless table. $m_1$ but not $m_2$, is fastened to the spring. If now $m_1$ and $m_2$ are pushed to the left , so that the spring is compressed a distance $d$, what will be the amplitude of the oscillation of $m_1$ after the spring system is released ?

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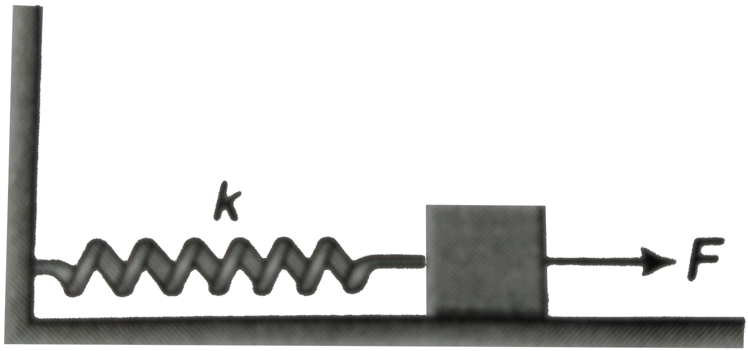
**33.** The spring shown in figure is unstretched when a man starts pulling on the cord. The mass of the block is $M$. If the man exerts a constant force $F$, find




(a) the amplitude and the time period of the motion of the block,

(b) the energy stored in the spring when the block passes through the equilibrium position and

(c) the kinetic energy of the block at this position.

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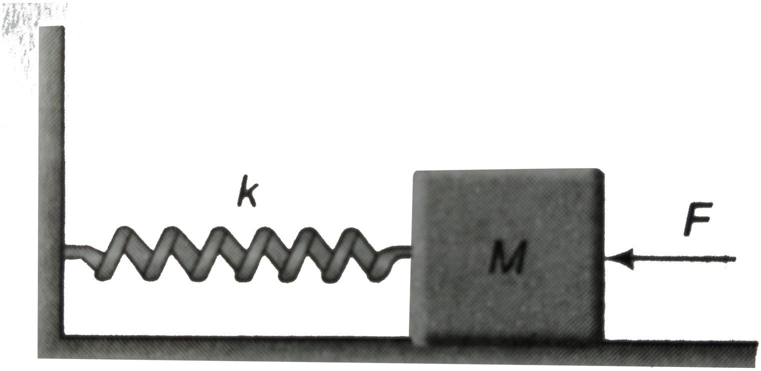
**34.** In figure, $k = 100N/m$, $M = 1kg$ and $F = 10N$




(a) Find the compression of the spring in the equilibrium position

(b) A sharp blow by some external agent imparts a speed of $2m/s$ to the block towards left. Find the sum of the potential energy of the spring and the kinetic energy of the block at this instant.

(c) Find the time period of the resulting simple harmonic motion.

(d) Find the amplitude.

(e) Write the potential energy of the spring when the block is at the left estreme.

(f) Write the potential energy of the spring when the block is at the right extreme.

The answers of (b), (e) and (f) are different. Explain why this does not violate the principle of conservation of energy ?

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**35.** Pendulum $A$ is a physical pendulum made from a thin, rigid and uniform rod whose length is $d$. One end of this rod is attached to the ceiling by a frictionless hinge, so that the rod is free to swing back and forth.

Pendulum $B$ is a simple pendulum whose length is also $d$. Obtain the ratio $\frac{T_A}{T_B}$ of their periods for small angle oscillations.

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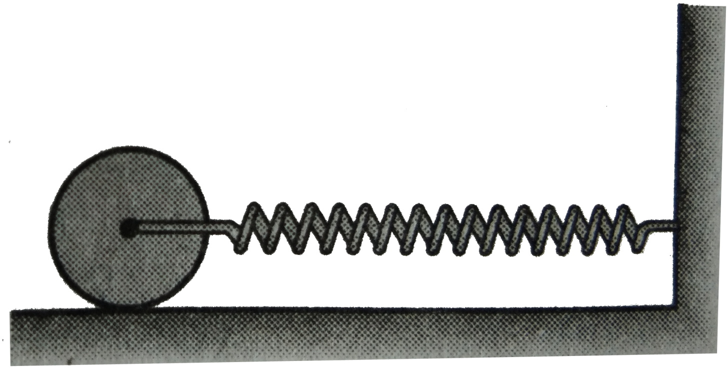
**36.** A solid cylinder of mass $m$ is attached to a horizontal spring with force constant $k$. The cylinder can roll without slipping along the horizontal plane. (See the accompanying figure.) Show that the center of mass of the cylinder executes simple harmonic motion with a period $T = 2\pi\sqrt{\frac{3m}{2k}}$, if displaced from mean position.



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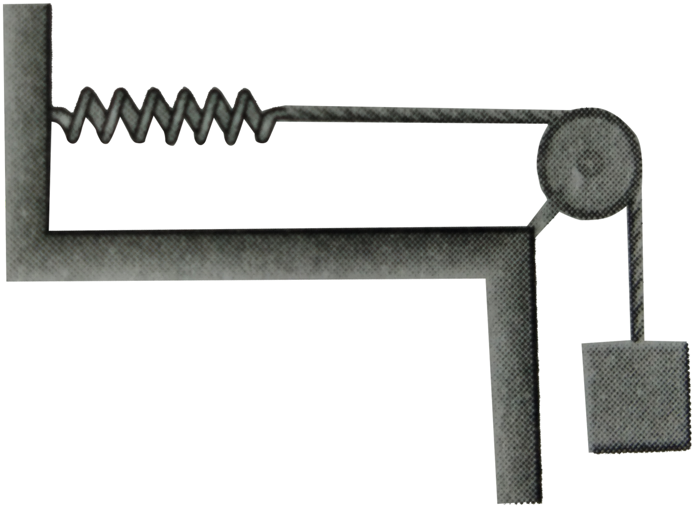
**37.** A cord is attached between a 0.50 kg block and a string with force constant $k = 20N/m$.The other end of the spring is attrached to the wall and the cord is placed over a pulley $(I = 0.60MR^2)$ of mass 5.0 kg and radius 0.50 m.(See the accompanying figure.) Assuming no slipping occurs what is the frequency of the oscillations when the body is set into motion ?



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**38.** Two linear SHM of equal amplitudes $A$ and frequencies $\omega$ and $2\omega$ are impressed on a particle along $x$ and $y-axes$ respectively. If the initial phase difference between them is $\pi/2$. Find the resultant path followed by the particle.

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**39.** A particle is subjected to two simple harmonic motions given by

$x_1 = 2.0\sin(100\pi t)$ and $x_2 = 2.0\sin(120\pi t + \pi/3)$

where, $x$ is in $cm$ and $t$ in second. Find the displacement of the particle at

(a) $t = 0.0125$,

(b) $t = 0.025$.

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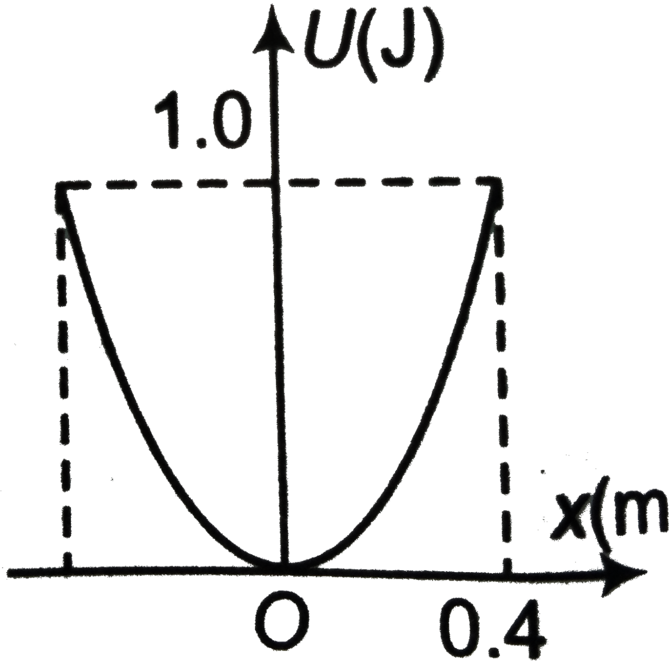
## Level 2 Single Correct

**1.** A particle of mass $2kg$ moves in simple harmonic motion and its potential energy $U$ varies with position $x$ as shown. The period of oscillation of the particle is




A. $\frac{2\pi}{5}s$

B. $2\frac{\sqrt{2\pi}}{5}s$

C. $\frac{\sqrt{2\pi}}{5}s$

D. $\frac{4\pi}{5}s$

**Answer: D**

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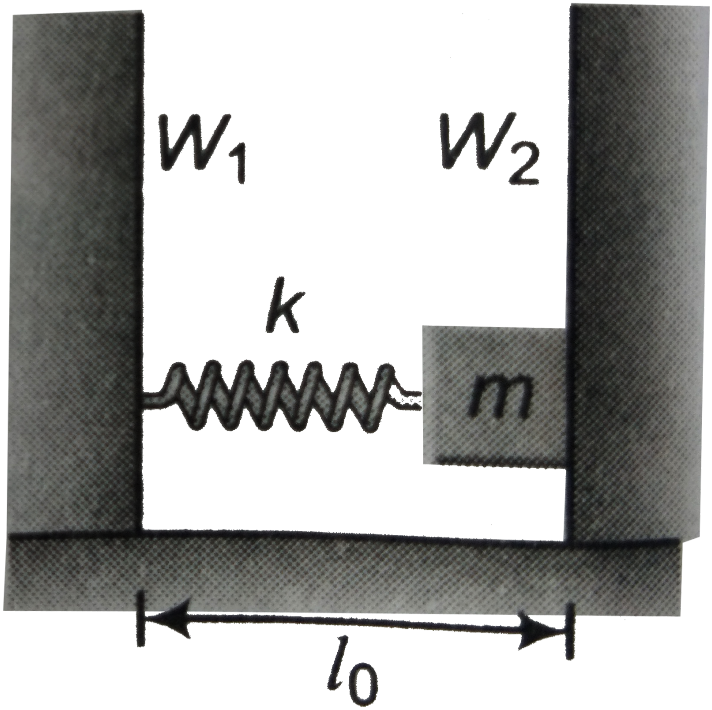
**2.** In the figure shown, a spring mass system is placed on a horizontal smooth surface in between two vertical rigid walls $W_1$ and $W_2$. One end of spring is fixed with wall $W_1$ and other end is attached with mass $m$ which is free to move. Initially, spring is tension free and having natural length $l_0$. Mass $m$ is compressed through a distance a and released. Taking the collision between wall $W_2$ and mass $m$ as elastic and $K$ as spring constant, the average force exerted by mass $m$ on wall $W_2$ in one oscillation of block is




A. (a) $\frac{2aK}{\pi}$

B. (b) $\frac{2ma}{\pi}$

C. (c) $\frac{aK}{\pi}$

D. $(d) \frac{2aK}{m}$

**Answer: A**

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**3.** Two simple harmonic motion are represrnted by the following equation $y_1 = 40 \sin \omega t$ and $y_2 = 10(\sin \omega t + c \cos \omega t)$. If their displacement amplitudes are equal, then the value of $c$ (in appropriate units) is

A. $\sqrt{13}$

B. $\sqrt{15}$

C. $\sqrt{17}$

D. $4$

**Answer: B**

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**4.** A particle executes simple harmonic motion with frequqncy $2.5Hz$ and amplitude $2m$. The speed of the particle $0.3s$ after crossing, the equilibrium position is

A. zero

B. $2\pi m/s$

C. $4\pi m/s$

D. $\pi m/s$

**Answer: A**

Watch Video Solution

**5.** A particle oscillates simple harmonic motion with a period of $16s$. Two second after crossing the equilibrium position its velocity becomes $1m/s$. The amplitude is

A. $\frac{\pi}{4}m$

B. $8\frac{\sqrt{2}}{\pi}m$

C. $\frac{8}{\pi}m$

D. $4\frac{\sqrt{2}}{\pi}m$

**Answer: B**

Watch Video Solution

**6.** A seconds pendulum is suspended from the ceiling of a trolley moving horizontally with an acceleration of $4m/s^2$ . Its period of oscillation is

A. $(a)1.90s$

B. $(b)1.70s$

C. $(c)2.30s$

D. $(d)1.40s$

**Answer: A**

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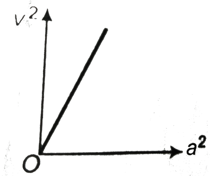
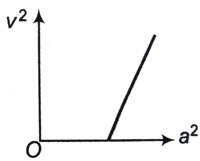
**7.** A particle is performing a linear simple harmonic motion. If the instantaneous acceleration and velocity of the particle are $a$ and $v$ respectively, identify the graph which correctly represents the relation between $a$ and $v$.

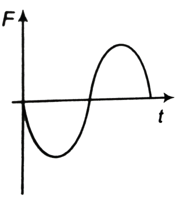
A. (a)



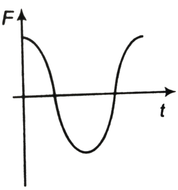

B. (b)




C. (c)




D. (d)



**Answer: C**

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**8.** In a vertical $U$ - tube a column of mercury oscillates simple harmonically. If the tube contains $1kg$ of mercury and $1cm$ of mercury column weighs $20g$, then the period of oscillation is

A. $1s$

B. $2s$

C. $\sqrt{2}s$

D. Insufficient data

**Answer: A**

Watch Video Solution

**9.** A solid cube of side a and density $\rho_0$ floats on the surface of a liquid of density $\rho$. If the cube is slightly pushed downward, then it oscillates simple harmonically with a period of

A. (a)$2\pi\sqrt{\frac{\rho_0}{\rho}\frac{a}{g}}$

B. (b)$2\pi\sqrt{\frac{\rho}{\rho_0}\frac{a}{g}}$

C. (c)$2\pi\sqrt{\frac{a}{\left(1-\frac{\rho}{\rho_0}\right)g}}$

D. (d)$2\pi\sqrt{\frac{a}{\left(1+\frac{\rho}{\rho_0}\right)g}}$

**Answer: A**

Watch Video Solution

**10.** A uniform stick of length $l$ is mounted so as to rotate about a horizontal axis perpendicular to the stick and at a distance $d$ from the centre of mass. The time period of small oscillation has a minimum value when $d/l$ is

A. $(a)\frac{1}{\sqrt{2}}$

B. $(b)\frac{1}{\sqrt{12}}$

C. $(c)\frac{1}{\sqrt{3}}$

D. $(d)\frac{1}{\sqrt{6}}$

**Answer: B**

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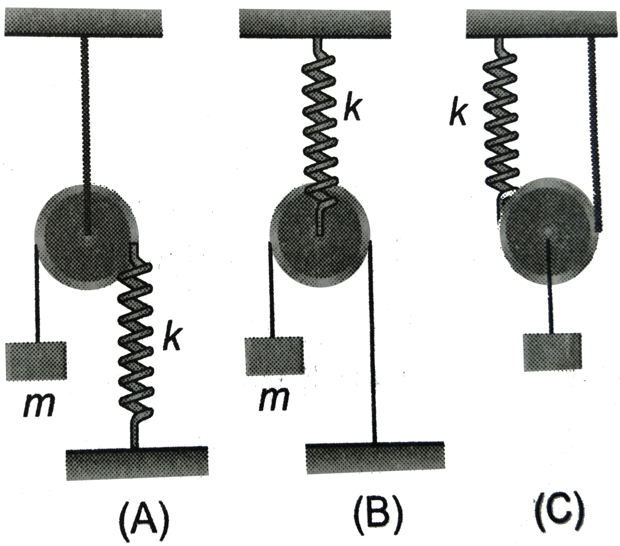
**11.** Three arrangements of spring - mass system are shown in figures (A), (B) and ( C). If $T_1$, $T_2$ and $T_3$ represent the respective periods of oscillation, then correct relation is



A. $T_1 > T_2 > T_3$

B. $T_3 > T_2 > T_1$

C. $T_2 > T_1 > T_3$

D. $T_2 > T_3 > T_1$

**Answer: C**

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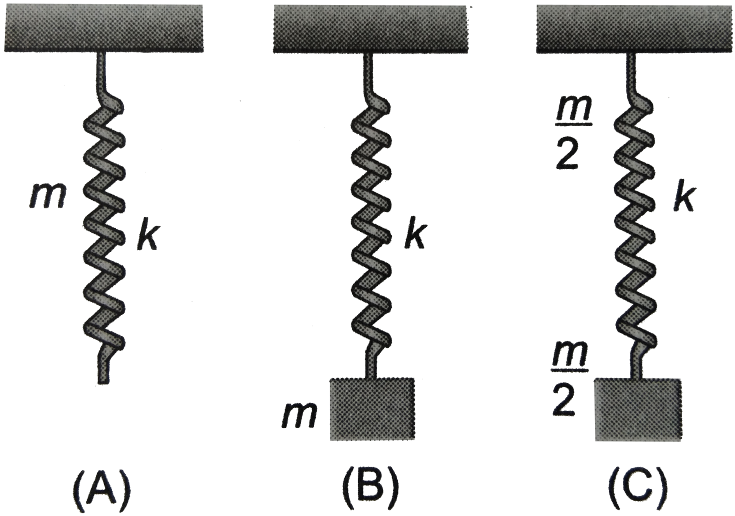
12. Three arrangements are shown in figure.




(a) A spring of mass $m$ and stiffness $k$

(b) A block of mass $m$ attached to massless spring of stiffness $k$

( c) A block of mass $\frac{m}{2}$ attached to a spring of mass $\frac{m}{2}$ and stiffness $k$

If $T_1, T_2$ and $T_3$ represent the period of oscillation in the three cases respectively, then identify the correct relation.

A. $T_1 < T_2 < T_3$

B. $T_1 < T_3 < T_2$

C. $T_1 > T_3 > T_2$

D. $T_3 < T_1 < T_2$

**Answer: B**

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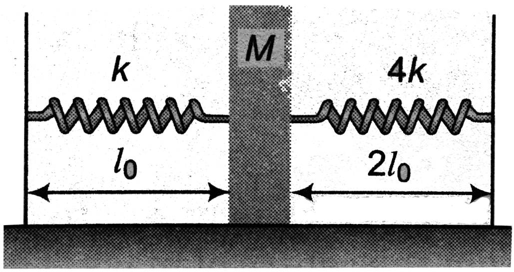
**13.** A block of mass $M$ is kept on a smooth surface and touches the two springs as shown in the figure but not attached to the springs. Initially springs are in their natural length. Now, the block is shifted $(l_0 / 2)$ from the given position in such a way that it compresses a spring and released. The time - period of oscillation of mass will be




A. $\frac{\pi}{2}\sqrt{\frac{M}{k}}$

B. $2\pi\sqrt{\frac{M}{5k}}$

C. $\frac{3\pi}{2}\sqrt{\frac{M}{k}}$

D. $\pi\sqrt{\frac{M}{2k}}$

**Answer: C**

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**14.** A particle moving on x - axis has potential energy $U = 2 - 20x + 5x^2$ joule along x - axis. The particle is relesed at $x = -3$. The maximum value of $x$ will be ($x$ is in metre)

A. $5m$

B. $3m$

C. $7m$

D. $8m$

**Answer: C**

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**15.** A block of mass $m$, when attached to a uniform ideal apring with force constant $k$ and free length $L$ executes SHM. The spring is then cut in two pieces, one with free length n $L$ and other with free length $(1-n)L$. The block is also divided in the same fraction. The smaller part of the block attached to longer part of the spring executes SHM with frequency $f_1$ . The bigger part of the block attached to smaller part of the spring executes SHM with frequency $f_2$. The ratio $f_1 / f_2$ is

A. $1$

B. $\frac{n}{1-n}$

C. $\frac{1+n}{n}$

D. $\frac{n}{1+n}$

**Answer: A**

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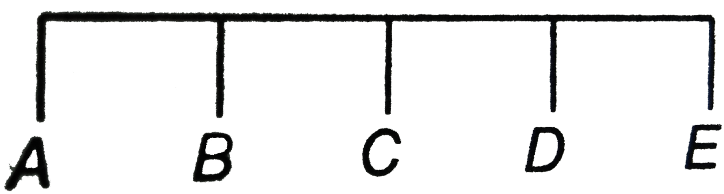
**16.** A body performs simple harmonic oscillations along the straight line $ABCDE$ with $C$ as the midpoint of $AE$. Its kinetic energies at $B$ and $D$ are each one fourth of its maximum value. If $AE = 2R$, the distance between $B$ and $D$ is



A. $\frac{\sqrt{3}}{2}R$

B. $\frac{R}{\sqrt{2}}$

C. $\sqrt{3}R$

D. $\sqrt{2}R$

**Answer: C**

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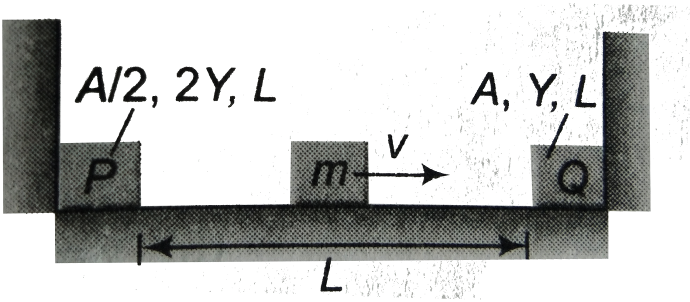
**17.** In the given figure, two elastic rods P and Q are rigidly joined to end supports. A small mass m is moving with velocity v between the rods. All collisions are assumed to be elastic and the surface is given to be smooth. The time period of small mass m will be (A=area of cross section, Y=Young's modulus, L=length of each rod)




A. $\dfrac{2L}{v} + 2\pi\sqrt{\dfrac{mL}{AY}}$

B. $\dfrac{2L}{v} + 2\pi\sqrt{\dfrac{2mL}{AY}}$

C. $\dfrac{2L}{v} + \pi\sqrt{\dfrac{mL}{AY}}$

D. $\dfrac{2L}{v}$

**Answer: A**

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**18.** A particle executes SHM of period $1.2s$ and amplitude $8cm$. Find the time it takes to travel $3cm$ from the positive extremity of its oscillation. $\left[\cos^{-1}(5/8) = 0.9rad\right]$

A. $0.28s$

B. $0.32s$

C. $0.17s$

D. $0.42s$

**Answer: C**

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**19.** A wire frame in the shape of an equilateral triangle is hinged at one vertex so that it can swing freely in a vertical plane, with the plane of the $\Delta$ always remaining vertical. The side of the frame is $1/\sqrt{3}m$. The time period in seconds of small oscillations of the frame will be-

A. $\pi/\sqrt{2}$

B. $\pi/\sqrt{3}$

C. $\pi/\sqrt{6}$

D. $\pi/\sqrt{5}$

**Answer: D**

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**20.** A particle moves along the x - axis according to $x = A[1 + \sin \omega t]$. What distance does is travel in time interval from $t = 0$ to $t = 2.5\pi / \omega$?

A. $4A$

B. $6A$

C. $5A$

D. $3A$

**Answer: C**

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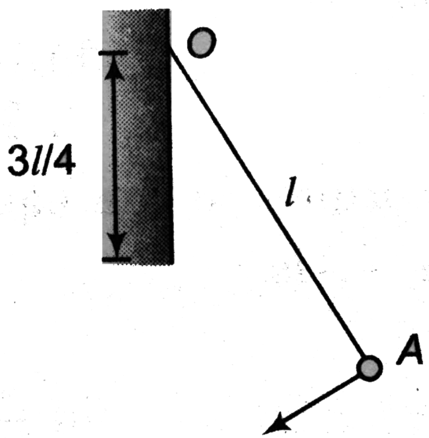
**21.** A small bob attached to a light inextensible thread of length $l$ has a periodic time $T$ when allowed to vibrate as a simple pendulum. The thread is now suspended from a fixed end $O$ of a vertical rigid rod of length $3l/4$. If now the pendulum performs periodic oscillations in this arrangement, the periodic time will be




A. $3T/4$

B. $4T/5$

C. $2T/3$

D. $5T/6$

**Answer: A**

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**22.** A stone is swinging in a horizontal circle of diameter $0.8m$ at $30rev/\min$. A distant light causes a shadow of the stone on a nearly wall. The amplitude and period of the SHM for the shadow of the stone are

A. $0.4m, 4s$

B. $0.2m, 2s$

C. $0.4m, 2s$

D. $0.8m, 2s$

**Answer: C**

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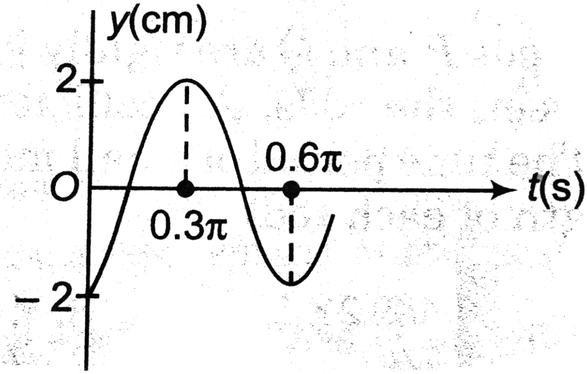
**23.** Part of SHM is graphed in the figure. Here, $y$ is displacement from mean position. The correct equation describing the SHM is




A. $y = 4\cos(0.6t)$

B. $y = 2\sin\left(\frac{10}{3}t - \frac{\pi}{2}\right)$

C. $y = 2\sin\left(\frac{\pi}{2} - \frac{10}{3}t\right)$

D. $y = 2\cos\left(0.6t + \frac{\pi}{2}\right)$

**Answer: B**

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**24.** A particle performs SHM with a period $T$ and amplitude a. The mean velocity of particle over the time interval during which it travels $a/2$ from the extreme position is

A. $6a/T$

B. $2a/T$

C. $3a/T$

D. $a/2T$

**Answer: C**

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**25.** A man of mass $60kg$ is standing on a platform executing SHM in the vertical plane. The displacement from the mean position varies as $y = 0.5\sin(2\pi ft)$. The value of $f$, for which the man will feel weightlessness at the highest point, is ($y$ in metre)

A. $g/4\pi$

B. $4\pi g$

C. $\frac{\sqrt{2g}}{2\pi}$

D. $2\pi\sqrt{2g}$

**Answer: C**

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**26.** A particle performs SHM on a straight line with time period $T$ and amplitude$A$. The average speed of the particle between two successive instants, when potential energy and kinetic energy become same is

A. $\frac{A}{T}$

B. $\frac{4\sqrt{2}A}{T}$

C. $\frac{2A}{T}$

D. $\frac{2\sqrt{2}A}{T}$

**Answer: B**

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**27.** The time taken by a particle performing SHM to pass from point $A$ to $B$ where its velocities are same is $2s$. After another $2s$ it returns to $B$. The ratio of distance $OB$ to its a amplitude (where $O$ is the mean position) is

A. $1 : \sqrt{2}$

B. $(\sqrt{2} - 1) : 1$

C. $1 : 2$

D. $1 : 2\sqrt{2}$

**Answer: A**

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**28.** A particle is executing SHM according to the equation $x = A\cos\omega t$. Average speed of the particle during the interval $0 \le t \le \frac{\pi}{6\omega}$ is

A. $\frac{\sqrt{3}A\omega}{2}$

B. $\frac{\sqrt{3}A\omega}{4}$

C. $\frac{3A\omega}{\pi}$

D. $\frac{3A\omega}{\pi}(2-\sqrt{3})$

**Answer: D**

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## Level 2 More Than One Correct

**1.** A simple pendulum with a bob of mass $m$ is suspended from the roof of a car moving with horizontal acceleration a

A. The string makes an angle of $\tan^{-1}(a/g)$ with the vertical

B. The string makes an angle of $\sin^{-1}\left(\frac{a}{g}\right)$ with the vertical

C. The tension in the string is $m\sqrt{a^2+g^2}$

D. The tension in the string is $m\sqrt{g^2-a^2}$

**Answer: A::C**

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**2.** A particle starts from a point $P$ at a distance of $A/2$ from the mean position $O$ and travels towards left as shown in the figure. If the time period of SHM, executed about $O$ is $T$ and amplitude $A$ then the equation of the motion of particle is

A. $x = A\sin\left(\frac{2\pi}{T}t + \frac{\pi}{6}\right)$

B. $x = A\sin\left(\frac{2\pi}{T}t + \frac{5\pi}{6}\right)$

C. $x = A\cos\left(\frac{2\pi}{T}t + \frac{\pi}{6}\right)$

D. $x = A\cos\left(\frac{2\pi}{T}t + \frac{\pi}{3}\right)$

**Answer: B::D**

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**3.** A spring has natural length $40cm$ and spring constant $500N/m$. A block of mass $1kg$ is attached at one end of the spring and other end of the spring is attached to a ceiling. The block is relesed from the position, where the spring has length $45cm$.

A. the block will perform SHM of amplitude $5cm$

B. the block will have maximum velocity $30\sqrt{5}cm/s$

C. the block will have maximum acceleration $15m/s^2$

D. the minimum elastic potential energy of the spring will be zero

**Answer: B::C::D**

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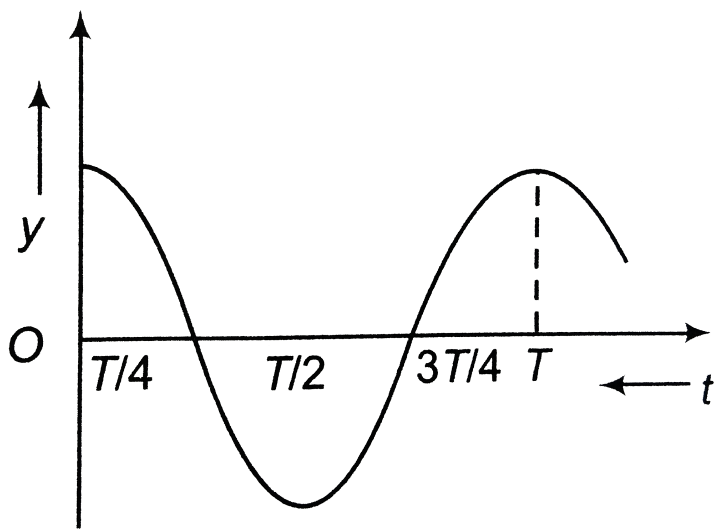
**4.** The displacement - time graph of a particle executing SHM is shown in figure. Which of the following statements is//are true ?




A. (a)The velocity is maximum at $t = T/2$

B. (b)The acceleration is maximum at $t = T$

C. (c)The force is zero at $t = 3T/4$

D. (d)The kinetic energy equals the total oscillation energy at $t = T/2$

**Answer: B::C**

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**5.** For a particle executing SHM, x = displacement from mean position, v = velocity and a = acceleration at any instant, then

A. $(a) v - x$ graph is a circle

B. $(b) v - x$ graph is an ellipse

C. $(c)a - x$ graph is a straight line

D. $(d)a - x$ graph is a circle

**Answer: B::C**

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**6.** The acceleration of a particle is $a = -100x + 50$. It is released from $x = 2$. Here, $a$ and $x$ are in SI units

A. (a)the particle will perform SHM of amplitude $2m$

B. (b)the particle will perform SHM of amplitude $1.5m$

C. (c)the particle will perform SHM of time period $0.63s$

D. (d)the particle will have a maximum velocity of $15m / s$

**Answer: B::C::D**

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**7.** Two particles are performing SHM in same phase. It means that

A. the two partcles must have same distance from the mean posotion simultaneously

B. two particle may have same distance from the mean position simultaneously

C. the two particles must have maximum speed simultaneously

D. the two particles may have maximum speed simultaneously

**Answer: B::C**

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**8.** A particle moves along y - axis according to the equation $y(\text{in cm}) = 3\sin 100\pi t + 8\sin^2 50\pi t - 6$

A. the particle perform SHM

B. the amplitude of the particle's oscillation is $5cm$

C. the mean position of the particle is at $y = -2cm$

D. the particle does not perform SHM

**Answer: A::B::C**

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## Level 2 Comprehension

**1.** A $2kg$ block hangs without vibrating at the bottom end of a spring with a force constant of $400N/m$. The top end of the spring is attached to the ceiling of an elevator car. The car is rising with an upward acceleration of $5m/s^2$ when the acceleration suddenly ceases at time $t=0$ and the car moves upward with constant speed $(g=10m/s^2)$

What is the angular frequencyof the block after the acceleration ceases ?

A. $10\sqrt{2}rad/s$

B. $20rad/s$

C. $20\sqrt{2}rad/s$

D. $32rad/s$

**Answer: A**

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**2.** A $2kg$ block hangs without vibrating at the bottom end of a spring with a force constant of $400N / m$. The top end of the spring is attached to the ceiling of an elevator car. The car is rising with an upward acceleration of $5m / s^2$ when the acceleration suddenly ceases at time $t = 0$ and the car moves upward with constant speed $(g = 10m / s^2$

The amplitude of the oscillation is

A. $(a) 7.5cm$

B. $(b) 5cm$

C. $(c) 2.5cm$

D. $(d) 1cm$

**Answer: C**

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## Level 2 Subjective

**1.** A $1kg$ block is executing simple harmonic motion of amplitude $0.1m$ on a smooth horizontal surface under the restoring force of a spring of spring constant $100N/m$. A block of mass $3kg$ is gently placed on it at the instant it passes through the mean position. Assuming that the two blocks move together. Find the frequency and the amplitude of the motion.

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**2.** Two particles are in SHM along same line. Time period of each is $T$ and amplitude is $A$. After how much time will they collide if at time $t=0$. (a) first particle is at $x_1 = +\frac{A}{2}$ and moving towards positive x - axis and second particle is at $x_2 = -\frac{A}{\sqrt{2}}$ and moving towards negative x - axis, (b) rest information are same as mentioned in part (a) except that particle first is also moving towards negative x - axis.

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**3.** A particle that hangs from a spring oscillates with an angular frequency of $2 rad/s$. The spring particle system is suspended from the celling of an elevator car and hangs motionless (relative to the elevator car) as the car descends at a constant speed of $1.5m/s$. The car then stops suddenly. (a) With what amplitude does the particle oscillate ? (b) What is the equation of motion for the particle ? (Choose upward as the position direction)

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**4.** A $2kg$ mass is attached to a spring of force constant $600N/m$ and rests on a smooth horizontal surface. A second mass of $1kg$ slides along the surface toward the first at $6m/s$.

(a) Find the amplitude of oscillation if the masses make a perfectly inelastic collision and remain together on the spring. what is the period of oscillation ?

(b) Find the amplitude and period of oscillation if the collision is perfectly elastic.

( c) For each case , write down the position $x$ as a function of time $t$ for the mass attached to the spring, assuming that the collision occurs at time $t = 0$. What is the impulse given to the `2kg mass in each case ?

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5. A block of mass $4kg$ hangs from a spring of force constant $k = 400N/m$. The block is pulled down $15cm$ below equilibrium and relesed. How long does it take

block to go from $12cm$ below equilibrium (on the way up) to $9cm$ above equilibrium ?

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**6.** A plank with a body of mass $m$ placed on it starts moving straight up according to the law $y = a(1 - \cos \omega t)$, where $y$ is the displacement from the initial position, $\omega = 11 rad / s$. Find

(a) The time independence of the force that the body exerts on the plank.

(b) The minimum amplitude of oscillations of the plank at which the body starts falling behind the plank.

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**7.** A particle of mass $m$ free to move in the $x - y$ plane is subjected to a force whose components are $F_x = -kx$ and $F_y = -ky$, where $k$ is a constant. The particle is released when $t = 0$ at the point $(2, 3)$. Prove that the subsequent motion is simple harmonic along the straight line $2y - 3x = 0$.

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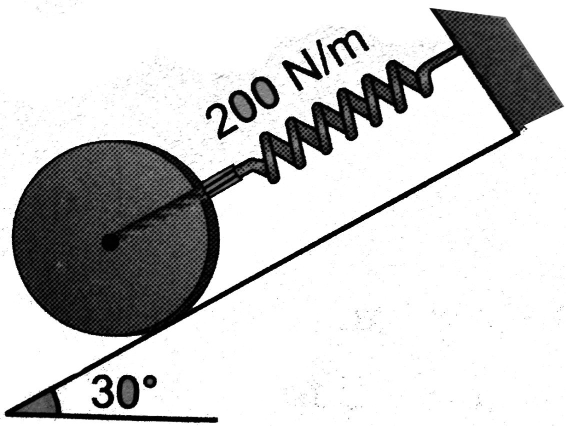
**8.** Determine the natural frequency of vibration of the $100N$ disk. Assume the disk does not slip on the inclined surface.

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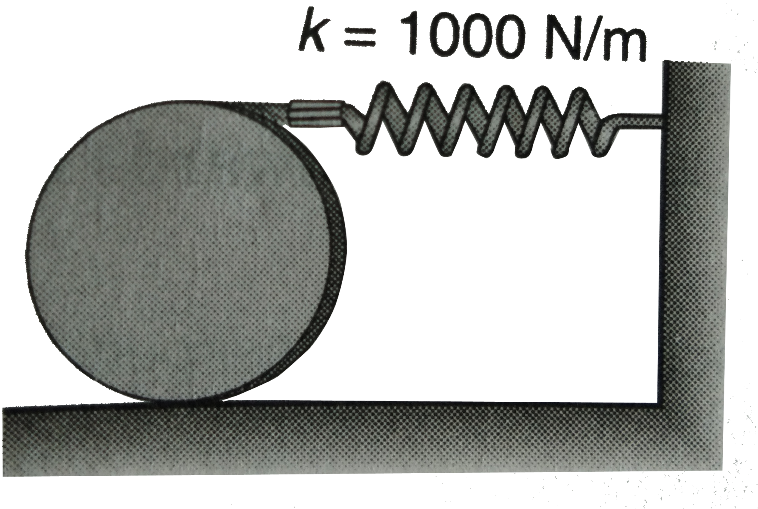
9. The disk has a weight of $100N$and rolls without slipping on the horizontal surface as it oscillates about its equilibrium position. If the disk is displaced, by rolling it counterclockwise $0.4rad$, determine the equation which describes its oscillatory motion when it is

released.

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10. A solid uniform cylinder of mass $m$ performs small oscillations due to the action of two springs of stiffness $k$ each (figure). Find the period of these oscillation in the absence of sliding.

$x$

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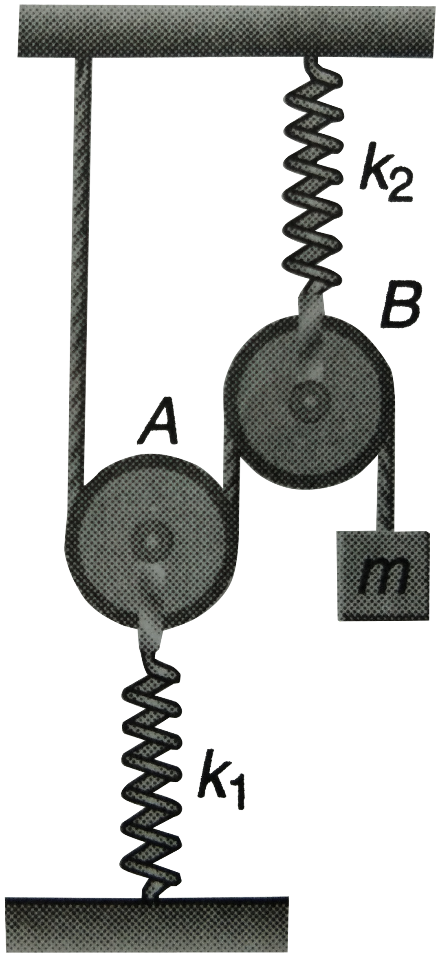
**11.** A block of mass $m$ is attached to one end of a light inextensible string passing over a smooth light pulley $B$ and under another smooth light pulley $A$ as shown in the figure. The other end of the string is fixed to a ceiling. $A$ and $B$ are held by spring of spring constants $k_1$ and $k_2$. Find angular frequency of small oscillations of small oscillations of the system.

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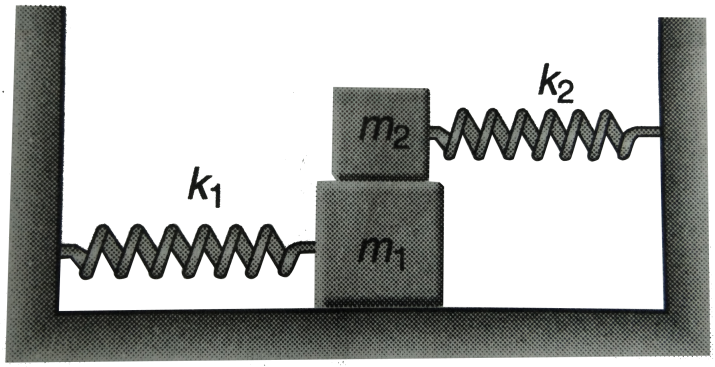
**12.** In the shown arrangement, both the spring are in their natural lengths. The coefficient of friction between $m_2$ and $m_1$ is $\mu$. There is no friction between $m_1$ and the surface. If the blocks are displaced slightly, they together perform simple harmonic motion. Obtain




(a) Frequency of such oscillations.

(b) The condition if the friction force on clock $m_2$ is to act in the direction of its displacement from mean position.

( c) If the condition obtained in (b) is met, what can be maximum of their oscillations ?

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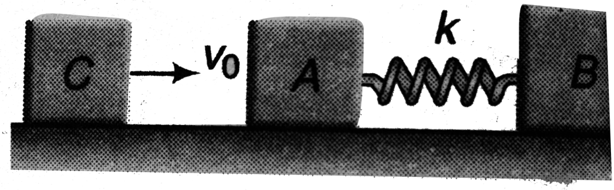
**13.** Two block $A$ and $B$ of masses $m_1 = 3kg$ and $m_2 = 6kg$ respectively are connected with each other by a spring of force constant $k = 200N/m$ as shown in figure. Blocks are pulled away from each other by $x_0 = 3cm$ and then released. When spring is in its natural length and block are moving towards each other, another block $C$ of mass $m = 3kg$ moving with velocity $v_0 = 0.4m/s$ (towards right) collides with $A$ and gets stuck to it. Neglecting friction, calculate




(a) velocity $v_1$ and $v_2$ of the blocks $A$ and $B$ respectively just before collision and their angular frequency .

(b) velocity of centre of mass of the system, after collision,

( c) amplitude of oscillation of combined body,

(d) loss of energy during collision.

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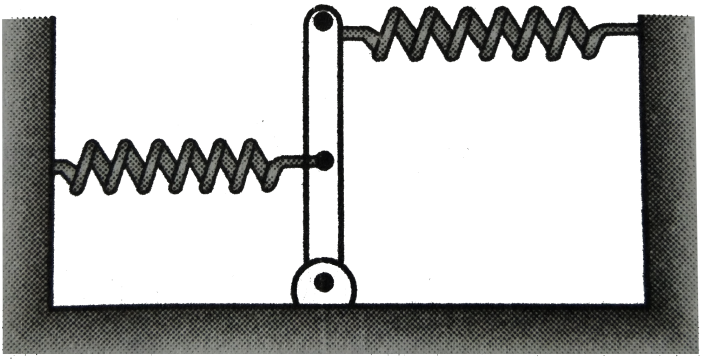
**14.** A rod of length $l$ and mass $m$, pivoted at one end, is held by a spring at its mid - point and a spring at far end. The spring have spring constant $k$. Find the frequency of small oscillations about the equilibrium position.



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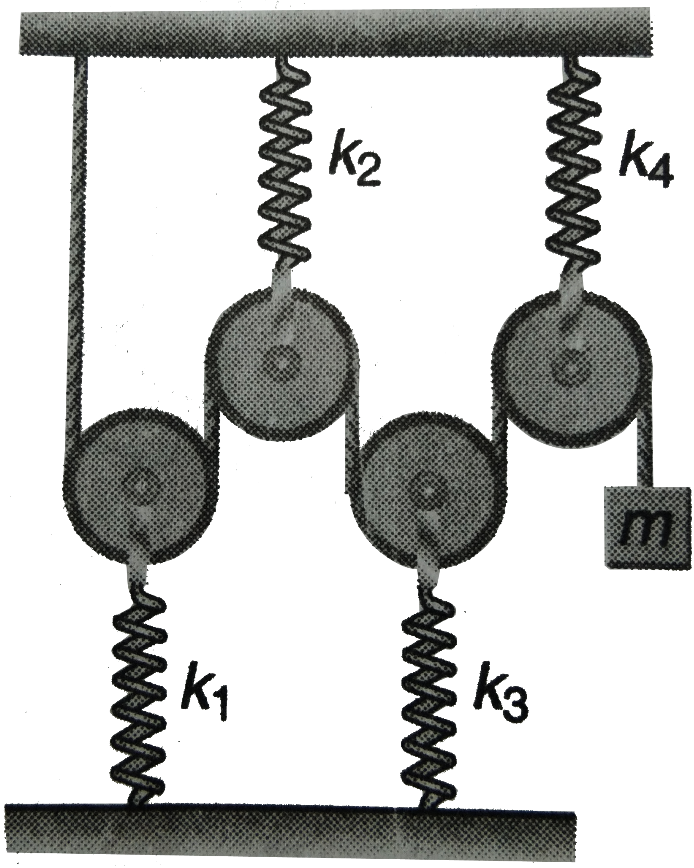
**15.** In the arrangement shown in figure, pulleys are light and spring are ideal. $K_1, k_2, k_3$and $k_4$ are force constant of the spring. Calculate period of small vertical oscillations of block of mass $m$.

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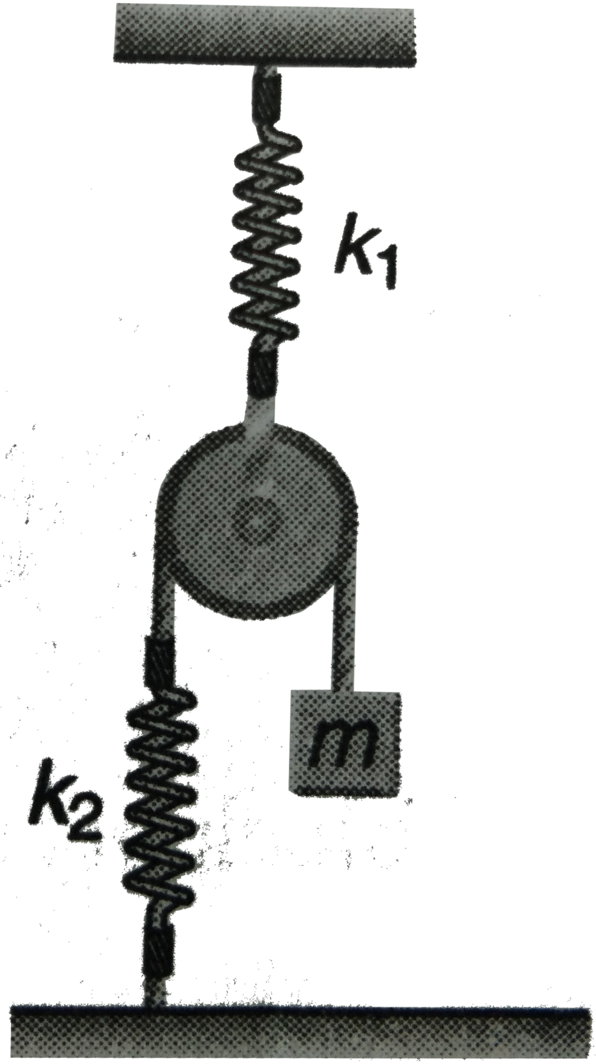
**16.** A light pulley is suspended at the lower end of a spring of constant $k_1$, as shown in figure. An inextensible string passes over the pulley. At one end of string a mass $m$ is suspended, the other end of the string is attached to another spring of constant $k_2$. The other ends of both the springs are attached to rigid supports, as shown. Neglecting masses of springs and any friction, find the time period of small oscillations of mass $m$

about equilibrium position.

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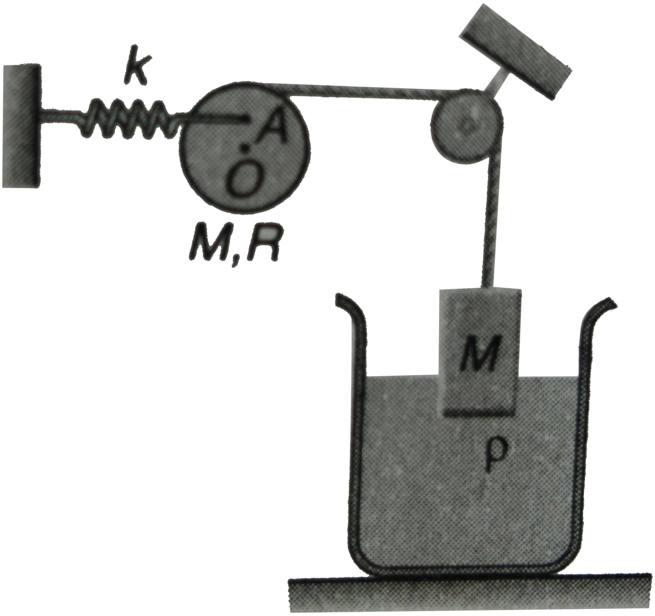
**17.** Figure shows a solid uniform cylinder of radius $R$ and mass $M$, which is free to rotate about a fixed horizontal axis $O$ and passes through centre of the cylinder. One end of an ideal spring of force constant $k$ is fixed and the other end is higed to the cylinder at $A$. Distance $OA$ is equal to $\frac{R}{2}$. An inextensible thread is wrapped round the cylinder and passes over a smooth, small pulley. A block of equal mass $M$ and having cross sectional area $A$ is suspended from free end of the thread. The block is partially immersed in a non-viscous liquid of density $\rho$.

If in equilibrium, spring is horizontal and line $OA$ is vertical, calculate frequency of small oscillations of the system.

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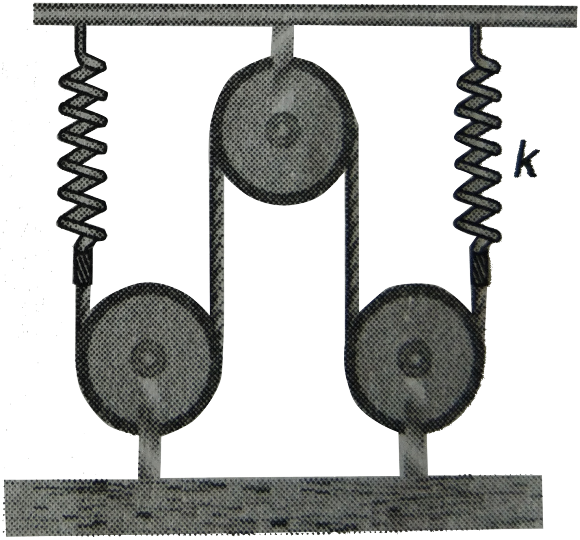
**18.** Find the natural frequency of the system shown in figure. The pulleys are smooth and massless.

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## Exercise 14.1

**1.** $a - x$ equation of a particle in SHM is $a + 4x = 0$

Here, $a$ is in $cm/s^2$ and $x$ in cm.Find time period in second.

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**2.** At $x = \frac{A}{4}$, what fraction of the mechanical energy is potential ? What fraction is kinetic ? Assume potential energy to be zero at mean position.

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**3.** A cart of mass $2.00kg$ is attached to the end of a horizontal spring with force constant $k = 150N/m$. The cart is displaced $15.0cm$ from its equilibrium position and released. What are

(a) the amplitude (b) the period ( c) the mechanical energy (e) the maximum velocity of the cart ? Neglect friction.

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**4.** A $0.5kg$ body performs simple harmonic motion with a frequency of $2Hz$ and an amplitude of $8mm$. Find the maximum velocity of the body, its maximum acceleration and the maximum restoring force to which the body is subjected.

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**5.** Can we use the equation $v = u +$ at in SHM or not ?

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## Intro. Exer.

1. A $2.0kg$ particle undergoes SHM according to $x = 1.5\cos\left(\frac{\pi t}{4} + \frac{\pi}{6}\right)$ (in SI .units)

(a) What is the total mechanical energy of the particle ?

(b) What is the shortest time required for the particle to move from $x = 0.5m$ to $x = -0.75m$ ?

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## Exercise 14.2

1. Given that the equation of motion of a mass is $x = 0.20 \sin(3.0t)m$ . Find the velocity and acceleration of the mass when the object is $5cm$ from its equilibrium position. Repeat for $x = 0$.

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2. A particle executes simple harmonic motion of amplitude $A$ along the x - axis. At $t = 0$, the position of the particle is $x = \frac{A}{2}$ and it moves along the positive x - direction. Find the phase constant $\delta$, if of the equation is written as $x = A \sin(\omega t + \delta)$.

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**3.** An object of mass $0.8kg$ is attached to one end of a spring and the system is set into simple harmonic motion. The displacement $x$ of the object as a fuction of time is shown in the figure. With the aid of the data, determine

(a) the amplitude $A$ of the motion,

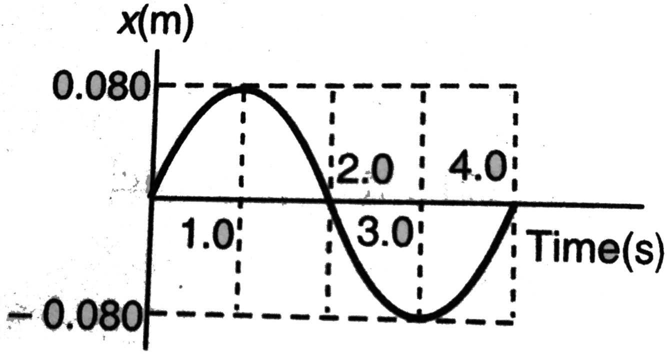
(b) the angular frequency $\omega$,

( c) the spring constant $K$,

(d) the speed of the object at $t = 1.0s$ and

(e) the magnitude of the object's acceleration at

$t = 1.0s.$

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**4.** The equation of motion of a particle started at t=0 is given by $x = 5\sin\left(20t + \frac{\pi}{3}\right)$, where x is in centimetre and t in second. When does the particle

a. first come rest

b. first have zero acceleration

c. first have maximum speed?

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**5.** Describe the motion corresponding to $x - t$ equation,

$x = 10 - 4\cos\omega t.$

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## Exercise 14.3

**1.** $a - x$ equation of a body in SHM is $a + 16x = 0$. Here, $x$ is in $cm$ and a in $cm/s^2$. Find time period of oscillations.

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**2.** $A$ mass $M$, attached to a spring, oscillates with a period of $2s$. If the mass is increased by $4kg$, the time period increases by one second. Assuming that Hooke's law is obeyed, find the initial mass $M$.

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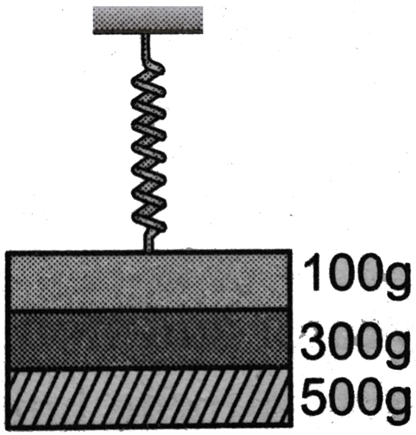
**3.** Three masses of $500g$, $300g$ and $100g$ are suspended at the end of a spring as shown and are in equilibrium. When the $500g$ mass is removed suddenly, the system oscillates with a period of $2s$. When the $300g$ mass is also removed, it will oscillate with period $T$. Find the value of $T$.

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**4.** A particle executes simple harmonic motion. Its instantaneous acceleration is given by $a = -px$, where $p$ is a positive constant and $x$ is the displacement from the mean position. Find angular frequency of oscillation.

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5. $A$ mass $M$ is suspended from a spring of negligible mass. The spring is pulled a little then released, so that the mass executes simple harmonic motion of time period $T$. If the mass is increased by $m$, the time period becomes $\frac{5T}{3}$. Find the ratio of $m/M$.

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6. The length of a simple pendulum is decreased by $21\%$. Find the percentage change in its time period.

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**7.** A particle executes SHM on a straight line path. The amplitude of oscillation is $2cm$. When the displacement of the particle from the mean position is $1cm$, the numerical value of magnitude of acceleration is equal to the mumerical value of velocity. Find the frequency of SHM (in $Hz$).

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## Exercise 14.4

**1.** A particle is subjected to two simple harmonic motions of the same frequency and direction. The amplitude of the first motion is $4.0cm$ and that of the second is $3.0cm$. Find the resultant amplitude if the phase difference between the two motion is

(a) $0^\circ$

(b) $60^\circ$

( c) $90^\circ$

(d) $180^\circ$

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**2.** A particle is subjected to two simple harmonic motions.

$x_1 = 4.0\sin(100\pi t)$ and $x_2 = 3.0\sin\left(100\pi t + \frac{\pi}{3}\right)$

Find

(a) the displacement at $t = 0$

(b) the maximum speed of the particle and

(c ) the maximum acceleration of the particle.

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**3.** Three simple harmonic motion of equal amplitudes $A$ and equal time periods in the same direction combine. The phase of the second motion is $60^\circ$ ahead of the first and the phase of the third motion is $60^\circ$ ahead of the second. Find the amplitude of the resultant motion.

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**4.** A particle is subjected to two simple harmonic motion in the same direction having equal amplitudes and equal frequency. If the resultant amplitude is equal to the amplitude of the individual motions. Find the phase difference between the individual motions.

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## Only one question is correct

**1.** A student says that he had applied a force $F = -k\sqrt{x}$ on a particle and the particle performs in simple harmonic motion. He refuses to tell whether k is a constant or not. Assume that he has worked only with positive x and no other force acted on the particle.

A. As X increases k increases

B. As X increases K decreases

C. As X increases k remains constant

D. The motion cannot be simple harmonic

**Answer: a**

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**2.** Equation of SHM is x=10sin10$\pi t$. Find the distance between the two points where speed is $50\pi$cm/s. x is in cm and t is in seconds.

A. 10cm

B. 14 cm

C. 17.32 cm

D. 8.66 cm

**Answer: c**

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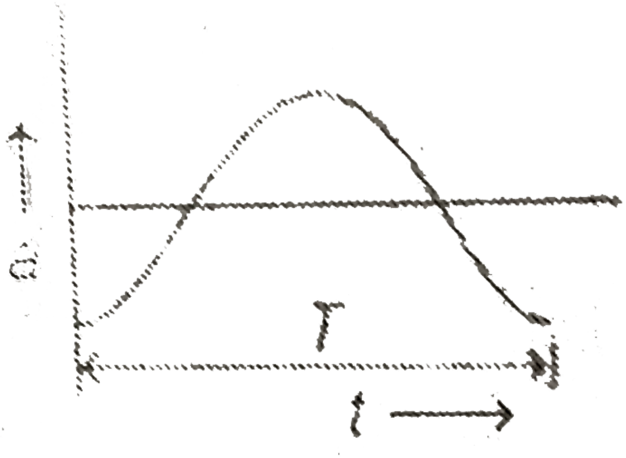
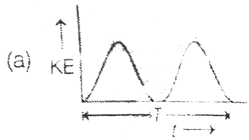
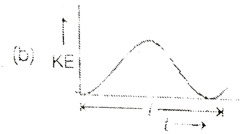
**3.** Acceleration versus time graph of a body in SHM is given by a curve shown below. T is the time period. Then corresponding graph between kinetic energy KE and time t is correctly represented by



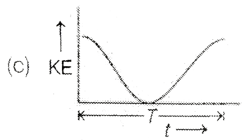

A.



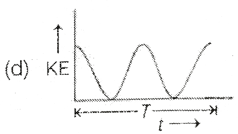

B.




C.




D.



**Answer: a**

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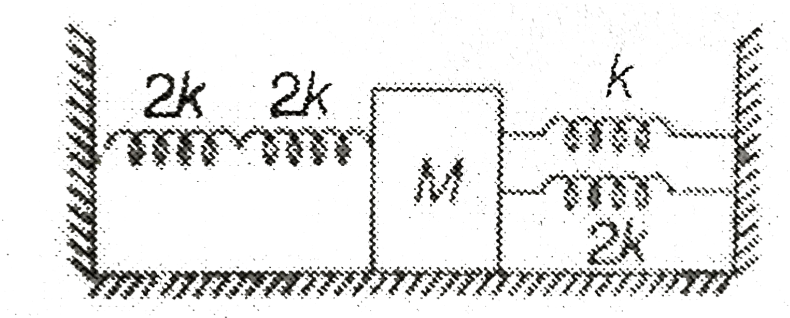
**4.** Four massless springs whose force constants are 2k, 2k, k and 2k respectively are attached to a mass M kept on a frictionless plane (as shown in figure). If the mass M is displaced in the horizontal direction.




A. $\frac{\frac{1}{2\pi}}{\sqrt{\frac{k}{4M}}}$

B. $\frac{1}{2\pi}\sqrt{\frac{4k}{M}}$

C. $\frac{1}{2\pi}\sqrt{\frac{k}{7M}}$

D. $\frac{1}{2\pi}\sqrt{\frac{7k}{M}}$

**Answer: B**

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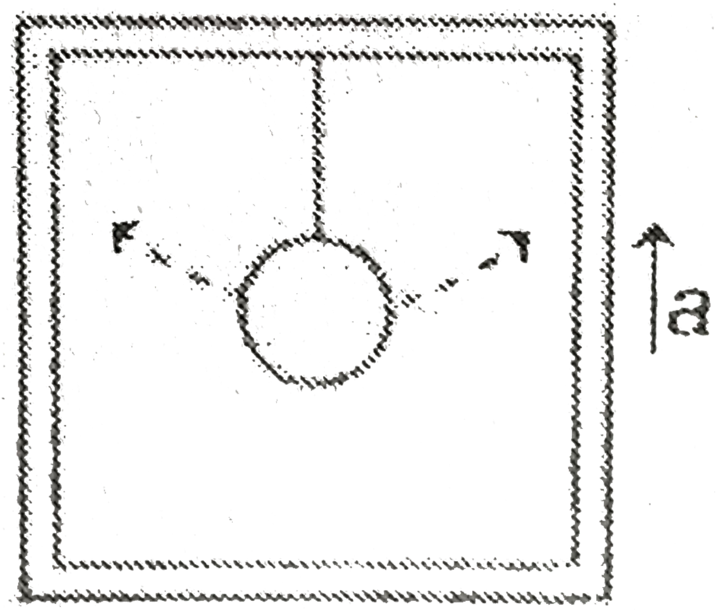
**5.** A scientist measures the time period of a simple pendulum as T in a lift at rest. If the lift moves up with accelerationi as one fourth of the acceleratioin of gravity, the new time period is




A. $\frac{T}{4}$

B. 4T

C. $\frac{2}{\sqrt{5}}$T

D. $\frac{\sqrt{5}}{2}T$

**Answer: C**

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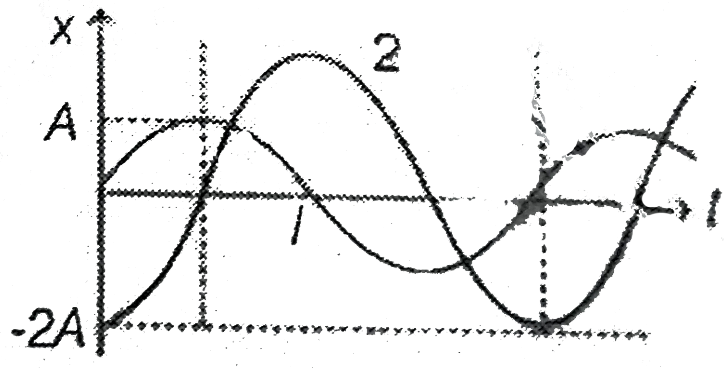
**6.** The osciallations represented by curve 1 in the graph are expressed by equation $x = A \sin \varepsilon t$. The equation for the oscillations represented by curve 2 is expressed as




A. $x = 2A \sin(\omega t - \pi / 2)$

B. $x = 2A \sin g(\omega t + \pi / 2)$

C. $x = \quad - 2A \sin(\omega t - \pi / 2)$

D. none of these

**Answer: A**

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**7.** A cuboidal piece of wood has dimensions a, b and c. its relatively density is d. it is floating in a large body of water such that side a is vertical. It is pushed down a bit and released. The time period of SHM executed by it is

A. $2\pi \frac{\sqrt{abc}}{g}$

B. $2\pi\sqrt{\frac{g}{da}}$

C. $2\pi\sqrt{\frac{bc}{dg}}$

D. $2\pi\sqrt{\frac{da}{g}}$

**Answer: D**

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**8.** The time taken by a particle performing SHM to pass from point A and B where it is velocities are same is 2s. After another 2 s it returns to B. The time period oscillation is (in seconds)

A. 2

B. 8

C. 6

D. 4

**Answer: B**

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**9.** Two particles undergo SHM along parallel lines with the same time period (T) and equal amplitudes. At particular instant, one particle is at its extreme position while the other is at its mean position. The move in the same direction. They will cross each other after a further time.

A. $T/2$

B. $3T/8$

C. $T/6$

D. $3T/4$

**Answer: B**

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**10.** A particle performing SHM is found at its equilibrium position at t = 1s and it is found to have a speed 0.25 = m//s at t=2s. If the period of oscillation is 6. Calculate amplitude of oscillation.

A. $\frac{3}{2\pi}m$

B. $\frac{3}{4\pi}m$

C. $\frac{6}{\pi}$m

D. $\frac{3}{8\pi}$m

**Answer: A**

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**11.** A particle is subjected to two mutually perpendicualr simple harmonic motions such that its x and y-coordinates are given by

$x = \sin \omega t, y = 2 \cos \omega t$

The path of the particle will be :

A. an ellipse

B. a straight line

C. a parabola

D. a circle

**Answer: A**

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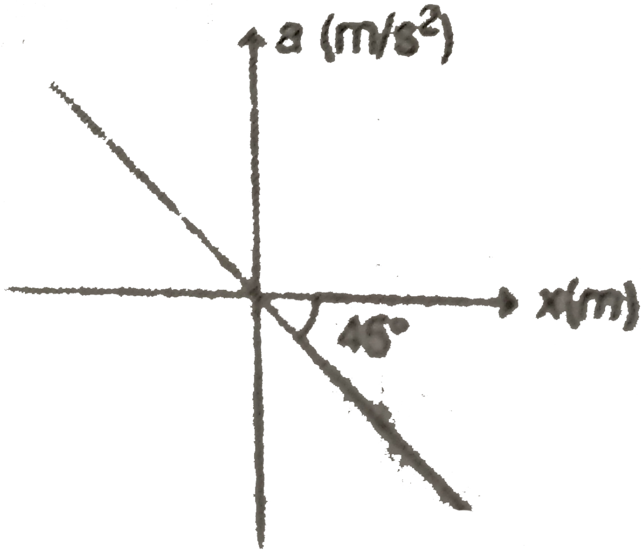
**12.** Acceleration -displacemnet graph of a particle executing SHM is as shown in given figure. The time period of its oscillations is (in s)




A. $\frac{\pi}{2}$

B. 2pi

C. pi

D. $\frac{\pi}{4}$

**Answer: B**

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**13.** A particle of mass 0.1 kg executes SHM under a for $F = (-10x)$ N. Speed of particle at mean position $6m/s$. Then amplitude of oscillations is

A. 0.6 m

B. 0.2m

C. 0.4m

D. 0.1m

**Answer: A**

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**14.** Displacement-time equation of a particle execution SHM is x=A sin$(\omega t+\frac{\pi}{6})$

Time taken by the particle to go directly from

$$x=-\frac{A}{2}\to x=+\frac{A}{2} is$$

A. $\frac{\pi}{2\omega}$

B. $\frac{\pi}{2\omega}$

C. $\frac{2\pi}{\omega}$

D. $\frac{\pi}{\omega}$

**Answer: A**

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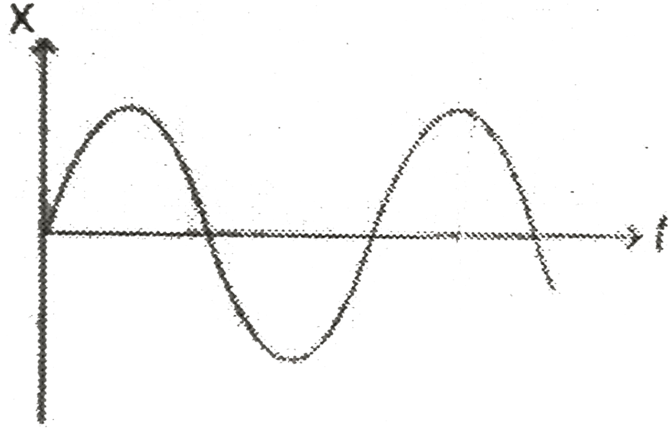
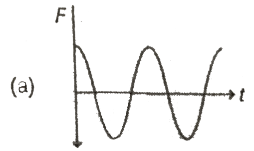
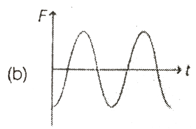
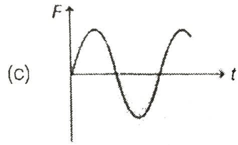
**15.** Displacement-time graph of a particle executing SHM is as shown

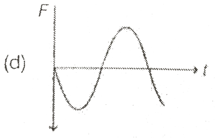



The corresponding force-time graph of the particle can be

A. 


B. 

C. 


D. 


**Answer: D**

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**16.** A uniform disc of radius R is pivoted at point O on its circumstances. The time period of small oscillations about an axis passing through O and perpendicular to plane of disc will be

A. $2\pi\left(\frac{R}{g}\right)$

B. $2\pi\sqrt{\frac{2R}{3g}}$

C. $2\pi\sqrt{\frac{2R}{g}}$

D. $2\pi\sqrt{3\frac{R}{2}g}$

**Answer: D**

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**17.** Two linear simple harmonic motions of equal amplitude and frequency are impressed on a particle along x and y axis respectively. The initial phase difference between them is $\frac{\pi}{2}$. The resultant path followed by the particle is

A. a circle

B. a straight line

C. an ellipse

D. a parabola

**Answer: A**

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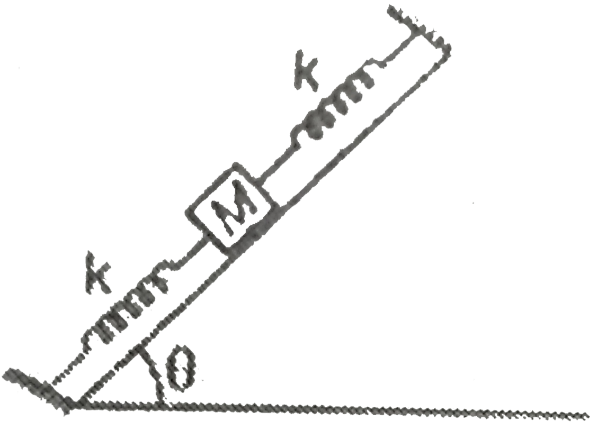
**18.** On a smooth inclined plane a body of mass M is attached between two springs. The other ends of the springs are fixed to firm supports. If each spring has a force constant k, the period of oscilation of the body is

(assuming the spring as massless)




A. $2\pi\sqrt{\frac{M}{2k}}$

B. $2\pi\sqrt{2\frac{M}{k}}$

C. $2\pi\sqrt{M\frac{\sin\theta}{2}k}$

D. $2\pi\sqrt{2M\frac{\sin\theta}{k}}$

**Answer: A**

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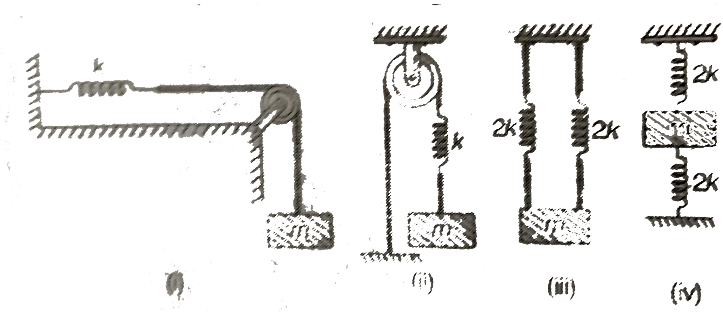
**19.** A block of mass m is suspended by different springs of force constant shown in figure.




A. $T_1 = T_2 = T_4$

B. $T_1 = T_2 \text{ and } T_3 = T_4$

C. $T_1 = T_2 = T_3$

D. $T_1 = T_3$ and $T_2 = T_4$

**Answer: B**

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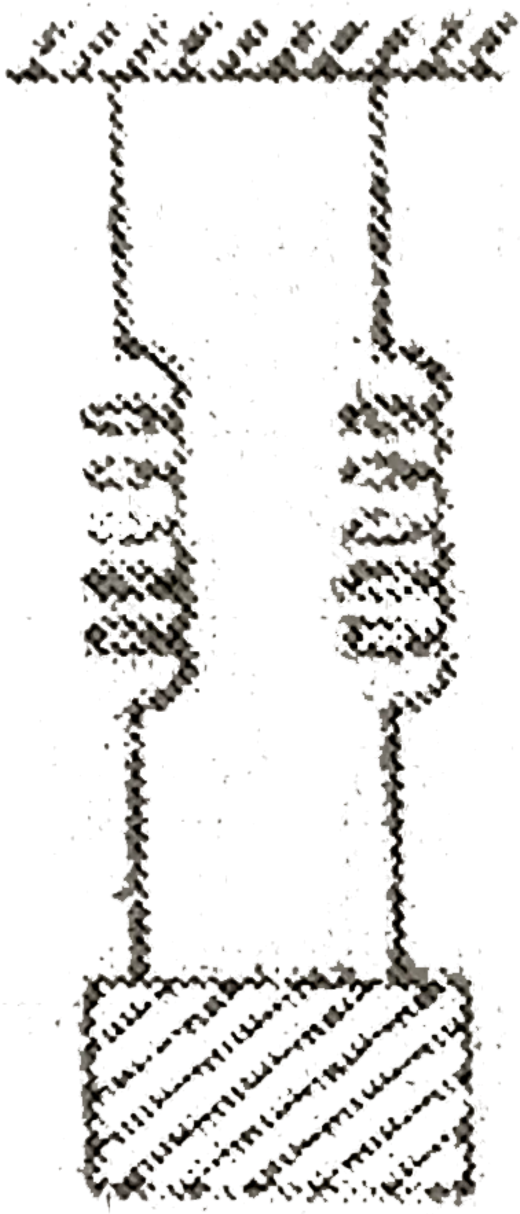
**20.** An object suspended from a spring exhibits oscillations of period T. Now the spring is cut in two halves and the same object is suspended with two halves as shown in figure. The new time period of oscillation will become



A. $\frac{T}{\sqrt{2}}$

B. 2T

C. T/2

D. $\frac{T}{2\sqrt{2}}$

**Answer: C**

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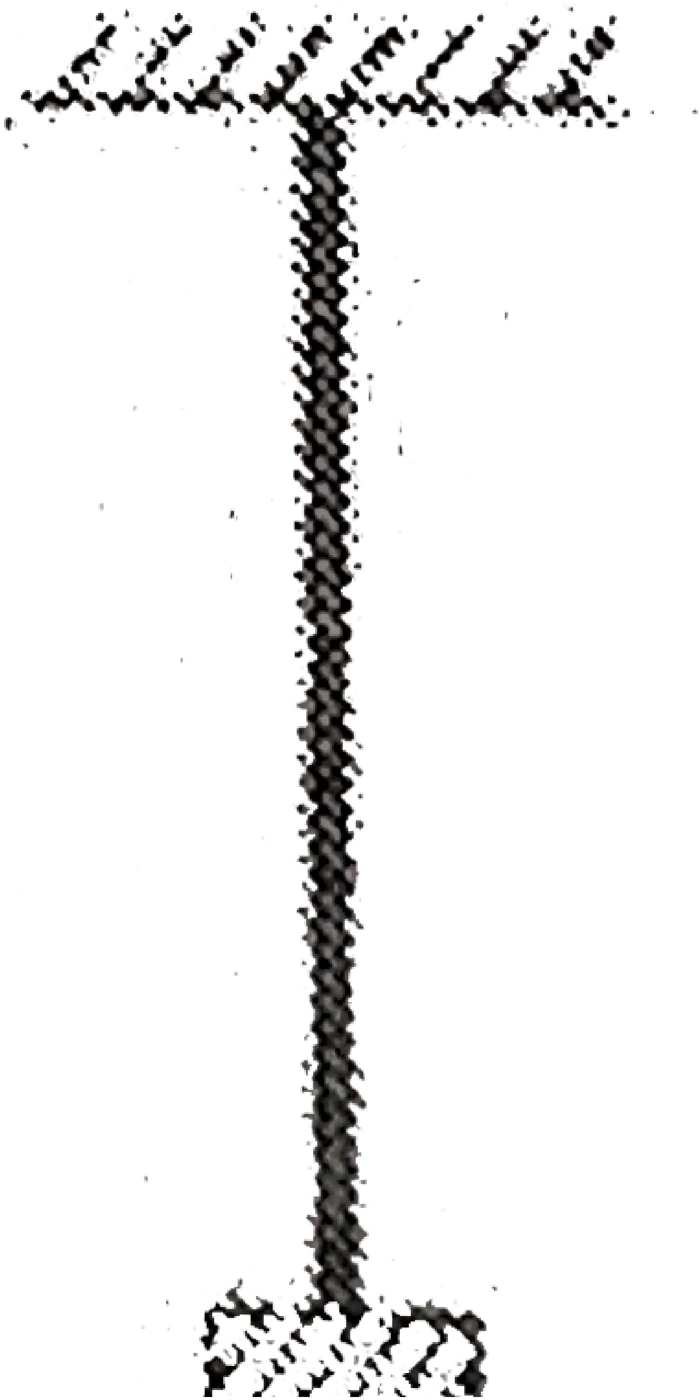
**21.** A wire of length l, area of cross-section A and Young,s modulus of elasticity Y is suspended form the roof of a building. A block of mass m is attached at lower end of the wire. If the block is displaced from its mean position and released then the block starts oscillating. Time period of these oscillations will be



A. $2\pi\frac{\sqrt{Al}}{mY}$

B. $2\pi\frac{\sqrt{AY}}{ml}$

C. $2\pi\frac{\sqrt{ml}}{YA}$

D. $2\pi\frac{\sqrt{m}}{Yal}$

**Answer: C**

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**22.** The potential energy of a harmonic oscillator of mass 2 kg in its mean positioin is 5J. If its total energy is 9J and its amplitude is 0.01m, its period will be

A. $\left(\frac{\pi}{100}\right)s$

B. $\frac{\pi}{50}s$

C. $\frac{\pi}{20}s$

D. $\left.\frac{\pi}{10}\right)$s

**Answer: A**

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**23.** Let $T_1$ and $T_2$ be the time periods of two springs A and B when a mass m is suspended from them separately. Now both the springs are connected in parallel and same mass m is suspended with them. Now let T be the time period in this position. Then

A. $T = T_1 + T_2$

B. $T = \frac{T_1 T_2}{T_1 + T_2}$

C. $T^2 = T_1^2 + T_2^2$

D. $\frac{1}{T^2} = \frac{1}{T_1^2} + \frac{1}{T_2^2}$

**Answer: D**

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**24.** A particle is subjected to two simple harmonic motions in the same direction having equal amplitudes and equal frequency. If the resulting amplitude is equal to the amplitude of individual motions, the phase difference between them is

A. $\frac{\pi}{3}$

B. $\frac{2\pi}{3}$

C. $\frac{\pi}{6}$

D. $\frac{\pi}{2}$

**Answer: B**

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**25.** A ball of mass 2kg hanging from a spring oscillates with a time period $2\pi$ seconds. Ball is removed when it is in equilibrium position, then spring shortens by

A. $10m$

B. $5m$

C. $20m$

D. $2\pi m$

**Answer: A**

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**26.** A simple pendulum 4 m long swings with an amplitude of 0.2 m. What is its acceleration at the ends of its path? (g = $10m/s^2$)

A. Zero

B. $10m/s^2$

C. $0.5m/s^2$

D. $2.5m/s^2$

**Answer: C**

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**27.** Two simple harmonic motions $y_1 = A \sin \omega t$ and $y_2$ = Acos$\omega$t are superimposed on a particle of mass m. The total mechanical energy of the particle is

A. $\frac{1}{2} m\omega^2 A^2$

B. $m\omega^2 A^2$

C. $\frac{1}{4} m\omega^2 A^2$

D. zero

**Answer: B**

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**28.** The maximum acceleratioin of a particle in SHM is made two times keeping the maximum speed to be constant. It is possible when

A. amplitude of oscillation is doubled while frequency remains constant

B. amplitude is doubled while frequency is halved

C. frequency is doubled while amplitude is halved

D. frequency of oscillatin is doubled while amplitude remains constant.

**Answer: C**

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**29.** Displacement-time equation of a particle executing SHM is x=4sin$(\omega t) + 3\sin(\omega t + \pi/3)$

Here, x is in cm and t ini sec. The amplitude of oscillation of the particle is approximately.

A. 7cm

B. 5cm

C. 6cm

D. 9cm

**Answer: C**

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**30.** Frequency of a particle executing SHM is 10 Hz. The particle is suspended from a vertical spring. At the highest point of its oscillation the spring is unstretched. Maximum speed of the particle is (g=10m/$s^2$

A. $2\pi m / s$

B. $\pi m / s$

C. $\frac{1}{\pi} m / s$

D. $\frac{1}{2\pi} m / s$

**Answer: D**

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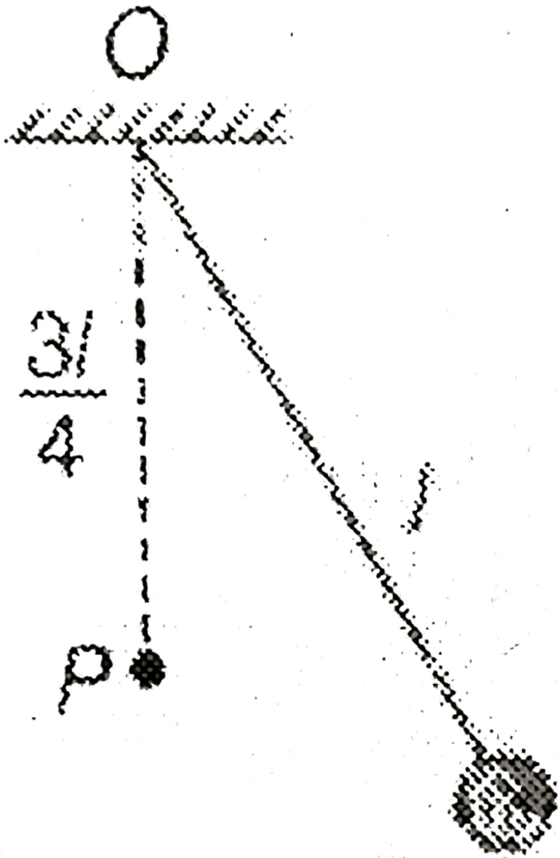
**31.** A pendulum has time period T for small oscillations. An obstacle P is situated below the point of suspension O at a distance $\frac{3l}{4}$. The pendulum is released from rest. Throughout the motion, the moving string makes small angle with vertical. Time after which the pendulum returns back to its initial position is




A. $T$

B. $\frac{3T}{4}$

C. $\frac{3T}{5}$

D. $\frac{4T}{5}$

**Answer: B**

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**32.** A particle moves according to the law, $x = a\cos(\pi t/2)$. . What is the distance covered by it in time interval $t = 0$ to $t = 3$ second.

A. 2a

B. 3a

C. 4a

D. a

**Answer: B**

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**33.** Two masses M and m are suspended together by massless spring of force constant -k. When the masses are in equilibrium, M is removed without disturbing the system. The amplitude of oscillations.

A. $\frac{Mg}{k}$

B. $\frac{mg}{k}$

C. $\frac{(M+m)g}{k}$

D. $\frac{(M-m)g}{k}$

**Answer: A**

Watch Video Solution

**34.** Maximum velocity ini SHM is $v_m$. The average velocity during motion from one extreme point to the other extreme point will be

A. $\frac{\pi}{2}v_m$

B. $\left(\frac{2}{\pi}\right)v_m$

C. $\left(\frac{4}{\pi}\right)v_m$

D. $\left(\frac{\pi}{4}\right)v_m$

**Answer: B**

Watch Video Solution

**35.** An object of mass 0.2 kg executes simple harmonic oscillation along the x-axis with a frequency $\frac{25}{\pi}$. At the position x = 0.04m, the object has kinetic energy 0.5J and potential energy 0.4J. amplitude of oscillation is (potential energy is zero mean position).

A. 6cm

B. 4cm

C. 8 cm

D. 2cm

**Answer: A**

Watch Video Solution

**36.** The potential energy of a particle of mass 1 kg $U = 10 + (x - 2)^2$. Herer, U is in joule and x in met. On the positive x=axis particle travels up to x=+6cm. Choose the wrong statement.

A. on negative x-axis particle travels up to x = -2m

B. The maximum kinetic energy of the particle is 16 J

C. The period of oscillation of the particle is $\sqrt{2\pi}$ seconds.

D. None of the above.

**Answer: C**

Watch Video Solution

**37.** A cylindrical block of wood of mass m and area cross-section A is floating in water (density = $\rho$) when its axis vertical. When pressed a little and the released the block starts oscillating. The period oscillations is

A. $\left(2\pi\sqrt{\frac{m}{\rho bid \wedge g}}\right.$

B. $2\pi\sqrt{\frac{mg}{\rho A}}$

C. $2\pi\sqrt{\frac{\rho A g}{m}}$

D. $\left.2\pi\frac{\sqrt{\rho A}}{mg}\right)$

**Answer: A**

Watch Video Solution

**38.** The displacement of two identical particles executing SHM are represented by equations.

$x_1 = 4\sin\left(10t + \frac{\pi}{6}\right)$ and $x_2 = 5\cos\varepsilon t$

For what value of epsilon energy of both the particles is same?

A. 16 unit

B. 6 unit

C. 4 unit

D. 8 unit

**Answer: D**

Watch Video Solution

**39.** A simple pendulum has time period T = 2s in air. If the whole arrangement is placed in a non viscous liquid whose density is 1/2 times the density of bob. The time period in the liquid will be

A. $\frac{2}{\sqrt{2}}$s

B. 4 s

C. $2\sqrt{2}$s

D. $4\sqrt{2}$s

**Answer: C**

Watch Video Solution

**40.** A rectangular block of mass m and area of cross-section A floats in a liquid of density $\rho$. If it is givan a small vertical displacement from equilibrium, it undergoes oscillation with a time period T, then select the wrong alternative.

A. $T^2 \alpha m$

B. $T^2 \alpha g$

C. $T^2 \alpha 1/A$

D. $T^2 \alpha \frac{1}{\rho}$

**Answer: B**

Watch Video Solution

**41.** Four simple harmonic vibrations $x_1 = 8\sin \varepsilon t$, $x_2 = 6\sin\left(\varepsilon t + \frac{\pi}{2}\right)$, $x_3 = 4\sin(\varepsilon t + \pi)$ and $x_4 = 2\sin\left(\varepsilon t + \frac{3\pi}{2}\right)$ are superimposed on each other. The resulting amplitude and its phase difference with $x_1$ are respectively.

A. $20, \tan^{-}\left(\frac{1}{2}\right)$

B. $4\sqrt{2}, \left(\frac{\pi}{2}\right)$

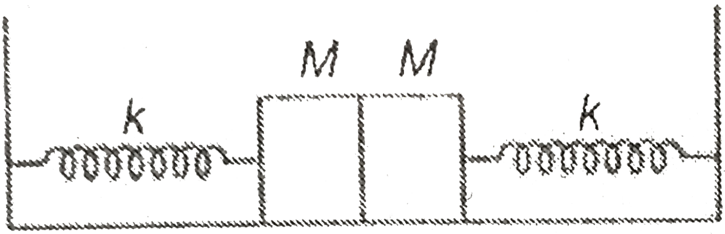
C. $20, \tan^{-1}(2)$

D. $4\sqrt{2}, \left(\frac{\pi}{4}\right)$

**Answer: D**

Watch Video Solution

**42.** An assembly of identicl spring mass system is placed on a smooth horizontal surface as shown. Initially the springs are relaxed. The left mass is displaced to the left while the right mass is displaced to the right and released. The resulting collision is elastic. The time period of the oscillatins of the system is.




A. $2\pi\sqrt{\frac{2M}{k}}$)

B. $2\pi\sqrt{\frac{M}{2k}}$

C. $2\pi\sqrt{\frac{M}{k}}$

D. $\pi\sqrt{\frac{M}{k}}$

**Answer: D**

Watch Video Solution

**43.** A body is executing simple harmonic motion. At a displacement x (from its mean position) its potential energy is $E_1$ and at a displacement y its potential energy is $E_2$. The potential energy is E at displacement (x+y) . Then:

A. $\sqrt{E} = \sqrt{E_1} - \sqrt{E_2}$

B. $\sqrt{E} = \sqrt{E_1} + \sqrt{E_2}$

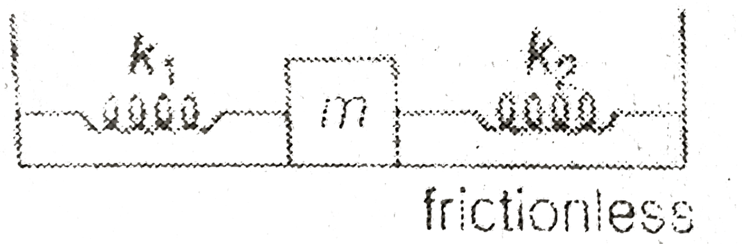
C. $E = E_1 - E_2$

D. $E = E_1 + E_2$

**Answer: B**

Watch Video Solution

**44.** Two springs with negligible massess and force constant of $k_1 = 200Nm^{-1}$ and $k_2 = 160Nm^{-1}$ are attached to the block of mass m = 10kg as shown in the figure. Initially the block is at rest at the equilibrium position the block is at rest at the equilibrium position ir. Which both springs are neither stretched nor compressed. At time t = 0, sharp impulse of 50 N-s is given to the block in horizontal direction.




A. period of oscialltions for the mass m is $\left(\frac{\pi}{6}\right)$ s

B. maximum velocity of the mass m during its oscillation is $10ms^{-1}$.

C. maximum velocity is 6m/s

D. amplitude of oscillations is $\frac{5}{6}$m.

**Answer: D**

Watch Video Solution

**45.** The potential energy of a harmonic oscillator of mass 2kg in its equilibrium position is 5 joules. Its total energy is 9 joules and its amplitude is 1cm. Its time period will be

A. 6.28 s

B. $3.14 \times 10^{-2}$s

C. 3.14 s

D. 0.314 s

**Answer: B**

Watch Video Solution

**46.** A vehicle is moving on a circular path of radius R with constant speed $\sqrt{gR}$. A simple pendulum of length l hangs from the ceilling of the vehicle. The time period of oscillations of the pendulum is

A. $2\pi\sqrt{\frac{l}{g}}$

B. $2\pi\sqrt{\frac{l}{\sqrt{2}g}}$

C. $2\pi\sqrt{\frac{\sqrt{2}l}{g}}$

D. None of these

**Answer: B**

Watch Video Solution

**47.** Two simple pendulum of length l and 16l are released from the same phase together. They will be at the same time phase after a minimum time.

A. $\frac{8\pi}{3}\sqrt{\frac{l}{g}}$

B. $\frac{\pi}{3}\sqrt{\frac{l}{g}}$

C. 2s

D. None of these

**Answer: A**

Watch Video Solution

**48.** A horizontal spring mass system is executing SHM with time period of 4s. At time t=0, it is at mean position. Find the minimum time after which its potential energy becomes three times of kinetic energy.

A. 1s

B. $\frac{1}{2}$s

C. $\frac{1}{3}$s

D. $\frac{2}{3}$s

**Answer: D**

Watch Video Solution

**1.** A particle moves such that its acceleration is given by

$a = -\beta(x-2)$

Here, $\beta$ is a positive constnt and x the x-coordinate with respect to the origin. Time period of oscillation is

A. $(2\pi)\sqrt{\beta}$

B. $2\pi\sqrt{\dfrac{1}{\beta}}$

C. $2\pi\sqrt{\beta+2}$

D. $2\pi\sqrt{\dfrac{1}{\beta+2}}$

**Answer: B**

Watch Video Solution

**2.** A particle starts oscillating simple harmoniclaly from its equilibrium postion. Then the ratio fo kinetic and potential energy of the principle at time $\frac{T}{12}$ is ($U_{mean}$=0, T= Time period)

A. $2:1$

B. $3:1$

C. $4:1$

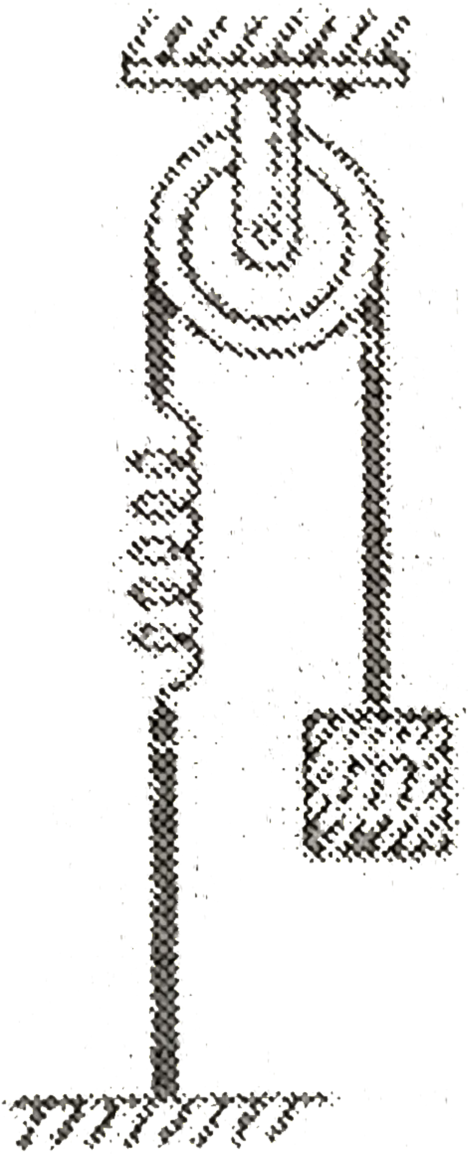
D. $1:4$

**Answer: B**

Watch Video Solution

**3.** A mass m = 8kg is attached to a spring as shown in figure and held in positioin so that the spring remains unstretched. The spring constant is 200 N/m. The mass m is then released and begins to undergo small oscillations. The maximum velocity of the mass will be

(g=10m/$s^2$)



A. 1 m/s

B. 2 m/s

C. 4 m/s

D. 5 m/s

**Answer: B**

Watch Video Solution

**4.** A block rides on position that is moving vertically with simple harmonic motion. The maximum speed of the piston is 2m/s. At what amplitude of motion will the block and piston separate? (g=10m/$s^2$)

A. 20 cm

B. 30cm

C. 40 cm

D. 50 cm

**Answer: C**

Watch Video Solution

**5.** An accurate pendulum clock is mounted on ground floor of a high building. How much time will it lose or gain in one day if its is transferred to top storey of a building which is h = 200m higher than the ground floor? Radius of earth is $6.4 \times 10^6$

A. it will lose 6.2 s

B. it will lose 2.7 s

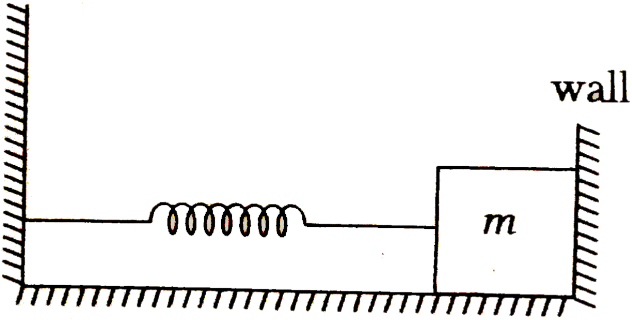
C. it will gain 5.2s

D. it will gain 1.6 s

**Answer: B**

Watch Video Solution

**6.** In the figure, the block of mass m, attached to the spring of stiffness k is in contact with the completely elastic wall, and the compression in the spring is e. The spring is compressed further by e by displacing the block towards left and is then released. If the collision between the block and the wall is completely elastic then the time period of oscillation of the block will be




A. $\frac{2\pi}{3}\Big)\sqrt{\frac{m}{k}}$

B. $(2\pi)\sqrt{\frac{m}{k}}$

C. $\frac{\pi}{3}\sqrt{\frac{m}{k}}$

D. $\frac{\pi}{6}\sqrt{\frac{m}{k}}$

**Answer: A**

Watch Video Solution

**7.** Vertical displacement of a plank with a body of mass m on it is varying according to the law $y = \sin \omega t + \sqrt{3} \cos \omega t$. The minimum value of $\omega$ for which the mass just breaks off the plank and the moment it occurs first time after t=0, are given by (y is positive towards vertically upwards).

A. $\sqrt{\frac{g}{2}}, \sqrt{\frac{2}{6}}, \frac{\pi}{\sqrt{g}}$

B. $\frac{g}{\sqrt{2}}, \frac{2}{3}\frac{\sqrt{\pi}}{g}\Big)$

C. $\sqrt{\frac{g}{2}}, \frac{\pi}{3}\Big)\sqrt{\frac{2}{g}}$

D. $\sqrt{2g}, \sqrt{\frac{2\pi}{3g}}$

**Answer: A**

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8. The displacement-time equation of a particle executing SHM is $A - A\sin(\omega t + \phi)$. At tme t=0 position of the particle is x=$\frac{A}{2}$ and it is moving along negative x-direction. Then the angle $\phi$ can be

A. $\frac{\pi}{6}$

B. $\frac{\pi}{3}$

C. $\frac{2\pi}{3}$

D. $\frac{5\pi}{6}$

**Answer: D**

Watch Video Solution

**9.** The maximum tension in the string of a pendulum is two times the minimum tension. Let $\theta_0$ is then what is angular amplitude

A. $\frac{1}{2}$

B. $\frac{3}{4}$

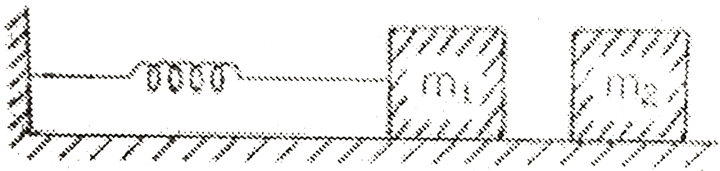
C. $\frac{2}{3}$

D. $\frac{3}{5}$

**Answer: B**

Watch Video Solution

**10.** Two blocks of masses $m_1$ and $m_2$ are kept on a smooth horizontal table as shown in figure. Block of mass $m_1$ (but not $m_2$ is fastened to the spring. If now both the blocks are pushed to the left so that the spring is compressed a distance d. The amplitude of oscillatin of block of mass $m_1$ after the system is released is




A. $d\sqrt{\frac{m_1}{m_1+m_2}}$

B. $d\sqrt{\frac{m_2}{m_1+m_2}}$

C. $d\sqrt{\frac{2m_2}{m_1+m_2}}$

D. $d\sqrt{\left(2\frac{m_1}{m_1+m_2}\right.}$

**Answer: A**

Watch Video Solution

**11.** Time period of a simple pendulum of length L is $T_1$ and time period of a uniform rod of the same length L pivoted about an end and oscillating in a vertical plane is $T_2$. Amplitude of osciallations in both the cases is small. Then $\frac{T_1}{T_2}$ is

A. $\sqrt{\frac{4}{3}}$

B. 1

C. $\sqrt{\frac{3}{2}}$

D. $\sqrt{\frac{1}{3}}$

**Answer: C**

Watch Video Solution

**12.** The potential energy of a particle of mass 1 kg in motin along the x-axis is given by

U = 4(1-cos2x)J

Here, x is in meter. The period of small osciallationis (in second) is

A. $2\pi)$

B. $\pi$

C. $\frac{\pi}{2}$

D. $\sqrt{2\pi}$

**Answer: C**

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**13.** A particle executing SHM while moving from one extremity is found at distance $x_1, x_2$ and $x_3$ from the center at the end of three successive seconds. The time period of oscillation is

Here $\theta = \cos^{-1}\left(\frac{x_1 + x_3}{2x_2}\right)$

A. $\frac{2\pi}{\theta}$

B. $\frac{\pi}{\theta}$

C. $\theta$

D. $\frac{\theta}{2\theta}$

**Answer: A**

Watch Video Solution

**14.** Two particles are executing SHM in a straight line. Amplitude A and the time period T of both the particles are equal. At time t=0, one particle is at displacement $x_1 = +A$ and the other $x_2 = \left(-\frac{A}{2}\right)$ and they are approaching towards each other. After what time they across each other? $\frac{T}{4}$

A. $\frac{T}{3}$

B. $\frac{T}{4}$

C. $\frac{5T}{6}$

D. $\frac{T}{6}$

**Answer: D**

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**15.** Maximum speed of a particle in simple harmonic motion is $v_{\max}$. Then average speed of this particle in one time period is equal to

A. $\frac{v_{\max}}{2}$

B. $\frac{v_{\max}}{\pi}$

C. $\frac{\pi v_{\max}}{2}$

D. $\frac{2v_{\max}}{\pi}$

**Answer: D**

Watch Video Solution

**16.** Two particles execute simple harmonic motion of the same amplitude and frequency along close parallel lines. They pass each other moving in opposite directions each time their displacement is half their amplitude. Their phase difference is

A. $\frac{5\pi}{6}$

B. $\frac{4\pi}{3}$

C. $\frac{\pi}{6}$

D. $\frac{2\pi}{3}$

**Answer: D**

Watch Video Solution

**17.** A block is kept on a rough horizontal plank. The coefficient of friction between the block and the plank is $\frac{1}{2}$. The plank is undergoing SHM of angular frequency 10 rad/s. The maximum amplitude of plank in which the block does not slip over the plank is (g= 10 m/$s^2$)

A. 4cm

B. 5cm

C. 10 cm

D. 16 cm

**Answer: B**

Watch Video Solution

**18.** A particle of mass m is executing osciallations about the origin on the x-axis with amplitude A. its potential energy is given as $U(x) = \alpha x^4$, where $\alpha$ is a positive constant. The x-coordinate of mass where potential energy is one-third the kinetic energy of particle is

A. $\pm \frac{A}{2}$

B. $\pm \frac{A}{\sqrt{2}}$

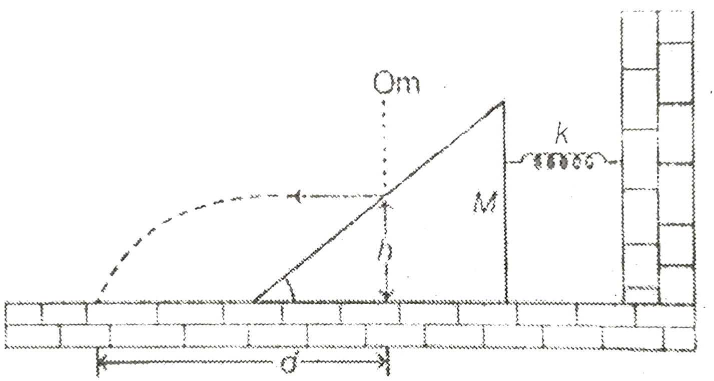
C. $\pm \frac{A}{3}$

D. $\pm \frac{A}{\sqrt{3}}$

**Answer: B**

Watch Video Solution

**19.** A ball of mass m when dropped from certain height as shown in diagram, strikes a wedge kept on smooth horizontal surface and move horizontally just after impact. If the ball strikes the ground at a distance d from its initial line of fall, thenthe amplitude of oscillation of wedge after being hit by the ball will be



A. $\frac{md}{M}\sqrt{\frac{Mg}{2kh}}$

B. $\frac{d}{m}\sqrt{\frac{kMg}{2h}}$

C. $d\sqrt{\frac{kg}{2Mh}}$

D. $d\sqrt{\frac{kg}{2mh}}$

**Answer: A**

Watch Video Solution

**20.** A particle performs SHM in a straight line. In the first second, starting from rest, it travels a distance a and in the next second it travels a distance b in the same side of mean position. The amplitude of the SHM is

A. a-b

B. $\frac{2a-b}{3}$

C. $\frac{2a^2}{3a-b}$

D. None of these

**Answer: C**

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**21.** The angular frequency of a spring block system is $\omega_0$. This system is suspended from the ceiling of an elevator moving downwards with a constant speed $v_0$. The block is at rest relative to the elevator. Lift is suddenly stopped. Assuming the downward as a positive direction. Then

A. The amplitude of the block is $\frac{v_0}{\omega_0}$

B. The equation of motion for the block is $\left(\frac{v_0}{\omega_0}\right)\sin\omega_0 t$

C. Both are correct

D. Both are wrong

**Answer: C**

Watch Video Solution

**22.** A small ball of density rho_(0) is released from the surface of a liquid whose density varies with depth h as $\rho = \frac{\rho_0}{2}(\alpha + \beta h)$. Mass of the ball is m. Select the most appropriate one option.

A. The particle will execute SHM

B. The maximum speed of the ball is $\frac{2-\alpha}{\sqrt{2}\beta}$

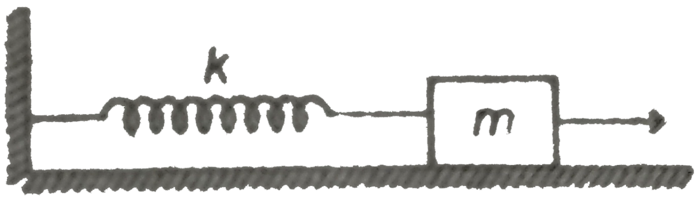
C. Both a and b are correct

D. Both a and b are wrong

**Answer: A**

Watch Video Solution

**23.** A constant force produces maximum velocity V on the block connected to the spring of force constant K as shown in the figure. When the force constant of spring becomes 4K, the maximum velocity of the block is




A. $\frac{V}{4}$

B. 2V

C. $V/2$

D. V

**Answer: C**

Watch Video Solution

**24.** Two blocks of masses $m_1$=1kg and $m_2$ = 2kg are connected by a spring of spring constant k = 24 N/m and placed on a frictionless horizontal surface. The block $m_1$ is imparted an initial velocity $v_0$ = 12cm/s to the right. The amplitude of oscillation is

A. 2 cm

B. 1 cm

C. 3 cm

D. 4 cm

**Answer: A**

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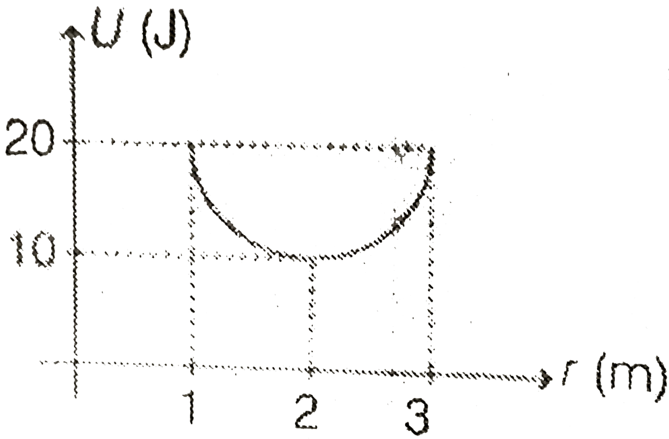
**25.** U.r graph of a particle performing SHM is as shown in figure. What conclusion cannot be drawn from the graph?




A. Mean position of the particle is at r=2m

B. Potential energy of the particle at mean position is 10 J

C. Amplitude of oscillation is 1m

D. None of the above.

**Answer: C**

Watch Video Solution

**26.** Two particles are in SHM along same line with same amplitude A and same time period T. At time t=0, particle 1 is at + $\frac{A}{2}$ and moving towards positive x-axis. At the same time particle 2 is at $-\frac{A}{2}$ and moving towards negative x-axis. Find the timewhen they will collide.

A. $\frac{2T}{3}$

B. $\frac{5T}{12}$

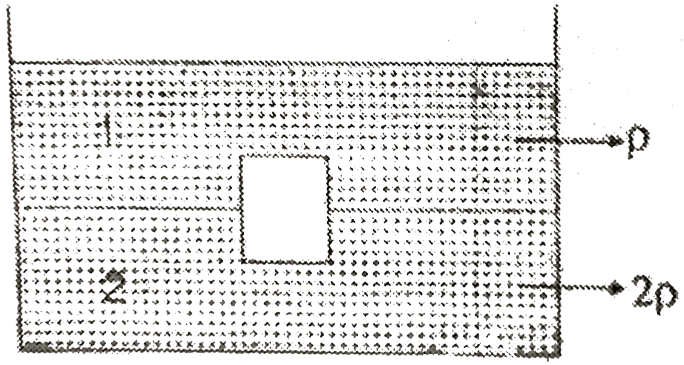
C. $\frac{4T}{3}$

D. $\frac{2T}{5}$

**Answer: B**

Watch Video Solution

**27.** A plank of area of cross-section A is half immersed in liquid 1 of density $\rho$ and half in liquid 2 of density $2\rho$. What is period of osciallation of the plank if it is slightly depressed downwards?




A. $2\pi\sqrt{\frac{m}{\rho A g}}$

B. $\pi\sqrt{\frac{m}{\rho A g}}$

C. $2\pi\sqrt{\frac{3m}{2\rho A g}}$

D. $2\pi\sqrt{\frac{m}{3\rho A g}}$

**Answer: A**

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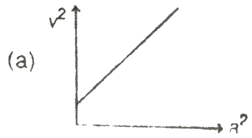
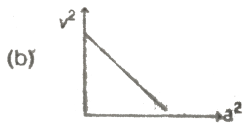
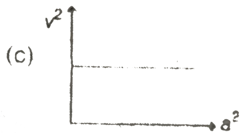
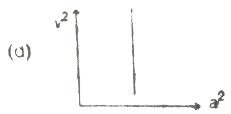
**28.** A mass M is performing linear simple harmonic motion. Then correct graph for acceleration a and corresponding linear velocity v is

A. 


B. 


C. 


D. 


**Answer: B**

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**29.** A test tube of length l and area of cross-section A has some iron fillings of mass M. The test tube floats normally in a liquid of density $\rho$ with length x dipped in the liquid. A disturbing force makes the tube oscillate in the liquid. The time period of oscillation is given by (neglect the mass of the test tube)

A. $\left(2\pi\sqrt{\frac{M\rho}{Ag}}\right.$

B. $2\pi\sqrt{\frac{x}{g}}$

C. $2\pi\sqrt{\frac{l}{g}}$

D. $2\pi\sqrt{\frac{M}{g}}$

**Answer: B**

Watch Video Solution

30. A particle is executing SHM according to the equation x $= A\cos\omega t$. Average speed of the particle during the interval $0 \leftarrow t \leftarrow \frac{\pi}{6\omega}$

A. $\frac{\sqrt{3}A\omega}{2}$

B. $\frac{\sqrt{3}A\omega}{4}$

C. $\left(\frac{\sqrt{A\omega}}{\pi}\right)$

D. None of these

**Answer: D**

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**31.** A particle performs $SHM$ of amplitude $A$ along a straight line .When it is at a distance of $\frac{\sqrt{3}}{2}$A from mean position its kinetic energy gets increased by an amount of $\frac{1}{2}m\omega^2A^2$ due to an impulsive force. Then its new amplitude becomes

A. $\frac{\sqrt{5}}{2}$A

B. $\frac{\sqrt{3}}{2}$A

C. $\sqrt{2}$A

D. $\frac{2}{\sqrt{5}}$A

**Answer: C**

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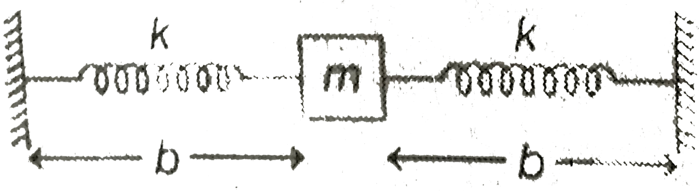
**32.** In the figure, a block of mass m is rigidly attached to two identical springs of stiffness k each. The other ends of the springs are connected to the fixed wall. When the block is in equilibrium, length of each spring is b, which is greater than the natural length of the spring. The time period of the oscillation of the block if it is displaced by small distance perpendicular to the length of the springs and released. Space is gravity free.




A. $2\pi\sqrt{\dfrac{mb}{k(b-1)}}$

B. $2\pi\sqrt{\dfrac{mb}{(2k)(b-l)}}$

C. $2\pi\sqrt{\left(m\frac{b-l}{kb}\right)}$

D. $2\pi\sqrt{\left(m\frac{b-l}{2kb}\right)}$

**Answer: B**

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**33.** A particle is placed at the lowest point of a smooth wire frame in the shape of a parabola, lying in the vertical xy-plane having equatioin $x^2$=5y(x,y are in meter). After slight displacement, the particle is set free. Find angular frequency of osciallation (in rad/sec) (Take g=10 m/$s^2$)

A. 2 rad/s

B. 4 rad/s

C. 6 rad/s

D. 8 rad/s

**Answer: A**

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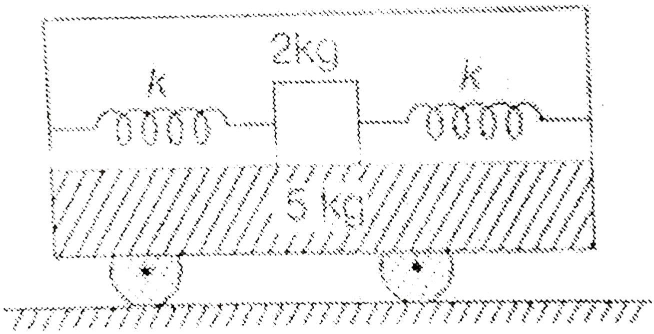
**34.** Two springs, each of spring constant k = 100N/m are attached to a block of mass 2kg as shown in figure. The block can slide smoothly along horizontal platform clamped to the opposite walls of a trolley of mass 5kg. The block is slightly displace dand then released. The period of oscillation is (in seconds). (all surfaces are smooth)




A. $T = 2\pi\sqrt{\frac{7}{1000}}$

B. $T = 2\pi\sqrt{\frac{1}{140}}$

C. $T = 2\pi\sqrt{\frac{1}{20}}$

D. $T = 2\pi\sqrt{\frac{49}{100}}$

**Answer: B**

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## More than one option is correct

**1.** A particle is executing SHM with amplitude A. At displacement $x = \left(-\frac{A}{4}\right)$, force acting on the particle is F, potential energy of the particle is U, velocity of particle is v and kinetic energy is K. Assuming potential energyh to be zero at mean position. At displacement x=A/2

A. Force acting on the particle will be 2F

B. potential energy of the particle will be 4U.

C. velocity of particle must be $\sqrt{\frac{4}{5}}$v

D. kinetic energy of particle will be 0.8 K

**Answer: B::D**

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**2.** A simple pendulum of length 1 m with a bob of mass m swings with an angular amplitude $30^\circ$. Then (g= $9.8m/s^2$

A. time period of pendulum is 2s

B. tension in the string is greater than mg $\cos 15^\circ$) at angualr displacement $15^\circ$

C. rate of change of speed at angular displacement $15^\circ$ is gsin$15^\circ$

D. tension in the string is mg cos $15^\circ$ at angular displacement $15^\circ$

**Answer: B::C**

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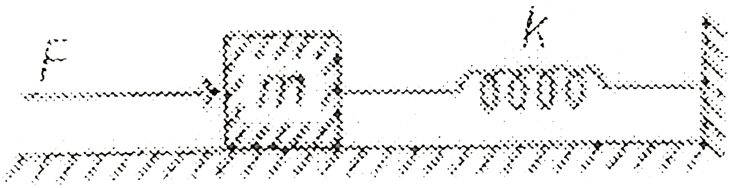
**3.** A constant force F is applied on a spring block system as shown in figure. The mass of the block is m and spring constant is k. The block is placed over a smooth surface. Initially the spring was unstretched. Choose the correct alternative(s)




A. The block will executes SHM

B. Amplitude of oscillation is $\frac{F}{2K}$

C. Time period of oscillation is $2\pi\sqrt{\frac{m}{k}}$

D. The maximum speed of block is $\frac{\sqrt{2Fx - kx^2}}{m}$

(Here, x=F/k).

**Answer: A::C::D**

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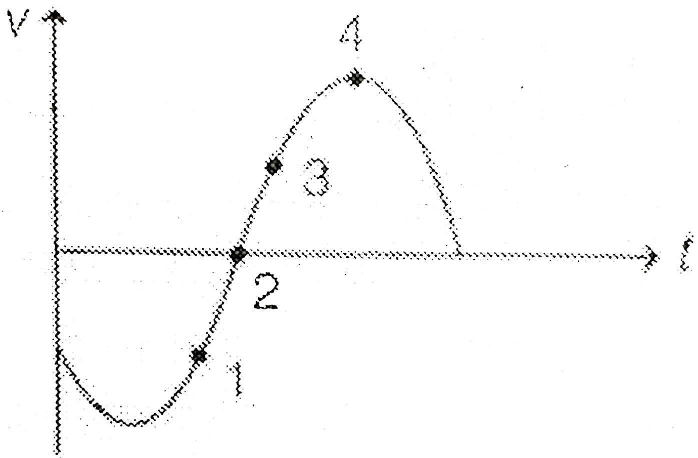
**4.** Velocity-time graph of a particle executing SHM is shown in figure. Select the correct alternative(s).




A. At position 1, displacement of particles may be positive or negative

B. At position 2, displacement of particlees is negative

C. At position 3, acceleration of particle is positvie

D. At position 4, acceleration of particle is positive

**Answer: B::C**

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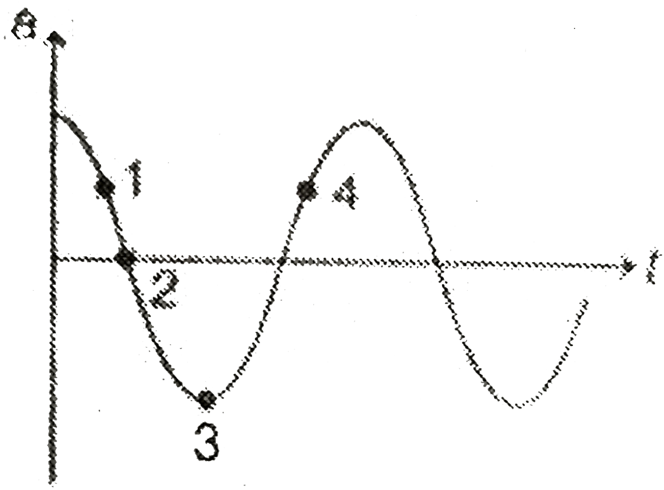
**5.** Accleration-time graph of a particle executing SHM is as shown in figure. Select the correct alternatives(s).




A. Displacement of particle at 1 is negative

B. velocity of particle at 2 is positive

C. potential energy of particle at 3 is maximum

D. Speed of particle at 4 is decreasing

**Answer: A::B::C::D**

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**6.** Density of a liquid varies with depth as $\rho = \alpha h$. A small ball of density $\rho_0$ is released from the free surface of the liquid. Then

A. the ball will execute SHM of amplitude $\frac{\rho_0}{\alpha}$

B. the mean position of the ball will be at a depth

$$\frac{\rho_0}{2\alpha}$$

C. the ball will sink to a maximum depth of $\frac{\rho_0}{\alpha}$

D. The ball sink to a maximum depth of $\frac{\rho_0}{\alpha}$

**Answer: A::C::D**

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**7.** A particle stars SHM at time t=0. Its amplitude is A and angular frequency is $\omega$. At time t=0 its kinetic energy is $\frac{E}{4}$. Assuming potential energy to be zero and the particle can be written as (E=total mechanical energy of oscillation).

A. x=A $\cos\left(\omega t+\frac{\pi}{6}\right)$

B. x = A$\sin\left(\omega t+\frac{\pi}{3}\right)$

C. X = A$\sin\left(\omega t-\frac{2\pi}{3}\right)$

D. x = A $\cos\left(\omega t-\frac{\pi}{6}\right)$

**Answer: A::B::C::D**

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**8.** The speed v of a particle moving along a straight line.

When it is at distance x from a fixed point on the line is

$v^2=144-9x^2$. Select the correct alternatives

A. The motioni of the particle is SHM with time period $T = \frac{2\pi}{3}$ units

B. The maximum displacement of the particle from the fixed point is 4 units

C. The magnitude of acceleration at a distance 3 units from the fixed point is 27 units

D. the motion of the particles is periodic but not simple harmonic

**Answer: A::B::C**

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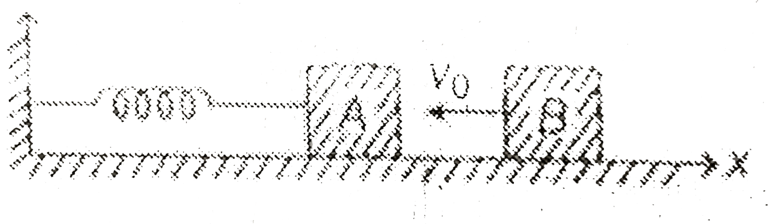
**9.** A block A of mass m connected with a spring of force constant k is executing SHM. The displacement time equation of the block is x=$x_0 + a\sin\omega t$. An identical block B moving towards negative x -axis with velocity $v_0$ collides elastically with block A at time t=0. Then




A. displacement time equation of A after collision will be $x = x_0 - v_0\sqrt{\frac{m}{k}}\sin\omega t$

B. displacement time equation of A after collision will be $x = x_0 + v_0\sqrt{\frac{m}{k}}\sin\omega t$

C. Velocity of b just after collision will be a $\omega$ towards positive x-direction.

D. velocity of B just after collision will be $v_0$ towards positive x-direction.

**Answer: A::C::D**

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**10.** A particle moves along the x-axis according to the equation $x = 4 + 3\sin(2\pi t)$

Hence, x in cm and t in seconds. Select the correct alternatives

A. The motion of the particle is simple harmonic with mean position at x=0

B. the motion of the particle is simple harmonic with mean position at x=4cm

C. The motion of the particle is simple harmonic with mean position at x=$-4cm$

D. Amplitude of osciallation is 3cm

**Answer: B::D**

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**11.** In simple harmonic motion

A. Potential energy and kinetic energy may not be equal in mean position.

B. potential energy and kinetic energy may be equal in extreme position

C. potential energy may be zero at extreme position

D. kinetic energy plus potential energy oscillates simple harmonically.

**Answer: A::B::C**

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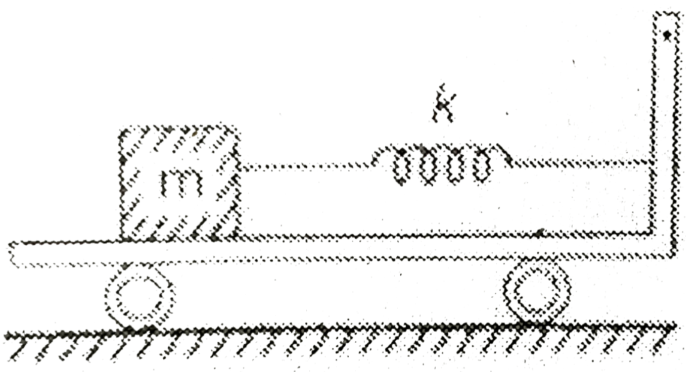
**12.** A block of mass m is attached to a massless spring of force constant k, the other end of which is fixed from the wall of a truck as shown in figure. The block is placed over a smooth surface and initially the spring is unstretched. Suddenly the truck starts moving towards right with a constant accleration $a_0$. As seen from the truck




A. The particle will execute SHM

B. The time period of oscillations will be $2\pi\sqrt{\frac{m}{k}}($

C. the amplitude of oscillations will be $\left(m^2a_0^2\right)$

D. The energy of oscillatioins will be $\frac{m^2a_0^2}{k}$

**Answer: A::B::C**

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**13.** A particle is executing SHM on a straight line. A and B are two points at which its velocity is zero. It passes through a certain point P(APltBP) at successive intervals of 0.5s and 1.5 s with a speed of 3m/s.

A. a. the maximum speed of particle is $3\sqrt{2}$m/s

B. b. the maximum speed of particle is $\sqrt{2}\frac{m}{s}$.

C. c. the ratio (AP/BP) is $\frac{\sqrt{2}-1}{\sqrt{2}+1}$

D. d. the ratio AP/BP is $\frac{1}{\sqrt{2}}$

**Answer: A::C**

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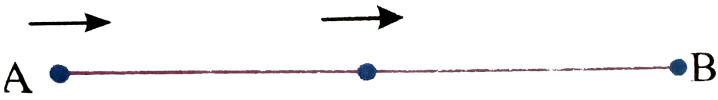
**14.** Two particles undergo $SHM$ along the same line with the same time period $(T)$ and equal amplitude $(A)$. At a particular instant one is at $x = -A$ and the other is at $x = 0$. If they start moving in the same direction then they will cross each other at




(i) $t = \frac{4T}{3}$ (ii) $t = \frac{3T}{8}$ (iii) $x = \frac{A}{2}$ (iv) $x = \frac{A}{\sqrt{2}}$

A. $t = \frac{4T}{3}$

B. $t = \frac{3T}{8}$

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

D. $x = \left(\frac{A}{\sqrt{2}}\right)$

**Answer: B::D**

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**15.** A particle of mass m is moving in a potential well, for which the potential energy is given by

$U(x) = U_0(1 - \cos ax)$ where $U_0$ and a are positive constants. Then (for the small value of x)

A. the time period of small osciallation is $T = 2\pi\sqrt{\frac{m}{aU_0}}$

B. the speed of the particle is maximum at x=0

C. the amplitude of oscillations is $\frac{\pi}{8}$

D. the time period of small osciallations is $T = 2\pi\sqrt{\frac{m}{a^2U_0}}$

**Answer: B::C::D**

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**16.** In a horizontal spring-block system force constant of spring is k = 16N/m, mass of the block is 1 kg. Maximum kinetic energy of the block is 8J. Then

A. amplitude of osciallation is 1m

B. at half the amplitude, potential energy stored in the spring is 2J.

C. at half the amplitude kinetic energy is 6J

D. angular frequency of oscillation is 16 rad/s

**Answer: A::B::C**

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**17.** Two small particles P and Q each of mass m are fixed along x-axis at points (a,0) and (-a,0). A third particle R is kept at origin. Then

A. if particle R is displaced along x-axis it will start oscillating.

B. oscillations of R along x-axis are simple harmonic in nature

C. if R is displaced of R along y-axis, it starts oscillating

D. oscillations along y-axis may be simple harmonic in nature.

**Answer: C::D**

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18. x-t equation of a particle moving along x-axis is given as

$x = A + A(1 - \cos \omega t)$

A. particle oscillates simple harmonically between $x = 2A$ and $x = A$

B. velocity of particle is maximum at $x = 2A$

C. time taken by particles in travelling from x=A to x=3A is $\frac{\pi}{\omega}$

D. time taken by particles in travelling from x=A to x=2A is $\frac{\pi}{2\omega}$

**Answer: B::C::D**

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**19.** In simple harmonic motion of a particle, maximum kinetic energy is 40 J and maximum potential energy is 60 J. then

A. minimum potential energy will be 20 J

B. potential energy at half the displacement will be 30J

C. kinetic energy at half the displacement is 40 J

D. potential energy or kinetic energy at some intermediate position cannot be found the given data

**Answer: A::B**

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**20.** Two particles are in SHM with same amplitude A and same regualr frequency $\omega$. At time t=0, one is at x $=+\frac{A}{2}$ and the other is at $x=-\frac{A}{2}$. Both are moving in the same direction.

A. phase difference between the two particles is $\frac{\pi}{3}$

B. phase difference between the two particles is $\frac{2\pi}{3}$

C. they will collide after time t= $\frac{\pi}{2\omega}$

D. they will collide after time t=$\frac{3\pi}{4\omega}$

**Answer: A::C**

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**21.** Time period of spring-block system on surface of earth is $T_1$ and that of a simple pendulum is $T_2$. At height h = R (the radius of earth) the corresponding values are $T'_1$ and $T'_2$ then

A. $T'_1 > T_1$

B. $T'_1 = T_1$

C. $T'_2 > T_2$

D. $T'_2 < T_2$

**Answer: B::C**

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**22.** A linear harmonic oscillator of force constant $2 \times 10^6 N/m$ and amplitude (0.01 m) has a total mechanical energy of (160 J). Its.

A. Maximum potential energy is 100 J

B. maximum kinetic energy is 100 J

C. maximum potential energy is 160 J

D. maximum potential energy is zero

**Answer: B::C**

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**23.** Three simple harmonic motions in the same direction having the same amplitude and same period are superposed. If each differ in phase from the next by $45^\circ$, then

A. the resultant amplitude is $(1+\sqrt{2})$a

B. the phase of the resultant motion relative to the first is $\tan^{-1}\left(\frac{1}{2}\right)$

C. the energy associated with the resulting motion is $(3+2\sqrt{2})$ times the energy associated with any single motion.

D. the resulting motion is not simple harmonic

**Answer: A::C**

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**24.** If y, v and a represent displacement velocity and acceleration at any instant for a particle executing SHM, which of the following statements are true?

A. v and y may have some direction

B. v and a may have same direction

C. a and y may have same direction

D. a and v may have opposite directions.

**Answer: A::B::D**

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**25.** The time period of a particle in simple harmonic motion is T. Assume potential energy at mean position to be zero. After a time of $\frac{T}{6}$ it passes its mean position ,then at t=0 its,

A. velocity will be one half its maximum velocity

B. displacement will be one half of its amplitude

C. Acceleration will be nearly $86^{\circ}$ of its maximum acceleration

D. kinetic energy = potential energy

**Answer: A::C**

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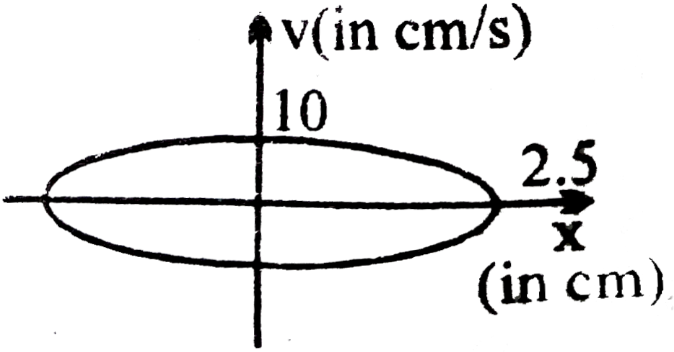
**26.** The figure shows a graph between velocity and displacement (from mean position) of a particle performing $SHM$:




A. the time period of the particle is 1.57s

B. the maximum acceleration will be 40 cm/$s^2$

C. the velocity of particle is $2\sqrt{21}$ cm/s when it is at a distance 1 cm from the mean position.

D. minimum acceleration is 4cm/$s^2$

**Answer: A::B::C**

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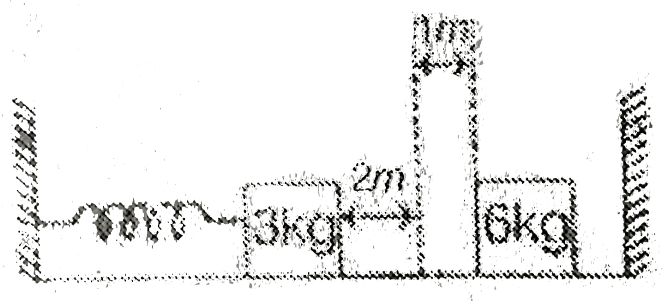
**27.** Two blocks of masses 3 kg and 6kg rest on horizontal smooth surface. The 3 kg block is attached to a spring with a force constant $k = 900 Nm^{-1}$ which is compressed 2m from beyond the equilibrium position. The 6 kg mass is at rest at 1m from mean position. 3kg mass strikes the 6 kg mass and the two stick together.




A. Veocity of the combined masses immediately after the collision is $10 ms^{-1}$.

B. velocity of the combined masses immediately after the collision is $5ms^{-1}$

C. amplitude of the resulting oscillation is $\sqrt{2}$m.

D. amplitude of the resulting oscillation is 1m.

**Answer: A::C**

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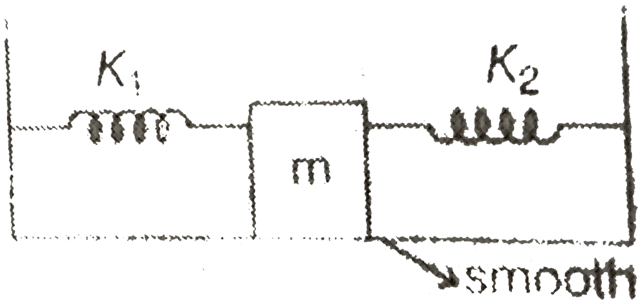
**28.** Two springs with negligible massess and force constant of $k_1 = 200Nm^{-1}$ and $k_2 = 160Nm^{-1}$ are attached to the block of mass m = 10kg as shown in the figure. Initially the block is at rest at the equilibrium position the block is at rest at the equilibrium position nor compressed. At time t=0, sharp impulse of 50 N-s is given to the block.




A. Period of oscillations for the mass m is $\frac{\pi}{3}$ s

B. maximum velocity of the mass m during its oscillations is $5ms^{-1}$

C. Data are insufficient to determine maximum velocity

D. Amplitude of oscillation is 0.42 m

**Answer: A::B**

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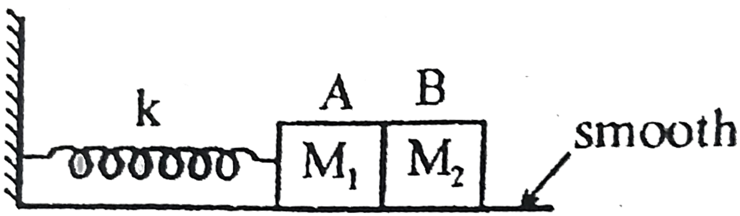
**29.** Initially spring is compressed by $x_0$ and blocks are in contact when system is released, then block starts moving and after some time contact between blocks, then




A. Blocks will be separated at natural length of spring.

B. After separation block A performs SHM os amplitude $x_0\sqrt{\frac{m_1}{m_1+m_2}}$

C. After separation maximum velocity of block A is $x_0\sqrt{\frac{k}{m_1+m_2}}$

D. After separation block A will perfom SHM of amplitude $x_0$

**Answer: A::B::C**

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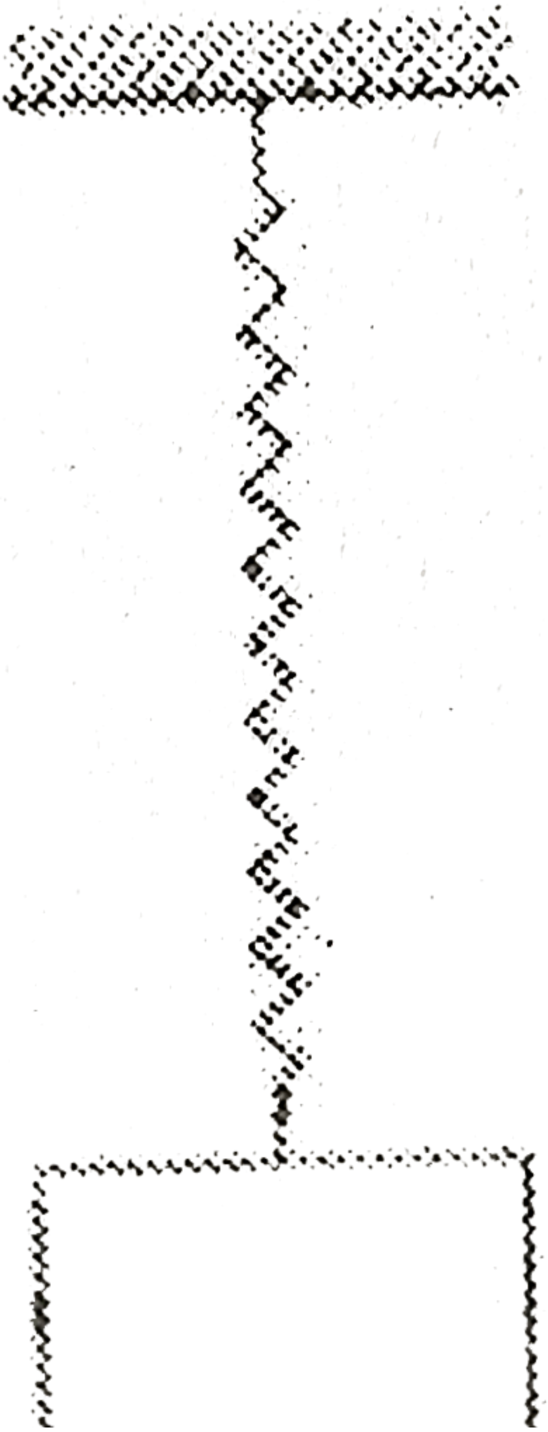
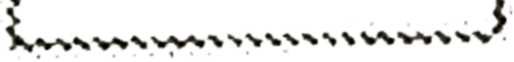
**30.** A block suspended from a spring is released when the spring is unstretched. Then choose the correct options.





A. Block starts oscillating simple harmonically

B. Throughout the motion block is accelerated

C. Maximum acceleration of block is g

D. In the upward motion of block, spring is detached from the block at its mean position, then block will rise upto more height from where it was released.

**Answer: A::C::D**

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**31.** Two smooth tunnels are dug from one side of earth's surface to the other side, one along a diameter are dropped from one end of each of the tunnels. Both particles oscillate simple harmonically along the tunnels. Let $T_1$ and $T_2$ be the time period of particles along the diameter and along the chord respectively. Then:

A. $T_1 = T_2$

B. $T_1 > T_2$

C. $v_1 = v_2$

D. $v_1 > v_2$

**Answer: A::D**

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**32.** Total energy of a particle executing oscillating motionis 3 joule and given by

$$E = x^2 + 2x + v^2 - 2v$$

Where x is the displacement from origin at x=0 and v is velocity of particle at x. Then choose the correct statements)

A. Amplitude of osciallation is 1m

B. Maximum velocity of particles during oscillation is 3m/sec.

C. Amplitude of oscillation is 2m

D. Maximum velocity of particle during oscillation is

$(\sqrt{5}+1)$ m/sec.

**Answer: C::D**

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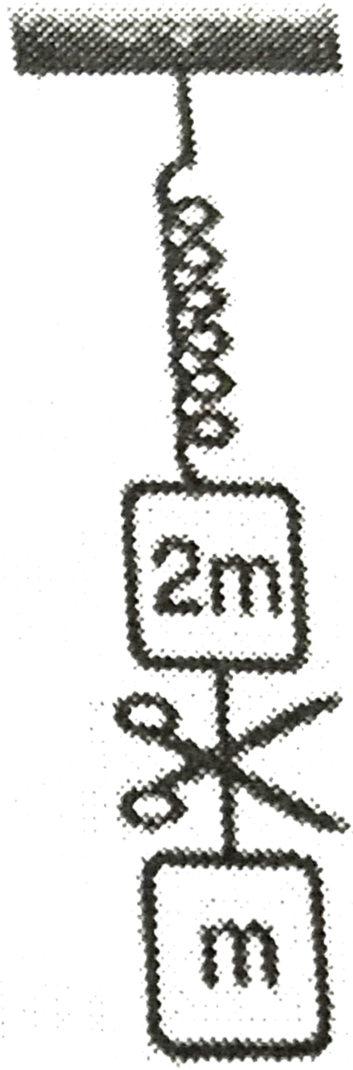
**33.** System shown in fig is in equilibrium and at rest. The spring and string are massless now the string is cut. The acceleration of mass 2m and m just after the string is cut will be:




A. $\frac{1}{6}$s

B. $\frac{1}{2}$s

C. $\frac{1}{3}$s

D. $\frac{2}{3}$s

**Answer: A::B**

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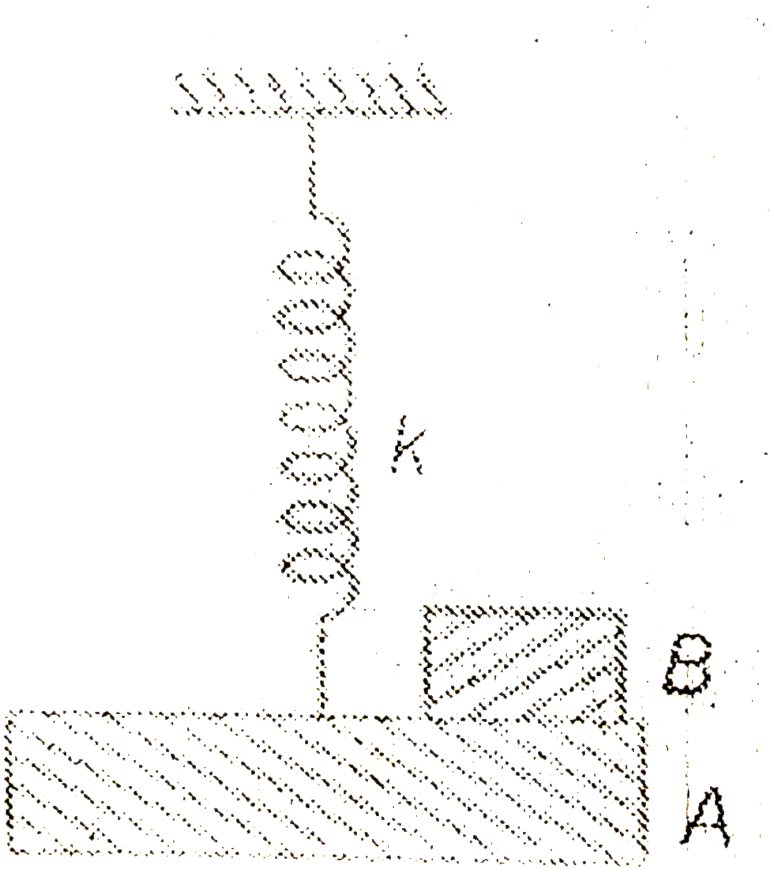
**34.** In the figure shown, a block A of mass m is rigidy attached to a light spring of stiffness k and suspended from a fixed support. Another block B of same mass is just placed on it and blocks are in equilibrium. Suddenly the block B is removed. Choose the correct options (s) afterward.




A. Block A will start SHM

B. Amplitude of oscillation of the block A is $\frac{mg}{k}$)

C. Maximum speed acquired by the block A is $\sqrt{\frac{m}{2k}}$

D.

**Answer: A::B::C**

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**35.** Passage IX) For SHM to take place force acting on the body should be proportional to -x or F = -kx. If A be the amplitude then energy of oscillation is $\frac{1}{2}\text{k}A^2$

Force acting on a block is $F = ( - 4x + 8)$. Here F is in Newton and x the position of block on x-axis in meter

A. motion of the block is periodic but not simple harmonic

B. Motion of the block is not periodic

C. motion of the block is simple harmonic about origin, x=0

D. motion of the block is simple harmonic about x=2m.

**Answer: D**

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**36.** Passage IX) For SHM to take place force acting on the body should be proportional to -x or F = -kx. If A be the amplitude then energy of oscillation is $\frac{1}{2}kA^2$

Force acting on a block is $F = (-4x + 8)$.

Here F is in Newton and x the position of block on x-axis in meter If energy of osciallation is 18 J, between what points the block will oscillate?

A. between x=0 and x=4m

B. between x=-1m and x=5m

C. between x=-2m and x=6m

D. between x=1m and x=3m

**Answer: B**

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**37.** Passage X) A 2kg block hangs without vibrating at the bottom end of a spring with a force constant of 400 N/m. The top end of the spring is attached to the ceiling of an elevator car. The car is rising with an upward acceleration of $5\frac{m}{s^2}$ when the acceleration suddenly ceases at t=0 and the car moves upward with constant speed. (g=10m/$s^2$)

What is the angular frequency of oscillation of the block after the acceleration ceases?

A. $(a)10\sqrt{2}$rad/s

B. $(b)20ra\frac{d}{s}$

C. $(c)20\sqrt{2}$rad/s

D. $(d)32ra\frac{d}{s}$

**Answer: A**

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**38.** Passage X) A 2kg block hangs without vibrating at the bottom end of a spring with a force constant of 400 N/m. The top end of the spring is attached to the ceiling of an elevator car. The car is rising with an upward acceleration of $5\frac{m}{s^2}$ when the acceleration suddenly ceases at t=0 and the car moves upward with constant speed. (g=10m/$s^2$)

The amplitude of the oscillations is

A. (a)7.5 cm

B. (b)5 cm

C. (c)2.5 cm

D. (d)1 cm

**Answer: C**

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**39.** A 2kg block hangs without vibrating at the bottom end of a spring with a force constant of 400N/m. The top end of the spring is attached to the ceiling of an elevator car. The car is rising with an upward acceleration of 5m/s2 when the acceleration suddenly ceases at time t=0 and the car moves upward with constant speed (g=10m/s2 The amplitude of the oscillation is

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**40.** Passage XI) The differential equation of a particle undergoing SHM is given by $a\frac{d^2x}{dt^2}$+bx = 0. The particle starts from the extreme position.

The time period of osciallation is given by

A. $\frac{2\pi}{b}$

B. $(2\pi)\sqrt{b}$

C. $(2\pi)\sqrt{\frac{b}{a}}$

D. $\left(2\pi\left(\sqrt{\frac{a}{b}}\right)\right.$

**Answer: D**

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**41.** Passage XI) The differential equation of a particle undergoing SHM is given by $a\frac{d^2x}{dt^2}$+bx = 0. The particle starts from the extreme position.

The ratio of the maximum acceleration to the maximum velocity of the particle is

A. b/a

B. a/b

C. $\sqrt{\frac{a}{b}}$

D. $\sqrt{\frac{b}{a}}$

**Answer: D**

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**42.** The equation of motion may be given by

A. $x = \pm A \sin\left(\sqrt{\frac{b}{a}}\right)$t

B. $x = \pm A \cos\left(\sqrt{\frac{b}{a}}\right)t$

C. $x = \pm A \sin\left(\sqrt{\frac{b}{a}}t + \theta\right)$ where $\theta = \frac{\pi}{2}$

D. None of the above.

**Answer: B**

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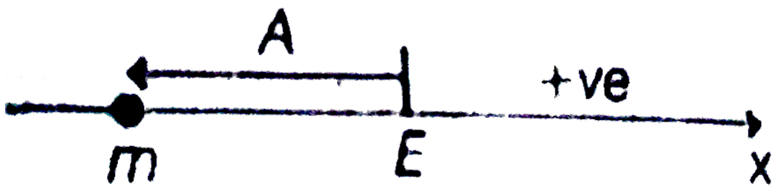
**43.** Passage XII)_ A particle of mass m is constrained to move along x-axis. A force F acts on the particle. F always points toward the position labelled E. For example, when the particle is to the left of E,Fpoints to the right. The magnitude of F is consant except at point E where it is zero. The systm is horizontal. F is the net force acting on the particle. the particle is displaced a distance A towards left from the equilibrium position E and released from rest at t=0.

What it is the time period of periodic motion of particle.




A. $4\left(\sqrt{\frac{2Am}{F}}\right.$

B. $2\left(\sqrt{\frac{2Am}{F}}\right)$

C. $\left(\sqrt{\frac{2Am}{F}}\right)$

D. None of these

**Answer: A**

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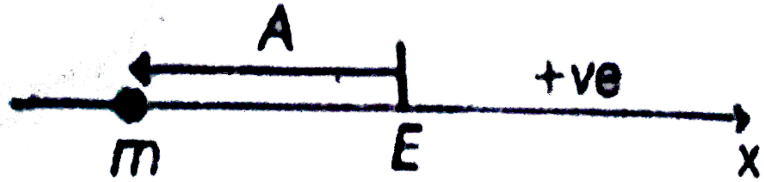
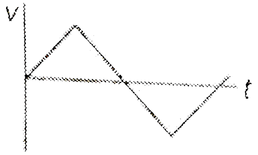
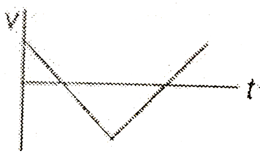
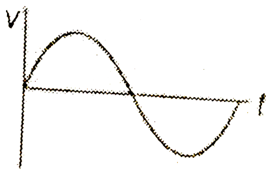
**44.** Passage XII)_ A particle of mass m is constrained to move along x-axis. A force F acts on the particle. F always points toward the position labelled E. For example, when the particle is to the left of E,Fpoints to the right. The magnitude of F is consant except at point E where it is zero. The systm is horizontal. F is the net force acting on the particle. the particle is displaced a distance A towards left from the equilibrium position E and released from rest at t=0.

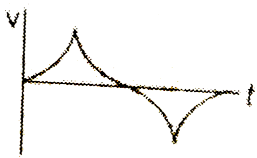
Velocity-time graph of the particle is




A. 


B. 


C. 


D. 


**Answer: A**

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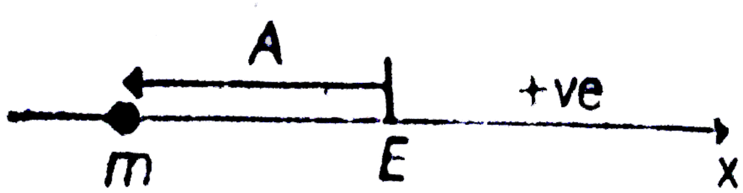
**45.** Passage XII)_ A particle of mass m is constrained to move along x-axis. A force F acts on the particle. F always points toward the position labelled E. For example, when the particle is to the left of E,Fpoints to the right. The magnitude of F is consant except at point E where it is zero. The systm is horizontal. F is the net force acting on the particle. the particle is displaced a distance A towards left from the equilibrium position E and released from rest at t=0.

Find minimum time it will take to reach from x $= -\frac{A}{2}$ to 0




A. $\frac{3}{2}\sqrt{\frac{mA}{F}}(\sqrt{2}-1)$

B. $\sqrt{\frac{mA}{F}}(\sqrt{2-1})$

C. $2\sqrt{\frac{mA}{F}}(\sqrt{2}-1)$

D. None of these

**Answer: B**

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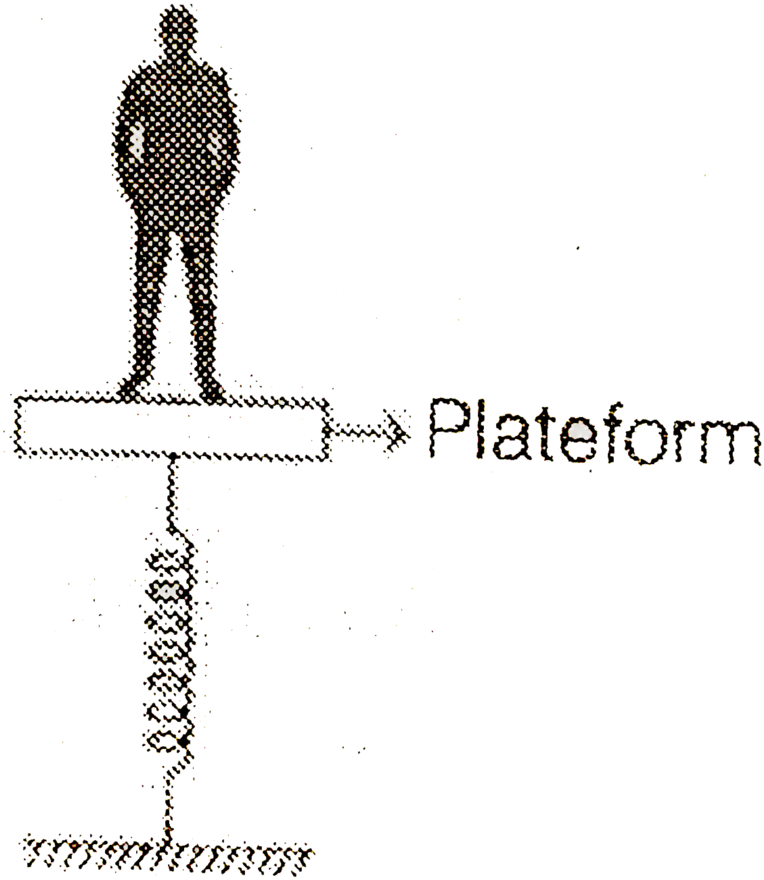
**46.** Passage XIII) Mr. Anoop having mass 50 kg is standing on a massless platform which oscillates up and down (doing SHM) of frequency 0.5 $\sec^{-1}$ and amplitude 0.4m. Platforms has a weighing machine fitted in it (Which is also massless). On which Anoop is standing. (Take $\left(\pi^2\right)$ = 10 and g = 10 $m/s^2$. Assume that at t=0 (Platform+Anoop) is at their highest point of oscillation.

[More than one option is correct]




Which of the following will be correct for reading of weighting machine

A. Maximum reading of weighing machine will be 70 kg

B. maximum reading will be at mean position

C. maximum reading will be at lower extremem position

D. Maximum reading will be at upper extreme position.

**Answer: A::C**

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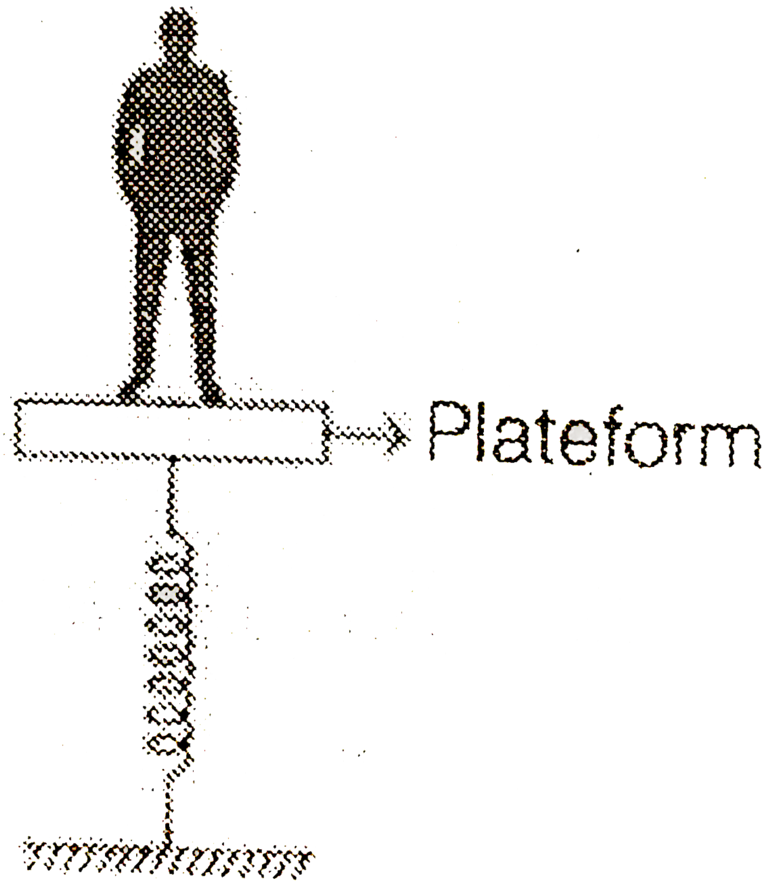
**47.** Passage XIII) Mr. Anoop having mass 50 kg is standing on a massless platform which oscillates up and down (doing SHM) of frequency 0.5 $\sec^{-1}$ and amplitude 0.4m. Platforms has a weighing machine fitted in it

(Which is also massless). On which Anoop is standing.

(Take $\left(\pi^2\right)$ = 10 and g = 10 $m/s^2$. Assume that at t=0

(Platform+Anoop) is at their highest point of oscillation.

[More than one option is correct]



Which of the following will be correct for reading of weighting machine

A. When reading is 55 kg, then compression will be 1.1m

B. When reading is 50 kg, then compression will be 1.0m

C. When reading is 50kg, then compression will be 1.1m

D. When reading is 55kg, then composition will be 1.0m

**Answer: A::B**

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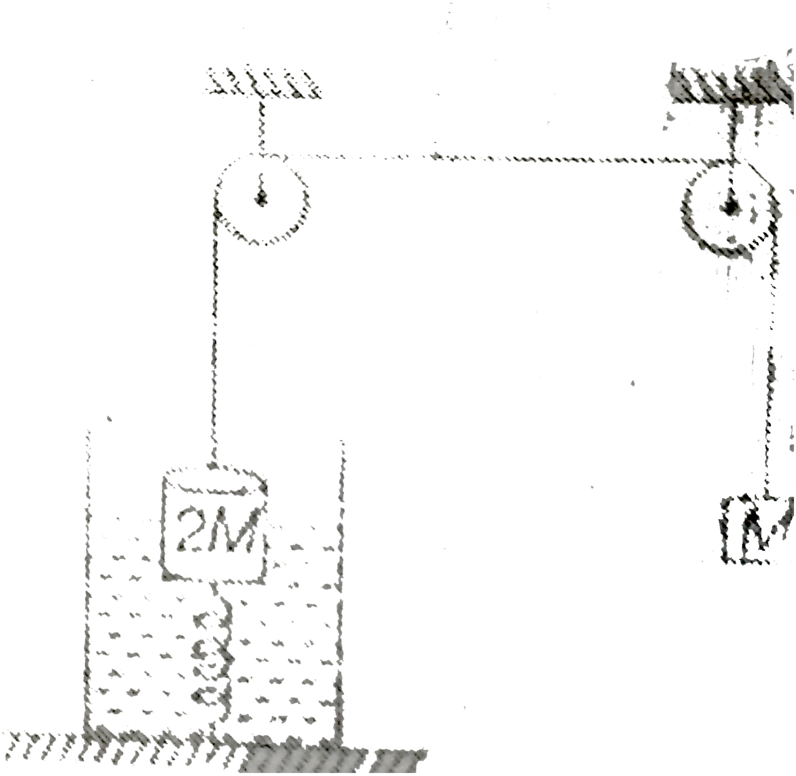
**48.** Passage XIV) A uniform cylindrical block of mass 2M and cross-sectional area A remains partially submerged in a non viscous liquid of density $\rho$, density of the material of the cylinder is $3\rho$. The cylinder is connected to lower end of the tank by means of a light spring of spring constant K. The other end of the cylinder is connected to anotehr block of mass M by means of a light inextensible sting as shown in the figure. The pulleys shown are massless and frictionless and assume that the cross-section of the cylinder is very small in comparison to that of the tank. Under equilibrium conditions, half of the cylinder is submerged. [given that cylinder always remains partially immersed)

Under equilibrium conditions




A. extensions of the spring is $\frac{Mg}{3K}$

B. compression of the spring is $\frac{2Mg}{3K}$

C. compression of the spring is $\frac{Mg}{8}k$

D. extension of the spring is $\frac{Mg}{6k}$

**Answer: B**

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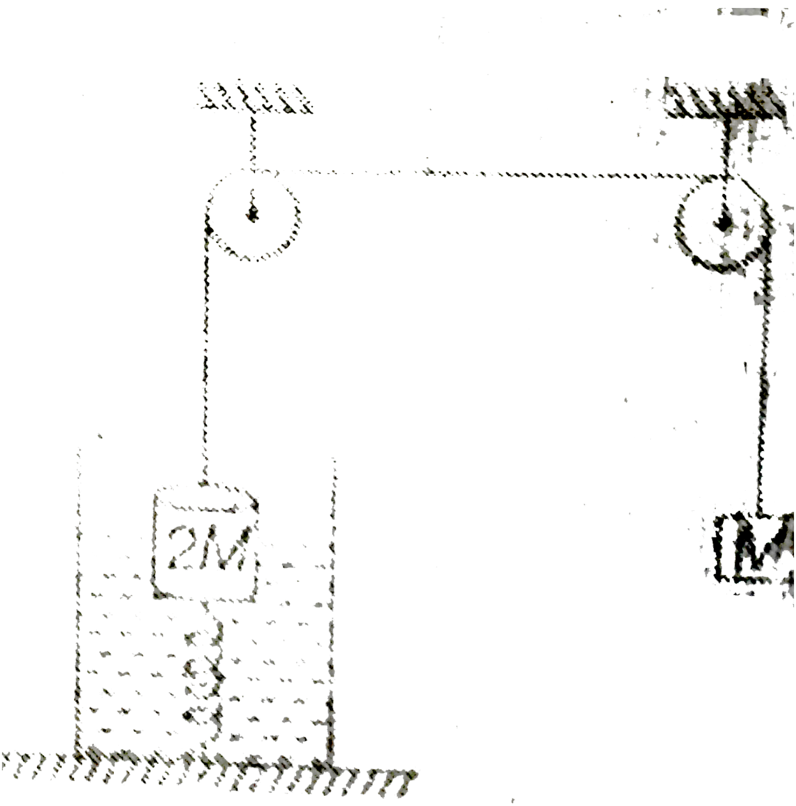
**49.** Passage XIV) A uniform cylindrical block of mass 2M and cross-sectional area A remains partially submerged in a non viscous liquid of density $\rho$, density of the material of the cylinder is $3\rho$. The cylinder is connected to lower end of the tank by means of a light spring of spring constant K. The other end of the cylinder is connected to anotehr block of mass M by means of a light inextensible sting as shown in the figure. The pulleys shown are massless and frictionless and assume that the cross-section of the cylinder is very small in comparison to that of the tank. Under equilibrium conditions, half of the cylinder is submerged. [given that cylinder always remains partially immersed)




By what maximum distance cylinder will be pushed downward into the liquid from equilibrium position so that when it is set free then tension in the string will not vanish [Assume at equilibrium position system was at rest]

A. $\frac{3Mg}{K + A\rho g}$

B. $\frac{3Mg}{2(K + A\rho g)}$

C. $\frac{8Mg}{3(K + A\rho g)}$

D. $\frac{3Mg}{2K + 3A\rho g}$

**Answer: A**

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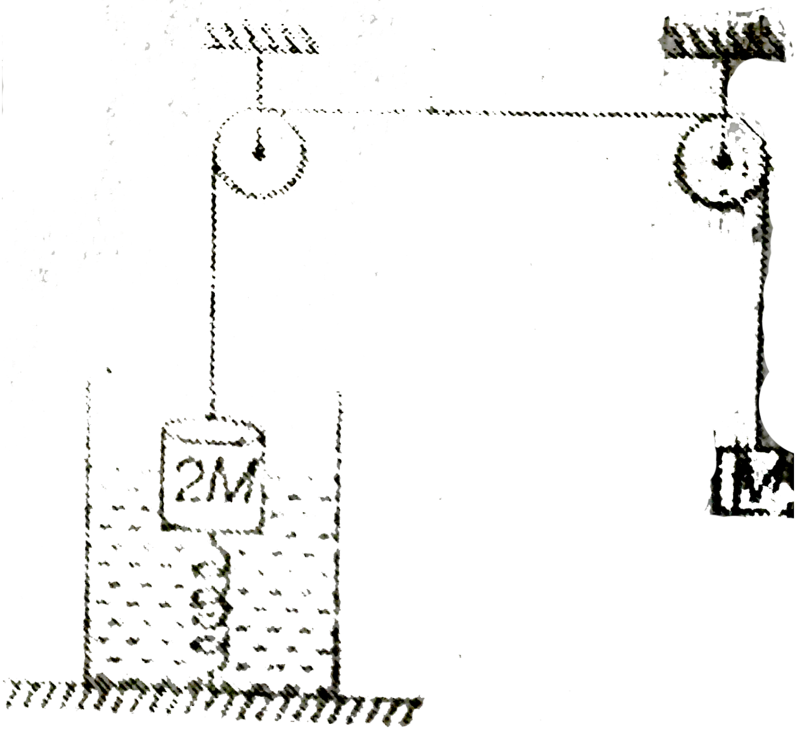
**50.** Passage XIV) A uniform cylindrical block of mass 2M and cross-sectional area A remains partially submerged in a non viscous liquid of density $\rho$, density of the material of the cylinder is $3\rho$. The cylinder is connected to lower end of the tank by means of a light spring of spring constant K. The other end of the cylinder is connected to anotehr block of mass M by means of a light inextensible sting as shown in the figure. The pulleys shown are massless and frictionless and assume that the cross-section of the cylinder is very small in comparison to that of the tank. Under equilibrium conditions, half of the cylinder is submerged. [given that cylinder always remains partially immersed)




If the cylinder is pushed down from equilibrium by a distance which is half the distance as calculated in the above question, determine time period of subsequent motion.

A. `(2pisqrt((3M)/(2(K+Arhog)

B. $\left(2\pi\sqrt{\dfrac{M}{2K+A\rho g}}\right.$

C. $2\pi\sqrt{\frac{3M}{K+A\rho g}}$

D. $2\pi\sqrt{\frac{2M}{K+3A\rho g}}$

**Answer: C**

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## Comprehension types

**1.** Passage I) In simple harmonic motion force acting on a particle is given as $F=-4x$, total mechanical energy of the particle is 10 J and amplitude of oscillations is 2m, At time t=0 acceleration of the particle is $-16\frac{m}{s^2}$. Mass of the particle is 0.5 kg.

Potential energy of the particle at mean position is

A. 10 J

B. 8 J

C. 6 J

D. 2 J

**Answer: D**

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**2.** Passage I) In simple harmonic motion force acting on a particle is given as $F = -4x$, total mechanical energy of the particle is 10 J and amplitude of oscillations is 2m, At time t=0 acceleration of the particle is $-16\frac{m}{s^2}$. Mass of the particle is 0.5 kg.

Displacement time equation equation of the particle is

A. $x = 2\sin 2t$

B. $x = 2\sin 4t$

C. $x = 2\cos 2t$

D. None of these

**Answer: D**

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**3.** Passage I) In simple harmonic motion force acting on a particle is given as $F = -4x$, total mechanical energy of the particle is 10 J and amplitude of oscillations is 2m, At time t=0 acceleration of the particle is $-16\frac{m}{s^2}$. Mass of the particle is 0.5 kg.

At x=+1m, potential energy and kinetic energy of the particle are

A. 2 J and 8 J

B. 8 J and 2 J

C. 6 J and 4 J

D. 4 J and 6 J

**Answer: D**

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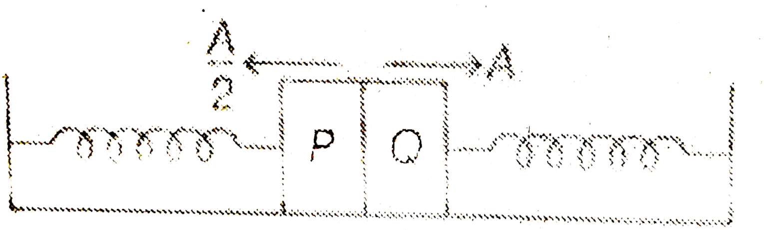
**4.** Passage II) Two identicla blocks P and Q have masses m each. They are attached to two identical springs initially unstretched. Now the left spring (along with P) is compressed by $\frac{A}{2}$ and the right spring (along with Q) is compressed by A. Both the blocks are released simultaneously. They collide perfectly inelastically. Initially time period of both blocks was T.




The time period of oscillation of combined mass is

A. $\frac{T}{\sqrt{2}}$

B. $\sqrt{T}$

C. T

D. $\frac{T}{2}$

**Answer: C**

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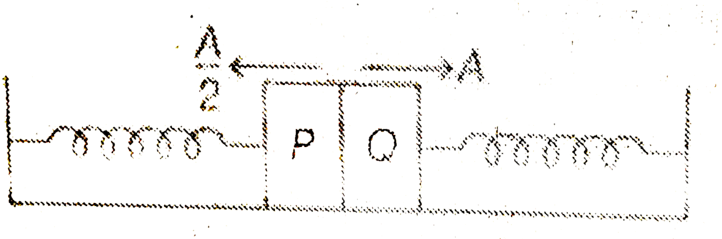
**5.** Passage II) Two identicla blocks P and Q have masses m each. They are attached to two identical springs initially unstretched. Now the left spring (along with P) is compressed by $\frac{A}{2}$ and the right spring (along with Q) is compressed by A. Both the blocks are released simultaneously. They collide perfectly inelastically. Initially time period of both blocks was T.




The amplitude of combined mass is

A. $\frac{A}{4}$

B. $\frac{A}{2}$

C. $\frac{2A}{3}$

D. $\frac{3A}{4}$

**Answer: A**

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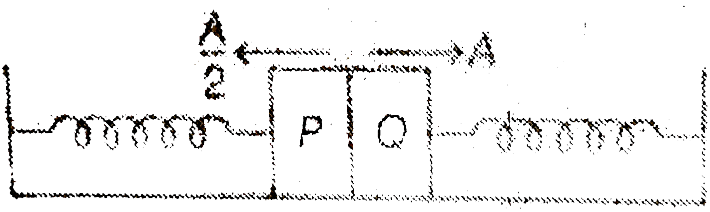
**6.** Passage II) Two identicla blocks P and Q have masses m each. They are attached to two identical springs initially unstretched. Now the left spring (along with P) is compressed by $\frac{A}{2}$ and the right spring (along with Q) is compressed by A. Both the blocks are released simultaneously. They collide perfectly inelastically. Initially time period of both blocks was T.




What is energy of osciallation of the combined mass?

A. $\frac{1}{2}kA^2$

B. $\frac{1}{4}kA^2$

C. $\frac{1}{8}kA^2$

D. $\left(\frac{1}{16}\right)kA^2$

**Answer: D**

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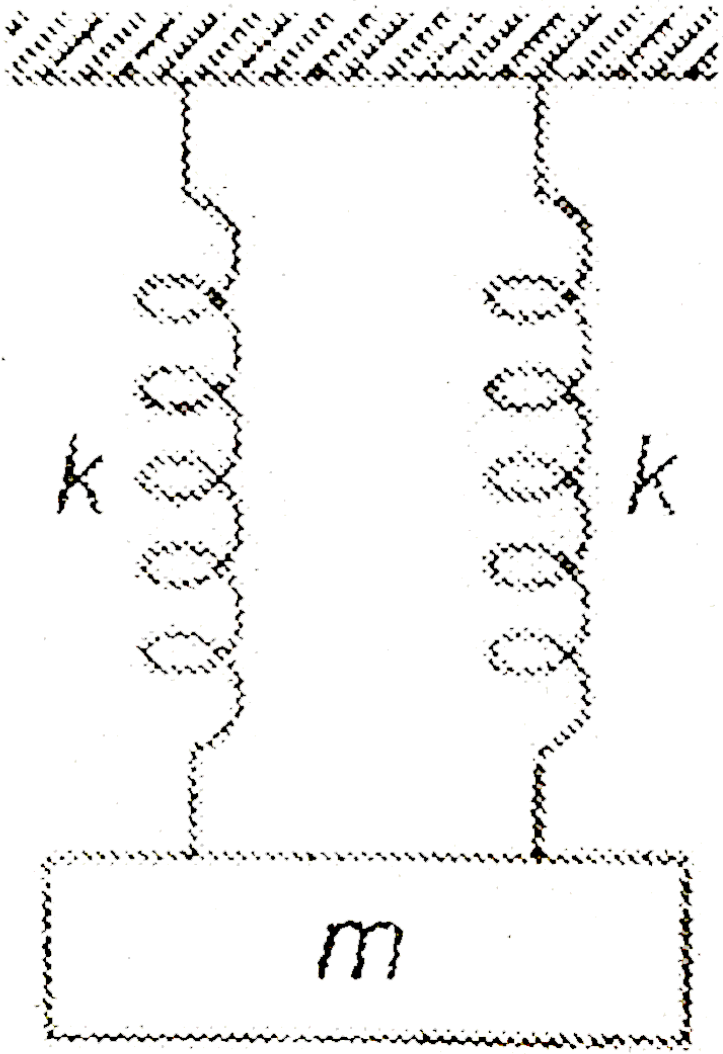
**7.** Passage III A block of mass m =1/2 kg is attached with two springs each of force contant k=10N/m as shown. The block is oscillating vertically up and down with amplitude A=25cm. When the block is at its mean position one of the spring breaks without changing momentum of block.




What is the new amplitude of osciallation of the block.

A. 10.6cm

B. 43.3 cm

C. 25 cm

D. 62.2 cm

**Answer: B**

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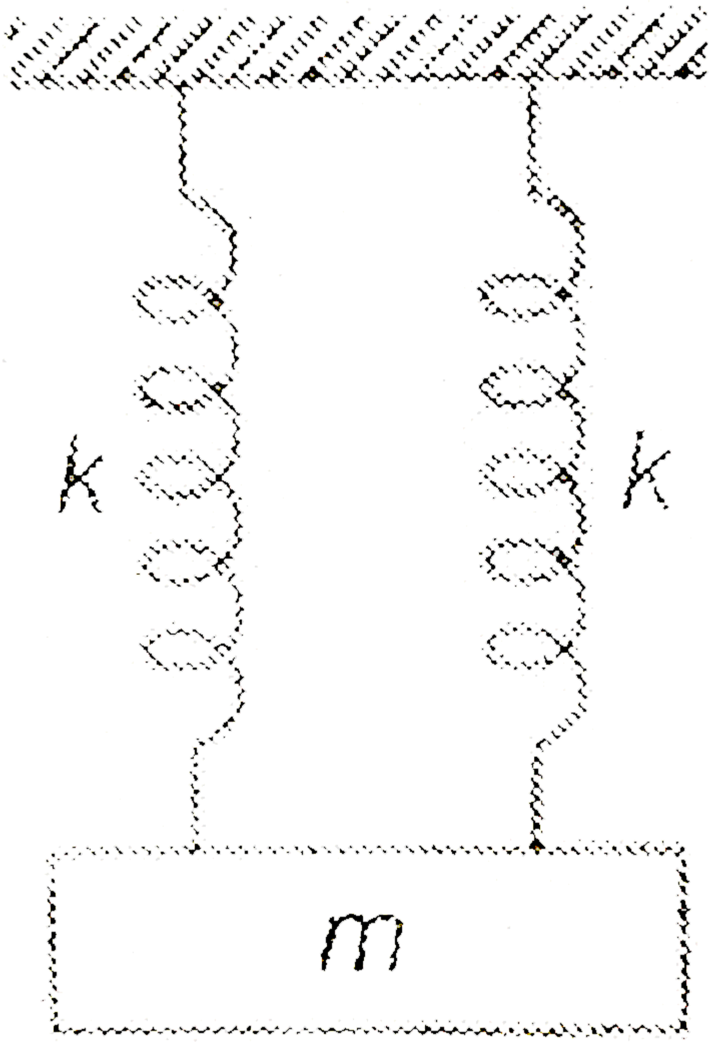
**8.** Passage III A block of mass m =1/2 kg is attached with two springs each of force contant k=10N/m as shown. The block is oscillating vertically up and down with amplitude A=25cm. When the block is at its mean position one of the spring breaks without changing momentum of block.




If instead of breaking one spring m/2 mass would have fallen from the block, then what will be the new amplitude?

A. 21.6cm

B. 26.2 cm

C. 15.8 cm

D. 16.9 cm

**Answer: A**

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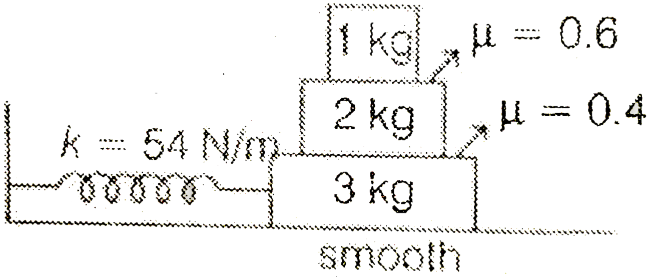
**9.** Passage IV) Angular frequency in SHM is given by $\omega = \sqrt{\frac{k}{m}}$. Maximum acceleration in SHM is $\omega^2$ A and maximum value of friction between two bodies in contact is $\mu N$, where N is the normal reaction between the bodies.




In the figure shown, what can be the maximum amplitude of the system so that there is no slipping between any of hte blocks?

A. $\frac{2}{7}$m

B. $\frac{3}{4}$m

C. $\frac{4}{9}$m

D. $\frac{10}{3}$m

**Answer: C**

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**10.** Angular frequnecy in SHM is given by $\omega = \sqrt{\frac{k}{m}}$,

Maximum acceleration in $SHM$ is $\omega^2 A$ and maximum value of frication between two bodies in contact is $\mu N$, where ?N is the normal reaction between the bodies.

Now the value of k, the force constant is increased then the maximum amplitude calculated in above question will :-

A. remain same

B. increase

C. decrease

D. data is insufficient

**Answer: C**

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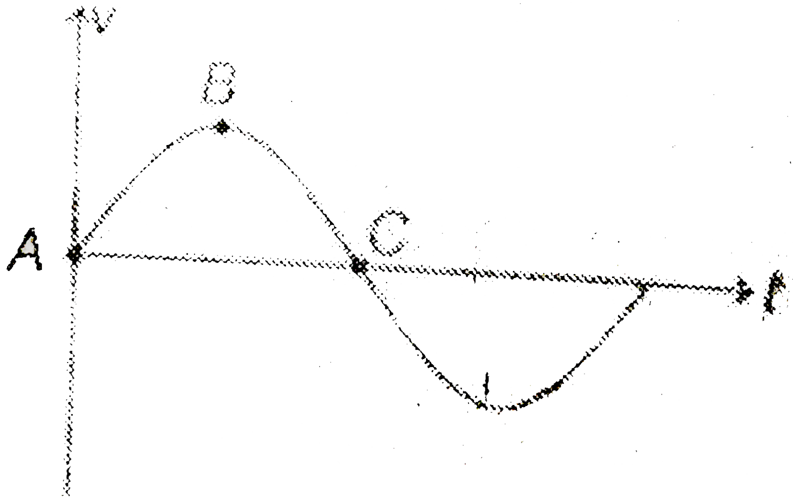
**11.** Passage V) In SHM displacement, velocity and acceleration all oscillate simple harmonically with same angular frequency $\omega$. Phase difference between any two is $\frac{\pi}{2}$ except that between displacement and acceleration which is $\pi$.

v-t graph of a particle is SHM is as shown in figure

Choose the wrong option.




A. At A particle is at extreme position

B. At B acceleration of particle is zero

C. At C acceleration of particle is maximum and in negative direction.

D. None of the above.

**Answer: D**

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**12.** Passage V) In SHM displacement, velocity and acceleration all oscillate simple harmonically with same angular frequency $\omega$. Phase difference between any two is $\frac{\pi}{2}$ except that between displacement and acceleration which is $\pi$.

Displacement -time equation of a particle is given as $x = A\sin\left(\omega t + \frac{\pi}{6}\right) - A\cos\left(\omega t + \frac{\pi}{6}\right)$, then:

A. the motion of the particle is not simple harmonic

B. at t=0, acceleration of particles is negative

C. at t-0, velocity of particle is negative

D. None of the above.

**Answer: D**

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**13.** Passage VI Two particles collide when they are at same position at same time.

Displacement time equation of two particles moving along x-axis are $x_1 = (8 + 3\sin\omega t)m$

and $x_2 = (4\cos\omega t)m$

Here, $\omega = \pi ra\frac{d}{s}$

The two particles will collide after time t=...................s.

A. 1

B. 2

C. 4

D. None of the above.

**Answer: D**

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**14.** Passage VI Two particles collide when they are at same position at same time.

Displacement time equation of two particles moving along x-axis are $x_1 = (8 + 3\sin \omega t)m$ and $x_2 = (4\cos \omega t)m$

Here, $\omega = \pi ra\frac{d}{s}$

The two particles will collide after time t=..................s.

A. 1

B. 2

C. 3

D. All of these

**Answer: B**

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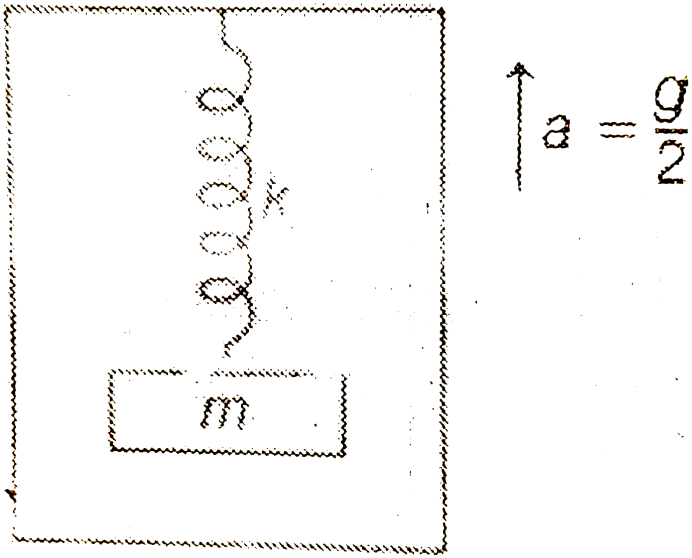
**15.** Passage VII There is a spring block system in a lift moving upwards with acceleration $a = \frac{g}{2}$




In mean position (of block's oscillations) spring is

A. Compressed by $\frac{mg}{2k}$

B. elongated by $\frac{mg}{k}$

C. Elongated by $\frac{mg}{2k}$

D. elongated by $\frac{3mg}{2k}$

**Answer: D**

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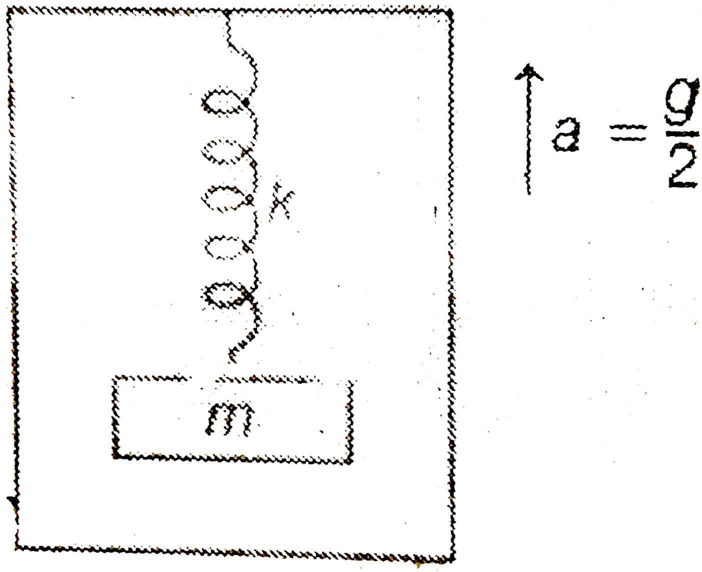
**16.** Passage VII There is a spring block system in a lift moving upwards with acceleration $a = \frac{g}{2}$




If maximum extension in the spring is $\frac{5mg}{2k}$, then maximum upward accleration $(a_1)$ and maximum downward acceleration $(a_2$ of the block are

A. $a_1$=(3g)/2`

B. $a_2 = \frac{g}{2}$

C. both are correct

D. both are wrong

**Answer: C**

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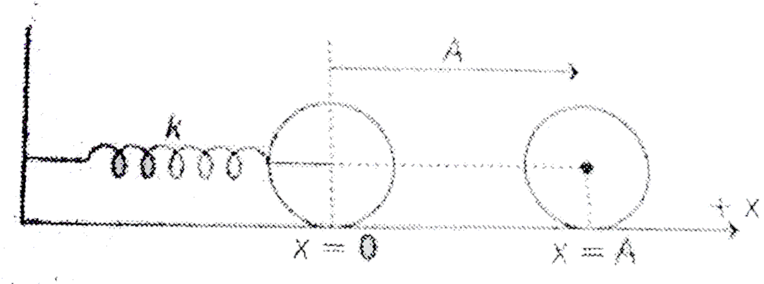
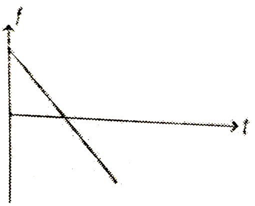
**17.** Passage VIII A disc of mass m and radius R is attached with a spring of force contant k at its center as shown in figure. At x-0, spring is unstretched. The disc is moved to x=A and then released. There is no slipping between disc and ground. Let f be the force of friction on the disc from the ground.

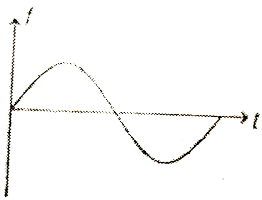



f versus t (time) graph will be as

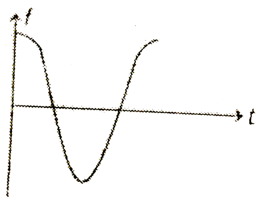
A.




B.




C.




D.

**Answer: C**

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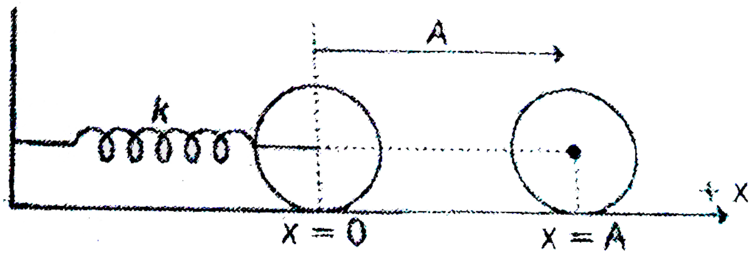
**18.** In the problem if k = 10 N/m, m=2kg, R=1m and A=2m.

Find linear speed of the disc at mean position.




A. $\sqrt{\frac{40}{3}}$m/s

B. $\sqrt{20}$m/s

C. $\sqrt{\frac{10}{3}}$m/s

D. $\sqrt{\frac{50}{3}}$m/s

**Answer: A**

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## Matrix matching type questions

**1.** In SHM, match the following.

| Table-1 | Table-2 |
|---|---|
| (A) Displacement and velocity | (P) Phase difference of zero |
| (B) Displacement and acceleration | (Q) Phase difference of $\pi/2$ |
| (C) Velocity and acceleration | (R) Phase difference of $\pi$ |

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**2.** In the equation $y = A\sin\left(\omega t + \frac{\pi}{4}\right)$ match the following for x=$\frac{A}{2}$.

| Table-1 | Table-2 |
|---|---|
| (A) Kinetic energy | (P) Half the maximum value |
| (B) Potential energy | (Q) 3/4 times the maximum value |
| (C) Acceleration | (R) 1/4 times the maximum value |
| | (S) Cannot say anything |

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**3.** In spring-block system match the following

| Table-1 | Table-2 |
|---|---|
| (A) If only $k$ (the spring constant) is made 4-times | (P) Speed will become 16 times |
| (B) If only $m$ (the mass of block) is made 4-times | (Q) Potential energy will become four times |
| (C) If $k$ and $m$ both are made 4-times | (R) Kinetic energy will remain unchanged |
| | (T) None |

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4. In $y = A\sin\omega t + A\sin\left(\omega t = \frac{2\pi}{3}\right)$, match the following.

| Column I | | Column II | |
|---|---|---|---|
| (A) | Motion | (p) | Is periodic but not SHM |
| (B) | Amplitude | (q) | Is SHM |
| (C) | Initial phase | (r) | $A$ |
| (D) | Maximum velocity | (s) | $\pi/3$ |
| | | (t) | $\omega A/2$ |
| | | (u) | None |

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**5.** In SHM match the following

| Table-1 | Table-2 |
|---|---|
| (A) Motion | (P) is periodic but not SHM |
| (B) Amplitude | (Q) is SHM |
| (C) Initial phase | (R) A |
| (D) Maximum velocity | (S) $\pi/3$ |
| | (T) $\omega A/2$ |
| | (U) None |

**5.** In SHM match the following.

| Table-1 | Table-2 |
|---|---|
| (A) Acceleration-displacement graph | (P) Parabola |
| (B) Velocity-acceleration graph | (Q) Straight line |
| (C) Acceleration-time graph | (R) Circle |
| (D) Velocity-time graph | (S) None |

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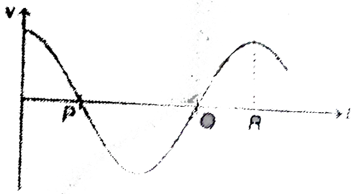
**6.** Velocity-time graph of a particle in SHM is as shown in figure. Match the following




| Table-1 | Table-2 |
|---|---|
| (A) At $P$ | (P) Particle is at $x = -A$ |
| (B) At $Q$ | (Q) Acceleration of particle is maximum |
| (C) At $R$ | (R) Displacement of particle is zero |
| | (S) Acceleration of particle is zero |
| | (T) None |

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**7.** A uniform rod of length l is suspended from a point P. and the rod is made to undergo small oscillations.

Match the following

| Table-1 | Table-2 |
|---|---|
| (A) If $P$ is the centre of mass then time period is | (P) Zero |
| (B) If $P$ is the end point then time period is | (Q) $2\pi\sqrt{\frac{l}{3g}}$ |
| (C) Length of simple pendulum having the time period equal to that of the rod when $P$ is end point | (R) $\frac{l}{3}$ |
| | (S) $\frac{2l}{3}$ |
| | (T) None |

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**8.** In the two block spring system, force constant of spring is k = 6N/m. Spring is stretched by 12 cm and then left. Match the following.


| Table-1 | Table-2 |
|---|---|
| (A) Angular frequency of oscillation | (P) $4.8 \times 10^{-3}$ SI unit |
| (B) Maximum kinetic energy of 1 kg | (Q) 3 SI unit |
| (C) Maximum kinetic energy of 2 kg | (R) $2.4 \times 10^{-3}$ SI unit |
| | (S) None |

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**9.** In case of second's pendulum, match the following (consider shape of earth also)

| Table-1 | Table-2 |
|---|---|
| (A) At pole | (P) $T > 2$ s |
| (B) On a satellite | (Q) $T < 2$ s |
| (C) At mountain | (R) $T = 2$ s |
| (D) At centre of earth | (S) $T = 0$ |
| | (T) $T = \infty$ |

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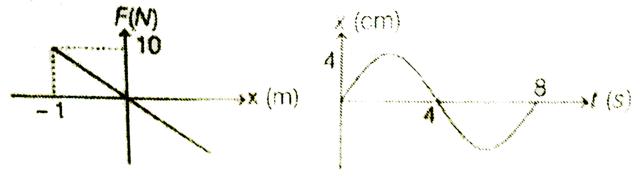
**10.** F-x and x-t graph of a principle in SHM are as shown in figure. Match the following.




| Table-1 | Table-2 |
|---|---|
| (A) Mass of the particle | (P) $\frac{\pi}{2}$ SI unit |
| (B) Maximum kinetic energy of particle | (Q) $(160/\pi^2)$ SI unit |
| (C) Angular frequency of particle | (R) $(8.0 \times 10^{-3})$ SI unit |
| | (T) None |

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**11.** x-t equation of a particle in SHM is given as x= $1.0 \sin(12\pi t)$ in SI units. Potential energy at mean position is zero. Mass of particle is $\frac{1}{4}$ kg. Match the following table (SI units).

| Table-1 | Table-2 |
|---|---|
| (A) Frequency with which kinetic energy oscillates | (P) $\frac{1}{2}$ |
| (B) Speed of particle is maximum at time $t =$ | (Q) $18\pi^2$ |
| (C) Maximum potential energy | (R) 12 |
| (D) Force constant $K$ | (S) $36\pi^2$ |

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**12.** In a spring-block system, match the following:

| Table-1 | Table-2 |
|---|---|
| (A) If only mass of the block is doubled | (P) Energy of oscillation becomes 4 times |
| (B) If only amplitude of oscillation is doubled | (Q) Speed of particle becomes 2 times |
| (C) If only force constant is doubled | (R) Time period becomes $\sqrt{2}$ times |
| (D) If only angular frequency is doubled | (S) Potential energy becomes 2 times |

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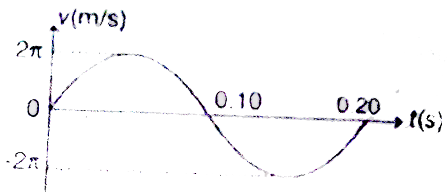
**13.** A simple harmonic oscillator consists of a block attached to a spring with k=200N/m. The block slides on a frictionless horizontal surface, with equilibrium point x=0. A graph of the block velocity v as a function of time t is shown. Correct match the required information in the left column with the values given in table.




| Table-1 | Table-2 |
|---|---|
| (A) The block's mass in kg | (P) −0.20 |
| (B) The block's displacement at $t = 0$ in metres | (Q) −200 |
| (C) The block's acceleration at $t = 0.10$ s in $m/s^2$ | (R) 0.20 |
| (D) The block's maximum kinetic energy in Joule | (S) 4.0 |

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## Integer type questions

**1.** Two particles are in SHM with the same amplitude and frequency along the same line and about the same point. If the maximum separation between them is $\sqrt{3}$ times their amplitude, the phase difference between them is $\frac{2\pi}{n}$. Find value of n

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**2.** A particle executes SHM with a frequency of 25 vib/s and has an amplitude of 0.02m. The speed of the particle

0.30 seconds after it is in the equilibrium position is ($n\pi$ )m/s. Find value of n

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**3.** A block of mass M=1 kg resting on a smooth horizontal surface is connected to a horizontal light spring of spring constant k=6N/m whose other end is fixed to a verticall wall. Another block of mass m=0.5 kg is placed over the block M. If the coefficient of friction between the two blocks $\mu$=0.4, find the maximum kinetic energy (in J) that the system can have for simple hormonic oscillation under the action of the spring.

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**4.** Force constant of a weightless spring is 16 N/m. A body of mass 1.0 kg suspended from it is pulled down through 5 cm from its mean position and the released. The maximum kinetic energy of the system (spring+body) will be (0.0x) J. Find value of x.

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**5.** A solid cube floats in water half immersed and has small vertical oscillations of time period $\frac{\pi}{5}$ s . Its mass (in kg) is (take , $g = 10ms^{-2}$)

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**6.** A particle under the action of one SHM has a period of 3 s and under the effect of another it has a period 4s. Its time period under the combined action of both the SHM's in the same direction is (0.4x)second. Find value of x?

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**7.** A cubical block of mass M vibrates horizontally with amplitude of 4.0 cm and a frequency of 2.0 Hz. A small block of mass is placed on the bigger block. In order that the smaller block does not side on the bigger block, the minimum value of the coefficient of static friction between the two blocks is (0.16x). Find the valule of x(Take $\pi^2$=10 and g=10m/$s^2$)

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**8.** A spring has a natural length of 50 cm and a force constant of $2.0 \times 10^3$ N$m^{-1}$. A body of mass 10 kg is suspended from it and the spring is stretched. If the body is pulled down to a length of 58 cm and released, it executes simple harmonic motion. The net force on the body when it is at its lowermost position of its oscillation is (10x) newton. Find value of x. (Take g=10m/$s^2$)

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**9.** A horizontal platform with an object placed on it is executing SHM in the vertical direction. The amplitude of oscillation is $4 \times 10^{-3}$m. The least period of these oscillations, so that the object is not detached from the platform is $\frac{\pi}{5x}$ second. Find value of x. Take g=10m/$s^2$

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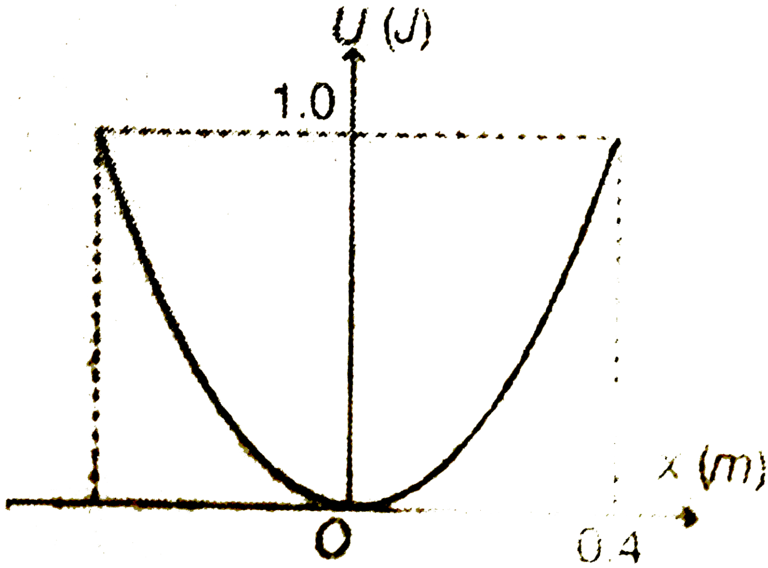
**10.** A particle of mass = 2kg moves in simple harmonic motion and its potential energy U varies with position x as shown. The period of oscillation of the particle is $\frac{n\pi}{5}$

second. Find value of n.

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**11.** A particle performs SHM with a period T and amplitude a. The mean velocity of the particle over the time interval during which it travels a distance $\frac{a}{2}$ from the extreme position is $\frac{xa}{2T}$. Find the value of x.

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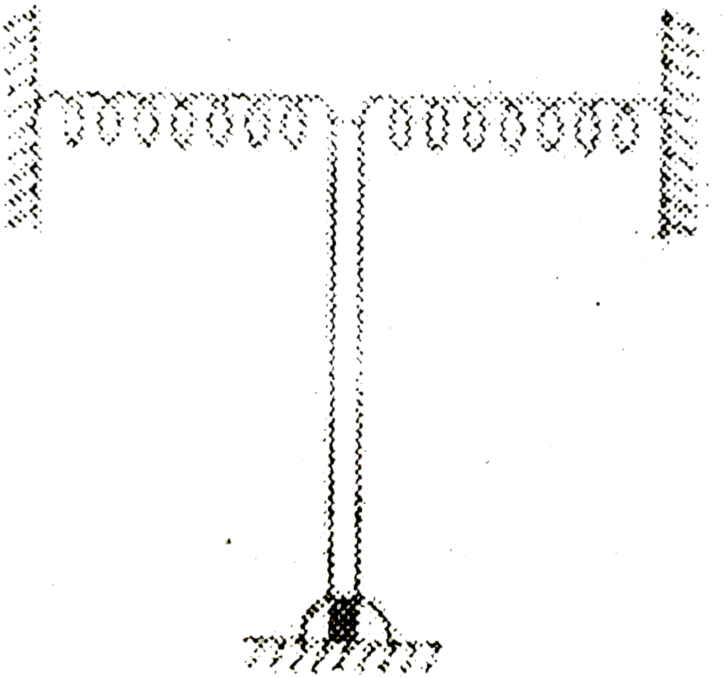
**12.** Two springs of spring constant $\frac{mg}{l}$ each are attached to the end of a uniform rod of mass m and length $l = \frac{5}{3}$m which is hinged in vertical plane as shown in figure. As the rod is rotated slightly about the hinge, it undergoes SHM with angular frequency $\omega$. Find

$\omega$ in rad/s.) Take g $= 10\frac{m}{s^2}$.



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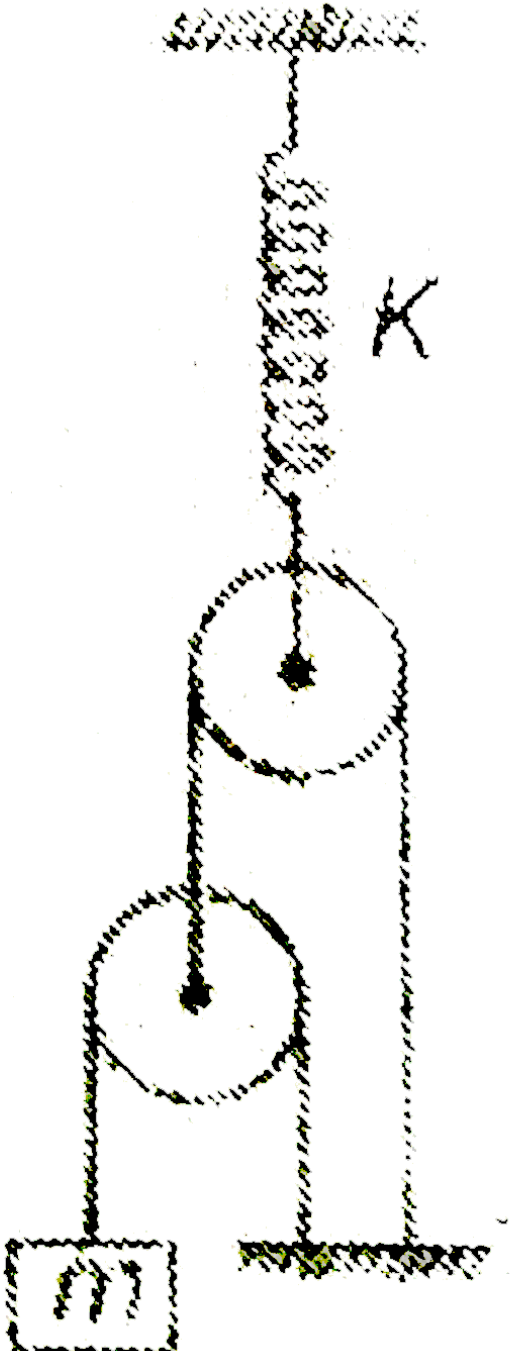
**13.** A block of mass m is connected with two ideal pullies and a massless spring of spring constant K as shown in figure. The block is slightly displaced from its equilibrium position. If the time period of oscillation is $\mu\pi\sqrt{\frac{m}{K}}$.

Then find the value of $\mu$.

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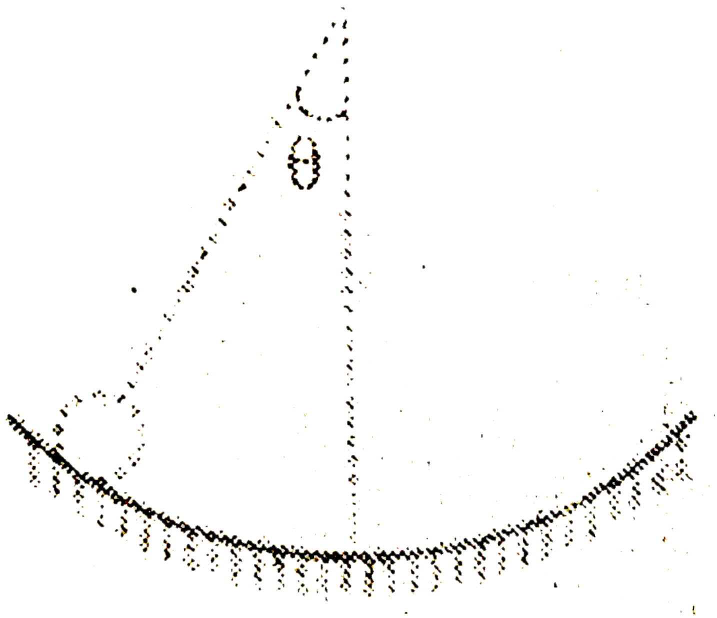
**14.** A ring of mass m and radius r rolls without slipping on a fixed hemispherical surface of radius R as shown. The time period of small oscillations of ring is $2\pi\sqrt{\frac{n(R-r)}{3g}}$ then find the value of n.

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## Example

**1.** A nurse in a hospital , noted for a patient that heart was beating 75 times a minutes. Find its frequency and time period.

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**2.** Two points are located at a distance of $10m$ and $15m$ from the source of oscillation. The period of oscillation is $0.05$s and the velocity of the wave is $300m/s$. What is the phase difference between the oscillation of two points?

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**3.** An object performs SHM of amplitude 5 cm and time period 4 s. If timing is started when the object is at the centre of the oscillation i.e., x=0 then calculate.

(i) Frequency of oscillation.

(ii) The displacement at 0.5 S.

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**4.** A particle executes SHM from extreme position and covers a distance equal to half to its amplitude in 1 s. find out it's Time Period.

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**5.** The shortest distance travelled by a particle executing SHM from mean position in 2 s is equal to $(\sqrt{3}/2)$ times its amplitude. Determine its time period.

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**6.** Find the equation fo simple harmonic motion of a particle whose amplitude is 0.04 and whose frequency is 50 Hz . The initial phase is $\pi/3$.

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**7.** A harmonic oscillation is represented by y=0.34 cos (3000t+0.74), where y and t are in mm and s respectively.

Deduce (i) and amplitude (ii) the frequency and angular frequency (iii) the period and (iv) the intial phase.

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**8.** A particle executes SHM with a time period of 4 s . Find the time taken by the particle to go from its mean position to half of its amplitude . Assume motion of particle to start from mean position.

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**9.** The particle is executing SHM on a line 4 cm long. If its velocity at mean position is 12 m/s , then determine its frequency.

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**10.** If a SHM is represented by the equation $x = 10\sin\left(\pi t + \frac{\pi}{6}\right)$ in Si units, then determine its amplitude, time period and maximum uelocity $v_{\max}$ ?

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**11.** Amplitude of a harmonic oscillator is A, when velocity of particle is half of maximum velocity, then determine position of particle.

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**12.** A particle executes SHM with a time period of 2s and amplitude 10 cm . Find its (i) Displacement (ii) Velocity (iii) Acceleration after 1/6 s, Starting from mean position.

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**13.** A body oscillates with SHM, accroding to the equation, $x = (5.0m)\cos\left[\left(2\pi rads^{-1}\right)t + \pi/4\right]$

At $t = 1.5s$, calculate the $(a)$ diplacement $(b)$ speed and $(c)$ acceleration of the body.

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**14.** A particle executes simple harmotic motion about the point $x = 0$. At time $t = 0$, it has displacement $x = 2cm$ and zero velocity. If the frequency of motion is $0.25s^{-1}$, find (a) the period, (b) angular frequency, ( c) the amplitude, (d) maximum speed, (e) the displacement from the mean position at $t = 1s$and (f) the velocity at $t = 1s$.

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**15.** Two particles move parallel to x - axis about the origin with the same amplitude and frequency. At a certain instant they are found at distance $\frac{A}{3}$ from the origin on opposite sides but their velocities are found to be in the same direction. What is the phase difference between the two ?

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**16.** A particle of mass 2 kg executing SHM has amplitude 10 cm and time period is 1 s.Find (i) the angular frequency (ii) the maximum speed (ii) the maximum acceleration (iv) the maximum restoring force (v) the speed when the displacement from the mean position is 8 cm (vi) the speed after $\frac{1}{12}$ s the particle was at the extreme position (vii) the time taken by the particle to go directly from its mean position to half the amplitude (viii) the time taken by the particle to go directly from its exterme position to half the amplitude.

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**17.** $F_1$ and $F_0$ are major components of

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**18.** The potential energy of a particle executing S.H.M. is 2.5 J, when its displacement is half of amplitude. The total energy of the particle will be

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**19.** A harmonic oscillation of force constant $4 \times 10^6 Nm^{-1}$ and amplitude 0.01 m has total energy 240 J. What is maximum kinetic energy and minimum potential energy?

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**20.** A linear harmonic oscillator has a total mechanical energy of $200J$. Potential energy of it at mean position is $50J$. Find

(i) the maximum kinetic energy,

(ii)the minimum potential energy,

(iii) the potential energy at extreme positions.

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**21.** A particle excutes SHM, at what value of displacement are the kinetic and potential energies equal?

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**22.** A particle starts oscillating simple harmonically from its equilibrium position then, the ratio of kinetic energy and potential energy of the particle at the time $T/12$ is: $(T = \text{time period})$

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**23.** A particle of mass 0.2 kg is excuting SHM of amplitude 0.2 m. When it passes through the mean position its kinetic energy is $64 \times 10^{-3} J$ . Obtain the equation of motion of this particle if the initial phase of oscillation is $\pi / 4$.

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**24.** A particle executes SHM with amplitude A and time period T. When the displacement from the equilibrium position is half the amplitude , what fractions of the total energy are kinetic and potential energy?

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**25.** The potential energy of a particle oscillating along x-axis is given as

$U = 20 + (x - 2)^2$

Here, $U$ is in joules and $x$ in meters. Total mechanical energy of the particle is $36J$.

(a) State whether the motion of the particle is simple harmonic or not.

(b) Find the mean position.

(c) Find the maximum kinetic energy of the particle.

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**26.** A block whose mass is 2 kg is fastened on a spring whose spring constant is 100 $Nm^{-1}$ . It is pulled to a distance of 0.1 m from over a frictionless surface and is released at t=0. Calculate the kinetic eneryg of the block when it is 0.05 m away from its mean position.

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**27.** Two pendulums differ in lengths by $22m$. They oscillate at the same place so that one of then makes 30 oscillations and the other makes 36 oscillations during the same time. The length $($ in $cm)$ of the pendulum are :

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**28.** The bob of simple pendulum executes SHM in water with a period T, while the period of oscillation of the bob is $T_0$ in air. Neglecting frictional force of water and given that the density of the bob is $\frac{4000}{3} kgm^{-3}$, find the ration between T and $T_0$.

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**29.** The length of a simple pendulum is 16 cm . It is suspended by the roof of a lift which is moving upwards with an accleration of $6.2ms^{-2}$. Find the time period of pendulum.

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**30.** A simple pendulum consists of a small sphere of mass $m$ suspended by a thread of length $l$. the sphere carries a positive charge $q$. The pendulum is placed in a uniform electric field of strength $E$ directed vertically upwards. With what period will pendulum oscillate if the electrostatic force acting on the sphere is less than the gravitational force ?

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**31.** A simple pendulum of length $l$ is suspended from the celing of a cart which is sliding without friction on as inclined plane of inclination theta . What will be the time period of the pendulum?

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32. Determine the period of small oscillations of a mathematical pendulum, that is a ball suspended by a thread $l = 20cm$ in length, if it is located in a liquid whose density is $\eta = 3.0$ times less than that of the ball. The resistance of the liquid is to be neglected.

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33. A bob of simple pendulum is suspended by a metallic wire. If $\alpha$ is the coefficient of linear expansion and $d\theta$ is t he change in temperature then prove that percentage change in time period is $50\alpha d\theta$.

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**34.** A block with a mass of $3.00kg$ is suspended from an ideal spring having negligible mass and stretches the spring by $0.2m$.

(a) What is the force constant of the spring?

(b) What is the period of oscillation of the block if it is pulled down and released ?

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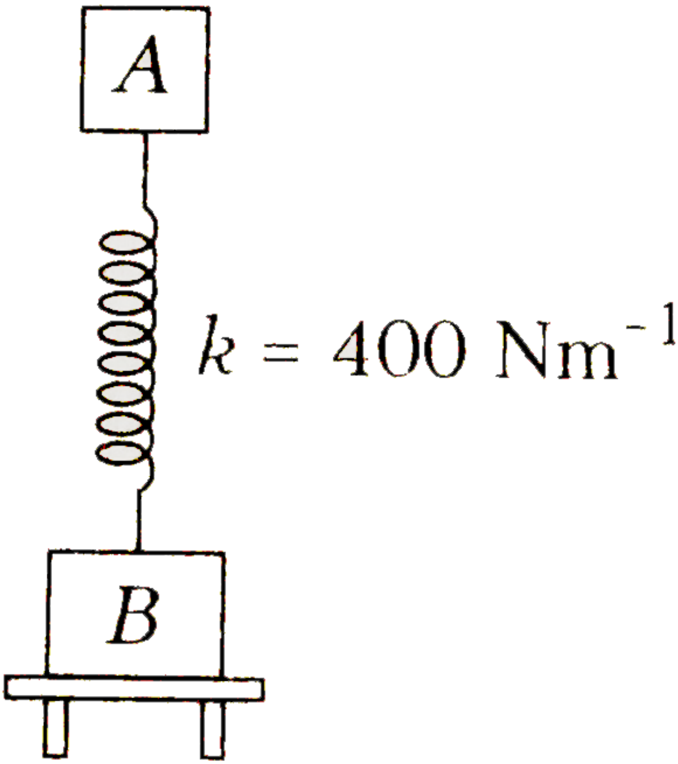
**35.** Two rigid bodies A and B of masses 1 kg and 2 kg respectively are rigidly connected to a spring of force constant 400 $Nm^{-1}$ . The body B rests on a horizontal table. From the rest position , the body A is compressed by 2 cm and then released . Deduce (i) teh frequency of oscillation, (ii) total oscillation energy, (iii) the amplitude of the harmonic vibration of the reaction of the table on body B.

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**36.** A block with mass $M$ attached to a horizontal spring with force constant $k$ is moving with simple harmonic motion having amplitude $A_1$. At the instant when the block passes through its equilibrium position a lump of putty with mass $m$ is dropped vertically on the block from a very small height and sticks to it.

(a) Find the new amplitude and period.

(b) Repeat part (a) for the case in which the putty is dropped on the block when it is at one end of its path.

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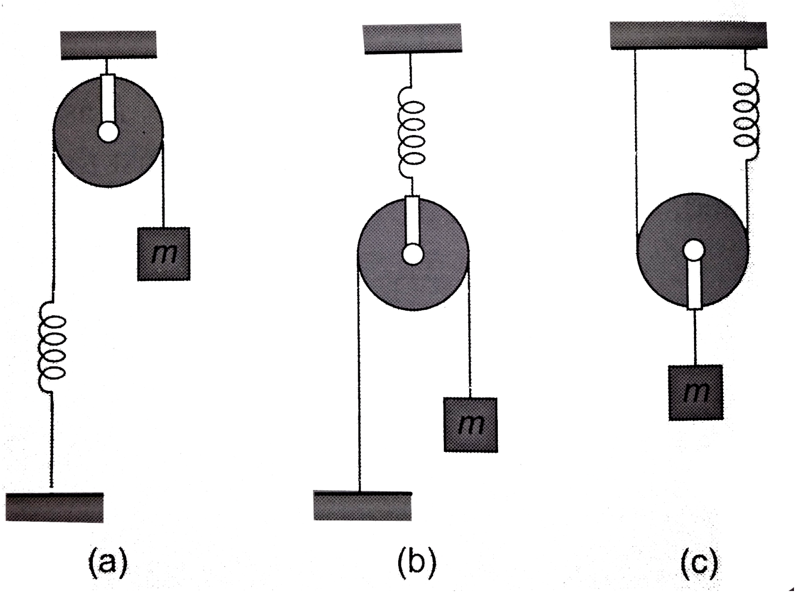
**37.** In the following arrangements, bock is slightly displaced vertically down from its equilibrium position and released. Find time period of vertical oscillations. The pulley is light.

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38. A block of mass $M$ suspended from a spring oscillates with time period $T$. If spring is cut in to two equal parts and same mass $M$ is suspended from one part, new period os oscillation is

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**39.** A 2.5 kg collar attached to a spring of foce constant 1000 $Nm^{-1}$ slides without friction on a horizontal rod. The collar is displaced from its equilibrium position by 5.0 cm and released. Calculate (i) the period of oscillation (ii) the maximum speed of the collar and (iii) the maximum acceleration of the collar.

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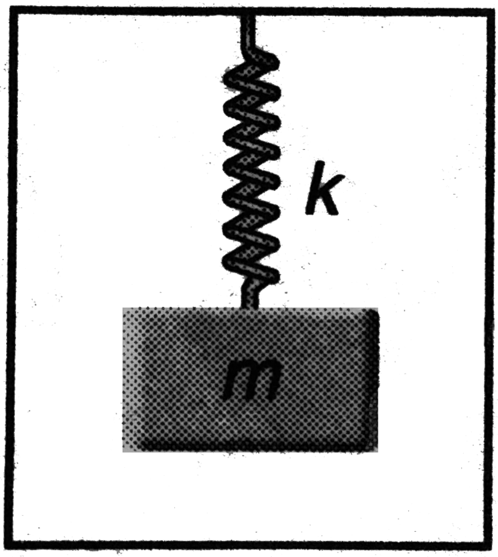
**40.** A spring mass system is hanging from the celling of an elevator in equilibrium. The elevator suddenly starts accelerating upwards with acceleration a. Find




(a) the frequency and

(b) the amplitude of the resulting SHM.

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**41.** A body of mass m attached to a spring which is oscillating with time period 4 s. If the mass of the body is increased by 4 kg, its time period increases by 2 s. Determine value of initial mass m.

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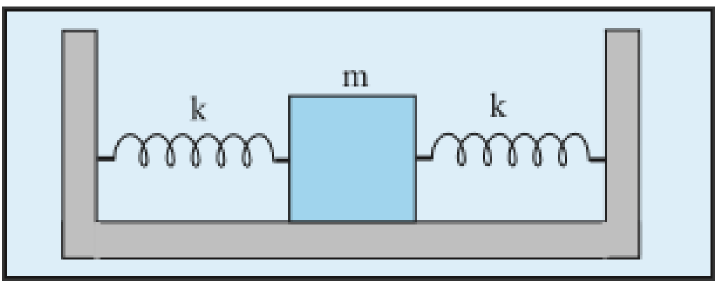
**42.** Two identical springs of spring constant k are attached to a block of mass m and to fixed supports as shown in Fig. 14.14. Show that when the mass is displaced from its equilibrium position on either side, it executes a simple harmonic motion. Find the period of oscillations.



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**43.** Two springs have force constants $k_1$ and $k_2 (k_1 > k_2)$. On which spring is more work done, if (i) they are stretched by the same force and (ii) they are stretched by the same amount ?

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**44.** Two masses $m_1$ and $m_2$ are suspended together by a massless spring of constant k. When the masses are in equilibrium, $m_1$ is removed without disturbing the system. Then the angular frequency of oscillation of $m_2$ is

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**45.** Periodic time of oscillation $T_1$ is obtained when a mass is suspended from a spring and if another spring is used with same mass then periodic time of oscillation is $T_2$ . Now if this mass is suspended from series combination of above springs then calculated the time period.

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**46.** An uniform disc is rotating at a constant speed in a vertical plane about a fixed horizontal axis passing through the centre of the disc. A piece of the disc from its rim detaches itself from the disc at the instant when it is at horizontal level with the centre of the disc and moving upwards, then about the fixed axis.

STATEMENT-1 : Angular speed of the disc about the aixs of rotation will increase.

and

STATEMENT-2 : Moment of inertia of the disc is decreased about the axis of rotation.

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**47.** Find the period of small oscillations of a uniform rod with length l , pivoted at one end.

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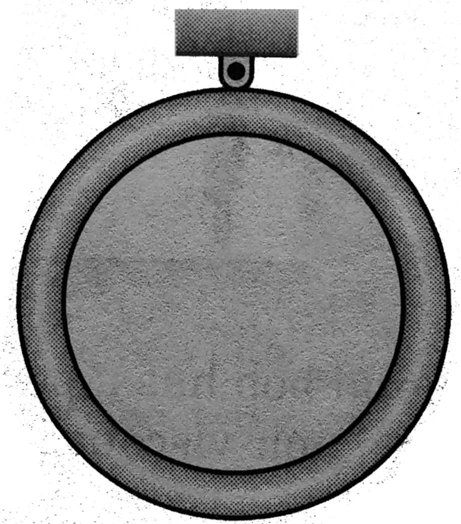
**48.** A ring of radius $r$ is suspended from a point on its circumference. Determine its angular frequency of small oscillations.



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**49.** If the earth were a homegeneous sphere and a straight hole was bored in it through its centre, so when a body is dropped in the hole, it will excutes SHM. Determine the time period of its oscillation . Radius of the earth is $6.4 \times 10^{6}$ m and $g = 9.8 ms^{-2}$

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**50.** A liquid of mss m is set into oscillations in a U-tube of cross section A. Its time period recorded is T, where $T = 2\pi\sqrt{l/2g}$ , here l is the length of liquid column. If the liquid of same mass is set into oscillations in U-tube of cross-section A/16 then determine time period of oscillation.

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**51.** A small block oscillates back and forth on as smooth concave surface of radius R in figure. Find the time period of small oscillation.

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**52.** The amplitude of a damped oscillator becomes half in one minutes. The amplitude after 3 minutes will be 1/x times of the original . Determine the value of x.

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**53.** Find the displacement equation of the simple harmonic motion obtained by conbining the motions.

$x_1 = 2\sin \omega t, x_2 = 4\sin \left(\omega t + \frac{\pi}{6}\right)$

and $x_3 = 6\sin\left(\omega t + \frac{\pi}{3}\right)$

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## Check point 11.1

**1.** For a particle executing simple harmonic motion, which of the following statements is not correct

A. vertical oscillations of a spring

B. motion of simple pendulum

C. The motion of planets around the sun is periodic but not simple harmonic motion.

D. vertical oscillation of a wooden plank floating in a liquid

**Answer: C**

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**2.** Select wrong statement about simple harmonic motion

A. The body is uniformly accelerated

B. The velocity of the body changes smoothly at all instants

C. The amplitude of oscillation is symmetric about the equilibirum position

D. The frequency of oscillation is independent of amplitude

**Answer: A**

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**3.** The amplitude and the time period in a S.H.M. is 0.5 cm and 0.4 sec respectively. If the initial phase is $\pi/2$

radian, then the equation of S.H.M. will be

A. y=0.5 sin $5\pi t$

B. y=0.5 sin $4\pi t$

C. y=0.5 sin $2.5\pi t$

D. y=0.5 cos $5\pi t$

**Answer: D**

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**4.** Which of the following is a necessary and sufficient condition for S.H.M.

A. Constant period

B. Constant acceleration

C. Proportionality between acceleration and velocity

D. Proportionality between restoring force and displacement.

**Answer: D**

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**5.** What is constant in SHM ?

A. Restoring force

B. kinetic energy

C. Potential energy

D. Periodic time

**Answer: D**

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**6.** A body is executing SHM with an amplitude of 0.1 m. Its velocity while passing through the mean position is $3ms^{-1}$. Its frequency in Hz is

A. $15\pi$

B. $\frac{15}{\pi}$

C. $30\pi$

D. $25\pi$

**Answer: B**

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**7.** The phase (at a time t) of a particle in simple harmonic motion tells

A. only the position of the particle at time t

B. only the direction of motion of the particle at time t

C. both the position and direction of motion of the paraticle at time t

D. neither the position of the particle nor its direction of motion at time t

**Answer: C**

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**8.** A particle is moving with constant angular velocity along the circumference of a circle. Which of the following statements is true

A. The particle executes SHM

B. Non-periodic motion

C. The projection of the particle on any of the diameters executes SHM

D. None of the above

**Answer: C**

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**9.** The displacement of a particle in SHM is indicated by equation y=10$\sin(20t + \pi/3)$ where, y is in metres. The value of time period of vibration will be (in second)

A. $10/\pi$

B. $\pi/10$

C. $2\pi / 10$

D. $10 / 2\pi$

**Answer: B**

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**10.** The equation of a simple harmonic motion is $X = 0.34\cos(3000t + 0.74)$ where X and t are in mm and sec . The frequency of motion is

A. 3000

B. $3000 / 2\pi$

C. $0.74 / 2\pi$

D. $3000/\pi$

**Answer: B**

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**11.** The maximum velocity of a simple harmonic motion represented by $y = \sin\left(100t + \frac{\pi}{6}\right)$ is given by

A. 300 units

B. $\frac{3\pi}{6}$ units

C. 100 units

D. $\frac{\pi}{6}$ units

**Answer: A**

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**12.** Velocity at mean position of a particle executing SHM is v. Velocity of the particle at a distance equal to half of the amplitude will be

A. $\frac{v}{2}$

B. $\frac{v}{\sqrt{2}}$

C. $\frac{\sqrt{3}}{2}v$

D. $\frac{\sqrt{3}}{4}$ v

**Answer: C**

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**13.** A particle executes simple harmonic motion with an amplitude of $4cm$ At the mean position the velocity of the particle is $10$cm/s. distance of the particle from the mean position when its speed $5$ cm/s is

A. $\sqrt{3}$ cm

B. $\sqrt{5}$ cm

C. $2\sqrt{3}$ cm

D. $2\sqrt{5}$ cm

**Answer: C**

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**14.** A body is executing simple harmonic motion with an angular frequency 2 rad/s . The velocity of the body at 20 mm displacement, when the amplitude of motion is 60 mm is -

A. 131 $mms^{-1}$

B. 118 $mms^{-1}$

C. 113 $mms^{-1}$

D. 90 $mms^{-1}$

**Answer: C**

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**15.** The displacement of a particle executing SHM is given by y=0.25 sin(200t) cm . The maximum speed of the particle is

A. 200 $cms^{-1}$

B. 100 $cms^{-1}$

C. 50 $cms^{-1}$

D. 5.25 $cms^{-1}$

**Answer: C**

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**16.** In $SHM$ there is always a constant ratio between displacement of the body and its

A. velocity

B. acceleration

C. mass

D. time period

**Answer: B**

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**17.** In simple harmonic motion, the ratio of acceleration of the particle to its displacement at any time is a measure of

A. spring constant

B. angular frequency

C. $(\text{angular frequency})^2$

D. restoring force

**Answer: C**

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**18.** For a particle executing simple harmonic motion, the acceleration is -

A. is uniform

B. varies linearly with time

C. is non-uniform

D. Both (b) and (c)

**Answer: C**

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**19.** What is the maximum acceleration of the particle doing the SHM $\gamma = 2\sin\left[\frac{\pi t}{2} + \phi\right]$ where gamma is in cm?

A. $\frac{\pi}{2} cms^{-2}$

B. $\frac{\pi^2}{2} cms^{-2}$

C. $\frac{\pi}{4} cms^{-2}$

D. $\frac{\pi^2}{4} cms^{-2}$

**Answer: B**

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**20.** The maximum acceleration of a simple harmonic oscillator is $a_0$ and maximum velocity is $v_0$. What is the amplitude?

A. $\frac{v_0^2}{a_0}$

B. $a_0 v_0$

C. $\frac{a_0^2}{v_0}$

D. $\frac{1}{a_0 v_0}$

**Answer: A**

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**21.** A particle executing simple harmonic motion has an amplitude of 6 cm . Its acceleration at a distance of 2 cm from the mean position is $8c\frac{m}{s^2}$ The maximum speed of the particle is

A. $8cms^{-1}$

B. $12cms^{-1}$

C. $16cms^{-1}$

D. $24cms^{-1}$

**Answer: B**

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**22.** For a particle in $S.H.M.$ if the maximum acceleration is $a$ and maximum velocity is $v$ then amplitude is

A. $va$

B. $\frac{v^2}{a}$

C. $\frac{v^2}{2a}$

D. $\frac{v}{a}$

**Answer: B**

Watch Video Solution

**23.** Average velocity of a particle executing SHM in one complete vibration is :

A. $\frac{\omega^2 A}{2}$

B. $\frac{\omega^2 A}{\sqrt{2}}$

C. zero

D. $A\omega^2$

**Answer: C**

Watch Video Solution

**24.** In simple harmonic motion,the particle is

A. always acceleration

B. always retarded

C. alternately acceleration and retarded

D. neither acceleration nor retarded

**Answer: C**

Watch Video Solution

**25.** In SHM , the acceleration is ahead of velocity by a phase angle

A. $0^\circ$

B. $\frac{\pi}{2}$

C. $\pi$

D. $2\pi$

**Answer: B**

Watch Video Solution

## Check point 11.2

**1.** The energy at the mean position of a pendulum will be

A. zero

B. partial PE and partial KE

C. totally KE

D. totally PE

**Answer: C**

Watch Video Solution

**2.** A body executes simple harmonic motion. The potential energy (P.E), the kinetic energy (K.E) and energy (T.E) are measured as a function of displacement $x$. Which of the following staements is true?

A. PE is maximum when x=0

B. KE is maximum when x=0

C. TE is zero when x=0

D. KE is maximum when x is maximum

**Answer: B**

Watch Video Solution

**3.** A body of mass 1 kg is executing simple harmonic motion. Its displacement y(cm) at t seconds is given by $y = 6\sin(100t + \pi/4)$. Its maximum kinetic energy is

A. 6 J

B. 18 J

C. 24 J

D. 36 J

**Answer: B**

Watch Video Solution

**4.** Force constant of a weightless spring is $16Nm^{-1}$. A body if mass 1 kg suspended from it is pulled down through 5 cm from its mean position and then released. The maximum kinetic energy of the body will be

A. $2 \times 10^{-2}$J

B. $4 \times 10^{-2}$J

C. $8 \times 10^{-2}$J

D. $16 \times 10^{-2}$J

**Answer: A**

Watch Video Solution

**5.** The total energy of a particle in SHM is E. Its kinetic energy at half the amplitude from mean position will be

A. E/2

B. E/3

C. E/4

D. 3E/4

**Answer: D**

Watch Video Solution

**6.** A particle undergoing SHM has the equation $x = A\sin(2\omega t + \phi)$ , where x represents the displacement of the particle. The kinetic energy oscillates with time period

A. $\frac{2\pi}{\omega}$

B. $\frac{\pi}{\omega}$

C. $\frac{4\pi}{\omega}$

D. None of these

**Answer: B**

Watch Video Solution

**7.** A particle executes SHM on a line 8 cm long . Its KE and PE will be equal when its distance from the mean position is

A. 4 cm

B. 2 cm

C. $2\sqrt{2}$

D. $\sqrt{2}$ cm

**Answer: C**

**8.** A particle is vibrating in a simple harmonic motion with an amplitude of 4 cm . At what displacement from the equilibrium position, is its energy half potential and half kinetic

A. 1 cm

B. $\sqrt{2}$ cm

C. 3 cm

D. $2\sqrt{2}$ cm

**Answer: D**

**9.** In SHM for how many times potential energy is equal to kinetic energy during one complete period

A. 1

B. 2

C. 4

D. 8

**Answer: C**

Watch Video Solution

**10.** The work done by the string of a simple pendulum during one complete oscillation is

A. equal to the total energy of the pendulum

B. equal to the KE of the pendulum

C. equal ot the KE of the pendulum

D. zero

**Answer: D**

Watch Video Solution

**11.** The total energy of a particle executing SHM is directly proportional to the square of the following quantity.

A. Acceleration

B. Amplitude

C. Time period

D. Mass

**Answer: B**

Watch Video Solution

**12.** The amplitude of a particle executing SHM is made three-fourth keeping its time period constant. Its total energy will be

A. 16 E

B. 8 E

C. 4 E

D. E

**Answer: D**

Watch Video Solution

**13.** Energy of particle executing SHM depends upon

A. amplitude only

B. Amplitude and frequency

C. velocity only

D. frequency only

**Answer: B**

Watch Video Solution

**14.** The total energy of a particle having a displacement x, executing simple harmonic motion is

A. $\propto x$

B. $\propto x^2$

C. independent of x

D. $\propto x^{1/2}$

**Answer: C**

Watch Video Solution

**15.** A particle of mass 0.10 kg executes SHM with an amplitude 0.05 m and frequency 20 vib/s. Its energy of oscillation is

A. 2 J

B. 4 J

C. 1 J

D. zero

**Answer: A**

Watch Video Solution

**16.** The total energy of a harmonic oscillator of mass 2 kg is 9 J. If its potential energy at mean position is 5 J , its KE at the mean position will be

A. 9 J

B. 14 J

C. 4 J

D. 11 J

**Answer: C**

Watch Video Solution

**17.** The value of total mechanical energy of a particle is SHM is

A. Always constant

B. Depend on time

C. $\frac{1}{2}KA^2\cos^2(\omega t + \phi)$

D. $\frac{1}{2}mA^2\cos^2(\omega t + \phi)$

**Answer: A**

Watch Video Solution

**18.** A particle starts simple harmonic motion from the mean position. Its amplitude is a and total energy E . At one instant its kinetic energy is 3E/4 . Its displacement at that instant is

A. $\frac{a}{\sqrt{2}}$

B. $\frac{a}{2}$

C. $\sqrt{3}\frac{a}{2}$

D. zero

**Answer: B**

Watch Video Solution

**19.** For any S.H.M., amplitude is 6 cm . If instantaneous potential energy is half the total energy then distance of particle from its mean position is

A. 3 cm

B. 4.2 cm

C. 5.8 cm

D. 6 cm

**Answer: B**

Watch Video Solution

**20.** A particle is performing S.H.M. Its total energy ie E When the displacement of the particle is half of its amplitude, its K.E. will be

A. E/2

B. E/4

C. 3E/4

D. E/8

**Answer: B**

Watch Video Solution

## Check point 11.3

**1.** If the metal bob of a simple pendulum is replaced by a wooden bob, then its time period will

A. increase

B. decrease

C. remain the same

D. may increase or decrease

**Answer: C**

Watch Video Solution

**2.** The length of a simple pendulum is $39.2/\pi^2$ m. If $g = 9.8m/s^2$ , the value of time period is

A. 4 s

B. 8 s

C. 2 s

D. 3 s

**Answer: A**

Watch Video Solution

**3.** The length of a simple pendulum is increased four times of its initial valuel, its time period with respect to its previous value will

A. become twice

B. not be different

C. be halved

D. be $\sqrt{2}$ times

**Answer: A**

Watch Video Solution

**4.** If length of a simple pendulum is increased by 69%, then the percentage increase in its time period is

A. 0.11

B. 0.21

C. 0.42

D. $10.5\%$

**Answer: D**

Watch Video Solution

**5.** A cabin is falling freely under gravity, what is the time period of a pendulum attached to its celling?

A. zero

B. $\infty$

C. 1 s

D. 2 s

**Answer: B**

Watch Video Solution

**6.** A simple pendulum is suspended from the roof of a trolley which moves in a horizontal direction with an acceleration $\alpha$, then the time period is given by $T = 2\pi\sqrt{\left(\frac{I}{g}\right)}$ where g is equal to

A. g

B. g-a

C. g+a

D. $\sqrt{g^2 + a^2}$

**Answer: D**

Watch Video Solution

**7.** A man measures the period of a simple pendulum inside a stationary lift and finds it to be T sec. if the lift accelerates upwards with an acceleration g/4, then the period of the pendulum will be

A. T

B. $\frac{T}{4}$

C. $\frac{2T}{\sqrt{5}}$

D. $2T\sqrt{5}$

**Answer: C**

Watch Video Solution

**8.** A simple pendulum has a hollow sphere containing mercury suspended by means of a wire. If a little mercury is drained off, the period of the pendulum will

A. remains unchanged

B. increase

C. decrease

D. becomes zero

**Answer: B**

Watch Video Solution

**9.** The time period of a simple pendulum of infinite length is (R=radius of earth).

A. infinite

B. $2\pi\sqrt{\frac{R}{g}}$

C. $2\pi\sqrt{\frac{g}{R}}$

D. $\frac{1}{2\pi}\sqrt{\frac{R}{g}}$

**Answer: B**

Watch Video Solution

**10.** The length of a second pendulum is

A. 99.8 cm

B. 99 cm

C. 100 cm

D. None of these

**Answer: C**

Watch Video Solution

**11.** A object of mass m is suspended from a spring and it executes SHM with frequency n. If the mass is increased 4 times , the new frequency will be

A. 2 n

B. n/2

C. n

D. n/4

**Answer: B**

Watch Video Solution

**12.** A mass m is suspended from a spring. Its frequency of oscillation is f. The spring is cut into two halves and the same mass is suspended from one of the pieces of the spring. The frequency of oscillation of the mass will be

A. $\sqrt{2}f$

B. $\frac{f}{2}$

C. $f$

D. $2f$

**Answer: A**

Watch Video Solution

**13.** Three mass 0.1 kg ,0.3 kg and 0.4 kg are suspended at end of a spring. When is 0.4 kg mass is removed , the system oscillates with a period 2 s . When the 0.3 kg mass is also removed , the system will oscillates with a period period

A. 1 s

B. 2 s

C. 3 s

D. 4 s

**Answer: A**

Watch Video Solution

**14.** Time period of a spring mass system is T.If this spring is cut into two parts whose lengths are in ratio 1:3 and the same mass is attached to the longer part, the new time period will be

A. $\sqrt{\frac{3}{2}}T$

B. $\frac{T}{\sqrt{3}}$

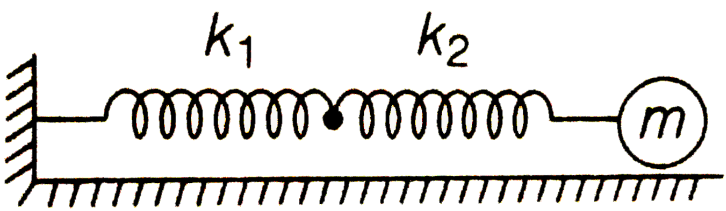
C. $\frac{\sqrt{3}T}{2}$

D. $\sqrt{3}T$

**Answer: B**

Watch Video Solution

**15.** As shown in the figure, two light springs of force constant $k_1$ and $k_2$ oscillate a block of mass m. Its effective force constant will be



A. $k_1k_2$

B. $k_1 + k_2$

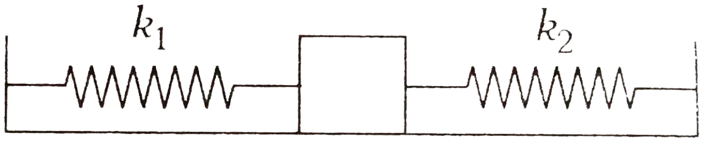
C. $\frac{1}{k_1} + \frac{1}{k_2}$

D. $\frac{k_1k_2}{k_1 + k_2}$

**Answer: D**

Watch Video Solution

**16.** If both spring consists $k_1$ and $k_2$ are increased to $4k_1$ and $4k_2$ respectively, what will be the new frequency , if f was the original frequency ?




A. f

B. 2f

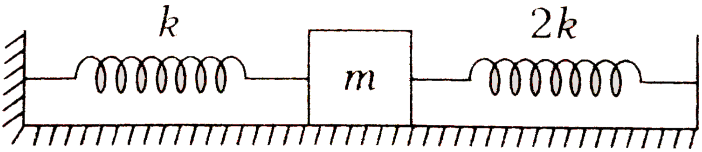
C. $\frac{1}{2}f$

D. 4f

**Answer: B**

Watch Video Solution

**17.** Frequency of oscillation is proportional to




A. $\sqrt{\frac{3k}{m}}$

B. $\sqrt{\frac{k}{m}}$

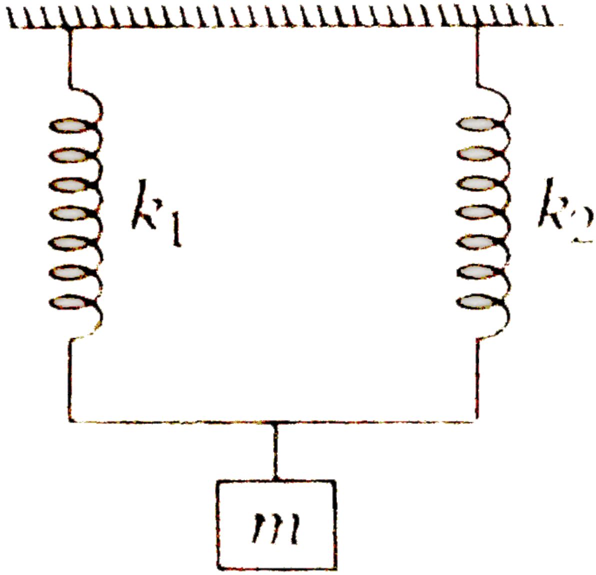
C. $\sqrt{\frac{2k}{m}}$

D. $\sqrt{\frac{m}{3k}}$

**Answer: A**

Watch Video Solution

**18.** The spring constants of two springs of same length are $k_1$ and $k_2$ as shown in figure. If an object of mass m is suspended and set in vibration , the period will be




A. $2\pi\sqrt{\frac{mk_1}{k_2}}$

B. $2\pi\sqrt{\frac{m}{k_1k_2}}$

C. $2\pi\sqrt{\frac{m}{k_1-k_2}}$

D. $2\pi\sqrt{m/(k_1+k_2)}$

**Answer: D**

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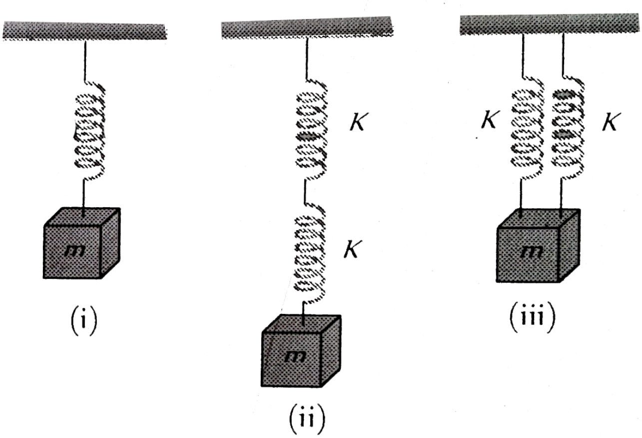
**19.** Five identical springs are used in the following three configurations. The time periods of vertical oscillations in configurations (i), (ii) and (iii) are in the ratio



A. $1:\sqrt{2}:\frac{1}{\sqrt{2}}$

B. $2:\sqrt{2}:\frac{1}{\sqrt{2}}$

C. $\frac{1}{\sqrt{2}}:2:1$

D. $2:\frac{1}{\sqrt{2}}:1$

**Answer: A**

Watch Video Solution

**20.** A thin uniform rod of length l is pivoted at its upper end. It is free to swing in a vertical plane. Its time period for oscillation of small amplitude is

A. $2\pi\sqrt{\frac{l}{g}}$

B. $2\pi\sqrt{\frac{2l}{3g}}$

C. $2\pi\sqrt{\frac{3l}{2g}}$

D. $2\pi\sqrt{\frac{l}{3g}}$

**Answer: B**

Watch Video Solution

## Check point 11.4

**1.** A point mass m is suspended at the end of a massless wire of length l and cross section. If Y is the Young's modulus for the wire, obtain the frequency of oscillation for the simple harmonic motion along the vertical line.

A. $\frac{1}{2\pi}\sqrt{\frac{LA}{mY}}$

B. $\frac{1}{2\pi}\sqrt{\frac{LAm}{Y}}$

C. $\frac{1}{2\pi}\sqrt{\frac{YA}{mL}}$

D. $\frac{1}{2\pi}\sqrt{\frac{mY}{AL}}$

**Answer: C**

Watch Video Solution

**2.** A rectangular block of mass m and area of cross-section A floats in a liquid of density $\rho$. If it is given a small vertical displacement from equilibrium, it undergoes oscillation with a time period T. Then

A. $T \propto m$

B. $T \propto \rho$

C. $T \propto \frac{1}{A}$

D. $T \propto \sqrt{\frac{1}{\rho}}$

**Answer: D**

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**3.** Imagine a narrow tunnel between the two diametrically opposite points of the earth. A particle of mass m is released in this tunnel . The time period of oscillation is

A. $\pi\sqrt{\frac{R}{g}}$

B. $\frac{\pi}{2}\sqrt{\frac{R}{g}}$

C. $2\pi\sqrt{\frac{R}{g}}$

D. $\frac{2}{\pi}\sqrt{\frac{R}{g}}$

**Answer: C**

Watch Video Solution

**4.** In damped oscillations damping froce is directly proportional to speed of ocillatior .If amplitude becomes half to its maximum value is 1 s, then after 2 s amplitude will be ($A_0$- initial amplitude)

A. $\frac{1}{4}A_0$

B. $\frac{1}{2}A_0$

C. $A_0$

D. $\frac{\sqrt{3}A_0}{2}$

**Answer: A**

Watch Video Solution

**5.** In case of damped oscillation frequency of oscillation is

A. greater than natural frequency

B. less than natural frequency

C. equal to nature frequency

D. Both (a) and (b)

**Answer: B**

Watch Video Solution

**6.** In damped oscillations, the amplitude is reduced to one-third of its initial value $a_0$ at the end of 100 oscillations. When the oscillator completes 200 oscillations ,its amplitude must be

A. $a_0 / 2$

B. $a_0 / 4$

C. $a_0 / 6$

D. $a_0 / 9$

**Answer: D**

Watch Video Solution

**7.** A weakly damped harmonic oscillator of frequency $n_1$ is driven by an external periodic force of frequency $n_2$. When the steady state is reached, the frequency of the oscillator will be

A. $n_1$

B. $n_2$

C. $\frac{n_1 + n_2}{2}$

D. $(n_1 + n_2)$

**Answer: B**

Watch Video Solution

**8.** In the case of sustained force oscillations the amplitude of oscillations

A. decreases linearly

B. decreases sinusodially

C. dereases exponentially

D. always remains constant

**Answer: D**

Watch Video Solution

**9.** Amplitude of vibrations remains constant in case of

(i) free vibrations

(ii) damped vibrations

(iii) maintained vibrations

(iv) forced vibrations

A. (i), (iii) and (iv)

B. (ii) and (iii)

C. (i) , (ii) and (iii)

D. (ii) and (iv)

**Answer: A**

Watch Video Solution

**10.** In forced oscillations , a particle oscillates simple harmonically with a frequency equal to

A. frequency of driving force

B. natural frequency of body

C. differnece of frequency of driving force and natrual frequency

D. mean of frequency of driving force and natural frequency

**Answer: A**

Watch Video Solution

**11.** Inc ase of a forced oscillation, the resonance peak becomes very sharp when the

A. applied periodic force is small

B. quality factor is small

C. damping force is small

D. restoring force is small

**Answer: C**

Watch Video Solution

**12.** Two sources of sound are in resonance when

A. they look like

B. they are situated at a particular distance from each other

C. they produce the sound of same frequency

D. they are excited by the same excittng device

**Answer: C**

Watch Video Solution

**13.** A tuning fork whose natural frequency is $440 H_Z$ is placed just above the open end of a tube that contains water. The water is slowly drained from the tube while the tuning fork remains in place and is kapt vibrating. The sound is found to be echanced when the air column is $60 cm$ long and when it is $100 cm$ long . Find the speed of sound in air.

A. gravitation

B. Newto's III law

C. resonance

D. consonance

**Answer: C**

Watch Video Solution

**14.** Resonance is a special case of

A. forced oscillations

B. damped oscillations

C. undamped oscillations

D. coupled oscillations

**Answer: A**

Watch Video Solution

**15.** During the phenonmenon of resonance

A. the amplitude of oscillation becomes large

B. the frequency of oscillation become large

C. the time period of oscillation becomes large

D. All of the above

**Answer: A**

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## chapter exercises

**1.** Which of the following quantities is always negative is SHM ?

Here, x is displacement , from mean position.

A. $F. a$

B. $v. s$

C. $a. s$

D. $F. v$

**Answer: C**

Watch Video Solution

**2.** In a simple pendulum the period of oscillation $(T)$ is related to the length of the pendulum $(L)$ as

A. $\frac{l}{T}$ =constant

B. $\frac{l^2}{T}$ =constant

C. $\frac{l}{T^2}$ =constant

D. $\frac{l^2}{T^2}$ =constant

**Answer: C**

Watch Video Solution

**3.** A particle executing simple harmonic motion along y - axis has its motion described by the equation $y = A\sin(\omega t) + B$. The amplitude of the simple harmonic motion is

A. A

B. B

C. A+B

D. $\sqrt{A+B}$

**Answer: A**

Watch Video Solution

**4.** Two particle are executing SHMs .The equations of their motions are

$$y_1 = 10\sin\left(\omega t + \frac{\pi}{4}\right) \text{ and } y_2 = 5\sin\left(\omega t + \frac{\sqrt{3}\pi}{4}\right)$$

What is the ratio of their amplitudes.

A. $1:1$

B. $2:1$

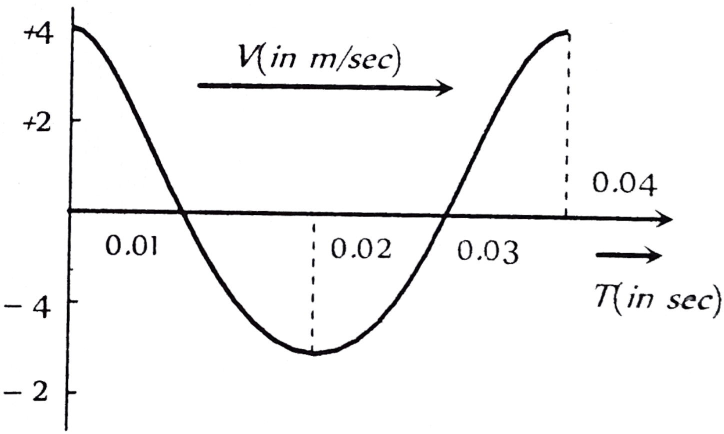
C. $1:2$

D. None of these

**Answer: B**

Watch Video Solution

**5.** The velocity-time diagram of a harmonic oscillator is shown in the adjoining figure. The frequency of oscillation is




A. 25 Hz

B. 50 Hz

C. 12.25 Hz

D. 33.3 Hz

**Answer: A**

Watch Video Solution

**6.** The ratio of frequencies of two pendulums are 2 : 3, then their length are in ratio

A. $\sqrt{\frac{2}{3}}$

B. $\sqrt{\frac{3}{2}}$

C. $\frac{4}{9}$

D. $\frac{9}{4}$

**Answer: D**

Watch Video Solution

**7.** A body oscillates with SHM according to the equation (in SHM unit ), $x = 5\cos\left(2\pi t + \frac{\pi}{4}\right)$. Its instantaneous displacement at t=1 s is

A. $\frac{\sqrt{2}}{5}$m

B. $\frac{1}{\sqrt{3}}$

C. $\frac{5}{\sqrt{2}}$

D. $\frac{1}{2}$ m

**Answer: C**

Watch Video Solution

**8.** A body is vibrating in simple harmonic motion . If its acceleration in $12cms^{-2}$ at a displacement 3 cm from the mean position, then time period is

A. 6.28 s

B. 3.14 s

C. 1.57 s

D. 2.57 s

**Answer: B**

Watch Video Solution

**9.** A horizontally placed spring mass system has time period T. The same system is now placed on a car moving with acceleration a in horizontal direction. Then,

A. time period will increase

B. time period will decrease

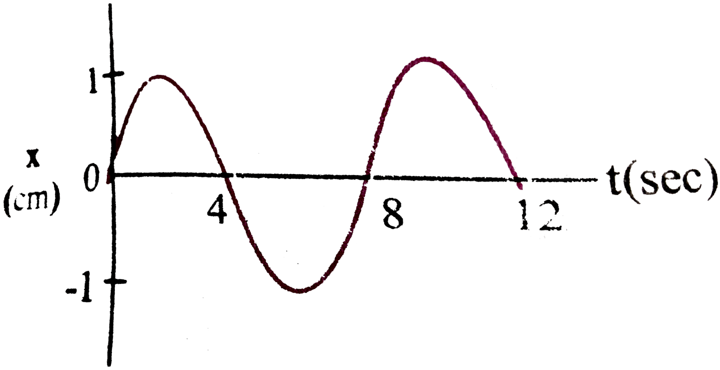
C. time period will remain constant

D. no conclusion can be drawn

**Answer: C**

Watch Video Solution

**10.** The $x - t$ graph of a particle undergoing simple harmonic motion is shown in figure. Acceleration of particle at $t = 4/3s$ is




A. 4

B. 3

C. 2

D. 1

**Answer: D**

Watch Video Solution

**11.** Two particle are executing simple harmonic motion.

At an instant of time t their displacement are

$y_1 = a\cos(\omega t)$ and $y_2 = a\sin(\omega t)$

Then the phase difference between $y_1$ and $y_2$ is

A. $120^\circ$

B. $90^\circ$

C. $180^\circ$

D. zero

**Answer: B**

Watch Video Solution

**12.** A particle executing SHM of amplitude 4 cm and $T = 4s$ .The time taken by it to move from positive extreme position to half the amplitude is

A. 1 s

B. $\frac{1}{3}$ s

C. $\frac{2}{3}$ s

D. $\sqrt{\frac{2}{3}}$ s

**Answer: C**

Watch Video Solution

**13.** The maximum acceleration of a particle un SHM is made two times keeping the maximum speed to be constant. It is possible when .

A. amplitude of oscillation is double while frequency remains constant

B. amplitude is double while frequency is halved

C. frequency is doubled while amplitude is halved

D. frequency of oscillation is doubled while amplitude remians constant

**Answer: C**

Watch Video Solution

**14.** Under the action of a force $F = -kx^3$ , the motion of a particle is (k=a positive constant)

A. simple harmonic motion

B. uniformly acceleration motion

C. not periodic

D. periodic but not simple harmonic

**Answer: D**

Watch Video Solution

**15.** A light spring of force constant $8Nm^{-1}$ is cut into two equal halves and the two are connected in parallel, the equivalent force constant of the system is

A. $16Nm^{-1}$

B. $32Nm^{-1}$

C. $8Nm^{-1}$

D. $24Nm^{-1}$

**Answer: B**

Watch Video Solution

**16.** In order that the resultant path on superimposing two mutually perpendicular SHM be a circle, the conditions are that

A. the amplitudes on both SHM should be equal and they should have a phase difference of $\frac{\pi}{2}$

B. the amplitude should be in the ratio 1:2 and the phase difference should be zero

C. the amplitude should be in the ratio 1:2 and the phase difference should be $\frac{\pi}{2}$

D. the amplitudes should be equal and the phase difference should be zero

**Answer: A**

Watch Video Solution

**17.** Time period of a particle executing $SHM$ is $8$ sec. At $t = 0$ it is at the mean position. The ratio of the distance covered by the particle in the $1st$ second to the $2nd$ second is:

A. $\frac{1}{\sqrt{2}+q}$

B. $\sqrt{2}$

C. $\frac{1}{\sqrt{2}}$

D. $\sqrt{2}+1$

**Answer: C**

Watch Video Solution

**18.** The force constant of a weightless spring is $16 Nm^{-1}$. A body of mass $1.0 kg$ suspended from it is pulled down through $5 cm$ and then released. The maximum energy of the system (spring + body) will be

A. $2 \times 10^{-2}$J

B. $4 \times 10^{-2}$J

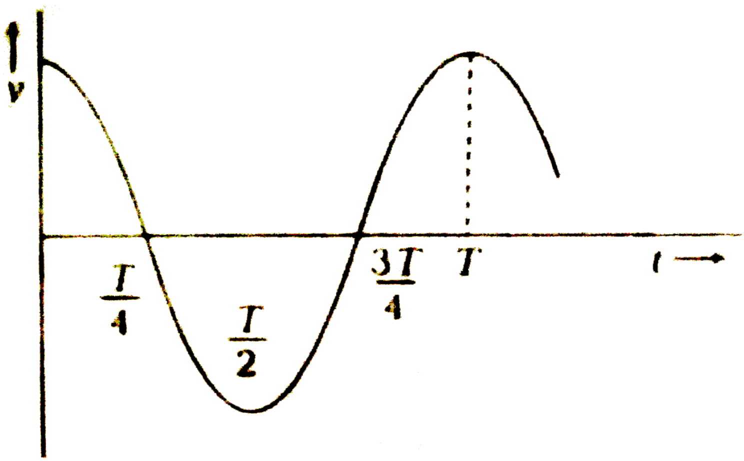
C. $8 \times 10^{-2}$J

D. $16 \times 10^{-2}$J

**Answer: A**

Watch Video Solution

**19.** The displecement-time graph of a particle execting SHM is shown in figure. Which of the following statements is false?




A. The acceleration is maximuym at t=T

B. Th force is zero at $t = \frac{3T}{4}$

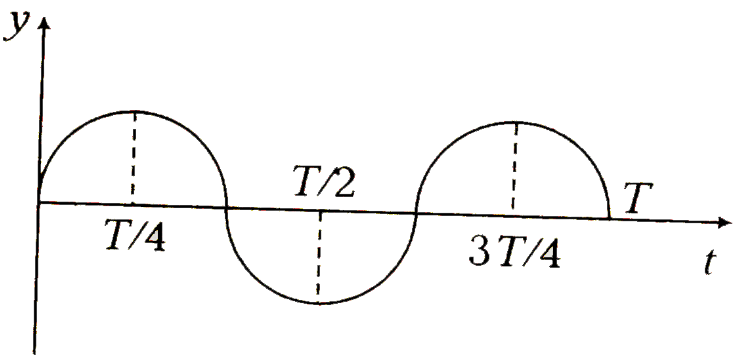
C. The potential energy equals the total oscillation energy at $t = \frac{T}{2}$

D. None of the above

**Answer: D**

Watch Video Solution

**20.** The graph shows the variation of displacement of a particle execting SHM with time . We infer from this graph that




A. the force is zero at time $\frac{3T}{4}$

B. the velocity is maximum at time $\frac{T}{2}$

C. the acceleration is maximum at time T

D. th PE is equal to total energy at time $\frac{T}{2}$

**Answer: D**

Watch Video Solution

**21.** The time period of a simple pendulum inside a stationary lift is $\sqrt{5}$ s. What will be the time period when the lift moves upward with an acceleration $\frac{g}{4}$?

A. $\sqrt{5}$ s

B. $2\sqrt{5}$ s

C. $(2+\sqrt{5})$ s

D. 2 s

**Answer: D**

Watch Video Solution

**22.** A linear harmonic oscillator of force constant $2 \times 10^6 N/m$ and amplitude $0.01m$ has a total mechanical energy of $160J$. Its

A. maximum potential energy is 160 J

B. maximum potential energy is 100 J

C. minimum potential energy is zero

D. minimum potential energy is 100 J

**Answer: A**

Watch Video Solution

**23.** A second pendulum is moved to moon where acceleration dur to gravity is 1/6 times that of the earth, the length of the second pendulum on moon would be

A. 6 times

B. 12 times

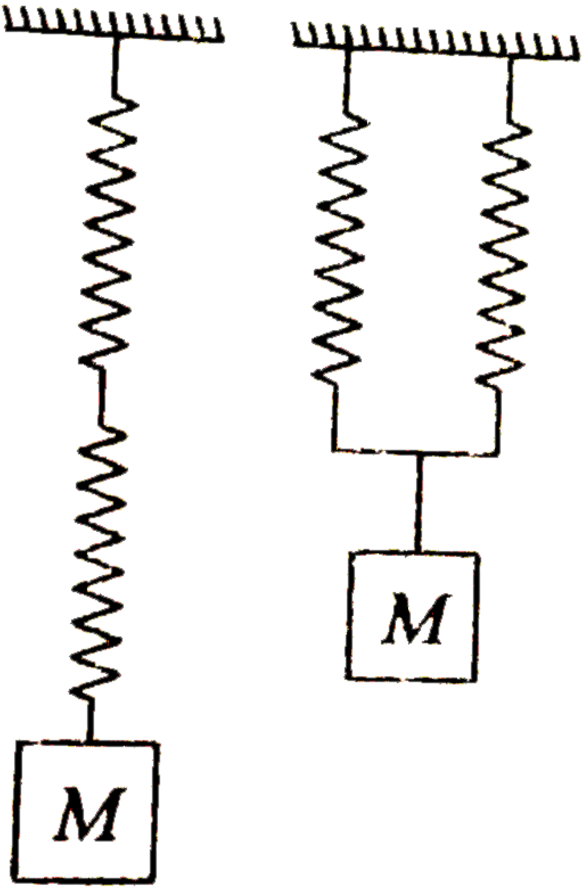
C. $\frac{1}{6}$ times

D. $\frac{1}{12}$ times

**Answer: C**

Watch Video Solution

**24.** Two identical springs of spring constant k each are connected in series and parallel as shown in figure. A mass M is suspended from them. The ratio of their frequencies of vertical oscillation will be




A. $1:2$

B. $2:1$

C. $4:1$

D. $1:4$

**Answer: A**

Watch Video Solution

**25.** The relation between acceleration and displacement of four particles are given below. The particle undergoing SHM is:

A. $a_x = +2x$

B. $a_x = +2x^2$

C. $a_x = -2x^2$

D. $a_x = -2x$

**Answer: D**

Watch Video Solution

**26.** A particle executing SHM has a maximum speed of $30cm/s$ and a maximum acceleration of $60c\frac{m}{s^2}$ . The period of oscillation is

A. $\pi$ s

B. $\frac{\pi}{2}$ s

C. $2\pi$ s

D. $\frac{\pi}{t}$ s

**Answer: A**

Watch Video Solution

**27.** A disc of radius $R$ and mass $M$ is pivoted at the rim and it set for small oscillations. If simple pendulum has to have the same period as that of the disc, the length of the simple pendulum should be

A. $\frac{5}{4}$ R

B. $\frac{2}{3}$ R

C. $\frac{3}{4}$ R

D. $\frac{3}{2}$ R

**Answer: D**

Watch Video Solution

**28.** If the length of second's pendulum is decreased by 2%, how many seconds it will lose per day

A. 3927s

B. 3727s

C. 3427s

D. 864s

**Answer: D**

Watch Video Solution

**29.** A clock with an iron pendulum keeps correct time at $20^\circ C$. How much time will it lose or gain in a day if the temperature changes to $40^\circ C$. Thermal coefficient of liner expansion $\alpha = 0.000012 per^\circ C$.

A. 10.3 second/day

B. 20.6 second/day

C. 5 second/day

D. 20 minute/day

**Answer: A**

Watch Video Solution

**30.** The equation of a damped simple harmonic motion is $m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = 0$. Then the angular frequency of oscillation is

A. $\omega = \left(\frac{k}{m} - \frac{b^2}{4m^2}\right)^{1/2}$

B. $\omega = \left(\frac{k}{m} - \frac{b}{4m}\right)^{1/2}$

C. $\omega = \left(\frac{k}{m} - \frac{b^2}{4m}\right)^{1/2}$

D. $\omega = \left(\frac{k}{m} - \frac{b^2}{4m^2}\right)^{-1/2}$

**Answer: A**

Watch Video Solution

**31.** The motion of a particle is given by $x = A\sin\omega t + B\cos\omega t$. The motion of the particle is

A. not simple harmonic

B. simple harmonic with amplitude A+B

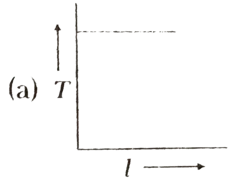
C. simple harmonic with amplitude $\frac{(A+B)}{2}$

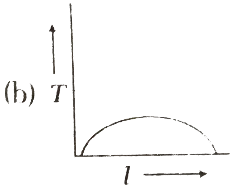
D. simple harmonic with amplitude $\sqrt{A^2 + B^2}$

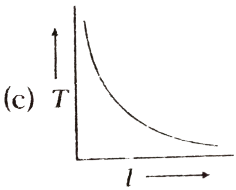
**Answer: D**

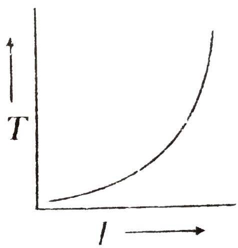
Watch Video Solution

**32.** In case of a simple pendulum, time period versus length is depicted by

A. 


B. 


C. 


D. 


**Answer: B**

Watch Video Solution

**33.** The displacement equation of a particle is $x = 3\sin 2t + 4\cos 2t$. The amplitude and maximum velocity will be respectively

A. 5,10

B. 3,2

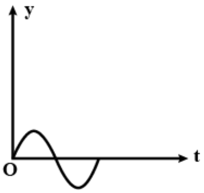
C. 4,2

D. 3,4

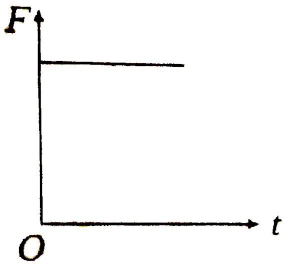
**Answer: A**

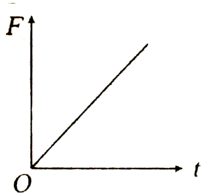
Watch Video Solution

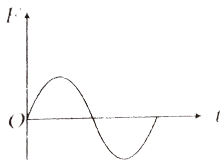
**34.** The displacement-time graph of a particle executing SHM is as shown in the figure.

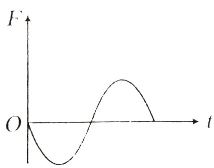


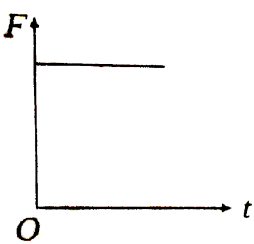

The corresponding force-time graph of the particle is

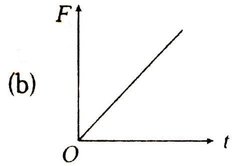
(a) 

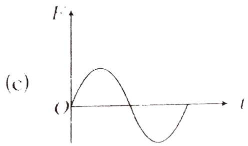

(b) 

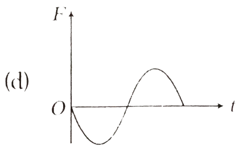

(c) 

(d) 

A. 

B. 


C. 


D. 


**Answer: D**

Watch Video Solution

**35.** A tunnel has been dug through the centre of the earth and a ball is released in it. It will reach the other end of the tunnel after

A. 84.6 min

B. 42.3 min

C. 1 day

D. will not reach the other end

**Answer: B**

Watch Video Solution

**36.** Two bodies (M) and (N) of equal masses are suspended from two separate massless springs of spring constants $(k_1)$ and $(k_2)$ respectively. If the two bodies oscillate vertically such that their maximum velocities are equal, the ratio of the amplitude of vibration of (M) to the of (N) is.

A. $\frac{k_1}{k_2}$

B. $\sqrt{\frac{k_1}{k_2}}$

C. $\frac{k_2}{k_1}$

D. $\sqrt{\frac{k_2}{k_1}}$

**Answer: D**

Watch Video Solution

**37.** A particle is executing simple harmonic motion with a period of T seconds and amplitude a metre . The shortest time it takes to reach a point $\frac{a}{\sqrt{2}}$ from its mean position in seconds is

A. T

B. $\frac{T}{4}$

C. $\frac{T}{8}$

D. $\frac{T}{16}$

**Answer: C**

Watch Video Solution

**38.** A mass $M$ is suspended from a massless spring. An additional mass $m$ stretches the spring further by a distance $x$. The combined mass will oscillate with a period

A. $2\pi\sqrt{\left\{\frac{(M+m)x}{mg}\right\}}$

B. $2\pi\sqrt{\left\{\frac{mg}{(M+m)x}\right\}}$

C. $\frac{\pi}{2}\sqrt{\left\{\frac{mg}{(M+m)x}\right\}}$

D. $2\pi\sqrt{\left\{\frac{(M+m)}{mgx}\right\}}$

**Answer: A**

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**39.** A particle executes linear simple harmonic motion with an amplitude of 2 cm . When the particle is at 1 cm from the mean position the magnitude of its velocity is equal to that of its acceleration. Then its time period in seconds is

A. $\frac{1}{2\pi\sqrt{3}}$

B. $2\pi\sqrt{3}$

C. $\frac{2\pi}{\sqrt{3}}$

D. $\frac{\sqrt{3}}{2\pi}$

**Answer: C**

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**40.** A spring has a natural length of 50 cm and a force constant of $2.0 \times 10^3$ N$m^{-1}$. A body of mass 10 kg is suspended from it and the spring is stretched. If the body is pulled down to a length of 58 cm and released, it executes simple harmonic motion. The net force on the body when it is at its lowermost position of its oscillation is (10x) newton. Find value of x. (Take g=10m/ $s^2$)

A. 20 N

B. 40 N

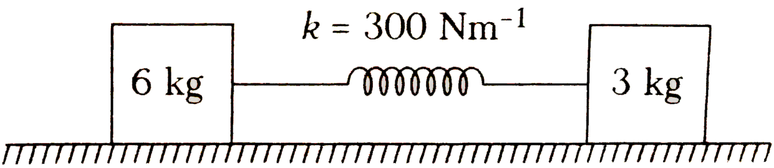
C. 60 N

D. 80 N

**Answer: C**

Watch Video Solution

**41.** Two point masses of 3 kg and 6 kg are attached to opposite ends of horizontal spring whose spring constant is $300Nm^{-1}$ as shown in the figure. The natural vibration frequency of the system is approximately




A. 4 Hz

B. 3 Hz

C. 2 Hz

D. 1 Hz

**Answer: C**

Watch Video Solution

**42.** In a spring- mass system , the length of the spring is L, and it has a mass M attached to it and oscillates with an angular frequency $\omega$. The spring is then cut into two parts, one (i) with relaxed length $\alpha L$ and the other (ii) with relaxed length $(1-\alpha)$ L. The force constants of the two spring A and B are

A. $\dfrac{k}{1-\alpha}$ and $\dfrac{k}{\alpha}$

B. $\dfrac{k}{\alpha}$ and $\dfrac{k}{1-\alpha}$

C. $\alpha k, (1-\alpha)k$

D. k and k

**Answer: B**

Watch Video Solution

**43.** A particle is attached to a vertical spring and is pulled down a distance 0.04m below its equilibrium position and is released from rest. The initial upward acceleration of the particle is $0.30ms^{-2}$. The period of the oscillation is

A. 4.08 s

B. 1.92 s

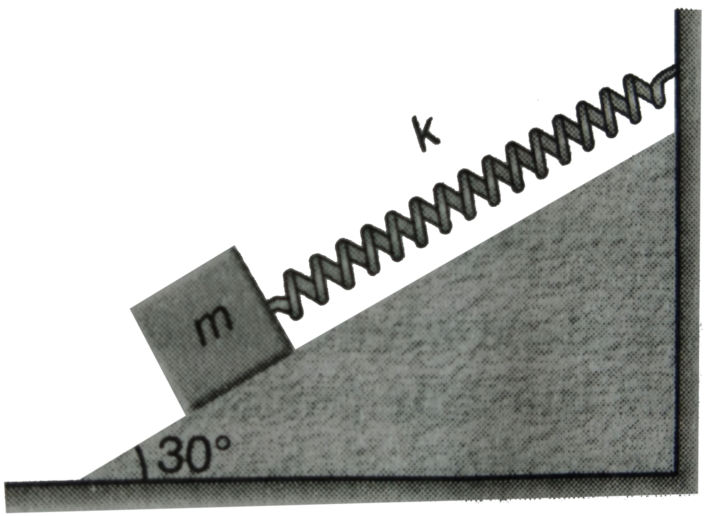
C. 3.90 s

D. 2.29 s

**Answer: D**

Watch Video Solution

**44.** A block of mass 0.2 kg is attached to a mass less spring of force constant 80 N/m as shown in figure. Find the period of oscillation. Take $g = 10m / s^2$. Neglect friction



A. $\pi$ s

B. $\frac{\pi}{10}$ s

C. $\frac{2\pi}{5}$ s

D. $\frac{\pi}{2}$ s

**Answer: B**

Watch Video Solution

**45.** Two simple harmonic motion are represrnted by the following equation $y_1 = 40 \sin \omega t$ and $y_2 = 10(\sin \omega t + c \cos \omega t)$. If their displacement amplitudes are equal, then the value of $c$ (in appropriate units) is

A. $\sqrt{13}$

B. $\sqrt{15}$

C. $\sqrt{17}$

D. 4

**Answer: B**

Watch Video Solution

**46.** The potential energy of a particle of mass 2 kg in SHM is $(9x^2)$J. Here x is the displacement from mean position . If total mechanical energy of the particle is 36 J. The maximum speed of the particle is

A. $4ms^{-1}$

B. $2ms^{-1}$

C. $6ms^{-1}$

D. $10ms^{-1}$

**Answer: C**

Watch Video Solution

**47.** A point particle if mass $0.1kg$ is executing SHM of amplitude $0.1m$. When the particle passes through the mean position, its kinetic energy is $8 \times 10^{-3}J$. Write down the equation of motion of this particle when the initial phase of oscillation is $45^\circ$.

A. $y = 0.1\cos\left(3t + \frac{\pi}{4}\right)$

B. $y = 0.1\sin\left(6t + \frac{\pi}{4}\right)$

C. $y = 0.1\sin\left(4t + \frac{\pi}{4}\right)$

D. $y = 0.1\cos\left(4t + \frac{\pi}{4}\right)$

**Answer: C**

Watch Video Solution

**48.** Molten-wax of mass m drops on a block of mass, M which is oscillating on a frictionless table. Select the incorrect option.

A. amplitude does not change

B. amplitude increase

C. time period decrease

D. time period increases

**Answer: D**

Watch Video Solution

**49.** The displacement of a particle is represented by the equation $y = 3\cos\left(\frac{\pi}{4} - 2\omega t\right)$.

The motion of the particle is

A. simple harmonic with period $2\pi/\omega$

B. simple harmonic with period $\pi/\omega$

C. periodic but not simple harmonic

D. non-periodic

**Answer: B**

Watch Video Solution

**50.** The displacement of a particle is repersented by the equation $y = 3\cos\left(\frac{\pi}{4} - 2\omega t\right)$. The motion of the particle is

(b)

(c) (d)

A. non-periodic

B. periodic but not simple harmonic

C. simple harmonic with period $2\pi / \omega$

D. simple harmonic with period $\pi / \omega$

**Answer: B**

Watch Video Solution

**51.** Motion of an oscillating liquid column in a U-tube is

A. periodic but not simple harmonic

B. non-periodic

C. simple harmonic and time period is independent of the density of the liquid

D. simple harmonic and time period is directly proportional to the density of the liquid.

**Answer: C**

Watch Video Solution

**52.** A particle is acted simultaneously by mutually perpendicular simple harmonic motions $x = a \cos \omega t$ and $y = a \sin \omega t$. The trajectory of motion of the particle will be

A. an ellipse

B. a parabola

C. a circle

D. a straight line

**Answer: C**

Watch Video Solution

**53.** The diplacement of a particle varies with time according to the relation $y = a\sin\omega t + b \cos\omega t$.

A. The motion is oscillatory but not SHM

B. The motion is SHM with amplitude a+b

C. The motion is SHM with amplitude $a^2 + b^2$

D. The motion is SHM with amplitude $\sqrt{a^2 + b^2}$

**Answer: D**

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**54.** The equation of motion of a particle is $x = a \quad \cos(\alpha t)^2$. The motion is

A. periodic but not simple oscillatory

B. periodic and oscillatory

C. oscillatory but not periodic

D. Neither periodic nor oscillatory

**Answer: C**

Watch Video Solution

**55.** A mass of 0.2 hg is attached to the lower end of a massles spring of force constant $200\frac{N}{m}$ the opper end of which is fixed to a rigid support. Study the following statements.

A. In equilibrium , the spring will be stretched by 1 cm

B. If the mass is raised till the spring becomes unstretched and then released , it will go down by 2 cm before moving upwards

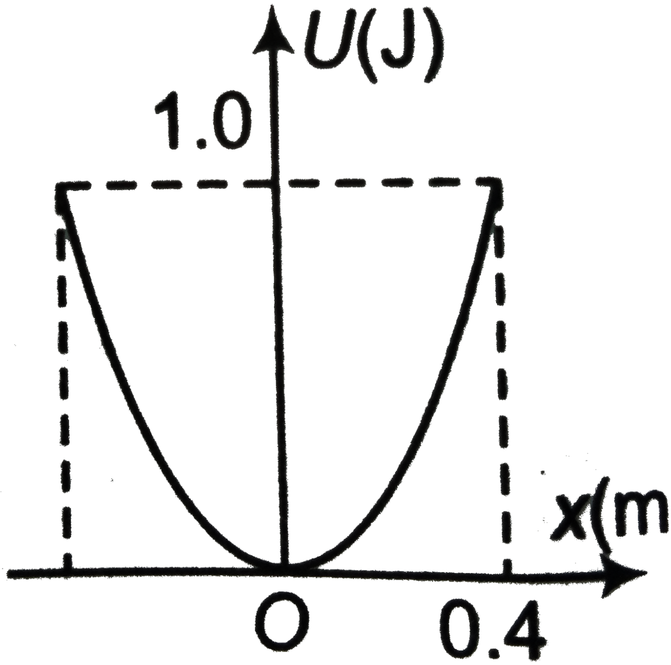
C. The frequency of oscillation will be nearly 5 Hz

D. All of the above

**Answer: D**

Watch Video Solution

**56.** A particle of mass $2kg$ moves in simple harmonic motion and its potential energy $U$ varies with position $x$ as shown. The period of oscillation of the particle is



A. $\frac{2\pi}{5}$ s

B. $\frac{2\sqrt{2}\pi}{5}s$

C. $\frac{\sqrt{2}\pi}{5}$ s

D. $\frac{4\pi}{5}$ s

**Answer: D**

Watch Video Solution

**57.** The speed v of a particle moving along a straight line. When it is at distance x from a fixed point on the line is $v^2 = 144 - 9x^2$. Select the correct alternatives

A. The magnitude of acceleration at a distance 3 units from the fixed point is 27 units

B. the motion is simple harmonic with $T = \frac{2\pi}{3}$ units

C. The maximum displacement from the fixed point is 4 units

D. all are correct

**Answer: D**

Watch Video Solution

**58.** A particle of mass 2kg executing SHM has amplitude 20cm and time period 1s. Its maximum speed is

A. amplitude of oscillation is approximately 2.53 m

B. minimum potential energy of the particle is 2 J

C. maximum acceleration of the particle is approximately $6.3ms^{-2}$

D. minimum kinetic energy of the particle is 2 J

**Answer: A::C**

Watch Video Solution

**59.** The potential energt of a particle of mass 0.1 kg, moving along the x-axis, is given by $U = 5x(x-4)J$, where x is in meter. It can be concluded that

A. The speed of the particle is maximum at x=2 m

B. The particle executes simple harmonic motion

C. The period of oscillation of the particle is $\frac{\pi}{5}$ s

D. all are correct

**Answer: D**

Watch Video Solution

**60.** A simple pendulum has a time period T in vacuum. Its time period when it is completely immersed in a liquid of density one-eight of the density of material of the bob is

A. $\sqrt{\frac{7}{9}}T$

B. $\sqrt{\frac{5}{8}}$ T

C. $\sqrt{\frac{3}{8}}T$

D. $\sqrt{\frac{8}{7}}T$

**Answer: D**

Watch Video Solution

**61.** A simple pendulum has time period $T$ The bob is given negative charge and surface below it is given positive change new time period will be

A. less than T

B. greater than T

C. equal to T

D. infinite

**Answer: A**

Watch Video Solution

**62.** Two simple pendulum whose lengths are $100cm$ and $121cm$ are suspended side by side. Then bobs are pulled together and then released. After how many minimum oscillations of the longer pendulum will two be in phase again. ?

A. 11

B. 10

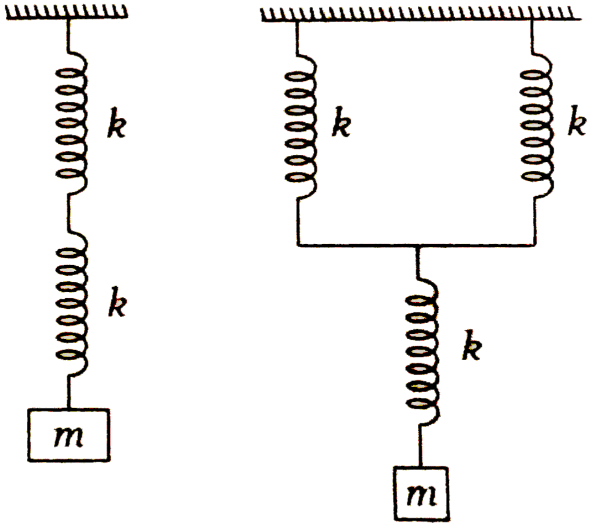
C. 21

D. 20

**Answer: B**

Watch Video Solution

**63.** Some springs are combined in series and parallel arrangement as shown in the figure and a mass m is suspended from them. The ratio of their frequencies will be




A. $1:1$

B. $2:1$

C. $\sqrt{3}:2$

D. $4:1$

**Answer: C**

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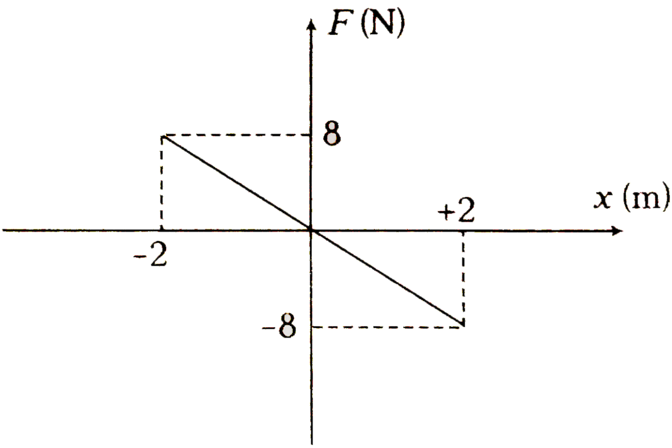
**64.** A body of mass 0.01 kg executes simple harmonic motion (SHM) about x=0 under the influence of a force shown in the figure. The period of the SHM is




A. 1.05 s

B. 0.52 s

C. 0.25 s

D. 0.31 s

**Answer: D**

Watch Video Solution

**65.** The vertical motion of a ship at sea is described by the equation $\frac{d^2(x)}{dt^2} = -4x$ , where x is the vertical height of the ship (in meter) above its mean position. If it oscillates through a height of 1 m

A. its maximum vertical speed will be $1ms^{-1}$

B. its maximum vertical speed will be $2ms^{-1}$

C. its greater vertical acceleration is $2ms^{-2}$

D. its greater vertical acceleration is $1ms^{-2}$

**Answer: B**

Watch Video Solution

**66.** A simple pendulum is suspended from the ceiling of a car and its period of oscillation is T when the car is at rest. The car starts moving on a horizontal road with a constant acceleration g (equal to the acceleration due to gravity, in magnitude) in the forward direction. To keep the time period same, the length of th pendulum

A. will have to be increased by $\sqrt{2}l$

B. will have to be increased by $(\sqrt{2}-1)l$

C. will have to be decreased by $\sqrt{2}l$

D. will have to be decreased by $(\sqrt{2}-1)l$

**Answer: A**

Watch Video Solution

**67.** A block of mass m, attacted to a string of spring constant k, oscillates on a smooth horizontal table. The other end of the spring is fixed to a wall. The block has a speed v when the spring is at its natural length. Before coming to an instantaneous rest. If the block moves a distance x from the mean position, then

A. $x=\sqrt{\frac{m}{k}}$

B. $a = \frac{1}{v}\sqrt{\frac{m}{k}}$

C. $x = v\sqrt{\frac{m}{k}}$

D. $x = \sqrt{\frac{mv}{k}}$

**Answer: C**

Watch Video Solution

**68.** A small ball is dropped from a certain height on the surface of a non-viscous liquid of density less than the density of ball. The motion of the ball is

A. SHM

B. periodic but not SHM

C. not periodic

D. SHM for half a period and non-periodic for rest half of the period

**Answer: B**

Watch Video Solution

**69.** Two particles execute SHM of same amplitude and frequency on parallel lines. They pass one another when moving in opposite directions each time their displacement is half of their amplitude. What is the phase difference between them?

A. $60^\circ$

B. $30^\circ$

C. $90^\circ$

D. $120^\circ$

**Answer: D**

Watch Video Solution

**70.** A mass is suspended separately by two springs of spring constants $k_1$ and $k_2$ in successive order. The time periods of oscillations in the two cases are $T_1$ and $T_2$ respectively. If the same mass be suspended by connecting the two springs in parallel, (as shown in figure) then the time period of oscillations is T. The correct relations is

A. $T^2 = T_1^2 + T_2^2$

B. $T^{-2} = T_1^{-2} + T_2^{-2}$

C. $T^{-1} = T_1^{-1} + T_2^{-1}$

D. $T = T_1 + T_2$

**Answer: B**

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**71.** A horizontal platform with an object placed on it is executing S.H.M. in the vertical direction. The amplitude of oscillation is $3.92 \times 10^{-3}$m. What must be the least period of these oscillation, so that the object is not detached from the platform

A. $\frac{\pi}{25}s$

B. $\frac{\pi}{5}s$

C. $\frac{\pi}{10}s$

D. $\frac{\pi}{50}s$

**Answer: A**

Watch Video Solution

**72.** Two masses 8 kg 4 kg are suspended together by a massless spring of spring constant $1000Nm^{-1}$ . When the masses are in equilibrium 8 kg is removed without disturbing the system . The amplitude of oscillation is

A. 0.5 m

B. 0.08 m

C. 0.4 m

D. 0.04 m

**Answer: B**

Watch Video Solution

**73.** In SHM , potential energy of a particle at mean position is $E_1$ and kinetic enregy is $E_2$ , then

A. $E_1 = E_2$

B. total potential energy at $x = \frac{\sqrt{3}A}{2}$ is $E_1 + \frac{3E_2}{4}$

C. total kinetic energy at $x = \frac{\sqrt{3}A}{2}$ is $\frac{3E_2}{4}$

D. total kinetic energy at $x = \frac{A}{\sqrt{2}}$ is $\frac{E_2}{4}$

**Answer: B**

Watch Video Solution

**74.** A particle executes SHM with amplitude of 20 cm and time period of 12 s. What is the minimum time required for it to move between two points 10 cm on either side of the mean position?

A. 1 s

B. 2 s

C. 3 s

D. 4 s

**Answer: B**

Watch Video Solution

**75.** A uniform spring whose unstressed length is l has a force constant k. The spring is cut into two pieces of unstressed lengths $l_1$ and $l_2$ where $l_1 = nl_2$ where n being on integer. Now a mass m is made to oscillate with first spring. The time period of its oscillation would be

A. $T = 2\pi\sqrt{\frac{mn}{k(n+1)}}$

B. $T = 2\pi\sqrt{\frac{m}{k(n+1)}}$

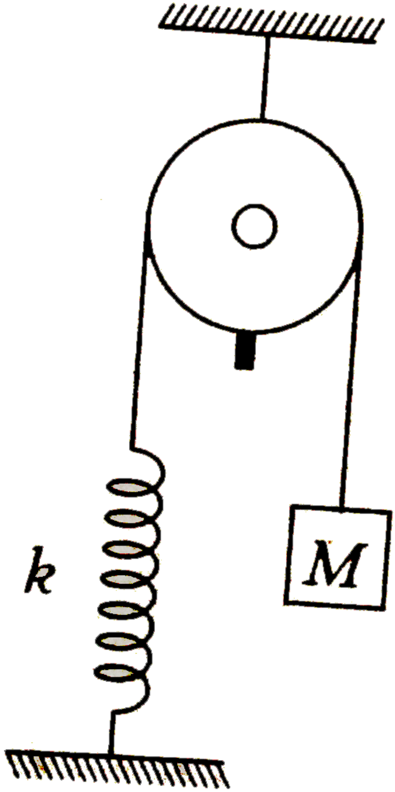
C. $T = 2\pi\sqrt{\frac{m}{k}}$

D. $T = 2\pi\sqrt{\frac{m(n+1)}{nk}}$

**Answer: A**

Watch Video Solution

**76.** A mass M=5 kg is attached to a string as shown in the figure and held in position so that the spring remains unstretched. The spring constant is $200Nm^{-1}$ . The mass M is then released and begins to undergo small oscillations. The amplitude of oscillation is




A. 0.5 m

B. 0.25 m

C. 0.2 m

D. 0.1 m

**Answer: B**

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**77.** A rectangular block of mass m and area of cross-section A floats in a liquid of density $\rho$. If it is given a small vertical displacement from equilibrium, it undergoes oscillation with a time period T. Then

A. $T \propto \sqrt{\rho}$

B. $T \propto \rho^0$

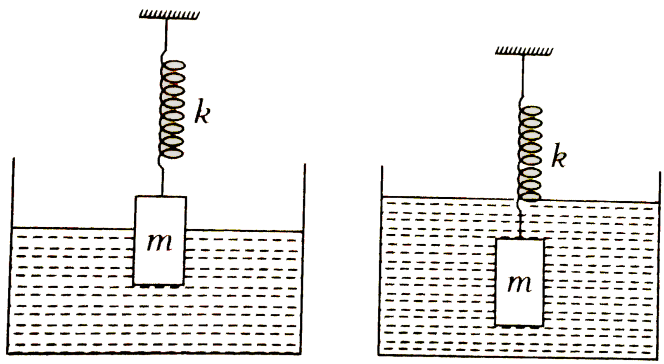
C. $T \propto \frac{1}{\rho}$

D. $T \propto \frac{1}{\sqrt{\rho}}$

**Answer: B**

Watch Video Solution

**78.** Period of small oscillations in the two cases shown in figure is $T_1$ and $T_2$ respectively . Assume fluid does not have any viscosity , then




A. $T_1 = T_2$

B. $T_1 < T_2$

C. $T_1 > T_2$

D. Cannot say anything

**Answer: B**

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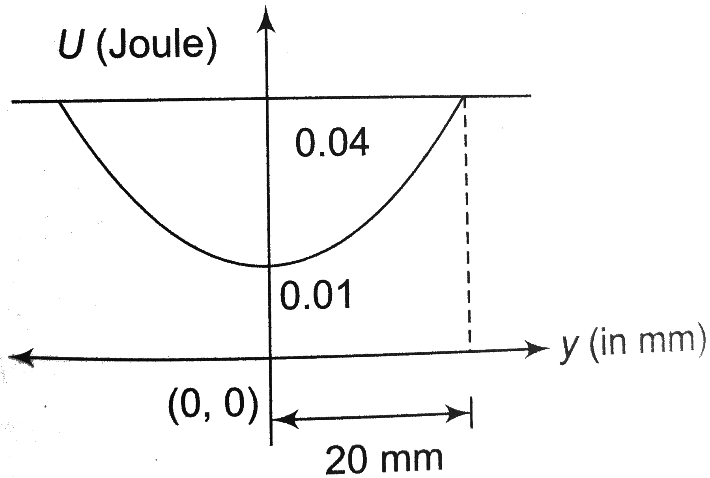
**79.** The variation of potential energy of harmonic oscillator is as shown in figure. The spring constant is



A. $1 \times 10^2 Nm^{-1}$

B. $1.5 \times 10^2 Nm^{-1}$

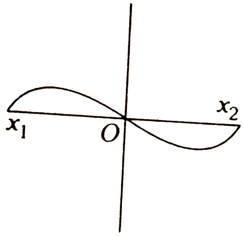
C. $2 \times 10^2 Nm^{-1}$

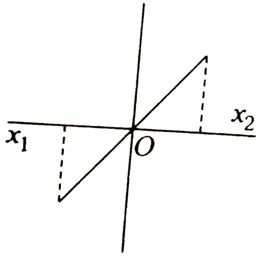
D. $3 \times 10^2 Nm^{-1}$

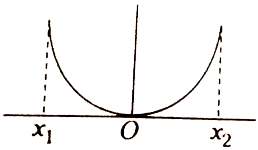
**Answer: B**

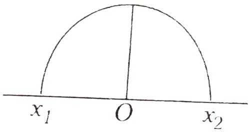
Watch Video Solution

**80.** A particle of mass m oscillates with simple harmonic motion between points $x_1$ and $x_2$, the equilibrium position being O. Its potential energy is plotted. It will be as given below in the graph

A. 


B. 


C. 


D. 


**Answer: C**

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**81.** A small ball is kept on the top of a sphere of radius $R$. The sphere start accelerating with constant acceleration of $10m/s^2$ horizontally. The angle of radial line with the vertical at which small ball leaves the sphere is $\frac{1}{2}\sin^{-1}(K/9)$. Find the value of $K$. [take $g = 10m/s^2$]

A. 4

B. 2

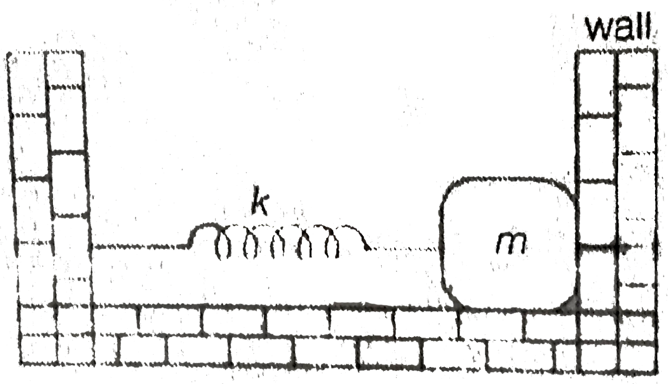
C. 1

D. 0.5

**Answer: A**

Watch Video Solution

**82.** In the figure, the block of mass m, attached to the spring of stiffness k is in correct with the completely elastic wall, and the compression in the spring is e. The spring is compressed further by e by displacing the block towards left and is then released. If the collision between the block and the wall is completely eleastic then the time period of oscillation of the block will be




A. $\frac{2\pi}{3}\sqrt{\frac{m}{k}}$

B. $2\pi\sqrt{\frac{m}{k}}$

C. $\frac{\pi}{3}\sqrt{\frac{m}{k}}$

D. $\frac{\pi}{6}\sqrt{\frac{m}{k}}$

**Answer: A**

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**83.** A cubical block of mass M vibrates horizontally with amplitude of 4.0 cm and a frequency of 2.0 Hz. A small block of mass is placed on the bigger block. In order that the smaller block does not side on the bigger block, the minimum value of the coefficient of static friction between the two blocks is (0.16x). Find the valule of x(Take $\pi^2$=10 and g=10m/$s^2$)

A. 0.36

B. 0.4

C. 0.64

D. 0.72

**Answer: C**

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**84.** Two pendulum of time periods 3 s and 7 s respectively start oscillating simultaneously from two opposite extreme positions. After how much time they will be in same phase?

A. $\frac{21}{8}s$

B. $\frac{21}{4}s$

C. $\frac{21}{2}$ s

D. $\frac{21}{10}s$

**Answer: A**

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**85.** A particle under the action of a force has a period of $3s$ and under the action of another force it has a period $4\sec$ in $SHM$. What will be its period under the combined action of both forces in the same direction?

A. 7 s

B. 5 s

C. 2.4 s

D. 0.4 s

**Answer: C**

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**86.** A particle performs SHM in a straight line. In the first second, starting from rest, it travels a distance a and in the next second it travels a distance b in the same side of mean position. The amplitude of the SHM is

A. a-b

B. $\dfrac{2a-b}{3}$

C. $\dfrac{2a^2}{3a-b}$

D. None of these

**Answer: C**

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**87.** A particle is in linear SHM of amplitude A and time period T. If v refers to its average speed during any interval of T/3 , then the maximum possible value of v is

A. $\dfrac{3\sqrt{3}}{T}A$

B. $\frac{\sqrt{3}A}{T}$

C. $\frac{2\sqrt{3}}{T}A$

D. $\frac{3A}{T}$

**Answer: A**

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**88.** A particle of mass m is dropped from a great height h above the hole in the earth dug along its diameter.

A. The motion of the particle is simple harmonic

B. The motion of the particle is periodic

C. The speed of the particle at the centre of earth equals $\sqrt{\frac{2GM}{(R+h)}}$ , where R and M are the radius and mass of the earth respectively

D. The speed of the particle at the centre of earth equals $\sqrt{\frac{GM(R+3h)}{R(R+h)}}$, where R and M are the radius and mass of the earth respectively

**Answer: D**

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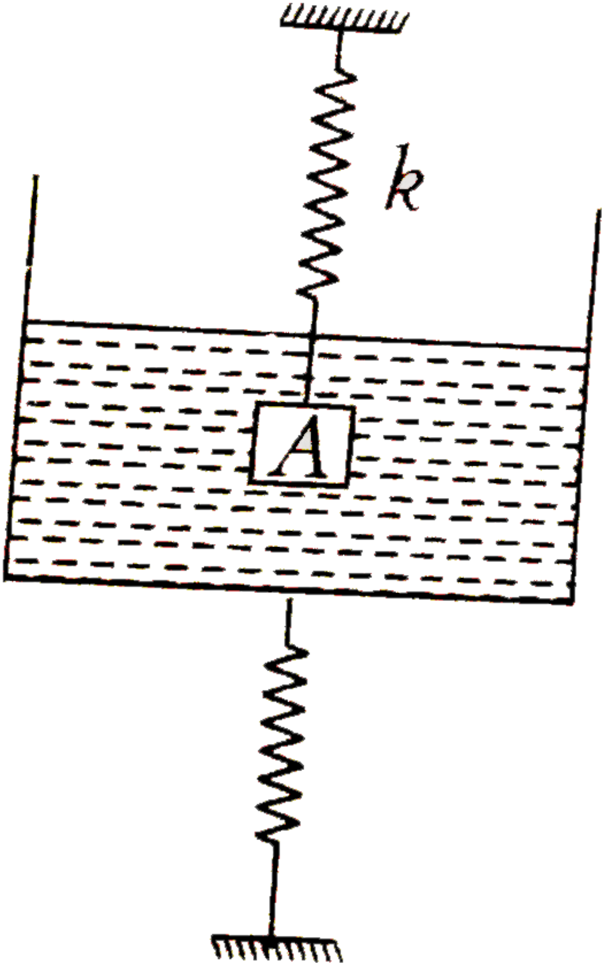
**89.** The system shown in figure is in equilibrium . The mass of the container with Liquid is M, density of liquid in the container is $\rho$ and the volume of the block is V. If the container is now displaced downwards through a distance $x_0$ and released such that the block remains well inside the liquid then during subsequent motion



A. time period of SHM of the container will be

$$2\pi\sqrt{\frac{M}{k}}$$

B. time period of SHM of the container will be

$$2\pi\sqrt{\frac{M+\rho V}{k}}$$

C. amplitude of SHM of the container is $x_0$

D. amplitude of SHM of the container is $2x_0$

**Answer: B**

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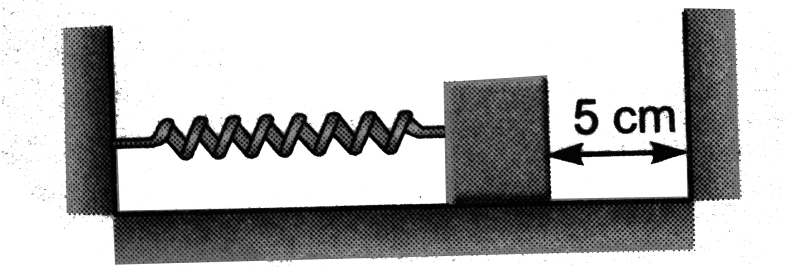
**90.** A block of mass $100g$ attached to a spring of stiffness $100N/m$ is lying on a frictionless floor as shown. The block is moved to compress the spring by $10cm$ and released. If the collision with the wall is elastic then find the time period of oscillations.




A. 0.2 s

B. 0.1 s

C. 0.15 s

D. 0.132 s

**Answer: D**

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**91.** One end of a long metallic wire of length (L) is tied to the ceiling. The other end is tied to a massless spring of spring constant . (K.A) mass (m) hangs freely from the free end of the spring. The area of cross- section and the Young's modulus of the wire are (A) and (Y) respectively. If the mass is slightly pulled down and released, it will oscillate with a time period (T) equal to :

A. $2\pi\sqrt{\frac{m}{k}}$

B. $2\pi\sqrt{\frac{m(YA+kL)}{YAK}}$

C. $2\pi\sqrt{\frac{m(YA+kL)}{AK}}$

D. $2\pi\sqrt{\frac{m(Y+kL)}{YAK}}$

**Answer: B**

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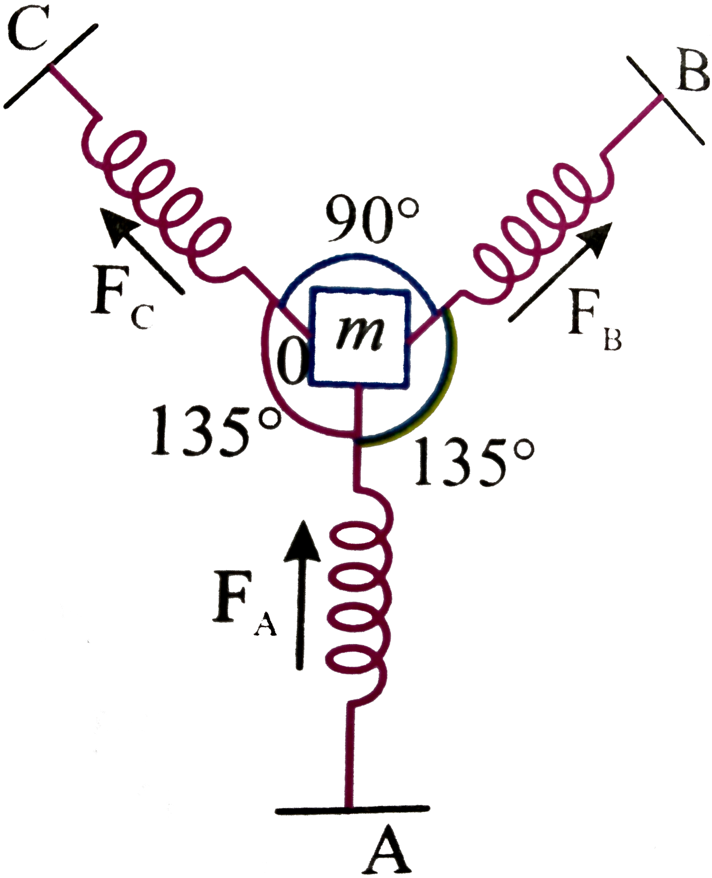
**92.** A particle of mass 'm' is attached to three identical springs $A, B$ and $C$ each of force constant 'K' as shown in figure. If the particle of mass 'm' is pushed slightly against the spring 'A' and released the period of oscillations is




A. $2\pi\sqrt{\frac{2m}{k}}$

B. $2\pi\sqrt{\frac{m}{2k}}$

C. $2\pi\sqrt{\frac{m}{k}}$

D. $2\pi\sqrt{\frac{m}{3k}}$

**Answer: B**

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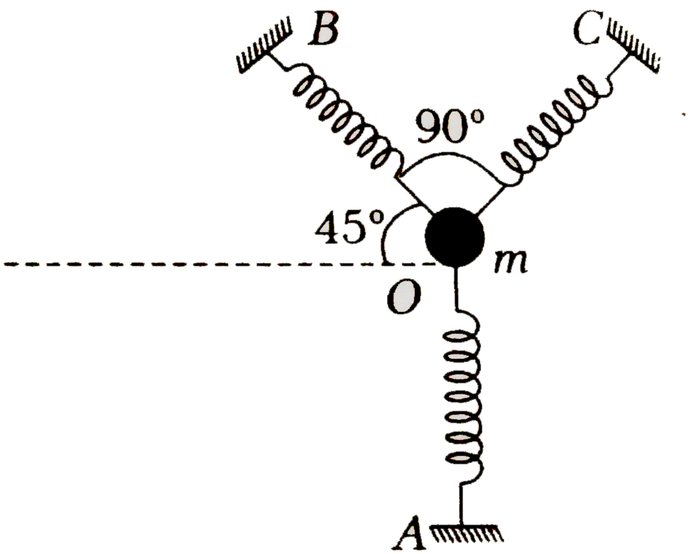
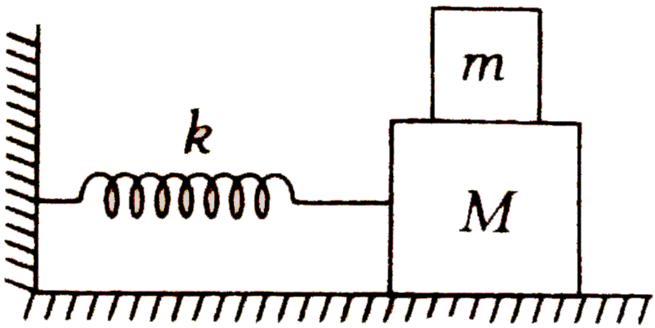
**93.** A mass M is attached to a horizontal spring of force constant k fixed one side to a rigid support as shown in figure. The mass oscillates on a frictionless surface with time period T and amplitude A. When the mass M is in equilibrium position, another mass m is gently placed on it. When will be the new amplitude of ocillation?




A. $\sqrt{\frac{(M+m)}{M}}A$

B. $\sqrt{\frac{(M-m)}{M}}A$

C. $\sqrt{\frac{M}{(M+m)}}A$

D. $\sqrt{\frac{M}{(M-m)}}A$

**Answer: C**

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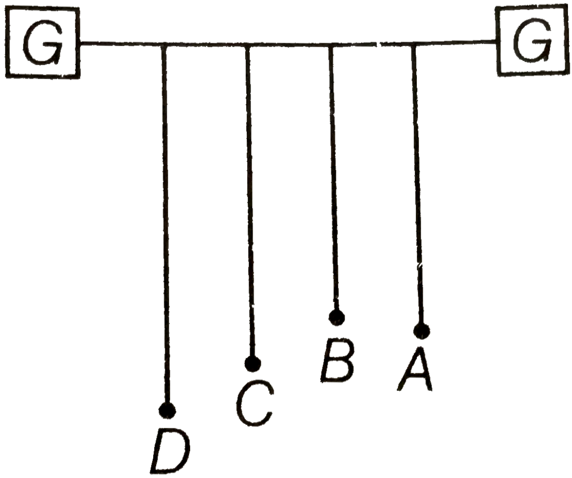
**94.** Four pendulums A, B, C and D are suspended from the same




elastic support as shown in figure. A and C are of the same length, while B is smaller than A and D is larger than A. If A is given a transverse displacement,

A. D will vibrate with maximum amplitude

B. C will vibrate with maximum amplitude

C. B will vibrate with maximum amplitude

D. All the four will oscillate with equal amplitude

**Answer: B**

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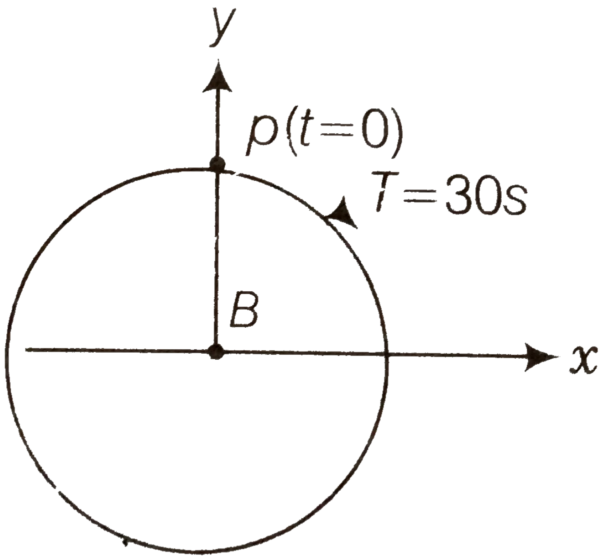
**95.** Figure shows the circular motion of a particle. The radius of the circle, the period, same of revolution and the initial position are indicated on the figure. The simple harmonic motion of the x-projection of the radius vector the rotating particle P is




A. $x(t) = B \sin\left(\frac{2\pi t}{30}\right)$

B. $x(t) = B \cos\left(\frac{\pi t}{15}\right)$

C. $x(t) = B\sin\left(\frac{\pi}{15} + \frac{\pi}{2}\right)$

D. $x(t) = B\cos\left(\frac{\pi t}{15} + \frac{\pi}{2}\right)$

**Answer: A**

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## Assertion and reason

**1.** Assertion :In SHM to find time taken in moving from one point to another point we can not apply the relation

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

Reason : In SHM speed is not constant.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: A**

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**2.** Assertion :Mean positon of SHM is the stable equlibrium position.

Reason: In stable equilibrium , position potential energy is minimum.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: A**

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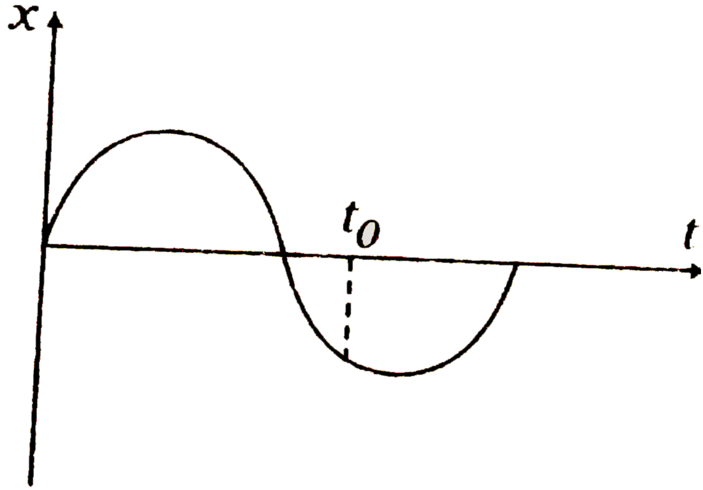
**3.** Assertion : In the x-t graph of a particle in SHM acceleration of particle at time $t_0$ is positive but velocity is negative




Reason :$a \propto \;-x$ and velocity is slope of x-t graph.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: A**

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**4.** Assertion : In $x = A\cos\omega t$, $x$ is the displacement measured from extreme position.

Reason : In the above equation $x = A$ at time $t = 0$.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: D**

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**5.** Assertion : If a pendulum is suspended in a lift and lift accelerates upwards, then its time period will decrease.

Reason : Effective value of g will be

$g_e = g + a$

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: A**

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**6.** Assertion : Simple harmonic motion is an example on one dimensional motion with non-uniform acceleration .

Reason : In simple harmonic motion, acceleration varies with displacement linearly.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: D**

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**7.** Assertion : If amplitude of SHM is increased , time period of SHM will increase.

Reason: If amplitude is increased, body have to travel more distance in one complete oscillation.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: D**

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**8.** Assertion : x-t equation of a particle in SHM is given as $: x = A\cos\omega t$

Reason : In the given equation the minimum potential energy is zero.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: C**

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**9.** Assertion : In x=3+4 $\cos\omega t$ , amplitude of oscillation is 4 units.

Reason : Mean position is at x=3.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: B**

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**10.** STATEMENT-1 : In simple harmonic motionn graph between celocity $(v)$ and displacement $(x)$ from mean position is elliptical.

STATEMENT-2 : Relation between $v$ and $x$ is given by $\frac{v^2}{\omega^2 A^2} + \frac{X^2}{A^2} = 1.$

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: A**

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**11.** Assertion : In x=5-4 $\sin \omega t$ , motion of body is SHM about the mean position x=5

Reason Amplitude of oscillation is 9.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: C**

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**12.** Assertion : Time period of a spring-block equation of a particle moving along X-axis is x=4+6$\sin\omega t$ . Under this situation, motion of particle is not simple harmonic.

Reason : $\frac{d^2x}{dt^2}$ for the given equation is proportional to -x.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: D**

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**13.** Assertion : Time period of a spring-block is T. If length of spring is decreased, time period will decrease.

Reason If length is decreased, then the block will have to travel less distance and it will take less time.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: C**

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**14.** Assertion : A particle performing SHM at certain instant is having velocity v. It again acquire a velocity v for the first time after a time interval of T second. Then the time period of oscillation is T second.

Reason : A particle performing SHM can have same velocity at two instants in one cycle.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: D**

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**15.** Assertion : Average kinetic energy in one oscillation during SHM of a body is $\frac{1}{4}m\omega^2A^2$.

Reason : Maximum kinetic energy is $\frac{1}{2}m\omega^2A^2$.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: B**

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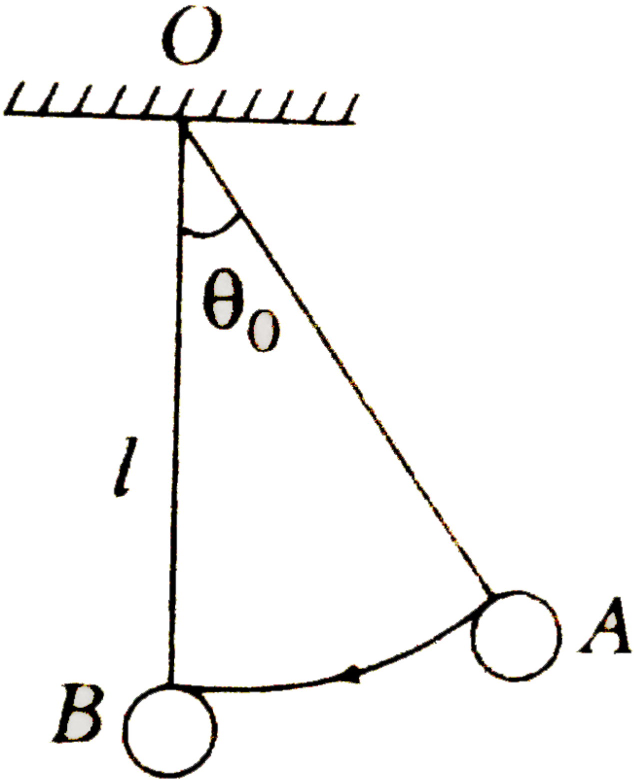
**16.** Assertion : Bob is released from rest position A. Given $\theta_0$ very small. Angular velocity of bob about point O is maximum and $\left(\sqrt{\frac{g}{l}}\right)\theta_0$ at point O.




Reason : For small angular amplitudes , motion of bob is simple harmonic

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: B**

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**17.** Assertion : In spring block system if length of spring and mass of block both are halved, then angular frequency of oscillations will remain unchanged.

Reason : Angular frequency is given by $\omega = \sqrt{\frac{k}{m}}$.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

**Answer: D**

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## Match the columns

**1.** In SHM match the following

| | Column I | | Column II |
|---|---|---|---|
| (A) | Displacement and velocity | (p) | Phase difference of zero |
| (B) | Displacement and acceleration | (q) | Phase difference of $\frac{\pi}{2}$ |
| (C) | Velocity and acceleration | (r) | Phase difference of $\pi$ |

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**2.** In SHM match the following

| | Column I | | Column II |
|---|---|---|---|
| (A) | Acceleration-displacement graph | (p) | Parabola |
| (B) | Velocity-acceleration graph | (q) | Straight line |
| (C) | Velocity-time graph | (r) | Circle |
| (D) | Acceleration-time graph | (s) | None |

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3. In case of second's pendulum, match the following (consider shape of earth also)

| Table-1 | Table-2 |
|---|---|
| (A) At pole | (P) $T > 2$ s |
| (B) On a satellite | (Q) $T < 2$ s |
| (C) At mountain | (R) $T = 2$ s |
| (D) At centre of earth | (S) $T = 0$ |
| | (T) $T = \infty$ |

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4. In the equation $y = A\sin\left(\omega t + \frac{\pi}{4}\right)$ match the following for x=$\frac{A}{2}$.

| Table-1 | Table-2 |
|---|---|
| (A) Kinetic energy | (P) Half the maximum value |
| (B) Potential energy | (Q) 3/4 times the maximum value |
| (C) Acceleration | (R) 1/4 times the maximum value |
| | (S) Cannot say anything |

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5. In spring-block system match the following

| Table-1 | Table-2 |
| --- | --- |
| (A) If only $k$ (the spring constant) is made 4-times | (P) Speed will become 16 times |
| (B) If only $m$ (the mass of block) is made 4-times | (Q) Potential energy will become four times |
| (C) If $k$ and $m$ both are made 4-times | (R) Kinetic energy will remain unchanged |
| | (T) None |

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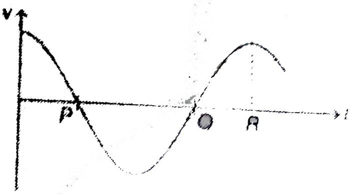
6. Velocity-time graph of a particle in SHM is as shown in figure. Match the following




| Table-1 | Table-2 |
|---|---|
| (A) At $P$ | (P) Particle is at $x = -A$ |
| (B) At $Q$ | (Q) Acceleration of particle is maximum |
| (C) At $R$ | (R) Displacement of particle is zero |
| | (S) Acceleration of particle is zero |
| | (T) None |

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**7.** In y= A sin $\omega$t + A sin ($\omega$t+(2$\pi$)/3)` match the following table.

| Table-1 | Table-2 |
|---|---|
| (A) Motion | (P) is periodic, but not SHM |
| (B) Amplitude | (Q) is SHM |
| (C) Initial phase | (R) $A$ |
| (D) Maximum velocity | (S) $\pi/3$ |
| | (T) $\omega A/2$ |
| | (U) None |

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**8.** x-t equation of a particle in SHM is given as x= $1.0\sin(12\pi t)$ in SI units. Potential energy at mean position is zero. Mass of particle is $\frac{1}{4}$ kg. Match the following table (SI units).

| Table-1 | Table-2 |
|---|---|
| (A) Frequency with which kinetic energy oscillates | (P) $\frac{1}{2}$ |
| (B) Speed of particle is maximum at time $t$ = | (Q) $18\pi^2$ |
| (C) Maximum potential energy | (R) 12 |
| (D) Force constant $K$ | (S) $36\pi^2$ |

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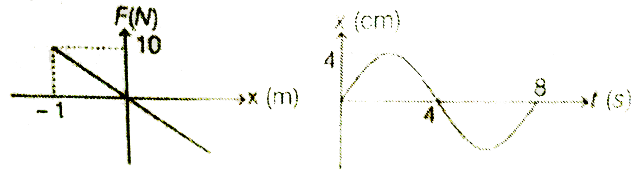
**9.** F-x and x-t graph of a principle in SHM are as shown in figure. Match the following.




| Table-1 | Table-2 |
| --- | --- |
| (A) Mass of the particle | (P) $\frac{\pi}{2}$ SI unit |
| (B) Maximum kinetic energy of particle | (Q) $(160/\pi^2)$ SI unit |
| (C) Angular frequency of particle | (R) $(8.0 \times 10^{-3})$ SI unit |
| | (T) None |

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**10.** In the two block spring system, force constant of spring is k = 6N/m. Spring is stretched by 12 cm and then left. Match the following.


| Table-1 | | Table-2 | |
|---|---|---|---|
| (A) | Angular frequency of oscillation | (P) | $4.8 \times 10^{-3}$ SI unit |
| (B) | Maximum kinetic energy of 1 kg | (Q) | 3 SI unit |
| (C) | Maximum kinetic energy of 2 kg | (R) | $2.4 \times 10^{-3}$ SI unit |
| | | (S) | None |

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**11.** A uniform rod of length l is suspended from a point P. and the rod is made to undergo small oscillations.

Match the following

| Table-1 | Table-2 |
|---|---|
| (A) If $P$ is the centre of mass then time period is | (P) Zero |
| (B) If $P$ is the end point then time period is | (Q) $2\pi\sqrt{\frac{l}{3g}}$ |
| (C) Length of simple pendulum having the time period equal to that of the rod when $P$ is end point | (R) $\frac{l}{3}$ |
| | (S) $\frac{2l}{3}$ |
| | (T) None |

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## Medical entraces gallery

**1.** A body of mass $m$ is attteched to the lower end of a spring whose upper end is fixed .The spring has negaligible mass .When the mass $m$ is slightly puylled down and released it oscillation with a time period of $3s$ when the mass $m$ is increased by $1kg$ time period of oscillations becomes $5s$ The value of $m$ in $kg$ is

A. $\frac{3}{4}$

B. $\frac{4}{3}$

C. $\frac{16}{3}$

D. $\frac{9}{16}$

**Answer: D**

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**2.** Two similar springs P and Q have spring constant $K_P$and $K_Q$ , such that $K_P > K_Q$. They are stretched, first by the same amount (case a), then by the same force (case b). The work done by the springs $W_P$ and $W_Q$ are related as , in case (a) and case (b), respectively

A. $W_P = W_Q, W_P > W_Q$

B. $W_P = W_Q, W_P = W_Q$

C. $W_P > W_Q, W_Q > W_P$

D. $W_P < W_Q, W_Q < W_P$

**Answer: C**

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3. A particle is executing SHM along a straight line. Its velocities at distances $x_1$ and $x_2$ from the mean position are $v_1$ and $v_2$, respectively. Its time period is

A. $2\pi\sqrt{\frac{x_1^2+x_2^2}{v_1^2+v_2^2}}$

B. $2\pi\sqrt{\frac{x_2^2-x_1^2}{v_1^2-v_2^2}}$

C. $2\pi\sqrt{\frac{v_1^2+v_2^2}{x_1^2+x_2^2}}$

D. $2\pi\sqrt{\frac{v_1^2-v_2^2}{x_1^2-x_2^2}}$

**Answer: B**

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**4.** The velocity v and displacement x of a particle executing simple harmonic motion are related as

$v\frac{dv}{dx} = -\omega^2 x.$

$At x = 0, v = v_0.$ Find the velocity v when the displacement becomes x.

A. $\sqrt{v_0^2 + \omega^2 x^2}$

B. $\sqrt{v_0^2 - \omega^2 x^2}$

C. $v = \sqrt[3]{v_0^3 + \omega^2 x^3}$

D. $v = v_0 - \left(\omega^3 x^3 e^{x^3}\right)^{1/3}$

**Answer: B**

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**5.** A body hanging from a spring stretches it by $2cm$ at the earth's surface. How much will the same body stretch the spring at a place $800cm$ above the earth's surface? Radius of the earth is $6400km$.

A. 0.79 cm

B. 1.79 cm

C. 0.21 cm

D. None of these

**Answer: A**

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**6.** A particle of mass 200 g executes a simpel harmonit motion. The resrtoring force is provided by a spring of spring constant $80Nm^{-1}$. Find the time period.

A. 0.93 s

B. 0.63 s

C. 0.31 s

D. None of these

**Answer: C**

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**7.** A particle of mass 40 g executes a simple harmonic motion of amplitude 2.0 cm. If the time period is 0.20 s, find the total mechanical energy of the system.

A. $14.8 \times 10^{-3} J$

B. $7.9 \times 10^{-3} J$

C. $23.7 \times 10^{-3} J$

D. $3.9 \times 10^{-3} J$

**Answer: D**

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**8.** A copper sphere attached to the bottom of a vertical spring is oscillating with time period 10 s. If the copper sphere is immersed in a fluid (assume the viscosity of the fluid is negligilbe) of specfic gravity $\frac{1}{4}$ of that of the copper, then time period of the oscillation is

A. 5 s

B. 10 s

C. 2.5 s

D. 20 s

**Answer: B**

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**9.** In case of uniform circular motion which of the following physical quantity do not remain constant

A. kinetic energy

B. potential energy

C. restoring force

D. Frequency

**Answer: D**

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**10.** Out of the following functions representing motion of a particle which represents SHM ?

I. $y = \sin \omega t - \cos \omega t$ , II. $y = \sin^3 \omega t$

III. $y = 5 \cos\left(\frac{3\pi}{4} - 3\omega t\right)$ , IV. $y = 1 + \omega t + \omega^2 t^2$

A. A and B

B. A and C

C. A only

D. A, B and C not D

**Answer: B**

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**11.** The ration 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

A. $2:1$

B. $3:1$

C. $8:1$

D. $1:1$

**Answer: B**

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**12.** A body oscillates with SHM according to the equation (in SHM unit ), $x = 5\cos\left(2\pi t + \frac{\pi}{4}\right)$ . Its instantaneous displacement at t=1 s is

A. $\frac{\sqrt{2}}{5}$ m

B. $\frac{1}{\sqrt{3}}$ m

C. $\frac{1}{2}$ m

D. $\frac{5}{\sqrt{2}}$ m

**Answer: D**

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**13.** Two pendulums having time period $T$ and $\frac{5T}{4}$. They start $S.H.M.$ at the same time from mean position. what will be the phase difference between them after the bigger pendulum has completes one oscillation ?

A. $45^{\circ}$

B. $90^{\circ}$

C. $60^{\circ}$

D. $30^{\circ}$

**Answer: B**

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**14.** The amplitude of a executing $SHM$ is $4cm$ At the mean position the speed of the particle is $16cm/s$ The distance of the particle from the mean position at which the speed the particle becomes $8\sqrt{3}cm/s$ will be

A. $2\sqrt{3}$ cm

B. $\sqrt{3}$ cm

C. 1 cm

D. 2 cm

**Answer: D**

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**15.** What is the phase difference between two simple harmonic motions represented by $x_1 = A\sin\left(\omega t + \frac{\pi}{6}\right)$ and $x_2 = A\cos\omega t$?

A. $\frac{\pi}{6}$

B. $\frac{\pi}{3}$

C. $\frac{\pi}{2}$

D. $\frac{2\pi}{3}$

**Answer: B**

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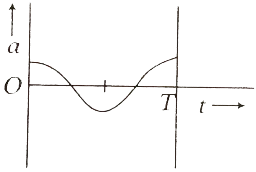
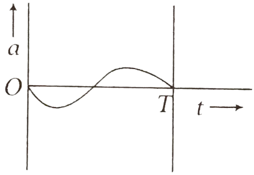
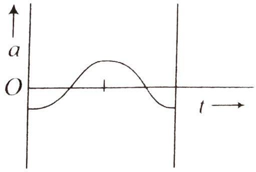
**16.** The oscillation of a body on a smooth horizental surface is respresented by the equation

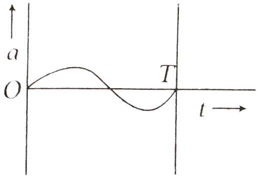
$X = A\cos(\omega t)$

where one of the following graph shown correctly the variation a with $t$?

A. 


B. 


C. 


D. 


**Answer: C**

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**17.** When a wave travels in a medium, the particle displacement is given by the equation $y = a\sin 2\pi(bt - cx)$, where $a$, $b$ and $c$ are constants. The maximum particle velocity will be twice the wave velocity. If

A. b=ac

B. $v = \frac{1}{ac}$

C. $c = \pi a$

D. $c = \frac{1}{\pi a}$

**Answer: D**

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**18.** When a particle executes SHM oscillates with a frequency v, then the kinetic energy of the particle

A. change periodically with a frequency of v

B. changes periodically with a frequency of 2v

C. changes periodically with a frequency of v/2

D. remain constant

**Answer: B**

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**19.** If a body is executing simple harmonic motion and its current displacement is $\sqrt{3}/2$ times the amplitude from its mean position , then the ratio between potential energy and kinetic energy is

A. $3:2$

B. $2:3$

C. $\sqrt{3}:1$

D. $3:1$

**Answer: D**

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**20.** A 10 kg metal block is attached to a spring constant $1000Nm^{-1}$. A block is displaced from equilibrium position by 10 cm and released. The maximum acceleration of the block is

A. $10ms^{-2}$

B. $100ms^{-2}$

C. $200ms^{-2}$

D. $0.1ms^{-2}$

**Answer: A**

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**21.** A block rests on a horizontal table which is executing SHM in the horizontal plane with an amplitude A. What will be the frequency of oscillation, the block will just start to slip? Coefficient of friction $= \mu$.

A. $\frac{1}{2\pi}\sqrt{\frac{\mu g}{A}}$

B. $\frac{1}{4\pi}\sqrt{\frac{\mu g}{A}}$

C. $2\pi\sqrt{\frac{A}{\mu g}}$

D. $4\pi\sqrt{\frac{A}{\mu g}}$

**Answer: A**

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**22.** The displacement $y$ of a particle executing periodic motion is given by

$$y = 4\frac{\cos^2(t)}{2}1000t$$

How many independent harmonic motions may be considered to superpose to results this expression :

A. 1

B. 2

C. 3

D. 4

**Answer: C**

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**23.** The time period of a simple pendulum of length 9.8 m is

A. 0.159 s

B. 3.14 s

C. 6.5 s

D. 6.28 s

**Answer: D**

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**24.** A particle executing of a simple harmonic motion covers a distance equal to half its amplitude in on e second . Then the time period of the simple harmonic motion is

A. 4 s

B. 6 s

C. 8 s

D. 12 s

**Answer: D**

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**25.** The diplacement , velocity and acceleration in a simple harmonic motion are related as the

A. displacement , velocity and acceleration all act in the same directionb

B. displacement and velocity act in the same direction but acceleration in the opposite direction.

C. velocity and acceleration are parallel and both are perpendicular to the displacement

D. displacement and acceleration are anti-parallel and both perpendicular to the velocity

**Answer: B**

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**26.** If $T_1$ and $T_2$ are the time-periods of oscillation of a simple pendulum on the surface of earth (of radius R) and at a depth d, the d is equal to

A. $\left(1 - \frac{T_1^2}{T_2^2}\right)R$

B. $\left(1 - \frac{T_2^2}{T_2^2}\right)R$

C. $\left(1 - \frac{T_2}{T_2}\right)R$

D. $\left(1 - \frac{T_2}{T_1}\right)R$

**Answer: A**

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**27.** A particle executes SHM in accordance with $x = A\sin\omega t$. If $t_1$ is the time taken by it to reach from x=0 to $x = \sqrt{3}(A/2)$and $t_2$ is the time taken by it to reach from $x = \sqrt{3}/2$A to x=A , the value of $t_1/t_2$ is

A. 2

B. $\frac{1}{2}$

C. 3

D. None of the these

**Answer: D**

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**28.** In case of a forced vibration the resonance wave becomes very sharp when the

A. Restoring force is small

B. damping force is small

C. quality factor is small

D. quality factor is small

**Answer: B**

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**29.** When a boy is playing on a swing in the sitting position , the time period of oscillations of the swing is

T. If the boy stands up , the time period of oscillation of the spring will be

A. more than T

B. less than T

C. equal to T

D. Cannot be predicted

**Answer: B**

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**30.** To make the frequency double of an oscillator, we have to

A. half the mass

B. quadruple the mass

C. double the mass

D. reduce the mass to one-fourth

**Answer: D**

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**31.** An SHM is give by $y=5\left[\sin(3\pi t)+\sqrt{3}\cos(3\pi t)\right]$.

What is the amplitude of the motion of y in metre ?

A. 10

B. 20

C. 1

D. 5

**Answer: A**

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**32.** Two simple harmonic motions are represented by the equations

$y_1 = 10\sin(3\pi t + \pi/4)$ and $y_2 = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$

their amplitude are in the ratio of ............ .

A. $1:2$

B. $2:1$

C. $1:1$

D. None of these

**Answer: C**

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**33.** If a simple pendulum is taken to place where g decreases by 2%, then the time period

A. increase by 5%

B. increase by 1%

C. increase by 2%

D. decrease by 5 %

**Answer: B**

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**34.** A simple pendulum executing S.H.M. is falling freely along with the support. Then

A. it does not oscillate at all

B. its periodic time increase

C. its periodic time decrease

D. None of the above

**Answer: A**

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**35.** Equations $y_1 = A \sin \omega t$ and $y_2 = \frac{A}{2} \sin \omega t + \frac{A}{2} \cos \omega t$ represent S.H.M. The ratio of the amplitudes of the two motions is

A. 0.5

B. $\sqrt{2}$

C. 1

D. 2

**Answer: B**

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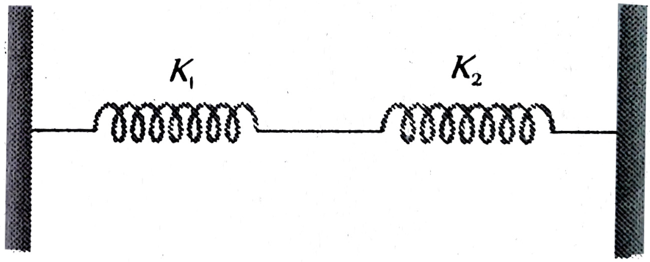
**36.** The effective spring constant of two spring system as shown in figure will be




A. $k_1 - k_2$

B. $k_1 + k_2$

C. $k_1 k_2 / k_1 - k_2$

D. $k_1 k_2 / k_1 + k_2$

**Answer: B**

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**37.** A block of mass $M$ suspended from a spring oscillates with time period $T$. If spring is cut in to two equal parts and same mass $M$ is suspended from one part, new period os oscillation is

A. 2T

B. $\sqrt{2}T$

C. $\frac{T}{\sqrt{2}}$

D. $\frac{T}{2}$

**Answer: D**

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**38.** Assertion: If bob of a simple pendulum is kept in a horizontal electric field, its period of oscillation will remain same.

Reason: If bob is charged and kept in horizontal electric field, then the time period will be decreased.

A. If both assertion and Reason are correct but Reason is the correct explanation of Assertion.
B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.
C. If Assertion is correct but Reason is incorrect.
D. If assertion is incorrect and reason is correct.

**Answer: B**

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**39.** The displacement of two identical particles executing $SHM$ are represented by equations $x_1 = 4\sin\left(10t + \frac{\pi}{6}\right) \& x_2 = 5\cos(\omega t)$ For what value of •, energy of both the particles is same.

A. 16 unit

B. 6 unit

C. 4 unit

D. 8 unit

**Answer: D**

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**40.** The amplitude and the periodic time of a S.H.M. are 5 cm and 6 sec respectively. At a distance of 2.5 cm away from the mean position, the phase will be

A. $\frac{\pi}{3}$

B. $\frac{\pi}{4}$

C. $\frac{\pi}{6}$

D. $\frac{5\pi}{12}$

**Answer: C**

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