PHYSICS

BOOKS - MODERN PUBLISHERS PHYSICS (HINGLISH)

OSCILLATIONS

Solved Examples

1. On an average a human heart is found to beat 75 times in a minute. Calculate its beat frequency and period.

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2. Which of the following functions of time represents (a) periodic motion, (b) non-periodic motion and (c) harmonic motion ?

find the period of each periodic motion. [ω is any positive constant]

(i) $\sin 2\omega t + \cos 2\omega t$

(ii) $\cos \omega t + 2 \sin 2\pi t + 3 \cos 3\pi t$

(iii) $\cos^2 \omega t$

(iv) $\sin(2\omega t + \pi / 3)$

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3. A simple harmonic motion is represented by $x = 5 \sin(10t + 0.25)$

Determine is

(i) amplitude

(ii) Angular frequency

(iii) Frequency

(iv) Time period

(v) Initial phase

[Displacement is measured in metres and time in seconds]

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4. A particle is executing simple harmonic motion with an amplitude of 10 cm and time period of 4s. Calculate its displacement, velocity and acceleration after 1/2 seconds, starting from the mean position.

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5. 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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6. A simple harmonic motion is represented by y = 8 sin 10 π t + 6 cos 10 πt, where is in cm and t is in sec. Calculate the amplitude time period and intial phase.

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7. A particle executed SHM amplitude 20cm and tme period 4s. What is minimum time required for the particle to move between two points 10cm on either side of mean position?

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8. For a simple pendulum, the time period is 3 s and has a maximum displacement of 5 cm on either side of its mean position. If at the beginning of the motion, the pendulum is at maximum displacement from its mean position, towards its right, then derive the displacement equation of the pendulum.

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9. The displacement of a particle undergoing S.H.M. as a function of time t is given by

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

Where x is in cm and t in second

The time taken by the particle to travel from (a) x = 0 to A/2 is t_a and time taken by it to travel from (b) x = A/2 to A is t_b. Calculate the ratio t_b / t_a.

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10. The relation between the distance of a point moving on a straight line measured from a fixed origin on it and its velocity v is given by

$$9v^2 = 16 - y^2$$

Show that the motion of the point is simple harmonic and calculate its time period.

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11. A particle is moving with S.H.M. along a straight line. When the distance of the particle form the mean position is 3 m and 4m, the corresponding values of velocities are 4m/s and 3m/s. What time it will take to travel 2 m from the positive extremity of the oscillation.

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12. A particle is executing linear S.H.M. with a maximum velocity of 50 cm/s and a maximum acceleration of 40 cm/s^2. Calculate the amplitude and the period of oscillation.

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13. A huge piston in a machine is undergoing, vertical S.H.M approximately with a frequency of 1 s^{-1}. A 5 kg block is placed on the piston. iF the block and the piston move together, determine the maximum amplitude of the piston S.H.M. such that block remains in contact with piston

take, g = 9.8 m/s^2

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14. When a man stands on a weighing machine placed on a horizontal platform, it reads 60 kg . With the help of a suitable mechanism, the platform is made to undergo vertical harmonic vibrations with a frequency of 1 vibration per second. Determine the effect of this S.H.M. on the reading of the weighing machine, The amplitude of vibration of the platform is 4 cm. Take g = 10 m/s^2.

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15. A block whose mass is 1 kg is fastened to a spring.The spring has a spring constant $50Nm^{-1}$. The block is pulled to a distance $x = 10cm$ from its equilibrium position at $x = 0$ on a frictionless surface at $t = 0$. Calculate the kinetic, potential and total energies of the block when it is 5cm away from the mean position.

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16. A body of mass 20 g acquires a velocity of 5 cm/s after one second of its starting from the mean position. If the time period of motion is 5 seconds, calculate the kinetic energy, potential energy and total energy of the body.

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17. 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 and kinetic and potential?

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18. A particle executes simple harmonic motion of a certain amplitude A. Calculate the distance from the mean position where the kinetic energy of particle is equal to its potential energy. Also, find the points where the speed of the particle is 1/3 of its maximum speed.

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19. A weight of 3 kg is placed on the pan of mass 1kg of a spring balance. IF the weight stretches the spring by 12 cm, find the frequency with which the empty pan oscillates.

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20. A mass of 0.1 kg hangs at the end of a spring. When a mass of 0.01 kg more is added at the end of the spring, it stretches by 5 cm more. When the extra 0.01 kg mass is removed, determine the time period of vibration of the system.

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21. A coil of natural length 40 cm and K = 10^3 N m is used to suspend of a mass of 10 kg from its one end.

(i) calculate the stretched length of the coil.

(ii) If the mass is further pulled down by stretching the coil to a length of 46 cm and then released, then calculate the frequency of oscillation of the suspended mass ? (Consider spring to be massless)

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22. 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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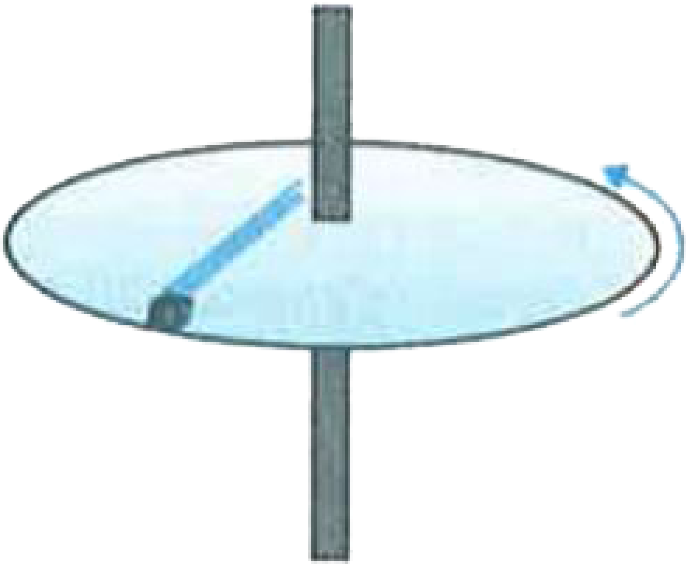
23. A small block of mass 1 kg is placed on a horizontal table, connected by a weightless spring to the central rod of the table as shown in the adjoining figure.

the table is set to rotate at a speed of 200 rpm which causes spring to stretch by 5 cm. If the original length of the spring is 30 cm, determine its force constant.



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24. Two masses $m_1 = 1.0kg$ and $m_2 = 0.5kg$ are suspended together by a massless spring of force constant, $k = 12.5Nm^{-1}$. When they are in equillibrium position, m_1 is gently removed. Calculate the angular frequency and the amplitude of oscillation of m_2. Given $g = 10ms^{-2}$.

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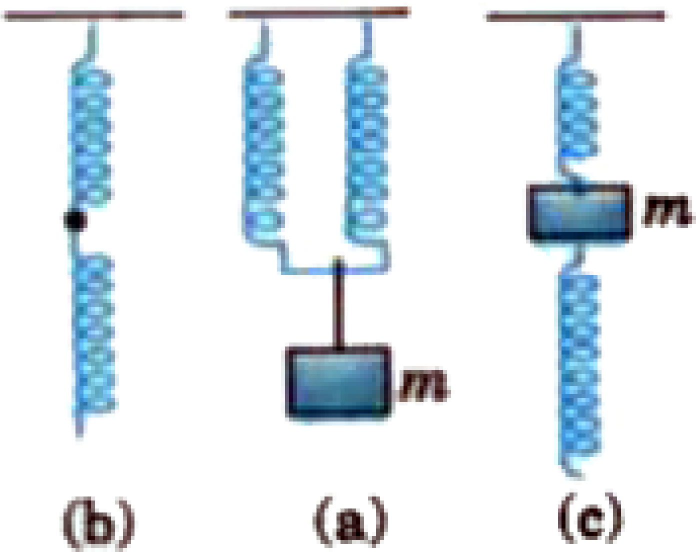
25. Two identical springs (springs constant K) are connected together in three different ways. In which case will the spring factor of the oscillation of the body be least ?



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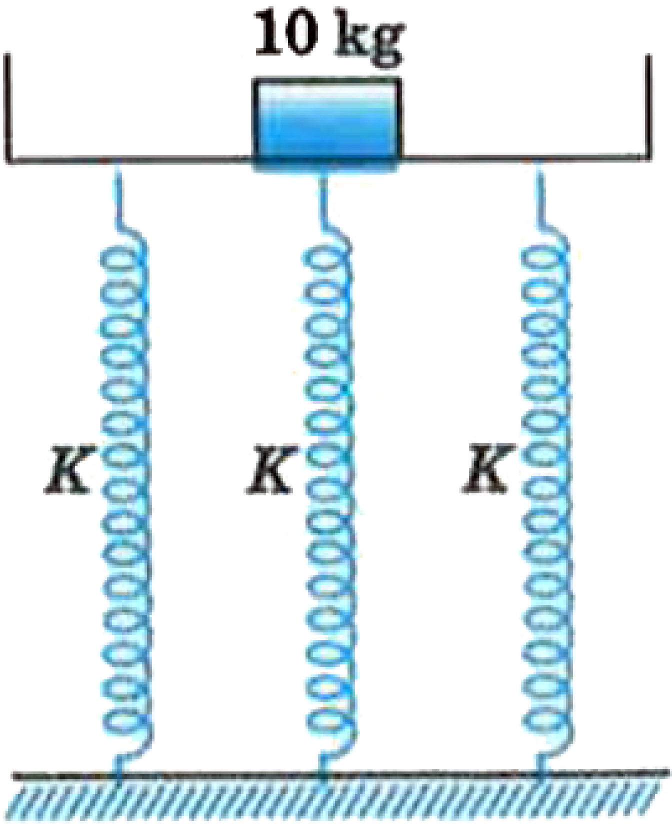
26. An arrangement of three identical spring and a block of mass 10 kg is shown in the adjoining figure. When the platform on which block is placed is slightly pressed down and released. It performs S.H.M. with a period of 2 s.

(i) Calculate the spring constant of the spring.

(ii) If a block of mass m is further placed on the platform, the new period of S.H.M. becomes 3.5 s. Find the value of m. (Assume platform to be massless)



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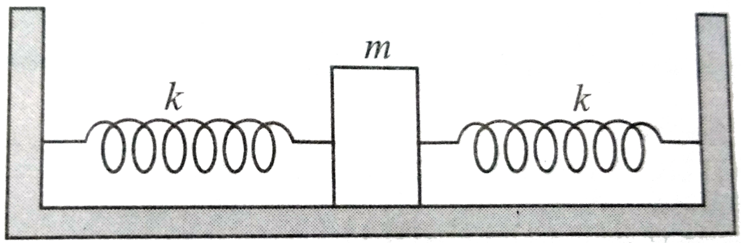
27. Two identical springs of spring constant k are attached to a block of mass m and to fixed supports as shown in the figure. The time period of oscillation is



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28. What is the length of a simple pendulum which ticks second?

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29. The length of a pendulum clock increase by 0.01% If it initially shows accurate time, deduce the error in time per day after increasing its length.

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30. The pendulums of lengths 100 cm and 110.25 cm start oscillating in phase. After how many oscillation will they again be in same phase ?

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31. A second pendulum is taken in a carriage. Find the period of oscillation when the carriage moves with an acceleration of $4 \cdot 2 m s^{-2}$ (i) vertically upwards (ii) vertically downwards and (ii) in a horizontal direction.

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32. A vertical U-tube contains liquid of uniform density upto a height of 3 cm. If the liquid in one arm is depressed and then released, it performs S.H.M. in the tube. Calculate its time period of oscillations.

Assume U-tube to be of uniform cross section.

Take, g = 980 cm/s^2

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33. A thin vertical tube of weight 12 g and external diameter 1 cm is made to float vertically in water by placing 12 g of mercury at its bottom. If the tube is depressed slightly and then released, determine the time period of S.H.M.

Take $g = 10m/s^2$

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34. A cylindrical wooden cork of mass 250 g and cross sectional area 10 cm^2 is floating into a beaker filled with water, with an extra weight of 30 g attached to its bottom, as shown in the adjoining figure. If the cork Performs, S.H.M., determine its frequency. take, Specific gravity of wood = 0.30

$g = 9.8m / s^2$

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35. A balance-wheel of a watch has a moment of inertia equal to 2×10^{-8} kg m^2. When it is rotated by 30°, a restoring torque of 5.13 $\times 10^{-6}$ Nm is generated, calculate its frequency of oscillations.

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Practice Problems

1. Which of the following functions represent (a) periodic motion, b) simple harmonic, (c) non-periodic, (d) periodic but not simple harmonic

(i) $\sin^2 \omega t$

(ii) $\sin 2\omega t + \cos 2\omega t$

(iii) $\cos\left(4\omega t + \frac{\pi}{6}\right)$

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2. Give the time period for the functions given below, which are simple harmonic in nature:

$e^{-\omega t}$

(ii) $\log(\omega t)$

(iii) $\sin \omega t + \cos \omega t$

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3. A simple harmonic motion is represented as

$x = 20 \sin(2\pi)t + 0.5]m$

find amplitude, angular frequency time period and initial phase.

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4. A body is oscillating with S.H.M. as

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

find the displacement, velocity and acceleration of the body at t = 2 s

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5. A particle is executing simple harmonic motion with a time period of 2s and amplitude 10 cm. Calculate its velocity and acceleration 2 seconds after starting from mean position.

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6. A particle executing S.H.M. is passing through the mean position with a velocity of 40 m/s.(a) Calculate the maximum displacement of the particle from mean position if particle completes 1000 oscillations per minute. (b) obtain the displacement equation of the particle.

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7. A particle executing simple harmonic motion along a straight line. The velocity of the particle is $5ms^{-1}$, when it is at a distance of 4 m from mean position and $3ms^{-1}$, when at a distance of 9 m from mean position. Calculate the time taken by the particle to travel 3 m from the positive extremity of oscillation.

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8. Calculate the time period of a particle whose acceleration is 5 cm s^{-2} at a distance of 5 cm from the mean posiiton.

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9. How much time will a particle oscillating according to equation y = 10 sin (0.9 πt)m take to move from mean position to position of maximum displacement ?

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10. A boy is standing on a weighing machine placed on a horizontal platform. The reading of weighing machine is 70 kg. Using a suitable mechanism the platform is made to execute harmonic vibrations with a frequency of 1 vibration per second. Calculate the maximum and minimum force exerted on the boy if the amplitude of vibration of platform is 6 cm.

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11. When displacement is one-third of the amplitude, what fraction of total energy is potential energy and what fraction is kinetic energy in simple harmonic motion ?

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12. A particle is executing simple harmonic motion with an amplitude 9 cm. Locate the point where its speed be one-third of its maximum speed.

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13. A particle executes simple harmonic motion with an amplitude 9 cm. At what displacement from the mean position, energy is half kinetic and half potential ?

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14. A particle is executing simple harmonic motion having total energy of 2×10^{-3} J and time period of 2π seconds. At $t = \frac{\pi}{3}$ second, the displacement of the particle is 0.11 m. Calculate the amplitude and mass of the particle.

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15. When a weight of 2kg is suspended from a spring, its length increases by 3 cm. If the weight is further pulled down by 12 cm and then released, it executes S.H.M. What will be the period of oscillation of the arrangement ? Also calculate the potential energy of the spring .

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Practice Problems 2

1. A spring of force constant 20 N/m is cut into four equal parts, All the four parts are now connected in parallel. Find the force constant of the combination.

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2. A mass m suspended by a spring, oscillates with frequency f_1. The same mass m oscillates with frequency f_2 if length of the spring is made one-third. Find the ratio f_1 / f_2.

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3. Find the effective force constant in the situation when infinite number of springs with springs constant k 2k, 4k, 8k, ... Respectively are connected in series.

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4. 5 N of force is required to stretch a spring by 3 cm. If the spring is divided into four equal sections, then calculate the force required to stretch one section by 4 cm.

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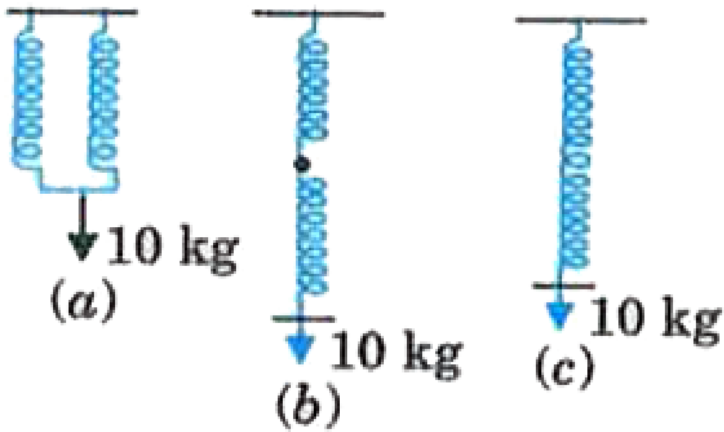
5. Calculate the elongation produced in each spring in the following cases, (a). (b) and (c) if springs are identical and having force constant of 150 Nm^{-1}.



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6. A mass m is suspended from a weightless spring. The time period of oscillation of mass is 3 s . Calculate the value of m if on suspending an additional mass of 3kg, time period increases by 2 s.

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7. Two particles P_1 and P_2 having identical masses are suspended from two massless springs of spring constant k_1 = 5 N/m and k_2 = 8 N/m respectively. If maximum velocity of oscillation for particle P_1 is twice than for particle P_2, then find the ratio of amplitudes for P_1 and P_2.

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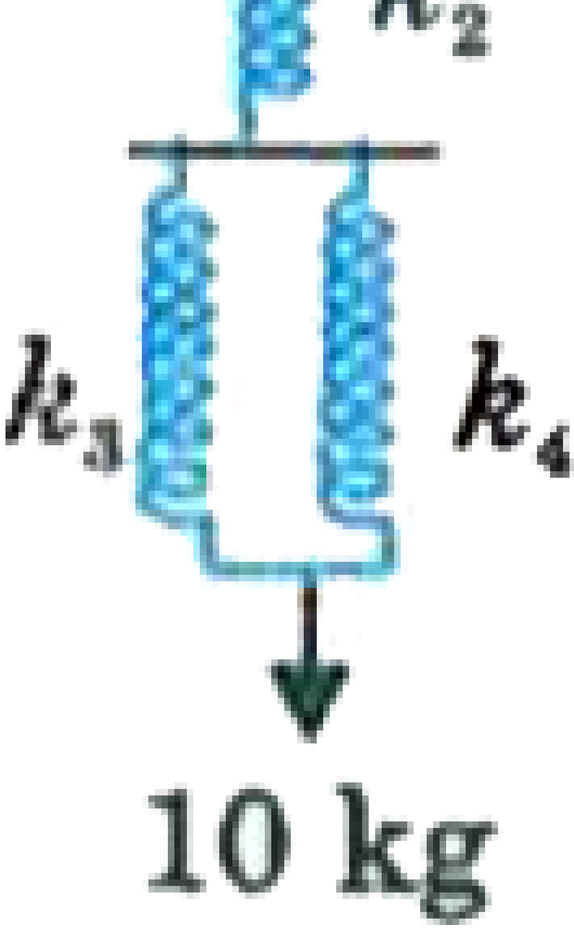
8. Calculate the frequency of oscillations of a mass m = 10 kg in the following arangement of springs. (Given $k_1 = k_2 = k_3 = k_4 = k = 3$ N/m)



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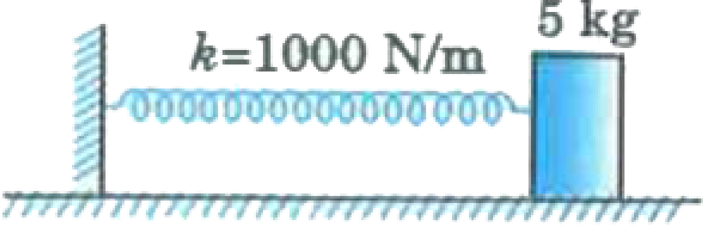
9. A mass of 5 kg is attached to the free end of a spring pulled sideways to a distance of 3 cm and released. What will be the



(a) Speed of this mass when spring is compressed by 2 cm ?

(b) Potential energy of the mass at the point where kinetic energy becomes zero ?

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10. The ratio of Young's modulus of two springs of same area of cross section and same length is 5 : 4 Equal masses are suspended from these springs. On stretching and then releasing, the springs start oscillating. Calculate the ratio of time period of oscillation.

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11. On compressing a spring by 0.5 m, a restoring force of 20 N is developed. When a body of mass 5 kg is placed on the spring, then calculate the (a) force constant of the spring.

(b) the distance through which the spring is depressed under the weight of the body.

(c) the period of oscillation of the spring if the the body is pushed down and then released.

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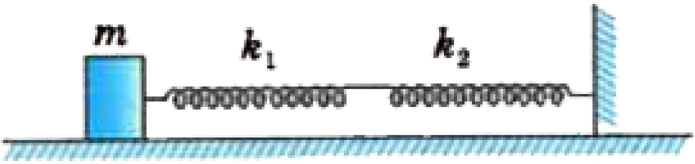
12. Two spring of spring constants k_1 and k_2 ar joined and are connected to a mass m as shown in the figure. Calculate the frequency of oscillation of mass m.



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13. A pendulum clock shows accurate timings. IF the length of the pendulum is increased by 1% then find the error in time per day.

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14. A second's pendulum is oscillating at a place where g = 9.8 m/s^2. If the pendulum is shifted to a place where g = 9.6 m/s^2, then to keep this time period unchanged, how much change of length should be introduced ?

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15. A second's pendulum is taken to a lift. Calculate the time period of oscillation of pendulum if the (a) lift it moving upwards with a = 4 m/s^2 and (b) downwards with a = 3 m/s^2

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16. If length of pendulum is increased by 2%. The time period will

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17. A simple pendulum has a time period T. The pendulum is completely immersed in a non-viscous liquid whose density is one-tenth of that of the material of the bob. The time period of the pendulum immersed in liquid is

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18. A sphere is hanged with a wire. A restoring torque of 5 Nm is produced when 30° rotation of the sphere is allowed to take place. What will be the frequency of angular oscillations if the moment of inertia of the sphere is 0.092 kg m ?

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19. A wooden block of mass 20 gram and cross section 20 cm^2 is floating on the surface of water. If it is slightly depressed and released from the equilibrium position, then calculate the frequency of oscillation of the block if specific gravity of wood is 0.28.

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20. A glass tube is floating in a liquid with 30 cm of its length immersed in the liquid. If the glass tube is pushed down and released, then calculate the time period of vibration of glass tube.

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Conceptual Questions

1. If acceleration $\propto$ displacement, will that be a sufficient condition for simple harmonic motion ?

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2. Mention the source responsible for providing restoring forces for simple harmonic oscillations in

(a) Column of mercury in U-tube

(b) Spring attached to a mass

(c) Simple pendulum

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3. Why are the functions tan ωt and cot ωt periodic but not harmonic ?

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4. For a particle undergoing SHM, when will be its

(a)velocity and displacement in the same direction

(b) velocity and acceleration in the same direction

(c) displacement and acceleration in the same direction

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5. Two simple pendulum of unequal lengths while oscillating meet each other at mean position. What is their phase difference ?

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6. A pendulum clock is taken to a high altitude. Will it gain or lose time?

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7. Can a pendulum clock be used inside an artificial satellite?

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8. A girl is swinging on a swing while sitting. Her identical twin a swinging on another swing while standing. Whose swing will have a greater time period of oscillations ?

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9. The bob of a simple pendulum is made of wood and bob of another pendulum, identical in size, is made of iron. Which of them will have a smaller time period?

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10. The bob of a simple pendulum is positively charged. A negatively charged metal plate is placed just below the bob as the pendulum starts oscillating. How will it affect the time period of the pendulum?

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11. A simple pendulum of length l and with a bob of mass m moving along a circular arc of angle θ in a vertical plane. A sphere of mass m is placed at the end of the circular arc. What momentum will be given to the sphere by the moving bob?

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12. A simple pendulum consists of a bob, which is a hollow sphere filled with a liquid completely. If a hole is made into the sphere at its bottom so that the liquid starts flowing out of it, how will the time period of the pendulum be affected? Consider that the liquid has uniform density.

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13. A mass suspended from a spring of spring constant k is made to oscillate with a time period T. Now, the spring is cut into three equal parts and the mass is suspended from one of the parts. What will be the new time period of oscillations?

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14. An aeroplane passing over a building sometimes causes rattling of windows in the building. Why?

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15. A simple pendulum consists of an inextensible string of length L and mass M. The oscillating pendulum is suspended inside a stationary lift. The lift then started descending with an acceleration $3.4m/s^2$. Will its time period increase, decrease or remain same?

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16. Statement-1 : Earthquakes cause vast devastation. Sometimes short and tall structures remain unaffected while the medium height structures fall

Statement-2 : The natural frequency of the medium structures coincides with the frequency of the seismic wave.

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17. A shelf moves vertically with simple harmonic motion whose time period of motion is T seconds. Find the maximum amplitude that it can have so that objects resting on the shelf may always remain in contact with it.

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18. From the ceiling of a train, a pendulum of length 'l' is suspended. The train is moving with an acceleration a_0 on horizontal surface. What must be the period of oscillation of pendulum?

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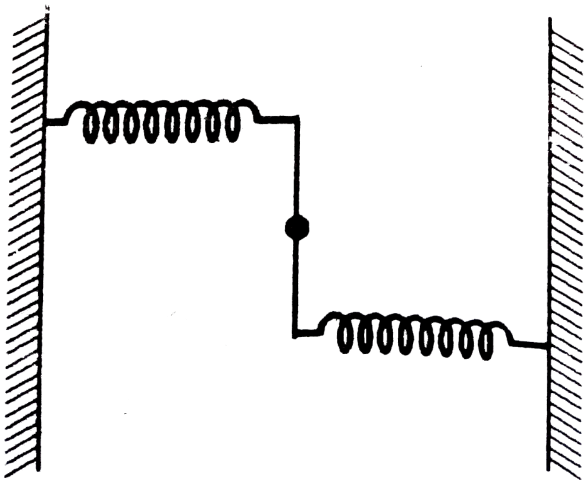
Tough Tricky Problems

1. A uniform rod of length L and mass M is pivotedat the centre. Its two ends are attached to two springs of equal spring constants. k. The springs as shown in the figure, and the rod is free to oscillate in hte horizontal plane. the rod is gently pushed through a small angle θ in one direction and released. the frequency of oscilllation is-



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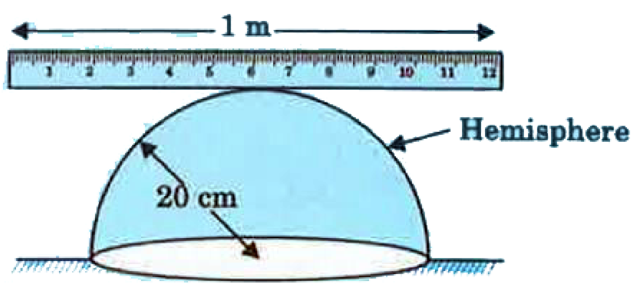
2. The arrangement shown below consists of a uniform metre scale of length 1 m, balanced on a fixed hemisphere of radius 20 cm. when one end of the scale is slightly pressed and released, it performs S.H.M. Determine the angular frequency of oscillations.

(Take g = 10 ms^{-2})



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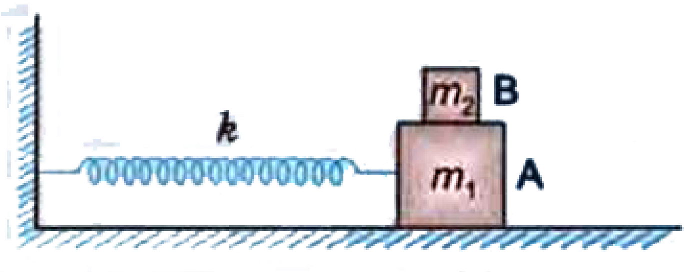
3. A block A of mass m_1 is placed on a horizontal frictionless table. It is connected to one end of a light spring of force constant k whose other end is fixed to a wall. A small block B of mass m_2 is placed on block A. The coefficient of static friction between the blocks is μ. The system is displaced slightly from its equilibrium position and released. What is the maximum amplitude of the resulting simple harmonic motion of the system so that the upper block does not slip over the lower block ?



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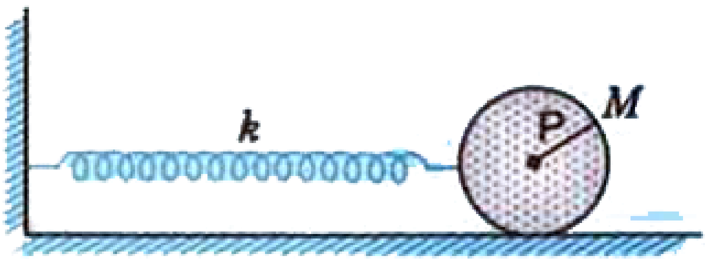
4. A solid sphere of mass M and Radius R is attached to a massless spring of force constant k as shown in the figure. The cylinder is pulled towards right slightly and released so that it executes simple harmonic motion of time period. If the cylinder rolls on the horizontal surface without slipping, calculate its time period of oscillation.



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5. A simple pendulum executes S.H.M. in water with a time period T_w. When the bob executes S.H.M. in air, time period is T_a, IF the density of bob of simple pendulum is 5000/3 kg/m^3 and frictional force of water is neglected, then find the relation between T_w and T_a.

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6. A block of mass M is lying on a frictionless horizontal surface and it connected to a spring of spring constant k, whose other end is fixed to a wall, system executes simple harmonic motion of amplitude A_0, when the block is passing through its equilibrium positions, an object of mass m is put on it and the two move together with a new time period T and amplitude A. Find the value of T and A in terms of given constants.

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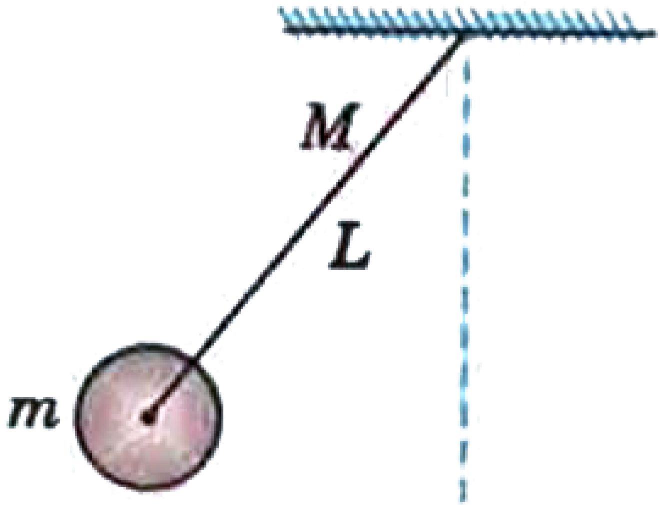
7. One end of a metal rod of length L and mass M is pivoted to a fixed support and to its free end, a thin disc of mass m and radius r (L) is attached at its centre. In one case, the disc is attached to the rod in such a way that it is not free to rotate about its centre and in another case, teh disc is free to rotate about its centre. When the rod-disc system is displaced slightly from its equilibrium position and released. it peforms S.H.M. in vertical plane. Compare the restoring torque acting on the system and angular frequency in both the cases.



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8. An ideal gas enclosed in a cylindrical container supports a freely moving piston of mass M. The piston and the cylinder have equal cross-sectional area A. When the piston is in equilibrium, the volume of the gas is V_0 and its pressure is P_0. The piston is slightly displaced from the equilibrium position and released. Assuming that the system is completely isolated from its surrounding, the piston executes a simple harmonic motion with frequency

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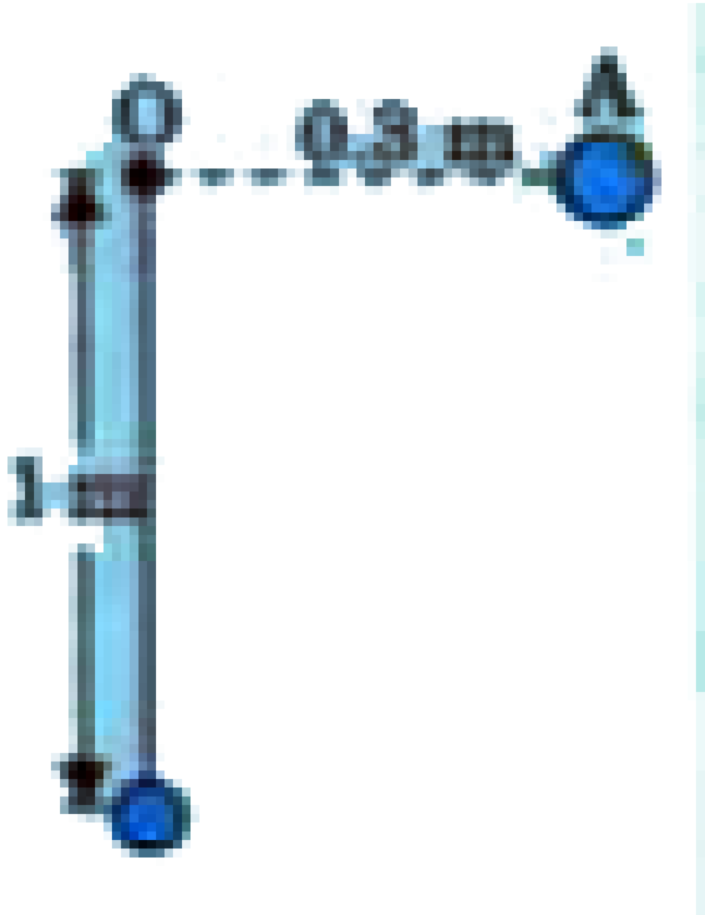
9. A simple pendulum consists of a bob suspended by inextensible and massless thread of length 1 m from a point O. When the bob is at extreme position of oscillation, the thread is suddenly caught by a bolt at a point A located at a distance 0.3 m from O. Now, the bob begins to oscillate in the new condition. Calculate the approximate change in time period of the pendulum. Take, g = 10 ms^{-2}.



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Ncert File Textbook Exercises

1. Which of the following examples represent periodic motion?

(a) A swimmer completing one return trip from one bank of a river to other bank. (b) A freely suspended bar magnet displaced from its $N - S$ direction and released. (c) A hydrogen molecule rotating about its centre of mass. (d) An arrow released from a bow.

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2. Which of the following examples represent (nearly) simple harmonic motion and which represent periodic but not simple harmonic motion?

(a) The rotation of earth about its axis. (b) Motion of an oscillating mercury column in a U tube,

(c) Motion of a ball bearing inside a smooth curved bowl, when released from a point slightly above the lower most position. (d) General vibrations of a polyatomic molecule about its equilibrium position.

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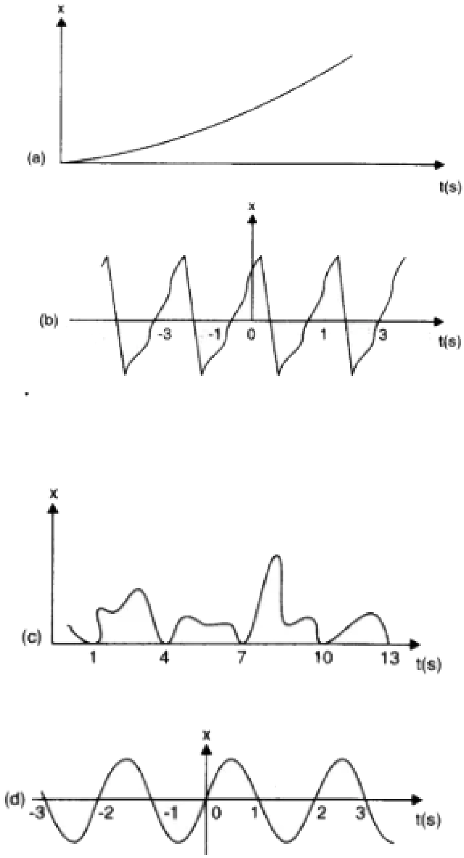
3. Fig. 14.23 depicts four x-t plots for linear motion of a particle. Which of the plots represent periodic motion? What is the period of motion (in case of periodic motion) ?



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4. Which of the following functions of time represent (a) simple harmonic, (b) periodic but not simple harmonic , and (c) non-periodic motion ? Give period for each case of periodic motion , ω is any positive constant). (a) $\sin \omega t - \cos \omega t)$ (b) $\sin^3 \omega t$ (c) $3 \cos\left(\frac{\pi}{4} - 2\omega t\right)$

(d) $\cos \omega t + \cos 3\omega t + \cos 5\omega t)$ (e) $\exp\left(-\omega^2 t^2\right)$ (f) $1 + \omega t + \omega^2 t^2$

Watch Video Solution

5. A particle is in linear S.H.M. between two points A and B, 10 cm apart. Take the direction from A to B as the positive direction and give the signs of velocity, acceleration and force on the particle when it is.

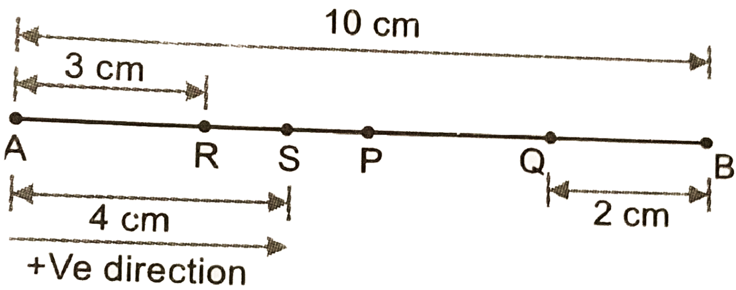
(a) at the end A (b) at the end B,

(c) at the mid point of AB going towards A,

(d) at 2 cm away from B going towards A,

(e) at 3 cm away from A goiing towards B, and

(f) at 4 cm away from A going towards A.



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6. Which of the following relationship between the acceleration, a and the displacement x of a particle involve simple harmonic motion.

(a) $a = 7.0x$ (b) $a = -200x^2$ (c) $a = -10x$ (d) $a = 100x^3$

Watch Video Solution

7. The motion of a particle in S.H.M. is described by the displacement function, $x = A\cos(\omega t + \phi)$, If the initial $(t = 0)$ position of the particle is 1cm and its initial velocity is ωcms^{-1}, what are its amplitude and initial phase angle ? The angular frequency of the particle is πs^{-1}.

If instead of the cosine function, we choose the sine function to describe the SHM: $x = B\sin(\omega t + \alpha)$, what are the amplitude and initial phase of the particle with the above initial conditions ?

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8. A spring balance has a scale that reads from 0 to 50kg. The length of the scale is 20cm. A body suspended from this spring, when displaced and released, oscillates with period of 0.60s. What is the weight of the body?

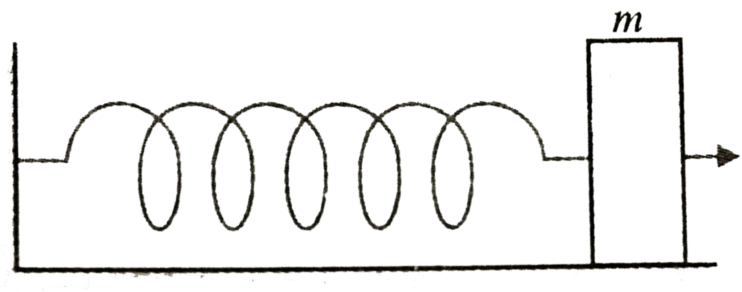
Watch Video Solution

9. A spring of force constant $1200 Nm^{-1}$ is mounted on a horizontal table as shown in figure. A mass of 3.0kg is attached to the free end of the spring, pulled side ways to a distance of 2.0cm and released. Determing.

(a) the frequency of oscillation of the mass.

(b) the maximum acceleration of the mass.

(c) the maximum speed of the mass.



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10. In exercise 14.9 let us take the position of mass when the spring is unstretched as x = 0, and the direction from left to right as the positive direction of X-axis. Give x as a function of time t for the oscillating mass if at the moment we start the stopwatch (t = 0), the mass is

(a) at the mean position.

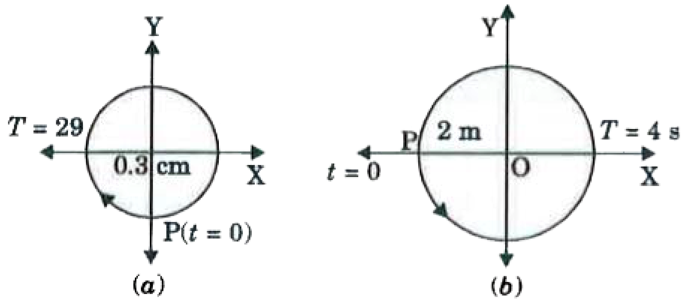
(b) at the maximum stretched position, and

(c) at the maximum compressed position.

IN what way do these functions for SHM differ from each other, in frequency in amplitude or the initial phase ?

View Text Solution

11. Figure below correspond to two circular motions. The radius of the circle, the period of revolution, the initial position, and the sense of revolution (i.e. clockwise or anticlockwise) are indicated on each figure. Obtain the corresponding simple harmonic motions of the x-projection of the radius vector of the revolving particle P in each case.



Watch Video Solution

12. Plot the corresponding reference circle for each of the following simple hoarmonic motions. Indicate the intial$(t=0)$ position of the particle, the radius of the circle, and the angular speed of the rotating particle. For simplicity, the sense of rotation may be fixed to be anticlockwise in every case : (x is in cm and t is in s).

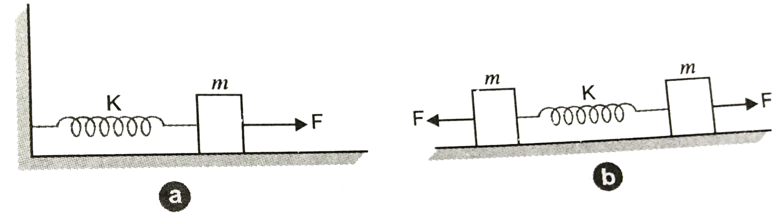
(a) $x = -2\sin(3t + \pi/3)$ (b)$x = \cos(\pi/6 - t)$ (c) $x = 3\sin(2\pi t + \pi/4)$ (d) $x = 2\cos \pi t$

Watch Video Solution

13. Figure a) shows a spring of force constant k clamped rigidly at once end and a mass m attached to its free end. A force F applied at the free end stretches the spring. Figure b) shows the same spring with both ends free and attached to a mass m at either end. Each end of the spring in figure is stretched by the same force F.

(a) What is the maximum extension of the spring in the two cases ?

(b) If the mass in figure and the two masses in figure are released free, what is the period of oscillation in each case?



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14. The piston in the cylinder head of a locomotive has a stroke (twice the amplitude) of 1.0m. If the piston moves with simple harmonic motion with an angular frequency of $200 rev / \min.$, what is its maximum speed ?

Watch Video Solution

15. The acceleration dula to gravity on the surface of moon is $1.7 ms^{-2}$. What is the time period of a simple pendulum on the surface of moon if its time period on the surface of earth is 3.5s ?

Watch Video Solution

16. Answer the following questions: (a) Time period of particle is S.H.M. depends on the force constant k and mass m of the particle $: T = 2\pi\sqrt{m/k}$. A simple pendulum executes S.H.M. approximately. Why then is the time-period of a pendulum independent of the mass of the pendulum?

(b) The motion of simple pendulum is approximately simple harmonic for small angles of oscillation. For large angle of oscillation, a more involved analysis (beyond the scope of this book) shows that T is greater that $2\pi\sqrt{l/g}$. Think of a quantitative argument to appreciate this result.

(c) A man with a wrist watch on his hand falls from the top of tower. Does the watch give correct time during the free fall?

(d) What is the frequency of oscillation of a simple pendulum mounted in a cabin that is freely falling under gravity?

17. A simple pendulum of length l and having a bob of mass M is suspended ina car. The car is moving on a circular track of radius R with a uniform speed v. If the pendulum makes small oscillations in a radial direction about its equilibrium, what will be its time period ?

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18. A cylindrical piece of cork of base area A and height h floats in a liquid of density ρ_1. The cork is depressed slightly and then released. Show that the cork oscillates up and down simple harmonically with a period

$$T = 2\pi\sqrt{\frac{h\rho}{\rho_1 g}}$$

Watch Video Solution

19. One end of a U-tube containing mercury is connected to a suction pump and the other end to atmosphere. A small pressure difference is maintained between the two columns. Show that, when the suction pump is removed, the column of mercury in the U-tube executes simple harmonic motion.

Watch Video Solution

Ncert Additional Exercises

1. An air chamber of volume v has a neck area of cross section a into which a ball of mass m just fits and can move up and down without any friction. Show that when the ball is pressed down a little and released for the time priod of oscillation, assuming pressure-volume variations of the air to be isothermal.

View Text Solution

2. You are riding an automobile of mass 3000kg. Assuming that you are examining the oscillation characteristics of its suspension system. The suspension sags 15cm when the entire automobile is placed on it. Also, the amplitude of oscillation decreases by50% during one complete oscillation. Estimate the values of (a) the spring constant k and (b) damping constant b for the spring and shock absorber system of one wheel, assuming that each wheel supports $750kg. g = 10m/s^2$.

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3. Show that for a particle in linear S.H.M., the average kinetic energy over a period of oscillation equals the average potential energy over the same period.

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4. A circular disc of mass 10kg is suspended by a wire attahced to its centre. The wire is twisted by rotating the disc and released. The period of torsional oscillations is found to be 1.5s. The radius of the disc is 15cm. Determing the torsional spring constant of the wire. (Torsional spring constant α is definied by the relation $J = -\alpha\theta$, where J is the restoring coubple and θ the angle of twist.

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5. A body describes simple harmonic motion with an amplitude of 5 cm and a period of $0.2s$. Find the acceleration and velocity of the body when the displacement is (a) 5cm, (b) 3cm, (c) 0 cm.

Watch Video Solution

6. A mass attached to a spring is free to oscillate, with angular velocity ω, in a horizontal plane without friction or damping. It is pulled to a distance x_0 and pushed towards the centre with a velocity v_0 at time $t = 0$. Determine the amplitude of the resulting oscillations in terms of the parameters ω, x_0 and v_0.

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Ncert Exemplar Problems Subjective Question Multiple Choice Questions Type I

1. 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 $2/\omega$

B. simple harmonic with perioed π/ω

C. periodic but not simple harmonic

D. non-periodic.

Answer: B

Watch Video Solution

2. The displacement of a particle is represented by the equation $y = \sin^3 \omega t$. The motion is

A. non-periodic

B. periodic but not simple harmonic

C. simple harmonic with period $2\pi/\omega$

D. simple harmonic with period π/ω.

Answer: B

Watch Video Solution

3. 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

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4. 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

5. 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

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6. The displacement 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 S.H.M.

B. The motion is S.H.M. with amplitude a + b

C. The motion is S.H.M. with amplitude $a^2 + b^2$

D. The motion is S.H.M. with amplitude $\sqrt{a^2 + b^2}$

Answer: D

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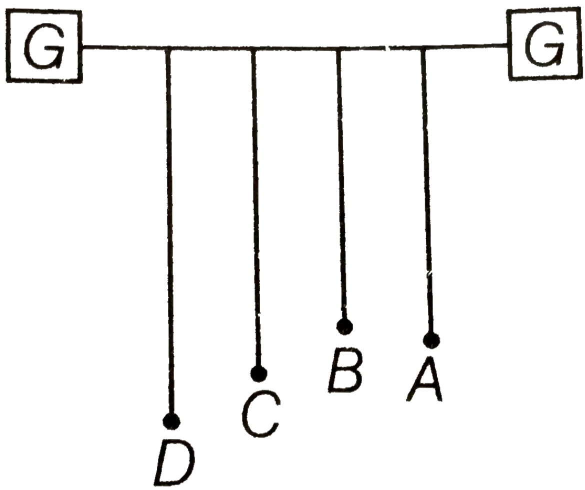
7. Four pendulums A, B, C and D are suspended from the same



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 will 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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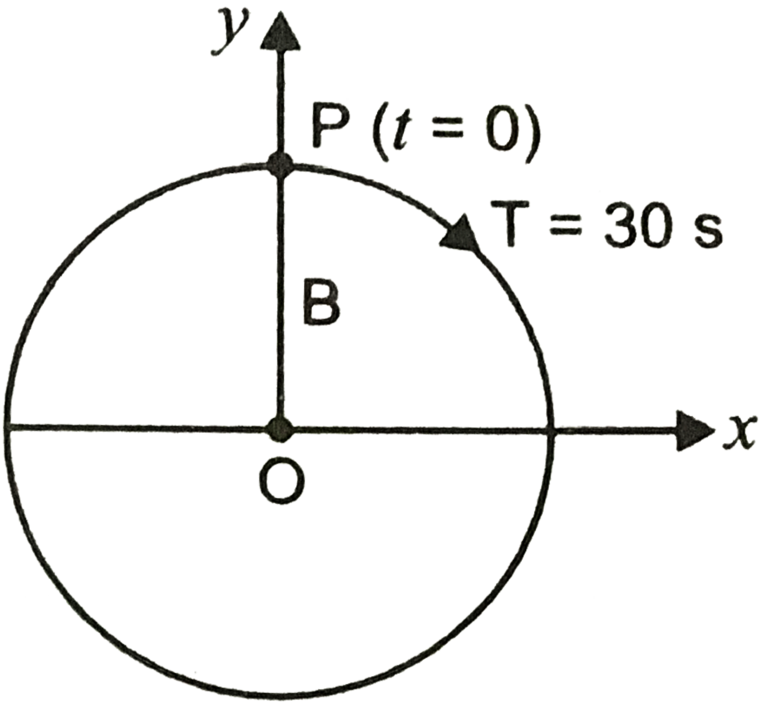
8. In the circular motion of a particle. The radius of the circle, the period, sense of revolution and the initial position are indicated on the figure. The simple harmonic motion of the x-projection of the radius vector of the rotating particle P is



A. $x(t) = B\sin\left(\frac{2\pi t}{30}\right)$

B. $x(t) = B\cos\left(\frac{\pi t}{15}\right)$

C. $x(t) = B\sin\left(\frac{\pi t}{15} + \frac{\pi}{2}\right)$

D. $x(t) = B\cos\left(\frac{\pi t}{15} + \frac{\pi}{2}\right)$

Answer: A

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9. The equation of motion of a particle is $x = a\cos(\alpha t)^2$ .The motion is

A. periodic but not oscillatory

B. periodic and oscillatory

C. oscillatory but not periodic

D. neither periodic nor oscillatory

Answer: C

Watch Video Solution

10. A particle executing S.H.M. has a maximum speed of 30cm/s and a maximum acceleration of $60cm/s^2$. The period of oscillation is

A. π s

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

C. 2π s

D. $\frac{\pi}{t}$ s

Answer: A

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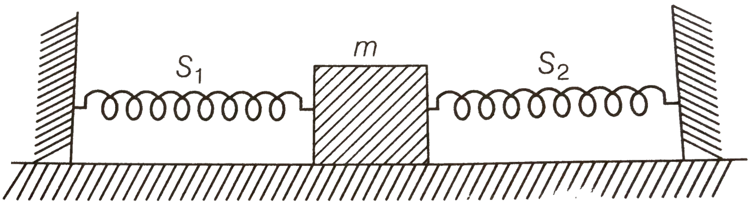
11. When a mass m is connected individually to two springs S_1 and S_2, the oscillation frequencies are v_1 and v_2. If the same mass is attached to the two springs as shown in figure, the oscillation frequency would be



A. $v_1 + v_2$

B. $\sqrt{v_1^2 + v_2^2}$

C. $\left(\frac{1}{v_1}\right) + \left(\frac{1}{v_2}\right)^{-1}$

D. $\sqrt{v_1^2 - v_2^2}$

Answer: B

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Ncert Exemplar Problems Subjective Question Multiple Choice Questions Type Ii

1. The rotation of earth about its axis is

A. periodic motion

B. simple harmonic motion

C. periodic but not simple harmonic motion

D. non-periodic motion.

Answer: A::C

Watch Video Solution

2. Motion of a ball bearing inside a smooth curved bowl, when released from a point slightly above the lower point is

A. simple harmonic motion

B. non-periodic motion

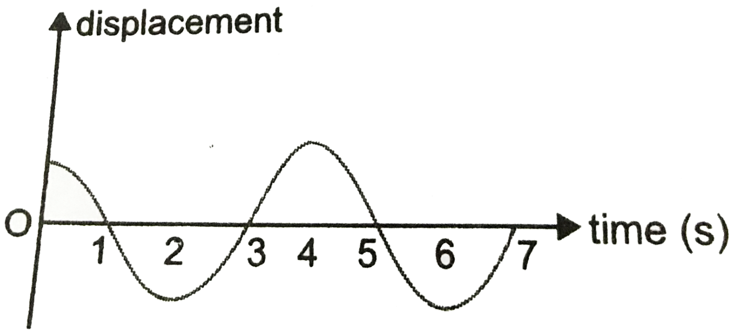
C. periodic motion

D. periodic but not S.H.M.

Answer: A::C

Watch Video Solution

3. Displacement vs. time curve for a particle executing S.H.M. is shown in figure. Choose the correct statements



A. Phase of the oscillator is same at t= 0 s and t = 2 s.

B. phase of the oscillator is same at t = 2 s and t = 6 s.

C. Phase of the oscillator is same at t = 1 s and t = 7 s.

D. Phase of the oscillator is same at t= 1 s and t = 5 s.

Answer: B::D

Watch Video Solution

4. Which of the following statements is/are true for a simple harmonic oscillator ?

A. Force acting is directly proportional to displacement from the mean position and opposite to it

B. Motion is periodic.

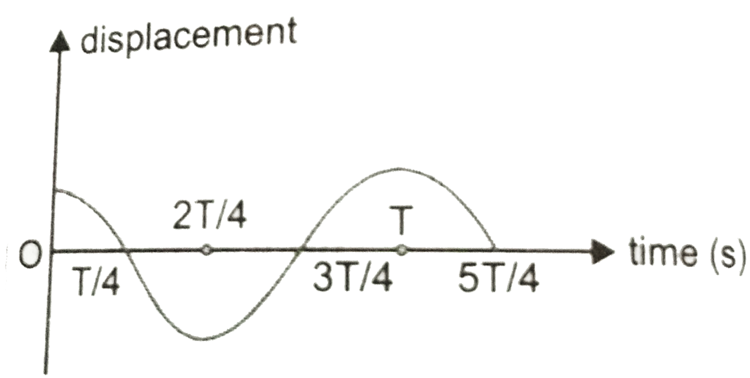
C. Acceleration of the oscillator is constant.

D. The velocity is periodic.

Answer: A::B::D

Watch Video Solution

5. The displacement time graph of a particle executing S.H.M. is shown in figure. Which of the following statement is / are true ?



A. The force is zero at $t = \frac{3T}{4}$

B. The acceleration is maximum at $t = \frac{4T}{4}$

C. The velocity is maximum at $t = \frac{T}{4}$

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

Answer: A::B::C

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6. A body is performing SHM, then its

A. average total energy per cycle is equal to its maximum kinetic energy.

B. average kinetic energy per cycle is equal to half of its maximum kinetic energy.

C. mean velocity over a complete cycle is equal to $\frac{2}{\pi}$ times of its maximum velocity.

D. root mean square velocity is $\frac{1}{\sqrt{2}}$ time of the maximum velocity.

Answer: A::B::D

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7. A particle is in linear simple harmonic motion between two points A and B, 10 cm apart (figure) . Take the direction from A to B as the $+ve$ direction and choose the correct statements.

A. The sign of velocity, acceleration and force on the particle when it is 3 cm away from A going towards B are positive.

B. The sign of velocity of the particle at C going towards O is negative.

C. the sign of velocity, acceleration and force on the particle when it is 4 cm away from B A going towards A are negative.

D. The sign of acceleration and force on the particle when it is at point B is negative.

Answer: A::C::D

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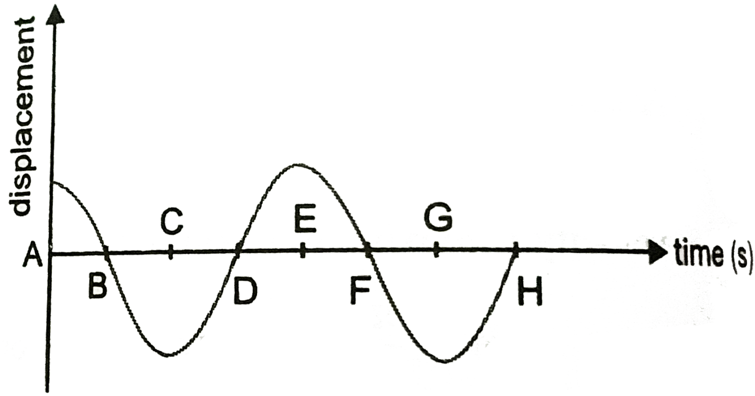
Ncert Exemplar Problems Subjective Question Very Short Answer Type Questions

1. Displacement versus time curve for a particle executing S.H.M. is shown in figure .Identidy the points marked at which (i) velocity of the oscillator is zero, (ii) speed of the oscillator is maximum.



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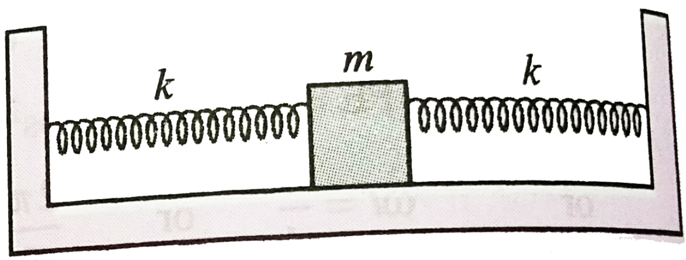
2. Two identical springs of spring constant k are attached to a block of mass m and to fixed supports as shown in figure. When the mass is displaced from equilibrium position by a distance x towards right, find the restoring force.



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3. What are the two basic characteristics of a simple harmonic motion?

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4. When will the motion of a simple pendulum be simple harmonic?

Watch Video Solution

5. What is the ratio of maximum acceleration to the maximum velocity of a simple harmonic oscillator?

Watch Video Solution

6. What is the ratio between the distance travelled by the oscillator in one time period and amplitude?

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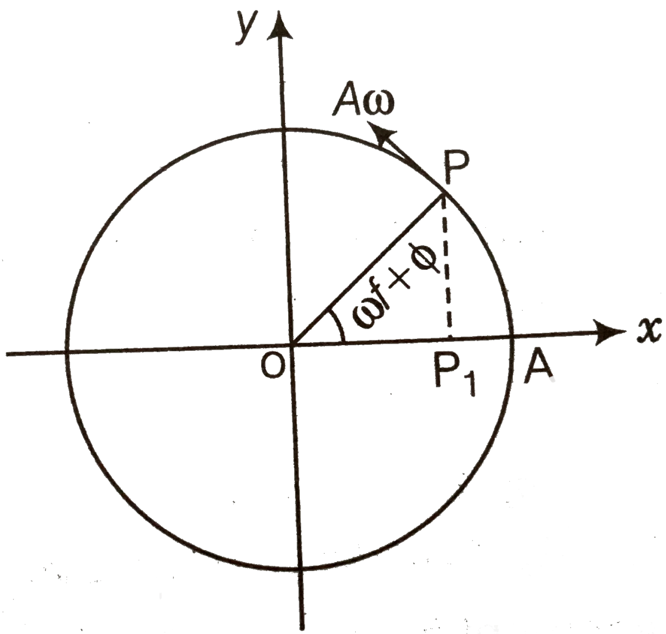
7. In figure, what be the sign of the velocity of the point P', which is the projection of the velocity of the reference particle P.P is moving in a circle of radius R in anti-clockwise direction.



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8. Show that for a particle executing S.H.M., velocity and displacement have a phase difference of $\pi / 2$.

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9. Draw a graph to show the the variation of P.E., K.E. and total eneryg of a simple harmonic oscillator with displacement .

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10. The length of a second's pendulum on the surface of earth is 1 m. What will be the length of a second's pendulum on the moon?

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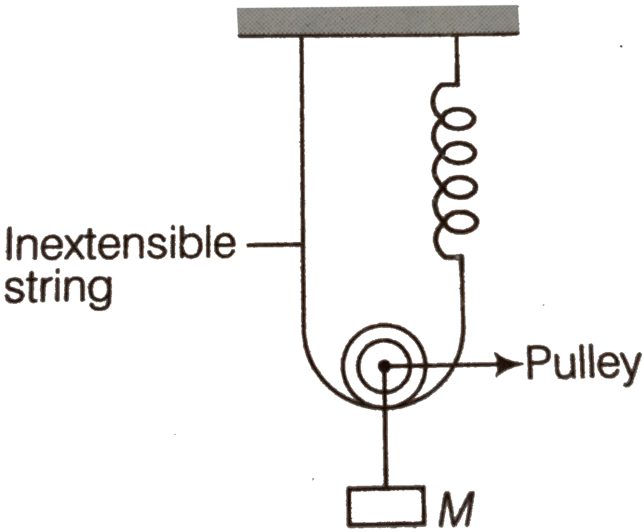
Ncert Exemplar Problems Subjective Question Short Answer Type Questions

1. Find the time period of mass M when displaced from its equilibrium position and then released for the system shown in figure.



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2. Show that the motion of a particle represented by $y = \sin \omega t - \cos \omega t$ is simple harmonic with a period of $2\pi / \omega$.

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3. Find the displacement of a simple harmonic oscillator at which its P.E. is half of the maximum energy of the oscillator.

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4. A body of mass m is situated in a potential field U(x) = $V_0(1 - \cos ax)$ when U_0 and α are constants. Find the time period of small oscillations.

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5. A mass of 2 kg is attached to the spring constant $50Nm^{-1}$. The block is pulled to a distance of 5cm from its equilibrium position at $x = 0$ on a horizontal frictionless surface from rest at $t = 0$. Write the expression for its displacement at anytime t.

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6. Consider a pair of identical pendulums, which oscillate with equal amplitude independently such that when one pendulum is at its extreme position making an angle of 2° to the right with the vertical , the other pendulum makes an angle of 1° to the left of the vertical. What is the phase difference between the pendulums?

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Hots Higher Order Thinking Skills Advanced Level

1. A simple pendulum consists of a bob, which is a hollow sphere filled with a liquid completely. If a hole is made into the sphere at its bottom so that the liquid starts flowing out of it, how will the time period of the pendulum be affected? Consider that the liquid has uniform density.

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2. A block is kept on a horizontal table that is executing simple harmonic motion of frequency v in the horizontal plane. The coefficient of static friction between the block and the table is μ. Determine the maximum amplitude of the table for which the block does not slip on the surface of the table.

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3. A simple pendulum hangs from the ceiling of a stationary. Lift and executes S.H.M. wih a time period T. When the lift started moving upwards, the distance covered by it while moving upwards varies with time t as y = $6t^2$ where y is in metre and t in seconds. Calculate the new time period of the pendulum.

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4. A train is travelling at a constant speed u around a circular track of radius R. A simple pendulum of length L and mass m is suspended from the ceiling of the compartment of the train. IF the tension in the string of the pendulum is T, then find the time period of oscillation.

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5. Springs of spring constant k, 2k, 4k , 8k, ... Are connected in series. A block of mass 50 kg is attached to the lower end of the last spring and the system is set into oscillation. If k = 3.0 N/cm, what is the time period of oscillations ?

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6. A circular disc of mass 12 kg is suspended by a wire attached to its centre. The wire is twisted by rotating the disc and then released, so that the time period of torsional oscillation is 2 s. If the radius of the disc is 10 cm, then calculate the torsional spring constant of the wire.

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7. A uniform cylinder of height h, mass m and cross sectional area A is suspended vertically from a fixed point by a massless spring of force constant k, A beaker full of water is placed under the cylinder so that $1/4^{th}$ of its volume is submerged in the water at equilibrium position. When the cylinder is given a small downward push and released, it starts oscillating vertically with small amplitude. Calculate the frequency of oscillation of the cylinder, Take, density of water =ρ.

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8. The figure shows the arrangement of three springs of different spring constant, connected to a mass m. When mass m oscillates find equivalent spring constant and the time period of vibration.

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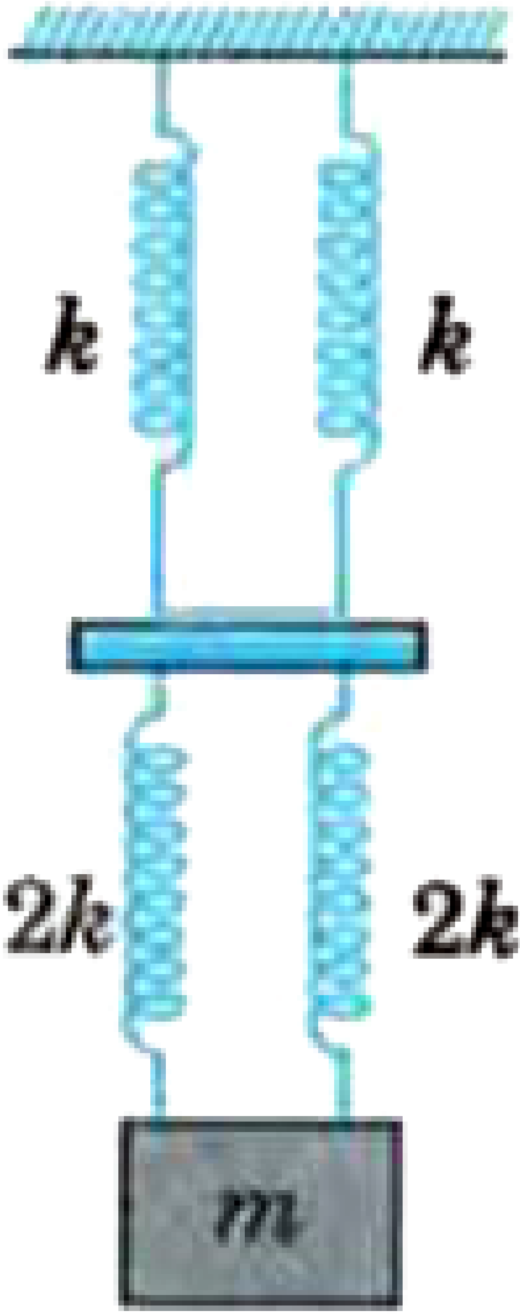
9. A pendulum suspended from the ceiling of an elevator at rest has a time period of oscillation equal to T_1. When the elevator moves up with an acceleration a, the time period becomes T_2 and when the elevator moves down with an acceleration a, its time period becomes T_3, then find the expression for T_1 in terms of T_2 and T_3.

Watch Video Solution

10. A simple harmonic motion oscillator has two springs of spring constant k and other two of spring constant 2k, arranged as shown in the figure. Calculate the time period of oscillator.


k
k
2k
2k
m

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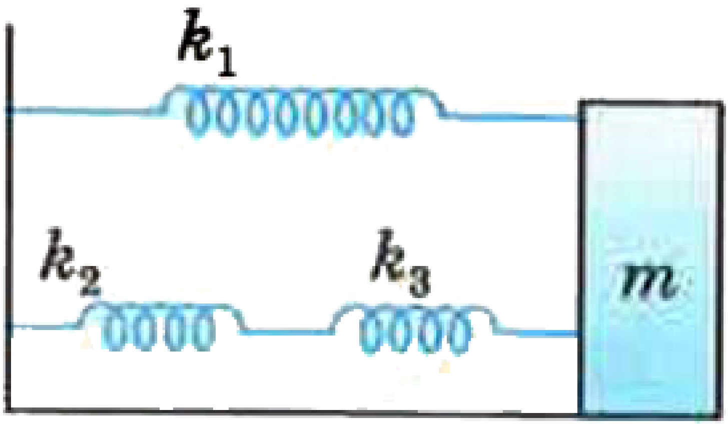
11. The figure shows an arrangement of mass m with three springs of different springs constant. When m is slightly displaced and then released, find the frequency of its motion.



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Revision Exercises Very Short Answer Questions

1. PERIODIC MOTION

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2. Define oscillatory motion.

Watch Video Solution

3. What do you mean by harmonic oscillation ?

Watch Video Solution

4. Give one example of periodic motion and oscillatory motion.

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5. PERIODIC FUNCTION

Watch Video Solution

6. What do you mean by simple harmonic motion ?

Watch Video Solution

7. Why sin θ, cos θ are periodic functions?

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8. What is the direction of displacement in a simple harmonic motion ?

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9. What is the direction of velocity in a simple harmonic motion ?

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10. What is the basic condition for a motion to be simple harmonic ?

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11. What is phase ? Discuss the phase relations between displacement, velocity and acceleration in simple harmonic motion.

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12. What is the phase relationship between diplacement, velocity and acceleration in SHM?

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13. What is acceleration amplitude ?

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14. When is a body said to be in neutral equilibrium ?

Watch Video Solution

15. What do you mean by force constant of a body ?

Watch Video Solution

16. At which position the potential energy of a harmonic oscillator is maximum or minimum ?

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17. At which position the kinetic energy of a harmonic oscillator is maximum or minimum ?

Watch Video Solution

18. Define simple pendulum.

Watch Video Solution

19. How will you define length of the simple pendulum ?

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20. The time period of a simple pendulum depends on its_____

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21. What forces keep the simple pendulum in simple harmonic motion?

Watch Video Solution

22. How time period of a simple pendulum depends on the acceleration due to gravity ?

Watch Video Solution

23. The time period of a simple pendulum of infinite length is (R=radius of earth).

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24. What is the time period of a simple pendulum if length of the pendulum is equal to the radius of Earth ?

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25. Will pendulum clock lose or gain time on hills or inside the mines ?

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Watch Video Solution

26. What will happen to the time period of a simple pendulum if it is made to oscillate in some fluid of density $\rho_0 < \rho$ (ρ= the density of bob)

Watch Video Solution

27. What is a second's pendulum?

Watch Video Solution

28. Effective length of a seconds pendulum is about.

Watch Video Solution

29. What will be the time period of a simple pendulum if it is made to oscillate in a satellite or a freely falling lift?

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30. What will be the spring constant k of a. spring if length of the spring is made n times?

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31. What will be the spring constant k of a spring if spring is divided in n equal parts?

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32. What do you mean by undamped oscillations?

Watch Video Solution

Watch Video Solution

33. How damping force depends on the velocity system?

Watch Video Solution

34. What are undamped and damped oscillations ?

Watch Video Solution

35. What are free oscillations? Give one example.

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36. What are forced oscillations? Give one example.

Watch Video Solution

37. What are resonant oscillations? Give one example.

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Revision Exercises Additional Question

1. A human heart beats 72 times in a minute. The beat frequency is

A. $1.39s^{-1}$

B. $1.2s^{-1}$

C. $1.42s^{-1}$

D. $1.9s^{-1}$

Answer: B

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2. The length of a second pendulum is

A. 99.3 cm

B. 99.3 m

C. 9.9 cm

D. 9.59 cm

Answer: A

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3. At mean position of an oscillating simple pendulum

A. acceleration is zero

B. velocity is minimum

C. kinetic energy is minimum

D. potential energy is maximum

Answer: A

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Revision Exercises Fill In The Blanks

1. A motion which can be represented by a single harmonic function is called ....

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2. In S.H.M., the restoring force acting in the particle is proportional to the............. from the mean position.

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3. Simple harmonic motion can be defined as .... of uniform circular motion upon a diameter of a circle.

Watch Video Solution

4. For two springs connected in series, the effective spring factor is .... than the individual spring factor of each spring.

Watch Video Solution

5. The restoring force for simple harmonic motion in case of simple pendulum is provided by ....

Watch Video Solution

6. When a particle moves from mean position to extreme position, its velocity and acceleration are in .... Direction.

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7. Glass windows may be broken by a far away explosion. Why?

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8. The time period of a simple pendulum depends on its_____

Watch Video Solution

9. In .... oscillations, the amplitude decreases gradually with the passage of time.

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Revision Exercises Short Answer Questions

1. Show that $\sin\theta$ and $\cos\theta$ are periodic functions.

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2. Distinguish between periodic and oscillatory motion with the help of examples.

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3. The trigonometric functions $\tan\theta, \cot\theta$ are periodic but not simple harmonic, whereas $\sin\theta$ and $\cos\theta$ are periodic as well as simple harmonic. Why ?

Watch Video Solution

4. Does the function $y = \cos^2 \omega t$ represent a periodic of a simple harmonic motion? What is the period of the motion?

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5. Distinguish clearly between Harmonic and Non-Harmonic oscillations.

Watch Video Solution

6. What do you mean by simple harmonic motion? Give at least two examples.

Watch Video Solution

7. What do you mean by restoring force? Explain with the help of an example.

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8. Suppose the bob of a simple pendulum is made up of ice. What will happen to the time period if the ice starts melting?

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9. Derive an expression for the instantaneous velocity of a particle executing S.H.M. Find the position where velocity is maximum and where it is minimum.

Watch Video Solution

10. Show that in simple harmonic motion, acceleration is directly proprotional to displacement.

Watch Video Solution

11. If a simple harmonic motion is represented by $\frac{d^2x}{dt^2} + \alpha x = 0$, its time period is :

Watch Video Solution

12. Derive an expression for the instantaneous acceleration of a particle executing S.H.M. Find the position where acceleration is maximum and where it is minimum.

Watch Video Solution

13. Is oscillation of a mass suspended by a spring simple harmonic ?

Watch Video Solution

14. A spring having a spring constant k is divded into three parts. Calculate the force constant for each part.

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15. Derive an expression for the time period of a body suspended from a spring once stretched and then released.

Watch Video Solution

16. The time period of an oscillating body is given by $T = 2\pi\sqrt{\frac{m}{adg}}$. What is the force equation for this body?

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17. Consider a liquid which fills a uniform U - tube uniform U- tube, as shown in figure , up to a height h. Find angular the frequency of small oscillation of th eliquid in the U - tube.

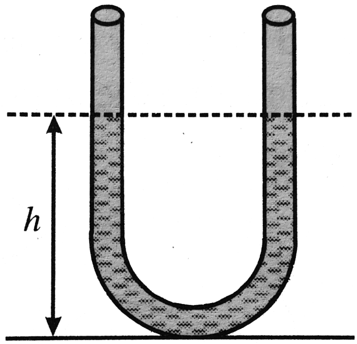

Fig. 4.130

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18. What will be the effect on (a) periodic time period (b) maximum velocity of a simple harmonic oscillator if amplitude is made three times?

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19. What do you mean by free and damped oscillations? Explain graphically.

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20. Free & Forced Oscillations

Watch Video Solution

21. Derive an expression for vibrations of a vertical spring.

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22. What are resonant oscillations? Explain with the help of suitable examples.

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23. What are coupled oscillations? Explain with the help of suitable examples.

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24. Find the phase difference between two simple pendulums of unequal lengths meeting at mean position while oscillating.

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Revision Exercises Long Answer Questions

1. Explain the geometrical interpretation of simple harmonic motion. Also find the maximum and minimum values of velocity and acceleration for a particle executing simple harmonic motion.

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2. Derive an expression for the total energy of a particle executing simple harmonic motion. Also, show graphically the variation of potential and kinetic energies with time in S.H.M.

Watch Video Solution

3. What is simple pendulum? Derive an expression for the time period and frequency of a simple pendulum of length l. What will be the effect on the time period of a simple pendulum if length of the pendulum becomes (a) greater than the radius of the Earth (b) becomes equal to the radius of the Earth?

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4. Distinguish between

(a) periodic and oscillatory motion

(b) free oscillations and forced oscillations

(c) Damped and undamped oscillations

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5. What is second's pendulum ? Find the length of second's pendulum for $g = 9.8m/s^2$? Also write expressions for the time period if the second's pendulum is an a carriage which is accelerating (a) upwards (b) downwards (c) horizontally. Also, fin the value of time period of it if is made to oscillate a freely falling lift.

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Revision Exercises Numerical Problems

1. A particle is executing simple harmonic motion with time period of 4 s and amplitude 10 cm. Calculate displacement, velocity after $\frac{1}{2}$ second starting from mean position.

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2. A body oscillates with S.H.M. according to the equation

$$x(t) = (10m)\cos\left[\left(2\pi t + \frac{\pi}{8}\right)\right]$$

Calculate displacement and velocity at t = 1 s.

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3. A particle is executing simple harmonic motion of amplitude 12 cm and time period 3 s. Calculate the time required by the particle to move between two points 6 cm on either side of mean position.

Watch Video Solution

4. A body is executing simple harmonic motion with time period of 3 s. After how much time interval (from t = 0) the displacement will be $\frac{1}{\sqrt{2}}$ times of its amplitude ?

Watch Video Solution

5. A particle is executing simple harmonic motion. The velocity of the particle is 10 m s^{-1}. What at a distance of 5 cm from mean position and 8 cm s^{-1} when at a distance of 12 cm from mean position. What will be the amplitude of motion ?

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6. A particle is executing simple harmonic motion with maximum velocity of 20 cm/s. Calculate the average velocity during its motion from one extreme to another.

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7. A body is executing simple harmonic motion under the action of a force F_1 with time period 1 s. The time period is 2s when body is acted by another force F_3. What will be the total time period when both the forces are acting in same direction simultaneously ?

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8. Calculate the maximum kinetic energy of a linear harmonic oscillator of force constant 12×10^5 N/m., amplitude 0.05 m.

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9. A particle is executing simple harmonic motion of amplitude 9 m. At what point the speed of the particle will be one third of its maximum speed ?

Watch Video Solution

10. When displacement in one third of total amplitude that what fraction of total energy is half potential and half kinetic ?

Watch Video Solution

11. An extension of 10 cm is produced in a spring (spring constant = 1000 Nm^{-1}). Calculate the work done to increase the extension from 10 cm to 20 cm.

Watch Video Solution

12. The bob of a simple pendulum executes simple harmonic motion with amplitude 4 cm and frequency 10 vibrations per second. Calculate the kinetic energy of the bob in lowest position if mass of bob is 2 kg.

Watch Video Solution

13. On suspending a heavy block of 2 kg from a massless spring, an extension of 5 cm is produced in the spring. If the block is further pulled down by 10 cm and then released then find the kinetic energy of oscillation of the spring.

Watch Video Solution

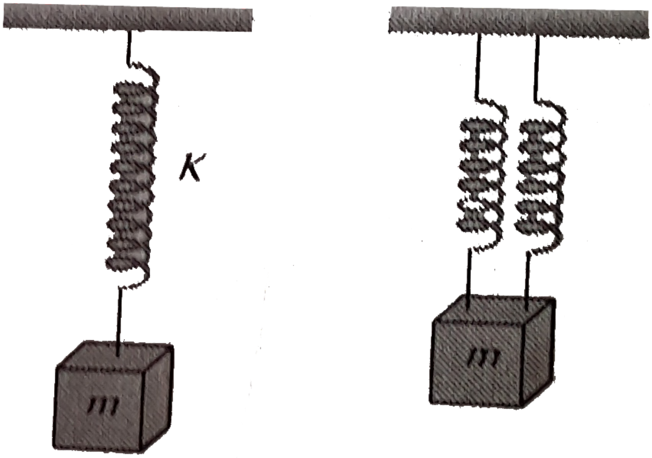
14. A particle executes simple harmonic motion of ampliltude A. At what distance from the mean position is its kinetic energy equal to its potential energy?

Watch Video Solution

15. A pan of 2 kg is attached to a spring balance. When a weight of 3 kg is placed on the pan. The spring is stretched by 12 cm. Calculate the frequency with which the empty pan will oscillate.

Watch Video Solution

16. A mass m performs oscillations of period T when hanged by spring of force constant K . If spring is cut in two parts and arranged in parallel and same mass is oscillated by them, then the new time period



will be

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17. A mass M attached to a spring of spring constant 0.7 N/m oscillates on a smooth horizontal table. When displacement is 0.3 m, velocity is 2 ms^{-1}. And when displacement is 0.4 m, velocity is 0.3 m/s. Calculate the vlaue of M.

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18. Two particles x and y having same masses are suspended by two massless springs of spring constants $k_1 = 4$ N/m and $k_2 = 9$ N/m respectively. Find the ratio of amplitude of x and y if maximum velocites during oscillation are equal.

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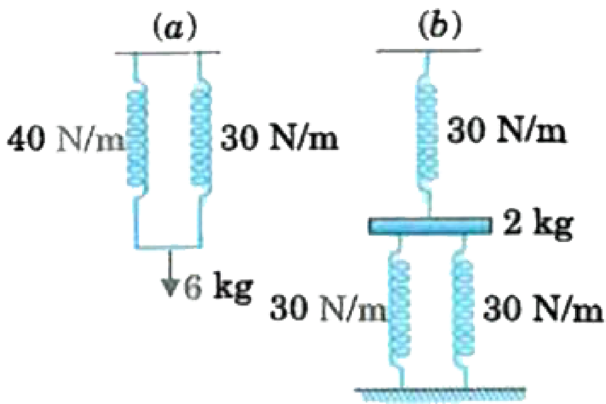
19. Calculate the elongation produced in each of the spring combinations:



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20. The length of a simple pendulum is increased by 30%. What will be the percentage increase in time period ?

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21. Calculate the length of the second's pendulum on the surface of moon where acceleration due to gravity is one sixth as that on earth.

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22. A body of mass 0.5 kg is suspended by a weightless spring of force constant 500 Nm^{-1}. Another body of mass 0.1 kg moving vertically upwards with velocity of 5 ms^{-1} hits the suspended body and gets embeded into the suspended body. What will be the frequency of oscillation ?

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23. In the above example, calculate the amplitude of motion.

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Competition File Multiple Choice Questions

1. A spring of force constant k is cut into two pieces whose lengths are in the ratio 1:2. The force constant of the longer piece?

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

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

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

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

Answer: D

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2. A simple pendulu has a time period T_1. The point of suspension of the pendulum is moved upword according to the relation $y = \frac{3}{2}t^2$, Where y is the vertical displacement . If the new time period is T_2 , The ratio of $\frac{T_1^2}{T_2^2}$ is $(g = 10m/s^2)$

A. $\frac{7}{10}$

B. $\frac{10}{7}$

C. $\frac{13}{10}$

D. $\frac{10}{13}$

Answer: D

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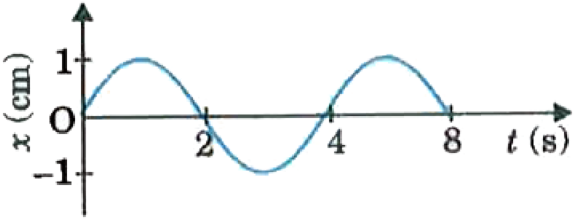
3. The displacement vs time graph of a particle undergoing S.H>M. Is shown below . The acceleration of the particle at $t = 2/3s$ is



A. $\frac{\sqrt{3}\pi^2}{8} cm / s^2$

B. $\frac{\pi^2}{8} cm / s^2$

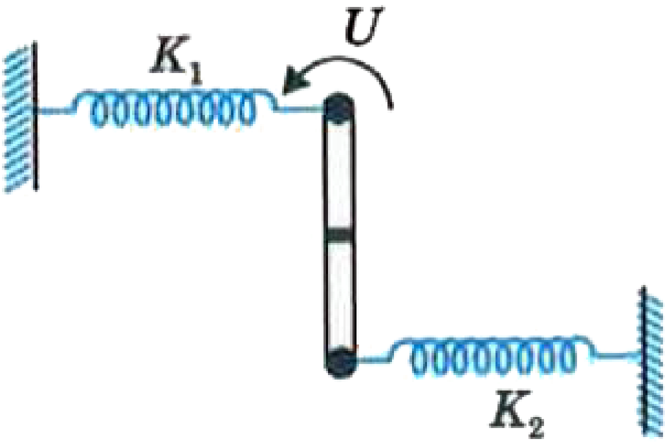
C. $\frac{-\sqrt{3}\pi^2}{8} cm / (s^2)$

D. $\frac{-\pi^2}{80 cm / s^2}$

Answer: C

Watch Video Solution

4. The arrangement shown of a uniform rod of length l and mass m, pivoted at the centre and its two ends attached to two springs of spring constant K_1 and K_2 . The other end of springs are fixed to two rigid supports the rod which is free to rotate in the horizontal plane , is pushed by a small angle in one direction and released . Teh frequency of oscillation of the rod is



A. $\frac{1}{2\pi}\frac{\sqrt{K_1+K_2}}{m}$

B. $\frac{1}{2\pi}\frac{\sqrt{K_1+K_2}}{3m}$

C. $\frac{1}{2\sqrt{3}\pi}\frac{\sqrt{K_1+K_2}}{m}$

D. $\frac{\sqrt{3}}{2\pi}\frac{\sqrt{K_1+K_2}}{m}$

Answer: D

Watch Video Solution

5. The arranghement shown in the figure below consits of a block of mass 0.1 kg attached to a spring of force cosntant $2 \times 10^{-3} N/M$ with the help of a pulley so that the spring remians unstretched.On releasing the block , it starts oscillating with a small amplitude . The maximum velocity of block during this motion is close to

A. 72m/s

B. 71m/s

C. 70m/s

D. 69m/s

Answer: D

Watch Video Solution

6. A body is executing a linear simple harmonic motion. At t=0, it is at one of the extreme position and travels 3cm in the first second and

4cm in the next second moving towards the other extreme position .

The amplitude of this S.H.M is

A. 17/18cm

B. 16/17cm

C. 19/18cm

D. 18/5cm

Answer: D

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7. The young modulii of two springs of equal length and equal cross sectional areas are in the ratio 2:3 both the springs are suspended and loaded with the same mass . When springs are stretched and released , the time period of oscillation of the two springs is in the ratio of

A. 3:2

B. 2:3

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

D. $\sqrt{2}$: $\sqrt{3}$

Answer: D

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8. The displacemtent x (in cm) of an oscillating body varies with time t as

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

The magnittude of maximum acceleration of the particle in cm/s^2 is

A. $\pi^2/3$

B. $3\pi^2$

C. $4\pi^2/3$

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

Answer: B

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9. A horizontal platform is undergoing vertical S.H>M of time period T. A block of mass M is placed on the platform . The maximum mplitude of the platform so that the block is not detached form it is

A. $\frac{gT^2}{2\pi \cdot 2}$

B. $\frac{gT^2}{4\pi^2}$

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

D. $\frac{4gT^2}{\pi^2}$

Answer: B

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10. Form the centre of a large concave mirror of radius of curvature 3 sm , a small sperical steel ball is placed at a little distance on the mirror itself . The ball is then released to execute oscillatory motion on the mirror . The time period of motion of the ball is

(Neglect friction and take $g = 10\frac{m}{s^2}$

A. 2.38s

B. 3.06s

C. 3.44s

D. 4.22s

Answer: C

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11. Aa simple pendulum is suspended from the ceiling of a vehicle which moves down an inclined plane o inclination Θ. The period of oscilation of the pendulum is

A. $2\pi\sqrt{\dfrac{L}{g\cos\theta}}$

B. $2\pi\sqrt{L\dfrac{\cos\theta}{g}}$

C. $2\pi\sqrt{\dfrac{L}{g\sin\theta}}$

D. $2\pi\sqrt{L\dfrac{\sin\theta}{g}}$

Answer: A

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12. A particle exectuing S.H.M has potential energy E_1 and E_2 for displacement x_1 and x_2 respectively . The potential energy at a displacement $X_1 + x_2$ is

A. $E_1 + E_2$

B. $\sqrt{E_1 E_2}$

C. $E_1^2 + E_2^2$

D. $E_1 + E_2 + 2\sqrt{E_1 E_2}$

Answer: D

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13. The bob of a simple pendulum is made of a material of density $\frac{6}{5} \times 10^3 \frac{k}{g} m^3$ The bob executes S.H.M in water with frequency v while the frequency of oscillation, the relationship between v and v_0 is

A. $V = \sqrt{3} v_0$

B. $V = \frac{1}{\sqrt{3}} v_0$

C. $v = \frac{v_0}{\sqrt{6}}$

D. $v = \sqrt{2} v_0$

Answer: C

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14. A small block of mass m is attached to free end of a spring of force cosntant k , whose other end is fixed to a rigid support . The block is lying on a frictionless horizontal plane and it starts moviOng away from fixed end of the spring a\t t= 0 with intial velocity u When the speed of the block is 0.6μ it collides with a fixed heavy mass elastically. After the collision with a fixed heavy mass elastically . Aftere the collision the time at which the block passes through its equilibrium position for the first time is close to

A. $\pi\frac{\sqrt{m}}{K}$

B. $1.86\frac{\sqrt{m}}{K}$

C. $2\frac{\sqrt{m}}{K}$

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

Answer: C

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15. A particle exectuing simple harmonic motion of time period T has x V and as its displacement , velocity and ecceleration , rexpectively . Which of the following quantities does not change with time ?

A. aT/x

B. $\frac{a^2T^2}{v^2}$

C. aT+2Pn

D. $a^{2T^2+2pn^2}$

Answer: A

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16. A particle undergoing forced oscillations has maximum amplitude for frequency V_1 of the force . Then Which of the following statement is true ?

A. $V_1 = V_2$

B. $V_1 < V_2$

C. $V_1 > V_2$

D. $V_1 < V_2$ when the damping is small and $V_1 > V_2$ when damping is large

Answer: A

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17. A second pendulum is shifted from Delhi to London . If the accelereation due to gravity at london is $981c\frac{m}{s^2}$ and increases in length of the pendulum is observed to be 0.2 cm , then the acceleration due to gravity at Delhi is

A. $983c\frac{m}{s^2}$

B. $979c\frac{m}{s^2}$

C. $985c\frac{m}{s^2}$

D. $977 cm / s^2$

Answer: B

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18. A charge of +q coulomb is carried bya wooden block , which when attached to a stretched spring as shown in the adjoining figure and released performs S.H.M of frequency n. If niw a uniform electric field $\vec{E}$ is switched on then the block will perform S.H.M of

A. Same frequency , with its mean position shifted.

B. Same frequency , with same mean position.

C. different frequency , with its mean position shifted.

D. different frequency , with same mean psotion .

Answer: A

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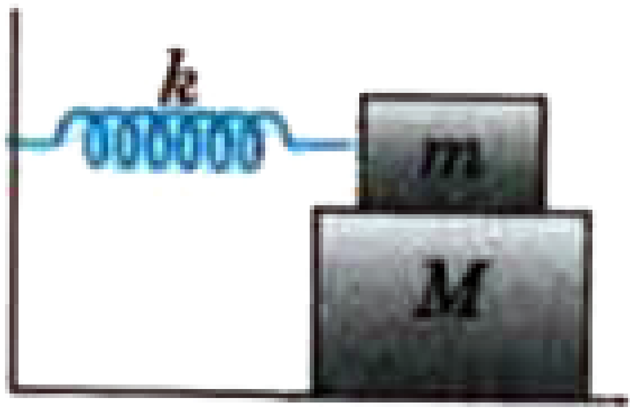
19. The arrangement shown below shows a block of mass M and m, with a spring of force constant k attached to the spring fixed to the wall . What will be the maximum value of frictional force between them if μ is the coefficient of friction and the blocks move together in S.H.M with amplitude A ?



A. $f = \left(\frac{m+M}{m}\right)kA$

B. $f = \left(\frac{m}{M}\right)kA$

C. $f = \left(\frac{M}{m+M}\right)kA$

D. $f = \left(\frac{m}{M-m}\right)KA$

Answer: C

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20. Dispalcement (x) and velocity (v) of a particle exectuting S.H.M are related as $2v^2 = 9 - x^2$. The time period of particle is

A. 4π

B. 2π

C. $4\sqrt{2}\pi$

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

Answer: D

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1. The paricle executing simple harmonic motion had kinetic energy and the total energy are respectively:

A. $\frac{K_0}{2}$ and K_0

B. K_0 and $2K_0$

C. K_0 and K_0

D. 0 and $2K_0$

Answer: C

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2. The distance moved by a particle in simple harmonic motion in one time period is

A. 4A

B. Zero

C. A

D. 2A

Answer: A

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3. A pendulum is hung from the roof of a sufficiently high building and is moving freely to and fro like a simple harmonic oscillator. The acceleration of the bob of the pendulum is 20 m/s^2 at a distance of 5 m from the mean position. The time period of oscillation is

A. 2s

B. πs

C. $2\pi s$

D. 1s

Answer: B

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4. Two simple harmonic motion of angular frequency 100 and $1000 rads^{-1}$ have the same displacement amplitude The ratio of their maximum acceleration is

A. $1 : 10^2$

B. $1 : 10^3$

C. $1 : 10^4$

D. $1 : 10$

Answer: A

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5. A point performs simple harmonic oscillation of period T and the equation of motion is given by $x = a \sin\left(\omega t + \frac{\pi}{6}\right)$. After the elapse of what fraction of the time period, the velocity of the point will be equal to half of its maximum velocity ?

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

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

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

D. $\frac{T}{8}$

Answer: C

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6. The displacement of a particle along the x- axis it given by $x = a\sin^2\omega t$ The motion of the particle corresponds to

A. non-simple harmonic motion

B. simple harmonic motion of frequency $\omega/2x$

C. simple harmonic motion of frequency $\omega/2x$

D. simple harmonic motion of frquency $3\omega / 2\pi$

Answer: C

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7. A mass falls from a height h and its time of fall t is recorded in terms of time period T of a simple pendulum. On the surface of earth it is found that $t = 2T$.The entire sete up is taken on the surface of another planet whose mass is half of that of earth and raidus the same experiment is repeated and corresponding times noted as t' and T' Then we can say

A. $t' = 2T'$

B. $t' = \sqrt{12}T'$

C. $t' > 2T'$

D. $t' < 2T'$

Answer: A

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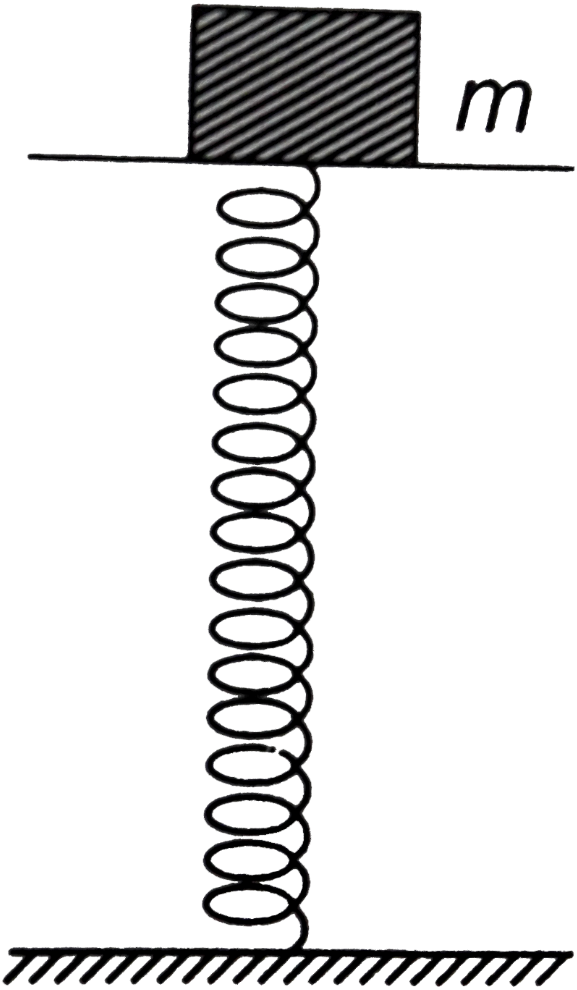
8. A mass of $2.0kg$ is put on a flat pan attached to a vertical spring fixed on the ground as shown in figure. The mass of the spring and the pan is negligible. When pressed slightly and realeased the mass executes a simple contant is $200N/m$. What should be the minimum amplitude of the motion, so that the mass gets the detached from the pan?

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



A. 10.0cm

B. Any value less than 12.0cm

C. 4.0cm

D. 8.0cm.

Answer: A

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9. A truck is staitonary and has a bob suspended by a lilght string in a frame attached to the truck The truck , suddenly moves to the right with an acceleration of a. The pendulum will tilt

A. to the left and angle of inclination of the penudlum with the verticle is $\sin^{-1}\left(\frac{g}{a}\right)$

B. to the left and angle of inclination of the pendulm with the verticle is $\tan^{-1}\left(\frac{\alpha}{g}\right)$

C. to the left and angle of inclination of the pendulum with the veritcal is $\sin^{-1}\left(\frac{a}{g}\right)$

D. to the left and angle of inclination of the pendulum with the veritcal is $\tan^{-1} 9\frac{g}{a}\Big)$

Answer: C

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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. Only (i)

B. Only (iv) does not represent S.H.M.

C. Only (i) and (ii)

D. Only (i) and (ii)

Answer: C

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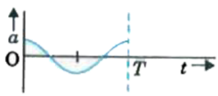
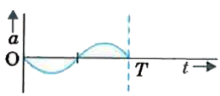
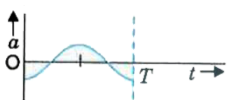
11. The oscillationof a body on a smooth horizontal surface is represented by the equation

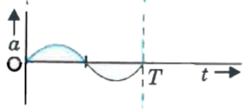
$x = A \cos \omega t$

where $x =$ displacement at time t, $\omega =$ frequency of oscillation. Which one of the following graphs shows correctly the variation of acceleration a with time t ?

A. 

B. 

C. 

D. 

Answer: C

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12. when two displacements represented by $y_1 = a\sin(\omega t)$ and $y_2 = b\cos(\omega t)$ are superimposed the motion is

A. Not a simple harmonic

B. Simple harmonic with amplitude $\frac{a}{b}$

C. Simple harmonic with amplitude $\sqrt{a}^2 + b^2$

D. Simple harmonic with amplitude $\frac{(a) + (b)}{2}$

Answer: C

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13. 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. $2\pi\sqrt{\dfrac{x_1^2 + x_2^2}{V_1^2 + V_1^2}}$

B. $2\pi\sqrt{\dfrac{x_2^2 - x_1^2}{V_1^2 - V_1^2}}$

C. $2\pi\sqrt{\dfrac{x_1^2 + x_2^2}{V_1^2 + V_2^2}}$

D. $2\pi\sqrt{\dfrac{x_1^2 - x_2^2}{V_1^2 - V_2^2}}$

Answer: B

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14. A particle executes linear simple harmonic motion with an amplitude of $3cm$. When the particle is at $2cm$ from the mean position, the magnitude of its velocity is equal to that of its acceleration. Then, its time period in seconds is

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

B. $\frac{\sqrt{5}}{2x}$

C. $\frac{4\pi}{\sqrt{5}}$

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

Answer: C

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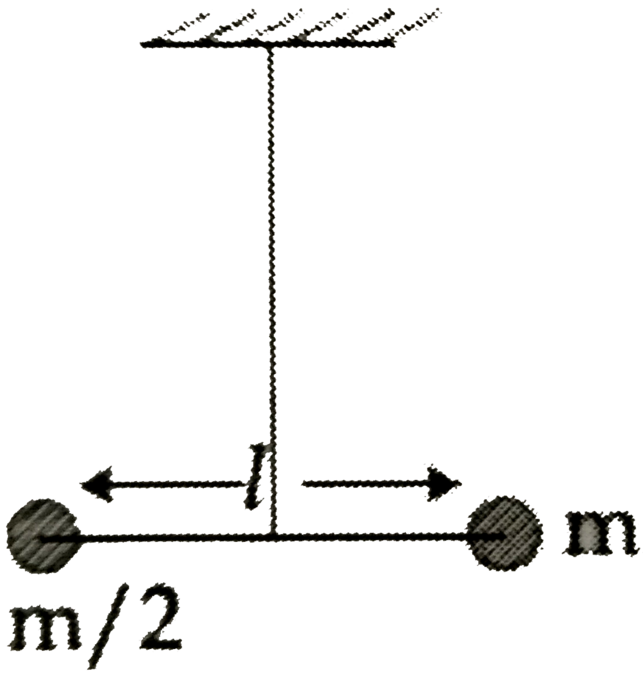
Competition File Multiple Choice Question Jee Main Other State Boards For Engineering Entrance

1. Two masses m and $\frac{m}{2}$ are connected at the two ends of a massless rigid rod of length l. The rod is suspended by a thin wire of torsional constant k at the centre of mass of the rod-mass system(see figure). Because of torsional constant k, the restoring torque is $\tau = k\theta$ for angular displacement θ. If the rod is rotated by θ_0 and released, the tension in it when it passes through its mean position will be :



A. $\frac{3k\theta_0^2}{l}$

B. $\frac{K\theta_0^2}{2l}$

C. $\frac{2k\theta_0^2}{l}$

D. $K\theta_0^2 \frac{)}{l}$

Answer: D

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2. A particle executes simple harmonic motion and is located at $x = a$, b at times t_0, $2t_0$ and $3t_0$ respectively. The frequency of the oscillation is :

A. $\frac{1}{2\pi t_0}\cos^{-1}\left(\frac{a+c}{2b}\right)$

B. $\frac{1}{2\pi t_0}\cos^{-1}\left(\frac{a+2b}{3c}\right)$

C. $\frac{1}{2\pi t_0\cos^{-1}\left(\frac{a+2b}{2c}\right)}$

D. $\frac{1}{2\pi t_0\cos^{-1}\left(\frac{a+2c}{b}\right)}$

Answer: A

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3. A point mass oscillates along the x-axis according to the law $x = x_0\cos(moegat - \pi/4). Iftheae \leq rationofthepartic \leq iswrienas$

a=A cos(omegat+delta), the .

A. $A = -x_0\omega^2, \delta = \frac{\pi}{4}$

B. $A = x_0\omega^2 \delta = -\frac{\pi}{4}$

C. $A = x_0\omega^2, \delta = \frac{3\pi}{4}$

D. $A = x_0, \delta = -\frac{\pi}{4}$

Answer: B

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4. A rod of mass 'M' and length '2L' is suspended at its middle by a wire. It exhibits torsional oscillations, if two masses each of 'm' are attached at distance $'L/2'$ from its centre on both sides, it reduces the oscillation frequency by 20%. The value of ratio m/M is close to :

A. 0.57

B. 0.17

C. 0.77

D. 0.37

Answer: D

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5. Two particles are executing simple harmonic of the same amplitude (A) and frequency ω along the x-axis . Their mean position is separated by distance `X_(0)(X_(0)gtA). If the maximum separation between them is (X_(0)+A), the phase difference between their motion is:

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

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

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

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

Answer: A

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6. A massless spring (k = 800 N/m), attached with a mass (500 g) is completely immersed in 1 kg of water. The spring is stretched by 2 cm and released so that it starts vibrating. What would be the order of magnitude of the change in the temperature of water when the vibrations stop completely? (Assume that the water container and spring receive negligible heat and specific heat of mass = 400 J/kg K, specific heat of water = 4184 J/kgk)

A. 10^{-5}K

B. $10^{-1}K$

C. $10^{-4}K$

D. $10^{-3}K$

Answer: A

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7. A wooden cube (density of wood $'d'$) of side $'l'$ flotes in a liquid of density $'\rho'$ with its upper and lower surfaces horizonta. If the cube is pushed slightly down and released, it performs simple harmonic motion of period $'T'$. Then, $'T'$ is equal to :-

A. $2\pi\frac{\sqrt{ld}}{pg}$

B. $2\pi\frac{\sqrt{lp}}{dg}$

C. $2\pi\frac{\sqrt{ld}}{(p-d)g}$

D. $2\pi\frac{\sqrt{ld}}{(p-d)g}$

Answer: C

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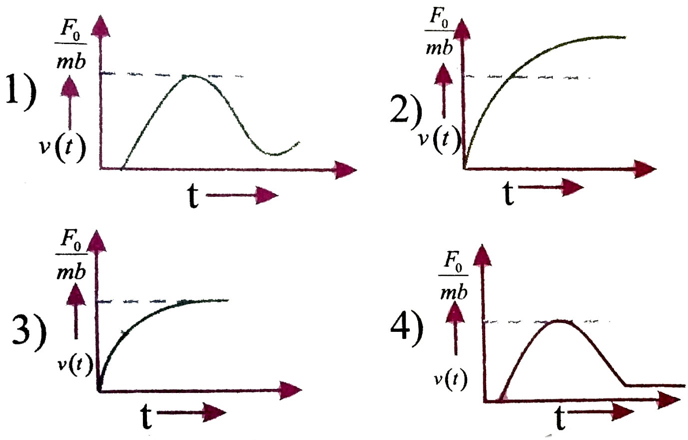
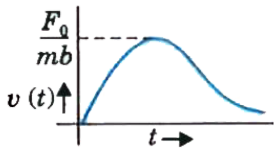
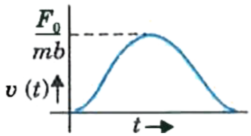
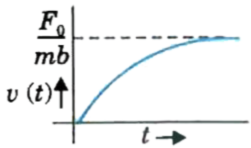
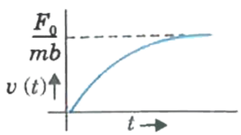
8. A particle of mass m is at rest at the origin at time $t = 0$ It is subjected to a force $F(t) = F_0 e^{-bt}$ in the X-direction. Its speed $V(t)$ is depicted by which of the following curves



A. 

B. 

C. 

D. 

Answer: D

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9. If a simple pendulum has significant amplitude (up to a factor of1//e of original) only in the period between $t - 0s \to t = \tau s$, then τ may be called the average life of the pendulum. When the sphetical bob of the pendulum suffers a retardation (due to viscous drag) proportional to its velocity with b as the constant of propotional to average life time of the pendulum is (assuming damping is small) in seconds:

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

B. $\frac{0.693}{b}$

C. b

D. $\frac{1}{b}$

Answer: A

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10. The displacement of a damped harmonic oscillator is given by $x(t) = e^{-0.1t}\cos(10\pi t + \phi)$. Here t is in seconds

The time taken for its amplitude of vibration to drop to half of its initial is close to :

A. 4s

B. 7s

C. 13s

D. 27s

Answer: B

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11. An ideal gas enclosed in a cylindrical container supports a freely moving piston of mass M. The piston and the cylinder have equal cross-sectional area A. When the piston is in equilibrium, the volume of the gas is V_0 and its pressure is P_0. The piston is slightly displaced from the equilibrium position and released. Assuming that the system is completely isolated from its surrounding, the piston executes a simple harmonic motion with frequency

A. $\frac{1}{2\pi}\frac{V_0MP_0}{A^2\gamma}$

B. $\frac{1}{2\pi}\frac{\sqrt{A^2\gamma P_0}}{MV_0}$

C. $\frac{1}{2\pi}\frac{\sqrt{MV_0}}{A\gamma P_0}$

D. $\frac{1}{2\pi}\frac{A\gamma P_0}{V_0M}$

Answer: B

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12. A particle moves with simple harmonic motion in a straight line. In first τs, after starting form rest it travels a destance a, and in next τs it travels 2a, in same direction, then:

A. Time perid of oscillation is 6t

B. amplitude of motion is 3a

C. time period of oscillations is 8t

D. amplitude of motion is 4a

Answer: A

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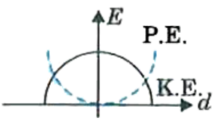
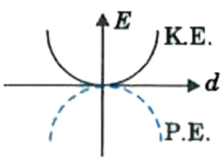
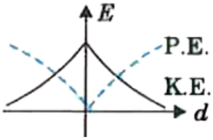
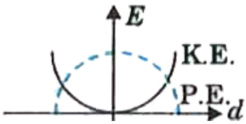
13. For a simple pendulum, a graph is plotted its kinetic energy (KE) and potential energy (PE) against its displacement d. Which one of the following represents these correctly?

A. 

B. 

C. 

D. 

Answer: A

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14. A particle performs simple harmonic mition with amplitude A. Its speed is trebled at the instant that it is at a destance $\frac{2A}{3}$ from equilibrium position. The new amplitude of the motion is:

A. 3A

B. $A\sqrt{3}$

C. $\frac{7A}{3}$

D. $\frac{A}{3}\sqrt{41}$

Answer: C

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15. If x, v and a denote the displacement, the velocity and the acceleration of a particle executing simple harmonic motion of time period T, then, which of the following does not change with time ?

A. $a^2T^2 + 4\pi^2v^2$

B. aT/x

C. $aT + 2\pi v$

D. aaT/V

Answer: A

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16. A pendulum with time period of $1s$ is losing energy due to damping. At time its energy is $45J$. If after completing 15 oscillations, its energy has become $15J$. Its damping constant (in s^{-1}) is :-

A. $\frac{1}{30} \in 3$

B. $\frac{1}{15} \in 3$

C. 2

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

Answer: A

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

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

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

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

Answer: A

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18. A 1 kg block attached to a spring vibrates with a frequency of 1 Hz on a frictionless horizontal table. Two springs identical to the original spring are attached in parallel to an 8 kg block placed on the same table. So, the frequency of vibration of the 8 kg block is

A. 2Hz

B. $\frac{1}{4}Hz$

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

D. $\frac{1}{2}Hz$

Answer: A

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19. The ratio of maximum acceleration to maximum velocity in a simple harmonic motion is $10s^{-1}$ At, t = 0 the displacement is 5 m. What is the maximum acceleration ? The initial phase is $\frac{\pi}{4}$

A. $5500\frac{m}{s^2}$

B. $750\sqrt{2}\frac{m}{s^2}$

C. $700\frac{m}{s^2}$

D. $500\sqrt{2}\frac{m}{s^2}$

Answer: D

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20. If an experiment to determine the period of a simple pendulum of length 1m , it is attached to different spherical bobs of raddi r_1 abd r_2. The two spherical bobs have uniform mass distribution . If the relative difference in the periods mass distribution.. If the relative differene in the periods is found to be $5 \times 10^{-4}s$, the difference in radii $|r_1 - r_2|$ is best given by

A. 0.01cm

B. 0.1cm

C. 0.5cm

D. 1cm

Answer: B

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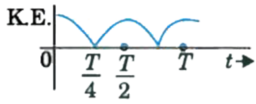
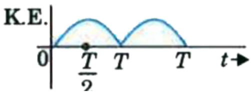
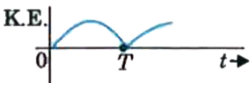
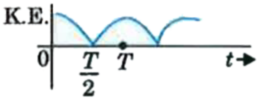
21. A particle is executing simple harmonic motion with a time period T. At time $t=0$, it is at its position of equilibium. The kinetice energy - time graph of the particle will look like

A. 

B. 

C. 

D. 

Answer: A

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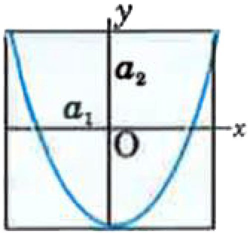
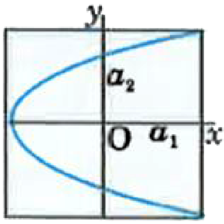
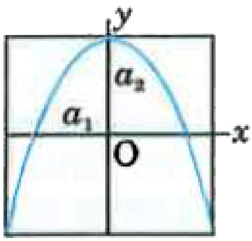
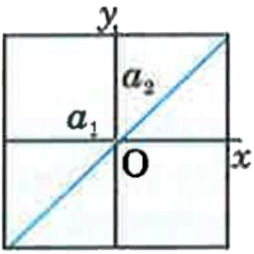
22. A particel which is simultaneously subjected to two perpendicular simple harmonic motions represented by $x=a_1\cos\omega t$ and $y=a_2\cos 2\omega t$ traces a curve given by :

A. 

B. 

C. 

D. 

Answer: A

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23. The angular frequency of the damped oscillator is given by $\omega = \sqrt{\frac{k}{m} - \frac{r^2}{4m^2}}$,where k is the spring constant, m is the mass of the oscillator and r is the damping constant. If the ratio $r^2 / (mk)$ is 8% ,the change in the time period compared to the undamped oscillator

A. increases by 1%

B. increases by 8%

C. decreases by 1%

D. decreases by 8%

Answer: A

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24. Which of the following expressions corresponds to simple harmonic motion along a straight line , where x is the displacement and a, b, c are positive constant ?

A. $a + bx - cx^2$

B. bx^2

C. $a - bx + cx^2$

D. $-bx$

Answer: D

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25. A silver atom in a solid oscillates in simple harmonic motion in some direction with a frequency of $10^{12}/\text{sec}$. What is the force constant of the bonds connecting one atom with the other? (Mole wt. of silver = 108 and Avagadro number `=6.02xx10^(23)" gm "mole^(-1))

A. 2.2N/m

B. 5.5N/m

C. 6.4N/m

D. 7.1N/m

Answer: D

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Competition File Jee Advanced For Iit Entrance

1. Student I, II and III perform an experiment for measuring the accelerationn due to gravity (g) using a simple pendulum . Theu use different lengths of the pedulum and /or record time for different number of oscillations . The observation are shoen in the table .

Least count for length =0.1cm

Least count for time =0.1s

Student	Length of the pendulum (cm)	Number of oscillations (n)	Total time for (n) oscillations (s)	Time period (s)
I	64.0	8	128.0	16.0
II	64.0	4	64.0	16.0
III	20.0	4	36.0	9.0

If $E_I, E_{II}$and $E_{III}$are the percentage errors in g,i.e $\frac{\Delta g}{g} \times 100$for students I, II, and III respectively ,

A. $E_I = 0$

B. E_I is minimum

C. $E_I = E_{II}$

D. E_{II} is maximum

Answer: B

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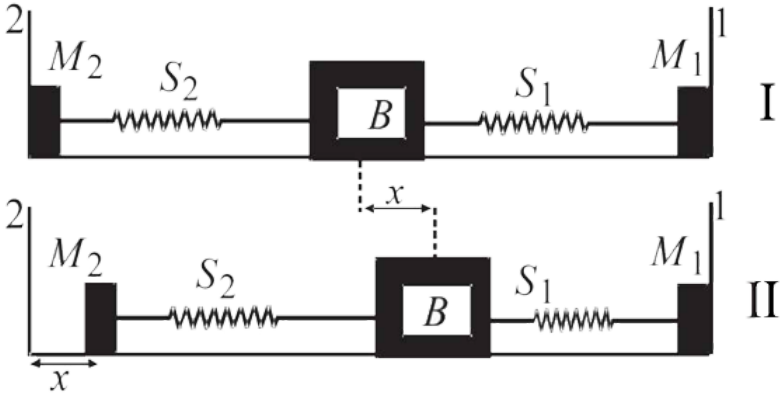
2. A block (B) is attached to two unstriched sprig S_1 and S_(2) with spring constant K and $4K$, respectively (see fig 1) The other ends are atteched in identical support M_1 and M_2 not attached in the walls . The springs and supports have negligible mass . There is no friction anywhere . The block B is displaced toword wall 1 by a small distance z (figure (ii)) and released . THe block return and moves a maximum displacements x and y are musured with reoact to the equalibrum of the block B and the ratio y/x is



A. 4

B. 2

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

D. $\frac{1}{4}$

Answer: C

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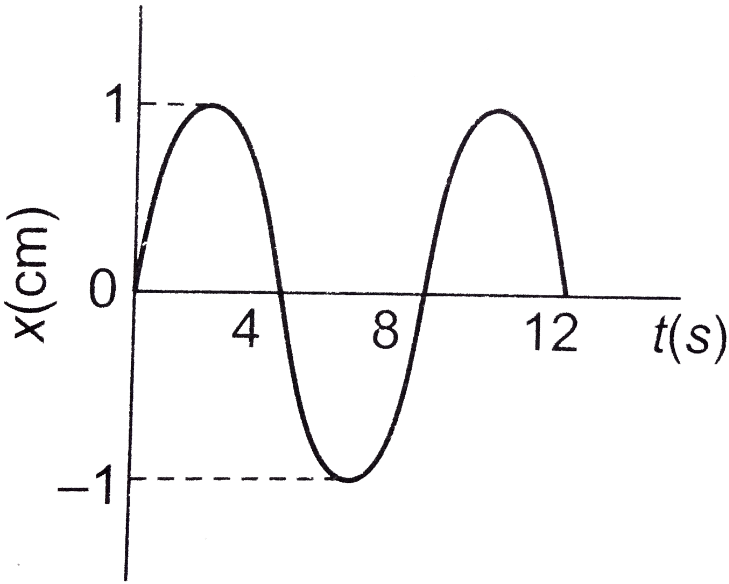
3. The x-t graph of a particle undergoing simple harmonic motion is shown below. The acceleration of the particle of $t = 4/3s$ is



A. $\frac{\sqrt{3}}{32}\pi^2 cm/s^2$

B. $\frac{-\pi^2}{32} cm/s^2$

C. $\frac{-\pi^2}{32} cm/s^2$

D. $\frac{\sqrt{3}}{32}\pi^2 cm/s^2$

Answer: D

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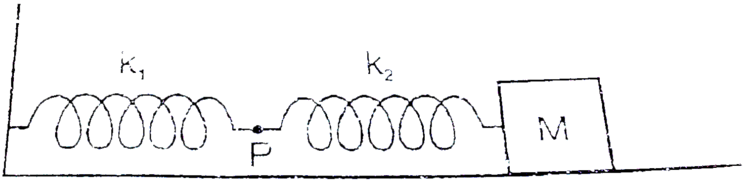
4. The mass M shown in the figure oscillates in simple harmnonic motion and amplitude A. The amplitude of the point P is



A. $\frac{K_1 A}{K_2}$

B. $\frac{K_2 A}{K_1}$

C. $\frac{K_1 A}{K_1 + K_2}$

D. $\frac{K_2 A}{K_1 + K_2}$

Answer: D

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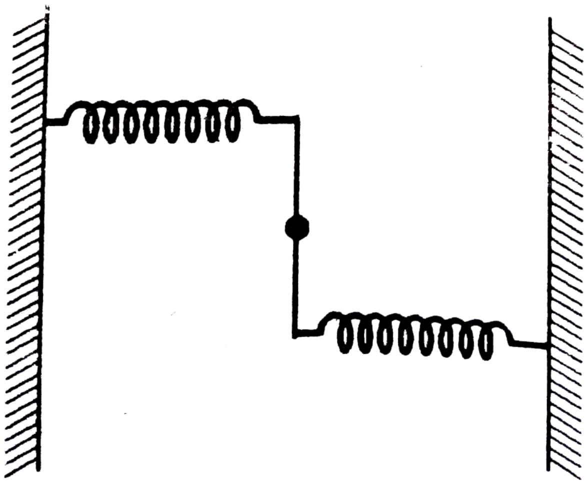
5. A uniform rod of length L and mass M is pivotedat the centre. Its two ends are attached to two springs of equal spring constants. k. The springs as shown in the figure, and the rod is free to oscillate in hte horizontal plane. the rod is gently pushed through a small angle θ in one direction and released. the frequency of oscilllation is-



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

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

C. $\frac{1}{2\pi}\frac{\sqrt{6k}}{M}$

D. $\frac{1}{2\pi}\frac{\sqrt{24k}}{M}$

Answer: C

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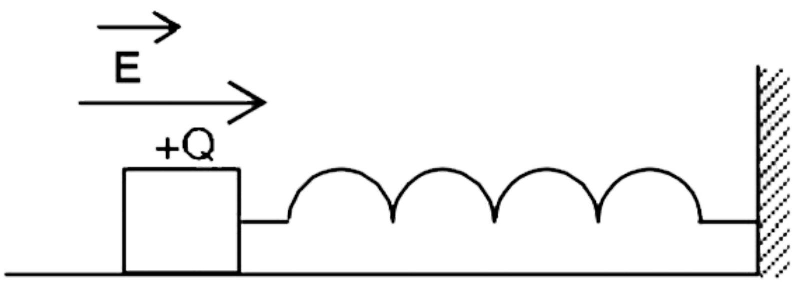
6. A wooden block performs SHM on a frictionaless surface with frequency, v_0. The block carries a charge +Q on its surface. If now a uniform electric field $\vec{E}$ is switched-on as shown, then the SHM of the block will be



A. of the same frequecny and with shifted mean position

B. of the same frequency and with the same mean position

C. of changed frequency and with shifted mean position

D. of changed frequency and with the same mean postion .

Answer: A

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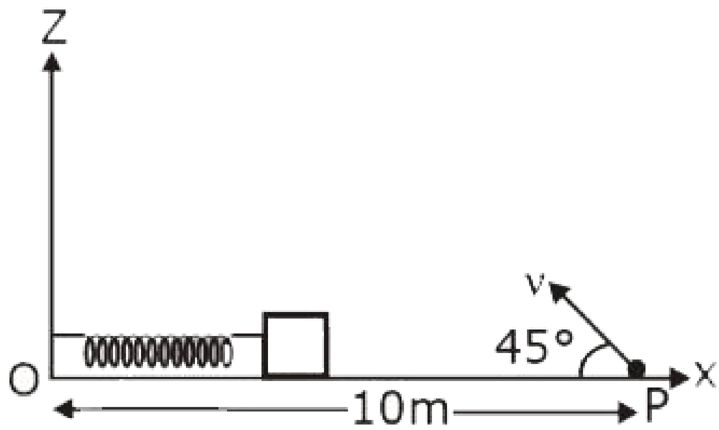
7. A small block is connected to one end of a massless spring of un-stretched length 4.9 m. The other end of the spring (see the figure) is fixed. The system lies on a horizontal frictionless surface. The block is stretched by 0.2 m and released from rest at t = 0. It then executes simple harmonic motion with angular frequency $\omega = \frac{\pi}{3}$ rad/s . Simultaneously at t = 0, a small pebble is projected with speed ν from point P at an angle of 45° as shown in the figure. Point P is at a horizontal distance of 10 m from O. If the pebble hits the block at t = 1s, the value of ν is (take g = 10 m/s^2)



A. $\sqrt{50}m / s$

B. $\sqrt{51}\frac{m}{s}$

C. $\sqrt{52}m / s$

D. $\sqrt{53}m / s$

Answer: A

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Competition File Multiple Choice Question

1. If the function $x = \cos^2 \omega t + b \sin^2 \omega t + c \sin \omega t \cos \omega t$ represent a simple harmonic motion , then which of the foloowing options can be possible ?

A. a=-b,c=2a

B. a=b,c=-2b

C. a=b=0,c $\neq$ 0

D. a=b,c=0

Answer: A::B::C

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2. A linear harmoinc oscillator of force constant $10^6 \frac{N}{m}$ and amplitude 1cm has a total mechanical energy of 80j . The its maximum

A. potential energy is 50J

B. potential energy is 80J

C. kinetic eneregy is 80J

D. Kineteic energy is 50J

Answer: B::D

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3. A simple pendulum of bob mass m and length l is displaced from its mean position O to a point A and then released . If v is the velocity of the bob at O, h is the height of string of pendulum when bob passes through point O is /are (neglect friction)

A. $\frac{2mgh}{l}$

B. $2mg\frac{1+(h)}{l}$

C. $mg\frac{1+(2h)}{l}$

D. $mg\frac{1-(2h)}{l}$

Answer: C

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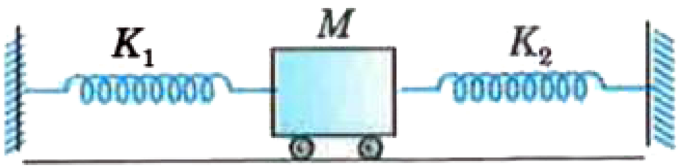
4. A trolley of mass M is connected to two springs of force constant K_1 and K_2 as shown in the figure When the trolley is displacement from its equilibrium postion by a distance a and released , it executes S.H.M of frequency f. If it comes to rest after somtimes due to friction, the total energy dissipated as heat is (Dampling forces are weak)



A. $\pi^2 ma^2 f^2$

B. $2\pi^2 ma^2 f^2$

C. $2a^2(K_1 + K_2)$

D. $\frac{1}{2}a^2(K_1 + K_2)$

Answer: B::D

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5. If a body is executing simple harmonic motion, then

A. moment of inertia

B. elasticity

C. inertia

D. accelaeration proportional to displacement

Answer: B::C::D

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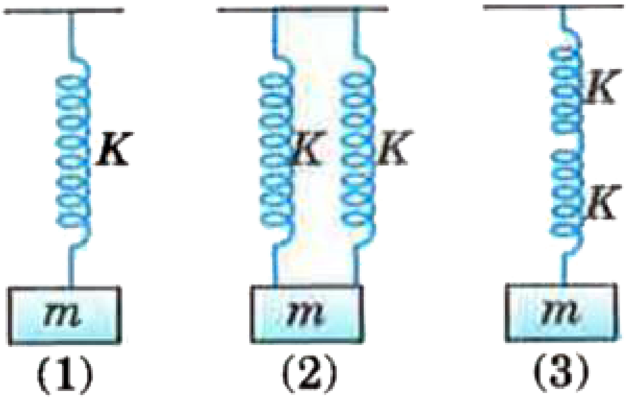
6. The figure shows the arrangement of block of mass m with one or more identical springs in three different ways . If Force cosntant of each springs is K and T_1, T_2 and T_3 are the time periods of oscillations of the arrangement 1, 2, and 3, respectibely, then



A. $T_2 = \frac{1}{\sqrt{2}T_1}$

B. $T_3 = \sqrt{2}Tt_1$

C. $T_3 = 2T_2$

D. $T_3 = \sqrt{2}T_2$

Answer: A::B::C

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7. A solid sphere of density σ with one -third of tis volume submerged . When the sphere is pressed down slightly and released , it executes S.H.M of time period T. Then (viscous effect is ignored)

A. $p = \frac{\sigma}{3}$

B. $p = 3\sigma$

C. $\frac{4\pi}{3}\sqrt{\frac{R}{g}}$

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

Answer: B::C

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8. A body of mass 40g is executing linear simple harmonic motion and has a velocity of 2cm/s when its displacement is 3cm and a velocity of 3 cm/s when its displacement is 2cm . Then

A. The angular frequency of oscillation is 1rad/s

B. The amplitude of oscillation is $3\sqrt{2}cm$

C. The maximum kinetic energy of oscillator is $2.6 \times 10^{-5}J$

D. The maximum potential energy ofocillator is $2.6 \times 10^{-5}J$

Answer: A::C::D

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9. In first case a srpings of ofrce constant K is fixed at one end a block of mass m is attahced to its other end and is placed on a horizontal frictionaless surface . In second case ,a similar springs with both ends free has a block of mass m attached to each of its ends. Each mass is streched by teh same force F in both the cases . If the mass in first released , then which of the following statement is true?

A. The maximum extension of springs is equal in both cases .

B. The maximum extension of sorings is more in first case than in second case

C. Time period of oscilation is equal in both the cases .

D. time period of oscillation in first case is $\sqrt{2}$ times of that in second case .

Answer: A::D

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10. 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 the same force (case b). The work done by the spring W_P and W_Q are related as, in case (b), respectively

A. $\delta = \dfrac{K_2}{K_1}$

B. $\delta = \dfrac{K_1}{K_2}$

C. $\delta = \dfrac{K_2}{K_1}$

D. $\delta = \dfrac{K_1}{K_2}$

Answer: B::C

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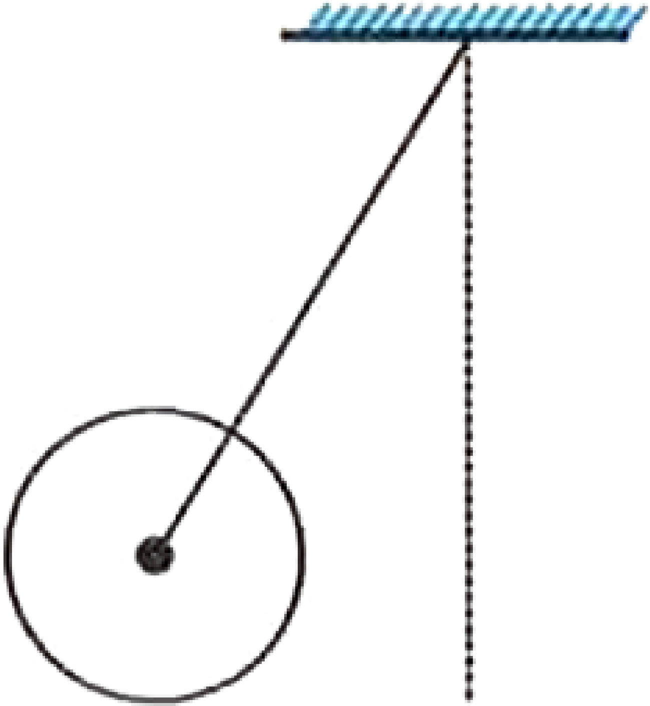
11. A metal rod of length 'L' and maws 'm' is pivoted at one end A thin disc of mass 'M' and radius 'R' (Which of the folowing statement (s) is (are) true ?



A. Restoring torque in case A = Restoring torque in case B

B. Restorings torque in case A lt Restoring torque in case B

C. Angular frequency for case A gt Angular frequency for case B.

D. Angular frquency for case A lt Angular frequency for case B.

Answer: A::D

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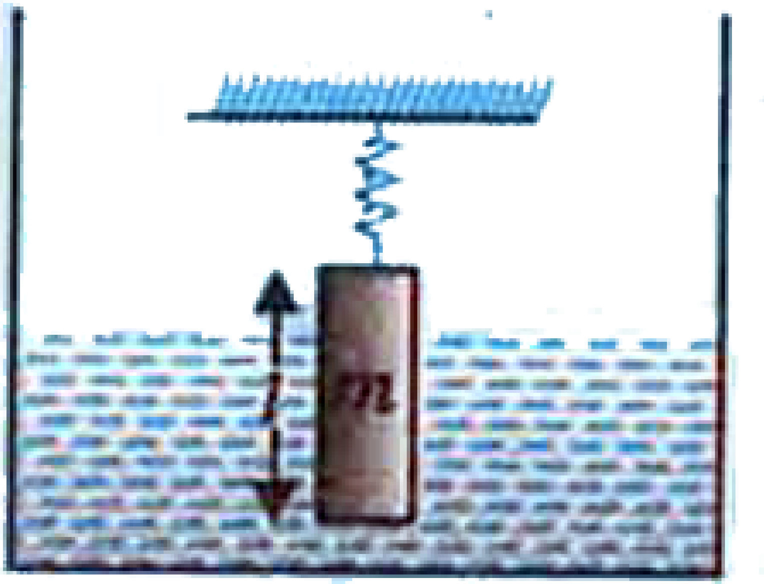
Competition File Multiple Choice Question Based On A Given Passage Comprehension

1. A uniform cylinder of mass m, length l and cross sectional area A is suspended with its vertical from a fixed point, with the help of a massless spirng of force constant (K), The cylinder is then submerged in a liquid of density p. At equilibrium the cylinder remains submerged in the liquid with $1/4^{th}$ of its volume outside the liquid, as shown in the figure. The elongation of hte spring at this point is x_0. WHen the cylinder is given a slight downward push into the liquid and then released, its starts oscillating with vertical S.H.M. of small amplitude.



The elongation X_0 produced in the springs when the syste is in equilibrium is

A. $\frac{g}{K}\left(m-\frac{1}{4}lAp\right)$

B. $\frac{g}{K}\left(m+\frac{1}{4}lAp\right)$

C. $\frac{g}{K}\left(m-\frac{3}{4}lAp\right)$

D. $\frac{g}{K}\left(m+\frac{3}{4}lAp\right)$

Answer: C

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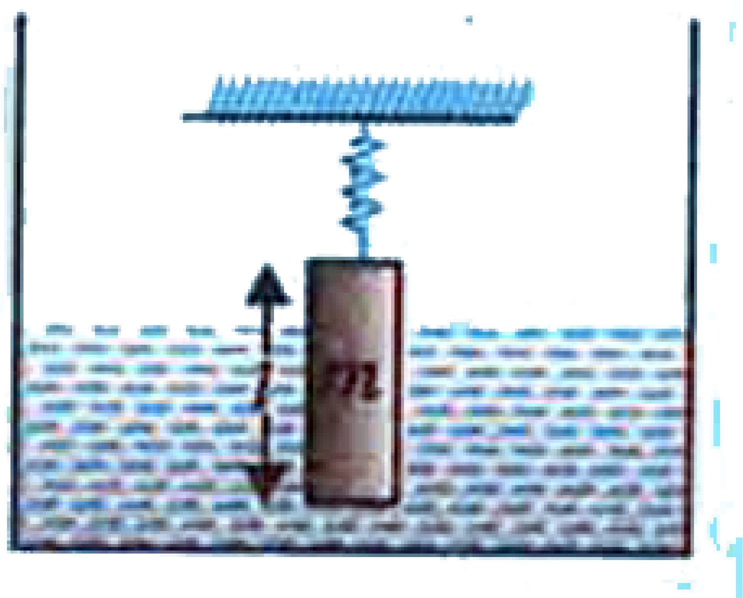
2. A uniform cylinder of mass m, length l and cross sectional area A is suspended with its vertical from a fixed point, with the help of a massless spirng of force constant (K), The cylinder is then submerged in a liquid of density p. At equilibrium the cylinder remains submerged in the liquid with $1/4^{th}$ of its volume outside the liquid, as shown in the figure. The elongation of hte spring at this point is x_0. WHen the cylinder is given a slight downward push into the liquid and then released, its starts oscillating with vertical S.H.M. of small amplitude.



If the cyleinder is displced by a small downward displacement a from its equilibrium postion and then released , the restoring force on it will be

A. $-\frac{[K+Apg]a}{4}$

B. $-\left[K+\frac{1}{4}Apg\right]a$

C. $-\left[K-\frac{1}{4}Apg\right]a$

D. $-[K+Apg]a$

Answer: D

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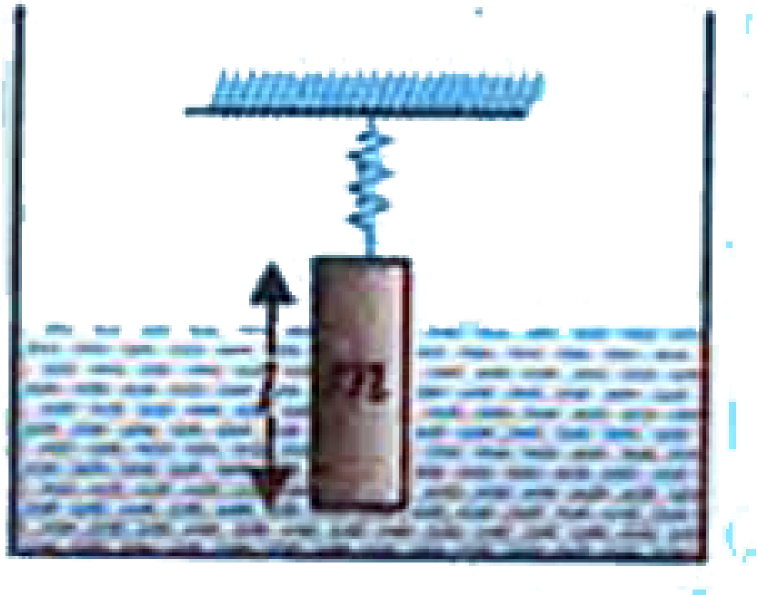
3. A uniform cylinder of mass m, length l and cross sectional area A is suspended with its vertical from a fixed point, with the help of a massless spirng of force constant (K), The cylinder is then submerged in a liquid of density p. At equilibrium the cylinder remains submerged in the liquid with $1/4^{th}$ of its volume outside the liquid, as shown in the figure. The elongation of hte spring at this point is x_0. WHen the cylinder is given a slight downward push into the liquid and then released, its starts oscillating with vertical S.H.M. of small amplitude.



Time period of vertical S.H.M of the cylinder is

A. $2\pi\left(\frac{m}{K+Apg}\right)^{1/2}$

B. $2\pi\left(\frac{m}{K-Apg}\right)^{1/2}$

C. $2\pi\left(\frac{m}{K-\frac{1}{4}Apg}\right)^{1/2}$

D. $2\pi\left(\frac{m}{K+\frac{1}{4}Apg}\right)^{1/2}$

Answer: A

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4. A light spring of force constant k is attached to a block of mass M placed on a horizontal firctionless surface from its one end and other end is fixed to a right support. The system is executing S.H.M. of amplitude A_1 and time period T_1. At some instant, the block passed through the equilibrium position and a small object of mass m is placed on it. The new amplitude and time period of the system now becomes A_2 and T_2 respectively.

The ratio $\frac{T_2}{T_1}$ is

A. $\left(\frac{M+m}{(M)^{1/2}}\right)$

B. $\left(\frac{M}{(M+m)^{1/2}}\right)$

C. $\left(\frac{M+m}{(m)^{1/2}}\right)$

D. $\left(\left(\frac{m}{M}\right)^{1/2}\right)$

Answer: A

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5. A light spring of force constant k is attached to a block of mass M placed on a horizontal firctionless surface from its one end and other end is fixed to a right support. The system is executing S.H.M. of amplitude A_1 and time period T_1. At some instant, the block passed through the equilibrium position and a small object of mass m is placed on it. The new amplitude and time period of the system now becomes A_2 and T_2 respectively.

The velcities of block before and after the object is placed on it are V_1 and V_2 respectively. Then the ratio V_2 / V_1

A. $\left(\frac{M+m}{M}\right)$

B. $\left(\frac{M}{M+m}\right)$

C. $\left(\frac{M-m}{M}0^{1/2}\right.$

D. $\left(\frac{M}{M+m}\right)\left(\frac{A_2}{A_1}\right.$

Answer: B

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6. A light spring of force constant k is attached to a block of mass M placed on a horizontal firctionless surface from its one end and other end is fixed to a right support. The system is executing S.H.M. of amplitude A_1 and time period T_1. At some instant, the block passed through the equilibrium position and a small object of mass m is placed on it. The new amplitude and time period of the system now becomes A_2 and T_2 respectively.

The ratio A_2 / A_1 is

A. $\left(\frac{M+m}{M}\right)^{1/2}$

B. $\left(\frac{M}{M+m}\right)^{1/2}$

C. $\left(\frac{M-m}{M^{1/2}}\right)$

D. $\left(\frac{M+m}{(M-m)^{1/2}}\right)$

Answer: B

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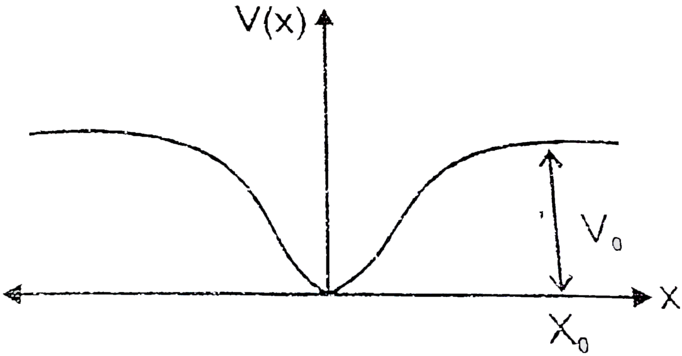
7. When a particle is mass m moves on the $x-$ axis in a potential of the from $V(x) = kx^2$, it performs simple harmonic motion. The corresponding thime periond is proportional to $\sqrt{\frac{m}{k}}$, as can be seen easily asing dimensional analysis. However, the motion of a pariticle can be periodic even when its potential enem increases on both sides $x = 0$ in a way different from kx^2 and its total energy is such that the particel does not escape to infinity. consider a particle of mass m moving onthe $x-$ axis . Its potential energy is $V(x) = \omega(\alpha > 0)$ for $|x|$ near the origin and becomes a constant equal to V_0 for $|x| \geq X_0$ (see figure)



If the total energy of the particle is E, it will perform is periodic motion why if :

A. EltO

B. E gt 0

C. $V_0 > E > 0$

D. $E > V_0$

Answer: C

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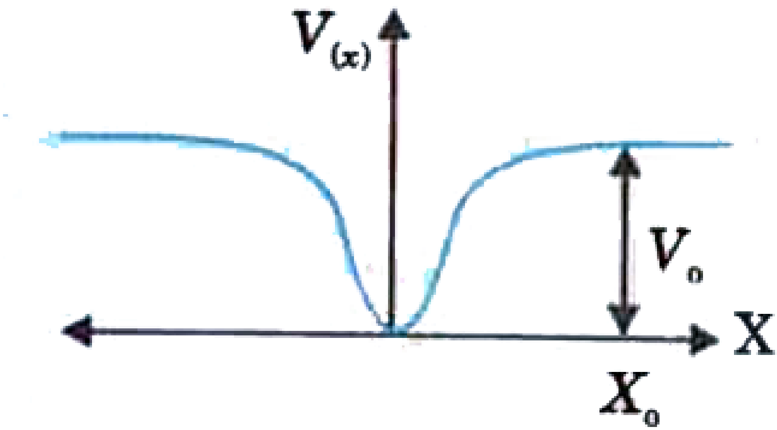
8. When a particle of mass m moves on the X-axis in a potential of the form $V(x) = kx^2$, it performs simple harmonic motion. The corresponding time period is proportional to

$\sqrt{\frac{m}{k}}$, as can be seen easily using dimensional analysis.

However, the motion of a particle can be periodic even when its potential energy increases on both sides of x = 0 in a way different from kx^2 and its total energy is such that the particle does not escape to infinity. Consider a particle of mass m moving on the X-axis. Its potential energy is V(x) $= ax^2 (a > 0)$ for |x| near the origin and becomes a constant equal to V_0 for $|x| \geq X_0$



For periodic motion os small amplitude A . The time periodic T of this particle is proportional to

A. $A\frac{\sqrt{m}}{\alpha}$

B. $\frac{1}{A}\frac{\sqrt{m}}{\alpha}$

C. $A\frac{\sqrt{\alpha}}{m}$

D. $\frac{1}{A}\frac{\sqrt{\alpha}}{m}$

Answer: B

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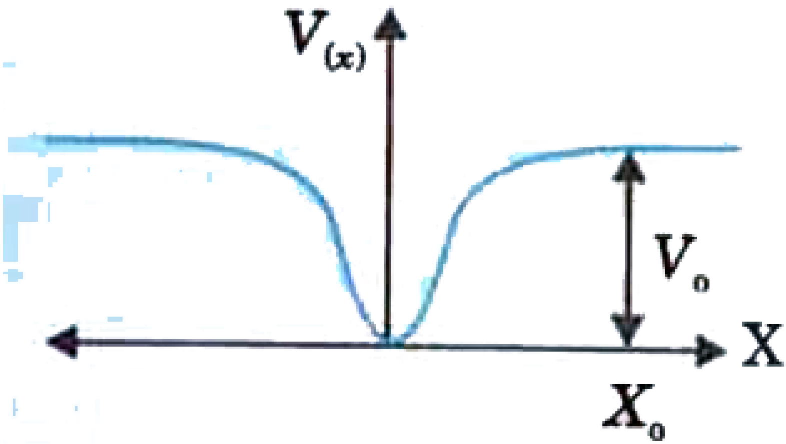
9. When a particle of mass m moves on the X-axis in a potential of the form $V(x)=kx^2$, it performs simple harmonic motion. The corresponding time period is proportional to

$\sqrt{\frac{m}{k}}$, as can be seen easily using dimensional analysis.

However, the motion of a particle can be periodic even when its potential energy increases on both sides of x = 0 in a way different from

kx^2 and its total energy is such that the particle does not escape to infinity. Consider a particle of mass m moving on the X-axis. Its potential energy is V(x) $= ax^2 (a > 0)$ for |x| near the origin and becomes a constant equal to V_0 for $|x| \geq X_0$



The acceleration of this particle for $|X| > X_0$ is

A. proportional to $\left(\frac{v_0}{mX_0}\right)$

B. propotinal to $\frac{\sqrt{V_0}}{mX_0}$

C. proportional to V_0

D. Zero

Answer: D

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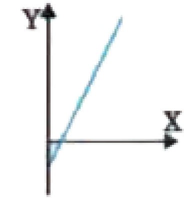
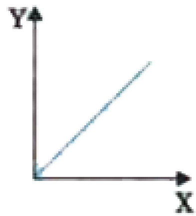
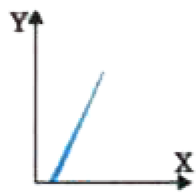
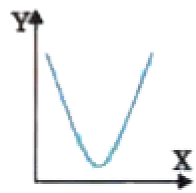
Competition File Matching Type Questions

1.

	List-I		List-II
P	Range of a projectile (Y- axis) as a function of its velocity (X-axis) when projected at a certain angle	1	
Q	Potential energy of a pendulum (Y-axis) as a function of its displacement (X-axis)	2	
R	Square of time period (Y-axis) of a pendulum as a function of its length (X-axis)	3	
S	Natural logarithm of amount of radiation emitted per unit time from a unit area of body (Y-axis) as a function of natural logarithm of absolute temperature of body (X-axis)	4	

A.
P	Q	R	S
1	3	2	4

B.
P	Q	R	S
1	2	4	3

C.
P	Q	R	S
2	4	3	1

D.
P	Q	R	S
4	2	3	1

Answer: D

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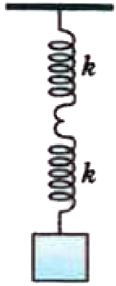
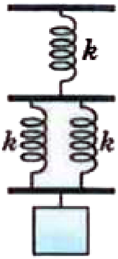
2.

List-I		List-II	
P	Effective force constant is k.	1	
Q	Effective force constant is $2k/3$.	2	
R	Effective force constant is $5k$.	3	
S	Effective force constant is $k/2$.	4	

A.

P	Q	R	S
1	3	2	4

B.

P	Q	R	S
1	2	4	3

C.

P	Q	R	S
2	4	3	1

D.

P	Q	R	S
4	2	3	1

Answer: B

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Competition File Matrix Match Type Questions

1. Column I describes some situations in which a small object moves. Column II describes some characteristics of these motion. Match the situtions in column I with the characteristics in column II.

Column - I		Column - II	
(a)	The object moves on the x-axis under a conservative force in such a way that its speed and position satisfy $v = c_1\sqrt{c_2 - x^2}$, where c_1 and c_2 are positive constants.	(p)	The object executes a simple harmonic motion.
(b)	The object moves on the x-axis in such a way that its velocity and its displacement from the origin satisfy $v = -kx$, where k is a positive constant.	(q)	The object does not change its direction.

(c)	The object is attached to one end of a massless spring of a given spring constant. The other end of the spring is attached to the ceiling of an elevator. Initially everything is at rest. The elevator starts going upwards with a constant acceleration a. The motion of the object is observed from the elevator during the period it maintains this acceleration.	(r)	The kinetic energy of the objects keeps on decreasing.
(d)	The object is projected from the earth's surface vertically upwards with a speed $2\sqrt{GM_e / R_e}$, where M_e is the mass of the earth and R_e is the radius of the earth. Neglect forces from objects other than the earth.	(s)	The object can change its direction only once.

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2. Column I describes some situtations in which a small object moves. Column II describes some characteristics of these motions. Match the situations in Column I with the characteristics in Column II.

	Column I		Column II
A	Properties required by a system to execute simple harmonic motion	p	Force constant
B	Factors on which time period in simple harmonic motion depends	q	Elasticity
C	Factors on which amplitude of particle executing S.H.M. depends	r	Mass/Inertia
D	Factors on which potential energy in S.H.M. depends	s	Initial Displacement
		t	Initial velocity
		u	Displacement from mean position at an instant

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Competition Integer Type Questions

1. A particle is executing simple harmonic motion under the action of a force F with a time period $\frac{3}{5}$s. When the force is changed to F', the time period of oscillation is $\frac{4}{5}$s. When both the forces F and F' act simultaneously in the same direction on the body, time period in seconds in $T = \frac{6a}{5b}$. COmpute the value of a + b.

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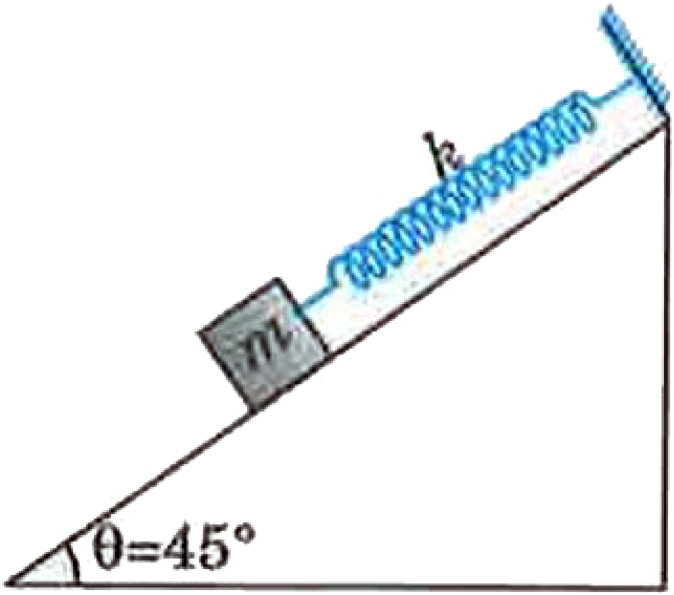
2. A spring of unstretched length 40 cm and spring constant k is attached to a block of mass 1 kg to one of its end. The other end of the spring is fixed on the top of a frictionless inclined plane of inclination $\theta = 45^{\circ}$ as shown in the figure, so that the spring extends by 3 cm. When the mass is displaced slightly and released the time period of the resulting oscillation is T. Determine the value of 5T close to nearest integer.



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3. The maximum seperation between two particles executing simple harmonic motion of the equal amplitude and same frequency along the same straight line and about the same mean position, is $\sqrt{3}$ times the amplitude of oscillation. IF the phase difference between them is ϕ, determine $2\pi / \phi$.

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4. A simple pendulum of time period of oscillation 2.0 s is suspended vertically. The point of suspension of the pendulum now starts moving vertically upwards with a velocity that varies with time t as $v = \alpha t$ where $\alpha = 3.5 ms^{-1}$. If the new time period of oscillation of ht pendulum is T, then find the value of 2.2T. (Take $g = 10 ms^{-2}$)

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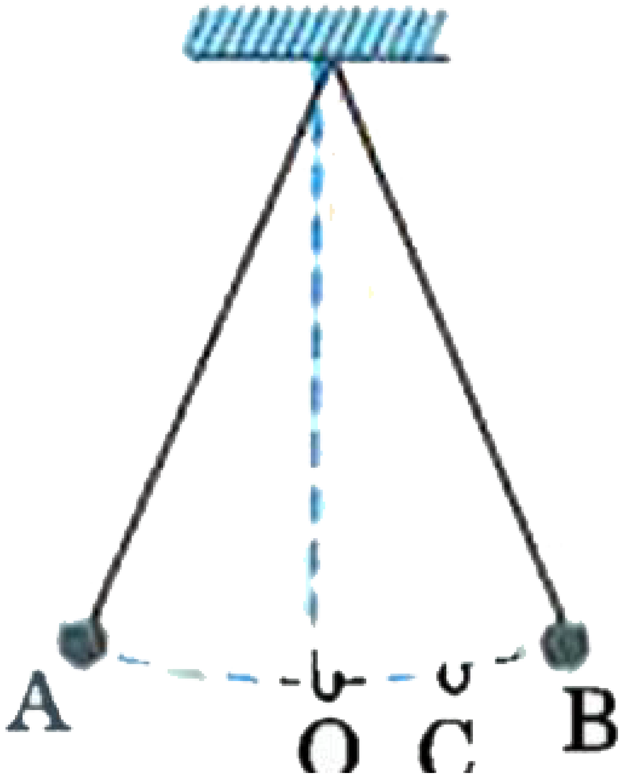
5. A simple pendulum suspended vertically from a rigid support is moving simple harmonically with a period of 5 s between two extreme

positions A and B as shown in the figure. The angular distance between A and B is 8 cm. If it takes t seconds for the pendulum to move from position B to position C, exactly midway O and C, then find $\frac{6}{5}t$.



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6. A particle executes a linear simple harmonic motion of amplitude 20 cm and time period 4 s. The minimum time period required for the

particle to move between two points located at 10 cm on either side of equilibrium position is t seconds, then compute 3t + 2 .

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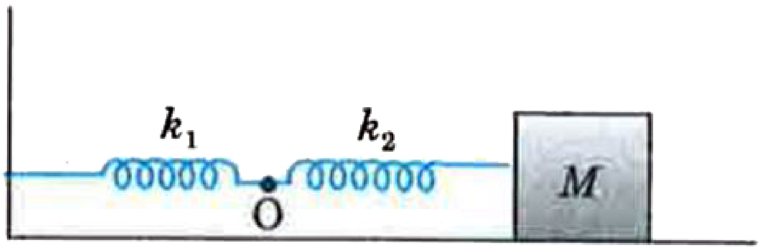
7. The figure shows a mass M attached to a series arrangement of two springs of spring constants k_1 and k_2 where $k_2 = 2k_1$. If the mass M oscillates in simple harmonic motion with amplitude A, the amplitude of the point O is $\frac{\alpha A}{\beta}$. Find $\beta - \alpha$.



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8. A block of mass m is suspended from a spring fixed to the ceiling of a room. The spring is stretched slightly and released so that the block executes S.H.M. of frequency v. IF the mass is increased by m' the frequency becomes $3v/5$. If $\frac{m'}{m} = \frac{q}{p}$, then find the value of $(q-p)$.

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9. Two simple harmonic motions are represented by the equations

$$y_1 = 8\frac{\sin(\pi)}{4}(10t+2),\ y_2 = 6\left(\sin 5\pi t + \sqrt{3}\cos 5\omega t\right)$$

IF the ratio of amplitudes of y_1 and y_2 is α and their respective ratio of time periods is β, then find β/α.

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10. A mass of 0.2 kg, length 1m and cross sectional area $4.9 \times 10^{-7} m^2$ is suspended from a massless wire. The mass is pulled slightly in the vertically downward direction and released. It performs simple harmonic motion of angular frequency 70 rad s^{-1}. If the Young's modulus of the material of the wire is $x \times 10^9 Nm^{-2}$, find the value of x.

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Competition Assertion Reason Type Questions

1. Assertion : For a particle excecuting simple harmonic motion , its velocity is maximum when the acceleration is minimum

Reason : In simple harmonic motion phase difference between displacement and velocity is $\left(\frac{\pi}{2}\right)$

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: B

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2. Assertion : A simple pendulum inside a satellite orbiting the earth has an infinite time period .

Reason : Time period of simple pendulum varies inversely with $\sqrt{g}$

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: A

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3. Assertion : The job of asimple pendulum consits of a hollow bal full of water and when a hole is made at the bottom of ball its time period first increases and then decreases

Reason : Weight of the ball decreases as water flows out of ut

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: B

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4. Assertion : Time period of a simple harmonic oscillator depends on amplitude and force cosntant

Reason : Frequency of a simple harmonic oscillatior is determined by tis elasticity and inertia .

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: D

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5. Assertion : when a springs of force constatn k is cut into two equal halves , the force cosntant of each half become $K/2$

Reasion : when an elastic springs is elongated by length x work done is $\frac{1}{2}kx^2$

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: A

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6. Assertion : time period of a simple pendulum does not depend on the mass of the bob

Reason : the restoring force is independent of the mass of the bob

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: C

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7. Assertion : The expression for displacment of a particle is

$x = A\sin(bt + C)$

Reasion : the value of x at time intervals t and $t + 2\frac{\pi}{b}$ is same .

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: A

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8. Assertion : For a simple pendulum performing oscillation , the tension in its strings is constant for all position of the job .

Reasion : The speed of job is different at different position which gives different values of tension in the string at different positions

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: D

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9. Assertion : Water in a U-tube executes S.H.M when water is replaced by mercury filled up to the same height , the time period of S.H.M will increases.

Reasion : Time period of liquid oscillating in a U-tube increases with density of liquid .

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: D

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10. Assertion : if a metal bob of a simple pendulm is replaced by wooden bob , its time period will not change .

Reasion : The amplitude of an oscillation pendulum decreases gradually with time .

A. If the assertion and reason are correct and reason is a correct explanation of the 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 both assertion and reason are incorrect

Answer: B

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Practice Test For Board Examination

1. At which position the kinetic energy of a harmonic oscillator is maximum or minimum ?

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2. Will a pendulum clock lose or gain time when taken to the top of a mountain?

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3. Assertion : The spring constant of a spring is k. When it is divided into n equal parts, then springconstant of one piece is k/n.

Reason : The spring constant is independent of material used for the spring.

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4. What provides the restoring force for simple harmonic oscillations in the following cases? (i)simple pendulum (ii) spring (iii) column of mercury in U tube.

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5. What is the basic condition for a motion to be simple harmonic ?

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6. What will be the effect on (a) periodic time (b) maximum velocity of a simple harmonic oscillator if amplitude is made four times ?

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7. Calculate the time period and frequency of oscillation if the maximum velocity of a particle executing simple harmonic motion is 6 m/s and amplitude is 5 mm.

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8. Derive an expression for instantaneous velocity and acceleration of a particle executing simple harmonic motion.

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9. Show that the acceleration is directly proportional to the displacement with the help of an example.

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10. Deduce the relation for the time period of a simple pendulum.

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11. What is a spring factor? Find its value in case of two springs connected in (i) series and (ii) parallel.

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12. (a) Derive an expression for the energy of a particle executing simple harmonic motion.

(b) The length of a simple pendulum in increased by 15%. What will be the percentage increase in time period ?

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