Exercise - I

(SINGLE CHOICE QUESTIONS)

LINEAR S.H.M

1. For a particle executing simple harmonic motion, the acceleration is proportional to.
(A) displacement from the mean position
(B) distance from the mean position
(C) distance travelled since t = 0
(D) speed

2. The distance moved by a particle in simple harmonic motion in one time period is
(A) A (B) 2A (C) 4A (D) zero

3. The time period of a particle in simple harmonic motion is equal to the time between consecutive appearance of the particle at a particular point in its motion. This point is
(A) the mean position
(B) an extreme position
(C) between the mean position and the positive extreme.
(D) between the mean position and the negative extreme.

4. Equations $y = 2A\cos^2\omega t$ and $y = A(\sin\omega t + \sqrt{3}\cos\omega t)$ represent the motion of two particles.
(A) Only one of these is S.H.M
(B) Ratio of maximum speeds is 2 : 1
(C) Ratio of maximum speeds is 1 : 1
(D) Ratio of maximum accelerations is 1 : 4

5. The displacement of a body executing SHM is given by $x = A\sin(2\pi t + \pi/3)$. The first time from t = 0 when the velocity is maximum is
(A) 0.33 sec (B) 0.16 sec
(C) 0.25 sec (D) 0.5 sec

6. A simple harmonic motion having an amplitude A and time period T is represented by the equation :
$y = 5\sin\pi(t + 4)$ m
Then the values of A (in m) and T (in sec) are :
(A) A = 5; T = 2 (B) A = 10 ; T = 1
(C) A = 5 ; T = 1 (D) A = 10 ; T = 2

7. Two particles are in SHM on same straight line with amplitude A and 2A and with same angular frequency ω. It is observed that when first particle is at a distance $A/\sqrt{2}$ from origin and going toward mean position, other particle is at extreme position on other side of mean position. Find phase difference between the two particles.
(A) 45° (B) 90°
(C) 135° (D) 180°

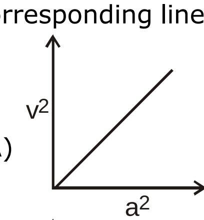
8. The maximum acceleration of a particle in SHM is made two times keeping the maximum speed to be constant. It is possible when
(A) amplitude of oscillation is doubled while frequency remains constant
(B) amplitude is doubled while frequency is halved
(C) frequency is doubled while amplitude is halved
(D) frequency is doubled while amplitude remains constant.

9. A small mass executes linear SHM about O with amplitude a and period T. Its displacement from O at time T/8 after passing through O is :
(A) a/8 (B) $a/2\sqrt{2}$
(C) a/2 (D) $a/\sqrt{2}$

10. The time period of a particle in simple harmonic motion is equal to the smallest time between the particle acquiring a particular velocity $\vec{v}$. The value of v is
(A) v_{max} (B) 0
(C) between 0 and v_{max}
(D) between 0 and $-v_{max}$

11. The average acceleration in one time period in a simple harmonic motion is
(A) $A\omega^2$ (B) $A\omega^2/2$
(C) $A\omega^2/\sqrt{2}$ (D) zero

12. A mass m is performing linear simple harmonic motion, then correct graph for acceleration a and corresponding linear velocity v is

(A)


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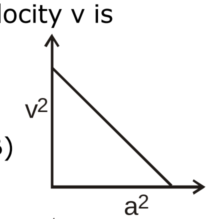

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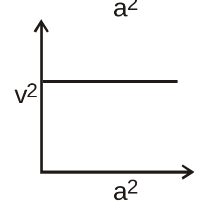

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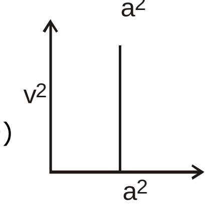
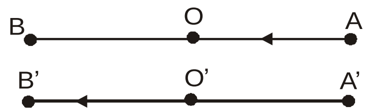


13. The time taken by a particle performing SHM to pass from point A to B where its velocities are same is 2 seconds. After another 2 seconds it returns to B. The time period of oscillation is (in seconds)
(A) 2 (B) 8
(C) 6 (D) 4

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



(A) T/8 (B) 3T/8
(C) T/6 (D) 4T/3

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

(A) $\frac{3}{2\pi}$ m (B) $\frac{3}{4\pi}$ m

(C) $\frac{6}{\pi}$ m (D) $\frac{3}{8\pi}$

16. A particle executes SHM with time period T and amplitude A. The maximum possible average velocity in time $\frac{T}{4}$ is

(A) $\frac{2A}{T}$ (B) $\frac{4A}{T}$

(C) $\frac{8A}{T}$ (D) $\frac{4\sqrt{2}A}{T}$

17. Time period of a particle executing SHM is 8 sec. At t = 0 it is at the mean position. The ratio of the distance covered by the particle in the 1 st second to the 2nd second is

(A) $\frac{1}{\sqrt{2}+1}$ (B) $\sqrt{2}$

(C) $\frac{1}{\sqrt{2}}$ (D) $\sqrt{2}$ + 1

18. The angular frequency of motion whose equation is $4\frac{d^2y}{dt^2}$ + 9y = 0 is (y = displacement and t = time)

(A) $\frac{9}{4}$ (B) $\frac{4}{9}$

(C) $\frac{3}{2}$ (D) $\frac{2}{3}$

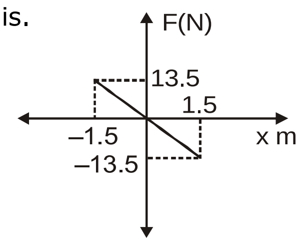
19. Two particles are in SHM in a straight line about same equilibrium position. Amplitude A and time period T of both the particles are equal. At time t = 0, one particle is at displacement y_1 = +A and the other at y_2 = – A/2, and they are approaching towards each other. After what time they cross each other ?
(A) T/3 (B) T/4
(C) 5T/6 (D) T/6

20. Two particles execute SHM of same amplitude of 20 cm with same period along the same line about the same equilibrium position. The maximum distance between the two is 20 cm. Their phase difference in radians is

(A) $\frac{2\pi}{3}$ (B) $\frac{\pi}{2}$

(C) $\frac{\pi}{3}$ (D) $\frac{\pi}{4}$

21. A particle of mass 1 kg is undergoing S.H.M., for which graph between force and displacement (from mean position) as shown. Its time period, in seconds, is.



(A) $\pi/3$ (B) $2\pi/3$
(C) $\pi/6$ (D) $3/\pi$

22. A point particle of mass 0.1 kg is executing S.H.M of amplitude of 0.1 m. When the particle passes through the mean position, its kinetic energy is 8 × 10^{-3} J. The equation of motion of this particle when the initial phase of oscillation is 45° can be given by

(A) $0.1\cos\left(4t+\frac{\pi}{4}\right)$ (B) $0.1\sin\left(4t+\frac{\pi}{4}\right)$

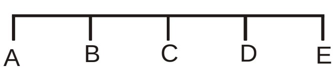
(C) $0.4\sin\left(t+\frac{\pi}{4}\right)$ (D) $0.2\sin\left(\frac{\pi}{2}+2t\right)$

23. A particle executes SHM of period 1.2 sec. and amplitude 8 cm. Find the time it takes to travel 3 cm from the positive extremely of its oscillation.
(A) 0.28 sec. (B) 0.32 sec.
(C) 0.17 sec. (D) 0.42 sec.

24. Two particles P and Q describe simple harmonic motions of same period, same amplitude, along the same line about the same equilibrium position O. When P and Q are on opposite sides of O at the same distance from O they have the same speed of 1.2 m/s in the same direction, when their displacements are the same they have the same speed of 1.6 m/s in opposite directions. The maximum velocity in m/s of either particle is
(A) 2.8 (B) 2.5
(C) 2.4 (D) 2

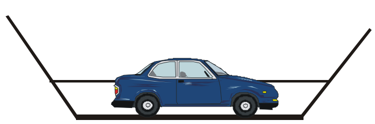
25. A particle performs SHM with a period T and amplitude a. The mean velocity of the particle over the time interval during which it travels a distance a/2 from the extreme position is
(A) a/T (B) 2a/T
(C) 3a/T (D) a/2T

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



(A) $\frac{\sqrt{3}R}{2}$ (B) $\frac{R}{\sqrt{2}}$
(C) $\sqrt{3}$ R (D) $\sqrt{2}$ R

27. A toy car of mass m is having two similar rubber ribbons attached to it as shown in the figure. The force constant of each rubber ribbon is k and surface is frictionless. The car is displaced from mean position by x cm and released. At the mean position the ribbons are underformed. Vibration period is



(A) $2\pi\sqrt{\frac{m(2k)}{k^2}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{m(2k)}{k^2}}$
(C) $2\pi\sqrt{\frac{m}{k}}$ (D) $2\pi\sqrt{\frac{m}{k+k}}$

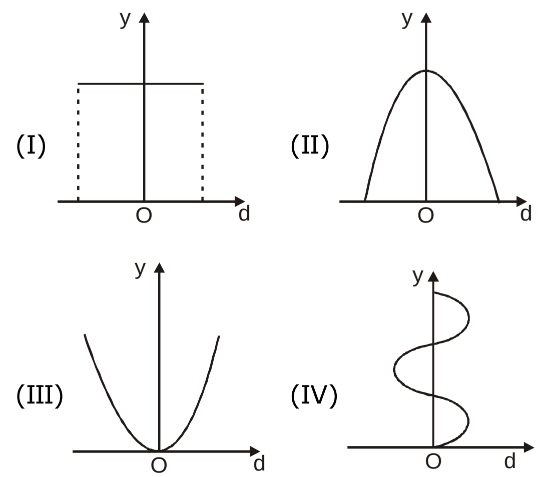
28. A spring mass system oscillates with a frequency ν. If it is taken in an elevator slowly accelerating upward, the frequency will
(A) increase (B) decrease
(C) remain same (D) become zero

29. A body at the end of a spring executes S.H.M. with a period t_1, while the corresponding period for another spring is t_2. If the period of oscillation with the two spring in series is T, then
(A) $T = t_1 + t_2$ (B) $T^2 = t_1^2 + t_2^2$
(C) $\frac{1}{T} = \frac{1}{t_1} + \frac{1}{t_2}$ (D) $\frac{1}{T^2} = \frac{1}{t_1^2} + \frac{1}{t_2^2}$

30. A particle moves along the x-axis according to : x = A. [1 + sin ωt]. What distance does it travel between t = 0 and t = 2.5π/ω ?
(A) 4A (B) 6A
(C) 5A (D) none

Question No. 31 to 33 (3 questions)

The graph in figure show that a quantity y varies with displacement d in a system undergoing simple harmonic motion.



Which graphs best represents the relationship obtained when y is

31. The total energy of the system
(A) I (B) II
(C) III (D) IV

32. The time
(A) I (B) II
(C) III (D) IV

33. The unbalanced force acting on the system.
(A) I (B) II
(C) III (D) None

34. A particle executes SHM on a straight line path. The amplitude of oscillation is 2 cm. When the displacement of the particle from the mean position is 1 cm, the numerical value of magnitude of acceleration is equal to the numerical value of magnitude of velocity. The frequency of SHM (in second^{-1}) is

(A) $2\pi\sqrt{3}$ (B) $\frac{2\pi}{\sqrt{3}}$
(C) $\frac{\sqrt{3}}{2\pi}$ (D) $\frac{1}{2\pi\sqrt{3}}$

35. The potential energy of a simple harmonic oscillator of mass 2 kg in its mean position is 5 J. If its total energy is 9J and its amplitude is 0.01 m, its time period would be

(A) $\frac{\pi}{10}$ sec (B) $\frac{\pi}{20}$ sec

(C) $\frac{\pi}{50}$ sec (D) $\frac{\pi}{100}$ sec

36. Find the ratio of time periods of two identical springs if they are first joined in series & then in parallel & a mass m is suspended from them

(A) 4 (B) 2

(C) 1 (D) 3

37. Two bodies P & Q of equal mass are suspended from two separate massless springs of force constants k_1 & k_2 respectively. If the maximum velocity of them are equal during their motion, the ratio of amplitude of P to Q is :

(A) $\frac{k_1}{k_2}$ (B) $\sqrt{\frac{k_2}{k_1}}$

(C) $\frac{k_2}{k_1}$ (D) $\sqrt{\frac{k_1}{k_2}}$

38. Vertical displacement of a plank with a body of mass 'm' on it is varying according to law y = sin ωt + $\sqrt{3}$ cos ωt. The minimum value of ω for which the mass just breaks off the plank and the moment it occurs first after t = 0 are given by (y is positive vertically upwards)

(A) $\sqrt{\frac{g}{2}}, \frac{\sqrt{2}}{6}\frac{\pi}{\sqrt{g}}$ (B) $\frac{g}{\sqrt{2}}, \frac{2}{3}\sqrt{\frac{\pi}{g}}$

(C) $\sqrt{\frac{g}{2}}, \frac{\pi}{3}\sqrt{\frac{2}{g}}$ (D) $\sqrt{2g}, \sqrt{\frac{2\pi}{3g}}$

39. Two particles A and B perform SHM along the same straight line with the same amplitude 'a', same frequency 'f' and same equilibrium position 'O'. The greatest distance between them is found to be 3a/2. At some instant of time they have the same displacement from mean position. What is the displacement?

(A) a / 2 (B) a$\sqrt{7}$ / 4

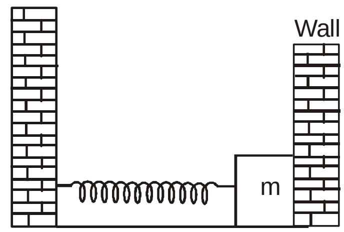
(C) $\sqrt{3}$ a / 2 (D) 3 a /4

40. A particle starts oscillating simple harmonically from its equilibrium position then, the ratio of kinetic energy and potential energy of the particle at the time T/12 is : (T = time period)

(A) 2 : 1 (B) 3 : 1

(C) 4 : 1 (D) 1 : 4

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



(A) $\frac{2\pi}{3}\sqrt{\frac{m}{k}}$ (B) $2\pi\sqrt{\frac{m}{k}}$

(C) $\frac{\pi}{3}\sqrt{\frac{m}{k}}$ (D) $\frac{\pi}{6}\sqrt{\frac{m}{k}}$

42. A spring mass system performs S.H.M. If the mass is doubled keeping amplitude same, then the total energy of S.H.M. will become :

(A) double (B) half

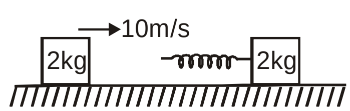
(C) unchanged (D) 4 times

43. A mass at the end of a spring executes harmonic motion about an equilibrium position with an amplitude A. Its speed as it passes through the equilibrium position is V. If extended 2A and released, the speed of the mass passing through the equilibrium position will be

(A) 2V (B) 4V

(C) $\frac{V}{2}$ (D) $\frac{V}{4}$

44. A 2 Kg block moving with 10 m/s strikes a spring of constant π^2N/m attached to 2 Kg block at rest kept on a smooth floor. The time for which rear moving block remain in contact with spring will be



(A) $\sqrt{2}$ sec (B) $\frac{1}{\sqrt{2}}$ sec

(C) 1 sec (D) $\frac{1}{2}$ sec

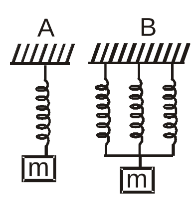
45. In the **above question**, the velocity of the rear 2 kg block after it separates from the spring will be :
(A) 0 m/s (B) 5 m/s
(C) 10 m/s (D) 7.5 m/s

46. A particle is subjected to two mutually perpendicular simple harmonic motions such that its x and y coordinates are given by x = 2 sin ωt ; y = 2 sin$\left(\omega t+\frac{\pi}{4}\right)$
The path of the particle will be :
(A) an ellipse (B) a straight line
(C) a parabola (D) a circle

47. The amplitude of the vibrating particle due to superposition of two **SHMs**, y_1 = sin $\left(\omega t+\frac{\pi}{3}\right)$ and y_2 = sin ωt is :
(A) 1 (B) $\sqrt{2}$
(C) $\sqrt{3}$ (D) 2

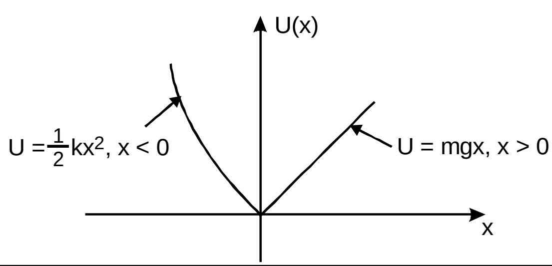
48. Two simple harmonic motions y_1 = A sin ωt and y_2 = A cos ωt are superimposed on a particle of mass m. The total mechanical energy of the particle is :
(A) $\frac{1}{2}m\omega^2A^2$ (B) $m\omega^2A^2$
(C) $\frac{1}{4}m\omega^2A^2$ (D) zero

49. The springs in fig. A and B are identical but length in A is three times each of that in B. The ratio of period T_A/T_B is



(A) √3 (B) 1/3
(C) 3 (D) 1/√3

50. A particle of mass m moves in the potential energy U shown above. The period of the motion when the particle has total energy E is

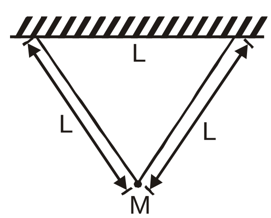


(A) $2\pi\sqrt{m/k}$ + $4\sqrt{2E/mg^2}$
(B) $2\pi\sqrt{m/k}$
(C) $\pi\sqrt{m/k}$ + $2\sqrt{2E/mg^2}$
(D) $2\sqrt{2E/mg^2}$

51. A particle of mass 4 kg moves between two points A and B on a smooth horizontal surface under the action of two forces such that when it is at a point P, the forces are $2\vec{PA}$ N and $2\vec{PB}$ N. If the particle is released from rest at A, find the time it takes to travel a quarter of the way from A to B.
(A) $\frac{\pi}{2}$ s (B) $\frac{\pi}{3}$ s
(C) πs (D) $\frac{\pi}{4}$ s

52. In an elevator, a spring clock of time period T_S (mass attached to a spring) and a pendulum clock of time period T_P are kept. If the elevator accelerates upwards
(A) T_S well as T_P increases
(B) T_S remain same, T_P increases
(C) T_S remains same, T_P decreases
(D) T_S as well as T_P decreases

53. A man is swinging on a swing made of 2 ropes of equal length L and in direction perpendicular to the plane of paper. The time period of the small oscillations about the mean position is

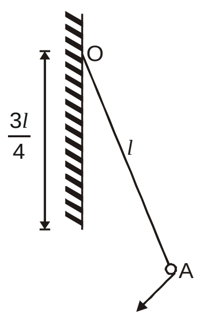


(A) $2\pi\sqrt{\frac{L}{2g}}$ (B) $2\pi\sqrt{\frac{\sqrt{3}L}{2g}}$
(C) $2\pi\sqrt{\frac{L}{2\sqrt{3}g}}$ (D) $\pi\sqrt{\frac{L}{g}}$

54. A ring of diameter 2m oscillates as a compound pendulum about a horizontal axis passing through a point at its rim. It oscillates such that its centre move in a plane which is perpendicular to the plane of the ring. The equivalent length of the simple pendulum is
(A) 2m (B) 4m
(C) 1.5 m (D) 3m

55. Two pendulums have time periods T and 5T/4. They start SHM at the same time from the mean position. After how many oscillations of the smaller pendulum they will be again in the same phase
(A) 5 (B) 4
(C) 11 (D) 9

56. A small bob attached to a light inextensible thread of length l has a periodic time T when allowed to vibrate as a simple pendulum. The thread is now suspended from a fixed end O of a vertical rigid rod of length $\frac{3\ell}{4}$ (as in figure). If now the pendulum performs periodic oscillations in this arrangement, the periodic time will be

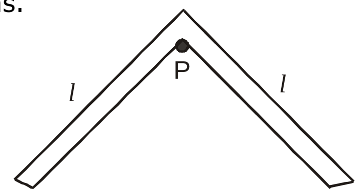


(A) $\frac{3T}{4}$ (B) $\frac{T}{2}$
(C) T (D) 2T

57. A simple pendulum is oscillating in a lift. If the lift is going down with constant velocity, the time period of the simple pendulum is T_1. If the lift is going down with some retardation its time period is T_2, then
(A) $T_1 > T_2$ (B) $T_1 < T_2$ (C) T_1 = T2
(D) depends upon the mass of the pendulum bob

58. A simple pendulum with length ℓ and bob of mass m executes SHM of small amplitude A. The maximum tension in the string will be
(A) mg $(1 + A/\ell)$ (B) mg $(1 + A/\ell)^2$
(C) mg $[1 + (A/\ell)^2]$ (D) 2 mg

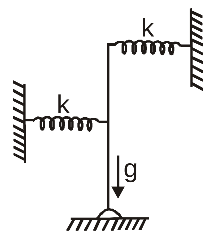
59. A system of two identical rods (L-shaped) of mass m and length l are resting on a peg P as shown in the figure. If the system is displaced in its plane by a small angle θ, find the period of oscillations.



(A) $2\pi\sqrt{\frac{\sqrt{2}l}{3g}}$ (B) $2\pi\sqrt{\frac{2\sqrt{2}l}{3g}}$

(C) $2\pi\sqrt{\frac{2l}{3g}}$ (D) $3\pi\sqrt{\frac{l}{3g}}$

60. In the figure shown, the spring are connected to the rod at one end and at the midpoint. The rod is hinged at its lower end. Rotational SHM of the rod (Mass m, length L) will occur only if



(A) k > mg / 3L (B) k > 2mg/3L
(C) k > 2mg/5L (D) k > 0

61. What is the angular frequency of oscillations of the rod in the above problem if k = mg/L ?
(A) $(3/2).[k/m]^{1/2}$ (B) $(3/4).[k/m]^{1/2}$
(C) $[2k/5m]^{1/2}$ (D) None

62. A ring is suspended at a point on its rim and it behaves as a second's pendulum when it oscillates such that its centre move in its own plane. The radius of the ring would be ($g = \pi^2$)
(A) 0.5 m (B) 1.0 m
(C) 0.67 m (D) 1.5 m

63. A rod whose ends are A & B of length 25 cm is hanged in vertical plane. When hanged from point A and point B the time periods calculated are 3 sec & 4 sec respectively. Given the moment of inertia of rod about axis perpendicular to the rod is in ratio 9 : 4 at points A and B. Find the distance of the centre of mass from point A.
(A) 9 cm (B) 5 cm
(C) 25 cm (D) 20 cm