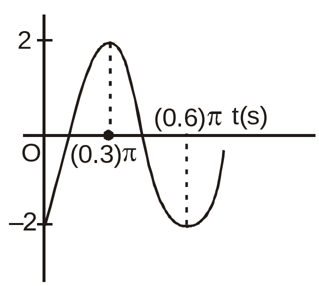
Exercise - II (Multiple Choice Problems)

1. A spring has natural length 40 cm and spring constant 500 N/m. A block of mass 1 kg is attached at one end of the spring and other end of the spring is attached to ceiling. The block released from the position, where the spring has length 45 cm.
(A) the block will perform SHM of amplitude 5 cm.
(B) the block will have maximum velocity $30\sqrt{5}$ cm/sec.
(C) the block will have maximum acceleration 15 m/s^2.
(D) the minimum potential energy of the spring will be zero.

2. A particle executing a simple harmonic motion of period 2s. When it is at its extreme displacement from its mean position, it receives an additional energy equal to what it had in its mean position. Due to this, in its subsequent motion,
(A) its amplitude will change and become equal to $\sqrt{2}$ times its previous amplitude
(B) its periodic time will become doubled i.e. 4s
(C) its potential energy will be decreased
(D) it will continue to execute simple harmonic motion of the same amplitude and period as before receiving the additional energy.

3. Part of a simple harmonic motion is graphed in the figure, where y is the displacement from the mean position. The correct equation describing this S.H.M is



(A) y = 4 cos (0.6t) (B) $y = 2\sin\left(\frac{10}{3}t - \frac{\pi}{2}\right)$

(C) $y = 4\sin\left(\frac{10}{3}t + \frac{\pi}{2}\right)$ (D) $y = 2\cos\left(\frac{10}{3}t + \frac{\pi}{2}\right)$

4. Two particles execute SHM with amplitude A and 2A and angular frequency ω and 2ω respectively. At t = 0 they starts with some initial phase difference. At, $t = \frac{2\pi}{3\omega}$. They are in same phase. Their initial phase difference is :

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

5. Two particles are in SHM with same angular frequency and amplitudes A and 2A respectively along same straight line with same mean position. They cross each other at position A/2 distance from mean position in opposite direction. The phase between them is :

(A) $\frac{5\pi}{6} - \sin^{-1}\left(\frac{1}{4}\right)$ (B) $\frac{\pi}{6} - \sin^{-1}\left(\frac{1}{4}\right)$

(C) $\frac{5\pi}{6} - \cos^{-1}\left(\frac{1}{4}\right)$ (D) $\frac{\pi}{6} - \cos^{-1}\left(\frac{1}{4}\right)$

6. The equation of motion for an oscillating particle is given by x = 3sin (4πt) + 4 cos(4πt), where x is in mm and t is in second
(A) The motion is simple harmonic
(B) The period of oscillation is 0.5 s
(C) The amplitude of oscillation is 5 mm
(D) The particle starts its motion from the equilibrium

7. A particle is executing SHM of amplitude A, about the mean position X = 0. Which of the following cannot be a possible phase difference between the positions of the particle at x = + A/2 and x = – A/$\sqrt{2}$.
(A) 75° (B) 165°
(C) 135° (D) 195°

8. Speed v of a particle moving along a straight line, when it is at a distance x from a fixed point on the line is given by $v^2 = 108 - 9x^2$ (all quantities in S.I. unit). Then
(A) The motion is uniformly accelerated along the straight line
(B) The magnitude of the acceleration at a distance 3 cm from the fixed point is 0.27 m/s^2.
(C) The motion is simple harmonic about x = $\sqrt{12}$ m.
(D) The maximum displacement from the fixed point is 4 cm.

9. A block is placed on a horizontal plank. The plank is performing SHM along a vertical line with amplitude of 40 cm. The block just loses contact with the plank when the plank is momentarily at rest. Then

(A) the period of its oscillations is $2\pi/5$ sec.
(B) the block weights on the plank double its weight, when the plank is at one of the positions of momentary rest.
(C) the block weights 1.5 times its weight on the plank halfway down from the mean position.
(D) the block weights its true weight on the plank, when velocity of the plank is maximum.

10. The potential energy of a particle of mass 0.1 kg, moving along x-axis, is given by $U = 5x(x - 4)$ J where x is in metres. It can be concluded that
(A) the particle is acted upon by a constant force
(B) the speed of the particle is maximum at x = 2 m
(C) the particle executes simple harmonic motion
(D) the period of oscillation of the particle is $\pi/5$ s

11. A particle is executing SHM with amplitude A, time period T, maximum acceleration a_0 and maximum velocity v_0. Its starts from mean position at t = 0 and at time t, it has the displacement A/2, acceleration a and velocity v then
(A) t = T/12 (B) $a = a_0/2$
(C) $v = v_0/2$ (D) t = T/8

12. The amplitude of a particle executing SHM about O is 10 cm. Then
(A) When the K.E. is 0.64 of its max. K.E. its displacement is 6cm from O.
(B) When the displacement is 5 cm from O its K.E. is 0.75 of its max. P.E.
(C) Its total energy at any point is equal to its maximum K.E.
(D) Its velocity is half the maximum velocity when its displacement is half the maximum displacement.

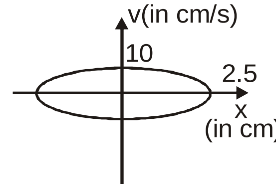
13. The displacement of a particle varies according to the relation $x = 3 \sin 100t + 8 \cos^2 50t$. Which of the following is/are correct about this motion.
(A) the motion of the particle is not S.H.M.
(B) theamplitude of the S.H.M. of the particle is 5 units
(C) the amplitude of the resultant S.H.M. is $\sqrt{73}$ units
(D) the maximum displacement of the particle from the origin is 9 units.

14. In SHM, acceleration versus displacement (from mean position) graph :
(A) is always a straight line passing through origin and slope $-m\omega^2$
(B) is always a straight line passing through origin and slope $+m\omega^2$
(C) is a straight line not necessarily passing through origin
(D) none of the above

15. A particle moves in xy plane according to the law $x = a \sin \omega t$ and $y = a(1 - \cos \omega t)$ where a and ω are constants. The particle traces
(A) a parabola
(B) a straight line equallyinclined to x and y axes
(C) a circle
(D) a distance proportional to time

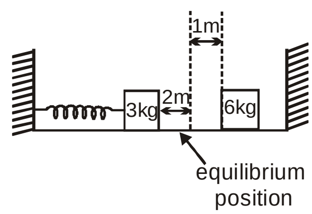
16. For a particle executing S.H.M., x = displacement from equilibrium position, v = velocity at any instant and a = acceleration at any instant, then
(A) v-x graph is a circle
(B) v-x graph is an ellipse
(C) a-x graph is a straight line
(D) a-v graph is an ellipse

17. The figure shows a graph between velocity and displacement (from mean position) of a particle performing SHM



(A) the time period of the particle is 1.57 s
(B) the maximum acceleration will be 40cm/s^2
(C) the velocity of particle is $2\sqrt{21}$ cm/s when it is at a distance 1 cm from the mean position.
(D) none of these

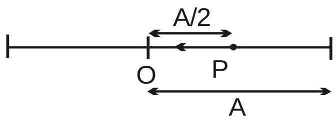
18. Two blocks of masses 3 kg and 6 kg rest on a horizontal smooth surface. The 3 kg block is attached to a spring with a force constant k = 900 Nm^{-1} which is compressed 2 m from beyond the equilibrium position. The 6 kg mass is at rest at 1m from mean position. 3kg mass strikes the 6 kg mass and the two stick together.



(A) velocity of the combined masses immediately after the collision is 10 ms^{-1}
(B) velocity of the combined masses immediately after thecollision is 5 ms^{-1}
(C) amplitude of the resulting oscillation is $\sqrt{2}$ m
(D) amplitude of the resulting oscillation is $\sqrt{5}/2$ m

19. A particle starts from a point P at a distance of A/2 from the mean position O & travels towards left as shown in the figure. If the time period of

SHM, executed about O is T and amplitude A then the equation of motion of particle is :



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

(C) $x = A \cos\left(\frac{2\pi}{T}t + \frac{\pi}{6}\right)$ (D) $x = A \cos\left(\frac{2\pi}{T}t + \frac{\pi}{3}\right)$

20. The angular frequency of a spring block system is ω_0. This system is suspended from the ceiling of an elevator moving downwards with a constant speed v_0. The block is at rest relative to the elevator. Lift is suddenly stopped. Assuming the downwards as a positive direction, choose the wrong statement.

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

(B) The initial phase of the block is π.

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

(D) The maximum speed of the block is v_0.

21. A disc of mass 3m and a disc of mass m are connected by a massless spring of stiffness k. The heavier disc is placed on the ground with the spring vertical and lighter disc on top. From its equilibrium position, the upper disc is pushed down by a distance δ and released. Then

(A) if $\delta > 3mg/k$, the lower disc will bounce up

(B) if $\delta = 2mg/k$, maximum normal reaction from ground on lower disc = 6 mg.

(C) if $\delta = 2mg/k$, maximum normal reaction from ground on lower disc = 4 mg.

(D) if $\delta > 4$ mg/k, the lower disc will bounce up

22. A system is oscillating with undamped simple harmonic motion. Then the

(A) average total energy per cycle of the motion is its maximum kinetic energy.

(B) average total energy per cycle of the motion is $\frac{1}{\sqrt{2}}$ times its maximum kinetic energy.

(C) root mean square velocity is $\frac{1}{\sqrt{2}}$ times its maximum velocity

(D) mean velocity is 1/2 of maximum velocity.

23. A particle of mass m performs SHM along a straight line with frequency f and amplitude A.

(A) The average kinetic energy of the particle is zero.

(B) The average potential energy is $m \pi^2 f^2 A^2$.

(C) The frequency of ocillation of kinetic energy is 2f.

(D) Velocity function leads acceleration by $\pi/2$.

24. A linear harmonic oscillator of force constant $2 \times 10^6 Nm^{-1}$ and amplitude 0.01 m has a total mechanical energy of 160 J. Its

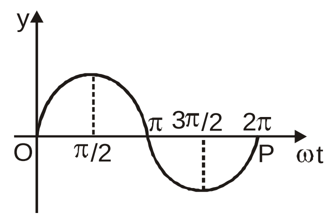
(A) maximum potential energy is 100 J

(B) maximum kinetic energy is 100J

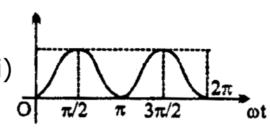
(C) maximum potential energy is 160 J

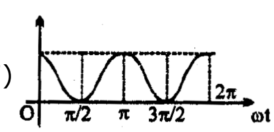
(D) minimum potential energy is zero.

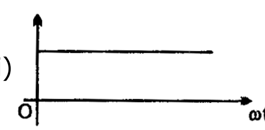
25. The graph plotted between phase angle (ϕ) and displacement of a particle from equilibrium position (y) is a sinusoidal curve as shown below. Then the best matching is

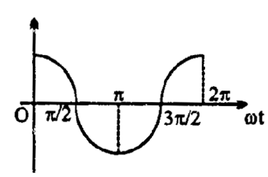


Column A	**Column B**
(A) K. E. versus phase angle curve	(i)
(B) P.E. versus phase angle curve	(ii)
(C) T.e. versus phase angle curve	(iii)
(D) Velocity versus phase angle curve	(iv)

(i)


(ii)


(iii)


(iv)


(A) (a) - (i), (b) - (ii), (c) - (iii) & (d) - (iv)

(B) (a) - (ii), (b) - (i), (c) - (iii) & (d) - (iv)

(C) (a) - (ii), (b) - (i), (c) - (iv) & (d) - (iii)

(D) (a) - (ii), (b) - (iii), (c) - (iv) & (d) - (i)