GUIDED REVISION

SHM

1. A particle of mass 1 kg, executing simple harmonic motion of period 20 s, crosses the mean position at t = 0 with velocity π cm/s.

(A) the maximum acceleration of the particle is 10 cm/s^2

(B) when it is 4 cm from the mean position, its velocity is $6\pi/10$ cm/s

(C) the kinetic energy of the particle when its displacement is 5 cm from the mean position is $\frac{3\pi^2}{8\times10^6}$ J

(D) its velocity at displacement 6 cm from the mean position is $8\pi/10$ cm/s

2. Two particles are in SHM with same amplitude A and same angular frequency ω. At time t=0, one is at $x = +\frac{A}{2}$ and other is at $x = -\frac{A}{2}$. Both are moving in same direction.

(A) Phase difference between the two particle is $\frac{\pi}{3}$

(B) Phase difference between the two particle is $\frac{2\pi}{3}$

(C) They will collide after time $t = \frac{\pi}{2\omega}$

(D) They will collide after time $t = \frac{3\pi}{\omega}$

3. A particle is performing SHM with its position given as $x = 2 + 5\sin\left(\pi t + \frac{\pi}{6}\right)$ where x (in m) & t (in sec). Which of the following is/are correct :-

(A) Equilibrium position is at x = 2m

(B) Maximum speed of particle is 5π m/s

(C) At t = 0 particle is 2.5 m away from mean position moving in negative direction

(D) At t = 0, x = 4.5 m; acceleration of particle is $-\pi^2(4.5)$ m/s^2

4. Two particles 'A' and 'B' start SHM at t = 0. Their positions as a function of time are given by $X_A = A\sin\omega t$; $X_B = A\sin(\omega t + \pi/3)$

	Column-I		Column-II
(A)	Minimum time when x is same	(P)	$\frac{5\pi}{6\omega}$
(B)	Minimum time when velocity is same	(Q)	$\frac{\pi}{3\omega}$
(C)	Minimum time after which $v_A < 0$ and $v_B < 0$	(R)	$\frac{\pi}{\omega}$
(D)	Minimum time after which $x_A < 0$ and $x_B < 0$	(S)	$\frac{\pi}{2\omega}$

5. A particle of mass 2 kg moves in a straight line. If v is the velocity at a distance x from a fixed point on the line and $v^2 = 3 - 4x^2$ then-

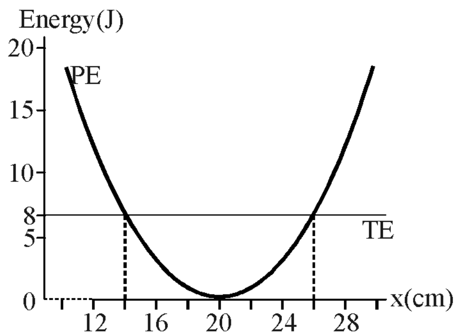
(A) The motion continues along the positive x-direction only.

(B) The motion is simple harmonic

(C) The oscillation frequency is 2 units ($\omega = 2$)

(D) The total energy of the particle is 3 units

6. Figure shows the potential-energy diagram and the total energy line of a particle oscillating on a spring.



(A) the amplitude of oscillation of particle is 6 cm.

(B) the spring constant is 4.44 kN/m.

(C) the mass of particle is 1kg.

(D) the maximum kinetic energy of particle is at x = 20 cm.

7. Acceleration of a particle which is at rest at x = 0 is $\vec{a} = (4 - 2x)\hat{i}$. Select the correct alternatives(s)-

(A) particle further comes to rest at x = 4

(B) particle oscillates about x = 2

(C) maximum speed of particle is 4 units

(D) all of the above

8. 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 100 J

(C) maximum potential energy is 160 J

(D) minimum potential energy is zero.

9. A body is performing S.H.M., then its

(A) average total energy of SHM per cycle is equal to its maximum kinetic energy.

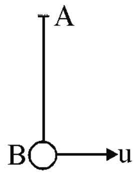
(B) average kinetic energy per cycle is equal to half of its maximum kinetic energy.

(C) mean velocity over a complete cycle is equal to $2/\pi$ times of its maximum velocity.

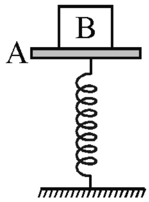
(D) root mean square velocity is $1/\sqrt{2}$ times of its maximum velocity

10. **Column I**

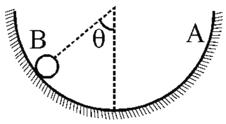
(A) A bob B hanging from a light string A of length 3 m is projected to left with a speed of 10 m/s.



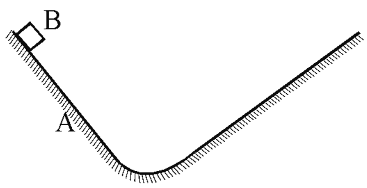
(B) The light platform with block B is pushed down by a distance $2x_0$ below mean position & released.
[x_0 is compression in mean position]



(C) A spherical solid ball B is released on a perfectly rough spherical surface A as shown $\left[\theta = \frac{\pi}{3}\right]$.



(D) Block B is released on a smooth track A as shown.



Column II

(P) The acceleration of centre of mass of B at some time can be equal to g.

(Q) The force exerted by A on B can be zero at some point.

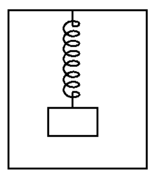
(R) the speed of the body B varies sinusoidally with time when force exerted by A on B is not zero.

(S) The motion of B is oscillatory.

(T) The motion of B is periodic.

DYNAMICS OF SHM

11. A spring mass system is hanging from the ceiling of an elevator in equilibrium. Elongation of spring is l. The elevator suddenly starts accelerating downwards with acceleration g/3 find



(a) the frequency and

(b) the amplitude of the resulting SHM.

12. The potential energy of a particle of mass 0.1 kg, moving along the x-axis, is given by $U = 5x(x-4)$J, where x is in metres. It can be concluded that :

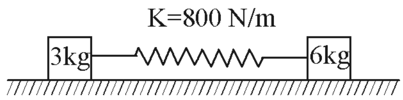
(A) the particle is acted upon by a constant force.

(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.

13. The system shown in the figure can move on a smooth surface. The spring is initially compressed by 6 cm and then released .



(A) the particles perform SHM with time period $\frac{\pi}{10}$ sec

(B) the block of mass 3 kg perform SHM with amplitude 4 cm

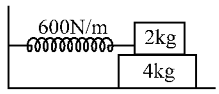
(C) the block of mass 6 kg will have maximum momentum 2.40 kg m/s

(D) none of these

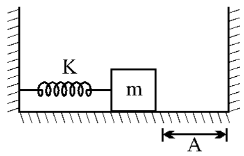
14. In the arrangement shown, the spring of force constant 600N/m is in the unstretched position. The coefficient of friction between the two blocks is 0.4 and that between the lower block & ground surface is zero. If both the blocks are displaced slightly and released, the system executes SHM.

(a) Find time period of their oscillation if they do not slip w.r.t. each other.

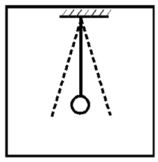
(b) What is the maximum amplitude of the oscillation for which sliding between them does not occur.



15. In the figure shown the spring is relaxed. The spring is compressed by 2 A and released. Mass m attached with the spring collides with the wall & loses two third of its kinetic energy & returns. Find the time after which the spring will have maximum compression first time after releasing. (Neglect Friction)



16. A simple pendulum is oscillating in a stationary lift with a time period T and an angular amplitude θ_0. When it is passing through the mean position, the lift starts accelerating upwards.



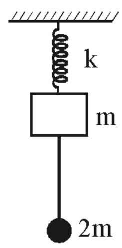
(A) The time period of its oscillation will increase

(B) Its angular amplitude would increase.

(C) The time period of its oscillation would decrease

(D) Its angular amplitude would decrease.

17. A bob of mass 2m hangs by a string attached to the block of mass m of a spring block system. The whole arrangement is in a state of equilibrium. The bob of mass 2m is pulled down slowly by a distance x_0 and released.



(A) For $x_0 = \frac{3mg}{k}$ maximum tension in string is 4mg

(B) For $x_0 > \frac{3mg}{k}$, minimum tension in string is mg

(C) Frequency of oscillation of system is $\frac{1}{2\pi}\sqrt{\frac{k}{3m}}$, for all non-zero values of x_0

(D) The motion will remain simple harmonic for $x_0 \le \frac{3mg}{k}$

18. Consider a spring that exerts the following restoring force

F = – kx for x > 0

F = – 4kx for x < 0

A mass m on a frictionless surface is attached to the spring displaced to x = A by stretching the spring and released :

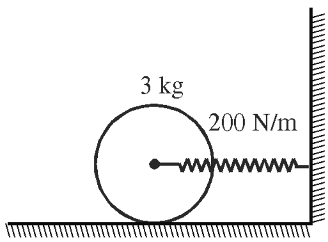
(A) The period of motion will be $T = \frac{3}{2}\pi\sqrt{\frac{m}{k}}$

(B) the most negative value the mass m can reach will be $x = -\frac{A}{2}$

(C) The time taken to move from x = A to $x = -\frac{A}{\sqrt{2}}$, straight away will be equal to $\frac{5\pi}{8}\sqrt{\frac{m}{k}}$

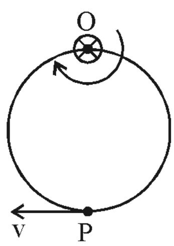
(D) The total energy of oscillations will be $\frac{5}{2}kA^2$

19. The uniform solid cylinder rolls without slipping in the system shown. If the maximum compression in spring is 15cm, the possible friction force acting on the cylinder during its motion is :



(A) 4N (B) 10N (C) 12N (D) 15N

20. A ring of mass m, radius r can oscillate in a vertical plane about is top most point 'O' as shown. Axis is normal to the plane of ring. Maximum speed of lowest point 'P' of ring is v.



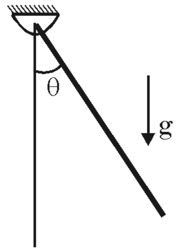
(A) Time period of SHM for small amplitudes is $2\pi\sqrt{\frac{2r}{g}}$

(B) Acceleration of centre of mass of ring at lowest position is zero.

(C) Hinge force when centre of mass is at lowest point is $\frac{mv^2}{4r}$

(D) Mechanical energy of oscillation is $\frac{mv^2}{4}$ (when potential energy at mean position is taken as zero.)

21. An uniform rod of mass m and length ℓ is pivoted at top and it can perform angular SHM in vertical plane according to equation $\theta = \theta_0 \sin \omega t$. At time $t = \frac{2\pi}{\omega}$ a point mass m (at rest) sticks to lowest end of rod.



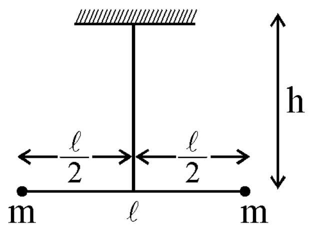
(A) New time period of rod will be $\frac{2}{\sqrt{3}}$ times of the time period before collision.

(B) New angular amplitude is $\frac{\theta_0}{\sqrt{12}}$

(C) New angular amplitude is $\frac{\theta_0}{4}$

(D) There will always be loss of kinetic energy of rod, irrespective of time at which mass sticks to rod.

22. Figure shows two particles connected with a light rod and entire arrangement hangs on a elastic wire. Neglect any gravitational effect, θ_0 = maximum angular displacement of the particles, C = torsional stiffness of wire. Mark the **CORRECT** statements :-



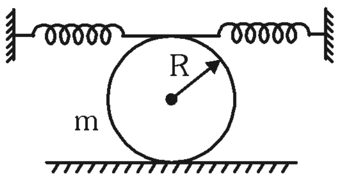
(A) Time period of oscillation is $\pi\ell\sqrt{\frac{2m}{C}}$

(B) Maximum tension in the rod is $\frac{C\theta_0^2}{\ell}$

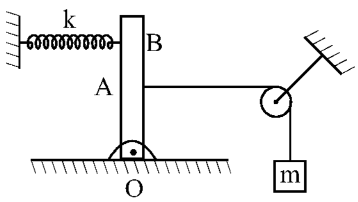
(C) The energy of oscillation is $\frac{1}{2}C\theta_0^2$

(D) The maximum tangential acceleration of particle is $\frac{C\theta_0}{m\ell}$

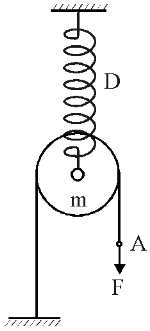
23. A solid uniform cylinder of mass m performs small oscillations due to the action of two springs combined stiffness equal to k (figure). The period of these oscillations in the absence of sliding is $T = \pi\sqrt{\frac{xm}{2k}}$. Then find x :



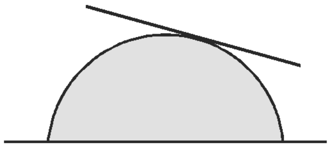
24. A massless rod is hinged at O. A string carrying a mass *m* at one end is attached to point A on the rod so that OA = a. At another point B (OB= b) of the rod, a horizontal spring of force constant *k* is attached as shown. Find the period of small vertical oscillations of mass *m* around its equilibrium position.



25. The axle of a pulley of mass m = 1 kg is attached to the end of a spring of spring constant k = 200 N/m whose other end is fixed to the ceiling. A rope of negligible mass is placed on the pulley such that its left end is fixed to the ground and its right end is hanging freely from the pulley which is at rest in equilibrium. We begin to pull the endpoint A at the right end of the rope by a constant vertical force of F = 15 N. Friction can be neglected between the rope and the pulley. Find the maximum displacement of point A after applying F. Express your answer in cm.



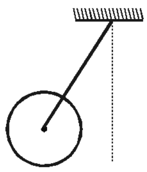
26. A uniform rod of length 2ℓ rocks to and fro on the top of a rough semicircular fixed cylinder of radius a. The period of small oscillations, of rod is



(A) $\dfrac{2\pi\ell}{\sqrt{3ga}}$ (B) $2\pi\sqrt{\dfrac{\ell}{3g}}$

(C) $2\pi\sqrt{\dfrac{a}{3g}}$ (D) $\dfrac{\pi\ell}{\sqrt{3ga}}$

27. A metal rod of length 'L' and mass 'm' is pivoted at one end. A thin disk of mass 'M' and radius 'R' (<L) is attached at its center to the free end of the rod. Consider two ways the disc is attached: (case A). The disc is not free to rotate about its center and (case B) the disc is free to rotated about its center. The rod-disc system performs SHM in vertical plane after being released from the same displaced position. Which of the following statement(s) is(are) true?



(A) Restoring torque in case A = Restoring torque in case B

(B) Restoring torque in case A < Restoring torque in case B

(C) Angular frequency for case A> Angular frequency for case B

(D) Angular frequency for case A< Angular frequency for case B

ANSWER KEY			SHM
1. Ans. (D)	**2. Ans. (A,C)**	**3. Ans. (A, B)**	
4. Ans. (A)-Q, (B)-P, (C)-S, (D)-R]		**5. Ans. (B,C,D)**	**6. Ans. (A,B,D)**
7. Ans. (A, B)	**8. Ans. (B,C)**	**9. Ans. (A,B,D)**	
10. Ans. (A) PQ (B) PQRST (C) ST (D) ST		**11. Ans. (a)** $\frac{1}{T}=\frac{1}{2\pi}\sqrt{\frac{g}{L}}$, **(b)** $\frac{L}{3}$	
12. Ans. (B,C,D)	**13. Ans. (A,B,C)**	**14. Ans: (a) π/5, (b) 2cm**	**15. Ans.** $\frac{17\pi}{12}\sqrt{\frac{m}{K}}$
16. Ans. (C,D)	**17. Ans. (A,D)**	**18. Ans. (AB)**	**19. Ans. (A,B)**
20. Ans. (A, D)	**21. Ans. (A, B)**	**22. Ans. (A, B, C, D)**	**23. Ans. 3**
24. Ans. $(2\pi a/b)(m/k)^{1/2}$	**25. Ans. 60**	**26. Ans. (A)**	**27. Ans. (A,D)**