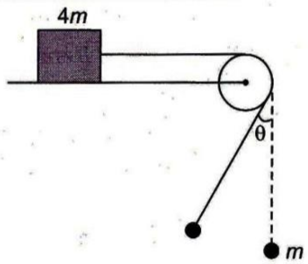
1. A heavy particle is tied to the end A of a string of length 1.6 m. Its other end O is fixed. It revolves as a conical pendulum with the string making $60°$ with the horizontal. Then,
(a) its period of revolution is $\frac{4\pi}{7}$ s
(b) the tension in the string is $\frac{2}{\sqrt{3}}$ times the weight of the particle
(c) the speed of the particle is $2.8\sqrt{3}$ m /s
(d) the centripetal acceleration of the particle is $\frac{9.8}{\sqrt{3}}$ m/s^2

2. A bullet of mass m moving with a horizontal velocity u strikes a stationary wooden block of mass M suspended by a string of length $L = 50$ cm. The bullet emerges out of the block with speed $\frac{u}{4}$. If $M = 6$ m, the minimum value of u so that the block can complete the vertical circle [Take $g = 10$ m/s^2]
(a) 10 m/s (b) 20 m/s
(c) 30 m/s (d) 40 m/s

3. Two bodies of mass m and $4m$ are attached to a spring as shown in the figure. The body of mass m hanging from a string of length l is executing periodic motion with amplitude $\theta = 60°$ while other body is at rest on the surface. The minimum coefficient of friction between the mass $4m$ and the horizontal surface must be



(a) $\frac{1}{4}$ (b) $\frac{1}{3}$
(c) $\frac{1}{2}$ (d) $\frac{2}{3}$

4. A mass is attached to the end of a string of length l which is tied to a fixed point O. The mass is released from the initial horizontal position of the string. Below the point O at what minimum distance a peg P should be fixed so that the mass turns about P and can describe a complete circle in the vertical plane?
(a) $\left(\frac{3}{5}\right) l$ (b) $\left(\frac{2}{5}\right) l$
(c) $\frac{l}{3}$ (d) $\frac{2l}{3}$

5. The bob of a 0.2 m pendulum describes an arc of circle in a vertical plane. If the tension in the cord is $\sqrt{3}$ times the weight of the bob when the cord makes an angle $30°$ with the vertical, the acceleration of the bob in that position is
(a) g (b) $\frac{g}{2}$
(c) $\frac{\sqrt{3}\,g}{2}$ (d) $\frac{g}{4}$

6. An automobile enters a turn of radius R. If the road is banked at an angle of $45°$ and the coefficient of friction is 1, the minimum speed with which the automobile can negotiate the turn without skidding is
(a) $\sqrt{\frac{rg}{2}}$ (b) $\frac{\sqrt{rg}}{2}$
(c) $\sqrt{rg}$ (d) zero

7. A jeep runs around a curve of radius 0.3 km at a constant speed of 60 ms^{-1}. The jeep covers a curve of $60°$ arc
(a) resultant change in velocity of jeep is 60 ms^{-1}
(b) instantaneous acceleration of jeep is 12 ms^{-2}
(c) average acceleration of jeep is approximately 11.5 ms^{-2}
(d) instantaneous and average acceleration are same in this case

8. A stone is tied to a string of length l and is whirled in a vertical circle with the other end of the string as the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of the change in velocity as it reaches a position where the string is horizontal (g being acceleration due to gravity) is
(a) $\sqrt{2(u^2 - gl)}$ (b) $\sqrt{u^2 - gl}$
(c) $u - \sqrt{u^2 - 2gl}$ (d) $\sqrt{2gl}$

9. A stone of mass 1 kg tied to a light inextensible string of length $L = \frac{10}{3}$ m, whirling in a circular path in a vertical plane. The ratio of maximum tension to the minimum tension in the string is 4. If g is taken to be 10 m/s^2, the speed of the stone at the highest point of the circle is
(a) 10 m/s (b) $5\sqrt{2}$ m/s
(c) $10\sqrt{3}$ m/s (d) 20 m/s

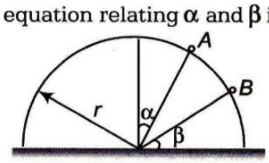
10. A wet open umbrella is held vertical and whirled about the handle at a uniform rate of 21 rev in 44 s. If the rim of the umbrella is a circle of 1 m in diameter and the height of the rim above the floor is 4.9 m. The locus of the drop on floor is a circle of radius
(a) $\sqrt{2.5}$ m (b) 1 m (c) 3 m (d) 1.5 m

11. A 50 kg girl is swinging on a swing from rest. Then, the power delivered when moving with a velocity of 2 m/s upwards in a direction making an angle $60°$ with the vertical is
(a) 980 W (b) 490 W
(c) $490\sqrt{3}$ W (d) 245 W

12. A particle of mass 1 g executes an oscillatory motion on the concave surface of a spherical dish of radius 2 m placed on a horizontal plane. If the motion of the particle begins from a point on the dish at a height of 1 cm from the horizontal plane and the coefficient of friction is 0.01, the total distance covered by the particle before it comes to rest, is approximately
(a) 2.0 m (b) 10.0 m (c) 1.0 m (d) 20.0 m

13. A particle suspended by a light inextensible thread of length l is projected horizontally from its lowest position with velocity $\sqrt{7gl/2}$. The string will slack after swinging through an angle equal to
(a) $30°$ (b) $90°$
(c) $120°$ (d) $150°$

14. A particle moves from rest at A on the surface of a smooth circular cylinder of radius r as shown. At B it leaves the cylinder. The equation relating α and β is



(a) $3\sin\alpha = 2\cos\beta$ (b) $2\sin\alpha = 3\cos\beta$
(c) $3\sin\beta = 2\cos\alpha$ (d) $2\sin\beta = 3\cos\alpha$

15. A ball suspended by a thread swings in a vertical plane so that its acceleration in the extreme position and lowest position are equal. The angle θ of thread deflection in the extreme position will be

(a) $\tan^{-1}(2)$ (b) $\tan^{-1}(\sqrt{2})$
(c) $\tan^{-1}\left(\frac{1}{2}\right)$ (d) $2\tan^{-1}\left(\frac{1}{2}\right)$

16. A body of mass m hangs at one end of a string of length l, the other end of which is fixed. It is given a horizontal velocity so that the string would just reach where it makes an angle of 60° with the vertical. The tension in the string at bottommost point position is

(a) $2\,mg$ (b) mg (c) $3\,mg$ (d) $\sqrt{3}\,mg$

17. A simple pendulum oscillates in a vertical plane. When it passes through the bottommost point, the tension in the string is 3 times the weight of the pendulum bob. What is the maximum displacement of the pendulum of the string with respect to the vertical

(a) 30° (b) 45° (c) 60° (d) 90°

18. A boy whirls a stone in a horizontal circle of radius 1.5 m and at height 2.0 m above level ground. The string breaks and the stone flies off tangentially and strikes the ground after travelling a horizontal distance of 10 m. What is the magnitude of the centripetal acceleration of the stone while in circular motion?

(a) 163 m/s^2 (b) 64 m/s^2
(c) 15.63 m/s^2 (d) 125 m/s^2

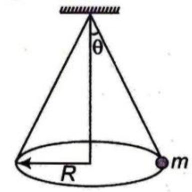
19. A stone is rotated in a vertical circle. Speed at bottommost point is $\sqrt{8gR}$, where R is the radius of circle. The ratio of tension at the top and the bottom is

(a) 1 : 2 (b) 1 : 3
(c) 2 : 3 (d) 1 : 4

20. The kinetic energy K of a particle moving along a circle of radius R depends on the distance covered s as $K = as^2$. The force acting on the particle is

(a) $\frac{2as^2}{R}$ (b) $2as\left(1+\frac{s^2}{R^2}\right)^{1/2}$
(c) $as\left(1+\frac{s^2}{R^2}\right)^{1/2}$ (d) None of these

21. A conical pendulum of length L makes an angle θ with the vertical. The time period will be

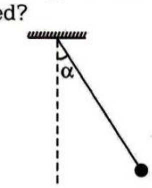


(a) $2\pi\sqrt{\frac{L\cos\theta}{g}}$ (b) $2\pi\sqrt{\frac{L}{g\cos\theta}}$
(c) $2\pi\sqrt{\frac{L\tan\theta}{\gamma}}$ (d) $2\pi\sqrt{\frac{L}{g\tan\theta}}$

22. A particle starts travelling on a circle with constant tangential acceleration. The angle between velocity vector and acceleration vector, at the moment when particle complete half the circular track, is

(a) $\tan^{-1}(2\pi)$ (b) $\tan^{-1}(\pi)$
(c) $\tan^{-1}(3\pi)$ (d) zero

23. A simple pendulum is vibrating with an angular amplitude of 90° as shown in the figure. For what value of α, is the acceleration directed?



(i) Vertically upwards (ii) Horizontally
(iii) Vertically downwards

(a) $0°, \cos^{-1}\left(\frac{1}{\sqrt{3}}\right), 90°$ (b) $90°, \cos^{-1}\left(\frac{1}{\sqrt{3}}\right), 0°$
(c) $0°, \cos^{-1}\sqrt{3}, 90°$ (d) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right), 90°, 0°$