01. A 4 kg stone tied at the end of a 1 m long string is whirled in a vertical circle. At the instant when the string makes an angle θ with the vertical, the linear speed of the stone is 4 m/s and the tension in the string is 103.2 N. Then the value of θ is

(*a*) 0° (*b*) 30°
(*c*) 60° (*d*) 90°

02. A bottle of sodawater is grasped by the neck and swung briskly in a circle. Near which portion of the bottle do the bubbles collect?

(*a*) Near the bottom
(*b*) Near the neck
(*c*) In the middle of the bottle
(*d*) Bubbles remain distributed uniformly throughout the volume of the bottle

03. A cyclist moves around a circular path of radius $39.2\times\sqrt{3}$ metres with a speed of 19.6 m/s. He must lean inwards at an angle θ with the vertical such that tan θ is equal to

(*a*) 1 (*b*) $\sqrt{3}$
(*c*) $1/\sqrt{3}$ (*d*) 2

04. A motorcyclist is moving inside a spherical cage of radius 5 m. The minimum speed with which he must pass the highest point without losing contact is ($g = 10$ m/s^2)

(*a*) 5 m/s (*b*) $5\sqrt{2}$ m/s
(*c*) 10 m/s (*d*) $10\sqrt{2}$ m/s

05. On a dry road, the maximum permissible speed of a car in a circular path is 10 m/s. If the road becomes wet, the maximum speed is $5\sqrt{2}$ m/s. If the coefficient of friction for dry road is μ, then that for the wet road is

(*a*) μ/2 (*b*) μ/3
(*c*) 2μ/3 (*d*) 3μ/4

06. A pendulum consisting of a small sphere of mass *m*, suspended by an inextensible and massless string is made to swing in a vertical plane. If the breaking strength of the string is 2*mg*, then the maximum angular amplitude of the displacement from the vertical can be

(*a*) 0° (*b*) 30°
(*c*) 60° (*d*) 90°

07. The bridge over a canal is in the form of a circular arc of radius 10 m. The maximum speed with which a motor cycle can cross the bridge without leaving the ground at the highest point is ($g = 10$ m/s^2)

(*a*) 10 m/s (*b*) 50 m/s
(*c*) 10 m/s (*d*) 1 m/s

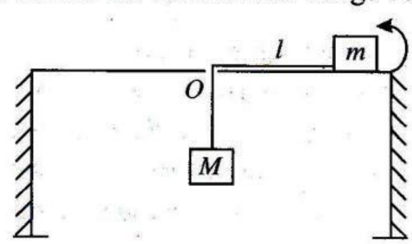
08. A car is moving on a circular road of radius 500 m. At some instant its speed is 30 m/s and is increasing at the rate of 2 m/s^2. The magnitude of its acceleration is

(*a*) 2 m/s^2 (*b*) 2.7 m/s^2
(*c*) 4 m/s^2 (*d*) 4.8 m/s

09. A tube of length *L* is filled completely with an incompressible liquid of mass *M* and closed at both the ends. The tube is then rotated in a horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is

(*a*) $M\omega^2L/2$ (*b*) $M\omega^2L$
(*c*) $M\omega^2L/4$ (*d*) $M\omega^2L^2/2$

10. Two masses *m* and *M* are connected by a light string that passes through a hole *O* at the centre of a smooth table. Mass *m* lies on the table and *M* hangs vertically. Now

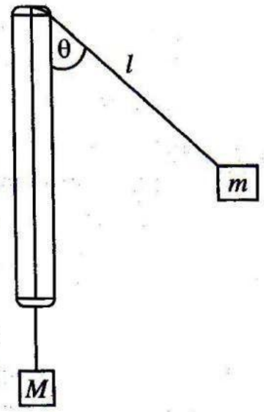


m is moved round in a horizontal circle with *O* as the centre. If *l* is the length of the string from *O* to *m* then the frequency with which *m* should revolve so that *M* remains stationary is

(*a*) $\frac{1}{2\pi}\sqrt{\frac{Mg}{ml}}$ (*b*) $\frac{1}{\pi}\sqrt{\frac{Mg}{ml}}$

(*c*) $\frac{1}{2\pi}\sqrt{\frac{ml}{Mg}}$ (*d*) $\frac{1}{\pi}\sqrt{\frac{ml}{Mg}}$

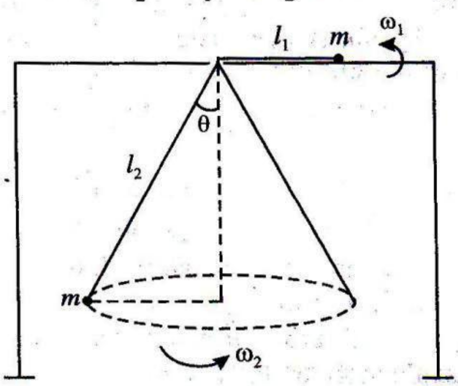
11. Two masses M and m hang at the two ends of a string that passes through a smooth tube as shown. The mass m moves in a circular path which lies in a horizontal plane. The length of the string from m to the top of the tube is l and θ is the angle this length makes with the vertical. What should be the frequency of revolution of m so that M remains stationary?



(a) $\frac{1}{2\pi}\sqrt{\frac{Mg}{ml}}$ (b) $\frac{1}{2\pi}\sqrt{\frac{Mg}{ml\cos\theta}}$

(c) $\frac{1}{2\pi}\sqrt{\frac{ml\cos\theta}{Mg}}$ (d) $\frac{1}{2\pi}\sqrt{\frac{ml}{Mg}}$

12. Two identical particles are attached at the ends of a light string which passes through a hole at the centre of a smooth table. One of the particles is made to move in a circle on the table with angular velocity ω_1 and the other is made to move in a horizontal circle as a conical pendulum with angular velocity ω_2. If l_1 and l_2 are the lengths of the



string over and under the table, then in order that the particle under the table neither moves down nor moves up, the ratio l_1/l_2 is

(a) ω_1/ω_2 (b) ω_2/ω_1

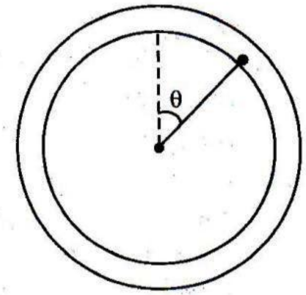
(c) ω_1^2/ω_2^2 (d) ω_2^2/ω_1^2

13. A nail is located at a certain distance vertically below the point of suspension of a simple pendulum of length 1 m. The bob is released from the position where the string makes an angle of 60° with the vertical. What should be the distance of the nail from the point of suspension so that the bob just performs revolution with the nail as centre?

(a) 0.2 m (b) 0.4 m

(c) 0.6 m (d) 0.8 m

14. A smooth circular tube is kept in a vertical plane. A particle of mass m, which can slide freely inside the tube, is placed at the highest point in the tube. If the particle is displaced slightly from rest, the force exerted by it on the wall of the tube at angular displacement θ is



(a) $mg(3 - 2\cos\theta)$ (b) $mg(3\cos\theta - 2)$

(c) $mg(4\cos\theta - 3)$ (d) $mg(4 - 3\cos\theta)$

15. Keeping the banking angle same, to increase the maximum speed with which a vehicle can travel on a circular road by 10%, the radius of curvature of the road has to be changed from 20 m to

(a) 16 m (b) 18 m

(c) 24.2 m (d) 30. 5 m

16. A small ring is threaded on a smooth wire bent in the form of a vertical circular loop of radius r. The loop is rotating with constant angular velocity ω about the vertical diameter while the ring remains at rest relative to the wire at a distance $r/2$ from the axis. Then ω^2 equals

(a) $\frac{2g}{r}$ (b) $\frac{2g}{r\sqrt{3}}$

(c) $\frac{\sqrt{3}g}{r}$ (d) $\frac{\sqrt{3}g}{2r}$

17. A stone is moved in a horizontal circle of radius 1.5 m by means of a string at a height of 2 m above the ground. The string breaks and the particle flies off horizontally, striking the ground 10 m away. Find the centripetal acceleration during circular motion ($g = 10\ m/s^2$).

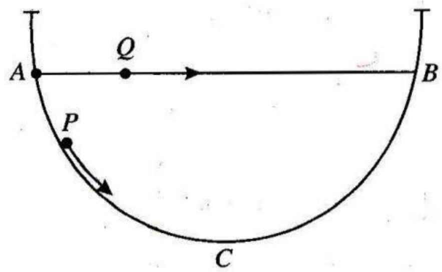
(a) 83.3 m/s^2 (b) 166.6 m/s^2

(c) 249.9 m/s^2 (d) 333.2 m/s^2

18. A car moving on a horizontal road may be thrown out of the road in taking a turn

(*a*) by the gravitational force
(*b*) due to the lack of proper centripetal force
(*c*) due to the rolling frictional force between the tyre and the road
(*d*) by the reaction of the ground

19. A particle P is sliding down a frictionless hemispherical bowl. It passes the point A at $t = 0$. At this instant of time, the horizontal component of its velocity is v. A bead Q of the same mass as P is ejected from A at $t = 0$ along the horizontal string AB with the speed v. Friction between the bead and the string may be neglected. Let t_P and t_Q be the respective times taken by P and Q to reach the point B. Then



(*a*) $t_P < t_Q$ (*b*) $t_P = t_Q$

(*c*) $t_P > t_Q$ (*d*) $\frac{t_P}{t_Q} = \frac{\text{length of are } ACB}{\text{length of chord } AB}$

20. A particle is moving in a horizontal circle in contact with the smooth inside surface of a right circular cone having its axis vertical and vertex down. The height of the plane of motion above the vertex is h and the semivertical angle of the cone is α. The period of revolution of the particle is

(*a*) $2\pi\sqrt{\frac{h\sin\alpha}{g}}$ (*b*) $2\pi\sqrt{\frac{h\tan\alpha}{g}}$

(*c*) $2\pi\tan\alpha\sqrt{\frac{h}{g}}$ (*d*) $2\pi\sin\alpha\sqrt{\frac{h}{g}}$

21. A mass m moves in a vertical circle at the end of a string of length L. Its velocity at the lowest point is v_0. The tension in the string when it makes an angle θ to the downward vertical is

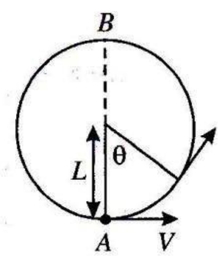
(*a*) $m\left[\frac{v_0^2}{L} + g(3\cos\theta - 2)\right]$

(*b*) $m\left[\frac{v_0^2}{L} + g(2\cos\theta - 3)\right]$

(*c*) $m\left[\frac{v_0^2}{2L} + 2g\ (3\cos\theta - 2)\right]$

(*d*) $m\left[\frac{v_0^2}{2L} + 2g\ (2\cos\theta - 3)\right]$

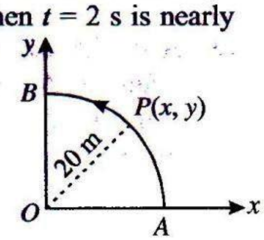
22. A bob of mass M is suspended by a massless string of length L. The horizontal velocity V at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is half of that at A satisfies



(*a*) $\theta = \frac{\pi}{4}$ (*b*) $\frac{\pi}{4} < \theta < \frac{\pi}{2}$

(*c*) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$ (*d*) $\frac{3\pi}{4} < \theta < \pi$

23. A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of P is such that it sweeps out a length $s = t^3 + 5$, where s is in metres and t is in seconds. The radius of the path is 20 m. The acceleration of P when $t = 2$ s is nearly



(*a*) 14 m s^{-2}
(*b*) 13 m s^{-2}
(*c*) 12 m s^{-2}
(*d*) 7.2 m s^{-2}

24. A body of mass m is tied to one end of a spring and whirled round in a horizontal plane with a constant angular velocity. The elongation in the spring is one centimetre. If the angular velocity is doubled, the elongation in the spring is 5 cm. The original length of the spring is

(*a*) 16 cm (*b*) 15 cm
(*c*) 14 cm (*d*) 13 cm

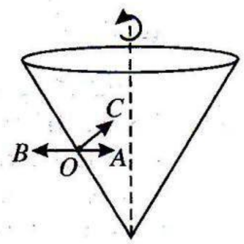
25. For a particle in uniform circular motion, the acceleration $\vec{a}$ at a point $P(R, \theta)$ on the circle of radius R is (Here θ is measured from the x-axis)

(a) $\frac{v^2}{R}\hat{i} + \frac{v^2}{R}\hat{j}$ (b) $-\frac{v^2}{R}\cos\theta\,\hat{i} + \frac{v^2}{R}\sin\theta\,\hat{j}$

(c) $-\frac{v^2}{R}\sin\theta\,\hat{i} + \frac{v^2}{R}\cos\theta\,\hat{j}$

(d) $-\frac{v^2}{R}\cos\theta\,\hat{i} - \frac{v^2}{R}\sin\theta\,\hat{j}$

26. A particle is lying at a point O on the inside rough surface of a cone which is rotating with a constant angular velocity about its axis which is vertical. The net force on the particle is

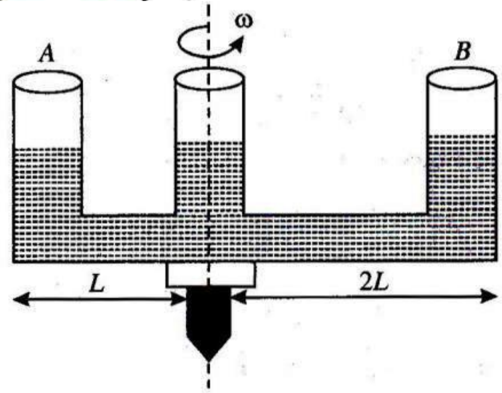


(a) zero
(b) acting along OC
(c) acting along OB
(d) acting along OA

27. An annular ring with inner and outer radii R_1 and R_2 is rolling without slipping with a uniform angular speed. The ratio of the forces experienced by the two particles situated on the inner and outer parts of the ring is

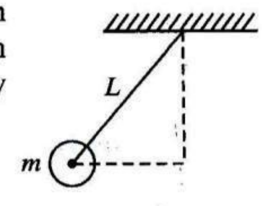
(a) $\frac{R_1}{R_2}$ (b) 1 (c) $\left(\frac{R_1}{R_2}\right)^2$ (d) $\frac{R_2}{R_1}$

28. A given shaped glass tube having uniform cross section is filled with water and is mounted on a rotatable shaft as shown in the figure. If the tube is rotated with a constant angular velocity ω, then



(a) water levels in both sections A and B goes up
(b) water level in section A goes up and that in B comes down
(c) water level in section A comes down and that in B goes up
(d) water levels remain the same in both the sections

29. A ball of mass (m) 0.5 kg is attached to the end of a string having length (L) 0.5 m. The ball is rotated on a horizontal circular path above vertical axis. The maximum tension the string can bear is 324 N. The maximum possible value of angular velocity of ball (in radian/s) is



(a) 9 (b) 18
(c) 27 (d) 36

30. Two cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2, respectively. Their speeds are such that they make complete circles in the same time t. The ratio of their centripetal accelerations is

(a) $m_1r_1 : m_2r_2$ (b) $m_1 : m_2$
(c) $r_1 : r_2$ (d) $1 : 1$