CIRCULAR MOTION

1. A particle is moving with a velocity of $\vec{v} = \left(3\hat{i} + 4t\hat{j}\right) m/s$. Find the ratio of tangential acceleration to that of normal acceleration at t = 1 sec.

(1) 4/3 (2) 3/4 (3) 5/3 (4) 3/5

2. In a circular motion of a particle, the tangential acceleration of the particle is given by a_t = 9 m/s^2. The radius of the circle is 4 m. The particle was initially at rest. Time after which acceleration of the particle makes an angle of 45° with the radial acceleration is :

(1) $\frac{1}{3}$ sec (2) $\frac{2}{3}$ sec

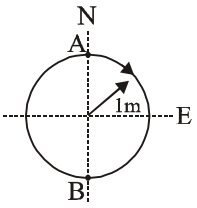
(3) 1 sec (4) $\frac{4}{3}$ sec

3. If the radii of circular path of two particles are in the ratio of 1 : 2, then in order to have same centripetal acceleration their speeds should be in the ratio of :-

(1) 1 : 4 (2) 4 : 1

(3) $1:\sqrt{2}$ (4) $\sqrt{2}:1$

4. In one second a particle moves with constant speed from point A to point B along the circular track of radius 1.0 m as shown in the figure. What is the average acceleration of the particle during this motion.



(1) 2π m/s^2 due east

(2) π m/s^2 due west

(3) Zero

(4) 2π m/s^2 due west

5. A particle is moving on a circular path such that at any instant its position vector, linear velocity, angular velocity, angular acceleration with respect to centre are $\vec{r}, \vec{v}, \vec{\omega}, \vec{\alpha}$ respectively. Net acceleration of the particle is :-

(1) $(\vec{\omega} \times \vec{v}) - (\vec{r} \times \vec{\alpha})$

(2) $(\vec{\omega} \times \vec{v}) + (\vec{r} \times \vec{\alpha})$

(3) $(\vec{v} \times \vec{\omega}) + (\vec{r} \times \vec{\alpha})$

(4) $(\vec{v} \times \vec{\omega}) - (\vec{r} \times \vec{\alpha})$

6. A car is moving on circular path of radius 100 m such that its speed is increasing at the rate of 5 m/s^2. At t = 0 it starts from rest. What is the radial acceleration of car at the instant it makes one complete round trip ?

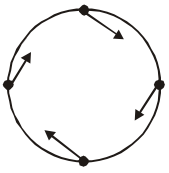
(1) 20π ms^{-2}

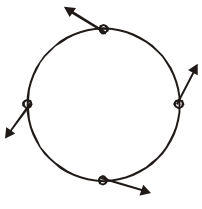
(2) 10π ms^{-2}

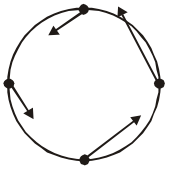
(3) 5π ms^{-2}

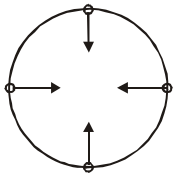
(4) None of these

7. A car speeds up in a circular path, which of the following figure illustrates the acceleration of the car?

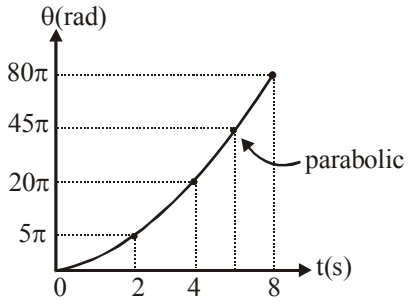
(1) 

(2) 

(3) 

(4) 

8. The angular displacement(θ) of the blades of a ceiling fan, when the fan is switched on at t = 0, is shown in figure. The average angular velocity of the fan blades during the first 8 seconds will be



(1) 40π rad/s (2) 20π rad/s

(3) 10π rad/s (4) 5π rad/s

9. An aeroplane flying at constant speed 115 m/s towards east, makes a gradual turn following a circular path to fly south. The turn takes 15 seconds to complete. The magnitudes of the centripetal acceleration and average acceleration during the turn, are

(1) $\frac{23\sqrt{2}}{3}\text{m/s}^2, \frac{23\sqrt{2}}{3}\text{m/s}^2$

(2) $\frac{46\pi}{3}\text{m/s}^2, \frac{23\sqrt{2}}{3}\text{m/s}^2$

(3) $\frac{23\pi}{6}\text{m/s}^2, \frac{23\sqrt{2}}{3}\text{m/s}^2$

(4) none of these

10. The track of motorcycle-race is circular and unbanked. There are two bikers on the road, one travels along a path of greater radius than the other. They both lean towards the centre at the same angle. Which one completes the circular path in less time?

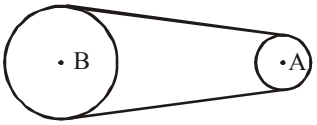
(1) biker having path of smaller radius.

(2) biker having path of larger radius.

(3) both will complete circle in same time.

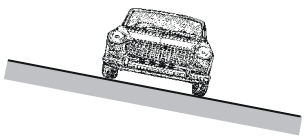
(4) Both can not lean at same angle if radius is different.

11. A wheel of radius 0.1 m (wheel A) is attached by a non stretching belt to a wheel of radius 0.2 m (wheel B). The belt does not slip. By the time, wheel B turns through one revolution, wheel A will rotate through x revolution. Find the value of x.



(1) 6 (2) 4 (3) 2 (4) 0

12. At a turn a track is banked for optimum speed of 40 km/h. At the instant shown in the figure a car is traveling out of the plane of the figure.



If the car travels at 60 km/h, the net frictional force acting on the wheels must be

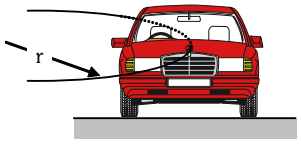
(1) static in nature and point downward along the bank of the track for safe driving.

(2) static in nature and points upward along the bank of the track for safe driving.

(3) kinetic in nature and points upward along the bank of the track for safe driving.

(4) kinetic in nature and points downwards along the bank of the track for safe driving.

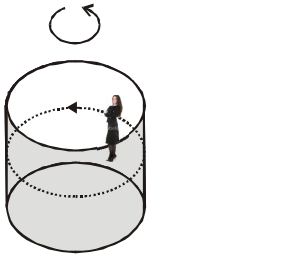
13. Two-wheeler can tilt while turning, but four-wheeler cannot. Estimate maximum safe speed of a four-wheeler on turn of radius 10 m assuming coefficient of static friction between tires and the flat road to be 0.64 and acceleration due to gravity to be 10 m/s^2.



(1) 6.4 m/s (2) 2.8 m/s

(3) 8 m/s (4) 10 m/s

14. A girl finds herself stuck with her back to the wall of a cylinder rotating about its axis. Which diagram correctly shows the forces acting on her?



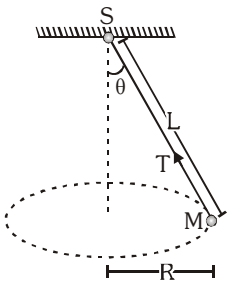
(1) 

(2) 

(3) 

(4) 

15. A string of length L is fixed at one end and carries a mass M at the other end. The string makes $2/\pi$ revolutions per second around the vertical axis through the fixed end as shown in the figure, then tension in the string is



(1) ML (2) 2 ML

(3) 4 ML (4) 16 ML

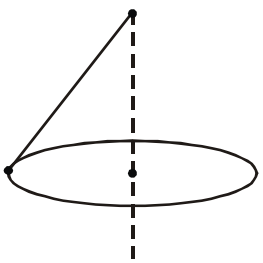
16. When a ball at rest hangs by a single vertical string, tension in the string is mg. If the ball is made to move in a horizontal circle so that the string describes a cone, string tension

(1) is mg.

(2) is greater than mg, always.

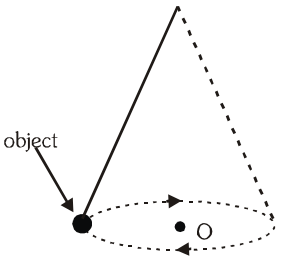
(3) is less than mg, always.

(4) may be greater or less than mg depending on the speed of the ball.



17. A small object, suspended by a string, rotates with constant speed, in a horizontal circle as shown in the figure. Point O is at the centre of the circle. Neglect air drag.

Which one of the following statements is correct?



(1) The object is in equilibrium.

(2) There is a resultant force on the object directed away from O.

(3) A force acts on the object in the direction of its motion.

(4) There is a resultant force on the object directed towards O.

18. A circular road of radius r is banked for a speed v = 40 km/hr. A car of mass m attempts to go on the circular road. The friction coefficient between the tyre and the road is negligible.

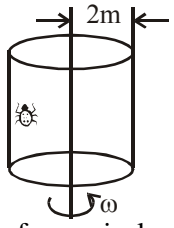
(1) The car cannot make a turn without skidding

(2) If the car turns at a speed less than 40 km/hr, it will slip up

(3) If the car turns at the correct speed of 40 km/hr, the force by the road on the car is equal to $\frac{mv^2}{r}$

(4) If the car turns at the correct speed of 40 km/hr, the force by the road on the car is greater than mg as well as greater than $\frac{mv^2}{r}$

19. An insect of mass m = 3 kg is inside a vertical drum of radius 2 m that is rotating with an angular velocity of 5 rad/sec. The insect does not fall off, then the minimum co-efficient of friction required is :



(1) 0.5
(2) 0.4
(3) 0.2
(4) none of these

20. The length of the string of a conical pendulum is ℓ and the mass of the bob is m. The point of support is at a height h above the horizontal plane in which the bob revolves. The tension in the string is :-

(1) $\frac{mg\ell}{h}$ (2) $\frac{mg\sqrt{\ell^2-h^2}}{\ell}$

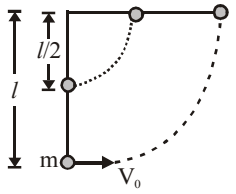
(3) $\frac{mgh}{\ell}$ (4) $\frac{mg\ell}{\sqrt{\ell^2-h^2}}$

21. A circular curve of a highway is designed for traffic moving at 72 km/h. If the radius of the curved path is 100 m, the correct angle of banking of the road should be given by :

(1) $\tan^{-1}\frac{2}{3}$ (2) $\tan^{-1}\frac{3}{5}$

(3) $\tan^{-1}\frac{2}{5}$ (4) $\tan^{-1}\frac{1}{4}$

22. A light rod of length ℓ is pivoted at the upper end. Two masses (each m), are attached to the rod, one at the middle and the other at the free end. What horizontal velocity must be imparted to the lower end mass, so that the rod may just take up the horizontal ?



(1) $\sqrt{\frac{6\ell g}{5}}$ (2) $\sqrt{\frac{\ell g}{5}}$ (3) $\sqrt{\frac{12\ell g}{5}}$ (4) $\sqrt{\frac{2\ell g}{5}}$

23. A body crosses the top most point of a vertical circle with critical speed. What will be its centripetal acceleration when the string is horizontal :-

(1) g (2) 2g (3) 3g (4) 6g

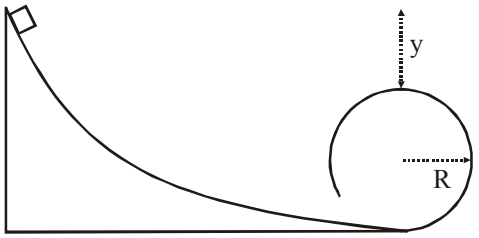
24. A particle is moving in a vertical circle the tension in the string when passing through two position at angle 30° & 60° from vertical from lowest position are T_1 & T_2 respectively :-

(1) $T_1 = T_2$ (2) $T_1 > T_2$ (3) $T_1 < T_2$ (4) $T_1 \geq T_2$

25. For a particle rotating in a vertical circle with uniform speed, the maximum and minimum tension in the string are in the ratio 5 : 3. If the radius of vertical circle is 2 m, the speed of revolving body is (g = 10 m/s^2)

(1) $\sqrt{5}$ m/s (2) $4\sqrt{5}$ m/s
(3) 5 m/s (4) 10 m/s

26. A small object of mass m starts from rest at the position shown and slides along the frictionless loop-the-loop track of radius R. What is the smallest value of y such that the object will slide without losing contact with the track?



(1) R/2 (2) R (3) R/4 (4) 3R/4

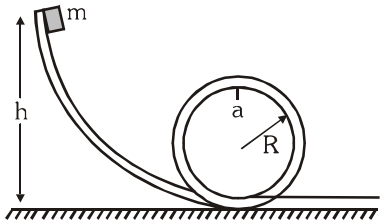
27. A weightless thread can bear a tension upto 3.7 kg-wt. A stone of mass 500 g is tied to it and revolved in a circular path of radius 4 m in a vertical plane. If g = 10 ms^{-2}, then the maximum angular velocity of the stone will be:-

(1) 4 rad s^{-1} (2) 16 rad s^{-1}
(3) $\sqrt{21}$ rad s^{-1} (4) 2 rad s^{-1}

28. A bead is arranged to move with constant speed around a loop that lies in a vertical plane. The magnitude of the net force on the bead is

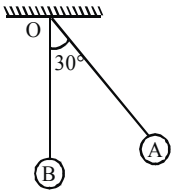
(1) maximum at the bottom
(2) maximum at the top
(3) maximum at the side points
(4) the same at all points

29. An object of mass m is released from rest at a height h above the surface of a table. The object slides along the inside of the loop. The loop track consisting of a ramp and a circular loop of radius R shown in the figure. Assume that the track is frictionless. When the object is at the top of the circular track it pushes against the track with a force equal to three times its weight. What height was the object dropped from ?



(1) 3R (2) 4R (3) 5R (4) 6R

30. A pendulum is released from rest from the point A as shown in the figure. The string of the pendulum is taut. OA makes an angle 30° with the vertical. The acceleration of the pendulum bob at this instant would be



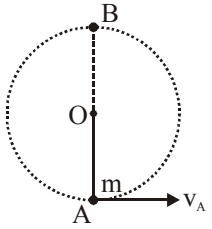
(1) along $\overrightarrow{AO}$

(2) along the vertical

(3) in a direction perpendicular to OA

(4) In a direction making an angle less than 30° with the vertical

31. A small ball of mass m is suspended from a light rod as shown. The ball is given a horizontal velocity at A equal to twice the minimum velocity required by the ball to complete the loop. Find the tension in the rod when the ball passes through the topmost point:-



(1) 15 mg (2) mg (3) 11 mg (4) 12 mg

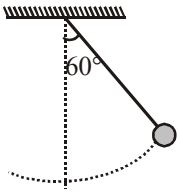
32. In vertical circular motion of a bob, match the entries of list–I with entries of list–II. Here v_0 is the velocity of bob at lowest point & T is tension in string.

	List-I (speed at lowest point)	**List-II (possible situation)**
(P)	$v_0 = \sqrt{5g\ell}$	(1) $T_{lowest} = 6mg$
(Q)	$v_0 = \sqrt{g\ell}$	(2) string will slack for a finite time
(R)	$v_0 = 2\sqrt{g\ell}$	(3) bob will oscillate
(S)	$v_0 = 3\sqrt{g\ell}$	(4) $T_{highest} = 4mg$

Code

	P	**Q**	**R**	**S**
(1)	1	2	3	4
(2)	4	2	3	1
(3)	1	3	2	4
(4)	4	3	2	1

33. A pendulum of length ℓ = 1m is released from $\theta_0 = 60°$. The rate of change of speed of the bob at $\theta = 30°$ is ($g = 10\ m/s^2$) :-



(1) $5\sqrt{3}\ m/s^2$ (2) 2.5 m/s^2

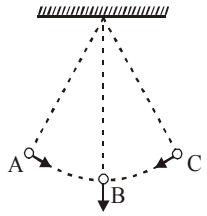
(3) 10 m/s^2 (4) 5 m/s^2

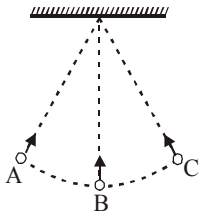
34. A weightless thread can withstand tension upto 30 N. A stone of mass 0.5 kg is tied to it and is revolved in a circular path of radius 2m in a vertical plane. If g = 10 m/s^2, then the maximum angular velocity of the stone can be:–

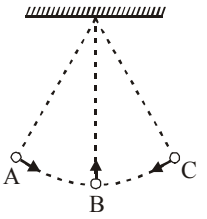
(1) 5 rad/s (2) $\sqrt{30}$ rad/s

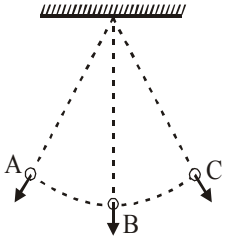
(3) $\sqrt{60}$ rad/s (4) 10 rad/s

35. A simple pendulum of mass m swings about point B between extreme positions A and C. Net force acting on the bob at these three points is correctly shown by

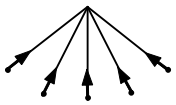
(1) 

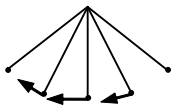
(2) 

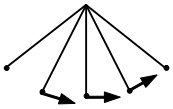
(3) 

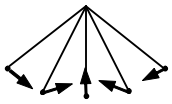
(4) 

36. Which of the following figures best illustrates the acceleration of a pendulum bob at different points between two extreme positions?

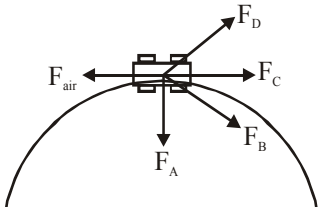
(1) 

(2) 

(3) 

(4) 

37. A car travels with constant speed on a circular road on level ground. In the diagram above, F_{air} is the force of air resistance on the car. Which of the other forces shown, best represents the horizontal force of the road on the car's tires?



(1) F_A (2) F_B (3) F_C (4) F_D

38. In non uniform circular motion rate of work done by force acting on particle is

(1) zero (2) non zero

(3) both (1) & (2) (4) none of these

39. If the overbridge is concave instead of being convex, the thrust on the road at the lowest position will be :-

(1) $mg + \frac{mv^2}{r}$

(2) $mg - \frac{mv^2}{r}$

(3) $\frac{m^2v^2g}{r}$

(4) $\frac{v^2g}{r}$

40. When a bus suddenly take a turn, the passengers are thrown outwards because of :-

(1) speed of motion

(2) inertia of motion

(3) acceleration of motion

(4) none of these

41. A car with closed windows takes a left turn. A helium filled balloon in the car will be pushed to the (as seen from car)

(1) right (2) left (3) front (4) back

42. A particle of mass m is observed from an inertial frame of reference, and is found to move in a circle of radius r with a uniform speed v. The centrifugal force on it is

(1) $\frac{mv^2}{r}$ towards the centre

(2) $\frac{mv^2}{r}$ away from the centre

(3) $\frac{mv^2}{r}$ along the tangent through the particle

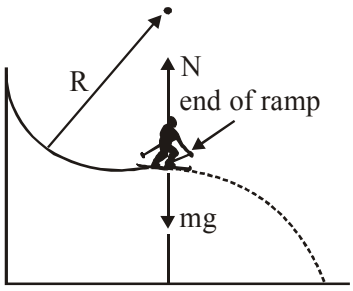
(4) Zero

43. A particle is projected with velocity u horizontally from the top of a fixed smooth sphere of radius 'a' so that it slides down the outside of the sphere. If the particle leaves the sphere when it has fallen a vertical distance $\left(\frac{a}{4}\right)$, the value of u is

(1) $\sqrt{ag}$ (2) $\sqrt{2ag}$

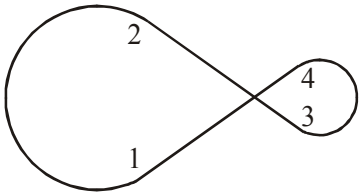
(3) $\frac{\sqrt{ag}}{2}$ (4) $\frac{3\sqrt{ag}}{2}$

44. A skier of mass M slides down a ramp shaped as a circle of radius R . At the end point of the ramp just before the skier is in the air, the magnitude of the normal force exerted by the ramp on the skier is N. The acceleration due to gravity is g. Then :-



(1) The magnitude of the normal force N is greater than Mg
(2) The magnitude of the normal force N is equal to Mg
(3) The magnitude of the normal force N is less than Mg
(4) The magnitude of the normal force N can be greater than, equal to, or less than Mg depending on the speed of the skier.

45. A car runs at constant speed around the horizontal race track shown in the figure. Over which portion of the track is the magnitude of the acceleration the greatest?



(1) From 1 to 2 (2) From 2 to 3
(3) From 3 to 4 (4) From 4 to 1

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	**1**	**2**	**3**	**4**	**1**	**1**	**3**	**3**	**3**	**1**	**3**	**1**	**3**	**3**	**4**	**2**	**4**	**4**	**3**	**1**
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**4**	**2**	**3**	**3**	**3**	**4**	**1**	**3**	**4**	**2**	**2**	**1**	**2**
Que.	41	42	43	44	45															
Ans.	**2**	**4**	**3**	**1**	**3**															