Topic Name : Circular Motion (PVCCM1)
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Target: JEE Main & Advanced | NEET
Marking Scheme: +4 & -1
Test Platform: premiumvikas.com
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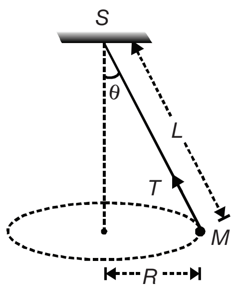
A journey of a thousand miles begins with a single step.

1. Three identical cars A, B and C are moving at the same speed on three bridges. The car A goes on a plane bridge B on a bridge convex upwards and C goes on a bridge concave upwards. Let F_A, F_B and F_C be the normal forces exerted by the cars on the bridges when they are at the middle of the bridges. Then
   (a) F_A is maximum of the three forces
   (b) F_B is maximum of the three forces
   (c) F_C is maximum of the three forces
   (d) $F_A = F_B = F_C$

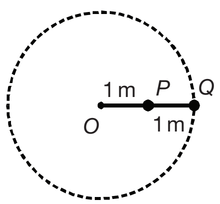
2. A string of length L is fixed at one end and carries a mass M at the other end. The string makes $2/\pi$ revolutions per second around the vertical axis through the fixed end as shown in the figure, then tension in the string is



   (a) ML (b) 2 ML
   (c) 4 ML (d) 16 ML

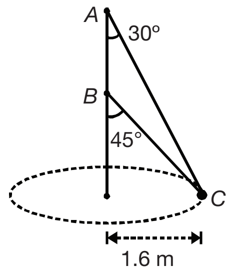
3. Two spheres of equal masses are attached to a string of length 2 m as shown in the figure. The string and the spheres are then whirled in a horizontal circle about O at a constant rate. What is the value of the ratio

$$\left(\frac{\text{Tension in the string between } P \text{ and } Q}{\text{Tension in the string between } P \text{ and } O}\right)$$



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

4. Two wires AC and BC are tied at C to a small sphere of mass 5 kg, which revolves at a constant speed v in the horizontal circle of radius 1.6 m. The minimum value of v is



   (a) 3.01 m/s (b) 4.01 m/s
   (c) 8.2 m/s (d) 3.96 m/s

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

6. A heavy small-sized sphere is suspended by a string of length l. The sphere rotates uniformly in a horizontal circle with the string making an angle θ with the vertical. Then the time period of this conical pendulum is
   (a) $t = 2\pi\sqrt{\dfrac{g}{l\sin\theta}}$ (b) $t = 2\pi\sqrt{\dfrac{l\sin\theta}{g}}$
   (c) $t = 2\pi\sqrt{\dfrac{l\cos\theta}{g}}$ (d) $t = 2\pi\sqrt{\dfrac{g}{l\cos\theta}}$

7. A body of mass M kg is on the top point of a smooth hemisphere of radius 5 m. It is released to slide down the surface of the hemisphere. It leaves the surface when its velocity is 5 m/s. At this instant the angle made by the radius vector of the body with the vertical is (Acceleration due to gravity = 10 m/s)
   (a) 30° (b) 45°
   (c) 60° (d) 90°

8. A small block slides down from the top of a hemisphere of radius r. It is assumed that there is no friction between the block and the hemisphere. At what height, h will the block lose contact with the surface of sphere?
   (a) $\frac{r}{3}$ (b) $\frac{2r}{3}$
   (c) $\frac{r}{2}$ (d) $\frac{r}{4}$

9. A hollow vertical cylinder of radius R and height h has smooth internal surface. A small particle is placed in contact with the inner side of the upper rim at a point P. It is given a horizontal speed v_0 tangential to rim. It leaves the lower rim at point Q, vertically below P. The number of revolutions made by the particle will be

(a) $\dfrac{h}{2\pi R}$ (b) $\dfrac{v_0}{\sqrt{2gh}}$

(c) $\dfrac{2\pi R}{h}$ (d) $\dfrac{v_0}{2\pi R}\left(\sqrt{\dfrac{2h}{g}}\right)$

10. A particle describes a horizontal circle in a conical funnel whose inner surface is smooth with speed of 0.5 m/s. What is the height of the plane of circle from vertex of the funnel?

(a) 0.25 cm (b) 2 cm

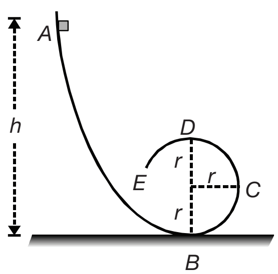
(c) 4 cm (d) 2.5 cm

11. A person with a mass of M kg stands in contact against the wall of a cylindrical drum of radius r rotating with an angular velocity ω. If the coefficient of friction between the wall and the clothing is μ, the minimum rotational speed of the cylinder which enables the person to remain stuck to the wall when the floor is suddenly removed, is

(a) $\omega_{\min} = \sqrt{\dfrac{g}{\mu r}}$ (b) $\omega_{\min} = \sqrt{\dfrac{\mu r}{g}}$

(c) $\omega_{\min} = \sqrt{\dfrac{2g}{\mu r}}$ (d) $\omega_{\min} = \sqrt{\dfrac{rg}{\mu}}$

12. *ABCDE* is a channel in the vertical plane, part *BCDE* being circular with radius r. A block is released from A and slides without friction and without rolling. The block will complete the loop if h is



(a) $h \le \dfrac{3}{2}r$ (b) $h \ge \dfrac{5}{2}r$

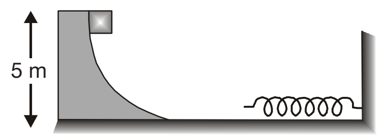
(c) $h \ge \dfrac{3}{2}r$ (d) $h \le \dfrac{5}{2}r$

13. A ball of mass m is tied up with string and rotated along a horizontal circle of radius r. At an instant, its velocity is v, and tension in string is T, the force required for circular motion is

(a) $T - \dfrac{mv^2}{r}$ (b) $T + \dfrac{mv^2}{r}$

(c) $\dfrac{mv^2}{r}$ (d) zero

14. Consider the situation shown in figure. A spring of spring constant 400 N/m is attached at one end to a wedge fixed rigidly with the horizontal part. A 40 g mass is released from rest while situated at a height 5 cm the curved track. The minimum deformation in the spring is nearly equal to (take $g = 10$ m/s^2)



(a) 9.8 m (b) 9.8 cm

(c) .98 m (d) 0.009 km

15. If a_r and a_t represent radial and tangential accelerations respectively, the motion of a particle will be uniformly circular, if

(a) $a_r = 0$ and $a_t = 0$ (b) $a_r = 0$, but $a_t \ne 0$

(c) $a_r \ne 0$ but $a_t = 0$ (d) $a_r \ne 0$, and $a_t \ne 0$

16. A body revolving in a circle with uniform speed possesses

(a) normal acceleration.

(b) uniform acceleration.

(c) tangential acceleration.

(d) None of these.

17. A particle is projected from the ground at an angle of $60°$ with horizontal with speed $u = 20$ m/s. The radius of curvature of the path of the particle, when its velocity makes an angle $30°$ with horizontal is ($g = 10$ m/s^2)

(a) 10.6 m (b) 12.8 m

(c) 15.4 m (d) 24.2 m

18. A particle covers equal distances around a circular path in equal intervals of time. It has uniform nonzero rate of change of

(a) linear displacement.

(b) angular displacement.

(c) linear velocity.

(d) angular velocity.

19. A particle is moving in a circle with uniform speed. It has constant

(a) velocity (b) acceleration

(c) kinetic energy (d) displacement

20. Which of the following statements is/are true about the rotatory motion along a circular path?

(a) Linear velocity is uniform when angular velocity is uniform.
(b) Magnitude of acceleration is constant.
(c) Acceleration is directed along the tangent to the circular path.
(d) None of the above statements is correct.

21. If a particle moves in a circle, describing equal angle in equal times, its velocity vector

(a) remains constant.
(b) changes in magnitude.
(c) changes in direction.
(d) changes both in magnitude and direction.

22. A car is moving along a circular path of radius 500 m with a speed of 30 m/s. If at some instant, its speed increases at the rate of 2 m/s^2, then at that instant the magnitude of resultant acceleration will be

(a) 4.7 m/s^2 (b) 3.8 m/s^2
(c) 3 m/s^2 (d) 2.7 m/s^2

23. A particle is moving along a circular path of radius 5 m with a uniform speed 5 m/s. What will be the average acceleration when the particle completes half revolution?

(a) Zero (b) 10 m/s^2
(c) 10π m/s^2 (d) $\frac{10}{\pi}$ m/s^2

24. A stone of mass m is tied to a string of length l and rotated in a circle with a constant speed v, if the string is released, the stone flies

(a) radially outward
(b) radially inward
(c) tangentially
(d) with an acceleration $\frac{mv^2}{l}$

25. Which of the following statements is false for a particle moving in a circle with a constant angular speed?

(a) The velocity is tangent to the circle.
(b) The acceleration vector is tangent to the circle.
(c) The acceleration vector points to the centre of the circle.
(d) The velocity and acceleration vectors are perpendicular to each other.

26. In uniform circular motion

(a) both velocity and acceleration are constant.
(b) acceleration and speed are constant, but velocity changes.
(c) both acceleration and velocity change.
(d) both acceleration and speed are constant.

27. The tangential component of acceleration of a particle in circular motion is due to

(a) speed of particle.
(b) change in the direction of velocity.
(c) change in the magnitude of velocity.
(d) rate of change of acceleration.

28. The normal component of acceleration of a particle in circular motion is due to

(a) speed of the particle.
(b) change in direction of velocity.
(c) change in the magnitude of velocity.
(d) rate of change of acceleration.

29. The average acceleration vector (taken over a full-circle) for a particle having a uniform circular motion is

(a) a constant vector of magnitude $\frac{V^2}{r}$.
(b) a null vector.
(c) a vector of magnitude $\frac{V^2}{r}$ directed normal to the plane of the given uniform circular motion.
(d) equal to the instantaneous acceleration vector.

30. A particle of mass M is moving in a horizontal circle of radius R with uniform speed V. When it moves from one point to a diametrically opposite point, its

(a) kinetic energy changes by $MV^2/4$.
(b) momentum does not change.
(c) momentum changes by $2MV$.
(d) kinetic energy changes by MV^2.

31. A wheel is subjected to uniform angular acceleration about its axis. Initially, its angular velocity is zero. In the first 2 seconds, it rotates through an angle θ_1; in the next 2 seconds it rotates through an additional angle θ_2. The ratio of θ_2/θ_1 is

(a) 1 (b) 2
(c) 3 (d) 5

32. The magnitude of the displacement of a particle moving in a circle of radius a with constant angular speed ω varies with time t as

(a) $2a \sin \omega t$ (b) $2a \sin \frac{\omega t}{2}$
(c) $2a \cos \omega t$ (d) $2a \cos \frac{\omega t}{2}$

33. If the equation for the displacement of a particle moving on a circular path is given by

$$\theta = 2t^3 + 0.5,$$

where θ is in radian and t in second, then the angular velocity of the particle is

(a) 8 rad/s (b) 12 rad/s
(c) 24 rad/s (d) 36 rad/s

34. A particle is moving in a circle of radius R in such a way that at any instant the total acceleration makes an angle of 45° with radius. Initial speed of particle is v_0. The time taken to complete the first revolution is

(a) $\frac{R}{v_0}e^{-2\pi}$ (b) $\frac{R}{v_0}(1-e^{-2\pi})$

(c) $\frac{R}{v_0}$ (d) $\frac{2R}{v_0}$

35. A train is moving towards north. At one place, it turns towards north-east. Here, we observe that
(a) the radius of curvature of outer rail will be greater than that of the inner rail.
(b) the radius of curvature of the inner rail will be greater than that of outer rail.
(c) the radius of curvature of one of the rails will be greater.
(d) the radius of curvature of the outer and inner rails will be the same.

36. Two particles of equal masses are revolving in circular paths of radii r_1 and r_2 respectively with the same speed. The ratio of their centripetal forces is

(a) $\frac{r_2}{r_1}$ (b) $\sqrt{\frac{r_2}{r_1}}$

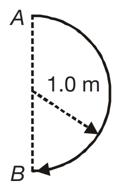
(c) $\left(\frac{r_1}{r_2}\right)^2$ (d) $\left(\frac{r_2}{r_1}\right)^2$

37. What is the angular velocity of earth

(a) $\frac{2\pi}{86400}$ rad/s (b) $\frac{2\pi}{3600}$ rad/s

(c) $\frac{2\pi}{24}$ rad/s (d) $\frac{2\pi}{6400}$ rad/s

38. In 0.1 s, a particle goes from point A to point B, moving in a semicircle of radius 1.0 m (see figure). The magnitude of the average velocity is



(a) 3.14 m/s (b) 2.0 m/s
(c) 1.0 m/s (d) Zero

39. A particle of mass m moves with constant speed along a circular path of radius r under the action of a force F. Its speed is

(a) $\sqrt{\frac{rF}{m}}$ (b) $\sqrt{\frac{F}{r}}$

(c) $\sqrt{Fmr}$ (d) $\sqrt{\frac{F}{mr}}$

40. A stone tied to the end of a string of 1 m long is whirled in a horizontal circle at a constant speed. If the stone makes 22 revolutions in 44 seconds, what is the magnitude and direction of acceleration of the stone?
(a) π^2 m/s^2, and direction along the radius towards the centre.
(b) π^2 m/s^2, and direction along the radius away from the centre.
(c) π^2 m/s^2, and direction along the tangent to the circle.
(d) $\pi^2/4$ m/s^2, and direction along the radius towards the centre.

41. 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) $\frac{ML^2\omega^2}{2}$ (b) $\frac{ML\omega^2}{2}$

(c) $\frac{ML^2\omega}{2}$ (d) $ML\omega^2$

42. Two boys are standing at the ends A and B of a ground, where $AB = a$. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other in a time t, where t is

(a) $\frac{a}{\sqrt{v^2+v_1^2}}$ (b) $\frac{a}{v+v_1}$

(c) $\frac{a}{v-v_1}$ (d) $\sqrt{\frac{a^2}{v^2-v_1^2}}$

43. In a two dimensional motion, instantaneous speed v_0 is a positive constant. Then which of the following are necessarily true?
(a) The acceleration of the particle is zero.
(b) The acceleration of the particle is bounded.
(c) The acceleration of the particle is necessarily in the plane of motion.
(d) The particle must be undergoing a uniform circular motion

In the following questions, a statement of assertion is followed by a statement of reason. While answering a question, you are required to choose the correct one out of the given five responses and mark it as
(a) *If both assertion and reason are true and reason is the correct explanation of the assertion.*
(b) *If both assertion and reason are true, but reason is not correct explanation of the assertion.*
(c) *If assertion is true, but reason is false.*
(d) *If both assertion and reason are false.*
(e) *If reason is true but assertion is false.*

44. Assertion: When an object is in uniform circular motion, its acceleration has both radial (or centripetal) and transverse components.

Reason: Acceleration in uniform circular motion is a pseudo vector

45. Assertion: Uniform circular motion is an accelerated motion.

Reason: In uniform circular motion, a body possesses centripetal acceleration.

46. Assertion: In circular motion, the centripetal and centrifugal force acting in opposite direction balance each other.

Reason: Centripetal and centrifugal force don't act at the same time because centrifugal force is a pseudo force.

47.Assertion: When a stone is moved along a circular path, the centripetal force is always balanced by centrifugal force on it.

Reason: It is in accordance with Newton's third law of motion.

48.Assertion: When a stone tied to a string is revolved along a vertical circle, the string has maximum tendency to break, when the stone is at the lowermost point.

Reason: It is because, the tension in the string is maximum at the lowermost point.

49.Assertion: The centrifugal force is a pseudo force.

Reason: It arises in an accelerated frame of reference.

50.Assertion: When a cyclist moves on the road, work done by the road on the cyclist is negative.

Reason: It is because, the frictional force between the road and the tyres of the cycle is in a direction opposite to the displacement of the cyclist.

51.Assertion: No work is done by the centripetal force, when a body is moved along a circular path.

Reason: The centripetal force is used up in making the body to move along circular path and hence no work is done.

52.Assertion: A cyclist leans inwards while taking a turn, while a man sitting in a car leans outwards on a curve.

Reason: Centripetal acceleration is acting towards the centre of the curve.

53.Assertion: Centripetal force does no work.

Reason: Force and displacement are perpendicular to each other.

54 Assertion: Work done in moving a body between two points in the gravitational field of the earth is independent of the path followed.

Reason: It is because, the gravitational force is a conservative force.

55.Assertion: When a cyclist moves on the road, work done by the cyclist on the road is zero.

Reason: It is because, the reaction of the road and displacement are perpendicular to each other.