3. Motion in Two Dimension – Multiple Choice Questions

1. Uniform Circular Motion

1. Two racing 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 each makes a complete circle in the same duration of time t. The ratio of the angular speed of the first to the second car is

(a) $m_1 : m_2$ (b) $r_1 : r_2$

(c) $1 : 1$ (d) $m_1 r_1 : m_2 r_2$

2. The angular speed of a fly wheel making 120 revolutions/minute is

(a) $2\pi\ rad/s$ (b) $4\pi^2\ rad/s$

(c) $\pi\ rad/s$ (d) $4\pi\ rad/s$

3. A particle moves in a circular orbit under the action of a central attractive force inversely proportional to the distance 'r'. The speed of the particle is

(a) Proportional to r^2 (b) Independent of r

(c) Proportional to r (d) Proportional to $1/r$

4. A cyclist turns around a curve at 15 miles/hour. If he turns at double the speed, the tendency to overturn is

(a) Doubled (b) Quadrupled

(c) Halved (d) Unchanged

5. A body of mass m is moving in a circle of radius r with a constant speed v. The force on the body is $\frac{mv^2}{r}$ and is directed towards the centre. What is the work done by this force in moving the body over half the circumference of the circle

(a) $\frac{mv^2}{r} \times \pi r$ (b) Zero

(c) $\frac{mv^2}{r^2}$ (d) $\frac{\pi r^2}{mv^2}$

6. 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) $\left(\frac{r_2}{r_1}\right)^2$

7. A stone tied to the end of a string $1m$ long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolution in 44 seconds, what is the magnitude and direction of acceleration of the stone

(a) $\pi^2/4\ ms^{-2}$ and direction along the radius towards the centre

(b) $\pi^2 ms^{-2}$ and direction along the radius away from the centre

(c) $\pi^2 ms^{-2}$ and direction along the radius towards the centre

(d) $\pi^2 ms^{-2}$ and direction along the tangent to the circle

8. When a body moves with a constant speed along a circle

(a) No work is done on it

(b) No acceleration is produced in the body

(c) No force acts on the body

(d) Its velocity remains constant

9. A car sometimes overturns while taking a turn. When it overturns, it is

(a) The inner wheel which leaves the ground first

(b) The outer wheel which leaves the ground first

(c) Both the wheels leave the ground simultaneously

(d) Either wheel leaves the ground first

10. Two bodies of mass 10 kg and 5 kg moving in concentric orbits of radii R and r such that their periods are the same. Then the ratio between their centripetal acceleration is

(a) R/r (b) r/R

(c) R^2/r^2 (d) r^2/R^2

11. A particle moves in a circle of radius 5 cm with constant speed and time period 0.2π s. The acceleration of the particle is

(a) $5 m/s^2$ (b) $15 m/s^2$

(c) $25 m/s^2$ (d) $36 m/s^2$

12. A car moves on a circular road. It describes equal angles about the centre in equal intervals of time. Which of the following statement about the velocity of the car is true

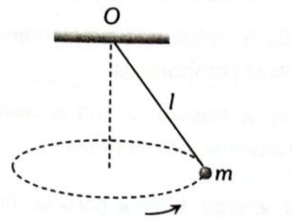
(a) Magnitude of velocity is not constant

(b) Both magnitude and direction of velocity change

(c) Velocity is directed towards the centre of the circle

(d) Magnitude of velocity is constant but direction changes

13. A point mass m is suspended from a light thread of length l, fixed at O, is whirled in a horizontal circle at constant speed as shown. From your point of view, stationary with respect to the mass, the forces on the mass are



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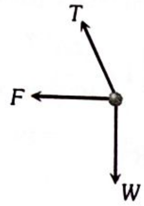

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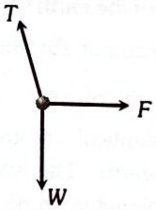

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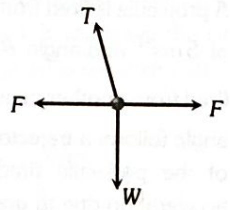


14. A car is moving with high velocity when it has a turn. A force acts on it outwardly because of

(a) Centripetal force (b) Centrifugal force

(c) Gravitational force (d) All the above

15. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 *seconds* for every circular loop. The average velocity and average speed for each circular loop respectively is

(a) $10 m/s, 10 m/s$ (b) $10 m/s, 0$

(c) 0, 0 (d) 0, 10 m/s

16. A particle moves in a circular orbit of radius r under a central attractive force $F = -\frac{k}{r}$, k is constant. The time period of its motion shall be proportional to

(a) $r^{1/2}$ (b) r

(c) $r^{3/2}$ (d) $r^{2/3}$

17. Two stones of masses m and $2m$ are whirled in horizontal circles the heavier one in radius $\frac{r}{2}$ and the lighter one in radius r. The tangential speed of lighter stone is n times that of the value of heavier stone when they experience same centripetal forces. The value of n is

(a) 3 (b) 4

(c) 1 (d) 2

18. A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45°, the speed of the car is

(a) $20 ms^{-1}$ (b) $30 ms^{-1}$

(c) $5 ms^{-1}$ (d) $10 ms^{-1}$

19. In a two dimensional motion, instantaneous speed v_0 is a positive constant. Then, which of the following are necessarily true

(a) The average velocity is not zero at any time

(b) Average acceleration must always vanish

(c) Displacements is equal time intervals are equal

(d) Equal path lengths are traversed in equal intervals

20. In a two dimensional motion, instantaneous speed v_0 is a positive constant. Then, which of the following are necessarily true

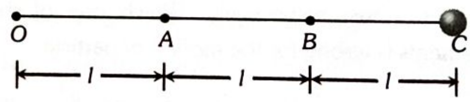
(a) The acceleration of the particle is zero

(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

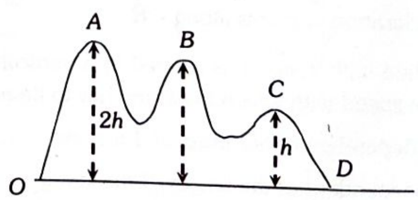
21. Three identical particles are joined together by a thread as shown in figure. All the three particles are moving in a horizontal plane. If the velocity of the outermost particle is v_0, then the ratio of tensions in the three sections of the string is



(a) 3 : 5 : 7 (b) 3 : 4 : 5

(c) 7 : 11 : 6 (d) 3 : 5 : 6

22. A small roller coaster starts at point A with a speed u on a curved track as shown in the figure



The friction between the roller coaster and the track is negligible and it always remains in contact with the track. The speed of roller coaster at point D on the track will be

(a) $(u^2 + gh)^{\frac{1}{2}}$ (b) $(u^2 + 2gh)^{\frac{1}{2}}$

(c) $(u^2 + 4gh)^{\frac{1}{2}}$ (d) u

2. Non-uniform Circular Motion

1. What is approximately the centripetal acceleration (in units of acceleration due to gravity on earth, $g = 10 m/s^2$) of an air-craft flying at a speed of 400 m/s through a circular arc of radius 0.6 km

(a) 267 (b) 169

(c) 135 (d) 302

2. A roller coaster is designed such that riders experience "weightlessness" as they go round the top of a hill whose radius of curvature is 20 m. The speed of the car at the top of the hill is between

(a) $16 m/s$ and $17 m/s$ (b) $13 m/s$ and $14 m/s$

(c) $14 m/s$ and $15 m/s$ (d) $15 m/s$ and $16 m/s$

3. A cane filled with water is revolved in a vertical circle of radius 4 m and the water just does not fall down. The time period of revolution will be

(a) 1 sec (b) 10 sec

(c) 8 sec (d) 4 sec

4. A car is moving with speed 30 m/sec on a circular path of radius 500 m. Its speed is increasing at the rate of $2 m/sec^2$, What is the acceleration of the car

(a) $2 m/sec^2$ (b) $2.7 m/sec^2$

(c) $1.8 m/sec^2$ (d) $9.8 m/sec^2$

5. The position vector of a particle $\vec{R}$ as a function of time is given by $\vec{R} = 4\sin(2\pi t)\hat{i} + 4\cos(2\pi t)\hat{j}$ where R is in meters, t is seconds and $\hat{i}$ and $\hat{j}$ denote unit vectors along $x-$ and $y-$ directions, respectively. Which one of the following statements is wrong for the motion of particle

(a) Magnitude of acceleration vector is $\frac{v^2}{R}$, where v is the velocity of particle

(b) Magnitude of the velocity of particle is $8 m/s$

(c) Path of the particle is a circle of radius $4m$

(d) Acceleration vector is along - $\vec{R}$

6. A stone tied with a string, is rotated in a vertical circle. The minimum speed with which the string has to be rotated

(a) Is independent of the mass of the stone

(b) Is independent of the length of the string

(c) Decreases with increasing mass of the stone

(d) Decreases with increasing in length of the string

7. A fan is making 600 revolutions per *minute*. If after some time it makes 1200 revolutions per *minute*, then increase in its angular velocity is

(a) $10\pi\, rad/sec$ (b) $20\pi\, rad/sec$

(c) $40\pi\, rad/sec$ (d) $60\pi\, rad/sec$

8. For a particle in a non-uniform accelerated circular motion

(a) Velocity is radial and acceleration is transverse only

(b) Velocity is transverse and acceleration is radial only

(c) Velocity is radial and acceleration has both radial and transverse components

(d) Velocity is transverse and acceleration has both radial and transverse components

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

(a) $2a\frac{s^2}{R}$ (b) $2as\left(1+\frac{s^2}{R^2}\right)^{1/2}$

(c) $2as$ (d) $2a\frac{R^2}{s}$

10. A projectile is fired from the surface of the earth with a velocity of $5 ms^{-1}$ and angle θ with the horizontal. Another projectile fired from another planet with a velocity of $3 ms^{-1}$ at the same angle follows a trajectory which is identical with the trajectory of the projectile fired from the earth. The value of the acceleration due to gravity on the planet is (in ms^{-2}) is (given $g = 9.8 ms^{-2}$)

(a) 16.3 (b) 110.8

(c) 3.5 (d) 5.9

11. One end of a string of length $1.0 m$ is tied to a body of mass $0.5 kg$. It is whirled in a vertical circle with angular frequency $4 rad/s$. The tension in the string when the body is at the lower most point of its motion will be equal to (Take $g = 10 m/s^2$)

(a) $3N$ (b) $5N$

(c) $8N$ (d) $13N$

12. A bucket full of water is revolved in vertical circle of radius $2m$. What should be the maximum time-period of revolution so that the water doesn't fall off the bucket

(a) 1 sec (b) 2 sec

(c) 3 sec (d) 4 sec

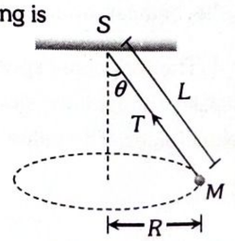
13. A string of length L is fixed at one end and carries a mass M at the other end. The string makes $2/\pi$ revolutions per *second* around the vertical axis through the fixed end as shown in the figure, then tension in the string is

(a) ML

(b) $2 ML$

(c) $4 ML$

(d) $16 ML$



14. A stone of mass 1 *kg* tied to a light inextensible string of length $L = \frac{10}{3} m$ 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 in the string is 4 and if g is taken to be $10 m/sec^2$, the speed of the stone at the highest point of the circle is

(a) $20 m/sec$ (b) $10\sqrt{3} m/sec$

(c) $5\sqrt{2} m/sec$ (d) $10 m/sec$

15. A particle is kept at rest at the top of a sphere of diameter 42 *m*. When disturbed slightly, it slides down. At what height '*h*' from the bottom, the particle will leave the sphere

(a) 14 *m* (b) 28 *m*

(c) 35 *m* (d) 7 *m*

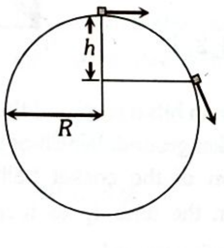
16. A particle originally at rest at the highest point of a smooth vertical circle is slightly displaced. It will leave the circle at a vertical distance *h* below the highest point such that

(a) $h = R$

(b) $h = \frac{R}{3}$

(c) $h = \frac{R}{2}$

(d) $h = \frac{2R}{3}$



3. Horizontal Projectile Motion

1. A stone is just released from the window of a train moving along a horizontal straight track. The stone will hit the ground following

(a) Straight path (b) Circular path

(c) Parabolic path (d) Hyperbolic path

2. A bomb is dropped from an aeroplane moving horizontally at constant speed. When air resistance is taken into consideration, the bomb

(a) Falls to earth exactly below the aeroplane

(b) Fall to earth behind the aeroplane

(c) Falls to earth ahead of the aeroplane

(d) Flies with the aeroplane

3. The maximum range of a gun on horizontal terrain is 16 *km*. If $g = 10 m/s^2$. What must be the muzzle velocity of the shell

(a) 200 *m/s* (b) 400 *m/s*

(c) 100 *m/s* (d) 50 *m/s*

4. An aeroplane moving horizontally with a speed of 720 *km/h* drops a food pocket, while flying at a height of 396.9 *m*. the time taken by a food pocket to reach the ground and its horizontal range is (Take $g = 9.8 m/sec^2$)

(a) 3 *sec* and 2000 *m* (b) 5 *sec* and 500 *m*

(c) 8 *sec* and 1500 *m* (d) 9 *sec* and 1800 *m*

5. A particle (*A*) is dropped from a height and another particle (*B*) is thrown in horizontal direction with speed of 5 *m/sec* from the same height. The correct statement is

(a) Both particles will reach at ground simultaneously

(b) Both particles will reach at ground with same speed

(c) Particle (*A*) will reach at ground first with respect to particle (*B*)

(d) Particle (*B*) will reach at ground first with respect to particle (*A*)

6. A ball is rolled off the edge of a horizontal table at a speed of 4 *m/second*. It hits the ground after 0.4 *second*. Which statement given below are true

(a) It hits the ground at a horizontal distance 1.6 *m* from the edge of the table

(b) The speed with which it hits the ground is 4.0 *m/second*

(c) Height of the table is 0.8 *m*

(d) It hits the ground at an angle of 60° to the horizontal

4. Oblique Projectile Motion

1. Which of the following sets of factors will affect the horizontal distance covered by an athlete in a long–jump event

(a) Speed before he jumps and his weight

(b) The direction in which he leaps and the initial speed

(c) The force with which he pushes the ground and his speed

(d) None of these

2. The speed of a projectile at its maximum height is half of its initial speed. The angle of projection is

(a) 60° (b) 15°

(c) 30° (d) 45°

3. A missile is fired for maximum range with an initial velocity of $20 m/s$. If $g = 10 m/s^2$, the range of the missile is

(a) 20 *m* (b) 40 *m*

(c) 50 *m* (d) 60 *m*

4. Galileo writes that for angles of projection of a projectile at angles $(45 + \theta)$ and $(45 - \theta)$, the horizontal ranges described by the projectile are in the ratio of (if $\theta \le 45$)

(a) 2 : 1 (b) 1 : 2

(c) 1 : 1 (d) 2 : 3

5. If a body A of mass M is thrown with velocity V at an angle of $30°$ to the horizontal and another body B of the same mass is thrown with the same speed at an angle of $60°$ to the horizontal. The ratio of horizontal range of A to B will be

(a) $1:3$ (b) $1:1$

(c) $1:\sqrt{3}$ (d) $\sqrt{3}:1$

6. For a projectile, the ratio of maximum height reached to the square of flight time is ($g = 10\ ms^{-2}$)

(a) 5 : 4 (b) 5 : 2

(c) 5 : 1 (d) 10 : 1

7. A body of mass m is thrown upwards at an angle θ with the horizontal with velocity v. While rising up the velocity of the mass after t seconds will be

(a) $\sqrt{(v\cos\theta)^2+(v\sin\theta)^2}$

(b) $\sqrt{(v\cos\theta-v\sin\theta)^2-gt}$

(c) $\sqrt{v^2+g^2t^2-(2v\sin\theta)gt}$

(d) $\sqrt{v^2+g^2t^2-(2v\cos\theta)gt}$

8. A cricketer can throw a ball to a maximum horizontal distance of 100 m. With the same effort, he throws the ball vertically upwards. The maximum height attained by the ball is

(a) 100 m (b) 80 m

(c) 60 m (d) 50 m

9. A cart is moving horizontally along a straight line with constant speed 30 m/s. A projectile is to be fired from the moving cart in such a way that it will return to the cart after the cart has moved 80m. At what speed (relative to the cart) must the projectile be fired (Take $g = 10 m/s^2$)

(a) $10 m/s$ (b) $10\sqrt{8}\ m/s$

(c) $\frac{40}{3} m/s$ (d) None of these

10. A projectile is fired at an angle of $45°$ with the horizontal. Elevation angle of the projectile at its highest point as seen from the point of projection, is

(a) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ (b) $45°$

(c) $60°$ (d) $\tan^{-1}\frac{1}{2}$

11. The horizontal range of a projectile fired at an angle of $15°$ is $50 m$. If it is fired with the same speed at an angle of $45°$, its range will be

(a) $60m$ (b) $71m$

(c) $100m$ (d) $141m$

12. A projectile is thrown in the upward direction making an angle of $60°$ with the horizontal direction with a velocity of 147 ms^{-1}. Then the time after which its inclination with the horizontal is $45°$, is

(a) 15 s (b) 10.98 s

(c) 5.49 s (d) 2.745 s

13. An object is projected with a velocity of 20 m/s making an angle of $45°$ with horizontal. The equation for the trajectory is $h = Ax - Bx^2$ where h is height, x is horizontal distance, A and B are constants. The ratio $A : B$ is ($g = 10\ ms^{-2}$)

(a) 1 : 5 (b) 5 : 1

(c) 1 : 40 (d) 40 : 1

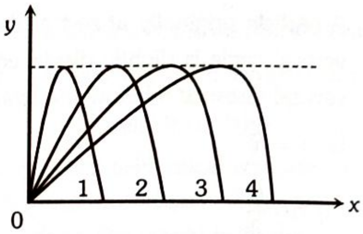
14. Figure shows four paths for a kicked football. Ignoring the effects of air on the flight, rank the paths according to initial horizontal velocity component, highest first

(a) 1, 2, 3, 4

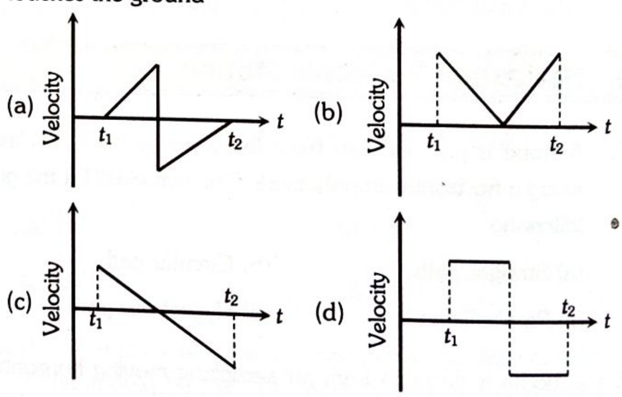
(b) 2, 3, 4, 1

(c) 3, 4, 1, 2

(d) 4, 3, 2, 1



15. A batsman hits a sixer and the ball touches the ground outside the cricket ground. Which of the following graph describes the variation of the cricket ball's vertical velocity v with time between the time t_1 as it hits the bat and time t_2 when it touches the ground



5. IIT-JEE/AIEEE

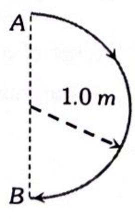
1. In 1.0 s, a particle goes from point A to point B, moving in a semicircle of radius 1.0 m (see figure). The magnitude of the average velocity is **[1999]**

(a) 3.14m/s

(b) 2.0 m/s

(c) 1.0 m/s

(d) Zero



2. 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 acceleration is **[2012]**

(a) $m_1r_1 : m_2r_2$ (b) $m_1 : m_2$

(c) $r_1 : r_2$ (d) $1 : 1$

3. Which of the following statements is false for a particle moving in a circle with a constant angular speed **[2004]**

(a) The velocity vector 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

4. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y-axis vertical) with a bead of mass m on it. The bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x-axis with a constant acceleration a. The distance of the new equilibrium position of the bead, where the bead can stay at rest with respect to the wire, from the y-axis is **[2009]**

(a) a/gk (b) $a/2gk$

(c) $2a/gk$ (d) $a/4gk$

5. A particle is moving in a circular path of radius a under the action of an attractive potential $U = -\frac{k}{2r^2}$. Its total energy is **[2018]**

(a) Zero (b) $-\frac{3}{2}\frac{k}{a^2}$

(c) $-\frac{k}{4a^2}$ (d) $\frac{k}{2a^2}$

6. 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) **[2010]**

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

7. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/sec. A plumb bob is suspended from the roof of the car by a light rigid rod of length 1.00 m. The angle made by the rod with track is **[1992]**

(a) Zero (b) 30°

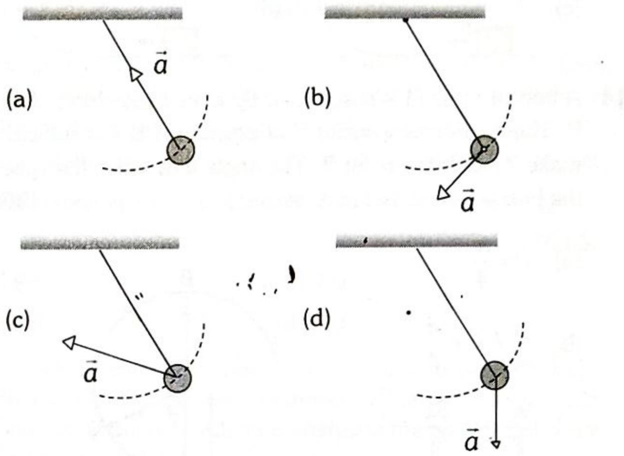
(c) 45° (d) 60°

8. A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as, $a_c = k^2rt^2$, The power delivered to the particle by the forces acting on it is **[1994]**

(a) $2\pi mk^2r^2t$ (b) mk^2r^2t

(c) $\frac{mk^4r^2t^5}{3}$ (d) Zero

9. A simple pendulum is oscillating without damping. When the displacement of the bob is less than maximum, its acceleration vector $\vec{a}$ is correctly shown in **[2002]**



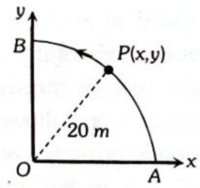
10. A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of 'P' is such that it sweeps out a length $s = t^3 + 5$, where s is in metres and t is in seconds. The radius of the path is 20 m. The acceleration of 'P' when $t = 2$ s is nearly **[2010]**

(a) $14 m/s^2$

(b) $13 m/s^2$

(c) $12 m/s^2$

(d) $7.2 m/s^2$



11. A stone tied to a string of length L is whirled in a vertical circle with the other end of the string at 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 its velocity as it reaches a position where the string is horizontal is **[1998]**

(a) $\sqrt{u^2 - 2gL}$ (b) $\sqrt{2gL}$

(c) $\sqrt{u^2 - gl}$ (d) $\sqrt{2(u^2 - gL)}$

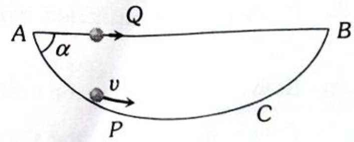
12. A particle P is sliding down a frictionless hemispherical bowl. It passes the point A at $t = 0$. At this instant of time, the horizontal component of its velocity is v. A bead Q of the same mass as P is ejected from A at $t = 0$ along the horizontal string AB (see figure) with the speed v. Friction between the bead and the string may be neglected. Let t_P and t_Q be the respective time taken by P and Q to reach the point B. Then **[1993]**

(a) $t_P < t_Q$

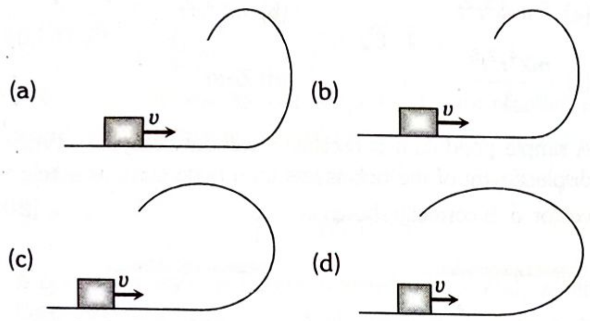
(b) $t_P = t_Q$

(c) $t_P > t_Q$

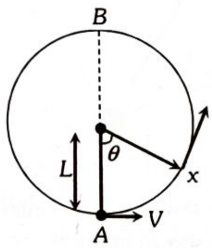
(d) All of these



13. A small block is shot into each of the four tracks as shown below. Each of the tracks rises to the same height. The speed with which the block enters the track is the same in all cases. At the highest point of the track, the normal reaction is maximum in **[2001]**



14. 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 **[2008]**



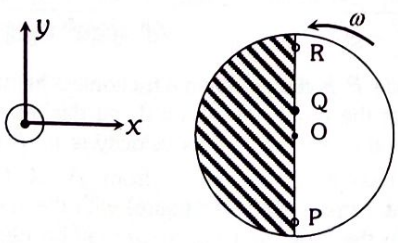
(a) $\theta=\frac{\pi}{4}$

(b) $\frac{\pi}{4}<\theta<\frac{\pi}{4}$

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

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

15. Consider a disc rotating in the horizontal plane with a constant angular speed ω about its centre O. The disc has a shaded region on one side of the diameter and an unshaded region on the other side as shown in the figure. When the disc is in the orientation as shown, two pebbles P and Q are simultaneously projected at an angle towards R. The velocity of projection is in the $y-z$ plane and is same for both pebbles with respect to the disc. Assume that (i) they land back on the disc before the disc has completed $\frac{1}{8}$ rotation. (ii) their range is less than half the disc radius, and (iii) ω remains constant throughout. Then **[2012]**



(a) P lands in the shaded region and Q in the unshaded region

(b) P lands in the unshaded region and Q in the shaded region

(c) Both P and Q land in the unshaded region

(d) Both P and Q land in the shaded region

16. A particle moves in a circular path with decreasing speed. Choose the correct statement **[2005]**

(a) Angular momentum remains constant

(b) Acceleration ($\vec{a}$) is towards the centre

(c) Particle moves in a spiral path with decreasing radius

(d) The direction of angular momentum remains constant

17. Four persons K, L, M and N are initially at the corners of a square of side of length d. If every person starts moving, such that K is always headed towards L, L towards M, M is headed directly towards N and N towards K, then the four persons will meet after **[1984]**

(a) $\frac{d}{\upsilon}$ sec

(b) $\frac{\sqrt{2d}}{\upsilon}$ sec

(c) $\frac{d}{\sqrt{2\upsilon}}$ sec

(d) $\frac{d}{2\upsilon}$ sec

18. A particle is moving with velocity $\vec{\upsilon}=K(y\hat{i}+x\hat{j})$, where K is a constant. The general equation for its path is **[2010]**

(a) $y^2=x^2+$ constant

(b) $y=x^2+$ constant

(c) $y^2=x+$ constant

(d) $xy=$ constant

19. A large number of bullets are fired in all directions with same speed υ. What is the maximum area on the ground on which these bullets will spread **[2011]**

(a) $\pi\frac{\upsilon^2}{g}$

(b) $\pi\frac{\upsilon^4}{g^2}$

(c) $\pi^2\frac{\upsilon^4}{g^2}$

(d) $\pi^2\frac{\upsilon^2}{g^2}$

20. A ball is projected with kinetic energy E at an angle of $45°$ to the horizontal. At the highest point during its flight, its kinetic energy will be **[2002]**

(a) Zero

(b) $E/2$

(c) $E/\sqrt{2}$

(d) E

21. A ball is thrown from a point with a speed υ_o at an angle of projection θ. From the same point and at the same instant a person starts running with a constant speed $\upsilon_o/2$ to catch the ball. Will the person be able to catch the ball? If yes, what should be the angle of projection **[2004]**

(a) Yes, $60°$

(b) Yes, $30°$

(c) No

(d) Yes, $45°$

22. The coordinates of a moving particle at any time 't' are given by $x=\alpha t^3$ and $y=\beta t^3$. The speed of the particle at time 't' is given by **[2003]**

(a) $\sqrt{\alpha^2+\beta^2}$

(b) $3t\sqrt{\alpha^2+\beta^2}$

(c) $3t^2\sqrt{\alpha^2+\beta^2}$

(d) $t^2\sqrt{\alpha^2+\beta^2}$

23. A projectile is projected with kinetic energy K. If it has the maximum possible horizontal range, then its kinetic energy at the highest point will be **[2007]**

(a) 0.25 K (b) 0.5 K

(c) 0.75 K (d) 1.0 K

24. A particle of mass m is projected from the ground with an initial speed u_0 at an angle α with the horizontal. At the highest point of its trajectory, it makes a completely inelastic collision with another identical particle, which was thrown vertically upward from the ground with the same initial speed u_0. The angle that the composite system makes with the horizontal immediately after the collision is **[2013]**

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{4}+\alpha$

(c) $\frac{\pi}{4}-\alpha$ (d) $\frac{\pi}{2}$

25. From a tower of height H, a particle is thrown vertically upwards with a speed u. The time taken by the particle, to hit the ground, is a n times that taken by it to reach the highest point of its path. The relation between H, u and n is **[2014]**

(a) $2gH=n^2u^2$ (b) $gH=(n-2)^2u^2$

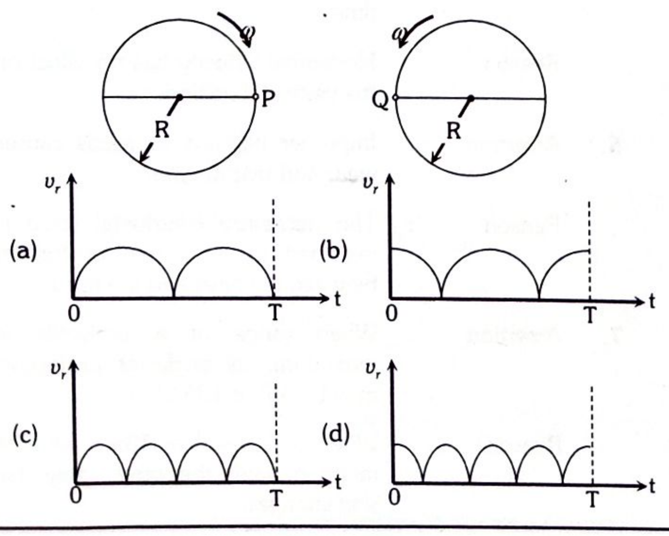
(c) $2gH=nu^2(n-2)$ (d) $gH=(n-2)u^2$

26. A projectile is given an initial velocity of $(\hat{i}+2\hat{j})$ m/s, where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical. If $g=10 m/s^2$, the equation of its trajectory is **[2013]**

(a) $y=x-5x^2$ (b) $y=2x-5x^2$

(c) $4y=2x-5x^2$ (d) $4y=2x-25x^2$

27. Two identical discs of same radius R are rotating about their axes in opposite directions with the same constant angular speed ω. The discs are in the same horizontal plane. At time $t=0$, the points P and Q are facing each other as shown in the figure. The relative speed between the two points P and Q is V_r as function of times best represented by **[2012]**



6. NEET/AIPMT

1. One end of a string of length l is connected to a particle of mass m and the other to a small peg on a smooth horizontal table. If the particle moves in a circle with speed v, the net force on the particle (directed towards the centre) is **[2017]**

2. The x and y coordinates of the particle at any time are $x=5t-2t^2$ and $y=10t$ respectively, where x and y are in meters and t in seconds. The acceleration of the particle at $t=2s$ is **[2017]**

(a) 0 (b) $5 m/s^2$

(c) $-4 m/s^2$ (d) $-8 m/s^2$

3. A uniform circular disc of radius 50 cm at rest is free to turn about an axis which is perpendicular to its plans and passes through its centre. It is subjected to a torque which produces a constant angular acceleration of $2.0 rad s^{-2}$. Its net acceleration in ms^{-2} at the end of 2.0 s is approximately **[2016]**

(a) 8.0 (b) 7.0

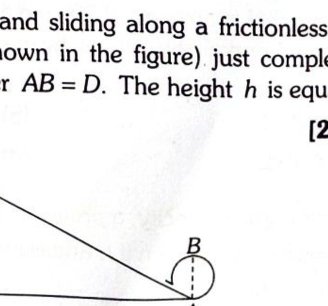
(c) 6.0 (d) 3.0

4. A particle of mass 10 g moves along a circle of radius 6.4 cm with a constant tangential acceleration. What is the magnitude of this acceleration if the kinetic energy of the particle becomes equal to $8\times10^{-4} J$ by the end of the second revolution after the beginning of the motion **[2016]**

(a) $0.1 m/s^2$ (b) $0.15 m/s^2$

(c) $0.18 m/s^2$ (d) $0.2 m/s^2$

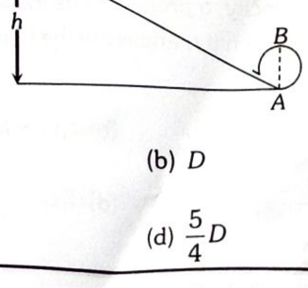
5. In the given figure, $a=15 m/s^2$ represents the total acceleration of a particle moving in the clockwise direction in a circle of radius $R=2.5 m$ at a given instant of time. The speed of the particle is **[2016]**



(a) 5.7 m/s (b) 6.2 m/s

(c) 4.5 m/s (d) 5.0 m/s

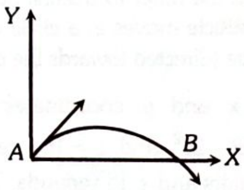
6. A body initially at rest and sliding along a frictionless track from a height h (as shown in the figure) just completes a vertical circle of diameter $AB=D$. The height h is equal to **[2018]**



(a) $\frac{3}{2}D$ (b) D

(c) $\frac{7}{5}D$ (d) $\frac{5}{4}D$

7. The velocity of a projectile at the initial point A is $(2\hat{i}+3\hat{j})\,m/s$. It's velocity (in m/s) at point B is **[2013]**



(a) $2\hat{i}+3\hat{j}$

(b) $-2\hat{i}-3\hat{j}$

(c) $-2\hat{i}+3\hat{j}$

(d) $2\hat{i}-3\hat{j}$

7. AIIMS

1. A mass is supported on a frictionless horizontal surface. It is attached to a string and rotates about a fixed centre at an angular velocity ω_0. If the length of the string and angular velocity both are doubled, the tension in the string which was initially T_0 is now **[1985]**

(a) T_0 (b) $T_0/2$

(c) $4T_0$ (d) $8T_0$

2. If a cyclist moving with a speed of 4.9 m/s on a level road can take a sharp circular turn of radius 4 m, then coefficient of friction between the cycle tyres and road is **[1999]**

(a) 0.41 (b) 0.51

(c) 0.61 (d) 0.71

3. A 1 kg stone at the end of 1 m long string is whirled in a vertical circle at constant speed of 4 m/sec. The tension in the string is 6 N, when the stone is at (g = 10 m/sec^2) **[1982]**

(a) Top of the circle (b) Bottom of the circle

(c) Half way down (d) None of the above

4. The horizontal range is four times the maximum height attained by a projectile. The angle of projection is **[1998]**

(a) 90° (b) 60°

(c) 45° (d) 30°

5. Two bodies are projected with the same velocity. If one is projected at an angle of 30° and the other at an angle of 60° to the horizontal, the ratio of the maximum heights reached is **[2001]**

(a) 3 : 1 (b) 1 : 3

(c) 1 : 2 (d) 2 : 1

6. For a given velocity, a projectile has the same range R for two angles of projection if t_1 and t_2 are the times of flight in the two cases then **[2008]**

(a) $t_1t_2 \propto R^2$ (b) $t_1t_2 \propto R$

(c) $t_1t_2 \propto \frac{1}{R}$ (d) $t_1t_2 \propto \frac{1}{R^2}$

8. Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(c) If assertion is true but reason is false.

(d) If the assertion and reason both are false.

(e) If assertion is false but reason is true.

1. Assertion : In projectile motion, the angle between the instantaneous velocity and acceleration at the highest point is 180°.

Reason : At the highest point, velocity of projectile will be in horizontal direction only.

2. Assertion : Two particles of different mass, projected with same velocity at same angles. The maximum height attained by both the particle will be same.

Reason : The maximum height of projectile is independent of particle mass.

3. Assertion : A body of mass 1 kg is making 1rps in a circle of radius 1 m. centrifugal force acting on it is $4\pi^2N$.

Reason : Centrifugal force is given by $F=\frac{mv^2}{r}$

4. Assertion : The trajectory of projectile is quadratic in y and linear in x.

Reason : y component of trajectory is independent of x-component.

5. Assertion : When a body is dropped or thrown horizontally from the same height, it would reach the ground at the same time.

Reason : Horizontal velocity has no effect on the vertical direction.

6. Assertion : Improper banking of roads causes wear and tear of tyres.

Reason : The necessary centripetal force is provided by the force of friction between the tyres and the road.

7. Assertion : When range of a projectile is maximum, its angle of projection may be 45° or 135°.

Reason : Whether θ is 45° or 135°, value of range remains the same, only the sign changes.

8. Assertion : In order to hit a target, a man should point his rifle in the same direction as target.

Reason : The horizontal range of the bullet is dependent on the angle of projectile with horizontal direction.

9. Assertion : During a turn, the value of centripetal force should be less than the limiting frictional force.

Reason : The centripetal force is provided by the frictional force between the tyres and the road.

10. Assertion : As the frictional force increases, the safe velocity limit for taking a turn on an unbanked road also increases.

Reason : Banking of roads will increase the value of limiting velocity.

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

Reason : Centripetal and centrifugal forces don't act at the same time.

12. Assertion : A safe turn by a cyclist should neither be fast nor sharp.

Reason : The bending angle from the vertical would decrease with increase in velocity.

3. Motion in Two Dimension – Answers Keys

1. Uniform Circular Motion

1	c	2	d	3	b	4	b	5	b
6	a	7	c	8	a	9	a	10	a
11	a	12	c	13	d	14	b	15	d
16	b	17	d	18	b	19	d	20	c
21	d	22	d						

2. Non-uniform Circular Motion

1	a	2	c	3	d	4	b	5	b
6	a	7	b	8	d	9	b	10	c
11	d	12	c	13	d	14	d	15	c
16	b								

3. Horizontal Projectile Motion

1	c	2	b	3	b	4	d	5	a
6	ac								

4. Oblique Projectile Motion

1	b	2	a	3	b	4	c	5	b
6	a	7	c	8	d	9	c	10	d
11	c	12	c	13	d	14	d	15	c

5. IIT-JEE/AIEEE

1	b	2	c	3	b	4	b	5	a
6	d	7	c	8	b	9	c	10	a
11	d	12	a	13	b	14	d	15	c
16	d	17	a	18	a	19	b	20	b
21	a	22	c	23	b	24	a	25	c
26	b	27	a						

6. NEET/AIPMT

1	a	2	c	3	a	4	a	5	a
6	d	7	d						

7. AIIMS

1	d	2	c	3	a	4	c	5	b
6	b								

8. Assertion & Reason

1	e	2	a	3	a	4	d	5	a
6	a	7	a	8	e	9	e	10	b
11	e	12	c						