

Motion in Two Dimension Assignment

1. A particle is moving in a plane with velocity given by $\vec{u} = u_0\hat{i} + (a\omega \cos \alpha)\hat{j}$ where \hat{i}, \hat{j} are unit vectors along x and y axes respectively. The trajectory of the particle if the particle starts from origin at $t = 0$ will be

(a) $y = a \sin\left(\frac{\omega x}{u_0}\right)$ (b) $y = a \cos\left(\frac{\omega x}{u_0}\right)$ (c) $y = \tan x$ (d) $y = \cos tx$

2. 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 ($g = 10 \text{ m/s}^2$)

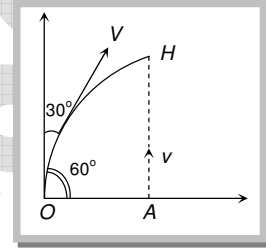
(a) $1 : 5$ (b) $5 : 1$ (c) $1 : 40$ (d) $40 : 1$

3. A ball is dropped from the top of a tower in a high speed wind. The wind exerts a steady force on the ball. The path followed by the ball will be

(a) Parabola (b) Circular arc (c) Elliptical arc (d) Straight line

4. A particle is projected with a speed V from a point O making an angle of 30° with the vertical. At the same instant, a second particle is thrown vertically upwards from a point A . The two particles reach H , the highest point on the parabolic path of particle simultaneously. Then ratio $\frac{V}{v}$ is

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



5. Two paper screens (A) and (B) are separated by a distance of 100 m . A bullet pierces (A) and (B) the hole in (B) is 10 cm below the hole in (A) . If the bullet is travelling horizontally at the time of hitting (A) . Then velocity of the bullet at (A) is

(a) 100 m/sec (b) 200 m/sec (c) 600 m/sec (d) 700 m/sec

6. A particle is thrown upward with a speed u at an angle θ with the horizontal. When the particle makes an angle ϕ with the horizontal, its speed changes to v , then

(a) $v = u \cos \theta \cos \phi$ (b) $v = u \cos \theta \sec \phi$ (c) $v = u \cos \theta$ (d) $v = u \sec \theta \cos \phi$

7. Mr. Naveen kicked off a football with an initial speed 19.6 m/s at a projection angle 45° . A receiver on the goal line 67.4 m away in the direction of the kick starts running to meet the ball at that instant. What must be his speed so that he could catch the ball before hitting the ground

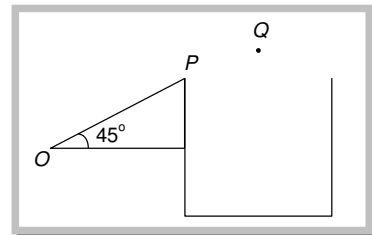
(a) 2.82 m/s (b) $2/\sqrt{2} \text{ m/s}$ (c) 39.2 m/s (d) 10 m/s

8. Two balls of same mass are thrown horizontally from the top of a tower in the opposite direction with velocities 3 m/s and 4 m/s . The distance between the balls, when their velocities are mutually perpendicular will be nearest to

(a) 10 m (b) 7 m (c) 5 m (d) 2.5 m

9. A motorcyclist starts from the bottom of a slope of angle 45° to cross the valley PR as shown in the figure. The width of the valley is 90 m and length of the slope is $80\sqrt{2} \text{ m}$. The minimum velocity at point O required to clear the valley will be

(a) 70 m/s
 (b) 30 m/s
 (c) 50 m/s
 (d) 100 m/s



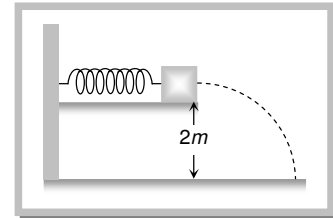
10. From the top of a tower of height h a body of a mass m is projected in the horizontal direction with a velocity v . It falls on the ground at a distance x from the tower. If a body of mass $2m$ is projected from the top of another tower of height $2h$ in the horizontal direction so that it falls on the ground at a distance $2x$ from the tower, the horizontal velocity of the second body is

(a) $2v$ (b) $\sqrt{2}v$ (c) $\frac{v}{2}$ (d) $\frac{v}{\sqrt{2}}$

11. A particle is projected with a speed $2\sqrt{gh}$ so that it clears two walls of equal height h which are at a distance $2h$ from each other. The time taken by the particle to pass between the two walls is

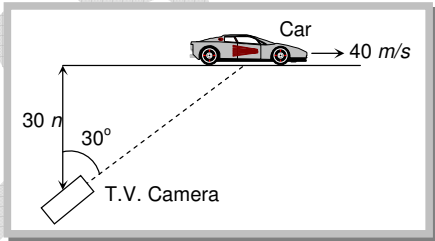
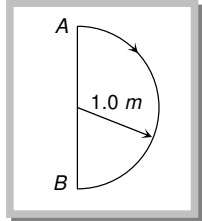
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- (a) $\sqrt{\frac{2h}{g}}$ (b) $\frac{2h}{g}$ (c) $\sqrt{2} \frac{h}{g}$ (d) $2\sqrt{\frac{h}{g}}$
12. A projectile is thrown in the upward direction making an angle of 60° with the horizontal direction with a velocity of 147 ms^{-1} . Then the time 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. A cannon ball is fired with a velocity v in a direction making an angle θ with the horizontal. At the highest point of its path it breaks into two parts of equal masses. One of the parts retraces the initial path of the ball. The speed of the second part immediately after explosion in m/s will be
 (a) $\frac{3}{2} v \cos \theta$ (b) $\sqrt{\frac{3}{2}} v \cos \theta$ (c) $2v \cos \theta$ (d) $3v \cos \theta$
14. From the top of a tower of height 40 m a ball is projected upwards with a speed of 20 m/s at an angle of elevation of 30° . Then the ratio of the total time taken by the ball to hit the ground to its time of flight (time taken to come back to the same elevation) is (take $g = 10 \text{ ms}^{-2}$)
 (a) 2 : 1 (b) 3 : 1 (c) 3 : 2 (d) 4 : 1
15. A shell is fired vertically upwards with a velocity v_1 from the deck of a ship travelling at a speed of v_2 . A person on the shore observes the motion of the shell as parabola whose horizontal range is given by
 (a) $\frac{2v_1^2 v_2}{g}$ (b) $\frac{2v_1 v_2^2}{g}$ (c) $\frac{2v_1 v_2}{g}$ (d) $\frac{2v_1^2 v_2^2}{g}$
16. A boy standing on a long rail road car throws a ball straight upward. The car is moving on the horizontal road with an acceleration of 1 m/s^2 and the projection velocity in the vertical direction is 9.8 m/s. How far behind the boy will the ball fall on the car
 (a) 1 m (b) 2 m (c) 4 m (d) 0.5 m
17. A projectile has a maximum range of 16 km. At the highest point of its motion, it explodes into two equal masses. One mass drops vertically downwards the horizontal distance covered by the other mass from the time of explosion is
 (a) 8 km (b) 16 km (c) 24 km (d) 32 km
18. Two projectiles A and B thrown with velocities v and $\frac{v}{2}$ have the same range. If B is thrown at an angle of 15° to the horizontal, A must have been thrown at an angle
 (a) $\sin^{-1}\left(\frac{1}{16}\right)$ (b) $\sin^{-1}\left(\frac{1}{4}\right)$ (c) $2 \sin^{-1}\left(\frac{1}{4}\right)$ (d) $\frac{1}{2} \sin^{-1}\left(\frac{1}{8}\right)$
19. A body is projected with a speed u in such a direction that the maximum height obtained is equal to its horizontal range. The horizontal range is
 (a) $\frac{8u^2}{17g}$ (b) $\frac{5u^2}{17g}$ (c) $\frac{6u^2}{13g}$ (d) $\frac{u^2}{2g}$
20. A body of mass m thrown horizontally with velocity v , from the top of tower of height h touches the level ground at a distance of 250 m from the foot of the tower. A body of mass $2m$, thrown horizontally with a velocity $v/2$, from the top of tower of height 4 h will touch the level ground at a distance from the foot of tower
 (a) 250 m (b) 500 m (c) 125 m (d) $250\sqrt{2} \text{ m}$
21. A small block of mass 0.1 kg is pressed against a horizontal spring fixed at one end to compress the spring through 5.0 cm as shown in figure. The spring constant is 100 N/m. When released the block moves horizontally till it leaves the spring. Where will it hit the ground 2 m below the spring
 (a) Vertically below the edge on which the mass is resting
 (b) At a horizontal distance of 1 m from free end of the spring
 (c) At a horizontal distance of 2 m from free end of the spring
 (d) At a horizontal distance of $\sqrt{2} \text{ m}$ from free end of the spring

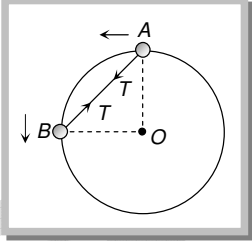
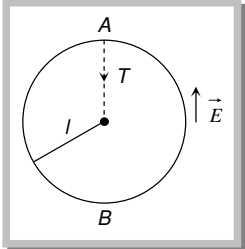


22. From a point on the ground at a distance 2 metres from the foot of a vertical wall, a ball is thrown at an angle of 45° which just clears the top of the wall and afterward strikes the ground at a distance 4m on the other side. The height of the wall is
 (a) $\frac{2}{3} m$ (b) $\frac{3}{4} m$ (c) $\frac{1}{3} m$ (d) $\frac{4}{3} m$
23. A ball is thrown from the top of a tower with an initial velocity of 10 m/s at an angle of 30° above the horizontal. It hits the ground at a distance of 17.3 m from the base of the tower. The height of the tower ($g = 10 \text{ m/s}^2$) will be
 (a) 10 m (b) 12 m (c) 110 m (d) 100 m

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24. A ball is projected from the ground at a speed of 10 m/s making angle 30° with the horizontal. Another ball is simultaneously released from a point on the vertical line along the maximum height of the projectile. Both the balls collide at the maximum height of the projectile. What was the initial height of the second ball
 (a) 1.0 m (b) 1.25 m (c) 2.0 m (d) 2.5 m
25. A hose shoots a stream of water at an angle of 60° the horizontal with a velocity of 20 m/s . Water will strike a wall at a distance of 10 m at a height
 (a) 5.36 m (b) 10.22 m (c) 12.42 m (d) 16.84 m
26. A particle having a mass of 0.5 kg is projected under gravity with a speed of 98 m/sec at an angle of 60° . The magnitude of the change in momentum in N-sec of the particle after 10 seconds is
 (a) 0.5 (b) 49 (c) 98 (d) 490
27. A projectile is fired at 30° with momentum p . neglecting friction the change in momentum on return to the ground will be
 (a) Zero (b) 30% (c) 60% (d) 100%
28. A ball is thrown up with a given angle to the horizontal. Then the total change of momentum by the instant it returns to the ground is equal to
 (a) Acceleration due to gravity \times total time of flight (b) Weight of the ball \times half the time of flight
 (c) Weight of the ball \times total time of flight (d) None of these
29. A racing car is travelling along a track at a constant speed of 40 m/s . A T.V. camera men is recording the event from a distance of 30 m directly away from the track as shown in figure. In order to keep the car under view in the position shown, the angular speed with which the camera should be rotated, is
 (a) $4/3 \text{ rad/sec}$
 (b) $3/4 \text{ rad/sec}$
 (c) $8/3\sqrt{3} \text{ rad/sec}$
 (d) 1 rad/sec
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30. A particle is moving along a circular path with angular speed ω about the axis passing through the centre. What will be its angular speed about a point on the other end of the diameter through the instantaneous position of the particle
 (a) 2ω (b) ω (c) $\omega/2$ (d) $\omega/4$
31. In 1.0 s a particle goes from point A to point B, moving in a semicircle of radius 1.0 m . The magnitude of the average velocity is
 (a) 3.14 m/s
 (b) 2.0 m/s
 (c) 1.0 m/s
 (d) Zero
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32. An aeroplane is moving in a horizontal circle with a uniform speed of 141 km/hr . Change in its velocity in one fourth revolution, from its initial direction will be
 (a) 100 km/hr at an angle of 90° (b) 141 km/hr at an angle of 135°
 (c) 200 km/hr at an angle of 135° (d) Zero
33. A particle is moving in a circular path with velocity varying with time as $v = 1.5 t^2 + 2t$. If 2 cm the radius of circular path, the angular acceleration at $t = 2 \text{ sec}$ will be
 (a) 4 rad/sec^2 (b) 40 rad/sec^2 (c) 400 rad/sec^2 (d) 0.4 rad/sec^2
34. An astronaut is rotating in a rotor of radius 4 m . If he can withstand maximum acceleration of $10g$, the maximum permissible frequency of rotor will be
 (a) $\frac{\pi}{5} \text{ Hz}$ (b) $\frac{2\pi}{5} \text{ Hz}$ (c) $\frac{5\pi}{5} \text{ Hz}$ (d) $\frac{5}{2\pi} \text{ Hz}$
35. A particle of mass m_1 is fastened to one end of a string and one of m_2 to the middle point, the other end of the string being fastened to a fixed point on a smooth horizontal table. The particles are then projected, so that the two portions of the string are always in the same straight line and describes horizontal circles. Find the ratio of tensions in the two parts of the string
 (a) $\frac{m_1}{m_1 + m_2}$ (b) $\frac{m_1 + m_2}{m_1}$ (c) $\frac{2m_1 + m_2}{2m_1}$ (d) $\frac{2m_1}{m_1 + m_2}$

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36. A toy cart is tied to the end of an unstretched string of length a . When revolved, the toy cart moves in a horizontal circle of radius $2a$ with a time period T . Now the toy cart is speeded up until it moves in a horizontal circle of radius $3a$ with a period T' . If Hooke's law holds, then
- (a) $T' = T$ (b) $T' = (3/2)T$ (c) $T' = (\sqrt{3}/2)T$ (d) $T' = \sqrt{(3/2)}T$
37. A chain of 125 links is $1.25m$ long and has a mass of $2kg$. With the ends fastened together it is set rotating at 3000 rev/min . Find the centripetal force on each link
- (a) $3.14N$ (b) $314 N$ (c) $\frac{1}{3.14}N$ (d) $\frac{1}{314} N$
38. Two bodies A and B each of mass m are tied together by a light string. Both bodies are bound to move on a frictionless ring in a vertical plane as shown in figure. Both bodies are released from rest from the positions shown in figure. Just after releasing, the tension in the string will be
- (a) $2mg$
 (b) $\frac{mg}{2}$
 (c) $\frac{mg}{\sqrt{2}}$
 (d) $mg\sqrt{2}$
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39. 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) $\frac{ML\omega^2}{2}$ (b) $ML\omega^2$ (c) $\frac{ML\omega^2}{4}$ (d) $\frac{ML^2\omega^2}{2}$
40. A cylindrical tube of length ' l ' radius ' r ' is filled by liquid of density ρ is rotated (ω), horizontally about an axis-through one of its edges. The force at the other end by the liquid is,
- (a) $\rho\pi r^2\omega^2 l^2$ (b) $\frac{\rho\pi r^2\omega^2 l}{2}$ (c) $\frac{\rho\pi r^2\omega^2 l^2}{2}$ (d) None of these
41. The driver of a car travelling at velocity v suddenly see a broad wall in front of him at a distance d . He should
- (a) Brake sharply (b) Turn sharply (c) (a) and (b) both (d) None of the above
42. A racing car of 1000 kg moves round a banked track at a constant speed of 108 km/hr . Assuming the total reaction at the wheels is normal to the track and the horizontal radius of the track is 100 m , calculate the angle of inclination of the track to the horizontal (take $g = 10 \text{ m/s}^2$)
- (a) 12° (b) 27° (c) 42° (d) 65°
43. In the above question, what is the reaction at the wheels
- (a) 13450 N (b) 26900 N (c) 6725 N (d) 40350 N
44. A car is moving with a speed v on a road inclined at an angle θ in a circular arc of radius r , the minimum coefficient of friction, so that the car does not slip away
- (a) $\frac{v^2}{rg} = \mu \tan \theta$ (b) $\mu = v^2 / rg$ (c) $\frac{v^2 \cos \theta - rg \sin \theta}{rg \cos \theta + v^2 \sin \theta}$ (d) $\frac{v^2 \cos \theta - rg \sin \theta}{rg \cos \theta - v^2 \sin \theta}$
45. A particle of mass M carries a charge $+Q$. It is attached to a string of length l and is whirled in a vertical circle in electric field \vec{E} directed upwards; what should be the minimum speed of the particle at A so that it loops the loop
- (a) $[(g + QE/M) l]^{1/2}$
 (b) $[(g - QE/M) l]^{1/2}$
 (c) $[(Mg + QE) l]^{1/2}$
 (d) $[(Mg - QE) l]^{1/2}$
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46. 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
- (a) $\sqrt{u^2 - 2gL}$ (b) $\sqrt{2gL}$ (c) $\sqrt{u^2 - gl}$ (d) $\sqrt{2(u^2 - gL)}$

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47. In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, m is the mass, e is the charge on the electron and ϵ_0 is the vacuum permittivity, then speed of the electron is
- (a) $\sqrt{\frac{\epsilon_0 a_0 m}{e}}$ (b) $\frac{e}{\sqrt{\epsilon_0 a_0 m}}$ (c) $\frac{\sqrt{4\pi\epsilon_0 a_0 m}}{e}$ (d) $\frac{e}{\sqrt{4\pi\epsilon_0 a_0 m}}$
48. A rubber band of length l has a stone of mass m tied to its one end. It is whirled with speed v so that the stone describes a horizontal circular path. The tension T in the rubber band is
- (a) Zero (b) mv^2/l (c) $>(mv^2)/l$ (d) $<mv^2/l$
49. A particle of mass m is executing uniform circular motion on a path of radius r . If p is the magnitude of its linear momentum. The radial force acting on the particle is
- (a) pmr (b) $\frac{rm}{p}$ (c) $\frac{mp^2}{r}$ (d) $\frac{p^2}{rm}$
50. The second's hand of a watch has length 6 cm. Speed of end point and magnitude of difference of velocities at two perpendicular positions will be
- (a) 6.28 and 0 mm/s (b) 8.88 and 4.44 mm/s (c) 8.88 and 6.28 mm/s (d) 6.28 and 8.88 mm/s