PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

CIRCULAR MOTION

Sample Problem

1. Find the magnitude of the centripetal acceleration of a car following a curve of radius 500 m at a speed of 25.0 m/s (about 90 km/h). Compare the acceleration with that due to gravity for this fairly gentle curve taken at high speed.

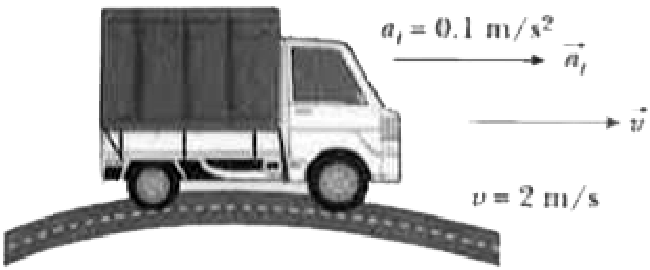
View Text Solution

2. IAF fighter pilots have long worried about taking a turn too tightly. As a pilot's body undergoes centripetal acceleration, with the head toward the center of curvature, the blood pressure in the brain decreases, leading to loss of brain function.

There are several warning signs. When the centripetal acceleration is 2g or 3g, the pilot feels heavy. At about 4g, the pilot's vision switches to black and white and narrows to tunnel vision. If that acceleration is sustained or increased, vision ceases adn, soon after, the pilot is unconscious a condition known as g-LOC for g-induced loss of consciousness. What is the magnitude of the acceleration in g units, of a pilot whose aircraft enters a horizontal circular turn with a velocity of $\bar{v}ati = \left(400\hat{i} + 300\hat{j}\right)$ m/s and 25 s later leaves the turn with a velocity of $\bar{v}\hat{j} = \left(- 400\hat{i} - 300\hat{j}\right)$ m/s? Assume speed is constant.

Watch Video Solution

3. A truck increases its speed at constant rate of $0.1m/s^2$ and it passes over a semicircular bridge of radius 40 m. At the time car reaches the top of the bridge, its speed is 2m/s. What are the magnitude and direction of the to total acceleration vector at this moment?



(a)

Watch Video Solution

4. Largely because of riding in cars, you are used to horizontal circular motion. Vertical circular motion would be a novelty. In this sample problem, such motion seems to defy the gravitational force.

In a 1901 circus performance, Allo Dare Devil Diavolo introduced the stunt of riding a bicycle in a loop the loop. Assuming that the loop is a circle with radius R=2.7m, what is the least speed v that Diavolo and hisbicycle could have at the top of the loop to remain in contact with it there?

Watch Video Solution

5. Even some seasoned roller coaster riders blanch at the thought of riding the Rotor, which is essentially a large, hollow cylinder that is rotated rapidly around its central axis.

Before the ride begins, a rider enters the cylinder through a door on the side and stands on a floor, up against a canvas covered wall. The door is closed, and as the cylinder begins to turn, the rider, wall, and floor move in unison. When the rider's speed reaches some predetermined value, the floor abruptly and alarminglly falls away. The rider does not fal with it but instead is pinned to the wall while the cylinder rotates, as if an unseen (and somewhat unfriendly) agent is pressin the body to the wall. Later, the floor is eased back to the rider's feet, the cylinder slows. and the rider sinks a few centimeters to regain footing on the floor. (Some riders consider all this to be fun.)

Suppose that the coefficient of static friction μ_s between the rider's clothing and the canvas is 0.40 and that the cylinder's radius R is 2.1 m.

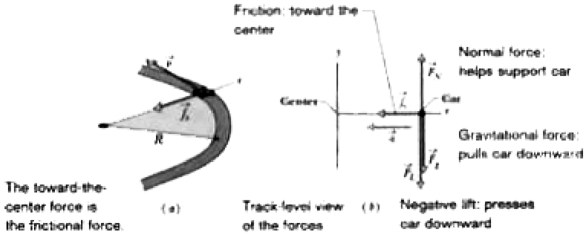
a. What minimum speed v must the cylinder and rider have if the rider is not to fall when the floor drops?

b. If the rider's mass is 49 kg, what is the magnitude of the centripetal force on her?

Watch Video Solution

6. Upside down racing: A modern race car is designed so that the passing air pushes down on it, allowing the car to travel much faster through a flat turn in a Grand Prix without friction failing. This downward push is called negative lift. Can a race can have so muchh negative lift it could be driven upside won on a long ceiling, as done fictionally by a sedan in the first Men in Black movie?

Figure represents a Grand Prix race car of mass m=600 kg as it travels on a flat in a circular arc of radius R=100m. Becuase of the shape of the car and the wings on it, passing air exerts a negative lift $\overrightarrow{F}_L$

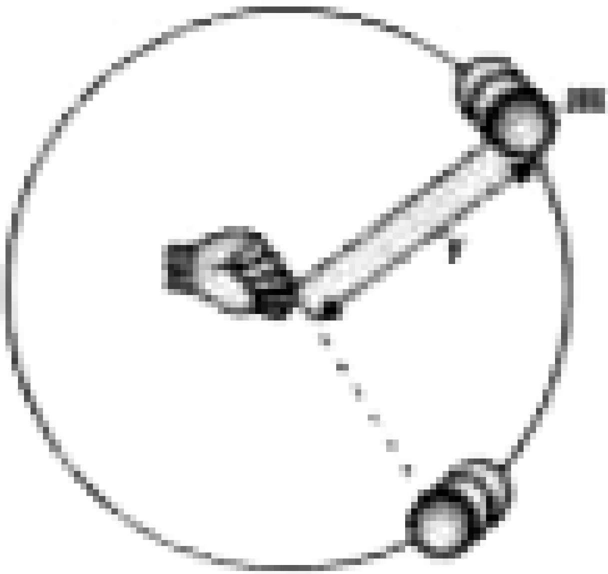


downward on the car. The coefficient of static friction between the tires and the track is 0.75. (Assume that the forces on the four tires are identical).

a. If the car is on the verge of sliding out of the turn when its speed is 28.6 m/s what is the magnitude of the negative lift $\vec{F}_L$, acting downward on the car?

b. The magnitude F_L of the negative lift on a car depends on the square of the car's speed v^2, just as the drag force does. Thus the negative lift on the car here is greater when the car travels faster, as it does on a straight section of track. What is the magnitude of the negative lift for a speed of 90 m/s?

7. A ball of mass 0.5 kg is attached to a light string of length 2m. The ball is whirled on la horizontal smooth surface is a circle of rdius 2 m as shown in fig. If the string can withstand tension up to 100 N, what is the maximum speed at which the bal can be whirled.



Watch Video Solution

8. This problem is quite challenging in setting up but takes only a few of algebra to solve. We deal with not only uniformly circular motion but also a ramp. However we will not need a tilted coordinate system as with other ramps. Insttead we can take a freeze frame of the motion and work with simply horizontaly and vertical axes. As always in this chapter, the starting point will be to apply Newton's second law, but that will required us to identify the force component that is responsible for the uniform circular motion.

Curved portions of highways. are always banked (tilted) to prevent cars from sliding off the highway. When a highway is dry, the frictional force between the tires and the road surface may be enough to prevent sliding. When the highway is wet, however, the frictional force may be neglifible, and baking is then essential. fig represents a car of mass m as it moves at a constant speed v to 20m/s around a banked circular track of radius R=190m. (It is a normal car, rather than a race car, which meas that any vertical force from the passing air is negligible). If the frictional force from the track is negligible, what bank angle θ prevents sliding?

View Text Solution

9. Particle A is suspended by a string tied at point O from the roof of a room. The same particle is also tied to one of the walls of that room, at point B. Find the tension in OA before and after AB is cut.

Watch Video Solution

10. A small ball of mass m is attached to a string of lengh R and moves in a vertical circle with a speed v m/s about a fixed

point O as illustrated in fig. Find the tension in the string, when it makes an angle θ with the vertical, in terms of v, θ and g.

Watch Video Solution

Problems

1. A police officer in hot pursuit drives her car through a circular turn of radius 300 m with a constant speed of 75.0km/h. Her mass is 55.0 kg. What are (a) the magnitude and (b) the angle (relative to vertical) of the net force the officer on the car seat?

Watch Video Solution

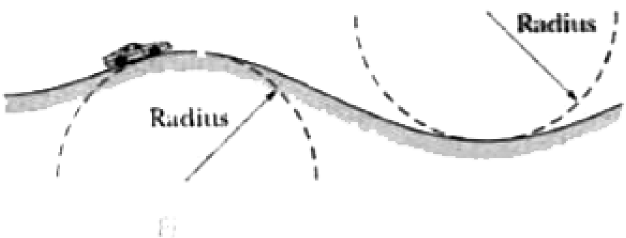
2. A circular motion addict of mass 80 kg rides a Ferris wheel around in a vertical circle of radius 12 m at a constant speed of 5.5 m/s (a) What is the period of the motion? What is the magnitude of the normal force on the addict from the seat when bothh go through (b) the highest point of the circular path and (c) the lowest point?

Watch Video Solution

3. A roller coaster car has mass of 1300 kg when fully loaded with passengers. As the car passes over the top of a circular hil of radius 20m, its speed is not changing. At the top of the hill, what are the (a) magnitude F_N and (b) direction (up or down) of the normal force on the car from the track if the car's speed is v=11m/s? What are (C) F_N and (d) the direction if v=14m/s?

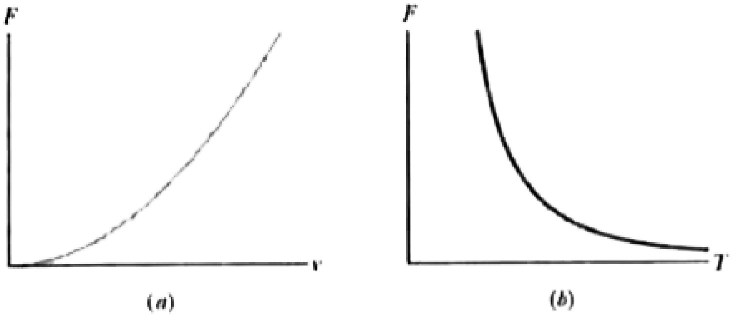
Watch Video Solution

4. In Fig a car is driven at constant speed over a circular hill and then into a circular valley with the same radius. At the top of the hill, the normal force on the driver from the car seat is 0. The driver's mass is 80.0 kg. what is the magnitude of the normal force on the driver from the seat when the car passes through the bottom of the valley?



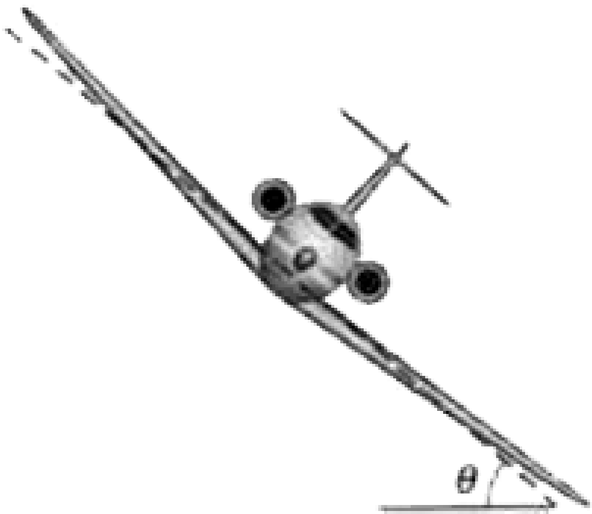
Watch Video Solution

5. An 85.0 kg passenger is made to move along a circular path of radius r=3.50 m in uniform circular motion. (a) Figure is a plot of the required magnitude F of the net centripetal force for a range of possible values of the passenger's speed v . What is the plot's slope at $v = 8.30 m/s$? (b) Figure is a plot of F for a range of possible values of T, the period of the motion. What is the plot's slope at $T = 2.50 s$?



Watch Video Solution

6. An airplane is flying in a horizontal circle at a speed of 600 km/h. If its wings aire tilted at $\theta = 40^{\circ}$ to the horizontal what is the radius of the circle in which the plane is flying? Assume that the required force is provided entirely by an aerodynamic lift that is perpendicular to the wing surface.



View Text Solution

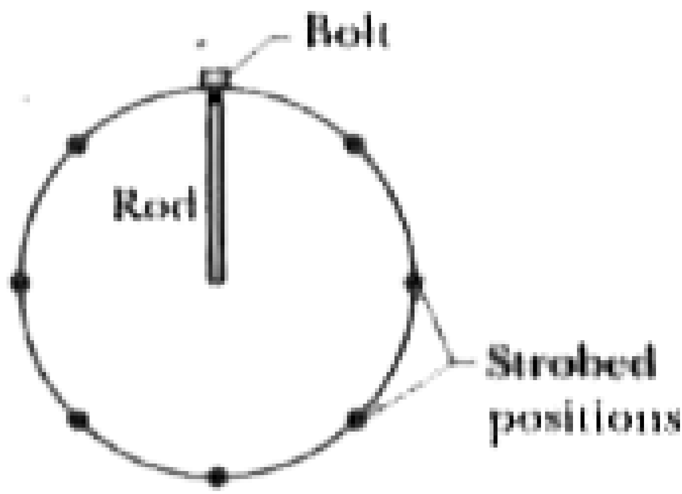
7. An amusement park ride consists of a car mvoing an a vertical circle on the end of a rigid boom of negligible mass. The combined weight of the car and riders is 6.0 kN, the circle's radius is 10m. At the top of the circle, what are the (a) magnitude F_B and (b) direction (up or down) of the force on the car from the boom if the car's speed is v=5.0m/s? What are (c) F_B and (d) the direction if v=12m/s?

Watch Video Solution

8. An old streetcar rounds a flat corner of radius 10.5 m at 16 km/h. What angle with the vertical will be made by the loosely hanging and straps?

Watch Video Solution

9. A bolt is threaded onto one end of a thin horizontal rod, and the rod is then rotated horizontally about its other end. An engineer monitors the motion by flashing a strobe lamp onto the rod and bolt, adjusting the strobe rate until the bolt appears to be in the same eight during each full rotation of the rod. The strobe rate is 2000 flashes per second, the bolt has mass 33 g and is at radius 4.0 cm. What is the magnitude of the force on the bolt from the rod?



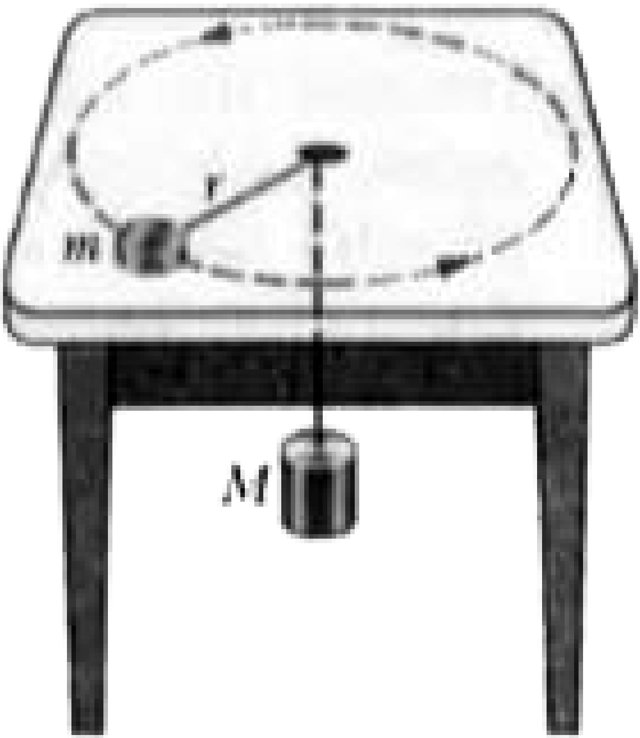
View Text Solution

10. A banked circular highway curve is designed for traffice moving at 65km/h. The radius of the curve is 200 m. Traffic is moving along the highway at 40 km/h on rainy day. What is

the minimum coefficient of friction between tires and road that will allow cars to take the turn without sliding off the road? (Assume the cars do not have negative lift.)

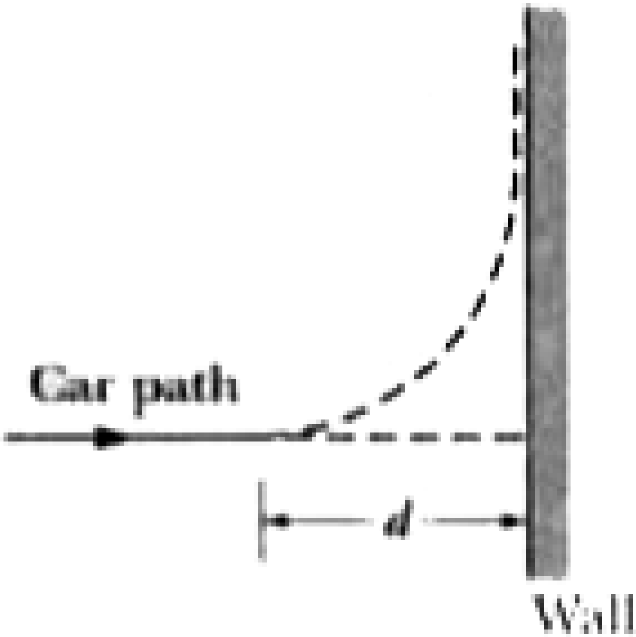
Watch Video Solution

11. A puck of mas m=1.50 kg slides in a circle of radius $r = 25.0$ cm on a frictionless table while attached to a hanging cylinder of mass M=2.50 kg by means of a cord that extends through a hole in the table. What speed keeps the cylinder at rest?



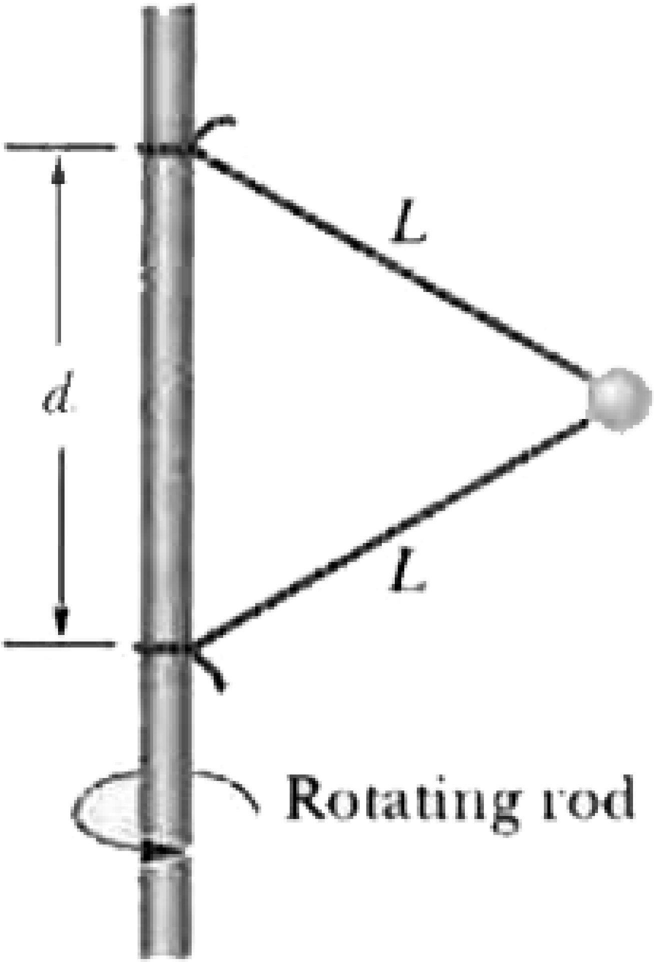
Watch Video Solution

12. Brake or turn? Figure depicts an overhead view of a car's path as the car travels toward a wall. Assume that the driver begins to brake the car when the distance to the wall is d=107 m, and take the car's mass a m=1400 kg, its initial speed as $v_0 = 35$ m/s and the coefficient of static friction as $\mu_s = 0.50$. Assume that car's weight is distributed evenly on the four wheels, even during braking (a) What magnitude of static friction is needed (between tires and road) to stop the car just as it reaches the wall? (b) What is the maximum possible static friction $f_{s\,,\text{max}}$/ (c) If the coefficient of kinetic frictic between the (sliding) tires and the road is $\mu_k = 0.40$, at what speed will the car hit the wall? To avoid the crash, a driver could elect to turn the car so that it just barely misses the wall, as shown in the figure. (d) What magnitude of frictional force would be required to keep the car in a circular path of radius d and at the given speed v_0, so that the car moves is a quarter circle and then parallel to the wall? (e) Is the required force less than $f_{s\,.\max}$ so that a circular path is possible?



View Text Solution

13. In fig 1.34 kg ball is connected by means of two mass less strings, each of length L=1.70m, to a vertical, rotating rod. The strings are tied to the rod with separation d=1.70 m and are taut. The tenion in the upper string is 35N. What are the (a) tension in the lower string, (b) magnitude of the net (b) magnitude of the net force $\overrightarrow{F}_{\text{net}}$ on the all, and (c) speed of the ball? (d) What is the direction of $\overrightarrow{F}_{\text{net}}$?



Watch Video Solution

14. A cylindrical bucket filled with watert is whirled around in a vertical circle of radius r. What can be the minimum speed at the top of the path if water does not all out from the bucketgt? If it continues with this speed, what normal contact force the bucket exerts on water at teh lowest point of the path?

Watch Video Solution

15. A metal ring of mass m and radius R is placed on a smooth horizontal table and is set rotating about its own axis in such a way that each part of the ring moves with a speed v. Find the tension in the ring.

Watch Video Solution

16. Imagine the standard kilogram is located on Earth's equator, where it moves in a circle of radius $6.400x10^6$m (Earth's radius) at a constant speed of 465m/s due to Earth's rotation. (a) What is the magnitude of the centripetal force on the standard kilogram during the rotation? Imagine that the stadard kilogram hangs from a spring balance at that location and assume that it would weigh exactly 9.80 N if Earth did not rotate. (b) What is the reading on the spring balance, that is what is the magnitude of the spring balance from the standard kilogram.

View Text Solution

17. A car is rounding a flat curve of radius R=220 m at the curve's maximum design speed v=94.0km/h. What is the magnitude of the net force on the seat cushion from a passenger with mass m=85.0 kg?

View Text Solution

18. A motorcycle has to move with a constant speed on an overbridge which is in the form of a circular arc of radius R and has a total length L. Suppose the motorcycle starts from the highest point.

a. what can its maximum velocity be for which the contact with the road is not broken at the highest point?

b. If the motorcycle goes at speed $\frac{1}{\sqrt{2}}$ times the maximum found in part a. where will it lose the contact with the road?

c. What maximum uniform speed can it maintain on the bridge if it does not lose contact anywhere on the bridge?

Watch Video Solution

19. A car moving at a speed of 36 km/hr is taking a turn on a circular road of radus 50 m. A small wooden plate is kept on the seat with its plane perpendilcular to the radius of the circular road figure. A small bock of mass 100 g is kept on the seat which rests against the plate. The friction coefficient between the block and the plate is $\mu = 0.58.$ a. Find the normal contact force exerted by the plate on the block. b. The plate is slowly turned so that the angle between the normal to the plate and the radius of the road slowly increases Find the angle at which the block will just start sliding on the plate.

Watch Video Solution

20. A block of mass m moves on a horizontal circle against the wall of a cylindrical room of radius R. The floor of the room onwhich the block moves is smoth but the friction coefficient between the wall and the block is μ. The block is given an initial speed v_0. As a function of the speed v write a. the normal force by the wall on the block. b. thefrictional force by the wall and c. the tangential acceleration of the block. d. Integrate the tangential acceleration $\left(\frac{dv}{dt} = v\frac{dv}{ds}\right)$ to obtain the speed of the block after one revoluton.

Watch Video Solution

21. A track consists of two circular pars ABC andCDE of equal rdius 100 m and joined smoothly as shown in figure.Each part sutends a right ngle at its centre. A cycle weighing 100 kg together with rider travels at a constant speed of 18 km/h on the track. A. Findteh nromal contct force by tehroad on the cycle whenit is at B and at D. b.Findteh force of friction exerted by the track on the tyres when the cycle is at B,C and D. c. Find the normal force between teh road and teh cycle just before and just after the cycle crosses C. d. What should be the minimum friction coefficient between the road and the tyre, which will ensure that teh cyclist can move with constant speed? Take $g = 10\frac{m}{s^2}$

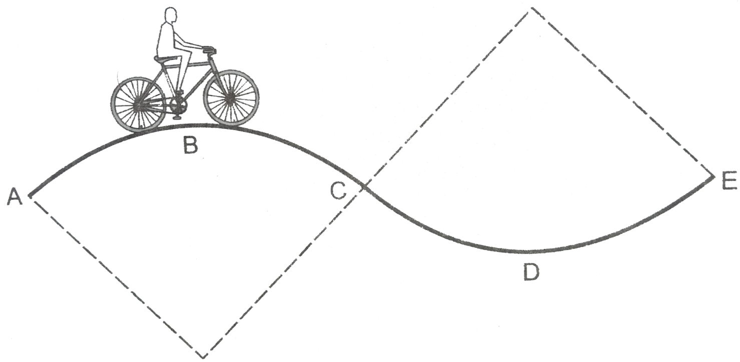


Figure 7-E1

Watch Video Solution

22. A table with smooth horizontal surface is turning at an angular speed ω about its axis. A groove is made on the surface along a radius and a particle is gently placed inside the groove at a distance a from the centre. Find the speed of the speed of the particle as its distance from teh centre becomes L.

Watch Video Solution

23. Suppose the bob of the previous problem has a speed of 1.4 m/s when the string makes an angle of 0.20 radian with the vertical. Find the tension at this instant. You can use $\cos\theta = 1 - \frac{\theta^2}{2}$ and $\sin\theta = \theta$ for small theta`.

Watch Video Solution

24. A block of mass m is kept on a horizontal ruler . The friction coefficient between the ruler and the block is μ . The ruler is fixed at one end the block is at a distance L from the fixed end . The ruler is rotated about the fixed end in the horizontal plane through the fixed end

a. What can the maximum angular speed be for which the block does not slip?

b. If the angular speed of the ruler is uniform increase from zero at an angular acceleration a at angular speed will the block slip?

Watch Video Solution

25. A table with smooth horizontal surface is fixed in a cabin that rotates with a uniform angular velocity ω in a circular pathof radius R. A smooth groove AB of length $L(< < R)$ is made on the surface of the table. The groove makes an angleθ with the radius OA of the circle in which the cabin rotates. A small particle is kept at the point A in the groove and is released to move along AB. Find the time taken by tehparticle to reach the point B.

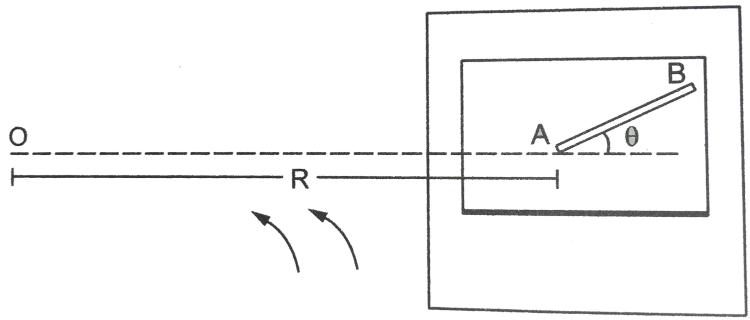


Figure 7-E3

Watch Video Solution

26. A car starts rest, on a horizontal circular road of radius R, the tangential acceleration of the car is a. The friction coefficient between the road and the tyre is μ Find the speed at which car will skid and also find the distance after travelling it skids.

Watch Video Solution

27. A table with smooth horizontal surface is placed in a cabin which moves in a circle of a large radius R Figure. A smooth pulley of small radius is fastened to the table. Two masses m and 2m placed on te tableare connected through a string going over the pulley. Initially the masses are held by a personwith the strings aslong teh outward radius and then the system is released from rest (with respect to the cabin). Find the magnitude of the initial acceleration of the mases as seen from the cabin and the tension in the starting.

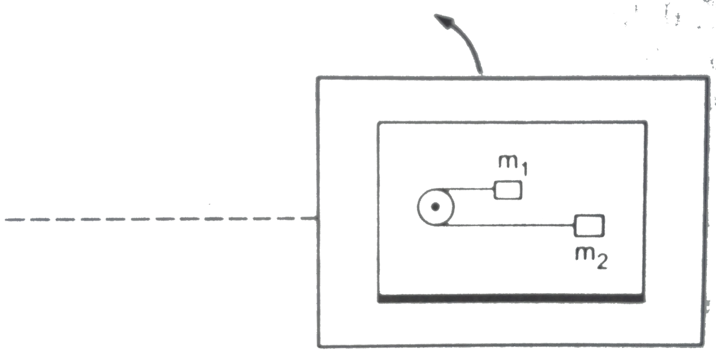
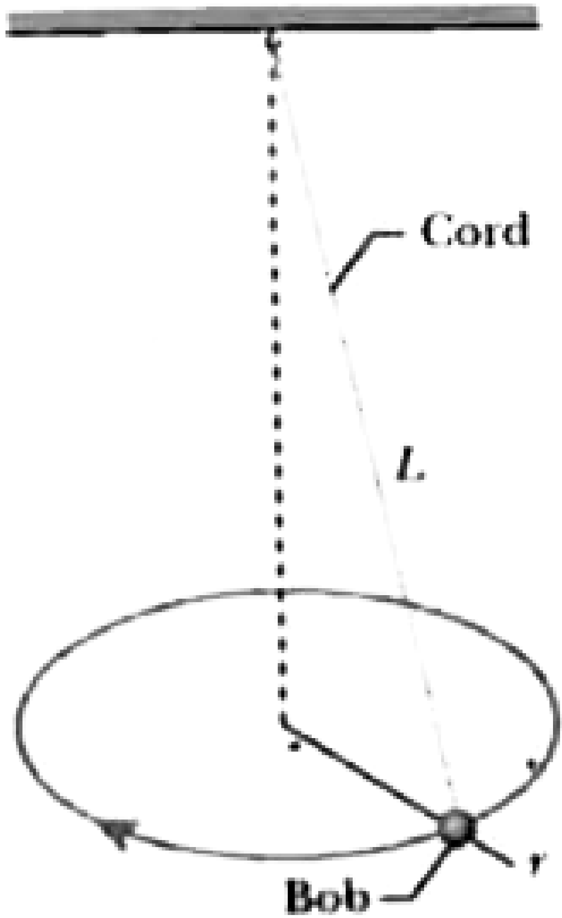


Figure 7-E5

Watch Video Solution

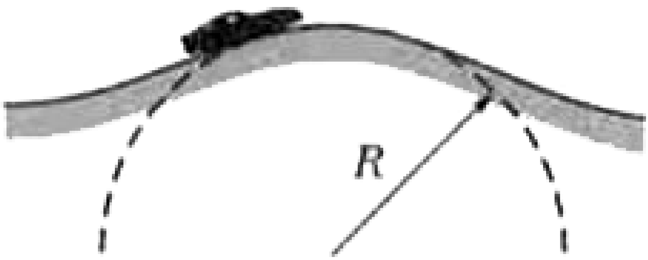
28. Figure shows a conical pendulum, in which the bob (the small object at the lower end of the cord) moves in a horizontal circle at constant speed. (The cord sweeps out a cone as the bob rotates). The bob has a mass of 0.040 kg, the string has length L=0.90 m and negligible mass, and teh bob follows a circular path of circumfernece 0.94m. What are (a)

The tension in the string and (b) the period of the motion?



Watch Video Solution

29. In fig a stuntman drives a car (without negative lift) over the top of a hill, the cross section of a hill, the cross section of which can be approximated by a circle of radius R=250 m. What is the greatest speed at which he can drive without the car leaving the road at the top of the hill?



Watch Video Solution

30. A car weighting 10.7 kN and travelling at 13.4 m/s without negative lift attmepts to round an unbanked curve with a radius of 61.0 m. (a) What magnitude of the frictional force on the tires is required to keep the car on its circular path? (b) If the coefficient of static friction betwen the tires and the road is 0.350, is the attempt at taking the curve successful?

Watch Video Solution

31. A certain string can withstand a maximum tensiion of 40 N without breaking. A child ties a 0.37 kg stone to one end and, holding the other end, whirls the stone in a vertical circle of radius 0.91 m, slowly increasing the speed until the string breaks. (a) Where is the stone on its path when the string breaks? (b) What is the speed of the stone as the string breaks?

Watch Video Solution

32. When a small 2.0 g coin is placed at a radius of 5.0 cm on a horizontal turntable that makes three full revolution is in 3.14s, the coin does not slip. What are (a) the coin's speed, the (b) magnitude and (c) direction (radially inward or outward) of the coin's acceleration, and the (d) magnitude and (e) direction(inward or outward) of the frictional force on the coin? The coin is on the verge of slipping if it is placed at a radius of 10 cm. (f) What is the coefficient of static friction between coin and turntable?

View Text Solution

33. A child placed a picnic basket on the outer rim of merry go round that has a radius of 4.6 m and revolves once every 30 s(a) What is the speed of a point on that rim? (b) What is the lowest value of the coefficient of static friction between basket and merry go round that allows the basket to stay on the ride?

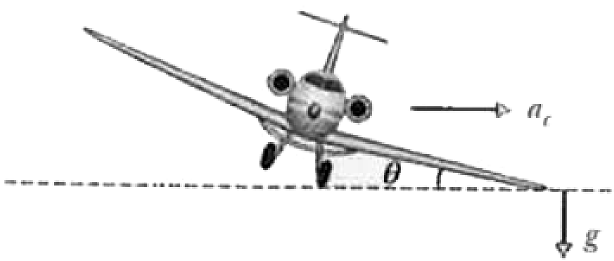
Watch Video Solution

34. In the Bohr model of the hydrogen atom an electron is pictured rotating in a circle (with a radius of $0.5 \times 10^{-10} m$) about the positive nucleus of the atom. The centripetal force is furnished by the electric attraction of the positive nucleus for the negative electron. How large is this force if the electron is moving with a speed of 2.3×10^6 m/s?

(The mass of an electron is $9 \times 10^{-31} kg$)

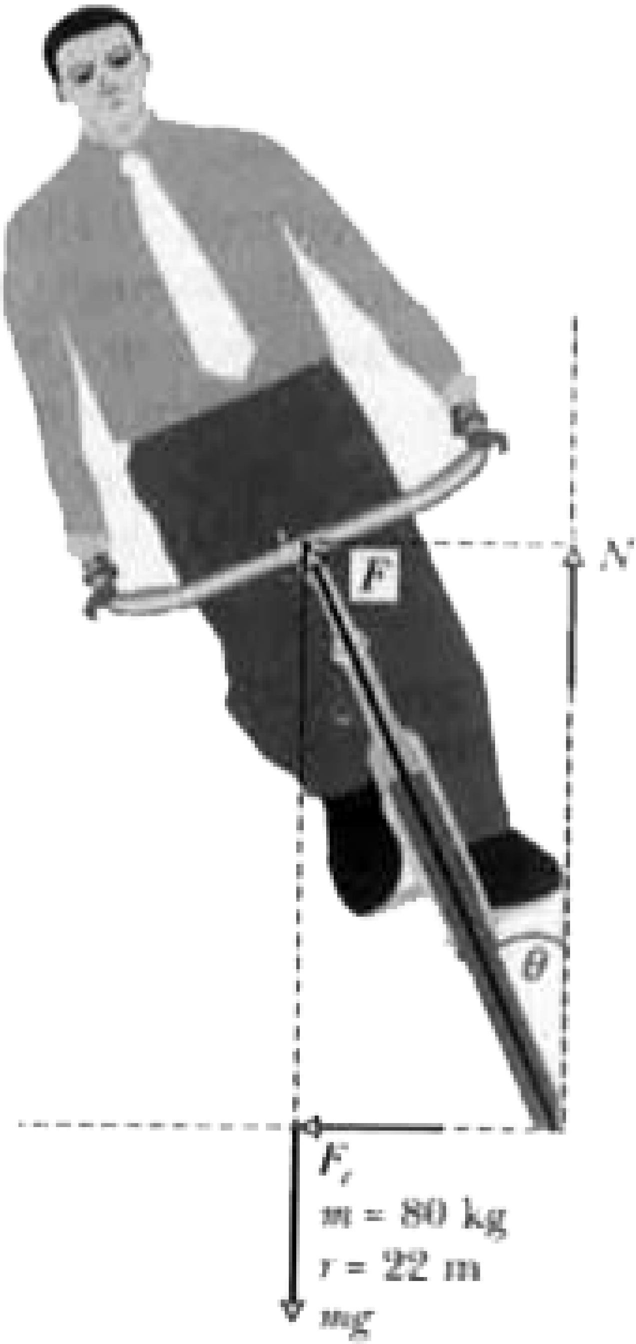
Watch Video Solution

35. As indicated in fig a plane flyilng at constant speed is banked at angle θ in order to fly in a horizontal circle of radius r. The aerodynamic lift force acts generally upward at right angles to the plane's wings and fuselage. Thislift force corresponds to the tension provided by the string in a conical pendulum or the normal force of a tanked road. (a) Obtain the equation for the required banking angle θ in terms of v,r and g . (b) What is the required angle for $v = 60\frac{m}{s}$ (216km/h) and r=1.0 km?



Watch Video Solution

36. A boy on a bicycle pedals around a circle of 22 m radius at a speed of 10m/s. The combined mass of the boy and the bicycle combined mass of the boy and the bicycle is 80 kg. (a) What is the centripetal force exerted by the pavement on the bicycle? (b) What is the upward force exerted by the pavement on the bicycle? See fig.



Watch Video Solution

37. At the equator, the effective value of g is smaller than at the this the centripetal acceleration due to the Earth's rotation. The magnitude of the centripetal acceleration must be subtracted from the magnitude of the acceleration due pruely to gravity in order to obtain the effective value of (a) Calcule the fractional diminution of g at the equator. Express your result as a percentage (b) How short would hte Earth's period of rotation have be in order for objects at the equator to the weightless (that is in order for the effective value of g to be zero)? (c) How woud be the period found in part (b) compare with that of a satellite skimming the surface of an aireles Earth?

View Text Solution

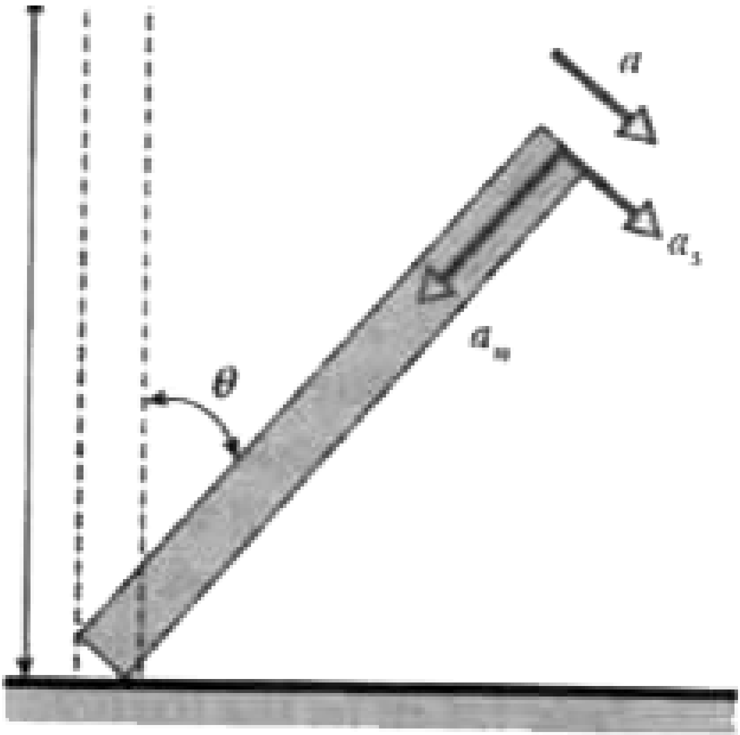
38. A particle is to slide along a horizontal circular path on the inside of a funnel. The surface of the tunnel is friction less. How fast must the particle be moving (in terms of r and θ) if it is to execute this motion?

Watch Video Solution

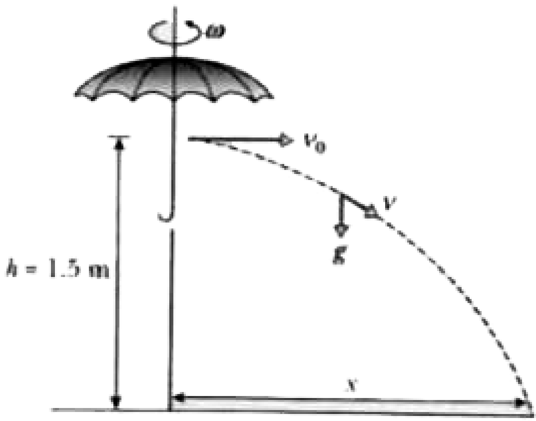
39. A roller coaster is designed such that riders experience "weightlessness" as they go round the top of a hill whose radius of curvature is $20m$. The speed of the car at the top of the hill is between

Watch Video Solution

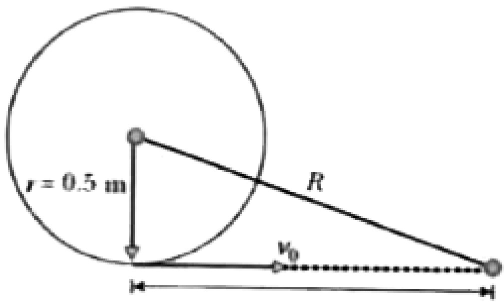
40. The angular acceleration of the toppling pole shown in fig is given by $a = k \sin \theta$, where θ is the angle between the of the pole and the vertical, and k is aconstant. The pole starts from rest at $\theta = 0$. Find (a) the tan gential and (b) the centripetal acceleration of the upper end of the pole in terms of k, θ, and (the length of the pole.)



41. A wet open umbrella is held up right as shown in fig and is twirled about the handle at a uniform rate of 21 rev in 44s. If the rim of the umbrella is a circle k 1 m in diameter, and the height of the rim above thefloor is 1.5 m. The drops of water spun off the rim hit the floor at a distance x from theaxis. Find x.



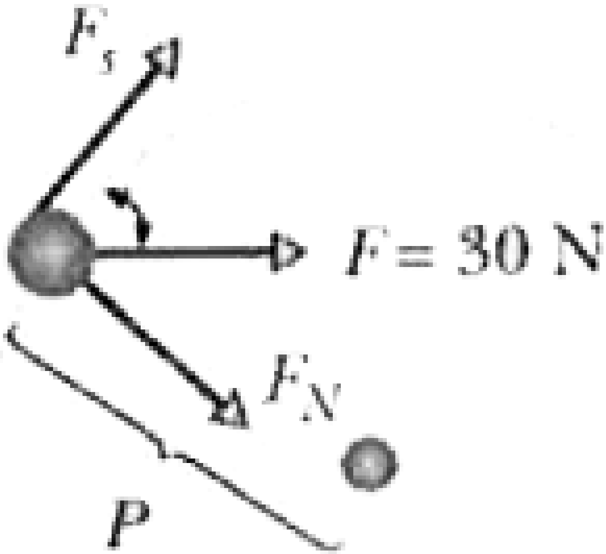
(a) Side view



(b) Top view

Watch Video Solution

42. A particle whose mass is 2 kg moves with a speed of 44 m/s on a curved path. The resultant force acting on the particle at a particular point of the curve is 30 N at 60° to the tangent to the curve, as shown in fig. At the point, find (a) the radius of curvature of the curve and (b) the tangential acceleration of the particle.



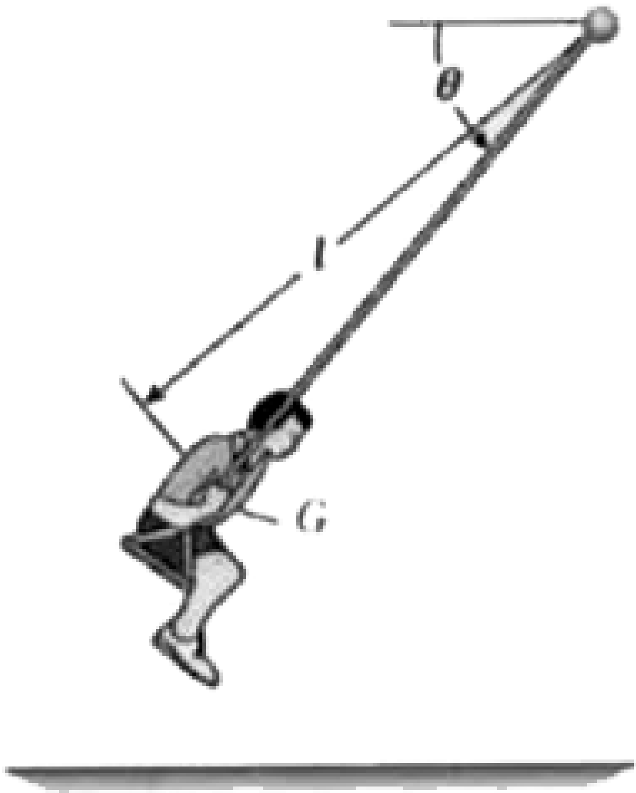
Watch Video Solution

43. A bug is crawling with constant speed v, along the spoke of a bicycle wheel, of radius a while the bicycle moves down the road with constant speed v. Find the accelerations of the bug as observed by a man standing beside the road, along the perpendicular to the spoke of the wheel.

Watch Video Solution

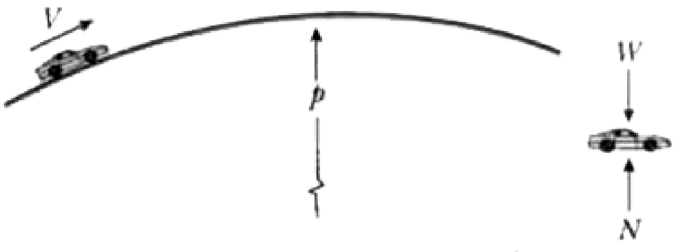
44. At the instant $\theta = \theta_1$ in the fig the boy's center of mass G has speed v_G, Determine the rate of increase in his speed and the tension in each of the two supporting cords of the swing at this instant. The boy has a weight W. Neglect his size and the mass of the seat and cords. Given m=20kg

$\theta_I = 53^\circ, v_G = 3$ m/s $l = 2$m



Watch Video Solution

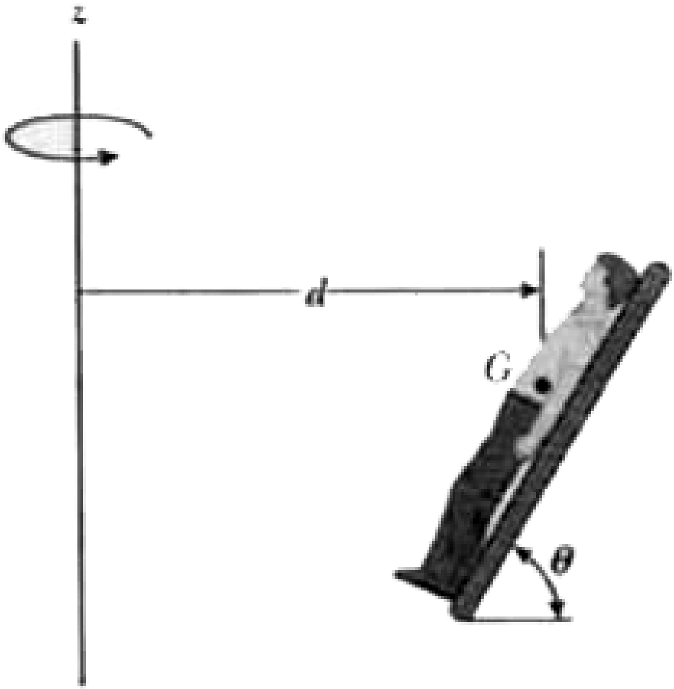
45. If the crest of the hill has a radius of curvature p determine the maximum constnat speed at which the car can travel over it without leaving the surface of the road. Neglect the size of the car in the calculation. The car has mass m. Given p=40m, m=1700kg, $g = 10m/s^2$



Watch Video Solution

46. The man has weight W and lies against the cushion for which the coefficient of static friction is μ_s. Determine the resultant normal and frictional forces the cushion exerts on him if due to rotation about the z axis, he has constant speed v. Neglect the size of the man. Given, W=150,

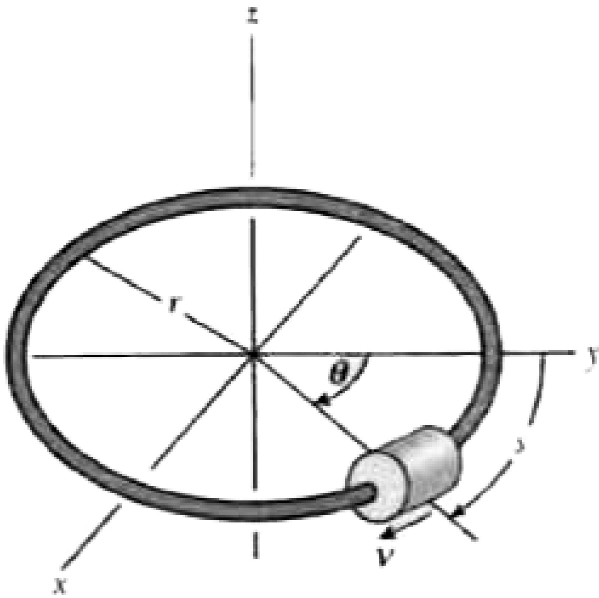
$lb, \mu_s = 0.5, v = 20 f\frac{t}{s}, \theta = 60^\circ, d = 8ft, g = 32ft/s^2$



Watch Video Solution

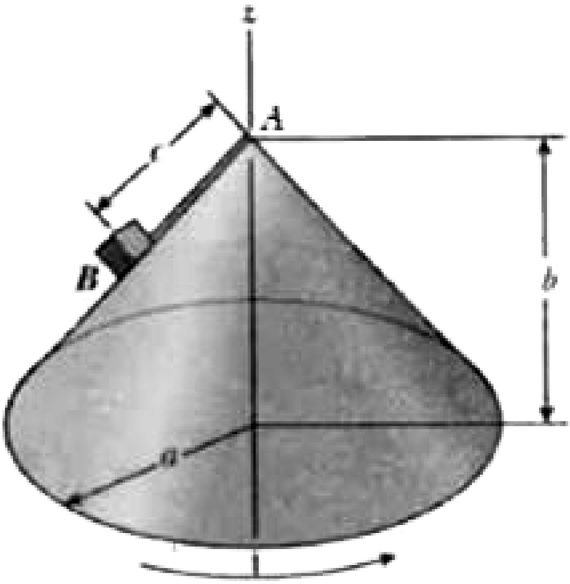
47. A collar having a mass M and negligible size slides over the surface of a horizontal circular rod for which the coefficient of kinetic friction is μ_k If the colar is given a speed v_1 and then released at $\theta = 0^\circ$, determine how far d it slides on the rod before coming to rest. Given, $M = 0.75kg, r = 100mm, \mu_k = 0.3, g = 9.81m/s^2, v_1 = 4m/s$

.



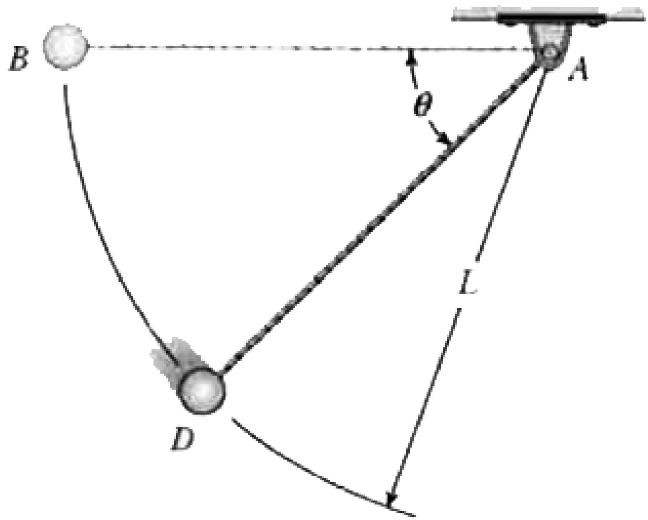
Watch Video Solution

48. The smooth block B, having mass M is attached to the vertex A of the right circular cone using a light cord. The cone is rotating at a constant angular rate about the z axis such that the block attains speed v. At this speed, determine the tension in the cord and the reaction which thecone exerts on the block. Neglect the size of the block. Given M=0.2kg, v=0.5m/s,a=300mm, b=400mm,c=200mm,$g = 9.81 m / s^2$



Watch Video Solution

49. The pendulum bob B of mass M is released from rest when $\theta = 0^\circ$. Determine the intitial tension in the cord and also at the instant the bob reaches point D, $\theta = \theta_1$. Neglect the size of the bob. Give $M = 3kg, \theta_1 = 45^\circ, L = 2m, g = 9.81m/s^2$.



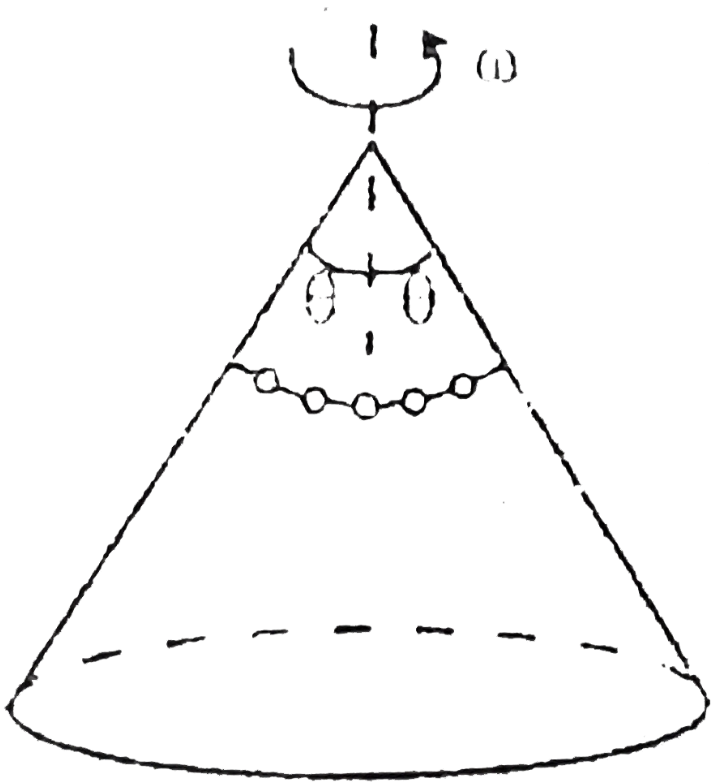
Watch Video Solution

50. A small coin is placed on a flat, horizontal turbtable. The turnable is observed to make three revolutions is 3.14 s. (a) What is the speed of the coin when it rides without slipping at a distance of 5.0 cm from the center of the turntable? (b) What is the acceleration (magnitude and direction) of the coin? (c) What are the magnitude and direction of the frictional force acting on the coi if the coin has a mass of 2.0 g? (d) What is the coefficient of static friction between the coin and the turntable if the coin is observed to slide off the turntable when it is more than 10 cm from the center of the turntable?

View Text Solution

51. A chain of mass 'm' and radius 'r' is placed onto a cone of semi vertical angle θ. Cone rotated with angular velocity ω.

Find the tension in the chain if it does not slide on the cone.



Watch Video Solution

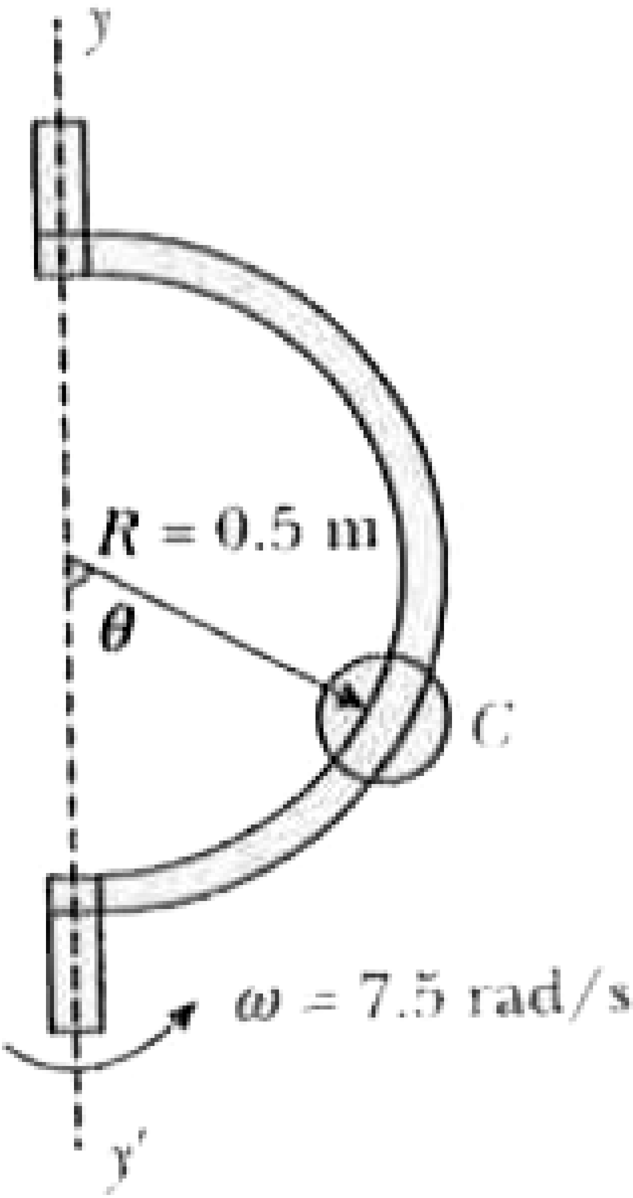
52. A hemispherical bowl of radius R is rotated about its axis of symmetry which is kept vertical.A small block is kept in the bowl at a position where the radius makes an angle θ with the vertical. The block rotates with the bowl without any slipping. The friction coefficient between the block and the bowl surface is μ. Find the range of the angular speed for which the block will not slip.

Watch Video Solution

53. A cat sits on a stationary merry go round, at a radius of 5.4 m from the center of the ride. Then the operator turns on the ride and brings it up to its proper turning rate of one complete rotation every 6.0 s. What is the least coefficient of static friction between the cat and the merry go round that will allow the cat to stay in place, without sliding?

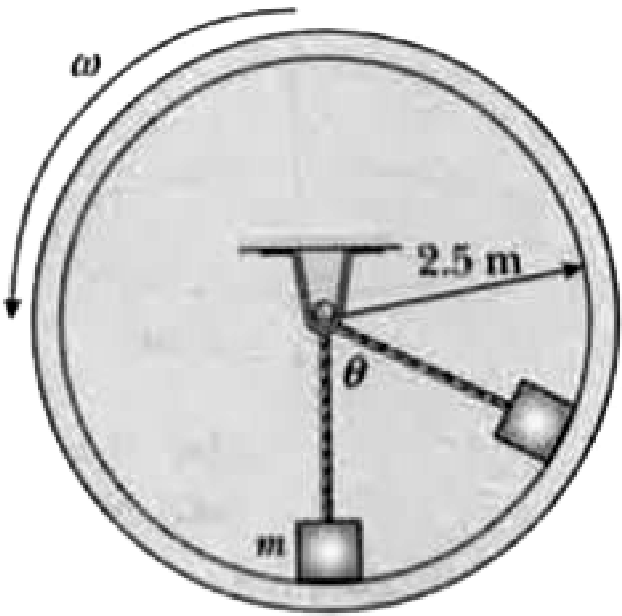
Watch Video Solution

54. A small 0.25 kg collar C many slide on a semicircular rod which is made to rotate about the vertical axis yy' at a constant of 7.5 rad/s. Determine the value of θ for which the collar will not slide on the rod, assuming no friction between the collar and the rod.



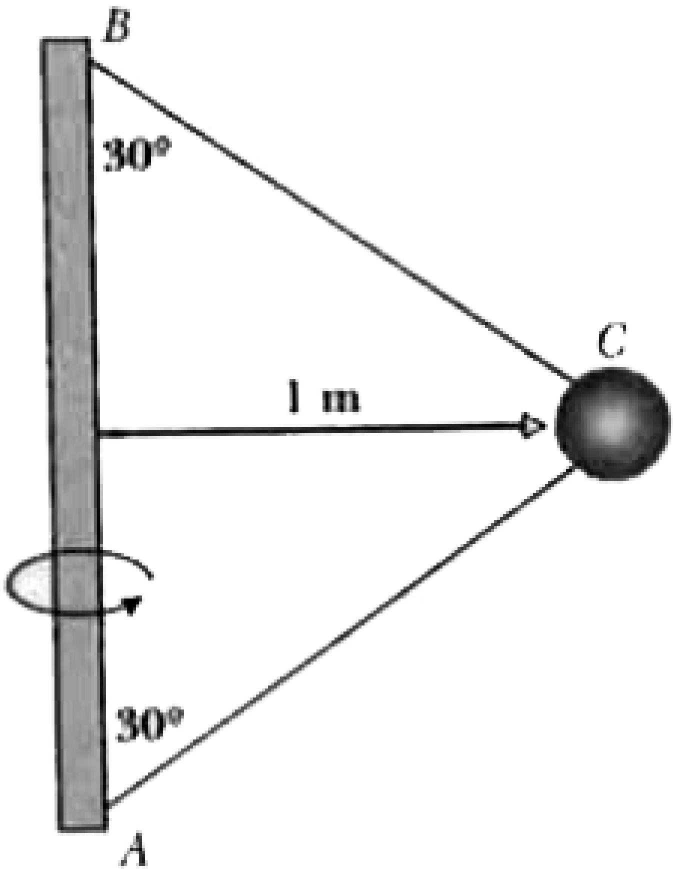
Watch Video Solution

55. A package of mass m is placed inside a drum that rotates in the vertical plane at the constant angular speed $\omega = 1.36$ rad/s. If the package reaches the position $\theta = 45^{\circ}$ before slipping determine the coefficient of friction between the package and drum. See fig.



Watch Video Solution

56. The mass at C is attached to the vertical pole AB by two wires. The assembly is rotating about AB at the constant angular speed ω. If the force in wire BC is twice the force in AC, determine the value of ω, see fig.



Watch Video Solution

Practice Questions Single Correct Choice Type

1. A particle is revolving in a circle with increasing its speed uniformly. Which of the following is constant ?

A. Centripetal acceleration

B. Tangential acceleration

C. Angular acceleration

D. None of these

Answer: B

Watch Video Solution

2. A particle of mass 2 kg is moving along a circular path of radius 1 m. If its angular speed is $2\pi \ \text{rad s}^{-1}$, the centripetal force on it is

A. $4\pi N$

B. $8\pi N$

C. $4\pi^4 N$

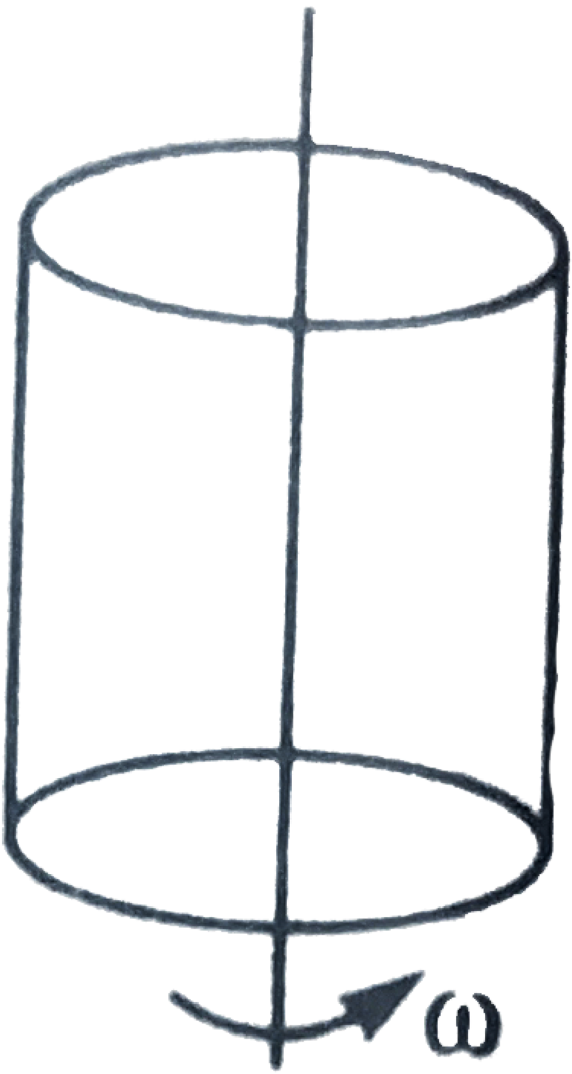
D. $8\pi^2 N$

Answer: D

Watch Video Solution

3. An insect of mass $m = 3kg$ is inside a vertical drum of radius $2m$ that is rotating with an angular velocity of

$5 rad s^{-1}$. The insect doesn't fall off. Then, the minimum coefficient of friction required is



A. 0.5

B. 0.4

C. 0.2

D. None of these

Answer: C

Watch Video Solution

4. The speed of revolution of a particle going around a circle is doubled and its speed is halved, what happens to the centripetal acceleration?

A. Becomes 4 times

B. Doubled

C. Halved

D. Remains unchanged

Answer: D

Watch Video Solution

5. A particle is moving on a circular path of 10 m radius. At any instant of time, its speed is $5ms^{-1}$ and the speed is increasing at a rate of $2ms^{-2}$. At this instant, the magnitude of the net acceleration will be

A. $3.2m/s^2$

B. $2m/s^2$

C. $2.5m/s^2$

D. $4.3m/s^2$

Answer: A

Watch Video Solution

6. A coin, placed on a rotating turntable slips, when it is placed at a distance of $9cm$ from the center. If the angular velocity of the turnable is tripled, it will just slip, If its distance from the center is

A. 27 cm

B. 9 cm

C. 3 cm

D. 1 cm

Answer: D

Watch Video Solution

7. A particle moves in a uniform circular motion. Choose the wrong statement.

A. The particle moves with constant speed.

B. The acceleration is always normal to the velocity.

C. The particle moves with uniform acceleration.

D. The particle moves with variable velocity.

Answer: C

Watch Video Solution

8. A bob of mass m, suspended by a string of length l_1 is given a minimum velocity required to complete a full circle in the vertical plane. At the highest point, it collides elasticallywith another bob of mass 2m suspended by a string of length l_2, which is initially at rest. Both strings are massless and inextensible. If the second bob, after collision acquires the minimum speed required to complete a full circle in the vertical plane, the ratio l_2 / l_1 is $(5/4)$n. The value of n is

A. 3

B. 6

C. 9

D. 5

Answer: C

View Text Solution

9. The direction of the angular velocity vector is along

A. the tangent to the circular path

B. the inward radius

C. the outward radius

D. the axis of rotation

Answer: D

Watch Video Solution

10. A stone is tied with a string and is rotated in a circle horizontally. When the string suddenly breaks, the stone will move

A. tangential to the motion

B. away from the center

C. towards the center

D. None of these

Answer: A

Watch Video Solution

11. The maximum tension that an inextensible ring of radius 1 m and mass density 0.1 kg m^{-1} can bear is 40 N. The maximum angular velocity with which it can be rotated in a circular path is

A. 20 rad/s

B. 18 rad/s

C. 16 rad/s

D. 15 rad/s

Answer: A

Watch Video Solution

12. 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 force is

A. $\frac{r_2}{r_1}$

B. $\sqrt{\frac{r_2}{r_1}}$

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

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

Answer: A

Watch Video Solution

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

A. 2π rad/s

B. $4\pi^2$ rad/s

C. π rad/s

D. 4π rad/s

Answer: D

Watch Video Solution

14. A mass 2 kg is whirled in a horizontal circle by means of a string at an initial speed of 5 revolutions per minute . Keeping the radius constant the tension in the string is doubled. The new speed is nearly

A. $\frac{5}{\sqrt{2}}$ rev/min

B. 10 rev/min

C. $10\sqrt{2}$rev/min

D. $5\sqrt{2}$rev/min

Answer: D

Watch Video Solution

15. A stone of mass of 16 kg is attached to a string 144 m long and is whirled in a horizontal circle. The maximum tension the string can withstand is 16 Newton . The maximum velocity of revolution that can be given to the stone without breaking it, will be

A. 20 m/s

B. 16 m/s

C. 14m/s

D. 12m/s

Answer: D

Watch Video Solution

16. A particle moves with constant speed v along a circular path of radius r and completes the circle in time T. The acceleration of the particle is

A. $\frac{2\pi v}{T}$

B. $\frac{2\pi r}{T}$

C. $\frac{2\pi r^2}{T}$

D. $\frac{2\pi v^2}{T}$

Answer: A

Watch Video Solution

17. A stone is attached to a rope of length l=80 cm is rotated with a speed of 240 rpm. At the moment when the velocity is directed vertically upwards, the rope breaks. To what height does the stone rise further?

A. 1.2 m

B. 41.2 m

C. 20.6 m

D. 24.9m

Answer: C

Watch Video Solution

18. If a cycle wheel of raduius 0.4m completes one revolution in one second, then acceleration of the cycle is

A. $0.4\pi m / s^2$

B. $0.8\pi m/s^2$

C. $0.4\pi^2 m/s^2$

D. $1.6\pi^2 m/s^2$

Answer: D

Watch Video Solution

19. A stone is tied to one end of a string. On holding the other end, the string is whirled in a horizontal plane with progressively increasing speed. It breaks at some speed because

A. the grvitational forces of the Earth is greater than the tension in string.

B. the required centripetal force is greater than the tension sustained by the string.

C. the required centripetal force is less than the tension in the string.

D. the centripetal force is greatr than the weight of the stone.

Answer: B

Watch Video Solution

20. A stone of mass 250 gram , attached at the end of a string of length 1.25 m is whirled in a horizontal circle at a speed of 5 m/s . What is the tension in the string ?

A. 2.5 N

B. 5 N

C. 6 N

D. 8 N

Answer: B

Watch Video Solution

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

A. $\dfrac{ML\omega^2}{2}$

B. $ML\omega^2$

C. $\frac{ML^2\omega^2}{2}$

D. $\frac{ML\omega^2}{4}$

Answer: B

Watch Video Solution

22. A van moving with a speed of $108km/h$ on level road where coefficient of friction between tyres and rod is 0.5 .For the safe driving of van the minimum radius of curvature of the rod will be $(g = 10m/s^2)$

A. 80 m

B. 40 m

C. 180 m

D. 20m

Answer: C

Watch Video Solution

23. A weightless thread can bear tension up to 3.7 kg weight. A stone of mass 500 g is tied at its one end revolved in a vertical circular path of radius 4m. If $g = 10m/s^2$, then the maximum angular velocity of the stone is (rad/s) is

A. 3

B. 4

C. 5

D. 6

Answer: B

Watch Video Solution

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

A. 1

B. 2

C. 3

D. 4

Answer: C

Watch Video Solution

25. A wheel of diameter 20 cm is rotating 600 rpm. The linear velocity of particle at its rim is

A. 6.28 cm/s

B. 62.8 cm/s

C. 0.628 cm/s

D. 628.8cm/s

Answer: D

Watch Video Solution

26. A wheel rotates with a constant angular velocity of 600 rpm. What is the angle through which the wheel rotates in 1s?

A. 5π rad

B. 20πrad

C. 15π rad

D. 10π rad

Answer: B

Watch Video Solution

27. An aeroplane is taking a turn in a horizontal plane. While doing so,

A. it remains horizontal

B. it inclines inward

C. it inclines outward

D. its wings becomes vertical.

Answer: B

Watch Video Solution

28. An electric fan has blades of length $30cm$ as measured from the axis of rotation. If the fan is rotating at $1200r \pm$, find the acceleration of a point on the tip of a blade.

A. $1600m / s^2$

B. $3200m / s^2$

C. $4800m / s^2$

D. $6000m/s^2$

Answer: C

Watch Video Solution

29. An electron revolve round the nucleous with the radius of the circular orbit is 'r' . To double the kinetic energy of the electron its orbital radius will be

A. $\sqrt{2}r$

B. $-\sqrt{2}r$

C. $\sqrt{3}r$

D. $-\sqrt{3}r$

Answer: A

Watch Video Solution

30. Angle between the centripetal acceleration and radius vector is

A. 90°

B. 180°

C. 0°

D. 45°

Answer: B

Watch Video Solution

31. Angular velocity of hour hand of a watch is

A. $\frac{\pi}{43200}$ rad/s

B. $\frac{\pi}{21600}$ rad/s

C. $\frac{\pi}{30}$ rad/s

D. $\frac{\pi}{1800}$ rad/s

Answer: B

Watch Video Solution

32. At a curved path of a road, the road bed is raised the curved path, the slop of the road bed is given by the equation

.

A. $\tan\theta = \frac{r}{gv^2}$

B. $\tan\theta = \frac{rg}{v^2}$

C. $\tan\theta = \frac{v^2 g}{r}$

D. $\tan\theta = \frac{v^2}{rg}$

Answer: D

Watch Video Solution

33. Centripetal force in velocity from can be expressed as

A. $\overrightarrow{F} = \frac{mv^2}{r}$

B. $\overrightarrow{F} = \frac{mv^2}{r}\overrightarrow{r}$

C. $\overrightarrow{F} = \frac{mv^2}{r^2}\overrightarrow{r}$

D. $\overrightarrow{F} = \frac{mv^2}{r}\overrightarrow{r}$

Answer: C

Watch Video Solution

Watch Video Solution

34. For a particle performing a uniform circular motion the acceleration is

A. constant in direction

B. constant in magnitude but not in direction

C. constant in magnitude and direction

D. constant neither in magnitude nor in direction.

Answer: B

Watch Video Solution

35. If a particle moves with uniform speed its tangntial acceleration will be

A. zero

B. constant in magnitude but not in direction

C. infinite

D. None of these

Answer: A

Watch Video Solution

36. If a stone of mass m is rotated in a vertical circular path of radius 1m, the critical velocity is

A. 6.32 m/s

B. 3.13 m/s

C. 9.48 m/s

D. 12.64m/s

Answer: B

Watch Video Solution

37. If T and T' are the periods of a simple pendulum and a conical pendulum of the sample length then .

A. $T_1 = T_2$

B. $T_1 > T_2$

C. $T_1 < T_2$

D. $T_1 = \frac{T_2}{2}$

Answer: B

Watch Video Solution

38. Tension of a string is 6.4 N and load is applied to it at its lower end of a string is 0.1 kg .If the length of string is 6 m , then its angular velocity will be `

A. 4 rad/s

B. 3rad/s

C. 2rad/s

D. 1rad/s

Answer: B

Watch Video Solution

39. In a vertical circle of radius r , at what point in its path a particle has tension equal to zero if it is just able to complete the vertical circle

A. Highest point

B. Lowest point

C. Any point

D. An horizontal point.

Answer: A

Watch Video Solution

40. In an atom, two electrons move around nucleus in circular orbits of radii (R) and (4R) . The ratio of the time taken by them to complete one revolution is :

A. $\frac{1}{4}$

B. 4

C. 8

D. $\frac{1}{8}$

Answer: D

Watch Video Solution

Practice Questions More Than One Correct Choice Type

1. A person applies a constant force $\overrightarrow{F}$ on a particle of mass m and finds tht the particle movs in a circle of radius r with a uniform speed v as seen from an inertial frame of reference.

A. This is not possible.

B. There are other forces on the particle.

C. The resultant of the other forces is mv^2/r towards the center.

D. The resultant of the other forces varies in magnitude as well as in direction.

Answer: B::D

Watch Video Solution

2. A cart moves with a constant speed along a horizontal circular path. From the cart, a particle is thrown up vertically with respect to the cart.

A. land outside the circular path

B. land somewhere on the circular path

C. follow a parabolic path

D. follow an elliptical path

Answer: A::B

Watch Video Solution

3. A car of maas M is moving on a horizontal circular path of radius r. At an instant its speed is v and is increasing at a rate a.

A. The acceleration of the car is towards the center of the path.

B. The magnitude of the frictional force on the car is greater than mv^2/r.

C. The friction coefficient between the ground and the car is not less than a/g

D. The friction coefficient between the ground and the car is $\mu = \tan^{-1}(v^2/rg)$.

Answer: B::C

Watch Video Solution

4. 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. Velociyt is constant

B. Magnitude of velocity is constant but the direction changes.

C. Both magnitude and direction of velocity change.

D. Velocity is directed towards the center of circle.

Answer: A::C::D

Watch Video Solution

5. A particle moves in a circle of radius $20cm$. Its linear speed is given by $v = 2t$ where t is in seconds and v in ms^{-1}. Then

A. the radial acceleration at t=2 is $80m/s^2$

B. the tangential acceleration at t=2 is $2m/s^2$

C. thenet acceleration at t=2 is larger than $80m / s^2$

D. Tagential acceleration remains constant in magnitude.

Answer: A::B::C::D

Watch Video Solution

6. An object follows a curved path. The following quantities may remain constant during the motion

A. Speed

B. Velocity

C. Acceleration

D. Magnitude of acceleration

Answer: A::C::D

Watch Video Solution

Practice Questions Linked Comprehension

1. When a cyclist turns on a circular path,the necessary centripetal force is provided by friction between the tyres and the road. If centripetal force is not provided by friction, then for the vehicle to move on circular path, the track is banked.

The correct angle of banking for a curved smooth road of radius $120m$ for a speed of $108km/h(g = 10ms^{-2})$ is

A. 30°

B. 37°

C. 45°

D. 60°

Answer: B

Watch Video Solution

2. When a cyclist turns on a circular path,the necessary centripetal force is provided by friction between the tyres and the road. If centripetal force is not provided by friction, then for the vehicle to move on circular path, the track is banked. If the speed of a vehicle is doubled, then for safety of vehicle

A. the angle of banking must be doubled.

B. the angle of banking must be four times.

C. the tangent of angle of banking must be doubled.

D. the tangent of angle of banking must be increased to four times.

Answer: D

Watch Video Solution

Practice Questions Matrix Type

1. A particle of mass m is moving on a circular path of constant r such that its centripetal acceleration a_C is varying with time t as $a_C = k^2rt^2$, when k is a constant. Then match the columns of the following data:

Column I	Column II
(a) Centripetal force	**(p)** mkr
(b) Tangential force	**(q)** mk^2r^2t
(c) Power delivered by centripetal force	**(r)** mk^2rt^2
(d) Power delivered by tangential force	**(s)** Zero

Watch Video Solution

2. In the given table Column I shows the different values of masses of the body. Column II shows the different values of angular speed of the body and Column III shows the radius of circle in which the body moves.

Column I	Column II	Column III
(I) Mass = 0.035 kg	(i) Angular speed = 2.09 rad/s	(J) Radius = 0.75 m
(II) Mass = 0.056 kg	(ii) Angular speed = 2.11 rad/s	(K) Radius = 0.85 m
(III) Mass = 0.06 kg	(iii) Angular speed = 1.9 rad/s	(L) Radius = 0.72 m
(IV) Mass = 0.029 kg	(iv) Angular speed = 2.17 rad/s	(M) Radius = 0.80 m

Which combination has 0.13N as the centrepetal force?

A. (i) (iii) (L)

B. (IV)(i)(M)

C. (II)(iv)(K)

D. (I)(i)(K)

Answer: D

Watch Video Solution

3. In the given table Column I shows the different values of masses of the body. Column II shows the different values of angular speed of the body and Column III shows the radius of circle in which the body moves.

Column I	Column II	Column III
(I) Mass = 0.035 kg	(i) Angular speed = 2.09 rad/s	(J) Radius = 0.75 m
(II) Mass = 0.056 kg	(ii) Angular speed = 2.11 rad/s	(K) Radius = 0.85 m
(III) Mass = 0.06 kg	(iii) Angular speed = 1.9 rad/s	(L) Radius = 0.72 m
(IV) Mass = 0.029 kg	(iv) Angular speed = 2.17 rad/s	(M) Radius = 0.80 m

Which combination has 0.199N as the centrepetal force?

A. (III)(ii)(L)

B. (II)(ii)(M)

C. (II)(iii)(K)

D. (I)(i)(M)

Answer: B

Watch Video Solution

4. In the given table column I shows the values of linear velocity. Column II shows the values of linear velocity, Column II shows the values of angular velocity and Column III shows the radius of the circle in which circular (angular) motion takes place.

Column I	Column II	Column III
(I) Linear velocity = 6 m/s	(i) Angular velocity = 4 rad/s	(J) Radius = 3 m
(II) Linear velocity = 10.15 m/s	(ii) Angular velocity = 2.11 rad/s	(K) Radius = 2 m
(III) Linear velocity = 3 m/s	(iii) Angular velocity = 3 rad/s	(L) Radius = 4 m
(IV) Linear velocity = 16 m/s	(iv) Angular velocity = 3.38 rad/s	(M) Radius = 4 m

Which combination describes the conditions when body starts with zero initial linear velocty and accelerates with $2m/s^2$ for 3s?

A. (II)(iv)(L)

B. (III)(i)(M)

C. (I)(iii)(K)

D. (IV)(ii)(J)

Answer: C

Watch Video Solution

5. In the given table column I shows the values of linear velocity. Column II shows the values of linear velocity, Column II shows the values of angular velocity and Column III shows the radius of the circle in which circular (angular) motion takes place.

Column I	Column II	Column III
(I) Linear velocity = 6 m/s	(i) Angular velocity = 4 rad/s	(J) Radius = 3 m
(II) Linear velocity = 10.15 m/s	(ii) Angular velocity = 2.11 rad/s	(K) Radius = 2 m
(III) Linear velocity = 3 m/s	(iii) Angular velocity = 3 rad/s	(L) Radius = 4 m
(IV) Linear velocity = 16 m/s	(iv) Angular velocity = 3.38 rad/s	(M) Radius = 4 m

Which combination describes the conditions when body starts with zero initial linear velocty and accelerates with $2\text{rad}/s^2$ for 3s?

A. (IV)(i)(L)

B. (III)(iv)(J)

C. (I)(ii)(M)

D. (II)(iii)(K)

Answer: A

Watch Video Solution

6. In the given table column I shows the values of linear velocity. Column II shows the values of linear velocity, Column II shows the values of angular velocity and Column III shows the radius of the circle in which circular (angular) motion takes place.

Column I	Column II	Column III
(I) Linear velocity = 6 m/s	(i) Angular velocity = 4 rad/s	(J) Radius = 3 m
(II) Linear velocity = 10.15 m/s	(ii) Angular velocity = 2.11 rad/s	(K) Radius = 2 m
(III) Linear velocity = 3 m/s	(iii) Angular velocity = 3 rad/s	(L) Radius = 4 m
(IV) Linear velocity = 16 m/s	(iv) Angular velocity = 3.38 rad/s	(M) Radius = 4 m

Which combination describes the conditions when body is displaced by 28 m in 4s and accelerates with 2m/s?

A. (IV)(iii)(K)

B. (I)(ii)(L)

C. (III)(i)(M)

D. (II)(iv)(J)

Answer: D

Watch Video Solution

Practice Questions Integer Type

1. 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

Watch Video Solution

2. A stone is projected at a speed v_0 and it makes an angle θ with the horizontal. Find the angular velocity of the projectile at the time when it reaches the same level with respect to the point of projection at the time it touches the ground.

Watch Video Solution

Check Points

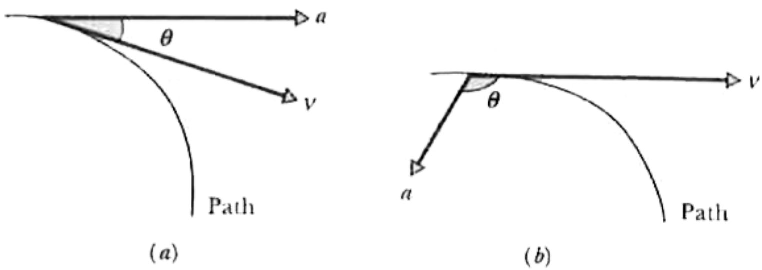
1. A manufacturer of CD drives claims that the player can spin the disc as frequency as 1200 revolutioins per minute. If the spinning is at this rate, what is the speed (in m/s) of the outer row of data on the disc, this row is located 5.6 cm from the center of the disc?

Watch Video Solution

2. An object moves at a constant speed along a circular path in a horizontal XY plane, with the center at the origin. When the object is at $x = -2m$, its velocity is $-(4m/s)\hat{j}$. What is the object's acceleration when it is $y = 2m$

Watch Video Solution

3. Among the two figures shown here, choose correct one in which the depicted situation is possible.



Watch Video Solution

4. If a missile is propelled horizontally with 20 m/s from some height, what is the value of R_C at t=2s?

Watch Video Solution

5. As every amusement park fan knows, a Ferris wheel is a ride consisting of seats mounted on a tall that rotates around a horizontal axis. When you ride in a Ferris wheel at constant speed, what are the directions of your acceleration $\vec{a}$ and the normal force $\vec{F}_N$ on you (from the always upright seat) as you pass through (a) the highest point and (b) the lowest point of the ride? (c) How does the magnitude of the acceleration at the highest point compare with that at the lowest point? (d) How do the magnitude of the normal force compare at those two points?

View Text Solution

6. Consider a car is moving on circular path of radius R wilth speed v. A block kept inside the frictionless surface of car is touching the wall. Write Newton's second law from the reference frame attached to observer at ground and car.

Watch Video Solution