PH 201 Homework Assignment Chapter on Uniform Circular Motion – 21 Problems Total

1. A car travels at a constant speed around a circular track whose radius is 2.6 km. The car goes once around the track in 360 s. What is the magnitude of the centripetal acceleration of the car?

Solution for Problem 1

2. Speedboat A negotiates a curve whose radius is 120 m. Speedboat B negotiates a curve whose radius is 240 m. Each boat experiences the same centripetal acceleration. What is the ratio v_A/v_B of the speeds of the boats?

Solution for Problem 2

3. The aorta is a major artery, rising upward from the left ventricle of the heart and curving down to carry blood to the abdomen and lower half of the body. The curved artery can be approximated as a semicircular arch whose diameter is 5.0 cm. If blood flows through the aortic arch at a speed of 0.32 m/s, what is the magnitude (in m/s^2) of the blood's centripetal acceleration?

Solution for Problem 3

4. Computer-controlled display screens provide drivers in the Indianapolis 500 with a variety of information about how their cars are performing. For instance, as a car is going through a turn, a speed of 221 mi/h (98.8 m/s) and centripetal acceleration of 3.00 g (three times the acceleration due to gravity) are displayed. Determine the radius of the turn (in meters).

Solution for Problem 4

5. A centrifuge is a device in which a small container of material is rotated at a high speed on a circular path. Such a device is used in medical laboratories, for instance, to cause the more dense red blood cells to settle through the less dense blood serum and collect at the bottom of the container. Suppose the centripetal acceleration of the sample is 6.25×10^3 times as large as the acceleration due to gravity. How many revolutions per minute is the sample making, if it is located at a radius of 5.00 cm from the axis of rotation?

Solution for Problem 5

6. The earth rotates once per day about an axis passing through the north and south poles, an axis that is perpendicular to the plane of the equator. Assuming the earth is a sphere with a radius of 6.38×10^6 m, determine the speed and centripetal acceleration of a person situated **(a)** at the equator and **(b)** at a latitude of 30.0° north of the equator.

Solution for Problem 6

7. Car A uses tires for which the coefficient of static friction is 1.1 on a particular unbanked curve. The maximum speed at which the car can negotiate this curve is 25 m/s. Car B uses tires for which the coefficient of static friction is 0.85 on the same curve. What is the maximum speed at which car B can negotiate the curve?

Solution for Problem 7

8. A speed skater goes around a turn that has a radius of 31 m. The skater has a speed of 14 m/s and experiences a centripetal force of 460 N. What is the mass of the skater?

Solution for Problem 8

9. A car is safely negotiating an unbanked circular turn at a speed of 21 m/s. The road is dry, and the maximum static frictional force acts on the tires. Suddenly a long wet patch in the road decreases the maximum static frictional force to one-third of its dry-road value. If the car is to continue safely around the curve, to what speed must the driver slow the car?

Solution for Problem 9

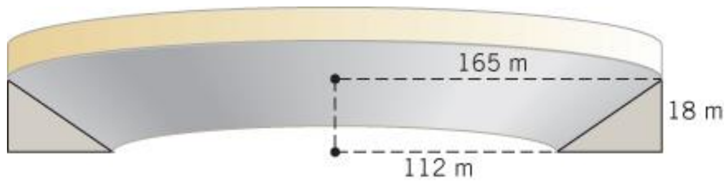
10. A penny is placed at the outer edge of a disk (radius = 0.150 m) that rotates about an axis perpendicular to the plane of the disk at its center. The period of the rotation is 1.80 s. Find the minimum coefficient of friction necessary to allow the penny to rotate along with the disk.

Solution for Problem 10

11. An 830-kg race car can drive around an unbanked turn at a maximum speed of 58 m/s without slipping. The turn has a radius of curvature of 160 m. Air flowing over the car's wing exerts a downward-pointing force (called the *downforce*) of 11 000 N on the car. **(a)** What is the coefficient of static friction between the track and the car's tires? **(b)** What would be the maximum speed if no downforce acted on the car?

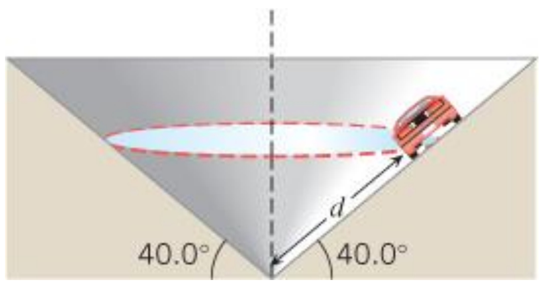
Solution for Problem 11

12. On a banked race track, the smallest circular path on which cars can move has a radius of 112 m, while the largest has a radius of 165 m, as the drawing illustrates. The height of the outer wall is 18 m. Find **(a)** the smallest and **(b)** the largest speed at which cars can move on this track without relying on friction.



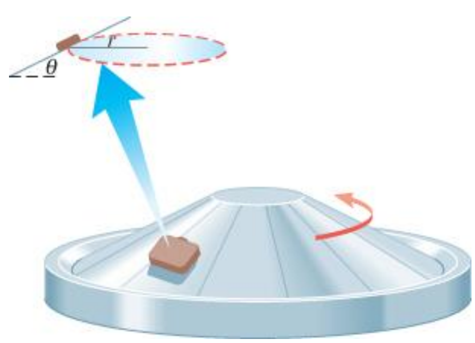
Solution for Problem 12

13. A racetrack has the shape of an inverted cone, as the drawing shows. On this surface the cars race in circles that are parallel to the ground. For a speed of 34.0 m/s, at what value of the distance *d* should a driver locate his car if he wishes to stay on a circular path without depending on friction?



Solution for Problem 13

14. The drawing shows a baggage carousel at an airport. Your suitcase has not slid all the way down the slope and is going around at a constant speed on a circle (r = 11.0 m) as the carousel turns. The coefficient of static friction between the suitcase and the carousel is 0.760, and the angle θ in the drawing is 36.0°. How much time is required for your suitcase to go around once?



Solution for Problem 14

15. A satellite is in a circular orbit around an unknown planet. The satellite has a speed of 1.70×10^4 m/s, and the radius of the orbit is 5.25×10^6 m. A second satellite also has a circular orbit around this same planet. The orbit of this second satellite has a radius of 8.60×10^6 m. What is the orbital speed of the second satellite?

Solution for Problem 15

16. Two newly discovered planets follow circular orbits around a star in a distant part of the galaxy. The orbital speeds of the planets are determined to be 43.3 km/s and 58.6 km/s. The slower planet's orbital period is 7.60 years. **(a)** What is the mass of the star? **(b)** What is the orbital period of the faster planet, in years?

Solution for Problem 16

17. Pilots of high-performance fighter planes can be subjected to large centripetal accelerations during high-speed turns. Because of these accelerations, the pilots are subjected to forces that can be much greater than their body weight, leading to an accumulation of blood in the abdomen and legs. As a result, the brain becomes starved for blood, and the pilot can lose consciousness ("black out"). The pilots wear "anti-G suits" to help keep the blood from draining out of the brain. To appreciate the forces that a fighter pilot must endure, consider the magnitude F_N of the normal force that the pilot's seat exerts on him at the bottom of a dive. The magnitude of the pilot's weight is W. The plane is traveling at 230 m/s on a vertical circle of radius 690 m. Determine the ratio F_N/W. For comparison, note that blackout can occur for values of F_N/W as small as 2 if the pilot is not wearing an anti-G suit.

Solution for Problem 17

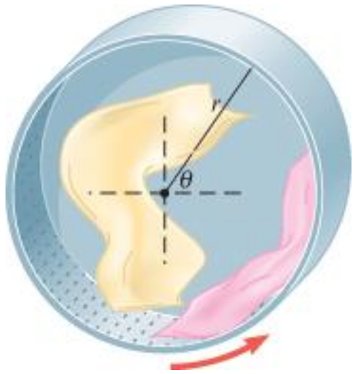
18. A 0.20-kg ball on a stick is whirled on a vertical circle at a constant speed. When the ball is at the three o'clock position, the stick tension is 16 N. Find the tensions in the stick when the ball is at the twelve o'clock and at the six o'clock positions.

Solution for Problem 18

19. A motorcycle is traveling up one side of a hill and down the other side. The crest of the hill is a circular arc with a radius of 45.0 m. Determine the maximum speed that the cycle can have while moving over the crest without losing contact with the road.

Solution for Problem 19

20. In an automatic clothes dryer, a hollow cylinder moves the clothes on a vertical circle (radius r = 0.32 m), as the drawing shows. The appliance is designed so that the clothes tumble gently as they dry. This means that when a piece of clothing reaches an angle of θ above the horizontal, it loses contact with the wall of the cylinder and falls onto the clothes below. How many revolutions per second should the cylinder make in order that the clothes lose contact with the wall when θ = 70.0°?



Solution for Problem 20

21. A roller coaster at an amusement park has a dip that bottoms out in a vertical circle of radius r. A passenger feels the seat of the car pushing upward on her with a force equal to twice her weight as she goes through the dip. If r = 20.0 m, how fast is the roller coaster traveling at the bottom of the dip?

Solution for Problem 21

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This page last updated on November 12, 2021