

CHAPTER 5: Circular Motion; Gravitation

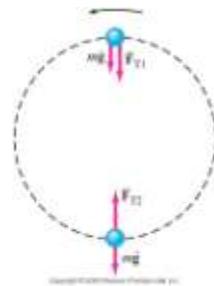
Problems

5–1 to 5–3 Uniform Circular Motion; Highway Curves

1. (I) A child sitting 1.10 m from the center of a merry-go-round moves with a speed of 1.25 m/s. Calculate (a) the centripetal acceleration of the child, and (b) the net horizontal force exerted on the child (mass = 25.0 kg).

5. (II) Suppose the space shuttle is in orbit 400 km from the Earth's surface, and circles the Earth about once every 90 minutes. Find the centripetal acceleration of the space shuttle in its orbit. Express your answer in terms of g , the gravitational acceleration at the Earth's surface.

7. (II) A ball on the end of a string is revolved at a uniform rate in a vertical circle of radius 72.0 cm, as shown in Fig. 5–33. If its speed is 4.00 m/s and its mass is 0.300 kg, calculate the tension in the string when the ball is (a) at the top of its path, and (b) at the bottom of its path.



9. (II) What is the maximum speed with which a 1050-kg car can round a turn of radius 77 m on a flat road if the coefficient of static friction between tires and road is 0.80? Is this result independent of the mass of the car?
13. (II) At what minimum speed must a roller coaster be traveling when upside down at the top of a circle so that the passengers will not fall out? Assume a radius of curvature of 7.4 m.
14. (II) A sports car of mass 950 kg (including the driver) crosses the rounded top of a hill (radius = 95 m) at 22 m/s. Determine (a) the normal force exerted by the road on the car, (b) the normal force exerted by the car on the 72-kg driver, and (c) the car speed at which the normal force on the driver equals zero.

18. (II) In a “Rotor-ride” at a carnival, people are rotated in a cylindrically walled “room.” (See Fig. 5–35.) The room radius is 4.6 m, and the rotation frequency is 0.50 revolutions per second when the floor drops out. What is the minimum coefficient of static friction so that the people will not slip down?

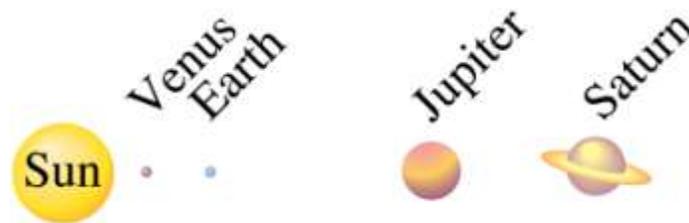
People on this ride say they were “pressed against the wall.” Is there really an outward force pressing them against the wall? If so, what is its source? If not, what is the proper description of their situation (besides “scary”)? [Hint: First draw the free-body diagram for a person.]



22. (III) A 1200-kg car rounds a curve of radius 67 m banked at an angle of 12° . If the car is traveling at 95 km/h, will a friction force be required? If so, how much and in what direction?

5–6 and 5–7 Law of Universal Gravitation

29. (I) At the surface of a certain planet, the gravitational acceleration g has a magnitude of 12.0 m/s^2 . A 21.0-kg brass ball is transported to this planet. What is (a) the mass of the brass ball on the Earth and on the planet, and (b) the weight of the brass ball on the Earth and on the planet?
32. (II) A hypothetical planet has a mass 1.66 times that of Earth, but the same radius. What is g near its surface?
35. (II) What is the distance from the Earth’s center to a point outside the Earth where the gravitational acceleration due to the Earth is $\frac{1}{10}$ of its value at the Earth’s surface?
40. (II) Every few hundred years most of the planets line up on the same side of the Sun. Calculate the total force on the Earth due to Venus, Jupiter, and Saturn, assuming all four planets are in a line (Fig. 5–38). The masses are $M_V = 0.815M_E$, $M_J = 318M_E$, $M_S = 95.1M_E$, and their mean distances from the Sun are 108, 150, 778, and 1430 million km, respectively. What fraction of the Sun’s force on the Earth is this?



5–8 Satellites; Weightlessness

48. (II) During an *Apollo* lunar landing mission, the command module continued to orbit the Moon at an altitude of about 100 km. How long did it take to go around the Moon once?

General Problems

66. Tarzan plans to cross a gorge by swinging in an arc from a hanging vine (Fig. 5–41).

If his arms are capable of exerting a force of 1400 N on the vine, what is the maximum speed he can tolerate at the lowest point of his swing? His mass is 80 kg, and the vine is 5.5 m long.



73. A jet pilot takes his aircraft in a vertical loop (Fig. 5–43). (a) If the jet is moving at a speed of 1300 km/h at the lowest point of the loop, determine the minimum radius of the circle so that the centripetal acceleration at the lowest point does not exceed $6.0 g$'s. (b) Calculate the 78-kg pilot's effective weight (the force with which the seat pushes up on him) at the bottom of the circle, and (c) at the top of the circle (assume the same speed).



Copyright © 2005 Pearson Prentice Hall, Inc.