Physics 201 Examples 5

Jan 30, 2013

1. (Calculate the L2 point between the earth and the moon). A spacecraft is on a journey to the moon. At what point, as measured from the center of the earth, does the gravitational force exerted on the spacecraft by the earth balance that exerted by the moon? This point lies on a line between the centers of the earth and the moon. The distance between the earth and the moon is 3.85×10^8 m, and the mass of the earth is 81.4 times as great as that of the moon.

3.47×10^8 m

2. How long does it take a plane, traveling at a constant speed of 110 m/s, to fly once around a circle whose radius is 2850 m?

160 s

3. 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 meters. 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 meters. What is the orbital speed of the second satellite?

1.33×10^4 m/s

4. A motorcycle has a constant speed of 25.0 m/s as it passes over the top of a hill whose radius of curvature is 126 meters. The mass of the motorcycle and driver is 342 kilograms. Find the magnitude of (a) the centripetal force and (b) the normal force that acts on the cycle.

(a) 1700 newtons
(b) 1660 newtons

5. A "swing" ride at a carnival consists of chairs that are swung in a circle by 15.0-meter cables attached to a vertical rotating pole, as Figure 1 shows. Suppose the total mass of a chair and its occupant is 179 kilograms. (a) Determine the tension in the cable attached to the chair (b) Find the speed of the chair.
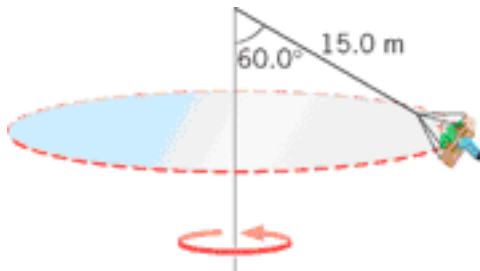
(a) 3510 newtons
(b) 14.8 m/s

60.0° 15.0 m

Figure 1: Problem 5.53

6. A bowling ball (mass = 7.2 kilograms, radius = 0.11 meters) and a billiard ball (mass = 0.38 kilograms, radius = 0.028 meters) may each be treated as uniform spheres. What is the magnitude of the maximum gravitational force that each can exert on the other?

9.6×10^{-9} newtons. (Or, if you prefer, 9.6 nanonewtons!)

7. A woman is riding a Jet Ski at a speed of 26 m/s and notices a seawall straight ahead. The farthest she can lean the craft in order to make a turn is 22°. This situation is like that of a car on a curve that is banked at an angle of 22°. If she tries to make the turn without slowing down, what is the minimum distance from the seawall that she can begin making her turn and still avoid a crash?

170 meters

8. Figure 2 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 ($r = 11.0$ meters) 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?
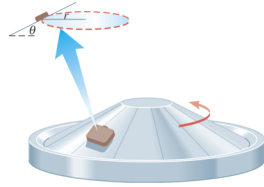
45.3 seconds

Figure 2: Problem 5.30

9. 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?

(a) 4.64×10^{31} kilograms
(b) 3.07 years

10. A child is twirling a 0.0120-kilogram plastic ball on a string in a horizontal circle whose radius is 0.100 meters. The ball travels once around the circle in 0.500 seconds. (a) Determine the centripetal force acting on the ball (b) If the speed is doubled, does the centripetal force double? If not, by what factor does the centripetal force increase?

(a) 0.190 newtons
(b) Four

11. At an amusement park there is a ride in which cylindrically shaped chambers spin around a central axis. People sit in seats facing the axis, their backs against the outer wall. At one instant the outer wall moves at a speed of 3.2 m/s, and an 83-kilogram person feels a 560-newton force pressing against his back. What is the radius of a chamber?

1.5 meters

12. At amusement parks, there is a popular ride where the floor of a rotating cylindrical room falls away, leaving the backs of the riders "plastered" against the wall. Suppose the radius of the room is 3.30 meters and the speed of the wall is 10.0 m/s when the floor falls away. (a) What is the source of the centripetal force acting on the riders? (b) How much centripetal force acts on a 55.0-kilogram rider? (c) What is the minimum coefficient of static friction that must exist between a rider's back and the wall, if the rider is to remain in place when the floor drops away?

(a) The wall
(b) 1670 newtons
(c) 0.323