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Chapter 8

1. A wheel rolls uniformly on level ground without slipping. A piece of mud on the wheel flies off when it is at 9 o'clock position (near of wheel). Describe the subsequent motion of the mud.

2. A rope goes over a circular pulley with a radius of 6.5 cm. If the pulley makes 4 revolutions without the rope slipping, what length of rope passes over the pulley?

3. A wheel rolls 5 revolutions on a horizontal surface without slipping. If the center of the wheel moves 3.2 m, what is the radius of the wheel?

4. A bawling ball with a radius of 15.0 cm travels down the lane so that its center is moving at 3.60 m/s. The bowler estimates that it makes about 7.50 complete revolutions in 2.00 s. Is it rolling without slipping? Prove your answer, assuming that the bowler's quick observation limits answers to two significant figures.

5. A ball with a radius of 15 cm rolls on a level surface, and the translational speed of the center of mass is 0.25 m/s. What is the angular speed about the center of mass if the ball rolls without slipping?

6. (a) When a disk rolls without slipping, should the product $r\omega$ be (1) greater than, (2) equal to, or (3) less than v_{CM}? (B) A disk with a radius of 0.15 m rotates through 270° as it travels 0.71 m. Does the disk rolls without slipping? Prove your answer.

7. A bocce ball with a diameter of 6.00 cm rolls without slipping on a level lawn. It has an initial angular speed of 2.35 rad/s and comes to rest after 2.50 m. Assuming constant deceleration, determine (a) the magnitude of its angular deceleration and (b) the magnitude of the maximum tangential acceleration of the ball's surface.

8. A cylinder with a diameter of 20 cm rolls with an angular speed of 0.050 rad/s on a level surface. If the cylinder experiences a uniform tangential acceleration of 0.018 m/s2 without slipping until its angular speed is 1.2 rad/s, through how many complete revolutions does the cylinder rotate during the time it accelerates?

9. In Fig. 8.4a, if the arm makes a 37° angle with the horizontal and a torque of 18 m N to be produced, what force must the biceps muscle supply?

10. The drain plug on a car's engine has been tightened to a torque of 25 m N. If a 0.15 –m-long wrench is used to change the oil, what is the minimum force needed to loosen the plug?

11. In Exercise 10, due to limited work space, you must crawl under the car. The force thus cannot be applied perpendicularly to the length of the wrench. If the applied force makes a 30° angle with the length of the wrench, what is the force required to loosen the drain plug?

12. How many different positions of stable equilibrium and unstable equilibrium are there for a cube? Consider each surface, edge, and corner to be a different position.

13. Two children are sitting on opposite ends of a uniform seesaw of negligible mass. (a) Can the seesaw be balanced if the masses of the children are different? How? (b) If a 35-kg child is 2.0 m from the pivot point (or fulcrum), how far from the pivot point will her 30 kg playmate have to sit on the other side for the seesaw to be in equilibrium?

14. A uniform meterstick pivoted at its center, as in Example 8.5, has a 100-g mass suspended at the 25.0-cm position. (a) At what position should a 75.0 g mass be suspended to put the system in equilibrium? (b) What mass would have to be suspended at the 90.0-cm position for the system to be in equilibrium?

15. A worker applies a horizontal force to the top edge of a crate to get it to tip forward (Fig. 8.36). If the create has a mass of 100 kg and is 1.6 m tall and 0.80 m in depth and width, what is the minimum force needed to make the crate start tipping? (Assume the center of mass of the crate is at its center and static friction great enough to prevent slipping).

16. Show that the balanced meterstick in Example 8.5 is in static rotational equilibrium about a horizontal axis through the 100-cm end of the stick.

17. Telephone and electrical lines are allowed to sag between poles so that the tension will not be too great when something hits or sits on the line. (a) Is it possible to have the lines perfectly horizontal? Why or why not? (b) Suppose that a line were stretched almost perfectly horizontally between two poles that are 30 m apart. If a 0.25-kg bird perches on the wire midway between the poles and the wire sags 1.0 cm, what would be the tension in the wire?

18. In Fig. 8.37, what is the force Fm supplied by the deltoid muscle so as to hold up the outstretched arm if the mass of the arm is 3.0 kg?

19. In Figure 8.4b, determine the force exerted by the bicep muscle, assuming that the hand is holding a ball with a mass of 5.00 kg. Assume that the mass of the forearm is 8.50 kg with its center of mass located 20.0 cm away from the elbow joint. (the black dot in the figure). Assume also that the center of mass of the ball in the hand is 30.0 cm away from the elbow joint.

20. A bowling ball (mass 7.00 kg and radius 17.0 cm) is released so fast that it skids without rotating down the lane (at least for a while). Assume the ball skids to the right and the coefficient of sliding friction between the ball and the lane surface is 0.400. (a) What is the direction of the torque exerted by the friction on the ball about the center of mass of the ball? (b) Determine the magnitude of this torque (again about the ball's center of mass).

21. A variation of Russell traction (Fig. 8.38) supports the lower leg in a cast. Suppose that the patient’s leg and cast have a combined mass of 15.0 kg and m1 is 4.50 kg. (a) What is the reaction force of the leg muscles to the traction? (b) What must m2 be to keep the leg horizontal?

22. In doing physical therapy for an injured knee joint, a person raises a 5.0-kg weighted boot as shown in Fig. 8.39. Compute the torque due to the boot for each position shown.

23. An artist wishes to construct a birds and bees mobile, as shown in Fig. 8.40. If the mass of the bee on the lower left is 0.10 kg and each vertical support string has a length of 30 cm, what are the masses of the other birds and bees?

24. The location of a person’s center of gravity relative to his or her height can be found using the arrangement shown in Fig. 8.41. The scales are initially adjusted to zero with the board alone. (a) Would you expect the location of the center of gravity to be (1) midway between the scales, (2) toward the scale at the person’s head, or (3) toward the scale at the person’s feet? Why? (b) Locate the center of gravity of the person relative to the horizontal dimension.

25. (a) How many uniform, identical textbooks of width 25.0 cm can be stacked on top of each other on a level surface without the stack falling over if each successive book is displaced 3.00 cm in width relative to the book below it? (b) If the books are 5.00 cm thick, what will be the height of the center of mass of the stack above the level surface?

26. If four metersticks were stacked on a table with 10 cm, 15 cm, 30 cm, and 50 cm, respectively, hanging over the edge, as shown in Fig. 8.42, would the top meterstick remain on the table?

27. A 10.0 kg solid uniform cube with 0.500-m sides rests on a level surface. What is the minimum amount of work necessary to put the cube into an unstable equilibrium position?

28. While standing on a long board resting on a scaffold, a 70-kg painter paints the side of a house, as shown in Fig. 8.43. If the mass of the board is 15 kg, how close to the end can the painter stand without tipping the board over?

29. A mass is suspended by two cords as shown in Fig. 8.44. What are tensions in the cords?

30. If the cord attached to the vertical wall in Fig. 8.44 were horizontal (instead of at a 30° angle), what would the tensions in the cords be?

31. A force is applied to a cord wrapped around a solid 2.0-kg cylinder as shown in Fig. 8.45. Assuming the cylinder rolls without slipping, what is the force of friction acting on the cylinder?

32. In circus act, a uniform board (length 3.00 m, mass 35.0 kg) is suspended from a bungie-type rope at one end, and the other end rests on a concrete pillar. When a clown (mass 75.0 kg) steps out halfway onto the board, the board tilts so the rope end is 30° from the horizontal and the rope stays vertical. (a) In which situation will the rope tension be larger: (1) the board without the clown on it, (2) the board with the clown on it, or (3) you can't tell from the data given? (b) Calculate the force exerted by the rope in both situations.

33. The forces acting on Einstein and the bicycle (fig. 2 of the Insight 8.1, Stability in Action) are the total weight of Einstein and the bicycle (mg) at the center of gravity of the system, the normal force (N) exerted by the road, and the force of static friction (f_s) acting on the tires due to the road. (a) If Einstein is to maintain balance, should the tangent of the lean angle θ ($\tan\theta$) be (1) greater than, (2) equal to, or (3) less than f_s/N? (b) The angle θ in the picture is about 11°. What is the minimum coefficient of static friction μ_s between the road and the tires? (c) If the radius of the circle is 6.5 m, what is the maximum sped of Einstein's bicycle?

34. A fixed 0.15-kg solid disk pulley with a radius 0.075 m is acted on by a net torque of 6.4 m N. What is the angular acceleration of the pulley?

35. What net torque is required to give a uniform 20-kg solid ball with a radius of 0.20 m an angular acceleration of 20 rad/s^2?

36. For the system of masses shown in Fig. 8.46, find the moment of inertia about (a) the x-axis, (b) the y-axis, and (c) an axis through the origin and perpendicular to the page (z-axis). Neglect the masses of the connecting rods.

37. A 2000-kg Ferris wheel accelerates from rest to an angular speed of 20 rad/s in 12 s. Approximate the Ferris wheel as a circular disk with a radius of 30 m. What is the net torque on the wheel?

38. Two objects of different masses are joined by a light rod. (a) Is the moment of inertia about the center of mass the minimum or the maximum? Why? (b) If the two masses are 3.0 kg and 5.0 kg and the length of the rod is 2.0 m, find the moments of inertia of the system about an axis perpendicular to the rod, through the center of the rod and center of mass.

39. Two masses are suspended from a pulley as shown in Fig. 8.47. The pulley itself has a mass of 0.20 kg, a radius of 0.15 m, and a constant torque of 0.35 m N due to the friction between the rotating pulley and its axle. What is the magnitude of the acceleration of the suspended masses if m_1 = 0.40 kg and m_2 = 0.80 kg?

40. To start her lawn mower, Julie pulls on a cord that is wrapped around a pulley. The pulley has a moment of inertia about its central axis of I = 0.550 kg m^2 and a radius of 5.00 cm. There is an equivalent frictional torque impeding her pull of τ_f = 0.430 m N. To accelerate the pulley at α = 4.55 rad/s^2, (a) how much torque does Julie need to apply to the pulley? (b) How much tension must the rope exert?

41. For the system shown in Fig. 8.48, m_1 = 8.0 kg, m_2 = 3.0 kg, θ = 30°, and the radius and mass of the pulley are 0.10 m and 0.10 kg, respectively. (a) What is the acceleration of the masses? (b) If the pulley has a constant frictional torque of 0.050 m N when the system is in motion, what is the acceleration of the masses?

42. A meterstick pivoted about a horizontal axis through the 0-cm end is held in a horizontal position and let go. (a) What is the initial tangential acceleration of the 100-cm position? Are surprised by this result? (b) Which position has a tangential acceleration equal to the acceleration due to gravity?

43. Pennies are placed every 10 cm on a meterstick. One end of the stick is put on a table and the other end is held horizontally with a finger, as shown in Fig. 8.49. If the finger is pulled away, what happens to the pennies?

44. A uniform 2.0-kg cylinder of radius 0.15 m is suspended by two strings wrapped around it (Fig. 8.50). As the cylinder descends, the strings unwind from it. What is the acceleration of the center of mass of the cylinder?

45. A planetary space probe is in the shape of a cylinder. To protect it from heat on one side (from the Sun's rays), operators on the Earth put it into a "barbecue mode," that is, they set it rotating about its long axis. To do this, they fire four small rockets mounted tangentially as shown in Fig. 8.51 (the probe is shown coming toward you). The object is to get the probe to rotate completely once every 30 s, starting from no rotation at all. They wish to do this by firing all four rockets for a certain length of time. Each rocket can exert a thrust of 50.0 N. Assume the probe is a uniform solid cylinder with a radius of 2.50 m and a mass of 1000 kg and neglect the mass of each rocket engine. Determine the amount of time the rockets need to be fired.

46. A ball of radius R and mass M rolls down an incline of angle θ. (a) For the ball to roll without slipping, should be the tangent of the maximum angle of incline (tan θ) be equal to (1) $3\mu_s/2$, (2) $5\mu_s/2$, (3) $7\mu_s/2$, or (4) $9\mu_s/2$? Here, μ_s is the coefficient of static friction. (b) If the ball is made of wood and the surface is also wood, what is the maximum angle of incline?

47. A constant retarding torque of 12 m N stops a rolling wheel of diameter 0.80 m in a distance of 15 m. How much work is done by the torque?

48. A person opens a door by applying a 15-N force perpendicular to it at a distance 0.90 m from the hinges. The door is pushed wide open (to 120°) in 2.0 s. (a) How much work was done? (b) What was the average power delivered?

49. In Fig. 8.23, a mass m descends a vertical distance from rest. (Neglect friction and the mass of the string) (a) From the conservation of mechanical energy, will the linear speed of the descending mass be (1) greater than, (2) equal to, or (3) less than $\sqrt{2gh}$? Why? (b) If m = 1.0 kg, M = 0.30 kg, and R = 0.15 kg, what is the linear speed of the mass after it has descended a vertical distance of 2.0 from rest?

50. A constant torque of 10 m N is applied to the rim of a 10-kg uniform disk of radius 0.20 m. What is the angular speed of the disk about an axis through its center after it rotates 2.0 revolutions from rest?

51. A 2.5-kg pulley of radius 0.15 m is pivoted about an axis through its center. What constant torque is required for the pulley to reach an angular speed of 25 rad/s after rotating 3.0 revolutions, starting from rest?

52. A solid ball of mass m rolls along a horizontal surface with a translational speed of v. What percent of its total kinetic energy is translational?

53. Estimate the ratio of the translational kinetic energy of the Earth as it orbits the Sun to the rotational kinetic energy it has about it N-S axis.

54. You wish to accelerate a small merry-go-round from rest to a rotational speed of one-third of a revolution per second by pushing tangentially on it. Assume the merry-go-round is a disk with a mass of 250 kg and a radius of 1.50 m. Ignoring friction, how hard do you have to push tangentially to accomplish this in 5.00 s?

55. A pencil 18 cm long stands vertically on its point end on a horizontal table. If it falls over without slipping, with what tangential speed does the eraser end strike the table?

56. A uniform sphere and a uniform cylinder with the same mass and radius roll at the same velocity side by side on a level surface without slipping. If the sphere and the cylinder approach an inclined plane and roll up it without slipping, will they be at the same height on the plane when they come to a stop? If not, what will be the percentage difference of the heights?

57. A hoop starts from rest at a height 1.2 m above the base of an inclined plane and rolls down under the influence of gravity. What is the linear speed of the hoop's center of mass just as the hoop leaves the incline and rolls onto a horizontal surface?

58. A cylindrical hoop, a cylinder, and a sphere of equal radius and mass are released at the same time from the top of an inclined plane. Using the conservation of mechanical energy, show that the sphere always gets to the bottom of the incline first with the fastest speed and that the hoop always arrives last with the slowest speed.

59. For the following objects, which all roll without slipping, determine the rotational kinetic energy about the center of mass as a percentage of the total kinetic energy: (a) a solid sphere, (b) a thin spherical shell, and (c) a thin cylindrical shell.

60. An industrial flywheel with a moment of inertia of 4.25×10^2 kg m^2 rotates with a speed of 7500 rpm. (a) How much work is required to bring the flywheel to rest? (b) If this work is done uniformly in 1.5 min, how much power is required?

61. A hollow, thin-shelled ball and a solid ball of equal mass are rolled up an inclined plane (without slipping) with both balls having the same initial velocity at the bottom of the plane. (a) Which ball rolls higher on the incline before coming to rest? (b) Do the radii of the balls make a difference? (c) After stopping, the balls roll back down the incline. By the conservation of energy, both balls should have the same speed when reaching the bottom of the incline. Show this explicitly.

62. In a tumbling clothes dryer, the cylindrical drum (radius 50.0 cm and mass 35.0 kg) rotates once every second. (a) Determine the rotational kinetic energy about its central axis. (b) If it started from rest and reached that speed in 2.50 s, determine the average net torque on the dryer drum.

63. A steel ball rolls down an incline into a loop-the loop of radius R (Fig. 8.52a). (a) What minimum speed must the ball have at the top of the loop in order to stay on the track? (b) At what vertical height (h) on the incline, in terms of the radius of the loop, must the ball be released in order for it to have the required speed at the top of the loop? (Neglect frictional losses.) (c) Figure 8.52b shows the loop-the-loop of a roller coaster. What are the sensations of the riders if the roller coaster has the minimum speed or a greater speed at the top of the loop?

64. What is the angular momentum of a 2.0-g particle moving counterclockwise (as viewed from above) with an angular speed of 5π rad/s in a horizontal circle of radius 15 cm? (Give the magnitude and direction.)

65. A 10-kg rotating disk of radius 0.25 m has an angular momentum of 0.45 kg m^2/s. What is the angular speed of the disk?

66. Compute the ratio of the magnitudes of the Earth's orbital angular momentum and its rotational angular momentum. Are these moments in the same direction?

67. The Earth revolves about the Sun and spins on its axis, which is tilted 23½º to its orbital plane. (a) Assuming a circular orbit, what is the magnitude of the angular momentum associated with the Earth's orbital motion about the Sun? (b) What is the magnitude of the angular momentum associated with the Earth's rotation on its axis?

68. The period of the Moon's rotation is the same as the period of its revolution: 27.3 days (sidereal). What is the angular momentum for each rotation and revolution?

69. Circular disks are used in automobile clutches and transmissions. When a rotating disk couples to a stationary one through frictional force, the energy from the rotating disk can transfer to the stationary one. (a) Is the angular-speed of the coupled disks (1) greater than, (2) less than, or (3) the same as the angular speed of the original rotating disk? Why? (b) If a disk rotating at 800 rpm couples to a stationary disk with three times the moment of inertia, what is the angular speed of the combination?

70. An ice skater has a moment of inertia of 100 kg m^2 when his arms are outstretched and a moment of inertia of 75 kg m^2 when his arms are tucked in close to his chest. If he starts to spin at an angular speed of 2.0 rps (revolutions per second) with his arms outstretched, what will his angular speed be when they are tucked in?

71. An ice skater spinning with outstretched arms has an angular speed of 4.0 rad/s. She tucks in her arms, decreasing her moment of inertia by 7.5%. (a) What is the resulting angular speed? (b) By what factor does the skater's kinetic energy change? (c) Where does the extra kinetic energy come from?

72. A billiard ball at rest is struck (bold arrow in Fig. 8.53) by a cue with an average force of 5.50 N lasting for 0.050 s. The cue contacts the ball's surface so that the lever arm is half the radius of the ball, as shown. If the cue ball has a mass of 200 g and a radius of 2.50 cm, determine the angular speed of the ball immediately after the blow.

73. A comet approaches the Sun as illustrated in Fig. 8.54 and is deflected by the Sun's gravitational attraction. This event is considered a collision, and b is called the impact parameter. Find the distance of closest approach (d) in terms of the impact parameter and the velocities (v_0 at large distances and v at closest approach). Assume that the radius of the Sun is negligible compared to d. (As the figure shows, the tail of a comet always "points" away from the Sun.)

74. While repairing his bicycle, a student turns it upside down and sets the front wheel spinning at 2.00 rev/s. Assume the wheel has a mass of 3.25 kg and all of the mass is located on the rim, which has a radius of 41.0 cm. To slow the wheel, he places his hand on the tire, thereby exerting a tangential force of friction on the wheel. It takes 3.50s to come to rest. Use the change in angular momentum to determine the force he exerts on the wheel. Assume the frictional force of the axle is negligible.

75. A kitten stands on the edge of a lazy Susan (a turntable). Assume that the lazy Susan has frictionless bearings and is initially at rest. (a) If the kitten starts to walk around the edge of the lazy Susan, the lazy Susan will (1) remain lazy and stationary, (2) rotate in the direction opposite that in which the kitten is walking, or (3) rotate in the direction the kitten is walking. Explain. (b) The mass of the kitten is 0.50 kg, and the lazy Susan has a mass of 1.5 kg and a radius of 0.30 m. If the kitten walks at a speed of 0.25 m/s, relative to the ground, what will be the angular speed of the lazy Susan? (s) When the kitten has walked completely around the edge and is back at its starting point, will that point be above the same point on the ground as it was at the start?

Chapter 9

1. A tennis racket has nylon strings. If one of the strings with a diameter of 1.0 mm is under a tension of 15 N, how much is it lengthened from its original length of 40 cm?

2. Suppose you use the tip of one finger to support a 1.0-kg object. If your finger has a diameter of 2.0 cm, what is the stress on your finger?

3. A 2.5-m nylon fishing line used to hold up a 8.0-kg fish has a diameter of 1.6 mm. How much is the line elongated?

4. A 5.0-m-long rod is stretched 0.10 m by a force. What is the strain in the rod?

5. A 250-N force is applied at a 37° angle to the surface of the end of a square bar. The surface is 4.00 cm on a side. What are (a) the compressional stress and (b) the shear stress on the bar?

6. A 4.0-kg object is supported by an aluminum wire of length 2.0 m and diameter 2.0 mm. How much will the wire stretch?

7. A copper wire has a length of 5.0 m and a diameter of 3.0 mm. Under what load will its length increase by 0.30 mm?

8. A metal wire 1.0 mm in diameter and 2.0 m long hangs vertically with a 6.0-kg object suspended from it. If the wire stretches 1.4 mm under the tension, what is the value of Young's modulus for the metal?

9. When railroad tracks are installed, gaps are left between the rails. (a) Should a greater gap be used if rails are installed on (1) a cold day or (2) a hot day? Or (3) does the temperature not make any difference? Why? (b) Each steel rail is 8.0 m long and has a cross-sectional area of 0.0025 m². On a hot day, each rail thermally expands as much as 3.0×10^{-3} m. If there were no gaps between the rails, what would be the force on the ends of each rail?

10. A rectangular steel column (20.0 cm × 15.0 cm) supports a load of 12.0 metric tons. If the column is 2.00 m in length before being stressed, what is the decrease in length?

11. A bimetallic rod as illustrated in Fig. 9.34 is composed of brass and copper. (a) If the rod is subjected to a compressive force, will the rod bend toward the brass or the copper? Why? (b) Justify your answer mathematically if the compressive force is 5.00×10^4 N.

12. Two same-size metal posts, one aluminum and one copper, are subjected to equal shear stresses. (a) Which post will show the larger deformation angle, (1) the copper post or (2) the aluminum post? Or (3) Is the angle the same for both? Why? (b) By what factor is the deformation angle of one post greater than the other?

13. A 85.0-kg person stands on one leg and 90% of the weight is supported by the upper leg connecting the knee and hip joint – the femur. Assuming the femur is 0.650 m long and has a radius of 2.00 cm, by how much is the bone compressed?

14. Two metal plates are held together by two steel rivets, each of diameter 0.20 cm and length 1.0 cm. How much force must be applied parallel to the plates to shear off both rivets?

15. (a) Which of the liquids in Table 9.1 has the greatest compressibility? Why? (b) For equal volumes of ethyl alcohol and water, which would require more pressure to be compressed by 0.10%, and how many times more?

16. How much pressure would be required to compress a quantity of mercury by 0.010%?

17. A brass cube 6.0 cm on each side is placed in a pressure chamber and subjected to a pressure of 1.2×10^7 N/m^2 on all of its surfaces. By how much will each side be compressed under this pressure?

18. A cylindrical eraser of negligible mass is dragged across a paper at a constant velocity to the right by its pencil. The coefficient of kinetic friction between eraser and paper is 0.650. The pencil pushes down with 4.20 N. The height of the eraser is 1.10 cm and its diameter is 0.760 cm. Its top surface is displaced horizontally 0.910 mm relative to the bottom. Determine the shear modulus of the eraser material.

19. A 45-kg traffic light is suspended from two steel cables of equal length and radii 0.50 cm. If each cable makes a 15° angle with the horizontal, what is the fractional increase in their length due to the weight of the light?

20. In his original barometer, Pascal used water instead of mercury. (a) Water is less dense than mercury, so the water barometer would have (1) a higher height than, (2) a lower height than, or (3) the same height as the mercury barometer. Why? (b) How high would the water column have been?

21. If you dive to a depth of 10 m below the surface of a lake, (a) what is the pressure due to the water alone? (b) What is the absolute pressure at that depth?

22. In an open U-tube, the pressure of a water column on one side is balanced by the pressure of a column of gasoline on the other side. (a) Compared to the height of the water column, the gasoline column will have (1) a higher height, (2) a lower height, or (3) the same height. Why? (b) If the height of the water column is 15 cm, what is the height of the gasoline column?

23. A 75.0-kg athlete performs a single-hand handstand. If the area of the hand in contact with the floor is 125 cm^2, what pressure is exerted on the floor?

24. A rectangular fish tank measuring 0.75 m × 0.50 m is filled with water to a height of 65 cm. What is the gauge pressure on the bottom of the tank?

25. (a) What is the absolute pressure at a depth of 10 m in a lake? (b) What is the gauge pressure?

26. The gauge pressure in both tires of a bicycle is 690 kPa. If the bicycle and the rider have a combined mass of 90.0 kg, what is the area of contact of each tire with the ground? (Assume that each tire supports half the total weight of the bicycle.)

27. In a sample of seawater taken from an oil spill, an oil layer 4.0 cm thick floats on 55 cm of water. If the density of the oil is 0.75×10^3 kg/m^3, what is the absolute pressure on the bottom of the container?

28. In a lecture demonstration, an empty can is used to demonstrate the force exerted by air pressure (Fig. 9.35). A small quantity of water is poured into the can, and the water is brought to a boil. Then the can is sealed with a rubber stopper. As you watch, the can is slowly crushed with sounds of metal bending. (Why is a rubber stopper used as a safety precaution?) (a) This is because of (1) thermal expansion and contraction, (2) a higher steam pressure inside the can, or (3) a lower pressure inside the can as steam condenses. Why? (b) Assuming the dimensions of the can are 0.24 m × 0.16 m × 0.10 m and the inside of the can is in a perfect vacuum, what is the total force exerted on the can by the air pressure?

29. What is the fractional decrease in pressure when a barometer is raised 40.0 m to the top of a building?

30. To drink a soda (assume same density as water) through a straw requires that your lower the pressure at the top of the straw. What does the pressure need to be at the top of a straw that is 15.0 cm above the surface of the soda in order for the soda to reach your lips?

31. During a plane flight, a passenger experiences ear pain due to a head cold that has clogged his Eustachian tubes. Assuming the pressure in his tubes remained at 1.00 atm (from sea level) and the cabin pressure is maintained at 0.900 atm, determine the air pressure force (including its direction) on one eardrum, assuming it has a diameter of 0.800 cm.

32. Here is a demonstration Pascal used to show the importance of a fluid's pressure on the fluid's depth (Fig. 9.36): An oak barrel with a lid of area 0.20 m^2 is filled with water. A long, thin tube of cross-sectional area 5.0×10^{-5} m^2 is inserted into a hole at the center of the lid, and water is poured into the tube. When the water reaches 12 m high, the barrel bursts. (a) What was the weight of the water in the tube? (b) What was the pressure of the water on the lid of the barrel? (c) What was the net force on the lid due to the water pressure?

33. The door and the seals on an aircraft are subject to a tremendous amount of force during flight. At an altitude of 10000 m (about 33000 ft), the air pressure outside the airplane is only 2.7×10^4 N/m^2, while the inside is still at normal atmospheric pressure, due to pressurization of the cabin. Calculate the force due to the air pressure on a door of area 3.0 m^2.

34. The pressure exerted by a person's lungs can be measured by having the person blow as hard as possible into one side of a manometer. If a person blowing into one side of an open-tube manometer produces an 80-cm

difference between the heights of the columns of water in the manometer arms, what is the gauge pressure of the lungs?