J.D. Wilson, A.J. Buffa, B. Lou, College Physics with Mastering Physics 7th edition, Addison-Wesley 2009

Chapter 2

1. What is the magnitude of the displacement of a car that travels half a lap along a circle that has a radius of 150 m? How about when the car travels a full lap?

2. A motorist travels 80 km at 100 km/h, and 50 km at 75 km/h. What is the average speed for the trip?

3. An Olympic sprinter can run 100 yd in 9.0 s. At the same rate, how long would it take the sprinter to run 100 m?

4. A senior citizen walks 0.30 km in 10 min, going around a shopping mall. (a) What is her average speed in meters per second? (b)If she wants to increase her average speed by 20% when walking a second lap, what would her travel time in minutes have to be?

5. A hospital patient is given 500 cc of saline by IV. If the saline is received at a rate of 4.0 mL/min, how long will it take for the half liter to run out?

6. A hospital nurse walks 25m to a patient's room at the end of the hall in 0.50 min. She talks with the patient for 4.0 min, and then walks back to the nursing station at the same rate she came. What was the nurse's average speed?

7. A train makes a round trip on a straight, level track. The first half of the trip is 300 km and is traveled at a speed of 75 km/h. After a 0.50 h layover, the train returns the 300 km at a speed of 85 km/h. What is the train's (a) average speed and (b) average velocity?

8. A car travels three-quarters of a lap on a circular track of radius R. (a) The magnitude of the displacement is (1) less than R, (2) greater than R, but less than 2R, (3) greater than 2R.(b) If R = 50 m, what is the magnitude of the displacement?

9. The interstate distance between two cities is 150 km. (a) if you drive the distance at a legal speed limit of 65 mi/h, how long would the trip take? (b) Suppose on the return trip you pushed it up to 80 mi/h (and didn't get caught). How much time would you save?

10. A race car travels a complete lap on a circular track of radius 500 m in 50 s. (a) The average velocity of the car is (1) zero, (2) 100 m/s, (3) 200 m/s, (4) none of the preceding. Why? (b) What is the average speed of the race car?

11. A student runs 30 m east, 40 m north, and 50 m west. (a) The magnitude of student's net displacement is (1) between 0 and 20 m, (2) between 20 m and 40 m, (3) between 40 m and 60 m. (b) What is his net displacement?

12. A student throws a ball vertically upward such that it travels 7.1 m to its maximum height.. If the ball is caught at the initial height 2.4 s after being thrown, (a) what is the ball's average speed, and (b) what is its average velocity?

13. An insect crawls along the edge of a rectangular swimming pool of length 27 m and width 21 m. If it crawls from corner A to corner B in 30 min,(a) what is its average speed, and (b) what is the magnitude of its average velocity?

14. A plot of position versus time is shown in Fig. 2.20 for an object in linear motion.(a) What are the average velocities for the segments AB,BC, CD, DE, EF, FG, and BG? (b) State whether the motion is uniform or nonuniform in each case. (c) What is the instantaneous velocity at point D?

15. In demonstrating a dance step, a person moves in one dimension, as shown in Fig. 2.21. What are (a) the average speed and (b) the average velocity for each phase of the motion? (c) What are the instantaneous velocities at t = 1.0 s, 2.5 s, 4.5 s, and 6.0 s? (d) What is the average velocity for the interval between t = 4.5 s and t = 9.0 s?

16. A high school kicker makes a 30.0-yd field goal attempt (in American football) and hits the crossbar at a height of 10.0 ft. (a) What is the net displacement of the football from time it leaves the ground until it hits the crossbar? (b) assuming the football took 2.50 s to hit the crossbar, what was its average velocity? (c) Explain, why you cannot determine its average speed from these data.

17. The location of a moving particle at a particular time is given by $x = at – bt^2$, where a = 10 m/s and b = 0.50 m/s^2. (a) Where is the particle at t = 0? (b) what is the particle's displacement for the time interval t_1 = 2.0 s and t_2 = 4.0 s?

18. The displacement of an object is given as a function of time by $x = 3t^2$ m. What is the magnitude of the average velocity for (a) Δt = 2.0 s – 0 s, and (b) Δt = 4.0 s – 2.0 s?

19. Short hair grows at a rate of about 2.0 cm/month. A college student has his hair cut to a length of 1.5 cm. He will have it cut again when the length is 3.5 cm. How long will it be until his next trip to the barber shop?

20. A student driving home for the holidays starts at 8:00 AM to make the 675-km trip, practically all of which is on nonurban interstate highways. If she wants to arrive home no later than 3:00 PM, what must be her minimum average speed? Will she have to exceed the 65-mi/h speed limit?

21. A regional airline flight consists of two legs with an intermediate stop. The airplane flies 400 km due north from airport A to airport B. From there, it flies 300 km due east to its final destination at airport C. (a) What is the plane's displacement from its starting point? (b) if the first leg takes 45 min and the second leg 30 min, what is the average velocity for the trip? (c) What is the average speed for the trip? (d) Why is the average speed not the same as the magnitude for the average velocity?

22. Two runners approaching each other on a straight track have constant speeds of 4.50 m/s and 3.50 m/s, respectively, when they are 100 m apart. How long will it take for the runners to meet, and at what position will they meet if the maintain these speeds?

23. An automobile traveling at 15.0 km/h along a straight, level road accelerates to 65.0 km/h in 6.00 s. What is the magnitude of the auto's average acceleration?

24. A sports car can accelerate from 0 to 60 mi/h in 3.9 s. what is the magnitude of the average acceleration of the car in meters per second squared?

25. If the sports car in exercise 24 can accelerate at a rate of 7.2 m/s^2, how long does the car take to accelerate from 0 to 60 mi/h?

26. A couple is traveling by car down a straight highway at 40 km/h. They see an accident in the distance, so the driver applies the brakes, and in 5.0 s the car uniformly slows down to rest. (a) The direction of the acceleration vector is (1) in the same direction as, (2) opposite to, (3) at 90° relative to the velocity vector. Why? (b) By how much must the velocity change each second from the start of braking to the car's complete stop?

27. A paramedic drives an ambulance at a constant speed of 75 km/h on a straight street for ten city blocks. Because of heavy traffic, the driver slows down to 30 km/h in 6.0 s and travels two more blocks. What was the average acceleration of the vehicle?

28. During liftoff, a hot air balloon accelerates upward at a rate of 3.0 m/s2. The balloonist drops an object over the side of the gondola when the speed is 15 m/s. (a) What is the object's acceleration after it is released (relative to the ground)? (b) How long does it take to hit the ground?

29. A new car owner wants to show a friend how fast her sports car is. The friend gets in his and drives down a straight, level highway at constant speed of 60 km/h to a point where the sports car is waiting. As the friend's car just passes, the sports car accelerates at a rate of 2.0 m/s^2. (a) How long does it take for sports car to catch up to the friend's car? (b) How far down the road does the sports car catch up to the friend's car? (c) How fast is the sports car going at this time?

30. After landing, a jetliner on a straight runaway taxis to a stop at an average velocity of 35.0 km/h. If the plane takes 7.00 s to come to rest, what are the plane's initial velocity and acceleration?

31. A train on a straight, level track has an initial speed of 35.0 km/h. A uniform acceleration of 1.50 m/s^2 is applied while the train travels 200 m. (a) What is the speed of the train at the end of this distance? (b) How long did it take for the train to travel the 200 m?

32. A hockey puck sliding along the ice to the left hits the boards head-on with a speed of 35m/s. As it reverses direction, it is in contact with the boards for 0.095 s, before rebounding at a slower speed of 11 m/s. Determine the average acceleration the puck experienced while hitting the boards. Typical car accelerations are 5.0 m/s^2. Comment on the size of your answer, and why it is so different from this value, especially when the puck speeds are similar to car speeds.

33. What is the acceleration for each graph segment in Fig. 2.23? Describe the motion of the object over the total time interval.

34. Figure 2.24 shows a plot of velocity versus time for an object in linear motion. (a) Compute the acceleration for each phase of motion. (b) Describe how the object moves during the last time segment.

35. A car initially traveling to the right at a steady speed of 25 m/s for 5.0 s applies its brakes and slows down at a constant rate of 5m/s^2 for 3.0 s. It then continues traveling to the right at a steady but lower speed with no additional braking for another 6 s. (a) To help with calculation, make a sketch of the car's velocity versus time, being sure to show all three time intervals. (b) What is its velocity after 3.0 s of breaking? (c)What was its displacement during the total 14.0 s of its motion? (d) What was its average speed for the 14.0 s?

36. A train normally travels at a uniform speed of 72 km/h on a long stretch of straight, level track. On a particular day, the train must make a 2.0 min stop at a station along this track. If the train decelerates at a uniform rate of 1.0 m/s^2 and, after the stop, accelerates at a rate of 0.50 m/s^2, how much time is lost because of stopping at the station?

37. At a sports car rally, a car starting from rest accelerates uniformly at a rate of 9.0 m/s^2 over a straight-line distance of 100 m. The time to beat is this event is 4.5 s. Does the driver beat this time? If not, what must the minimum acceleration be to do so?

38. A car accelerates from rest at a constant rate of 2.0 m/s^2 for 5.0 s. (a) What is the speed of the car at the end of that time? (b) How far does the car travel in this time?

39. A car traveling at 25 mi/h is to stop on a 35-m-long shoulder of the road. (a) What is the required magnitude of the minimum acceleration? (b) How much time will elapse during this minimum deceleration until the car stops?

40. A motorboat traveling on a straight course slows down uniformly from 60 km/h to 40 km/h in a distance of 50 m. What is the boat's acceleration?

41. The driver of a pickup truck going 100 km/h applies the brakes, giving the truck a uniform deceleration of 6.50 m/s^2 while it travels 20.0 m. (a) What is the speed of the truck in kilometers per hour at the end of this distance? (b) How much time has elapsed?

42. A roller coaster car traveling at a constant speed of 20.0 m/s on a level track comes to a straight incline with a constant slope. While going up the incline, the car has a constant acceleration of 0.750 m/s^2 in magnitude. (a) What is the speed of the car at 10.0 s on the incline? (b) How far has the car traveled up the incline at this time?

43. A rocket car is traveling at a constant speed of 250 km/h on a salt flat. The driver gives the car a reverse thrust, and the car experiences a continuous and constant deceleration of 8.25 m/s^2. How much time elapses until the car is 175 m from the point where the reverse thrust is applied?

44. Two identical cars capable of accelerating at 3.00 m/s^2 are racing on a straight track with running starts. Car A has an initial speed of 2.50 m/s; car B starts with speed of 5.00 m/s. (a) What is the separation of the two cars after 10 s? (b) Which is moving faster after 10 s?

45. According to Newton's laws of motion, a frictionless 30° incline should provide an acceleration of 4.90 m/s^2 down the incline. A student with s stopwatch finds that an object, starting from rest, slides down a 15.00-m very smooth incline in exactly 3.00 s. Is the incline frictionless?

46. An object moves in the +x-direction at a speed of 40 m/s. As it passes through the origin, it starts to experience a constant acceleration of 3.5 m/s^2 in the –x-direction. (a) What will happen next? (1) The object will reverse its direction of travel at the origin; (b) the object will keep traveling in the +x-direction; (3) the object will travel in the +x-direction and then reverses its direction. Why? (b) How much time elapses before the object returns to the origin? (c) What is the velocity of the object when it returns to the origin?

47. A rifle bullet with a muzzle speed of 330 m/s is fired directly into a special dense material that stops the bullet in 25.0 cm. Assuming the bullet's deceleration to be constant, what is its magnitude?

48. The speed limit in a school zone is 40 km/h (about 25 mi/h). A driver traveling at this speed sees a child run onto the road 13 m ahead of his car. He applies the brakes, and the car decelerates at a uniform rate of 8.0 m/s^2. If the driver's reaction time is 0.25 s, will the car stop before hitting the child?

49. Assuming a reaction time of 0.50 s for the driver in exercise 48, will the car stop before hitting the child?

50. A bullet traveling horizontally at a speed of 350 m/s hits a board perpendicular to its surface, passes through and emerges on the other side at a speed of 210 m/s. If the board is 4.0 cm thick, how long does the bullet take to pass through it?

51. (a) Show that the area under the curve of a velocity-versus-time plot for a constant acceleration is equal to the displacement. (b) Compute the distance traveled for the motion represented by Fig. 2.23.

52. An object initially at rest experiences an acceleration of 2.00 m/s^2 on a level surface. Under these conditions, it travels 6.00 m. Let's designate the first 3.00 m as phase 1 with a subscript of 1 for those quantities, and the second 3.00 m as phase 2 with a subscript of 2. (a) The times for traveling each phase should be related by which condition: (1) $t_1 < t_2$, (2) $t_1 = t_2$, or (3) $t_1 > t_2$? (b) Now calculate the two travel times and compare them quantitatively.

53. A car initially at rest experiences loss of its parking brake and rolls down a straight hill with a constant acceleration of 0.850 m/s^2, traveling a total of 100 m. Let's designate the first half of the distance as phase 1 with a subscript of 1 for those quantities, and the second half as phase 2 with a subscript of 2. (a) The car's speed at the end of each phase should be related by which condition: (1) $v_1 < 1/2v_2$, (2) $v_1 = 1/2v_2$, or (3) $v_1 > 1/2v_2$? (b) Now calculate the two speeds and compare them quantitatively.

54. An object initially at rest experiences an acceleration of 1.5 m/s^2 for 6.0 s and then travels at that constant velocity for another 8.0 s. What is the object's average velocity over the 14-s interval?

55. Figure 2.24 shows a plot of velocity versus time for an object in linear motion. (a) What are the instantaneous velocities at t = 8.0 s and t = 11.0 s? (b) Compute the final displacement of the object. (c) Compute the total distance the object travels.

56. (a) A car traveling at a speed of v can brake to an emergency stop in a distance x. Assuming all other driving conditions are similar, if the traveling speed of the car doubles, the stopping distance will be (1) $\sqrt{2}x$, (2) 2x, (3)

4x. (b) A driver traveling at 40 km/h in a school zone can brake to an emergency stop in 3.00 m. What would be the braking distance if the car were traveling at 60.0 km/h?

57. A car accelerates horizontally from rest on a level road at a constant acceleration of 3.00 m/s^2. Down the road, it passes through two photocells ("electric eyes" designated by 1 for the first one and 2 for the second one) that are separated by 20.0 m. The time interval to travel this 20.0-m distance as measured by the electric eyes is 1.40 s. (a) Calculate the speed of the car as it passes each electric eye. (b) How far is it from the start to the first electric eye? (c) How long did it take the car to get to the first electric eye?

58. An automobile is traveling on a long, straight highway at a steady 75.0 km/h when the driver sees a wreck 150 m ahead. At that instant, she applies the brakes (ignore reaction time). Between her and the wreck are two different surfaces. First there is 100 m of ice, where the deceleration is only 1.00m/s^2. From then on, it is dry concrete, where the deceleration is a more normal 7.00 m/s^2. (a) What was the car's speed just after leaving the icy portion of the road? (b) What is the total distance her car travels before it comes to a stop? (c) What is the total time it took the car to stop?

59. A student drops a ball from the top of a tall building; the ball takes 2.8 s to reach the ground. (a) What was the ball's speed just before hitting the ground? (b) What is the height of the building?

60. The time it takes for an object dropped from the top of cliff A to hit the water in the lake below is twice the time it takes for another object dropped from the top of cliff B to reach the lake. (a) The height of cliff A is (1) one-half, (2) two times, (3) four times that of cliff B. (b) If it takes 1.80 s for the object to fall from cliff A to the water, what are the heights of cliffs A and B?

61. For the motion of a dropped object in free fall, sketch the general forms of the graphs of (a) v versus t and (b) y versus t.

62. You can perform a popular trick by dropping a dollar bill (lengthwise) through the thumb and forefinger of a fellow student. Tell your fellow student to grab the dollar bill as fast as possible, and he or she can have the dollar if able to catch it. Is this proposal a good deal? Justify your answer.

63. A juggler tosses a ball vertically a certain distance. How much higher must the ball be tossed so as to spend twice as much time in the air?

64. A boy throws a stone straight upward with an initial speed of 15.0 m/s. What maximum height will the stone reach before falling back down?

65. In exercise 64, what would be the maximum height of the stone if the boy and the stone were on the surface of the Moon, where the acceleration due to gravity is only one-sixth of that of the Earth's?

66. The Petronas Twin Towers in Malaysia and the Chicago Sears Tower have heights of about 452 m and 443 m, respectively. If objects were dropped from the top of each, what would be the difference in the time it takes the object to reach the ground?

67. In an air bag test, a car traveling at 100 km/h is remotely driven into a brick wall. Suppose an identical car is dropped onto a hard surface. From what height would the car have to be dropped to have the same impact as that with the brick wall?

68. You throw a stone vertically upward with an initial speed of 6.0 m/s from a third-story office window. If the window is 12 m above the ground, find (a) the time the stone is in flight and (b) the speed of the stone just before it hits the ground.

69. A Super Ball is dropped from a height of 4.00 m. Assuming the ball rebounds with 95% of its impact speed, (a) the ball would bounce to (1) less than 95%, (2) equal to 95%, or (3) more than 95% of the initial height? (b) how long will the ball go?

70. In Fig. 2.25, a student at a window on the second floor of a dorm sees his math professor walking on the sidewalk beside the building. He drops a water balloon from 18.0 m above the ground when the professor is 1.00 m from the point directly beneath the window. If the professor is 1.70 m tall and walks at a rate of 0.450 m/s, does the balloon hit her? If not, how close does it come?

71. A photographer in a helicopter ascending vertically at a constant rate of 12.5 m/s accidentally drops a camera out of the window when the helicopter is 60.0 m above the ground. (a) How long will the camera take to reach the ground? (b) What will its speed be when it hits?

72. The acceleration due to gravity on the Moon is about one-sixth of that on the Earth. (a) If an object were dropped from the same height on the Moon and on the Earth, the time it would take to reach the surface on the Moon is (1) $\sqrt{6}$, (2) 6, or (3) 36 times the time it would take on the Earth.(b) For a projectile with an initial velocity of 18.0 m/s upward, what would be the maximum height and the total time of flight on the Moon and on the Earth?

73. It takes 0.210 s for a dropped object to pass a window that is 1.35 m tall. From what height above the top of the window was the object released?

74. A tennis ball is dropped from a height of 10.0 m. It rebounds off the floor and comes up to a height of only 4.00 m on its first rebound. (Ignore the small amount of time the ball is in contact with the floor.) (a) Determine the ball’s speed just before it hits the floor on the way down (b) Determine the ball’s speed as it leaves the floor on its way up to its first rebound height. (c) How long is the ball in the air from the time it is dropped until the time it reaches its maximum height on the first rebound?

75. A pollution-sampling rocket is launched straight upward with rockets providing a constant acceleration of 12.0 m/s^2 for the first 1000 m of flight. At that point the rocket motors cut off and the rocket itself is in free fall. Ignore air resistance. (a) What is the rocket’s speed when the engines cut off? (b) What is the maximum altitude reached by this rocket? (c) What is the time it takes to get to its maximum altitude?

76. A test rocket containing a probe to determine the composition of the upper atmosphere is fired vertically upward from an initial position at ground level. During the time t while its fuel lasts, the rocket ascends with a constant upward acceleration of magnitude $2g$. Assume that the rocket travels to a small enough height that the Earth's gravitational force can be considered constant. (a) What are the speed and height, in terms of g and t, when the rocket’s fuel runs out? (b) What is the maximum height the rocket reaches in terms of g and t? (c) If t = 30.0 s, calculate the rocket’s maximum height.

77. A car and a motorcycle start from rest at the same time on a straight track, but the motorcycle is 25.0 m behind the car. The car accelerates at a uniform rate of 3.70 m/s^2 and the motorcycle at a uniform rate of 4.40 m/s^2. (a) How much time elapses before the motorcycle overtakes the car? (b) How far will each have traveled during that time? (c) How far ahead of the car will the motorcycle be 2.00 s later? (Both vehicles are still accelerating.)

78. Two joggers run at the same average speed. Jogger A cuts directly north across the diameter of the circular track, while jogger B takes the full semicircle to meet his partner on the opposite side of the track. Assume their common average speed is 2.60 m/s and the track has a diameter of 150 meters.
(a) How many seconds ahead of jogger B does jogger A arrive? (b) How do their travel distances compare? (c) How do their displacements compare? (d) How do their average velocities compare?

Chapter 3

1. An airplane climbs at an angle of 15° with a horizontal component of speed of 200 km/h. (a) What is the plane’s actual speed? (b) What is the magnitude of the vertical component of its velocity?

2. A golf ball is hit with an initial speed of 35 m/s at an angle less than 45° above the horizontal. (a) The horizontal velocity component is (1) greater than, (2) equal to, (3) less than the vertical component. Why? (b) if the ball is hit at an angle of 37°, what are the initial horizontal and vertical velocity components?

3. The x- and y-components of an acceleration vector are 3.0 and 4.0 m/s^2, respectively. (a) The magnitude of the acceleration vector is (1) less than 3.0 m/s^2, (2) between 3.0 m/s^2 and 4.0 m/s^2, (3) between 4.0 m/s^2 and 7.0 m/s^2, (4) equal to 7.0 m/s^2. (b) What are the magnitude and direction of the acceleration vector?

4. If the magnitude of a velocity vector is 7.0 m/s and the x-component is 3.0 m/s, what is the y-component?

5. The x-component of a velocity vector that has an angle 37° to the +x-axis has a magnitude of 4.8 m/s. (a) What is the magnitude of the velocity? (b) What is the magnitude of the y-component of the velocity?

6. A student walks 100 m west and 50 m south. (a) To get back to the starting point, the student must walk in a general direction of (1) south of west, (2) north of east, (3) south of east, (4) north of west. (b) What displacement will bring the student back to the starting point?

7. A student strolls diagonally across a level rectangular campus plaza, covering the 50-m distance in 1.0 min. (a) If the diagonal route makes a 37° angle with the long side of the plaza, what would be the distance traveled if the student had walked halfway around the outside of the plaza instead of along the diagonal route? (b) If the student had walked the outside route in 1.0 min at a constant speed, how much time would she have spent on each side?

8. A ball rolls at a constant velocity of 1.50 m/s at an angle 45° below the +x-axis in the fourth quadrant. If we take the ball to be at the origin at t = 0 what are its coordinates (x,y) 1.65 s later?

9. A ball rolling on a table has a velocity with rectangular components $v_x = 0.60$ m/s and $v_y = 0.80$ m/s. What is the displacement of the ball in an interval of 2.5 s?

10. A hot air balloon rises vertically with a speed of 1.5 m/s. at the same time, there is a horizontal 10 km/h wind blowing. In which direction is the balloon moving?

11. During part of its trajectory (which lasts exactly 1 min) a missile travels ar a constant speed of a 2000 mi/h while maintaining a constant orientation angle of 20° from vertical. (a) During this phase, what is true about its velocity components: (1) $v_y > v_x$, (2) $v_y = v_x$, (3) $v_y < v_x$? (b) Determine the two velocity components analytically to confirm your choice in part (a) and also calculate how far the missile will rise during this time.

12. At the instant a ball rolls off a rooftop it has a horizontal velocity component of +10 m/s and a vertical component (downward) of 15.0 m/s. (a) Determine the angle of the roof. (b) What is the ball's speed as it leaves the roof?

13. A particle moves at a speed of 3.0 m/s in the +x-direction. Upon reaching the origin, the particle receives a continuous constant acceleration of 0.75 m/s^2 in the –y-direction. What is the position of the particle 4.0 s later?

14. At a constant speed of 60 km/h, an automobile travels 700 m along a straight highway that is inclined 4.0° to the horizontal. An observer notes only the vertical motion of the car. What is the car's (a) vertical velocity magnitude and (b) vertical travel distance?

15. A baseball player hits a home run into the right field upper deck. The ball lands in a row that is 135 m horizontally from home plate and 25.0 m above the playing field. An avid fan measures its time of flight to be 4.10 s. (a) Determine the ball's average velocity components (b) Determine the magnitude and angle of its average velocity. (c) Explain why you cannot determine its average speed from the data given.

36. A block weighing 50 N rests on an inclined plane. Its weight is a force directed vertically downward, as illustrated in Fig. 3.30. Find the components of the force parallel to the surface of the plane and perpendicular to it.

37. Two displacements, one with magnitude of 15.0 m and a second with a magnitude of 20.0 m, can have any angle you want. (a) How would you create the sum of these two vectors so it has the largest magnitude possible? What is that magnitude? (b) How would you orient them so the magnitude of the sum was at its minimum? What value would that be? (c) Generalize the result to any two vectors.

38. A person walks from point A to point B as shown in Fig. 3.31. What is the person's displacement relative to point A?

39. A meteorologist tracks the movement of a thunderstorm with Doppler radar. At 8:00 pm, the storm was 60 mi northeast of her station. At 10:00 pm, the storm is at 75 mi north. (a) The general direction of the thunderstorm's velocity is (1) south of east, (2) north of west, (3) north of east, (4) south of west. (b) What is the average velocity of the storm?

40. A flight controller determines that an airplane is 20.0 mi south of him. Half an hour later, the same plane is 35.0 mi northwest of him. (a) The general direction of airplane's velocity is (1) east of south, (2) north of west, (3) north of east, (4) west of south. (b) If the plane is flying with constant velocity, what is it velocity during this time?

41. Fig. 3.32 depicts a decorative window (the thick inner square) weighting 100 N suspended in a patio opening (the thin outer square). The upper two corner cables are each at 45° and the left one exerts a force (F_1) of 100 N on the window. (a) How does the magnitude of the force exerted by the upper right cable (F_2) compare to that exerted by the left cable: (1) $F_2 > F_1$, (2) $F_2 = F_1$, or $F_2 < F_1$? (b) Use your result from part (a) to help determine the force exerted by the bottom cable (F_3).

42. A golfer lines up for her first putt at a hole that is 10.5 m exactly northwest of her ball's location. She hits the ball 10.5 m and straight, but at the wrong angle, 40° from due north. In order for the golfer to have a "two putt green," determine (a) the angle of the second putt (b) the magnitude of the second putt's displacement. (c) Determine why you cannot determine the length of travel of the second putt.

43. Two students are pulling a box as shown in Fig. 3.26, where F_1 = 100 N and F_2 = 150 N. What third force would cause the box to be stationary when all three forces are applied?

44. A ball with a horizontal speed of 1.0 m/s rolls off a bench 2.0 m high. (a) How long will the ball take to reach the floor? (b) How far from a point on the floor directly below the edge of the bench will the ball land?

45. An electron is ejected horizontally at a speed of 1.5×10^6 m/s from the electron gun of a computer monitor. If the viewing screen is 35 cm from the end of the gun, how far will the electron travel in the vertical direction before hitting the screen? Based on your answer, do you think designers need to worry about this gravitational effect?

46. A ball rolls horizontally with a speed of 7.6 m/s off the edge of a tall platform. If the ball lands 8.7 m from the point on the ground directly below the edge of the platform, what is the height of the platform?

47. A ball is projected horizontally with an initial speed of 5.0 m/s. Find its (a) position and (b) velocity at t = 2.5 s.

48. An artillery crew wants to shell a position on level ground 35 km away. If the gun has muzzle velocity of 770 m/s, to what angle of elevation should the gun be raised?

49. A pitcher throws a fastball horizontally at a speed of 140 km/h toward home plate, 18.4 m away. (a) If the batter's combined reaction and swing times total 0.350 s, how long can the batter watch the ball after it has left the pitcher's hand before swinging? (b) In traveling to the plate, how far does the ball drop from its original horizontal line.

50. Ball A rolls at a constant speed of 0.25 m/s on a table 0.95 m above the floor, and ball B rolls on the floor directly under the first ball and with the same speed and direction. (a) When ball A rolls off the table and hits

the floor, (1) ball B is ahead of ball A, (2) ball B collides with ball A, or (3) ball A is ahead of ball B. Why? (b) When ball A hits the floor, how far from the point directly below the edge of the table will both balls be?

51. The pilot of a cargo plane flying 300 km/h at an altitude of 1.5 km wants to drop a load of supplies to campers at a particular location on the level ground. Having the designated point in site, the pilot prepares to drop the supplies. What should the angle be between the horizontal and the pilot's line of site when the package is released? (b) What is the location of the plane when supplies hit the ground?

52. A wheeled car with a spring-loaded cannon fires a metal ball vertically. If the vertical initial speed of the ball is 5 m/s as the cannon moves horizontally at a speed of 0.75 m/s, (a) How far from the launch point does the ball fall back into the cannon? And (b) what would happen if the cannon were accelerating?

53. A convertible travels down a straight, level road at a slow speed of 13 km/h. A person in the car throws a ball with a speed of 3.6 m/s forward at an angle of 30° to the horizontal. Where is the car when the ball lands?

54. A good-guy stuntman is being chased by bad guys on a building's level roof. He comes to the edge and is to jump to the level roof of a lower building 4.0 m below and 5.0 m away. What is the minimum launch speed the stuntman needs to complete the jump?

55. An astronaut on the Moon fires a projectile from a launcher on a level surface so as to get the maximum range. If the launcher gives the projectile a muzzle velocity of 25 m/s, what is the range of the projectile?

56. In 2004 two Martian probes successfully landed on the Red Planet. The final phase of the landing involved bouncing the probes until they came to rest (they were surrounded by protective inflated "balloons"). During one of the bounces, the telemetry (electronic data sent back to Earth) indicated that the probe took off at 25.0 m/s at an angle of 20° and landed 110 m away (and then bounced again). Assuming the landing region was level, determine the acceleration due to gravity near the Martian surface.

57. In laboratory situations, a projectile's range can be used to determine its speed. To see how this is done, suppose a ball rolls off a horizontal table and lands 1.5 m out from the edge of the table. If the tabletop is 90 cm above the floor, determine (a) the time the ball is in the air, and (b) the ball's speed as it left the table top.

58. A stone thrown off a bridge 20 m above a river has an initial velocity of 12 m/s at an angle of 45º above the horizontal. (a) What is the range of the stone? (b) At what velocity does the stone strike the water?

59. If the maximum height reached by a projectile launched on level ground is equal to half the projectile's range, what is the launch angle?

60. William Tell is said to have shot an apple off his son's head with an arrow. If the arrow was shot with an initial speed of 55 m/s and the boy was 15 m away, at what launch angle did Bill aim the arrow?

61. This time, William Tell is shooting at an apple that hangs on a tree. The apple is a horizontal distance of 20.0 away and at a height of 4.00 m above the ground. If the arrow is released from a height of 1.00 m above the ground and hits the apple 0.500 s later, what is the arrow's initial velocity?

62. The apparatus for a popular lecture demonstration is shown in Fig. 3.35. The gun is aimed directly at a can, which is released at the same time that the gun is fired. This gun won't miss as long as the initial speed of the bullet is sufficient to reach the falling target before the target hits the floor. Verify this statement, using the figure.

63. A shot-putter launches the shot from a vertical distance of 2.0 m off the ground (from just above her ear) at a speed of 12.0 m/s. The initial velocity is at an angle of 20° above the horizontal. Assume the ground is flat. (a) Compared to a projectile launched at the same angle and speed at ground level, would the shot be in the air (1) a longer time, (2) a shorter time, or (3) the same amount of time? (b) Justify your answer explicitly, determine the shot's range and velocity just before impact in unit vector (component) notation.

64. A ditch 2.5 m wide crosses a trail bike path. An upward incline of 15° has been built up on the approach so that the top of the incline is level with the top of the ditch. What is the minimum speed a trail bike must be moving to clear the ditch? (Add 1.4 m to the range for the back of the bike to clear the ditch safely.)

65. A ball rolls down a roof that makes an angle of 30° to the horizontal. It rolls off the edge with a speed of 5.00 m/s. The distance to the ground from that point is two stories or 7.00 m. (a) How long is the ball in the air? (b)How far from the base of the house does it land? (c) What is its speed just before landing?

66. A quarterback passes a football at a velocity of 50 ft/s at an angle of 40° to the horizontal toward an intended receiver 30 yd downfield. The pass is released 5.0 ft above the ground. Assume that the receiver is stationary and that he will catch the ball if it comes to him. Will the pass be completed? If not, will the throw be long or short?

67. A 2.05-m-tall basketball player takes a shot when he is 6.02 m from the basket (at the three point line). If the ball launch angle is 25° and the ball was launched at the level of the players head, what must be the release speed of the ball for the player to make the shot? The basket is 3.05 m above the floor.

68. While you are traveling in a car on a straight, level interstate highway at 90 km/h, another car passes you in the same direction; its speedometer reads 120 km/h. (a) What is your velocity relative to the other driver? (b) What is the other car's velocity relative to you?

69. A shopper is in a hurry to catch a bargain in a department store. She walks up the escalator, rather than letting it carry her, at a speed of 1.0 m/s relative to the escalator. If the escalator is 10 m long and moves at a speed of 0.50 m/s, how long does it take for the shopper to get to the next floor?

70. A motorboat's speed in still water is 2.0 m/s. The driver wants to go directly across a river with a current of 1.5 m/s. At what angle upstream should the boat be steered?

71. A person riding in the back of a pickup truck traveling at 70 km/h on a straight, level road throws a ball with a speed of 15 km/h relative to the truck in the direction opposite to the truck's motion. What is the velocity of the ball (a) relative to a stationary observer by the side of the road, and (b) relative to the driver of a car moving in the same direction as the truck at a speed of 90 km/h?

72. In Exercise 71, what are the relative velocities if the ball is thrown in the direction of the truck?

73. In a 500-m stretch of a river, the speed of the current is a steady 5.0 m/s. How long does a boat take to finish a round trip (upstream and downstream) if the speed of the boat is 7.5 m/s relative to still water?

74. A moving walkway in an airport is 75 m long and moves at a speed of 0.30 m/s. A passenger, after traveling 25 m while standing on the walkway, starts to walk at a speed of 0.50 m/s relative to the surface of the walkway. How long does she take to travel the total distance of the walkway?

75. A swimmer swims north at 0.15 m/s relative to still water across a river that flows at a rate of 0.20 m/s from west to east. (a) The general direction of the swimmer's velocity, relative to the riverbank is (1) north to east, (2) south of west, (3) north of west, (4) south of east. (b) Calculate the swimmer's velocity relative to the riverbank.

76. A boat that travels at a speed of 6.75 m/s in still water is to go directly across a river and back. The current flows at 0.50 m/s. (a) At what angle(s) must the boat be steered? (b) How long does it take to make the round trip?

77. A pouring rain comes straight down with a raindrop speed of 6.0 m/s. A woman with an umbrella walks eastward at a brisk clip of 1.5 m/s to get home. At what angle should she tilt her umbrella to get the maximum protection from the rain?

78. It is raining, and there is no wind. When you are sitting in a stationary car, the rain falls straight down relative to the car and the ground. But when you're driving, the rain appears to hit the windshield at an angle. (a) As the velocity of the car increases, this angle (1) also increases, (2) remains the same, (3) decreases. Why? (b)

If the raindrops fall straight down at a speed of 10 m/s, but appear to make an angle of 25° degrees to the vertical, what is the speed of the car?

79. If the flower rate of the current in a straight river is a greater than the speed of a boat in the water, the boat cannot make a trip directly across the river. Prove this statement.

80. You are in a fast powerboat that is capable of a sustained steady speed of 20.0 m/s in still water. On a swift, straight section of a river you travel parallel to the bank of the river. You note that you take 15.0 s to go between two trees on the riverbank that are 400 m apart. (a) (1) Are you traveling with current, (2) are you traveling against the current, or (3) is the no current? (b) If there is no current, determine its speed.

81. An observer by the side of a straight, level, north-south road watches a car (A) moving south at a rate of 75 km/h. A driver in another car (B) going north at 50 km/h also observes car A. (a) What is car's A velocity as observed from car B? (b) If the roadside observer sees car A brake to a stop in 6.0 s, what constant acceleration would be measured?

82. An airplane flies due north with an air speed of 250 km/h. A steady wind at 75 km/h blows eastward. (Air speed is the speed relative to the air). (a) What is the plane's ground speed? (b) If the pilot wants to fly due north, what should his heading be?

83. A shopper in a mall is on an escalator that is moving downward at an angle of 41.8° below the horizontal at a constant speed of 0.75 m/s. At the same time a little boy drops a toy parachute from a floor above the escalator and it descends at a steady vertical speed of 0.50 m/s. Determine the speed of the parachute toy as observed from the moving escalator.

84. An airplane is flying at 150 mi/h (its speed in still air) in a direction such that with a wind of 60.0 mi/h blowing from east to west, the airplane travels in a straight line southward. (a) What must be the plane's heading for it to fly directly south? (b) If the plane has to go 200 mi in the southward direction, how long does it take?

Chapter 4

1. Which has more inertia, 20 cm^3 of water or 10 cm^3 of aluminum, and how many times more?

2. Two forces act on a 5.0-kg object sitting on a frictionless horizontal surface. One force is 30 N in the +x-direction, and the other is 35 N in the –x-direction. What is the acceleration of the object?

3. In Exercise 2, if the 35-n force acted downward at an angle of 40° relative to the horizontal, what would be the acceleration in this case?

4. A net force of 4.0 N gives an object an acceleration of 10 m/s2. What is the mass of the object?

5. Consider a 2.0-kg ball and 6.0-kg ball in free fall. (a) What is the net force acting on each? (b) What is the acceleration of each?

6. A hockey puck with a weight of 0.50 lb is sliding freely across a section of very smooth (frictionless) horizontal ice. (a) When it is sliding freely, how does the upward force of the ice on the puck (the normal force) compare with the upward force when the puck is sitting permanently at rest:
(1) the upward force is greater when the puck is sliding; (2) the upward force is less when it is sliding
(3) the upward force is the same in both situations? (b) Calculate the upward force on the puck in both situations.

7. A 5.0-kg block at rest on a frictionless surface is acted on by forces F_1 = 5.5 N and F_2 = 3.5 N as illustrated in Fig. 4.33. What additional force will keep the block at rest?

8. (a) You are told that an object has zero acceleration. Which of the following is true: (1) The object is at rest; (2) The object is moving with constant velocity; (3) Both of these is possible, or (4) neither 1 nor 2 is possible. (b) Two forces on the object are $F_1 = 3.6$ N at 74º below the +x axis and $F_2 = 3.6$ N at 34 º above the -x axis. Is there a third force on the object? Why or why not? If there is a third force, what is it?

9. A fish weighing 25 lb is caught and hauled onto the boat. (a) Compare the tension in the fishing line when the fish is brought up vertically at a constant speed to the tension when the fish is held vertically at rest for the picture taking ceremony on the wharf. In which case is the tension largest: (1) when the fish is moving up (2) when the fish is being held steady, or (3) the tension is the same in both situations? (b) Calculate the tension in the fishing line.

10. A 1.5-kg object moves up the y-axis at a constant speed. When it reaches the origin, the forces $F_1 = 5.0$ N at 37° above the +x-axis, $F_2 = 2.5$ N in the +x-direction, $F_3 = 3.5$ N at 45° below the -x-axis, and $F_4 = 1.5$ N in the -y-direction are applied to it. (a) Will the object continue to move along the y-axis? (b) If not, what simultaneously applied force will keep it moving along the y-axis at a constant speed?

11. Three horizontal forces (the only horizontal ones) act on a box sitting on a floor. One (call it F_1) acts due east and has a magnitude of 150 lb. A second force (call it F_2) has an easterly component of 30.0 lb and a southerly component of 40.0 lb. The box remains in rest. (a) Sketch the two known forces on the box. In which quadrant is the unknown third force: (1) the first quadrant; (2) the second quadrant; (3) the third quadrant, or (4) the fourth quadrant? (b) Find the unknown third force in newtons and compare your answer to the sketched estimate.

12. A 6.0-N net force is applied to a 1.5-kg mass. What is the object's acceleration?

13. A force acts on a 1.5-kg mass, giving it an acceleration of 3.0 m/s^2. (a1) If the same force acts on a 2.5-kg mass, what acceleration would be produced? (b) What is the magnitude of the force?

14. A loaded Boeing 747 jumbo jet has a mass of 2.0×10^5 kg. What net force is required to give the plane an acceleration of 3.5 m/s^2 down the runway for take offs.

15. A 6.0-kg object is brought to the Moon, where the acceleration due to gravity is only one-sixth of that on the Earth. (a) The mass of the object on the Moon is (1) zero, (2) 1.0 kg, (3) 6.0 kg, (4) 36 kg. Why? (b) What is the weight of the object on the Moon?

16. A gun is fired and a 50-g bullet is accelerated to a muzzle speed of 100 m/s. If the length of the gun barrel is 0.90 cm, what is the magnitude of the accelerating force?

17. Fig. 4.34 shows a product label. (a) This label is correct (1) on the Earth; (2) on the Moon, where the acceleration due to gravity is only one-sixth of that on the Earth; (3) in deep space, where there is little gravity; (4) all of the preceding. (b) What mass of lasagna would a label show for an amount that weight 2 lb on the Moon?

18. In a college homecoming competition, eighteen students lift a sports car. While holding the car off the ground, each student exerts an upward force of 400 N. (a) What is the mass of the car in kilograms? (b) What is its weight in pounds?

19. (a) A horizontal force acts on an object on a frictionless horizontal surface. If the force is halved and the mass of the object is doubled, the acceleration will be (1) four times, (2) two times, (3) one-half, (4) one-fourth as great. (b) If the acceleration of the object is 1.0 m/s^2, and the force on it is doubled and its mass is halved, what is the new acceleration?

20. A force of 50 N acts on a mass m_1, giving it an acceleration of 4.0 m/s^2. The same force acts on a mass m_2 and produces an acceleration of 12 m/s^2. What acceleration will this force produce if the total system is $m_1 + m_2$?

21. A student weighing 800 N crouches on a scale and suddenly springs vertically upward. His roommate notices that the scale reads 900 N momentarily just as he leaves the scale. With what acceleration does he leave the scale?

22. The engine of a 1.0-kg toy plane exerts a 15-N forward force. If the air exerts an 8.0-N resistive force on the plane, what is the magnitude of the acceleration of the plane?

23. When a horizontal force of 300 N is applied to a 75.0-kg box, the box slides on a level floor, opposed by a force of kinetic friction of 120 N. What is the magnitude of the acceleration of the box?

24. A rocket is far away from all planets and stars, so gravity is not a consideration. It is using its rocket engines to accelerate upward with an acceleration of a = 9.8 m/s^2. On the floor of the main deck is a crate with a mass of 75 kg. (a) How many forces are acting on the crate? (1) zero; (2) one; (3) two; (4) three? (b) Determine the normal force on the crate and compare it to the normal force the crate would experience if it were at rest on the surface of the Earth.

25. An object (mass 10.0 kg) slides upward on a slippery vertical wall. A force F of 60 N acts at a angle of 60° as shown in Fig. 4.36. (a) Determine the normal force exerted on the object by the wall. (b) Determine the object's acceleration.

26. In an emergency stop to avoid an accident, a shoulder-strap seat belt holds a 60 kg passenger in place. If the car was initially traveling at 90 km/h and came to a stop in 5.5 s along a straight, level road, what was the average force applied to the passenger by the seatbelt?

27. A student is assigned the task of measuring the startup acceleration of a large RV using an iron ball suspended from the ceiling by a long string. In accelerating from rest, the ball no longer hangs vertically, but at an angle to the vertical. (a) Is the angle of the ball forward or backward from the vertical? (b) If the string makes an angle of 3.0° from the vertical, what is the initial acceleration of the RV?

28. A force of 10 N acts on two blocks on a frictionless surface. (a) What is the acceleration of the system? (b) What force does block A exert on block B? (c) What force does block B exert on block A?

29. A 2.0-kg object has an acceleration of 1.5 m/s^2 at 30° above the –x-axis. Write the force vector producing this acceleration in component form.

30. In a pole-sliding game among friends, a 90 kg man makes a total vertical drop of 7.0 m while gripping the pole which exerts and upward force (call it F_p) on him. Starting from rest and sliding with a constant acceleration, his slide takes 2.5 s. (a) Draw the man's free body diagram being sure to label all the forces. (b) What is the magnitude of the upward force exerted on the man by the pole? (c) A friend whose mass is only 75 kg, slides down the same distance, but the pole force is only 80% of the force on his buddy. How long did the second person's slide take?

31. A book is sitting on a horizontal surface. (a) There is (are) (1) one, (2) two, or (3) three force(s) acting on the book. (b) Identify the reaction force to each force on the book.

32. In an Olympic figure-skating event, a 65-kg male skater pushes a 45-kg female skater, causing her to accelerate at a rate of 2.0 m/s^2. At what rate will the male skater accelerate? What is the direction of his acceleration?

33. A sprinter of mass 65.0 kg starts his race by pushing horizontally backward on the starting block with a force of 200 N. (a) What force causes him to accelerate out of the blocks; (1) his push on the blocks; (2) the downward force of gravity; or (3) the force the blocks exert forward on him. (b) Determine his initial acceleration as he leaves the blocks.

34. Jane and John, with masses of 50 kg and 60 kg, respectively, stand on a frictionless surface 10 m apart. John pulls on a rope that connects him to Jane, giving Jane an acceleration of 0.92 m/s^2 toward him. (a) What is John's acceleration? (b) If the pulling force is applied constantly, where will Jane and John meet?

35. During a daring rescue, a helicopter rescue squad initially accelerates a little girl (mass 25.0 kg) vertically off the roof of a burning building. They do this by dropping a rope down to her, which she holds on to as they pull her up. Neglect the mass of the rope. (a) What force causes the girl to accelerate vertically upward: (1) her weight; (2) the pull of the helicopter on the rope; (3) the pull of the rope on the girl? (b) Determine the pull of the rope (the tension) if she initially accelerates upward at 0.750 m/s^2.

36. A 75.0-kg person is standing on a scale in an elevator. What is the reading on the scale in newtons if the elevator is (a) at rest, (b) moving up at a constant velocity of 2.00 m/s, and (c) accelerating up at 2.00 m/s^2?

37. In Exercise 36, what if the elevator is accelerating down at 2.00 m/s^2?

38. (a) When an object is on an inclined plane, the normal force exerted by the inclined plane on the object is (a) less than, (2) equal to, (3) more than the weight of the object. Why? (b) For a 10-kg object on a 30° inclined plane, what are the object's weight and the normal force exerted on the object by the inclined plane?

39. The weight of a 500-kg object is 4900 N. (a) When the object is on a moving elevator, its measured weight could be (1) zero, (2) between zero and 4900 N, (3) more than 4900 N, (4) all of the preceding. Why? (b) Describe the motion if the object's measured weight is only 4000 N in a moving elevator.

40. A boy pulls a box of mass 30 kg with a force of 25 N in the direction shown in Fig 4.48. (a)Ignoring friction, what is the acceleration of the box? (b) What is the normal force exerted on the box by the ground?

41. A girl pushes a 25-kg lawn mower as shown in fig. 4.39. If F = 30 N and θ = 37° (a) what is the acceleration of the mower, and (b) what is the normal force exerted on the mower by the lawn? Ignore friction.

42. A 3000-kg truck tows a 1500-kg car by a chain. If the net forward force on the truck by the ground is 3200 N, (a) what is the acceleration of the car, and (b) what is the tension in the connecting chain?

43. A block of mass 25.0 kg slides down a frictionless surface inclined at 30°. To ensure that the block does not accelerate, what is the smallest force you must exert on it and what is its direction?

44. An Olympic skier coasts down a slope with an angle of inclination of 37°. Neglecting friction, there is (are) (1) one, (2) two, (3) three force(s) acting on the skier. (b) What is the acceleration of the skier? (c) If the skier has a speed of 5.0 m/s at the top of the slope, what is his speed when he reaches the bottom of the 35 m long slope?

45. A car coasts (engine off) up a 30° grade. If the speed of the car is 25 m/s at the bottom of the grades, what is the distance traveled by the car before it comes to rest.

46. Assuming ideal frictionless conditions for the apparatus shown in Fig, 4.40, what is the acceleration of the system if (a) m_1 = 0.25 kg, m_2 = 0.50 kg, and m_3 = 0.25 kg, and (b) m_1 = 0.35 kg, m_2 = 0.15 kg, and m_3 = 0.50 kg?

47. A rope is fixed at both ends on two trees and a bag is hung in the middle of the rope (causing the rope to sag vertically). (a) The tension in the rope depends on (1) only the tree separation, (2) only the sag, (3) both the tree separation and sag, (4) neither the tree separation nor the sag. (b) If the tree separation is 10 m, the mass of the bag is 5.0 kg, and the sag is 0.20 m, what is the tension in the line?

48. A 55-kg gymnast hangs vertically from a pair of parallel rings. (a) If the ropes supporting the rings are attached to the ceiling directly above, what is the tension in each rope? (b) If the ropes are supported so that they make an angle of 45° with the ceiling, what is the tension in each rope?

49. A physicist's car has a small lead weight suspended from a string attached to the interior ceiling. Starting from rest, after a fraction of a second the car accelerates at a steady rate for about 10 s. During that time, the string (with the weight on the end of it) makes a backward (opposite the acceleration) angle of 15.0° from the vertical. Determine the car's (and weight's) acceleration during the 10-s interval.

50. A 10-kg mass is suspended as shown in Fig. 4.41. What is the tension in the cord between points A and B?

51. Referring to Fig. 4.41, what are the tensions in all the cord?

52. At the end of most landing runaways in airports, an extension of the runway is constructed using a special substance called formcrete. Formcrete can support the weight of cars, but crumbles under the weight of airplanes to slow them down if they run off the end of a runway. If a plane of mass 2.50×10^5 kg is to stop from a speed of 25.0 m/s on a 100 long stretch of formcrete, what is the average force exerted on the plane by the formcrete?

53. A rifle weighs 50.0 N and its barrel is 0.750 m long. It shoots a 25.0-g bullet, which leaves the barrel at a speed (muzzle velocity) of 300 m/s after being uniformly accelerated. What is the magnitude of the force exerted on the rifle by the bullet?

54. A horizontal force of 40 N acting on a block on a frictionless, level surface produces an acceleration of 2.5 m/s^2. A second block, with a mass of 4.0 kg, is dropped onto the first. What is the magnitude of the acceleration of the combination of blocks if the same force continues to act?

55. The Atwood machine consists of two masses suspended form a fixed pulley, as shown in Fig. 4.42. It is named after the British scientist George Atwood (1746-1807), who used it to study motion and to measure the value of g. If m_1 = 0.55 kg and m_2 =0.80 kg, (a) what is the acceleration of the system? (b) What is the magnitude of the tension in the string?

56. An Atwood machine (see Fig. 4.42) has suspended masses of 0.25 kg and 0.20 kg. Under ideal conditions, what will be the acceleration of the smaller mass?

57. One mass, m_1 = 0.215 kg, of an ideal Atwood machine (see Fig. 4.42) rests on the floor 1.10 m below the other mass, m_2 = 0.255 kg, (a) If the masses are released from rest, how long does it take m_2 to reach the floor? (b) How high will mass m_1 ascend from the floor?

58. Two blocks are connected by a light string and accelerated upward by a pulling force F. The mass of the upper block is 50.0 kg and that of the lower block is 100 kg . The upward acceleration of the system as a whole is 1.50 m/s^2. Neglect the mass of the string. (a) Draw the free-body diagram of each block. Use the diagrams to determine which of the following is true for the magnitude of the string tension T compared to other forces: (1) $T > w_2$ and $T < F$; (2) $T > w_2$ and $T > F$; (3) $T < w_2$ and $T < F$; (4) $T = w_2$ and $T < F$? (b) Apply Newton's laws to find the required pull, F. (c) Find the tension in the string, T.

59. Two blocks on a level, frictionless table are in contact. The mass of the left block is 5.00 kg and the mass of the right block is 10.0 kg, and they accelerate to the left at 1.50 m/s^2. A person on the left exerts a force (F_1) of 75.0 N to the right. Another person exerts an unknown force (F_2) to the left. (a) Determine the force F_2. (b) Calculate the force of contact N between the two blocks.

60. In the frictionless apparatus shown in Fig. 4.43 m_1 = 2.0 kg. What is m_2 if both masses are at rest? How about if both masses are moving at constant velocity?

61. In the ideal setup shown in Fig. 4.43, m_1 = 3.0 kg and m_2 = 2.5 kg. (a) What is the acceleration of the masses? (b) What is the tension in the string?

62. A 20-kg box sits on a rough horizontal surface. When a horizontal force of 120 N is applied, the object accelerates at 1.0 m/s^2. (a) If the applied force is doubled, the acceleration will (1) increase, but less than double; (2) also double; (3) increase, but more than double. Why? (b) Calculate the acceleration to prove your answer to part (a).

63. The coefficient of static and kinetic friction between a 50.0-kg box and a horizontal surface are 0.500 and 0.400, respectively. (a) What is the acceleration of the object if a 250-N horizontal force is applied to the box? (b) What is the acceleration if the applied force is 235 N?

64. In moving a 35.0-kg desk from one side of a classroom to the other, a professor finds that a horizontal force of 275 N is necessary to set the desk in motion, and a force of 195 N is necessary to keep it in motion at constant speed. What are the coefficients of (a) static and (b) kinetic friction between the desk and the floor?

65. A 40-kg crate is at rest on a level surface. If the coefficient of static friction between the crate and the surface is 0.69, what horizontal force is required to get the crate moving?

66. A packing crate is placed on a 20° inclined plane. If the coefficient of static friction between the crate and the plane is 0.65, will the crate slide down the plane if released from rest? Justify your answer.

67. A 1500-kg automobile travels at 90 km/h along a straight concrete highway. Faced with an emergency situation, the driver jams on the brakes, and the car skids to a stop. What will be the car's stopping distance for (a) dry pavement and (b) wet pavement?

68. A hockey player hits a puck with his stick, giving the puck an initial speed of 5.0 m/s. If the puck slows uniformly and comes to rest in a distance of 20 m, what is the coefficient of kinetic friction between the ice and the puck?

69. A crate sits on a flat-bed truck that is traveling with a speed of 50 km/h on a straight, level road. If the coefficient of static friction between the crate and the truck bed is 0.30, in how short a distance can the truck stop with a constant acceleration without the crate sliding?

70. A block is projected with a speed of 2.5 m/s on a horizontal surface. If the block comes to rest in 1.5 m, what is the coefficient of kinetic friction between the block and the surface?

71. A block is projected with a speed of 3.0 m/s on a horizontal surface. If the coefficient of kinetic friction between the block and the surface is 0.60, how far does the block slide before coming to rest?

72. A person has a choice while trying to push a crate across a horizontal pad of concrete: push it at a downward angle of 30°, or pull it at an upward angle 30°. (a) Which choice is most likely to require less force on the part of the person: (1) pushing at a downward angle; (2) pulling at the same angle; (3) pushing or pulling shouldn't matter? (b) If the crate has a mass of 50.0 kg and the coefficient of kinetic friction between it and the concrete is 0.750, calculate the required force to move it across the concrete at a steady speed for both situations.

73. Suppose the slope conditions for the skier shown in Fig. 4.44 are such that the skier travels with a constant velocity. From the photo, could you find the coefficient of kinetic friction between the snowy surface and the skis? If so, describe how this would be done.

74. A 5.0-kg wooden block is placed is placed on an adjustable wooden inclined plane. (a) What is the angle of incline above which the block will start to slide down the plane? (b) At what angle of incline will the block then slide down the plane at a constant speed?

75. A block that has a mass of 2.0 kg and 10 cm on a side just begins to slide down an inclined plane with a 30° angle of incline (Fig. 4.45). Another block of the same height and same material has base dimensions of 20 cm × 10 cm and thus a mass of 4.0 kg. (a) At what critical angle will the more massive block start to slide down the plane? Why? (b) Estimate the coefficient of static friction between the block and the plane.

76. In the apparatus shown in Fig. 4.46, m_1 = 10 kg and the coefficients of static and kinetic friction between m_1 and the table are 0.60 and 0.40 respectively. (a) What mass of m_2 will just barely set the system in motion? (b) After the system begins to move, what is the acceleration?

77. In loading a fish delivery truck, a person pushes a block of ice up a 20° incline at constant speed. The push is 150 N in magnitude and parallel to the incline. The block has a mass of 35.0 kg. (a) Is the incline frictionless? (b) If not, what is the force of kinetic friction on the block of ice?

78. An object (mass 3.0 kg) slides upward on a vertical wall at constant velocity when a force F of 60 N acts on it at an angle of 60° to the horizontal. (a) Draw the free-body diagram of the object. (b) Using Newton's laws find the normal force on the object. (c) Determine the force of kinetic friction on the object.

79. In the apparatus shown in Fig. 4.43, m_1 = 2.0 kg and the coefficients of static and kinetic friction between m_1 and the table are 0.30 and 0.20 respectively. (a) What is m_2 if both masses are at rest? (b) What is m_2 if both masses are moving at constant velocity?

80. For the apparatus shown in Fig. 4.40, what is the minimum value of the coefficient of static friction between the block (m_3) and the table that would keep the system at rest if m_1 = 0.25 kg, m_2 = 0.50 kg, and m_3 = 0.75 kg?

81. If the coefficient of kinetic friction between the block and the table in Fig. 4.40 is 0.560, and m_1 = 0.150 kg and m_2 = 0.250 kg, (a) what should m_3 be if the system is to move with a constant speed? (b) If m_3 = 0.100 kg, what is the magnitude of the acceleration of the system?

83. Two blocks (A and B) remain stuck together as they are pulled to the right by a force F = 200 N. B is on a rough horizontal tabletop (coefficient of kinetic friction of 0.800). (a) What is the acceleration of the system? (b) What is the force of friction between the two objects?