53. [I] Someone runs up four zigzagging flights of stairs, each one 10-m long and rising 6.0-m high. At the end of the climb, the person stands directly above the starting point. Determine the runner's total displacement.

54. [I] Draw the vector $\vec{\mathbf{A}}$, 10 units long pointing due east, and graphically add to it the vector $\vec{\mathbf{B}}$, 15 units long pointing northeast at 45°. Measure both the magnitude of the resultant and its direction.

55. [I] Graphically subtract $\vec{\mathbf{A}}$ (5.0 units–EAST) from $\vec{\mathbf{B}}$ (7.1 units–45° N OF E) to get $\vec{\mathbf{C}}$.

56. [I] Graphically determine $\vec{\mathbf{C}}$, which is the resultant of $\vec{\mathbf{A}}$ = 20 units–30° S OF E and $\vec{\mathbf{B}}$ = 10 units–30° N OF E.

57. [I] Graphically add $\vec{\mathbf{A}}$ = 5.0 units–EAST to $\vec{\mathbf{B}}$ = 7.1 units–45° N OF W to get $\vec{\mathbf{C}}$.

58. [II] An athlete dashes past the starting point in a straight-line run at a fairly constant speed of 5 m/s for the first 2 s and then at 10 m/s for the next 3 s. At that moment she abruptly stops, turns around, waits 1 s, and runs back to the start with a constant speed in 3 s. Draw a graph of the magnitude of her displacement versus time.

59. [II] A cannonball fired from a gun at ground level located 20 m away from a castle rises high into the air in a smooth arc and sails down, crashing into the wall 60 m up from the ground. Determine the projectile's displacement.

60. [II] While playing catch a young woman throws a ball. It leaves her hand 1.00 m above the ground, sails through the air, and strikes a building that is 5.00 m away from her. The ball hits the wall at a height of 13.0 m. What was the magnitude of its displacement from its launch point at the moment it struck the wall? Draw a diagram.

61. [II] A kid at a window 20.0 m up from the street throws a ball high into the air at an angle somewhere around 50°. It lands at a spot directly in front of and beneath him, 30.0 m from the building. What is the magnitude of the displacement of the point of impact with respect to him? Draw a diagram.

62. [II] Two soccer players are 20.0 m apart when one kicks a ball into the air. In a moment the ball is midway between them and 10.0 m high. What is the magnitude of the displacement of the ball, at that instant, from each player's foot? Draw a diagram.

63. [II] At $t = 0$ a car traveling south at 20.0 m/s on a straight track passes inches from a stationary observer. What is the magnitude of the displacement of the car with respect to the observer 10.0 s later if she (who happens to be a world-class runner), in the meantime, has raced 100 m north along the road?

64. [II] Standing still sniffing the air, a dog observes a kid on a bike pass him at 10.0 m/s heading due north. Fifteen seconds later the bike reaches an intersection and turns due east without slowing down. What is the magnitude of the displacement of the bike with respect to the dog after an additional 10.0 s? Draw a diagram.

SECTION 2.7: INSTANTANEOUS VELOCITY

SECTION 2.8: COMPONENTS AND VECTOR ADDITION

65. [I] A bumblebee flew 43 m along a twisting path only to land on a flower 3.0 m due south of the point on its hive from which it started. If the entire journey took 10 s, what was its average speed and average velocity? [*Hint: Average speed is total distance traveled (a scalar) over time; average velocity is net displacement (a vector) over time.*]

66. [I] While on vacation a tourist left the center of town in a rented car having an odometer reading of 26 725.10 km. He traveled south of west for 6.00 h and then swung northeast for 14.0 h, ending up 420 km due east of the center of town. At that point the odometer reading was 27 725.10 km. Compute his average velocity and average speed.

67. [I] The city of Kisirkaya on the Black Sea is 27.0 km due north of Istanbul. A party of photographers leaves Istanbul heading west at 11:00 in the morning. They stop for lunch on the road and arrive at Kisirkaya at 8:30 in the evening. What was their average velocity over the journey? Can you compute their average speed?

68. [I] A driver in a cross-country race heads due east, attaining a speed of 30 km/h in 10 s. Maintaining that speed for another 30.0 min, he then makes a hard 90° left turn and heads north. After 50.0 min at that speed and heading, he veers right and slows, moving northeast at 20 km/h for the next 40.0 min, at which point he crosses the finish line. What is the car's velocity at each of the following times: (a) 40 s, (b) 30.0 min, (c) 50 min, and (d) 100 min?

69. [I] Determine the two acute angles of an exactly 5-12-13 right triangle accurate to two decimal places (four significant figures).

70. [I] What is the ratio of the sides of a right triangle whose acute angles are 30° and 60°? *This ratio is a good one to remember.* Which side is opposite the 30° angle?

71. [I] A telescope pointed directly at the top of a distant flagpole makes an angle of 25° with the ground. If the scope is low to the ground and 25 m from the base of the pole, how tall is the pole? Draw a diagram.

72. [I] A Roman catapult fires a boulder with a launch speed of 20 m/s at an angle of 60° with the ground. What are the projectile's initial horizontal and vertical speeds? Draw a diagram. (See the previous problem.)

73. [I] A skier is moving at 85 km/h straight down a tall mountain having a 60.0° slope. At what rate is his altitude decreasing? Draw a diagram.

74. [I] A pintail duck is flying northwest at 10 m/s. (a) At what rate is it progressing north? (b) What is the magnitude of its westward velocity component? Draw a diagram.

75. [I] A bullet is fired from a 1910 9-mm Luger pointed up at 32.0° with respect to the horizontal. If the muzzle speed—that is, the speed at which the projectile leaves the gun—is 300 m/s, find the magnitudes of: (a) the horizontal and (b) the vertical components of the bullet's initial velocity. (c) Check your results using the Pythagorean Theorem.

76. [I] A rope tied to the top of a flagpole makes an angle of 45° with the ground. If a circus performer walks up the $10\sqrt{2}$-m rope, what is her altitude at the top?

77. [I] A toy electric train runs along a straight length of track. Its displacement versus time curve is shown in Fig. P77. Is the train's velocity ever constant, and if so, when? What is its instantaneous velocity at $t = 2.0$ s and at $t = 6.5$ s? Did it change direction, and if so when?

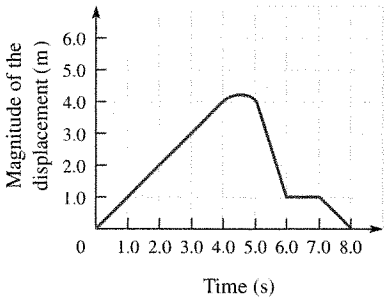

Figure P77