3.2 Vector Addition and Subtraction*

21. **MC** Two linear vectors of magnitudes 3 and 4, respectively, are added. The magnitude of the resultant vector is (a) 1, (b) 7, (c) between 1 and 7.

22. **MC** The resultant of $\vec{\mathbf{A}} - \vec{\mathbf{B}}$ is the same as (a) $\vec{\mathbf{B}} - \vec{\mathbf{A}}$, (b) $-\vec{\mathbf{A}} + \vec{\mathbf{B}}$, or (c) $-(\vec{\mathbf{A}} + \vec{\mathbf{B}})$, (d) $-(\vec{\mathbf{B}} - \vec{\mathbf{A}})$.

23. **MC** A unit vector has (a) magnitude, (b) direction, (c) neither of these, (d) both of these.

25. **CQ** Can a nonzero vector have a zero *x*-component? Explain.

26. **CQ** Is it possible to add a vector quantity to a scalar quantity?

27. **CQ** Can $\vec{\mathbf{A}} + \vec{\mathbf{B}}$ equal zero, when $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ have nonzero magnitudes? Explain.

33. ● During a takeoff (in still air), an airplane moves at a speed of $120\,\text{mi/h}$ at an angle of 20° above the ground. What is the horizontal speed of the plane?

36. **IE** ●● (a) If each of the two components (*x* and *y*) of a vector are doubled, (1) the vector's magnitude doubles, but the direction remains unchanged; (2) the vector's magnitude remains unchanged, but the direction angle doubles; or (3) both the vector's magnitude and direction angle double. (b) If the *x*- and *y*-components of a vector of 10 m at 45° are tripled, what is the new vector?

40. ●● For the vectors shown in ▼ Fig. 3.26, determine $\vec{\mathbf{A}} + \vec{\mathbf{B}} + \vec{\mathbf{C}}$.

41. ●● For the velocity vectors shown in Fig. 3.26, determine $\vec{\mathbf{A}} - \vec{\mathbf{B}} - \vec{\mathbf{C}}$.

52. **IE** ●●● ▼ Fig. 3.29 depicts a decorative window (the thick inner square) weighing 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 upper 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).

53. ●●● A golfer lines up for his first putt at a hole that is 10.5 m exactly northwest of his ball's location. He 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 and (b) the magnitude of the second putt's displacement. (c) Determine why you cannot determine the length of travel of the second putt.

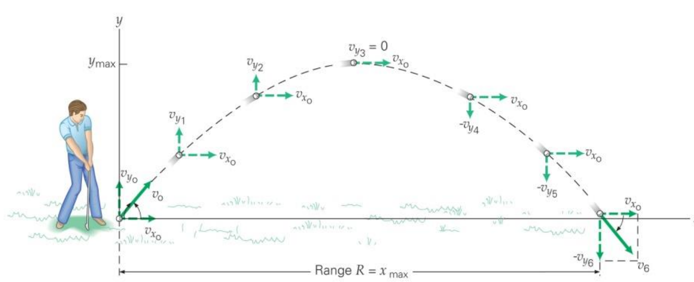
3.3 Projectile Motion*

55. **MC** If air resistance is neglected, the motion of an object projected at an angle consists of a uniform downward acceleration combined with (a) an equal horizontal acceleration, (b) a uniform horizontal velocity, (c) a constant upward velocity, (d) an acceleration that is always perpendicular to the path of motion.

56. **MC** A football is thrown on a long pass. Compared to the ball's initial horizontal velocity, the horizontal component of its velocity at the highest point is (a) greater, (b) less, (c) the same.

57. **MC** A football is thrown on a long pass. Compared to the ball's initial vertical velocity, the vertical component of its velocity at the highest point is (a) greater, (b) less, (c) the same.

58. **CQ** A golf ball is hit on a level fairway. When it lands, its velocity vector has rotated through an angle of 90°. What was the launch angle of the golf ball? [*Hint*: See Fig. 3.11.]



59. **CQ** A multiflash photograph shows one ball dropping from rest and, at the same time, another ball projected horizontally at the same height. The two balls hit the ground at the same time. Why? Explain.

62. ●An electron is ejected horizontally at a speed of $1.5 \times 10^6\ \text{m/s}$ 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?

67. **IE** ●● Ball A rolls at a constant speed of $0.25\,\text{m/s}$ 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, (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 each ball be?

70. ●● A soccer player kicks a stationary ball, giving it a speed of 15.0 m/s at an angle of 15.0° to the horizontal. (a) What is the maximum height reached by the ball? (b) What is the ball's range? (c) How could the range be increased?

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

84. ●●● 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 launch angle is 25° and the ball was launched at the level of the player's 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.

86. **MC** You are traveling in a car on a straight, level road going 70 km/h. A car coming toward you appears to be traveling 130 km/h. How fast is the other car going: (a) 130 km/h, (b) 60 km/h, (c) 70 km/h, or (d) 80 km/h? (

87. **MC** Two cars approach each other on a straight, level highway. Car A travels at 60 km/h and car B at 80 km/h. The driver of car B sees car A approaching at a speed of (a) 60 km/h, (b) 80 km/h, (c) 20 km/h, (d) greater than 100 km/h. (

88. **MC** For the situation in Exercise 87, at what speed does the driver of car A see car B approaching: (a) 60 km/h. (b) 80 km/h, (c) 20 km/h, or (d) greater than 100 km/h?

89. **CQ** We often take the Earth or ground as a stationary frame of reference. Is this really true? Explain.

90. **CQ** A student walks on a treadmill moving at 4.0 m/s and remains at the same place in the gym. (a) What is the student's velocity relative to the gym floor? (b) What is the student's speed relative to the treadmill?

91. **CQ** You are running in the rain along a straight sidewalk to your dorm. If the rain is falling vertically downward relative to the ground, how should you hold your umbrella so as to minimize the rain landing on you? Explain.

92. **CQ** When driving to the basket for a layup, a basketball player usually tosses the ball gently upward relative to herself. Explain why?

98. ●● 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?

102. **IE** ●● 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° to the vertical, what is the speed of the car?

111. An early technique for "dropping" a nuclear bomb was not to drop it, but to let it go while the plane was climbing at a rapid rate. The idea was to "toss" it upward at a steep angle, thus giving the plane time to turn and get away before the bomb exploded. Assume the plane is traveling at 600 km/h when it releases the bomb at an angle of 75° above the horizontal. Also assume that the plane releases the bomb at an altitude of 4000 m above the ground, and the bomb is set to detonate at an altitude of 500 m above the ground. Ignoring air resistance, (a) how long does the plane have to get away before the bomb detonates? (b) What maximum height above ground level does the bomb reach? (c) What is the bomb's speed just as it detonates?

112. At a merging on-ramp of a busy Los Angeles freeway, car A is moving directly east on the freeway at a steady speed of 35.0 m/s. Car B is merging onto the freeway from the on-ramp, which points 10° north of due east, moving at 30.0 m/s. (See ▼Fig. 3.37.) If they collide, it will be at the point marked **x** in the figure, which initially is 350 m down the road from the position of car A. Use the *x*–*y* coordinate system to signify E–W versus N–S directions. (a) What is the velocity of car B relative to car A? (b) Show that they do *not* collide at point **x**. (c) Determine how far apart the cars are (and which is ahead) when car B reaches point **x**.

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* A few exercises in this section use force vectors $(\vec{\mathbf{F}})$. These vectors should be treated as vectors to be added, just as you would treat velocity vectors. The SI unit of force is the newton (N). A force vector might be written as $\vec{\mathbf{F}} = 50\ \text{N}$ at an angle of 20°. Some familiarity with $\vec{\mathbf{F}}$ vectors will be helpful in Chapter 4.

* Assume angels to be exact for significant figure purposes.