

QQ5. As a projectile moves in its parabolic path, the velocity and acceleration vectors are perpendicular to each other (a) everywhere along the projectile's path, (b) at the peak of its path, (c) nowhere along its path, or (d) not enough information is given.

### Chapter 3 Problems

#### Section 3.4 Motion in Two Dimensions

17. The best leaper in the animal kingdom is the puma, which can jump to a height of 12 ft when leaving the ground at an angle of  $45^\circ$ . With what speed, in SI units, must the animal leave the ground to reach that height?

19. **PhysicsNow™** A tennis player standing 12.6 m from the net hits the ball at  $3.00^\circ$  above the horizontal. To clear the net, the ball must rise at least 0.330 m. If the ball just clears the net at the apex of its trajectory, how fast was the ball moving when it left the racquet?

21. A brick is thrown upward from the top of a building at an angle of  $25^\circ$  to the horizontal and with an initial speed of 15 m/s. If the brick is in flight for 3.0 s, how tall is the building?

22. A placekicker must kick a football from a point 36.0 m (about 39 yd) from the goal, and the ball must clear the crossbar, which is 3.05 m high. When kicked, the ball leaves the ground with a velocity of 20.0 m/s at an angle of  $53^\circ$  to the horizontal. (a) By how much does the ball clear or fall short of clearing the crossbar? (b) Does the

ball approach the crossbar while still rising or while falling?

25. A projectile is launched with an initial speed of 60.0 m/s at an angle of  $30.0^\circ$  above the horizontal. The projectile lands on a hillside 4.00 s later. Neglect air friction. (a) What is the projectile's velocity at the highest point of its trajectory? (b) What is the straight-line distance from where the projectile was launched to where it hits its target?

#### Section 3.5 Relative Velocity

27. A Chinook (King) salmon (Genus *Oncorhynchus*) can jump out of water with a speed of 6.26 m/s. (See Problem 4.9, page 83 for an investigation of how the fish can leave the water at a higher speed than it can swim underwater.) If the salmon is in a stream with water speed equal to 1.50 m/s, how high in the air can the fish jump if it leaves the water traveling vertically upwards relative to the Earth?

29. **PhysicsNow™** A rowboat crosses a river with a velocity of 3.30 mi/h at an angle  $62.5^\circ$  north of west relative to the water. The river is 0.505 mi wide and carries an eastward current of 1.25 mi/h. How far upstream is the boat when it reaches the opposite shore?

31. How long does it take an automobile traveling in the left lane of a highway at 60.0 km/h to overtake (become even with) another car that is traveling in the right lane at 40.0 km/h when the cars' front bumpers are initially 100 m apart?