SECTIONS 3–5 AND 3–6
(neglect air resistance)

19. (I) A tiger leaps horizontally from a 7.5-m-high rock with a speed of 4.5 m/s. How far from the base of the rock will she land?

20. (I) A diver running 1.6 m/s dives out horizontally from the edge of a vertical cliff and reaches the water below 3.0 s later. How high was the cliff and how far from its base did the diver hit the water?

21. (II) A fire hose held near the ground shoots water at a speed of 6.5 m/s. At what angle(s) should the nozzle point in order that the water land 2.0 m away (Fig. 3–37)? Why are there two different angles?

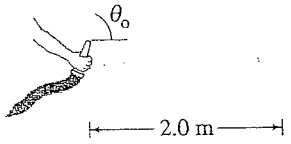

FIGURE 3–37 Problem 21.

22. (II) Romeo is chucking pebbles gently up to Juliet's window, and he wants the pebbles to hit the window with only a horizontal component of velocity. He is standing at the edge of a rose garden 8.0 m below her window and 9.0 m from the base of the wall (Fig. 3–38). How fast are the pebbles going when they hit her window?

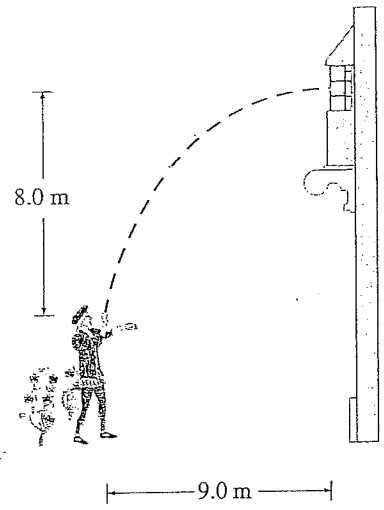

FIGURE 3–38 Problem 22.

23. (II) Suppose the kick in Example 3–4 is attempted 36.0 m from the goalposts, whose crossbar is 3.00 m above the ground. If the football is directed correctly between the goalposts, will it pass over the bar and be a field goal? Show why or why not. If not, from what horizontal distance must this kick be made if it is to score?

24. (II) A ball is thrown horizontally from the roof of a building 56 m tall and lands 45 m from the base. What was the ball's initial speed?

25. (II) Show that the speed with which a projectile leaves the ground is equal to its speed just before it strikes the ground at the end of its journey, assuming the firing level equals the landing level.

26. (II) A football is kicked at ground level with a speed of 20.0 m/s at an angle of 37.0° to the horizontal. How much later does it hit the ground?

27. (II) A ball thrown horizontally at 22.2 m/s from the roof of a building lands 36.0 m from the base of the building. How high is the building?

28. (II) A shot-putter throws the shot with an initial speed of 14 m/s at a 40° angle to the horizontal. Calculate the horizontal distance traveled by the shot if it leaves the athlete's hand at a height of 2.2 m above the ground.

29. (II) Determine how much farther a person can jump on the Moon as compared to the Earth if the takeoff speed and angle are the same. The acceleration due to gravity on the Moon is one-sixth what it is on Earth.

30. (II) An athlete executing a long jump leaves the ground at a 30° angle and travels 7.80 m. (*a*) What was the takeoff speed? (*b*) If this speed were increased by just 5.0 percent, how much longer would the jump be?

31. (II) The pilot of an airplane traveling 160 km/h wants to drop supplies to flood victims isolated on a patch of land 160 m below. The supplies should be dropped how many seconds before the plane is directly overhead?

32. (II) A hunter aims directly at a target (on the same level) 120 m away. (*a*) If the bullet leaves the gun at a speed of 250 m/s, by how much will it miss the target? (*b*) At what angle should the gun be aimed so the target will be hit?

33. (II) Show that the time required for a projectile to reach its highest point is equal to the time for it to return from this highest point to its original height.

34. (II) A projectile is fired with an initial speed of 40.0 m/s. Plot on graph paper its trajectory for initial projection angles of $\theta = 15°, 30°, 45°, 60°, 75°$, and 90°. Plot at least 10 points for each curve.

35. (II) A projectile is fired with an initial speed of 75.2 m/s at an angle of 34.5° above the horizontal on a long flat firing range. Determine (*a*) the maximum height reached by the projectile, (*b*) the total time in the air, (*c*) the total horizontal distance covered (that is, the range), and (*d*) the velocity of the projectile 1.50 s after firing.