5. A child throws a ball onto the roof of a house, then catches it with a baseball glove 1.0 m above the ground, as in **Figure 15**. The ball leaves the roof with a speed of 3.2 m/s.
   (a) For how long is the ball airborne after leaving the roof?
   (b) What is the horizontal distance from the glove to the edge of the roof?
   (c) What is the velocity of the ball just before it lands in the glove?

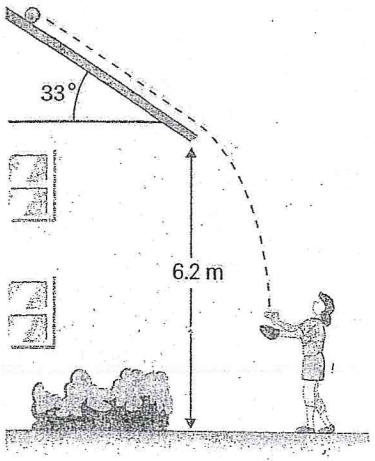


**Figure 15**

6. For a projectile that lands at the same level from which it starts, state another launch angle above the horizontal that would result in the same range as a projectile launched at an angle of 36°, 16°, and 45.6°. Air resistance is negligible.
7. During World War I, the German army bombarded Paris with a huge gun referred to, by the Allied Forces, as "Big Bertha." Assume that Big Bertha fired shells with an initial velocity of $1.1 \times 10^3$ m/s [45° above the horizontal].
   (a) How long was each shell airborne, if the launch point was at the same level as the landing point?
   (b) Determine the maximum horizontal range of each shell.
   (c) Determine the maximum height of each shell.
8. An astronaut on the Moon, where $|\vec{g}| = 1.6$ m/s$^2$, strikes a golf ball giving the ball a velocity of 32 m/s [35° above the Moon's horizontal]. The ball lands in a crater floor that is 15 m below the level where it was struck. Determine
   (a) the maximum height of the ball
   (b) the time of flight of the ball
   (c) the horizontal range of the ball

**Making Connections**

11. In real-life situations, projectile motion is often more complex than what has been presented in this section. For example, to determine the horizontal range of a shot in shot put competitions, the following equation is used:

$$\Delta x = \Delta x_1 + \Delta x_2 + \Delta x_3$$

$$\Delta x = 0.30 \text{ m} + \frac{2v_i^2 \sin\theta \cos\theta}{g} + v_i \cos\theta \left( \frac{-v_i \sin\theta + \sqrt{v_i^2 \sin^2\theta + |2g\Delta y|}}{g} \right)$$

where 0.30 m is the average distance the athlete's hand goes beyond the starting line, $v_i$ is the magnitude of the initial velocity, $\theta$ is the angle of launch above the horizontal, $\Delta y$ is the height above the ground where the shot leaves the hand, and $g$ is the magnitude of the acceleration due to gravity (**Figure 17**).
   (a) Determine the range of a shot released 2.2 m above the ground with an initial velocity of 13 m/s [42° above the horizontal].
   (b) Compare your answer in (a) to the world record for the shot put (currently about 23.1 m).
   (c) Why do you think the equation given here differs from the equation for horizontal range derived in this section?

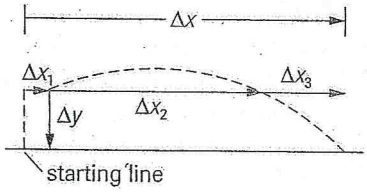


**Figure 17**