

# Projectile Motion Extra Practice

1) A tiger leaps horizontally from a 6.5-m-high rock with a speed of 3.5 m/s. How far from the base of the rock will she land?

3) 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 4.5 m below her window and 5.0 m from the base of the wall (Fig. 3-34). How fast are the pebbles going when they hit her window?

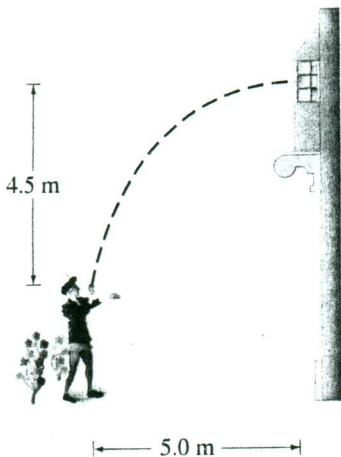
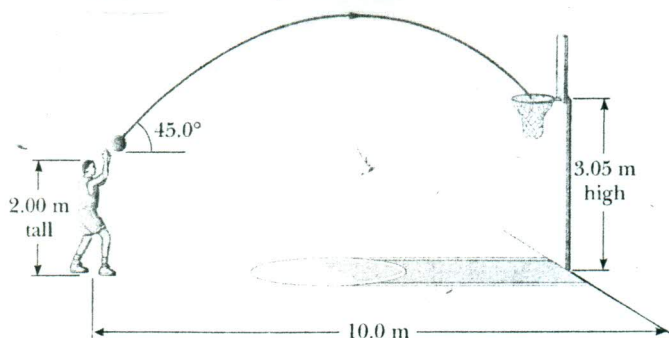


FIGURE 3-34

8) A hunter aims directly at a target (on the same level) 75.0 m away. (a) If the bullet leaves the gun at a speed of 180 m/s, by how much will it miss the target? (b) At what angle should the gun be aimed so as to hit the target?

10) A projectile is fired with an initial speed of 65.2 m/s at an angle of  $34.5^\circ$  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.

10.5) A 2.00-m-tall basketball player wants to make a goal from 10.0 m from the basket, as in Figure P3.46. If he shoots the ball at a  $45.0^\circ$  angle, at what initial speed must he throw the basketball so that it goes through the hoop without striking the backboard?



2) A diver running 1.8 m/s dives out horizontally from the edge of a vertical cliff and 3.0 s later reaches the water below. How high was the cliff, and how far from its base did the diver hit the water?

4) A ball is thrown horizontally from the roof of a building 45.0 m tall and lands 24.0 m from the base. What was the ball's initial speed?

5) A football is kicked at ground level with a speed of 18.0 m/s at an angle of  $35.0^\circ$  to the horizontal. How much later does it hit the ground?

6) 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 tall is the building?

7) An athlete executing a long jump leaves the ground at a  $28.0^\circ$  angle and travels 7.80 m. (a) What was the takeoff speed? (b) If this speed were increased by just 5.0%, how much longer would the jump be?

9) A projectile is shot from the edge of a cliff 125 m above ground level with an initial speed of 65.0 m/s at an angle of  $37.0^\circ$  with the horizontal, as shown in Fig. 3-35. (a) Determine the time taken by the projectile to hit point P at ground level. (b) Determine the range X of the projectile as measured from the base of the cliff. At the instant just before the projectile hits point P, find (c) the horizontal and the vertical components of its velocity, (d) the magnitude of the velocity, and (e) the angle made by the velocity vector with the horizontal. (f) Find the maximum height above the cliff top reached by the projectile.

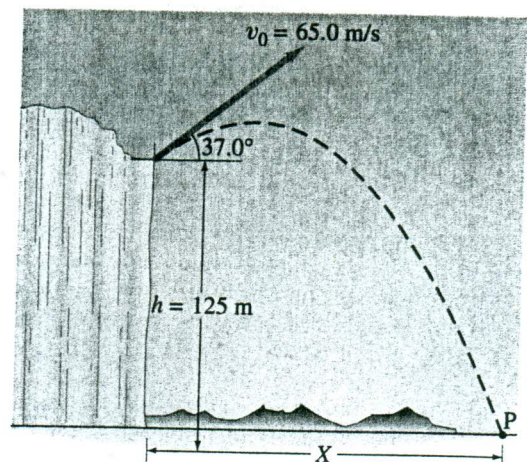
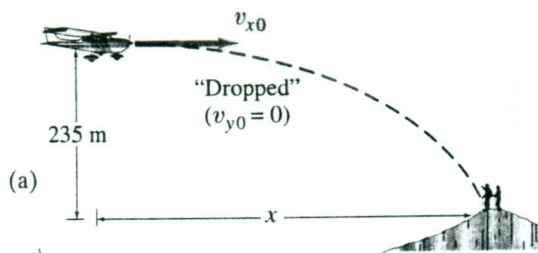


FIGURE 3-35

11) The pilot of an airplane traveling 180 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?

13) A rescue plane wants to drop supplies to isolated mountain climbers on a rocky ridge 235 m below. If the plane is traveling horizontally with a speed of 250 km/h (69.4 m/s), (a) how far in advance of the recipients (horizontal distance) must the goods be dropped



16) A student stands at the edge of a cliff and throws a stone horizontally over the edge with a speed of 18.0 m/s. The cliff is 50.0 m above a flat horizontal beach, as shown in Figure P3.18. How long after being released does the stone strike the beach below the cliff? With what speed and angle of impact does it land?

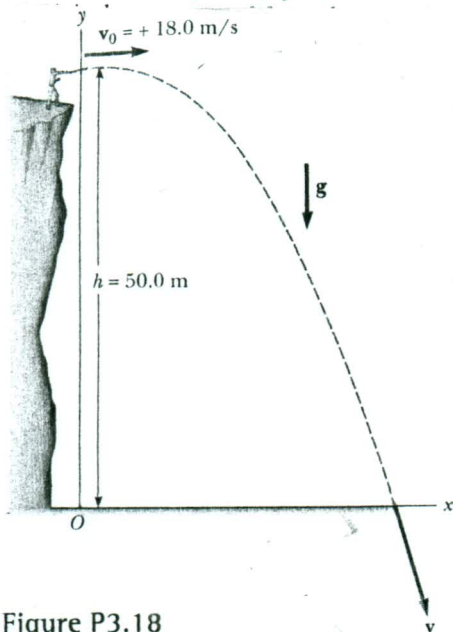


Figure P3.18

20) A place kicker must kick a football from a point 36.0 m (about 40.0 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 speed of 20.0 m/s at an angle of  $53.0^\circ$  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?

12) A shotputter throws the shot with an initial speed of 15.5 m/s at a  $34.0^\circ$  angle to the horizontal. Calculate the horizontal distance traveled by the shot if it leaves the athlete's hand at a height of 2.20 m above the ground.

14) The fastest recorded pitch in major-league baseball, thrown by Nolan Ryan in 1974, was clocked at 100.8 mi/h. If a pitch were thrown horizontally with this velocity, how far would the ball fall vertically by the time it reached home plate 60.0 ft away?

15) Tom the cat is chasing Jerry the mouse across a table surface 1.5 m above the floor. Jerry steps out of the way at the last second, and Tom slides off the edge of the table at a speed of 5.0 m/s. Where will Tom strike the floor, and what velocity components will he have just before he hits?

17) 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?

18) A car is parked on a cliff overlooking the ocean on an incline that makes an angle of  $24.0^\circ$  below the horizontal. The negligent driver leaves the car in neutral, and the emergency brakes are defective. The car rolls from rest down the incline with a constant acceleration of  $4.00 \text{ m/s}^2$  for a distance of 50.0 m to the edge of the cliff. The cliff is 30.0 m above the ocean. Find (a) the car's position relative to the base of the cliff when the car lands in the ocean, and (b) the length of time the car is in the air.

19) **EXAMPLE 3-5 A kicked football.** A football is kicked at an angle  $\theta_0 = 37.0^\circ$  with a velocity of 20.0 m/s, as shown in Fig. 3-22. Calculate (a) the maximum height, (b) the time of travel before the football hits the ground, (c) how far away it hits the ground, (d) the velocity vector at the maximum height, and (e) the acceleration vector at maximum height. Assume the ball leaves the foot at ground level, and ignore air resistance and rotation of the ball.

Suppose the kick in Example 3-5 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.

21) A firefighter, 50.0 m away from a burning building, directs a stream of water from a ground level fire hose at an angle of  $30.0^\circ$  above the horizontal. If the speed of the stream as it leaves the hose is 40.0 m/s, at what height will the stream of water strike the building?

22) A projectile is launched with an initial speed of 60 m/s at an angle of  $30^\circ$  above the horizontal. The projectile lands on a hillside 4.0 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?