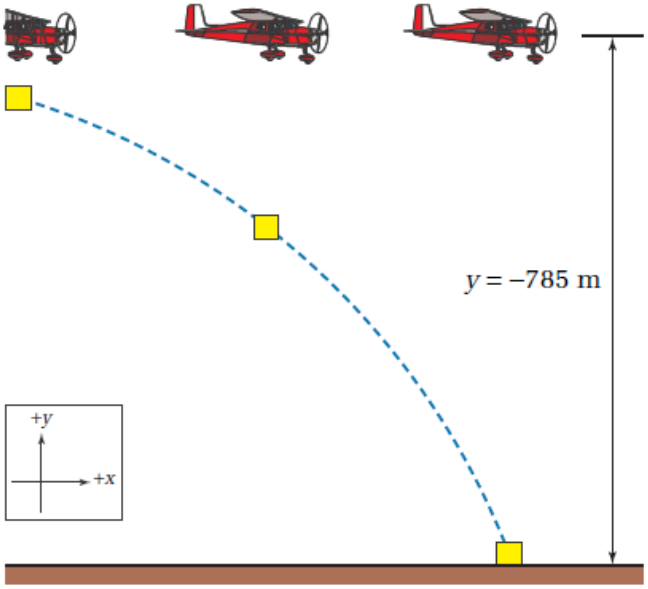
Physics 122: Projectile Problems

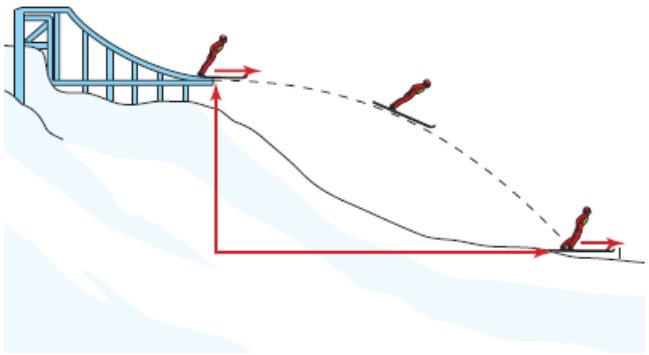
Chapter 11 Pg 536 – 537

1. An airplane is dropping supplies to northern villages that are isolated by severe blizzards and cannot be reached by land vehicles. The airplane is flying at an altitude of 785 m and at a constant horizontal velocity of 53.5 m/s. At what horizontal distance before the drop point should the co-pilot drop the supplies so that they will land at the drop point? (Neglect air friction.)



2. A cougar is crouched on the branch of a tree that is 3.82 m above the ground. He sees an unsuspecting rabbit on the ground, sitting 4.12 m from the spot directly below the branch on which he is crouched. At what horizontal velocity should the cougar jump from the branch in order to land at the point at which the rabbit is sitting?

3. A skier leaves a jump with a horizontal velocity of 22.4 m/s. If the landing point is 78.5 m lower than the end of the ski jump, what horizontal distance did the skier jump? What was the skier's velocity when she landed? (Neglect air friction.)



4. An archer shoots an arrow toward a target, giving it a horizontal velocity of 70.1 m/s. If the target is 12.5 m away from the archer, at what vertical distance below the point of release will the arrow hit the target? (Neglect air friction.)

5. In a physics experiment, you are rolling a golf ball off a table. If the tabletop is 1.22 m above the floor and the golf ball hits the floor 1.52 m horizontally from the table, what was the initial velocity of the golf ball?

6. As you sit at your desk at home, your favourite autographed baseball rolls across a shelf at 1.0 m/s and falls 1.5 m to the floor. How far does it land from the base of the shelf?

7. A stone is thrown horizontally at 22 m/s from a canyon wall that is 55 m high. At what distance from the base of the canyon wall will the stone land?

8. A sharpshooter shoots a bullet horizontally over level ground with a velocity of 3.00×10^2 m/s. At the instant that the bullet leaves the barrel, its empty shell casing falls vertically and strikes the ground with a vertical velocity of 5.00 m/s.

   (a) How far does the bullet travel?

   (b) What is the vertical component of the bullet's velocity at the instant before it hits the ground?

1. Fizzicks jumps off a diving board with a horizontal velocity of +3.1 m/s and lands in the water 1.8 s later. How high was the diving board and how far from the edge of the board did he land? (16 m, 5.6 m)

Physics 122: Projectile Problems

2. A ball bearing traveling with constant speed rolls off a lab bench that is 0.928 m high. If it hits the ground 0.422 m from the edge of the bench, how fast was the ball bearing rolling across the table initially? (0.970 m/s)

3. Johnny shoots a stone horizontally with a velocity of +25 m/s from his slingshot while standing on the roof of a building on his father's farm. When he dropped an identical stone from the same spot, it took 1.85 s to hit the ground. What was the height of the building? (16.8 m)

4. A stone is thrown horizontally from a cliff 15.0 m high.
    a) The initial velocity is +24.0 m/s. How far from the base of the cliff does the stone strike the ground? (42.0 m)
    b) What is the final vertical velocity of the stone just before the stone hits the ground? (-17.1 m/s)
    c) Calculate the velocity of the stone just before the stone hits the ground? (29.5 m/s, 35.5° S of E)

5. A cannonball is fired from a cannon. If the initial horizontal and vertical components of the velocity are +32 m/s and +27 m/s respectively, at what angle was the cannon ball launched and at what speed was it fired? (40° to the horizontal, 42 m/s) How long will the cannonball be in the air? (5.5 s)

6. A projectile fired at an angle remains in the air for 8.42 s after it is fired. The initial horizontal component of its velocity is +150 m/s.
    a) Calculate the projectile's range? (1260 m)
    b) How long after being fired did it reach its maximum height? (4.21 s)

7. A ball is thrown from the top of one building toward the wall of a second taller building 15.2 m away. The ball is thrown with an initial velocity of 6.10 m/s at an angle of 40.0° to the horizontal. How far below its original position does the ball hit the second building? (39.1 m below its original position)

8. A baseball player throws a ball from center field to home plate with a velocity of 35.0 m/s at an angle of 30.0° with the ground. Assuming the ball is caught at the same height at which it was thrown; calculate the horizontal distance traveled by the ball before it is caught. (108 m)

9. A projectile is fired with an initial velocity of 75.2 m/s at an angle of 34.5° above the horizontal along a long flat firing range. Determine the
    a) maximum height reached by the projectile (92.7 m)
    b) range of the projectile (539 m)
    c) speed of the projectile 1.50 s after being fired (68.0 m/s)

10. A hockey player hits a puck with his hockey stick and the puck is launched at an angle of 45° to the ice surface. The puck hits the ice 35 m down the length of the rink. Find the velocity of the puck when it left the hockey stick. (19 m/s at 45° to the horizontal)

11. During a football play, the receiver starts running at 3.2 m/s in a straight line directly in front of the quarterback as soon as the quarterback gets the ball. The quarterback, however, has to wait 4.3 seconds before throwing the football at an angle of 45° to the horizontal. With what initial speed does the QB have to throw the football so that it lands where the receiver will be? (m/s)

12. A cannonball has a muzzle speed of 35 m/s. If the cannon ball is launched from the ground then what is the maximum range of the cannonball? The launch angle for maximum range is 45°. (125 m)

13. Suppose the cannon from #12 were placed on a 17 m high castle wall. What is its new maximum range? (140 m)

14. How high should the cannon from #12 be placed to pulverize advancing orcs that are 200 m away; assuming that 200 m is the maximum range of the cannon? (120 m)

15. The King, fed up with stupid, ugly orcs, wants to increase the maximum range of his cannons to 500 m. The cannons are placed 25 m up in the castle. What muzzle speed should the cannonballs have? (68.3 m/s)

16. **Challenge**: MHR Page 549 PP #14.

PRACTICE PROBLEMS

Chapter 11 Pg 543

9. While hiking in the wilderness, you come to the top of a cliff that is 60.0 m high. You throw a stone from the cliff, giving it an initial velocity of 21 m/s at 35° above the horizontal. How far from the base of the cliff does the stone land?

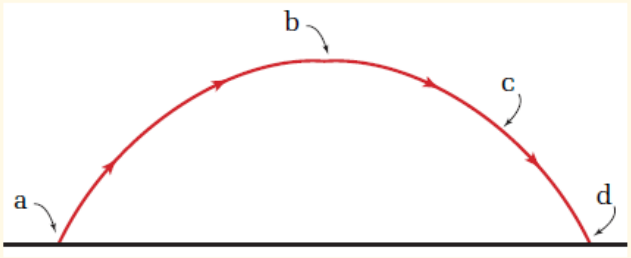
10. A batter hits a baseball, giving it an initial velocity of 41 m/s at 47° above the horizontal. It is a home run, and the ball is caught by a fan in the stands. The vertical component of the velocity of the ball when the fan caught it was −11 m/s. How high is the fan seated above the field?

11. During baseball practice, you go up into the bleachers to retrieve a ball. You throw the ball back into the playing field at an angle of 42° above the horizontal, giving it an initial velocity of 15 m/s. If the ball is 5.3 m above the level of the playing field when you throw it, what will be the velocity of the ball when it hits the ground of the playing field?

12. Large insects such as locusts can jump as far as 75 cm horizontally on a level surface. An entomologist analyzed a photograph and found that the insect's launch angle was 55°. What was the insect's initial velocity?

11.1 Section Review

1. K/U Projectiles travel in two dimensions at the same time. Why is it possible to apply kinematic equations for one dimension to projectile motion?
2. K/U How does the analysis of projectiles launched at an angle differ from the analysis of projectiles launched horizontally?
3. C Explain why time is a particularly significant parameter when analyzing projectile motion.
4. C What can you infer about the velocity at each labelled point on the trajectory in this diagram?



5. C Imagine that you are solving a problem in projectile motion in which you are asked to find the time at which a projectile reaches a certain vertical position. When you solve the problem, you find two different positive values for time that both satisfy the conditions of the problem. Explain how this result is not only possible, but also logical.
6. K/U What properties of projectile motion must you apply when deriving an equation for the maximum height of a projectile?
7. K/U What properties of projectile motion must you apply when deriving an equation for the range of a projectile?
8. I Suppose you knew the maximum height reached by a projectile. Could you find its launch angle from this information alone? If not, what additional information would be required?