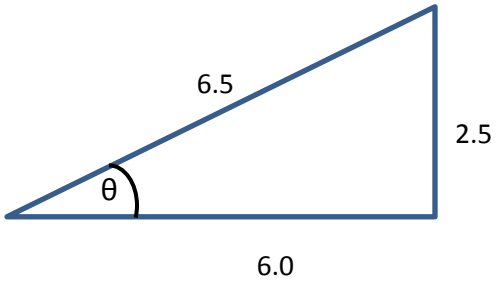
Homework: Ch 3

1. When approaching a projectile motion problem what steps would you take in order to determine a solution?

2. Why is time always the same no matter which direction (*x* or *y*) you are analyzing when completing a projectile motion problem?

3. Imagine you are launching a potato using an air cannon. At what angle, relative to the ground, would you want to put the cannon in order to launch the potato the greatest distance? Justify your answer.

4. For the triangle below determine the sine, cosine, and tangent for the angle θ.



5. Vectors **A** and **B** are defined as follows:

$$\mathbf{A} = 20.0 \text{ m at } \theta = 35^\circ$$
$$\mathbf{B} = 5.85 \text{ m at } \theta = 125^\circ$$

   a. Find **A** + **B**.
   b. Find **A** – **B**.
   c. Find **B** – **A**.

6. What are (a) the *x* component and (b) the *y* component of a vector **a** in the *xy* plane if its direction is 250° counterclockwise from the positive direction of the *x* axis and its magnitude is 7.3 m?

7. The *x* component of vector **B** is -25.0 m and the *y* component is +40.0 m. (a) What is the magnitude of vector **B**? (b) What is the angle between the vector **B** and the positive direction of *x*?

8. A heavy piece of machinery is raised by sliding it a distance 12.5 m along a plane oriented at an angle of 20.0º to the horizontal. How far has the machinery moved horizontally? How about vertically?

9. A sailboat sets out from the U.S. side of Lake Erie for a point on the Canadian side, 90.0 km due north. The sailor, however, ends up 50.0 km due east of the starting point. How far and in what direction must the sailor now sail to reach the original destination?

10. Show that the equation for determining a projectile's path is

$$y = x \tan\theta - \frac{gx^2}{2(v_0 \cos\theta)^2}$$

11. Extreme sports enthusiasts have been known to jump off the top of El Capitan, a sheer granite cliff 910 m high in Yosemite National Park. Assume that a jumper runs horizontally off the top of El Capitan with a speed of 5.00 m/s and enjoys a free fall until she is 150 m above the valley floor, at which time she opens her parachute.
    a. Ignoring air resistance, how long is the jumper in free fall?
    b. How far from the cliff is the jumper when she opens her chute?

12. A ball is thrown upward from the roof of a building that is 50.0 m high.
    a. If the maximum height attained by the ball is H = 75.0 m, with what speed will the ball strike the ground as it falls back down? Ignore air resistance.
    b. What is the initial velocity of the ball as it leaves the pitcher's hand?
    c. If the ball was now thrown with the same initial velocity, but now at an angle of 45˚ above the horizontal, what is the new speed of the ball when it strikes the ground?

13. A football player punts a football so that it will have a hang time (time in flight) of 4.5s and land 46 m away. If the ball leaves the player's foot 150 cm above the ground, what must be the magnitude and angle (above the horizontal) of the ball's initial velocity?

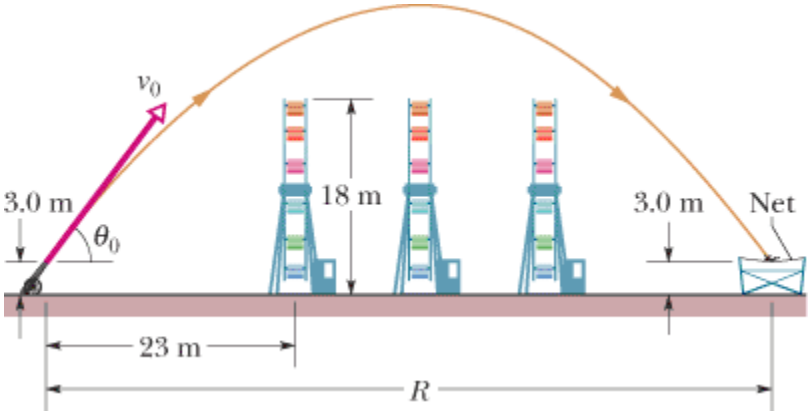
14. A projectile is launched with an initial speed of 30 m/s at an angle of 60º above the horizontal. What is the magnitude and angle of the velocity 2.0 s after launch?

15. In the 1991 World Track and Field Championships in Tokyo, Mike Powell jumped 8.95 m, breaking by a full 5 cm the 23-year long-jump record set by Bob Beamon. Assume that Powell's speed on takeoff was 9.5 m/s (about equal to that of a sprinter) and that g = 9.81 m/s^2 in Tokyo. How much less was Powell's range than the maximum possible range for a particle launched at the same speed?

16. A dart is thrown horizontally with an initial speed of 10 m/s towards point *P*, the bull's eye on the dart board. It hits at point *Q* on the rim, vertically below *P*, 0.19s later. What is the distance between points *P* and *Q*?

17. An airplane in level flight at an altitude of H and with a constant speed V, travels in the positive x-direction. At time $t = 0$ s, the air plane drops a package of mass m.
    a. What is the total distance the package traveled in the x-direction before landing? Give you answer in terms of H, V, and g.
    b. Using your equation from part a, determine the distance traveled by the package if the initial altitude of the plane was 4400 km and the velocity was 125 mph (miles per hour).

18. In 1939 or 1940, Emanuel Zacchini took his human-cannonball act to an extreme: After being shot from a cannon, he soared over three Ferris wheels and into a net, as shown in the figure below. Assume that he is launched with a speed of 26.5 m/s and at an angle of 53.0°.
    a. Treating him as a particle, calculate his clearance over the first wheel.
    b. If he reached maximum height over the middle wheel, by how much did he clear it?
    c. How far from the cannon should the net's center have been positioned (neglect air drag)?



19. In the figure to the right, a movie stuntman is to run across and directly off a rooftop, to land on the roof of the next building.
    a. Can he land there if he runs at 4.5 m/s?
    b. If not, what minimum velocity would he need to make the jump?