Recall: The basic steps to solve related rates problems are:

a) Read the problem and organize the key facts and quantities described.

b) Draw and label a diagram representing the situation and introduce variables for unknown quantities.

c) Express all known facts and rates in terms of the variables introduced and their derivatives.

d) Formulate a general equation relating the variables.

e) Differentiate the general equation implicitly, yielding the general relationship between the rates.

f) Substitute any known values and rates, then use algebra to solve to find the unknown rate of change.

Solve the following related rates exercises:

1. The width of a rectangle is half its length. At what rate is its area increasing if its width is 10cm and is increasing at $0.5\frac{cm}{sec}$?

2. Sand being emptied from a hopper at the rate of $10\frac{ft^3}{sec}$ forms a conical pile whose height is always twice its radius. At what rate is the radius of the pile increasing when its height is 5 feet?

3. Water is being collected from a block of ice with a square base. The water is produced because the ice is melting in such a way that each edge is the base of the block is decreasing at 2 inches per hour, while the height of the block is decreasing at 3 inches per hour. What is the rate of the flow of water into the collecting basin when the base has an edge length of 3 feet, and the block is 3 feet tall? (You may assume that water and ice have the same density).

4. A balloon is 200 feet off the ground and rising vertically at the constant rate of 15 feet per second. An automobile passes beneath the balloon travelling along a straight road at the constant rate of 45 mph. How fast is the distance between them changing 1 second later?

5. Two ships are sailing toward the same small island. One ship, the *Pinta*, is east of the island and is sailing due west at 15 miles per hour. The other, the *Niña*, is north of the island and is sailing due south at 20 miles per hour. At a certain time, the *Pinta* is 30 miles from the island, and the *Niña* is 40 miles from the island. Are the ships drawing closer together or farther apart? At what rate?

6. Suppose a triangle has sides a and b, and angle θ between the sides a and b. Suppose a is currently 10 feet, b is 15 feet, and θ is $\frac{\pi}{3}$ radians. Also, at this instant a is increasing at 3 feet per second, b is decreasing at a rate of 2 feet per second, and θ is decreasing at a rate of $\frac{2}{25}$ radians per second. What is the rate of change of the area of the triangle at this moment?