Guidelines for Solving Related Rates Problems (CLP Section 3.2):

(a) **Read the problem.** What is the unknown? What are the given quantities? What are the given conditions? What are you asked to do?

(b) **Draw a diagram and introduce notation** If possible, draw a diagram and label it with given values and with variables for the unknown quantities. Translate what the problem gives you and asks of you into a mathematical statement. For example, “the area of a circle is increasing at a rate of 5 cm$^3$/min” can be expressed as $\frac{dA}{dt} = 5$, where $A = A(t)$ is the area of the circle at time $t$.

(c) **Find an equation.** Write down an equation that relates the variable you want to know about to other variables in the problem. This equation often (but not always!) comes from the geometry of the diagram you drew in part (b).

(d) **Differentiate with respect to time.** Do all the variables change with time?

(e) **Substitute in the known values.** Solve for the unknown rate. It’s possible that some additional work may be required, such as referring back to the equation you wrote down in part (d) to find values of the variables at a specific time.

(f) **Answer the Problem!** Answer what were you asked by writing a concluding statement.

**Problems.**

1. Suppose that air is being pumped into a spherical balloon at rate of 100 cm$^3$/s. How fast is the diameter increasing when it is 50 cm?

2. An ice cube that is 3 cm on each side is melting at the rate of 2 cubic cm per minute. How fast is the length of each side decreasing?

3. A canister of oil is forming a circular oil slick around itself in the ocean in such a way that the area is increasing at a rate of 2 square ft per minute. How fast is the radius of the slick increasing when its radius is 10 ft?

4. One end of a 13-foot ladder is on the ground and the other end rests on a vertical wall. If the bottom end slides away from the wall at the rate of 3 ft/sec, how fast is the top of the ladder sliding down the wall when the bottom of the ladder is 5 feet from the wall?

5. A spotlight on the ground shines on a wall 12 meters away. If a two meter man walks from the spotlight to the wall at a speed of 1.6 meters per second, how fast is the length of his shadow on the wall decreasing when he is 4 meters from the wall?

6. While in Wonderland, Alice eats a cookie that makes her grow taller at a rate of 0.5 ft/min. If she is standing 40 feet away from a light which is 20 feet tall, how fast is the length of her shadow changing when she is 15 feet tall?

7. (Final Exam 2013) At a distance of 4 kilometres from the launch site, a spectator is observing a rocket being launched. If the rocket lifts off vertically and is rising at a speed of 0.7 kilometres/second when it is at an altitude of 3 kilometres, how fast is the distance between the rocket and the spectator changing at that instant?

8. (Final Exam 2010) Two cylindrical swimming pools are being filled simultaneously with water, at exactly the same rate measured in $m^3/min$. The smaller pool has a radius of 5m and the height of the water in the smaller pool is increasing at a rate of 0.5m/min. The larger pool has a radius of 8m. How fast is the height of the water increasing in the larger pool? Your answer must be a specific numerical value.