Objectives:

- Solve for an unknown rate of change using related rates of change.

1. Draw a diagram.

2. Label your diagram, including units. If a quantity in the diagram is not changing, label it with a number. If a quantity in the diagram is changing, label it with a function.
ex.) If a person is 6 feet tall, label the person's height as __________ .
If a person is running away from a tree, label distance between person and tree as ________ .

3. Identify the rates of change you know.
ex.) Suppose the problem states that a buffalo's velocity after 3 hours of running is 40 miles per hour, and you labeled the buffalo's potion in the diagram as $x(t)$. Then we know the problem will involve the buffalo's velocity, ______ . We also know that ____________________
ex.) If the problem states that a beam from the lighthouse is turning once per minute and you labeled the angle of the beam as θ in your diagram, we know the problem will involve ____________________ and ____________________ .

4. Identify the rate of change that you wish to find.
ex.) If the problem asks you to find how fast the height $h(t)$ of a rising balloon is increasing at $t = 3$, write __________ or _______________

5. Write a function that describes the relationship between the quantities in the problem. Whenever possible, use creative methods to reduce the number of variables in the function.
ex.) If we know $\frac{dr}{dt}$, the rate of change of the radius of a circle and want to know $\frac{dA}{dt}$, the rate of change of the area of the same circle, write __________ .

6. Take the derivative of the function you found in part 5 with respect to time.
ex.) ____________________

7. Substitute actual numbers for every known quantity in the derivative you found in part 6. Then solve for the unknown rate of change. Remember to use units when stating your answer.
We ONLY substitute ______________________________ .

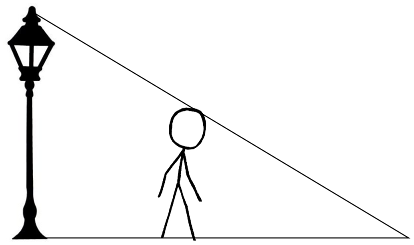
8. Intuition check! Check to make sure that your understanding of the physical scenario makes sense with the answer you found.

1. Chocolate milk is spilling onto the floor and it accumulates in a circular puddle. The radius of the puddle increases at a rate of 4 cm/min. How fast is the area of the puddle increasing when the radius is 5 centimeters?

2. A conical paper cup is 10 cm tall with a radius of 10 cm. The cup is being filled with water so that the water level rises at a rate of 2 cm/sec. At what rate is water being poured into the cup when the water level is 8 centimeters?

3. A spherical balloon is inflated so that r, its radius, increases at a rate of $\frac{2}{r}$ cm/sec. How fast is the volume of the balloon increasing when the radius is 4 centimeters?

4. A 7 ft tall person is walking away from a 20 ft tall lamppost at a rate of 5 ft/sec. At what rate is the length of the person's shadow changing when the person is 16 feet from the lamppost?



5. An observer stands 700 feet away from a launch pad to observe a rocket launch. The rocket blasts off and maintains a velocity of 900 ft/sec. How fast is the observer-to-rocket distance changing when the rocket is 2400 feet from the ground?

6. A 20ft ladder is left leaning against the wall and begins to slide down the wall. As the ladder slides, the angle between the ladder and the ground is decreasing by 5 radians per second. Find the rate at which the top of the ladder is moving down the wall when the top of the ladder hits the ground.

   Another way to think about it: