When you are done with your homework you should be able to…

- π Find a related rate
- π Use related rates to solve real-life problems

Warm-up 1: Find the derivative of with respect to *y*.

$x^2 y = 2$

Warm-up 2:
Find the volume of a cone with a radius of 24 inches and a height of 10 inches. Round to the nearest hundredth.

**FINDING RELATED RATES**

We use the __________________ rule to _________________ find the rates of change of two or more related variables that are changing with respect to _____________.

Some common formulas used in this section:

- Volume of a…
  - Sphere: _____________________
  - Right Circular Cylinder: __________________
  - Right Circular Cone: ________________

– Rectangular Pyramid: _______________

• Pythagorean Theorem: _______________

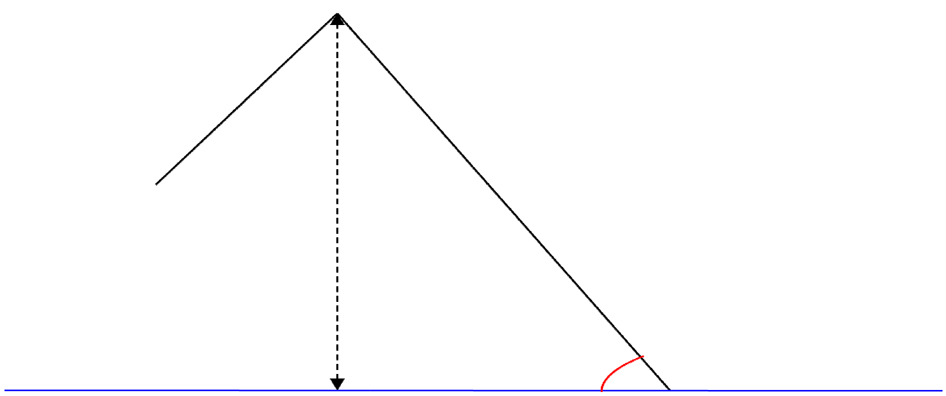
**GUIDELINES FOR SOLVING RELATED-RATE PROBLEMS**

1. Identify all **given** quantities and quantities **to be determined**. Make a sketch and label the quantities.
2. Write an equation involving the variables whose rates of change either are given or are to be determined.
3. Using the **Chain Rule**, implicitly differentiate both sides of the equation **with respect to time *t***.
4. **After** completing step 3, substitute into the **resulting equation** all known values for the variables and their rates of change. Then solve for the required rate of change.

Example 1: Find the **rate of change of the distance** between the origin and a **moving point** on the graph of $y = \sin x$ if $\frac{dx}{dt} = 2\text{cm/sec}$.

Example 2: Find the **rate of change of the volume** of a cone **if dr/dt is 2 inches per minute and h = 3r when r = 6 inches**. Round to the nearest hundredth. How is this problem different than the warm-up problem?

Example 3: Angle of Elevation. A fish is reeled in at a rate of 1 foot per second from a point 10 feet above the water. At what rate is the angle between the line and the water changing when there is a total of 25 feet of line out?



Example 4: Consider the following situation:

A container, in the shape of an inverted right circular cone, has a radius of 5 inches at the top and a height of 7 inches. At the instant when the water in the container is 6 inches deep, the surface level is falling at the rate of -1.3 in/s. Find the rate at which the water is being drained.