

**Problem 1 – Example & Explanation**

*Water is draining from a cylindrical tank at 4 liters/seconds. If the radius of the tank is 2 centimeters, how fast is the surface dropping?*

**Step 1:** Assign variables, list given information, and determine the unknown(s).

- Variables:
  
  
  
- Given information:
  
  
  
- Unknown(s):

**Step 2:** Write a formula relating given(s) and unknown(s) for a cylindrical tank.

**Step 3:** Differentiate both sides of the equation from Step 2 with respect to  $t$  to find the related rates.

- Is this problem solved using the Product Rule? Explain.
  
  
  
- Use implicit differentiation to differentiate the equation. Show your work.

**Step 4:** *Evaluate—substitute and answer the question being asked!*

- How fast is the surface dropping when the radius is 2 cm?

**Problem 2 – Additional Example & Explanation**

*Two cars leave at the same time, one traveling east at 15 units/hour and the other traveling north at 8 units/hour. At what rate is the distance between them increasing when the car going east is 30 units from the starting point?*

**Step 1:** Assign variables, list given information, and determine the goal.

**Step 2:** What equation relates what is known and what you want to find?

**Step 3:** Implicitly differentiate both sides of the equation from Step 2 with respect to  $t$  to find the related rates.

**Step 4:** Substitute to evaluate.

- Show these key steps
- What is the correct answer to the original problem?

**Problem 3 – Homework/Extension**

1. A spherical bubble is being blown up. The volume is increasing at the rate of  $9 \text{ mm}^3$  per second. At what rate is the radius increasing when the radius is 3 mm?
2. A point moves along the curve  $y = -0.5x^2 + 8$  in such a way that the  $y$  value is decreasing at the rate of 2 units per second. At what rate is  $x$  changing when  $x = 4$ ?
3. A particle moves on the curve  $y = \frac{4}{(x+1)^2 + 3}$  such that  $\frac{dy}{dt} = 6$ . Find the instantaneous rate of change of  $x$  with respect to  $t$  when  $x = 2$ .
4. A balloon is submerged in liquid nitrogen. The balloon's diameter contracts when it is cooled. The diameter of the sphere is decreasing at a rate of 4 cm/s, how fast is the surface area changing when the radius is 10 centimeters?
5. Two trains leave the station at the same time with one train traveling south at 20 mph and the other traveling west at 33 mph. How fast is the distance between the trains changing after 3 hours?
6. A cylindrical tumbler with a radius of 3 cm has its height increasing at a rate of 2.5 cm/sec. Find the rate of change of the volume of the cylinder when the height is 12.56 cm.