

## Miscellaneous Related Rates

To do these problems, you may need to use one or more of the following: The Pythagorean Theorem, Similar Triangles, Proportionality (  $A$  is proportional to  $B$  means that  $A = kB$ , for some constant  $k$ ).

1. The top of a 25-foot ladder, leaning against a vertical wall, is slipping down the wall at a rate of 1 foot per second. How fast is the bottom of the ladder slipping along the ground when the bottom of the ladder is 7 feet away from the base of the wall?
2. A 5-foot girl is walking toward a 20-foot lamppost at a rate of 6 feet per second. How fast is the tip of her shadow (cast by the lamppost) moving?
3. Under the same conditions as above, how fast is the length of the girl's shadow changing?
4. A rocket is shot vertically upward with an initial velocity of 400 feet per second. Its height  $s$  after  $t$  seconds is  $s = 400t - 16t^2$ . How fast is the distance changing from the rocket to an observer on the ground 1800 feet away from the launch site, when the rocket is still rising and is 2400 feet above the ground?
5. A small funnel in the shape of a cone is being emptied of fluid at the rate of 12 cubic centimeters per second (the tip of the cone is downward). The height of the cone is 20 cm and the radius of the top is 4 cm. How fast is the fluid level dropping when the level stands 5 cm above the vertex of the cone [The volume of a cone is  $V = \frac{1}{3}\pi r^2 h$ ].
6. A balloon is being inflated by a pump at the rate of 2 cubic inches per second. How fast is the diameter changing when the radius is  $\frac{1}{2}$  inch?
7. A particle moves on the hyperbola  $x^2 - 18y^2 = 9$  in such a way that its  $y$  coordinate increases at a constant rate of 9 units per second. How fast is the  $x$ -coordinate changing when  $x = 9$ ?
8. An object moves along the graph of  $y = f(x)$ . At a certain point, the slope of the curve is  $\frac{1}{2}$  and the  $x$ -coordinate is decreasing at 3 units per second. At that point, how fast is the  $y$ -coordinate changing?
9. A rectangular trough is 8 feet long, 2 feet across the top, and 4 feet deep. If water flows in at a rate of 2 cubic feet per minute, how fast is the surface rising when the water is 1 foot deep?
10. If a mothball (sphere) evaporates at a rate proportional to its surface area  $4\pi r^2$ , show that its radius decreases at a constant rate.
11. If an object is moving along the curve  $y = x^3$ , at what point(s) is the  $y$ -coordinate changing 3 times more rapidly than the  $x$ -coordinate?