Recall: \( \frac{df}{dx} \) is the rate of the change of \( f \) with respect to \( x \).

**Notation.**

- In this section, we use, again, only \( \frac{df}{dx} \) or \( \frac{dy}{dx} \) rather than \( f' \) or \( y' \).
- \( t = \) time
- \( r = \) radius, \( \ell = \) length or diameter
- \( A = \) area, \( S = \) surface area, \( V = \) volume

1. **Example.** Air is being pumped into a spherical balloon so that its volume increases at a rate of 100 cm\(^3\)/s. How fast is the radius of the balloon increasing when the diameter is 50 cm?

(a) Picture and Parameters.

(b) Known rate(s)

(c) Unknown rate to find out

(d) An equation that relates parameters in (a)

(e) Differentiate the equation in (d) with respect to an appropriate variable

(f) Find the unknown rate. (Write the unit also.)
2. **Exercise 12.** If a snowball melts so that its surface area decreases at a rate of 1 cm²/min., find the rate at which the diameter decreases when the diameter is 10 cm.

(a) Picture and Parameters.

(b) Known rate(s)

(c) Unknown rate to find out

(d) An equation that relates parameters in (a)

(e) Differentiate the equation in (d) with respect to an appropriate variable

(f) Find the unknown rate. (Write the unit also.)
3. **Example.** A ladder 10 ft. long rests against a vertical wall. If the bottom of the ladder slides away from the wall at a rate of 1 ft/s, how fast is the top ladder sliding down the wall when the bottom of the ladder is 6 ft from the wall?

(a) Picture and Parameters.

(b) Known rate(s)

(c) Unknown rate to find out

(d) An equation that relates parameters in (a)

(e) Differentiate the equation in (d) with respect to an appropriate variable

(f) Find the unknown rate. (Write the unit also.)
4. **Example.** Car A is traveling west at 50 mi/h and Car B is traveling north at 60 mi/h. Both are headed for the intersection of the two roads. At what rate are the cars approaching each other when Car A is 0.3 mi and Car B is 0.4 mi from the intersection?

   (a) Picture and Parameters.

   (b) Known rate(s)

   (c) Unknown rate to find out

   (d) An equation that relates parameters in (a)

   (e) Differentiate the equation in (d) with respect to an appropriate variable

   (f) Find the unknown rate. (Write the unit also.)