

**Accumulated [or total or net] change is given by the definite integral whose integrand is the rate of change.**

$$\int_a^b f'(x)dx = f(b) - f(a)$$

**Think: Change in  $f$  from  $x = a$  to  $x = b$**

Consider these examples:

### **Exercises**

Write a sentence to answer each of the following questions.

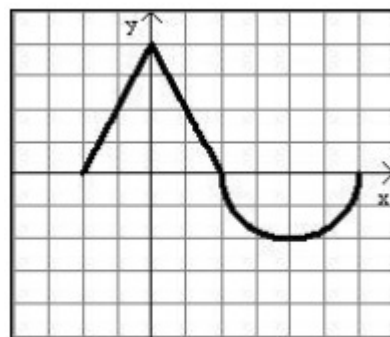
1. If  $h(t)$  is the rate of change of the height of a conical pile of sand measured in feet per hour, what does  $\int_0^5 h(t) dt$  represent? Answer in correct units.
2. If  $v(t)$  is the velocity of a particle moving along the  $x$ -axis, measured in feet per second, what does  $\int_3^{10} v(t) dt$  represent? Answer in correct units.
3. If  $b(t)$  is the rate of growth of the number of bacteria in a dish, measured in number of bacteria per hour, what does  $\int_2^6 b(t) dt$  represent? Answer in correct units.
4. If  $v(t)$  is the velocity of a particle moving along the  $x$ -axis at time  $t$ , and the position  $x(t)$  is 5 at time  $t = 2$ , (a) write an integral expression that represents the position of the particle at time  $t = 10$ , and (b) write an integral expression that gives the total distance traveled by the particle from time  $t = 2$  to time  $t = 10$ .
5. If  $p(t)$  is the rate of growth of a rabbit population, measured in rabbits per year, and there were 100 rabbits in the year 2005 ( $t = 0$ ), write an integral expression that represents the rabbit population in 2007.

**Now for a geometric look at FTC**

The graph of  $f'$  on  $-2 \leq x \leq 6$  consists of two line segments and a semicircle as shown at right.

Given that  $f(-2) = 5$ ,

find  $f(0)$ ,  $f(2)$ , and  $f(6)$ .



Graph of  $f'$

**Here is a nice calculator-friendly FTC problem to ponder**

A pizza with a temperature of  $95^\circ\text{C}$  is put into a  $25^\circ\text{C}$  room when  $t = 0$ . The pizza's temperature is decreasing at a rate of  $r(t) = 6e^{-0.1t}^\circ\text{C}$  per minute. Estimate the pizza's temperature when  $t = 5$  minutes.

**Another calculator-friendly problem**

A particle moving along the  $x$ -axis has position  $x(t)$  at time  $t$  with the velocity of the particle given by  $v(t) = 5 \sin(t^2)$ . At time  $t = 6$ , the particle's position is  $(4, 0)$ . Find the position of the particle when  $t = 7$ .

**And for the first of many water-related problems**

Water flows into a tank at a rate of  $\frac{dW}{dt} = \frac{1}{75}(600 + 20t - t^2)$  where  $\frac{dW}{dt}$  is measured in gallons per hour and  $t$  is measured in hours. If there are 150 gallons of water in the tank at time  $t = 0$ , how many gallons of water are in the tank when  $t = 24$ ?

