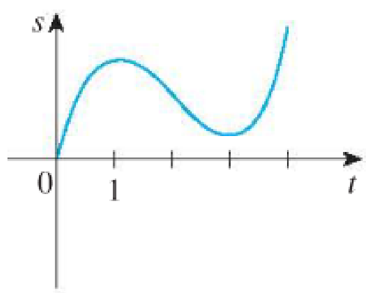
1. (a) On what interval is $f(x) = x\ln(x)$ decreasing?
   (b) On what interval is f concave upward?

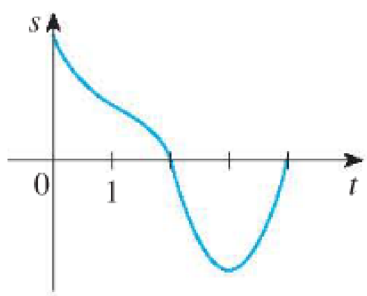
2. Let $f(x) = \log_a(3x^2 - 2)$. For what value of a is $f'(1) = 3$?

3. Use logarithmic differentiation to find the derivative of the function.
   (a) $y = \sqrt{x}e^{x^2}(x^2+1)^{10}$
   (b) $y = x^{\cos(x)}$

4. Find a formula for $f^{(n)}(x)$ of $f(x) = \ln(x-1)$.

5. Graphs of the *position* functions of two particles are shown, where t is measured in seconds. When is each particle speeding up? When is it slowing down? Explain.

   (a) 

   (b) 

6. If a ball is thrown vertically upward with a velocity of 80 ft/s, then its height after t seconds is $s = 80t - 16t^2$.
   (a) What is the maximum height reached by the ball?
   (b) What is the velocity of the ball when it is 96 ft above the ground on its way up? On its way down?

7. The number of yeast cells in a laboratory culture increases rapidly initially but levels off eventually. The population is modeled by the function

$$n = f(t) = \frac{a}{1 + be^{-0.7t}}$$

where t is measured in hours. At time $t = 0$ the population is 20 cells and is increasing at a rate of 12 cells/hour. Find the values of a and b. According to this model, what happens to the yeast population in the long run?

8. The cost function for production of a commodity is

$$C(x) = 339 + 25x - 0.09x^2 + 0.0004x^3$$

   (a) Find and interpret $C'(100)$.
   (b) Compare $C'(100)$ with the cost of producing the 101st item.

9. The table shows the population of Nepal (in millions) as of June 30 of the given year. Use a linear approximation to estimate the population at midyear in 1989. Use another linear approximation to predict the population in 2010.

t	1985	1990	1995	2000	2005
$N(t)$	17.04	19.33	21.91	24.70	27.68

10. Find the linear approximation of the function $g(x) = \sqrt[3]{1+x}$ at $a = 0$ and use it to approximate the numbers $\sqrt[3]{0.95}$ and $\sqrt[3]{1.1}$. Illustrate by graphing g and the tangent line.

11. Explain, in terms of linear approximations or differentials, why the approximation is reasonable.

$$(1.01)^6 \approx 1.06$$

12. Use differentials to estimate the amount of paint needed to apply a coat of paint 0.05 cm thick to a hemispherical dome with diameter 50 m.