

### 3.4E: Exercises for Section 3.3

In exercises 1 - 12, find  $f'(x)$  for each function.

1)  $f(x) = x^7 + 10$

2)  $f(x) = 5x^3 - x + 1$

**Answer**

$$f'(x) = 15x^2 - 1$$

3)  $f(x) = 4x^2 - 7x$

4)  $f(x) = 8x^4 + 9x^2 - 1$

**Answer**

$$f'(x) = 32x^3 + 18x$$

5)  $f(x) = x^4 + 2x$

6)  $f(x) = 3x \left( 18x^4 + \frac{13}{x+1} \right)$

**Answer**

$$f'(x) = 270x^4 + \frac{39}{(x+1)^2}$$

7)  $f(x) = (x+2)(2x^2-3)$

8)  $f(x) = x^2 \left( \frac{2}{x^2} + \frac{5}{x^3} \right)$

**Answer**

$$f'(x) = \frac{-5}{x^2}$$

9)  $f(x) = \frac{x^3 + 2x^2 - 4}{3}$

10)  $f(x) = \frac{4x^3 - 2x + 1}{x^2}$

**Answer**

$$f'(x) = \frac{4x^4 + 2x^2 - 2x}{x^4}$$

11)  $f(x) = \frac{x^2 + 4}{x^2 - 4}$

12)  $f(x) = \frac{x+9}{x^2 - 7x + 1}$

**Answer**

$$f'(x) = \frac{-x^2 - 18x + 64}{(x^2 - 7x + 1)^2}$$

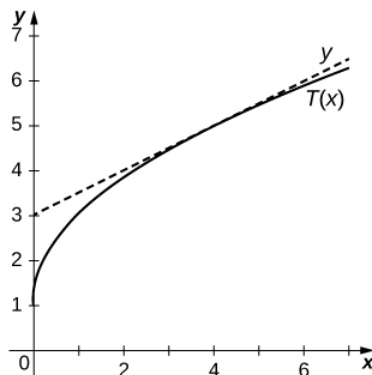
In exercises 13 - 16, find the equation of the tangent line  $T(x)$  to the graph of the given function at the indicated point. Use a graphing calculator to graph the function and the tangent line.

13) [T]  $y = 3x^2 + 4x + 1$  at  $(0, 1)$

14) [T]  $y = 2\sqrt{x} + 1$  at  $(4, 5)$

**Answer**

$$T(x) = \frac{1}{2}x + 3$$

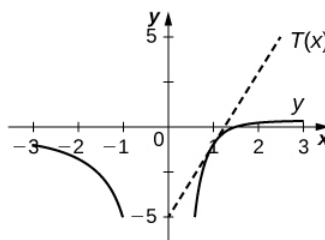


15) [T]  $y = \frac{2x}{x-1}$  at  $(-1, 1)$

16) [T]  $y = \frac{2}{x} - \frac{3}{x^2}$  at  $(1, -1)$

**Answer**

$$T(x) = 4x - 5$$



In exercises 17 - 20, assume that  $f(x)$  and  $g(x)$  are both differentiable functions for all  $x$ . Find the derivative of each of the functions  $h(x)$ .

17)  $h(x) = 4f(x) + \frac{g(x)}{7}$

18)  $h(x) = x^3 f(x)$

**Answer**

$$h'(x) = 3x^2 f(x) + x^3 f'(x)$$

19)  $h(x) = \frac{f(x)g(x)}{2}$

20)  $h(x) = \frac{3f(x)}{g(x) + 2}$

**Answer**

$$h'(x) = \frac{3f'(x)(g(x) + 2) - 3f(x)g'(x)}{(g(x) + 2)^2}$$

For exercises 21 - 24, assume that  $f(x)$  and  $g(x)$  are both differentiable functions with values as given in the following table. Use the following table to calculate the following derivatives.

$x$	1	2	3	4
$f(x)$	3	5	-2	0
$g(x)$	2	3	-4	6
$f'(x)$	-1	7	8	-3
$g'(x)$	4	1	2	9

21) Find  $h'(1)$  if  $h(x) = xf(x) + 4g(x)$ .

22) Find  $h'(2)$  if  $h(x) = \frac{f(x)}{g(x)}$ .

**Answer**

$$h'(2) = \frac{16}{9}$$

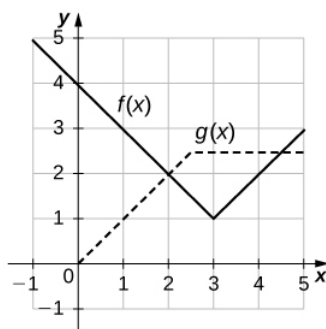
23) Find  $h'(3)$  if  $h(x) = 2x + f(x)g(x)$ .

24) Find  $h'(4)$  if  $h(x) = \frac{1}{x} + \frac{g(x)}{f(x)}$ .

**Answer**

$h'(4)$  is undefined.

In exercises 25 - 27, use the following figure to find the indicated derivatives, if they exist.



25) Let  $h(x) = f(x) + g(x)$ . Find

a)  $h'(1)$ ,

b)  $h'(3)$ , and

c)  $h'(4)$ .

26) Let  $h(x) = f(x)g(x)$ . Find

a)  $h'(1)$ ,

b)  $h'(3)$ , and

c)  $h'(4)$ .

**Answer**

a.  $h'(1) = 2$ ,

b.  $h'(3)$  does not exist,

c.  $h'(4) = 2.5$

27) Let  $h(x) = \frac{f(x)}{g(x)}$ . Find

- a)  $h'(1)$ ,
- b)  $h'(3)$ , and
- c)  $h'(4)$ .

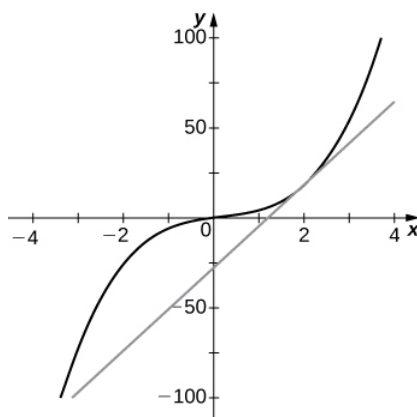
In exercises 28 - 31,

- a) evaluate  $f'(a)$ , and
- b) graph the function  $f(x)$  and the tangent line at  $x = a$ .

28) [T]  $f(x) = 2x^3 + 3x - x^2$ ,  $a = 2$

**Answer**

- a. 23
- b.  $y = 23x - 28$

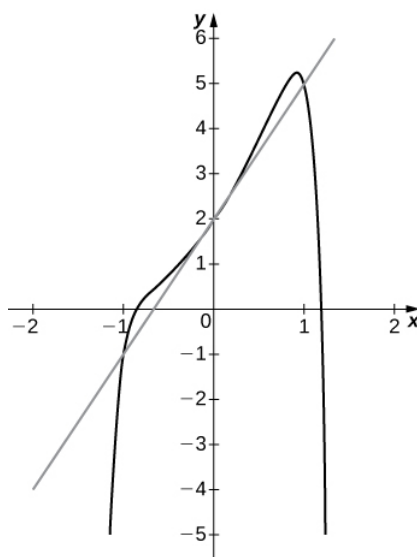


29) [T]  $f(x) = \frac{1}{x} - x^2$ ,  $a = 1$

30) [T]  $f(x) = x^2 - x^{12} + 3x + 2$ ,  $a = 0$

**Answer**

- a. 3
- b.  $y = 3x + 2$



31) [T]  $f(x) = \frac{1}{x} - x^{2/3}$ ,  $a = -1$

32) Find the equation of the tangent line to the graph of  $f(x) = 2x^3 + 4x^2 - 5x - 3$  at  $x = -1$ .

**Answer**

$$y = -7x - 3$$

33) Find the equation of the tangent line to the graph of  $f(x) = x^2 + \frac{4}{x} - 10$  at  $x = 8$ .

34) Find the equation of the tangent line to the graph of  $f(x) = (3x - x^2)(3 - x - x^2)$  at  $x = 1$ .

**Answer**

$$y = -5x + 7$$

35) Find the point on the graph of  $f(x) = x^3$  such that the tangent line at that point has an  $x$ -intercept of  $(6, 0)$ .

36) Find the equation of the line passing through the point  $P(3, 3)$  and tangent to the graph of  $f(x) = \frac{6}{x-1}$ .

**Answer**

$$y = -\frac{3}{2}x + \frac{15}{2}$$

37) Determine all points on the graph of  $f(x) = x^3 + x^2 - x - 1$  for which the slope of the tangent line is

a. horizontal

b.  $-1$ .

38) Find a quadratic polynomial such that  $f(1) = 5$ ,  $f'(1) = 3$  and  $f''(1) = -6$ .

**Answer**

$$y = -3x^2 + 9x - 1$$

39) A car driving along a freeway with traffic has traveled  $s(t) = t^3 - 6t^2 + 9t$  meters in  $t$  seconds.

a. Determine the time in seconds when the velocity of the car is 0.

b. Determine the acceleration of the car when the velocity is 0.

40) [T] A herring swimming along a straight line has traveled  $s(t) = \frac{t^2}{t^2 + 2}$  feet in  $t$

seconds. Determine the velocity of the herring when it has traveled 3 seconds.

**Answer**

$$\frac{12}{121} \text{ or } 0.0992 \text{ ft/s}$$

41) The population in millions of arctic flounder in the Atlantic Ocean is modeled by the function  $P(t) = \frac{8t+3}{0.2t^2+1}$ , where  $t$  is measured in years.

a. Determine the initial flounder population.

b. Determine  $P'(10)$  and briefly interpret the result.

42) [T] The concentration of antibiotic in the bloodstream  $t$  hours after being injected is given by the function  $C(t) = \frac{2t^2+t}{t^3+50}$ , where  $C$  is measured in milligrams per liter of blood.

a. Find the rate of change of  $C(t)$ .

b. Determine the rate of change for  $t = 8, 12, 24$ , and  $36$ .

c. Briefly describe what seems to be occurring as the number of hours increases.

**Answer**

a.  $\frac{-2t^4 - 2t^3 + 200t + 50}{(t^3 + 50)^2}$

b.  $-0.02395\text{mg/L-hr}$ ,  $-0.01344\text{mg/L-hr}$ ,  $-0.003566\text{mg/L-hr}$ ,  $-0.001579\text{mg/L-hr}$

c. The rate at which the concentration of drug in the bloodstream decreases is slowing to 0 as time increases.

43) A book publisher has a cost function given by  $C(x) = \frac{x^3 + 2x + 3}{x^2}$ , where  $x$  is the number of copies of a book in thousands and  $C$  is the cost, per book, measured in dollars. Evaluate  $C'(2)$  and explain its meaning.

44) [T] According to Newton's law of universal gravitation, the force  $F$  between two bodies of constant mass  $m_1$  and  $m_2$  is given by the formula  $F = \frac{Gm_1m_2}{d^2}$ , where  $G$  is the gravitational constant and  $d$  is the distance between the bodies.

a. Suppose that  $G$ ,  $m_1$ , and  $m_2$  are constants. Find the rate of change of force  $F$  with respect to distance  $d$ .

b. Find the rate of change of force  $F$  with gravitational constant  $G = 6.67 \times 10^{-11} \text{Nm}^2/\text{kg}^2$ , on two bodies 10 meters apart, each with a mass of 1000 kilograms.

**Answer**

a.  $F'(d) = \frac{-2Gm_1m_2}{d^3}$

b.  $-1.33 \times 10^{-7} \text{ N/m}$

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