

Then

$$\begin{aligned} \frac{f(x+h) - f(x)}{h} &= \frac{[2x^2 + 4xh + 2h^2 - x - h - 3] - [2x^2 - x - 3]}{h} \\ &= \frac{2x^2 + 4xh + 2h^2 - x - h - 3 - 2x^2 + x + 3}{h} \\ &= \frac{4xh + 2h^2 - h}{h} \\ &= \frac{h(4x + 2h - 1)}{h \cdot 1} = \frac{h}{h} \cdot \frac{4x + 2h - 1}{1} = 4x + 2h - 1. \end{aligned}$$

 Now Try Exercise 61.

## 2.2 Exercise Set

Given that  $f(x) = x^2 - 3$  and  $g(x) = 2x + 1$ , find each of the following, if it exists.

- |   |                             |
|---|-----------------------------|
| 1. $(f+g)(5)$ 33                        | 2. $(fg)(0)$ -3             |
| 3. $(f-g)(-1)$ -1                       | 4. $(fg)(2)$ 5              |
| 5. $(f/g)(-\frac{1}{2})$ Does not exist | 6. $(f-g)(0)$ -4            |
| 7. $(fg)(-\frac{1}{2})$ 0               | 8. $(f/g)(-\sqrt{3})$ 0     |
| 9. $(g-f)(-1)$ 1                        | 10. $(g/f)(-\frac{1}{2})$ 0 |

Given that  $h(x) = x + 4$  and  $g(x) = \sqrt{x-1}$ , find each of the following, if it exists.

- |                                   |                                  |
|-----------------------------------|----------------------------------|
| 11. $(h-g)(-4)$<br>Does not exist | 12. $(gh)(10)$ 42                |
| 13. $(g/h)(1)$ 0                  | 14. $(h/g)(1)$<br>Does not exist |
| 15. $(g+h)(1)$ 5                  | 16. $(hg)(3)$ $7\sqrt{2}$        |

For each pair of functions in Exercises 17–32:

- a) Find the domain of  $f$ ,  $g$ ,  $f+g$ ,  $f-g$ ,  $fg$ ,  $ff$ ,  $f/g$ , and  $g/f$ .
- b) Find  $(f+g)(x)$ ,  $(f-g)(x)$ ,  $(fg)(x)$ ,  $(ff)(x)$ ,  $(f/g)(x)$ , and  $(g/f)(x)$ .

17.  $f(x) = 2x + 3$ ,  $g(x) = 3 - 5x$  □
18.  $f(x) = -x + 1$ ,  $g(x) = 4x - 2$  □
19.  $f(x) = x - 3$ ,  $g(x) = \sqrt{x+4}$  □
20.  $f(x) = x + 2$ ,  $g(x) = \sqrt{x-1}$  □
21.  $f(x) = 2x - 1$ ,  $g(x) = -2x^2$  □
22.  $f(x) = x^2 - 1$ ,  $g(x) = 2x + 5$  □
23.  $f(x) = \sqrt{x-3}$ ,  $g(x) = \sqrt{x+3}$  □

24.  $f(x) = \sqrt{x}$ ,  $g(x) = \sqrt{2-x}$  □

25.  $f(x) = x + 1$ ,  $g(x) = |x|$  □

26.  $f(x) = 4|x|$ ,  $g(x) = 1 - x$  □

27.  $f(x) = x^3$ ,  $g(x) = 2x^2 + 5x - 3$  □

28.  $f(x) = x^2 - 4$ ,  $g(x) = x^3$  □

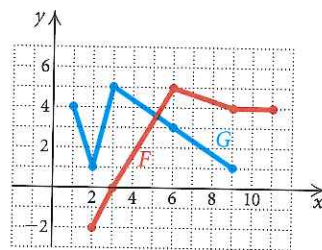
29.  $f(x) = \frac{4}{x+1}$ ,  $g(x) = \frac{1}{6-x}$  □

30.  $f(x) = 2x^2$ ,  $g(x) = \frac{2}{x-5}$  □

31.  $f(x) = \frac{1}{x}$ ,  $g(x) = x - 3$  □

32.  $f(x) = \sqrt{x+6}$ ,  $g(x) = \frac{1}{x}$  □

In Exercises 33–38, consider the functions  $F$  and  $G$  as shown in the following graph.

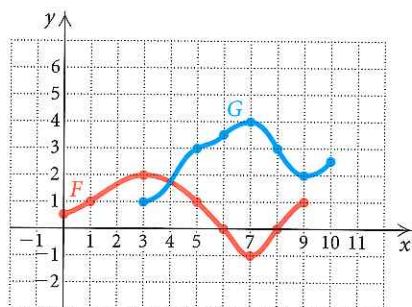


33. Find the domain of  $F$ , the domain of  $G$ , and the domain of  $F+G$ . □

34. Find the domain of  $F-G$ ,  $FG$ , and  $F/G$ . [2, 9]

35. Find the domain of  $G/F$ .  $[2, 3) \cup (3, 9]$   
 36. Graph  $F + G$ .   
 37. Graph  $G - F$ .   
 38. Graph  $F - G$ .

In Exercises 39–44, consider the functions  $F$  and  $G$  as shown in the following graph.



39. Find the domain of  $F$ , the domain of  $G$ , and the domain of  $F + G$ .   
 40. Find the domain of  $F - G$ ,  $FG$ , and  $F/G$ .  $[3, 9]$   
 41. Find the domain of  $G/F$ .  $[3, 6) \cup (6, 8) \cup (8, 9]$   
 42. Graph  $F + G$ .   
 43. Graph  $G - F$ .       44. Graph  $F - G$ .   
 45. **Total Cost, Revenue, and Profit.** In economics, functions that involve revenue, cost, and profit are used. For example, suppose that  $R(x)$  and  $C(x)$  denote the total revenue and the total cost, respectively, of producing a new kind of tool for King Hardware Wholesalers. Then the difference

$$P(x) = R(x) - C(x)$$

represents the total profit for producing  $x$  tools. Given

$R(x) = 60x - 0.4x^2$  and  $C(x) = 3x + 13$ , find each of the following.

- a)  $P(x)$      $P(x) = -0.4x^2 + 57x - 13$   
 b)  $R(100)$ ,  $C(100)$ , and  $P(100)$    
 46. **Total Cost, Revenue, and Profit.** Given that  $R(x) = 200x - x^2$  and  $C(x) = 5000 + 8x$ , for a new radio produced by Clear Communication, find each of the following. (See Exercise 45.)  
 a)  $P(x)$      $P(x) = -x^2 + 192x - 5000$   
 b)  $R(175)$ ,  $C(175)$ , and  $P(175)$

For each function  $f$ , construct and simplify the difference quotient

$$\frac{f(x+h) - f(x)}{h}$$

47.  $f(x) = 3x - 5$     3      48.  $f(x) = 4x - 1$     4  
 49.  $f(x) = 6x + 2$     6      50.  $f(x) = 5x + 3$     5  
 51.  $f(x) = \frac{1}{3}x + 1$      $\frac{1}{3}$       52.  $f(x) = -\frac{1}{2}x + 7$      $-\frac{1}{2}$   
 53.  $f(x) = \frac{1}{3x}$           54.  $f(x) = \frac{1}{2x}$       
 55.  $f(x) = -\frac{1}{4x}$           56.  $f(x) = -\frac{1}{x}$       
 57.  $f(x) = x^2 + 1$      $2x + h$       58.  $f(x) = x^2 - 3$      $2x + h$   
 59.  $f(x) = 4 - x^2$      $-2x - h$       60.  $f(x) = 2 - x^2$      $-2x - h$   
 61.  $f(x) = 3x^2 - 2x + 1$      $6x + 3h - 2$       62.  $f(x) = 5x^2 + 4x$      $10x + 5h + 4$   
 63.  $f(x) = 4 + 5|x|$           64.  $f(x) = 2|x| + 3x$       
 65.  $f(x) = x^3$      $3x^2 + 3xh + h^2$       66.  $f(x) = x^3 - 2x$      $3x^2 + 3xh + h^2 - 2$   
 67.  $f(x) = \frac{x}{x+3}$           68.  $f(x) = \frac{x}{2-x}$

### Skill Maintenance

Graph the equation.

69.  $y = 3x - 1$           70.  $2x + y = 4$       
 71.  $x - 3y = 3$           72.  $y = x^2 + 1$

### Synthesis

73. Write equations for two functions  $f$  and  $g$  such that the domain of  $f - g$  is  $\{x \mid x \neq -7 \text{ and } x \neq 3\}$ .   
 74. For functions  $h$  and  $f$ , find the domain of  $h + f$ ,  $h - f$ ,  $hf$ , and  $h/f$  if  $h = \{(-4, 13), (-1, 7), (0, 5), (\frac{5}{2}, 0), (3, -5)\}$ , and  $f = \{(-4, -7), (-2, -5), (0, -3), (3, 0), (5, 2), (9, 6)\}$ .   
 75. Find the domain of  $(h/g)(x)$  given that  $h(x) = \frac{5x}{3x-7}$  and  $g(x) = \frac{x^4-1}{5x-15}$ .  $(-\infty, -1) \cup (-1, 1) \cup (1, \frac{7}{3}) \cup (\frac{7}{3}, 3) \cup (3, \infty)$