Level *

Evaluate the following function $f(x) = 2x^2+3x-1$

1.) f(-2)
2.) f(0)
3.) f(3)
4.) f(-5)

Level **

Evaluate the following function $f(x)= 3x^3+5$

1.) f(b)
2.) f(-2b)
3.) $f(b^2)$
4.) $f(3b^3)$

Level ***

Evaluate the following function $f(x)= -2x^2-3x$

$g(x)= x-2$

1.) f(x+1)
2.) f(2x-3)
3.) f(2x-1)
4.) f(g(2))
5.) g(f(-1))

Answer key

Level *

1.) $f(-2) = 2(-2)^2 + 3(-2) - 1$
$= 2(4) - 6 - 1$
$= 8 - 6 - 1$
$= 8 - 7$
$f(-2) = 1$

2) $f(0) = 2(0)^2 + 3(0) + 1$
$f(0) = 0 + 0 - 1$
$f(0) = -1$

3.) $f(3) = 2(3)^2 + 3(3) - 1$
$f(3) = 18 + 9 - 1$
$f(3) = 18 + 8$
$f(3) = 26$

4.) $f(-5) = 2(-5)^2 + 3(-5) - 1$
$= 2(25) - 15 - 1$
$= 50 - 16$
$f(-5) = 34$

Level **

1.) $f(b) = 3(b)^3 + 5$
$f(b) = 3b^3 + 5$

2.) $f(-2b) = 3(-2b)^3 + 5$
$= 3(-8b^3) + 5$
$f(-2b) = -24b^3 + 5$

3.) $f(b^2) = 3(b^2)^3 + 5$
$f(b^2) = 3b^6 + 5$

4.) $f(3b^3) = 3(3b^3)^3 + 5$
$= 3(27b^9) + 5$
$f(3b^3 = 81b^9 + 5$

Level ***

1.) $f(x+1) = -2(x+1)^2 - 3(x+1)$
$= -2(x+1)(x+1) - 3(x+1)$
$= -2(x^2 + x + x + 1) - 3x - 3$
$= -2(x^2 + 2x + 1) - 3x - 3$
$= -2x^2 - 4x - 2 - 3x - 3$
$f(x+1) = -2x^2 - 7x - 5$

2.) $f(2x-3) = -2(2x-3)^2 - 3(2x-3)$
$= -2(2x-3)(2x-3) - 3(2x-3)$
$= -2(4x^2 - 6x - 6x + 9) - 3(2x-3)$
$= -2(4x^2 - 12x + 9) - 6x + 9$
$= -8x^2 + 24x - 18 - 6x + 9$
$f(2x-3) = -8x^2 + 18x - 9$

3.) $f(2x-1) = -2(2x-1)^2 - 3(2x-1)$
$= -2(2x-1)(2x-1) - 6x + 3$
$= -2(4x^2 - 2x - 2x + 1) - 6x + 3$
$= -2(4x^2 - 4x + 1) - 6x + 3$
$= -8x^2 + 8x - 2 - 6x + 3$
$= -8x^2 + 2x + 1$

4.) $f(g(2)) = 0$ start w inside $g(2)$

$g(2) = 2 - 2$
$g(2) = 0$
$f(0) = -2(0)^2 - 3(0)$
$f(0) = 0$

5.) $g(f(-1)) = -1$

$f(-1) = -2(-1)^2 - 3(-1) = -2(1) + 3 = -2 + 3 = 1$
$g(1) = 1 - 2 = -1$

29. Let $f(x) = x^2 - 3x + 1$. Compute the following.
(a) $f(1)$ (b) $f(0)$ (c) $f(-1)$ (d) $f(3/2)$ (e) $f(z)$ (f) $f(x+1)$ (g) $f(a+1)$ (h) $f(-x)$ (i) $|f(1)|$ (j) $f(\sqrt{3})$ (k) $f(1+\sqrt{2})$ (l) $|1 - f(2)|$

30. Let $H(x) = 1 - x + x^2 - x^3$.
(a) Which number is larger, $H(0)$ or $H(1)$?
(b) Find $H(\frac{1}{2})$. Does $H(\frac{1}{2}) + H(\frac{1}{2}) = H(1)$?

31. Let $f(x) = 3x^2$. Find the following.
(a) $f(2x)$ (b) $2f(x)$ (c) $f(x^2)$ (d) $[f(x)]^2$ (e) $f(x/2)$ (f) $f(x)/2$

For checking: No two answers are the same.

32. Let $f(x) = 4 - 3x$. Find the following.
(a) $f(2)$ (b) $f(-3)$ (c) $f(2) + f(-3)$ (d) $f(2+3)$ (e) $f(2x)$ (f) $2f(x)$ (g) $f(x^2)$ (h) $f(1/x)$ (i) $f[f(x)]$ (j) $x^2 f(x)$ (k) $1/f(x)$ (l) $f(-x)$ (m) $-f(x)$ (n) $-f(-x)$

33. Let $H(x) = 1 - 2x^2$. Find the following.
(a) $H(\sqrt{2})$ (b) $H(5/6)$ (c) $H(x+1)$ (d) $H(x+h)$

34. (a) If $f(x) = 2x + 1$, does $f(3+1) = f(3) + f(1)$?
(b) If $f(x) = 2x$, does $f(3+1) = f(3) + f(1)$?
(c) If $f(x) = \sqrt{x}$, does $f(3+1) = f(3) + f(1)$?

35. Let $g(x) = 2$, for all x. Find each output.
(a) $g(0)$ (b) $g(5)$ (c) $g(x+h)$

36. Let $g(t) = |t - 4|$. Find $g(3)$. Find $g(x+4)$.

37. Let $f(x) = x^2 - 6x$. In each case, find all real numbers x (if any) that satisfy the given equation.
(a) $f(x) = 16$ (b) $f(x) = -10$ (c) $f(x) = -9$

38. Let $g(t) = (4t - 6)/(t - 4)$. In each case, find all the real number solutions (if any) for the given equation.
(a) $g(t) = 14$ (b) $g(t) = 4$ (c) $g(t) = 0$

For Exercises 39 and 40, refer to the demand function given in Example 7. In each case, solve the indicated equation for n. Round each answer to the nearest integer and interpret the result.

39. $p(n) = 8$

40. $p(n) = 18$

In Exercises 41 and 42, p refers to the demand function given in Example 7. Now assume that a second economist proposes an alternative model f for the demand function:

$$f(n) = 4 + \frac{3000}{n + 100} \qquad (100 \le n \le 1500)$$

where n is the number of tee shirts that can be sold per month at a price of f(n) dollars per shirt.

41. At a price level of \$19 per shirt, compare the predictions for monthly sales obtained using each model. *Hint*: You need to solve each of the equations $p(n) = 19$ and $f(n) = 19$ and interpret the results.

42. Show that at a price level of \$10 per shirt, the model p predicts more than twice as many sales per month as does the model f. *Hint*: Solve each of the equations $p(n) = 10$ and $f(n) = 10$, and interpret the results.

In Exercises 43 and 44, let $T(x) = 2x^2 - 3x$. Find (and simplify) each expression.

43. (a) $T(x+2)$ (b) $T(x-2)$ (c) $T(x+2) - T(x-2)$

44. (a) $T(x+h)$ (b) $T(x-h)$ (c) $T(x+h) - T(x-h)$

In Exercises 45–48, refer to the following table. The left-hand column of the table lists four errors to avoid in working with function notation. In each case, use the function $f(x) = x^2 - 1$ and give a numerical example showing that the expressions on each side of the equation are not equal.

Errors to avoid	Numerical example showing that the equation is not, in general, valid
45. $f(a+b) = f(a) + f(b)$	
46. $f(ab) = f(a) \cdot f(b)$	
47. $f\left(\frac{1}{a}\right) = \frac{1}{f(a)}$	
48. $\frac{f(a)}{f(b)} = \frac{a}{b}$	

B

49. Let $f(x) = (x - a)/(x + a)$.
(a) Find $f(a)$, $f(2a)$, and $f(3a)$. Is it true that $f(3a) = f(a) + f(2a)$?
(b) Show that $f(5a) = 2f(2a)$.

50. Let $k(x) = 5x^3 + \frac{5}{x^3} - x - \frac{1}{x}$. Show that $k(x) = k(1/x)$.

51. Let $f(x) = 2x + 3$. Find values for a and b such that the equation $f(ax + b) = x$ is true for all values of x. *Hint*: Use the fact that if two polynomials (in the variable x) are equal for all values of x, then the corresponding coefficients are equal.

52. Let $f(t) = (t - x)/(t + y)$. Show that

$$f(x + y) + f(x - y) = \frac{-2y^2}{x^2 + 2xy}$$

53. Let $f(z) = \frac{3z - 4}{5z - 3}$. Find $f\left(\frac{3z - 4}{5z - 3}\right)$.

54. Let $F(x) = \frac{ax + b}{cx - a}$. Show that $F\left(\frac{ax + b}{cx - a}\right) = x$, where $a^2 + bc \neq 0$.

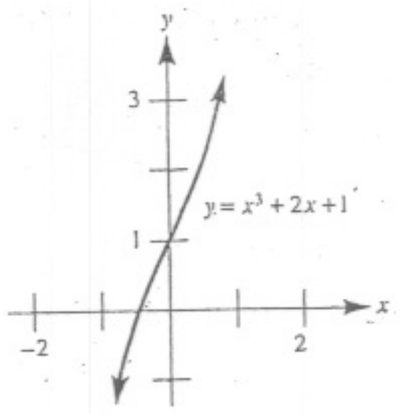
55. If $f(x) = -2x^2 + 6x + k$ and $f(0) = -1$, find k.

56. If $g(x) = x^2 - 3xk - 4$ and $g(1) = -2$, find k.

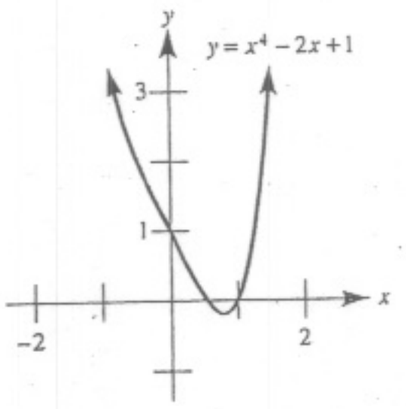
57. Let $h(x) = x^2 - 4x - c$. Find a nonzero value for c such that $h(c) = c$.

58. Let the function L be defined by the following rule: $L(x)$ *is the exponent to which 2 must be raised to yield x.* (For the moment, we won't concern ourselves with the domain and range.) Then $L(8) = 3$, for example, since the exponent to

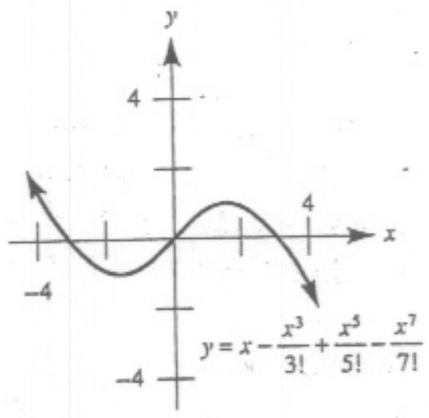
71. $[-0.453, \infty)$



73. $(-\infty, 0.544) \cup (1, \infty)$



75. $(-3.079, 0) \cup (3.079, \infty)$



77. (a) April through September
(b) January, October, November, December

79. $(-\infty, -2] \cup [2, \infty)$

81. $(-\infty, 0) \cup (\frac{1}{2}, \infty)$ **83.** $(\frac{1}{5}, \frac{4}{5})$

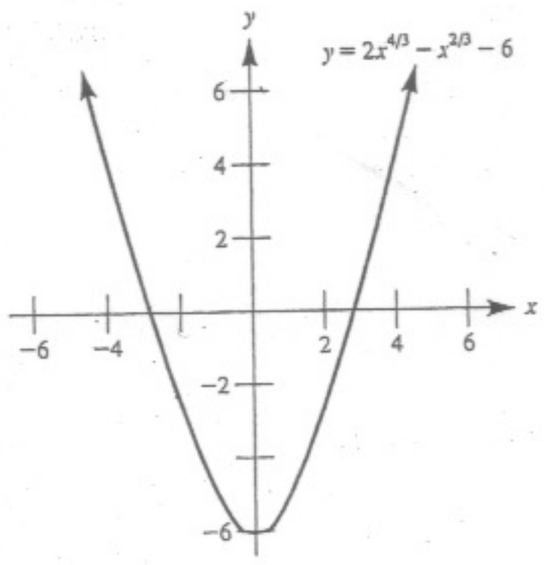
85. $c = 2$

Chapter 2 Review Exercises

1. True **3.** False **5.** False
7. True **9.** False **11.** False
13. $x = \frac{1}{3}, -\frac{1}{2}$ **15.** $x = -6, 4$
17. $x = -1, 10$ **19.** $x = \frac{2}{3}, 3$
21. $t = \dfrac{-1 \pm \sqrt{3}}{2}$ **23.** $x = -6, -8$
25. $x = 256, 6561$ **27.** $x = \frac{1}{4}$
29. $x = 10$ **31.** $x = 2$ **33.** $x = \dfrac{1}{2y}$
35. $x = \dfrac{a+b}{ab}, -\dfrac{2}{a}$
37. $x = -a$ or $x = -b$
39. $(-2, 1)$ **41.** $[-\frac{1}{2}, \frac{1}{2}]$
43. $(-\infty, -2] \cup [3, \infty)$ **45.** $(-8$
47. $(3 - \sqrt{10}, 3 + \sqrt{10})$
49. $(-5, -3) \cup (3, 5)$ **51.** $(-2, ($
53. $(-\frac{5}{2}, 4)$
55. $\left(-\infty, -\sqrt{\dfrac{3+\sqrt{5}}{2}}\right) \cup \left(-\sqrt{\dfrac{3-\sqrt{5}}{2}}, 0\right) \cup \left(0, \sqrt{\dfrac{3-\sqrt{5}}{2}}\right) \cup \left(\sqrt{\dfrac{3+\sqrt{5}}{2}}, \infty\right)$
57. $(-\infty, 3 - 2\sqrt{2}] \cup [3 + 2\sqrt{2}, \infty)$
59. $x^2 + 7x + 12 = 0$ **61.** 7 and 12
63. $-1 + \sqrt{2}$ cm
65. $(16 \text{ cm}, \infty)$ **67.** 21, 22, 23
69. $\dfrac{-(a+b) + \sqrt{a^2 + 6ab + b^2}}{4}$
71. The ball thrown from 100 ft.
73. $x = \sqrt{2}/2$ **75.** $\dfrac{F}{1+\sqrt{2}}$

Chapter 2 Test

1. (a) $x = -5, 1$ **(b)** $x = -2 \pm \sqrt{5}$
2. $x = \pm 2, \pm\sqrt{3}$ **3.** $x = -2, 2$
4. $x = -\frac{1}{3}, 1$ **5.** -4
6. $x^2 - 4x - 59 = 0$
7. $x = \pm\sqrt{\dfrac{3+\sqrt{13}}{2}} \approx \pm 1.817$
8. (a) $x \approx -2.83, 2.83$



(b) $x = \pm 2\sqrt{2} \approx \pm 2.83$ **9.** $(-\infty, 3]$
10. $(\frac{27}{10}, \frac{31}{10})$ **11.** $[\frac{7}{3}, 3]$ **12.** $[-8, \infty)$
13. $(-2, \frac{-3-\sqrt{3}}{3}] \cup (-1, \frac{-3+\sqrt{3}}{3}] \cup (0, \infty)$ **14.** $[-\frac{3}{2}, \frac{3}{2}]$ **15.** $(-4, -7)$
16. $x = 6$ is a solution to the original equation. However, $x = -1$ results in the statement $\sqrt{4} = -2$, which is false. Thus $x = -1$ is an extraneous solution of the original equation, even though it is a solution to the subsequent equation $x^2 - 5x - 6 = 0$.

CHAPTER 3

Exercise Set 3.1

1. (a) $g(1975) = \$2.00$
(b) $g(1995) - g(1975) = \$2.25$; The minimum wage increased \$2.25 from 1975 to 1995. **3. (a)** range
(b) $h(\text{Mars}) = 2$ **(c)** $h(\text{Neptune})$; Neptune has more moons than does Pluto. **5. (a)** f and g **(b)** range of f: $\{1, 2, 3\}$; range of g: $\{2, 3\}$ **7. (a)** g
(b) range of g: $\{i, j\}$ **9. (a)** $(-\infty, \infty)$
(b) $(-\infty, \frac{1}{5}) \cup (\frac{1}{5}, \infty)$ **(c)** $(-\infty, \frac{1}{5}]$
(d) $(-\infty, \infty)$ **11. (a)** $(-\infty, \infty)$
(b) $(-\infty, -3) \cup (-3, 3) \cup (3, \infty)$
(c) $(-\infty, -3) \cup [3, \infty)$ **(d)** $(-\infty, \infty)$
13. (a) $(-\infty, \infty)$
(b) $(-\infty, 3) \cup (3, 5) \cup (5, \infty)$
(c) $(-\infty, 3] \cup [5, \infty)$ **(d)** $(-\infty, \infty)$
15. (a) $(-\infty, -3) \cup (-3, \infty)$
(b) $(-\infty, -3) \cup [2, \infty)$
(c) $(-\infty, -3) \cup (-3, \infty)$
17. domain: $(-\infty, \infty)$; range: $(-\infty, \infty)$
19. domain: $(-\infty, \infty)$; range: $(-\infty, \infty)$
21. domain: $(-\infty, 6) \cup (6, \infty)$; range: $(-\infty, \frac{4}{3}) \cup (\frac{4}{3}, \infty)$
23. (a) domain: $(-\infty, 5) \cup (5, \infty)$; range: $(-\infty, 1) \cup (1, \infty)$
(b) domain: $(-\infty, \sqrt[3]{5}) \cup (\sqrt[3]{5}, \infty)$; range: $(-\infty, 1) \cup (1, \infty)$
25. domain: $(-\infty, \infty)$; range: $[4, \infty)$
27. (a) $y = (x-3)^2$ **(b)** $y = x^2 - 3$
(c) $y = (3x)^2$ **(d)** $y = 3x^2$
29. (a) -1 **(b)** 1 **(c)** 5 **(d)** $-\frac{5}{4}$
(e) $z^2 - 3z + 1$ **(f)** $x^2 - x - 1$
(g) $a^2 - a - 1$ **(h)** $x^2 + 3x + 1$
(i) 1 **(j)** $4 - 3\sqrt{3}$ **(k)** $1 - \sqrt{2}$
(l) 2 **31. (a)** $12x^2$ **(b)** $6x^2$ **(c)** $3x^4$
(d) $9x^4$ **(e)** $\frac{3}{4}x^2$ **(f)** $\frac{3}{2}x^2$ **33. (a)** -3
(b) $-\frac{7}{18}$ **(c)** $-2x^2 - 4x - 1$
(d) $1 - 2x^2 - 4xh - 2h^2$ **35. (a)** 2
(b) 2 **(c)** 2 **37. (a)** $x = -2, 8$
(b) no real solutions **(c)** $x = 3$
39. 1041 tee shirts per month
41. first model: 124 sales; second model: 100 sales **43. (a)** $2x^2 + 5x + 2$
(b) $2x^2 - 11x + 14$ **(c)** $16x - 12$
45. $a = 1$ and $b = 2$ **47.** $a = 2$
49. (a) $f(a) = 0, f(2a) = \frac{1}{3}, f(3a) = \frac{1}{2}$: No **51.** $a = \frac{1}{2}$ and $b = -\frac{3}{2}$ **53.** z
55. $k = -1$ **57.** $c = 6$ **59.** 0