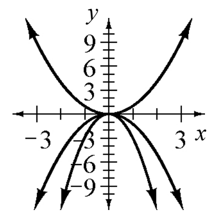
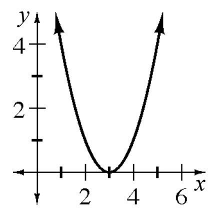
Lesson 4.1.1

4-5. **smallest: a: 2, b: 0, c: –3, d: none**
largest: a: none, b: none, c: none, d: 0, e: at the vertex

4-6. **Graph consists of three parabolas. One is standard, and two open downward. One of the downward-opening parabolas appears “fatter” than the standard one does, and the other downward-facing parabola appears “skinnier” than the standard one does. The negative coefficient causes parabolas to open downward, without changing the vertex. See graph at right.**

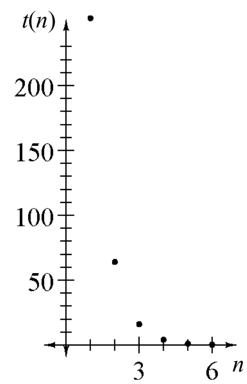


4-7. **a: parabola with vertex (3, 0); graph:**



b: shifted to the right three units

4-8. **a: 4, 1, 0.25; $t(n) = 256(0.25)^n$**
b: They get smaller, but are never negative.
c: See graph at right. They get very close to zero.



4-9. **B**

4-10. **a: $y = -\frac{2}{3}x - 4$, b: $y = 2$, c: $x = 2$, d: $y = \frac{2}{3}x - \frac{8}{3}$**

4-11. **a: a cylinder, b: $45\pi = 141.37$ cubic units**

4-12. **a: Answers vary, b: Answers vary, c: A circle has infinite lines of symmetry.**

Lesson 4.1.2

4-18. **Explanations vary, but a careful graph is to scale, done on graph paper, and with key points clearly labeled.**

4-19. **a: (0, –6); b: (–6, 0) and (1, 0);**
c: (*i*) (0, 0) and (–5, 0), the graph of $p(x)$ is 6 units lower than $q(x)$;
(*ii*) –6

4-20. **(5, 14)**

4-21. **a: 1.5; b: $-\frac{18}{5}$; c: 8; d: –3, 2**

4-22. a: 3, b: $\frac{1}{x^2y^4}$, c: $\frac{\sqrt{y}}{x}$

4-23. a: $3p + 3d = 22.50$ and $p + 3d + 3(8) = 37.5$, so popcorn = $4.50 and a drink = $3.00.
b: Answers vary.

4-24. Numbers above the third quartile are 83, 84, and 85.

4-25. a: 0.625 hours or about 37.5 minutes, b: 0.77 hours or about 46.2 minutes, c: at least $22.99 per minute

4-26. a: vertex at $(-3,-8)$, opens up, vertically stretched
b: x-intercepts (–5, 0) and (–1, 0), y-intercept (0, 10)

4-27. a: Tables or graphs should be the same.
b: sample work:

$$y = 3(x-1)^2 - 5$$
$$y = 3(x^2 - 2x + 1) - 5$$
$$y = 3x^2 - 6x + 3 - 5$$
$$y = 3x^2 - 6x - 2$$

c: Students could point out that the a ends up being the coefficient of x^2 after the binomial is squared.

4-28. a: $y = (x-8)^2 - 5$, b: $y = 10(x+6)^2$, c: $y = -0.6(x+7)^2 - 2$

4-29. a: $y = -x + 3$, b: $y = -\frac{3}{4}x + 12$, c: $y = \frac{1}{3}x - \frac{5}{3}$

4-30. a: $\sqrt{61}$, b: $30°$, c: $\tan^{-1}(\frac{4}{5})$, d: $5\sqrt{3}$

4-31. b: $5\sqrt{2}$, c: $6\sqrt{2}$, d: $3\sqrt{5}$

4-32. a: $x = 46.71$, b: $x = 8.19$

4-33. a: about $365.00, b: $y = 300(1.04)^x$

Lesson 4.1.3

4-39. **a: $y=0, 6$; b: $n=0, -5$; c: $t=0, 7$; d: $x=0, -9$; e: There is no constant term when each equation is set equal to zero, so the variable is a common factor after like terms are collected.**

4-40. **a: $(7,-16)$, $y=(x-7)^2-16$; b: $(2,-16)$, $y=(x-2)^2-16$; c: $(7,-9)$, $y=(x-7)^2-9$; d: $(2, -1)$**

4-41. **a: $(2,-1)$; b: When $x=2$, $(x-2)^2$ will equal zero and $y=-1$, the smallest possible value for *y* in the equation. So the *y*-value of the vertex is the minimum value in the range of the function.**

4-42. **a: 9.015 gigatons, b: $C(x)=8(1.01)^{(x+2)}$ if *x* represents years since 2000 or $8.16(1.01)^x$**

4-43. **a: 2, b: 1, c: 1, d: 2, e: 2, f: 1, h: If the factored version includes a perfect-square binomial factor, the parabola will touch at one point only.**

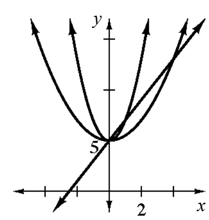
4-44. **a: 4, b: $\frac{1}{16x^4y^{10}}$, c: $6xy^2$**

4-45. **a: $\frac{8}{27}$, b: $\frac{12}{27}$, c: $\frac{6}{27}$, d: $\frac{1}{27}$**

Lesson 4.1.4

4-51. **Possibilities include $y=-\frac{1}{72}(x-60)^2+50$, $y=-\frac{1}{72}x^2+50$, and $y=-\frac{1}{72}x^2$. The domain and range should include only those values that correspond to the water passing between the boat and the warehouse.**

4-52. **See graph at right.**
a: The 2 in the equation indicates the slope of the graph.
b: No, because only lines have (constant) slopes. The 2 in this equation is the stretch factor.

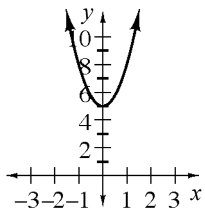


4-53. **No, they never curve back. Reasons vary, but one reason for this is that there is only one height for each *x*. Another reason is that it takes bigger *x*-values to get bigger *y*-values.**

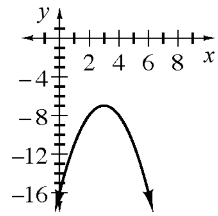
4-54. **No, they do not have asymptotes. Reasons vary, but one reason for this is that the domain of a parabola is unlimited (any number can be squared).**

4-55. **a: *x*: $(1, 0), (-\frac{5}{2}, 0)$, *y*: $(0, -5)$; b: *x*: $(2, 0)$, *y*: none**

4-56. a: stretched parabola, vertex $(0, 5)$



b: inverted parabola, vertex $(3, -7)$



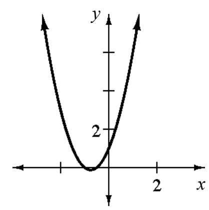
4-57. a: $g(\frac{1}{2}) = -4.75$, b: $g(h+1) = h^2 + 2h - 4$

4-58. a: $x = \pm 5$, b: $x = \pm\sqrt{11}$

Lesson 4.2.1

4-64. possible equation: $y = -\frac{4}{25}(x-5)^2 + 8$, standing at $(0, 0)$; domain: $0 \le x \le 10$, range: $4 \le y \le 8$

4-65. See graph at right below.
a: $x: (-\frac{1}{2}, 0), (-1, 0)$; $y: (0, 1)$; b: $x = -\frac{3}{4}$; c: $(-\frac{3}{4}, -\frac{1}{8})$ or $(-0.75, -0.125)$



4-66. Move it up 0.125 units: $y = 2x^2 + 3x + 1.125$.

4-67. a: $2\sqrt{6}$, b: $3\sqrt{2}$, c: $2\sqrt{3}$, d: $5\sqrt{3}$

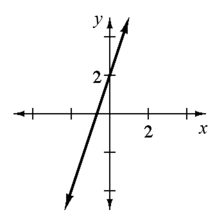
4-68. a: 32, b: $x^2y^2\sqrt{x}$, c: $\frac{x^2}{y}$

4-69. $c + m = 18$ and $\$4.89c + \$5.43m = \$92.07$; 10.5 pounds of Colombian and 7.5 pounds of Mocha Java

4-70. a: 15 ft., b: surface area of concrete: 793.14 sq. ft.; 528.76 cu. ft.; $1,263.74

4-71. vertex $(-3.5, -20.25)$, $y = (x+3.5)^2 - 20.25$

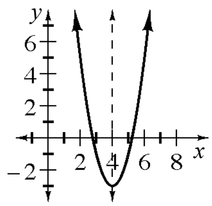
4-72. a: See graph at right.
b: $y = 3x + 2$
c: 2, 5, 8, 11
d: One is continuous and one is discrete. They have the same slope, so the "lines" are parallel, but they have different intercepts.



4-73. a: $4.116 \cdot 10^{12}$, b: $y = 1.665(10^{12})(1.0317)^t$, c: Explanations vary.

4-74. a: $6\sqrt{x} + 3\sqrt{y}$, b: 32, c: 5, d: $\frac{\sqrt{3}}{2}$

4-75. a: $6x^3 + 8x^4y$, b: $x^{14}y^9$

4-76. graph: 

symmetry $x = 4$

4-77. a: $4\pi + \frac{4}{3}\pi \approx 16.755 \text{ m}^3$
b: No, it will not double, because of the r, r^2, r^3 relationship. $V = \frac{80\pi}{3} \approx 83.776 \text{ m}^3$
c: $V = \frac{4}{3}\pi r^3 + 4\pi r^2$

4-78. a: $y = \frac{1}{x+2}$, b: $y = x^2 - 5$, c: $y = (x-3)^3$, d: $y = 2^x - 3$, e: $y = 3x - 6$,
f: $y = (x+2)^3 + 3$, g: $y = (x+3)^2 - 6$, h: $y = -(x-3)^2 + 6$, i: $y = (x+3)^3 - 2$

4-79. He should move it up 6 units or redraw the axes 6 units lower.

4-80. y-intercept: $(0, -17)$; x-intercepts: $(-2 \pm \sqrt{21}, 0)$ or $(\sim 2.58, 0)$ and $(\sim 6.58, 0)$

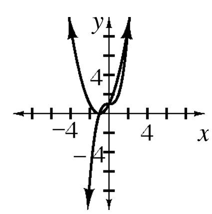
4-81. a: 18, b: $\frac{3}{2}$, c: $\frac{1}{\sqrt{3}}$ or $\frac{\sqrt{3}}{3}$, d: $11 + 6\sqrt{2}$

4-82. a: $(2x-3y)(2x+3y)$, b: $2x^3(2+x^2)(2-x^2)$, c: $(x^2+9y^2)(x-3y)(x+3y)$,
d: $2x^3(4+x^4)$, e: They all contain a factor that is a difference of squares.

4-83. $x = \frac{-by^3+c+7}{a}$

4-84. $n = 24$; $\sqrt{650} = 5\sqrt{26}$

4-85. a: graph shown at right, b: 2, c: -1, d: $\sqrt[3]{-13}$, e: no solution,
f: three because the graphs cross three times, g: $x^3 - x^2 - 2x$



Lesson 4.2.2

4-91. a: $y = (x-2)^2 + 3$, b: $y = (x-2)^3 + 3$, c: $y = -2(x+6)^2$

4-92. a: domain: all real numbers, range: $y \geq 3$
b: domain: all real numbers, range: all real numbers
c: domain: all real numbers, range: $y \leq 0$

4-93. a: compresses or stretches, b: shifts up or down, c: shifts left or right,
d: shifts up or down

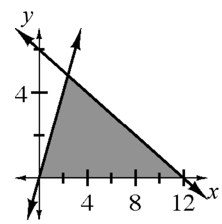
4-94. a: $\sqrt{146} \approx 12.1$, b: $\sqrt{145} \approx 12.0$, c: $\sqrt{50} \approx 7.1$, d: $5\sqrt{2}$

4-95. a: $\frac{2}{25}$, b: $\frac{3x^2y^3}{z^4}$, c: $54m^5n$, d: $y\sqrt[3]{5x^2z}$

4-96. a: $x = \pm\sqrt{\frac{y}{2}} + 17$, b: $x = (y+7)^3 - 5$

4-97. a: (10, 48), b: $(\frac{29}{5}, \frac{9}{5})$

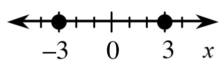
4-98. See graph at right.



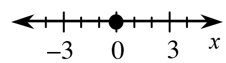
a: $y = 2x$: (0, 0), $y = -\frac{1}{2}x + 6$: (0, 6), (12, 0)
b: It should be a triangle with vertices (0, 0), (12, 0), and (2.4, 4.8).
c: domain: $0 \le x \le 12$, range: $0 \le y \le 4.8$
d: $A = \frac{1}{2}(12)(4.8) = 28.8$ square units

Lesson 4.2.3

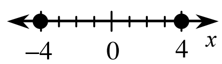
4-103. a:



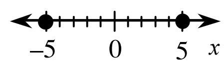
b:



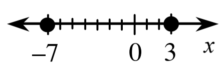
c:



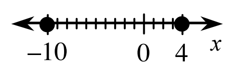
d:



e:



f:



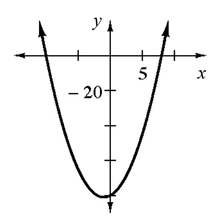
4-104. a: $|6| = 6$ and $|-6| = 6$, b: Explanations vary.

4-105. a: 57, –43; b: 43, –57; c: –2, 22; d: no solution;
e: subtraction, 117 – 42; f: $|x - 47| = 21$, $|47 - x| = 21$;
g: (*i*) $|x - 4| = 12$ or $|4 - x| = 12$, (*ii*) $|x + 9| = 15$ or $|-9 - x| = 15$

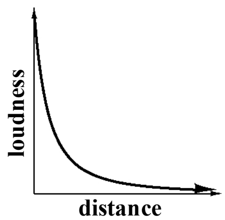
4-106. There is no difference. It doesn't matter which one you use.

4-107. $y \approx 2(x-5)^2 + 2$ and $y \approx -\frac{1}{2}(x-5)^2 + 2$

4-108. graph shown at right



x-intercepts: (–10, 0), (8, 0), y-intercept: (0, –80)
vertex: (–1, –81)
equation in graphing form: $y = (x+1)^2 - 81$

4-109. a: 

b: Loudness depends on distance

4-110. a: $8\sqrt{3}$, b: $3\sqrt{x}$, c: 12, d: 108

4-111. yes, when $n = 117$

Lesson 4.2.4

4-119. a: $y = -\frac{3}{4}(x-2)^2 + 3$, b: $x = -\frac{2}{9}(y-3)^2 + 2$

4-120. After x is factored out, a quadratic equation is the other factor. After using the Quadratic Formula the solutions are $\frac{-23 \pm \sqrt{561}}{8}$ and 0.

4-121. a: x-intercept: (–1, 0), y-intercept: (0, 2), vertex: (–1, 0), equation: $y = 2(x+1)^2$
b: x-intercepts: (0, 0) and (2, 0), y-intercept: (0, 0), vertex: (1, 1), equation: $y = -(x-1)^2 + 1$

4-122. a: slope 1, distance $\sqrt{32} = 4\sqrt{2} \approx 5.66$; b: slope $\frac{1}{2}$, distance $\sqrt{45} = 3\sqrt{5} \approx 6.71$; c: slope $\frac{37}{28}$, distance $\sqrt{2153} \approx 46.40$; d: slope 1, distance $\sqrt{1250} = 25\sqrt{2} \approx 35.36$

4-123. a: $y = x$, b: $(\frac{1}{2}, \frac{1}{3})$, c: $(\frac{1}{2}, \frac{1}{3})$,
d: The solution to the system is the point at which the lines intersect.

4-124. a: x-intercepts: (2, 0) and (6, 0), y-intercept: (0, 2), vertex: (4, –2), domain: all real numbers, range: $y \geq -2$
b: x-intercepts: (–4, 0) and (2, 0), y-intercept: (0, 2), vertex: (–1, 3), domain: all real numbers, range: $y \leq 3$

4-125. a: –2, b: –2, c: $\frac{1}{2}$, d: –1,
e: The product of the slopes of any two perpendicular lines is –1.

4-126. a: $x = 21$, b: $x = 10\sqrt{5} \approx 22.4$, c: $x = 50$

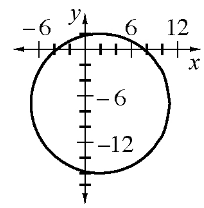
4-127. a: $\frac{1}{4}$, b: $\frac{1}{3}$

Lesson 4.3.1

4-135. a: $(-3, 6)$, $y = (x+3)^2 + 6$; b: $(2, 5)$, $y = (x-2)^2 + 5$;
c: $(-4, -16)$, $y = (x+4)^2 - 16$; d: $(-2.5, -8.25)$, $y = (x+2.5)^2 - 8.25$

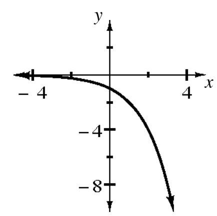
4-136. $\frac{b^2}{4}$

4-137. a: a circle
b: The center is $(2, -7)$, and the radius is 9 units long.
c: See graph at right.
No, it is not a function, because there are two outputs for every input between –7 and 11.

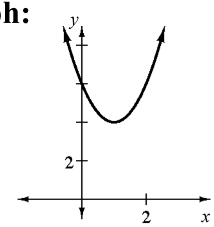


4-138. The second graph shifts the first 5 units left and 7 units up and stretches it by a factor of 4.

4-139. The second graph is a reflection of the first across the x-axis:



4-140. graph:



a: $y = 2x^2 - 4x + 6$
b: There is no difference, but explanations vary.
c: $y = x^2$
d: $y = x^2$

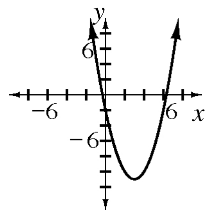
4-141. a: x-intercept: $(-3, 0)$, y-intercept: $(0, 27)$; b: x-intercept: none, y-intercept: $(0, 2)$

4-142. a: $h(3) = \frac{1}{5}$; b: $h(-3) = -1$; c: $h(a-2) = \frac{1}{a}$

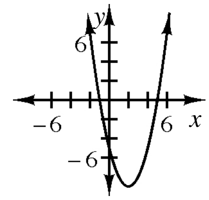
4-143. Some possibilities are $(0, -9)$ and $(6, -5)$.

Lesson 4.3.2

4-148. a: $y = (x-3)^2 - 11$



b: $y = (x-2)^2 - 9$



4-149. $y = (x-2.5)^2 + 0.75$, vertex (2.5, 0.75)

4-150. Maximum profit is $25 million when n = 5 million.

4-151. He is incorrect. Justifications vary.

4-152. $f(x) = x^2 + 1$

4-153. ± 11, ± 9, ± 19

4-154. Answers vary.

4-155. a: $x^2 - 1$
b: $2x^3 + 4x^2 + 2x$
c: $x^3 - 2x^2 - x + 2$
d: y-intercept: $(0, 2)$, x-intercepts: $(1, 0)$, $(-1, 0)$, $(2, 0)$