**b)** Knowing the axis of symmetry and direction of opening is not enough to know the number of $x$-intercepts because the vertex may be above, on, or below the $x$-axis and so may have two, one, or no $x$-intercepts. Examples may vary.

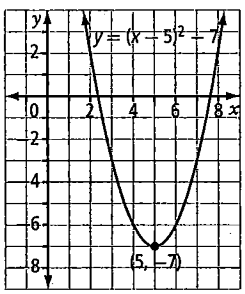
**12.** $y = \frac{4ac - b^2}{4a}$. Explanations may vary.

## 3.3 Completing the Square, pages 137–141

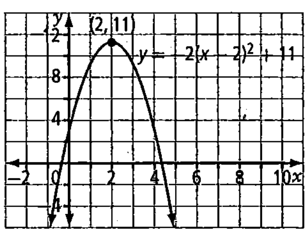
**1.** **a)** $y = (x + 1)^2 + 2$; vertex $(-1, 2)$
**b)** $y = (x + 6)^2 - 16$; vertex $(-6, -16)$
**c)** $y = -(x - 4)^2 + 9$; vertex $(4, 9)$
**d)** $y = -(x + 5)^2 - 6$; vertex $(-5, -6)$

**2.** **a)** $y = 2(x + 2)^2 - 7$; vertex $(-2, -7)$
**b)** $y = 5(x - 6)^2 - 14$; vertex $(6, -14)$
**c)** $y = -4(x - 3)^2 + 15$; vertex $(3, 15)$
**d)** $y = -7(x + 3)^2 + 66$; vertex $(-3, 66)$

**3.** **a)** $y = (x - 5)^2 - 7$




**b)** $y = -2(x - 2)^2 + 11$




**4.** **a)** not quadratic
**b)** quadratic; $y = -2x^2 + 4x + 28$ with vertex $(1, 30)$
**c)** quadratic; $y = 2x^2 - 19x + 41$ with vertex $\left(\frac{19}{4}, -\frac{33}{8}\right)$
**d)** not quadratic

**5.** **a)** Expanding $y = (x + 1)^2 - 36$ leads to the function $y = x^2 + 2x - 35$. Completing the square on $y = x^2 + 2x - 35$ results in $y = (x + 1)^2 - 36$. Also, the graphs of the two functions appear identical.

**b)** Expanding $y = -2(x - 4)^2 + 3$ leads to the function $y = -2x^2 + 16x - 29$. Completing the square on $y = -2x^2 + 16x - 29$ results in $y = -2(x - 4)^2 + 3$. Also, the graphs of the two functions appear identical.

**c)** Expanding $y = \frac{1}{2}(x - 5)^2 - 4$ leads to the function $y = \frac{1}{2}x^2 - 5x + \frac{17}{2}$. Completing the square on $y = \frac{1}{2}x^2 - 5x + \frac{17}{2}$ results in $y = \frac{1}{2}(x - 5)^2 - 4$. Also, the graphs of the two functions appear identical.

**6.** **a)** minimum of $-6.33$ at $x = 0.67$
**b)** minimum of $-2$ at $x = 6$
**c)** maximum of 7 at $x = 4$
**d)** minimum of 0.99 at $x = 0.06$

**7.** 80 components

**8.** **a)** The maximum height is 22 m after 2 s.
**b)** Answers may vary.
**c)** The maximum height is 22.39 m. Answers may vary.

**9.** **a)** $r = (12 + x)(500 - 25x)$, where $x$ is the number of \$1 price increases and $r$ is the sales revenue
**b)** $r = -25(x - 4)^2 + 6400$
**c)** The vertex represents the number of \$1 price increases that yields the maximum revenue.
**d)** There should be 4 increases of \$1, so the price of the product should be \$16 to obtain a maximum revenue of \$6400.

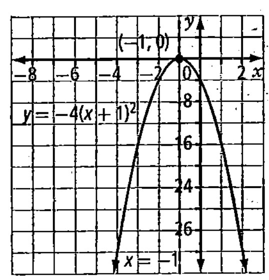
**10.** **a)** $2l + 10w = 100$
**b)** Answers may vary. Example: $l = -5w + 50$
**c)** $A = w(-5w + 50)$ **d)** $(5, 125)$
**e)** The length should be 25 m and each width should be 5 m.

## Chapter 3 Review, pages 142–144

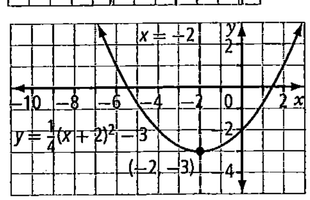
**1.** **a)** two $x$-intercepts, $x = -5$, domain $\{x \mid x \in R\}$, range $\{y \mid y \leq 6, y \in R\}$
**b)** one $x$-intercept, $x = 8$, domain $\{x \mid x \in R\}$, range $\{y \mid y \geq 0, y \in R\}$

**2.** **a)** $(3, -7)$; maximum value is $-7$
**b)** $(-11, 8)$; minimum value is 8

**3.** **a)**




**b)**

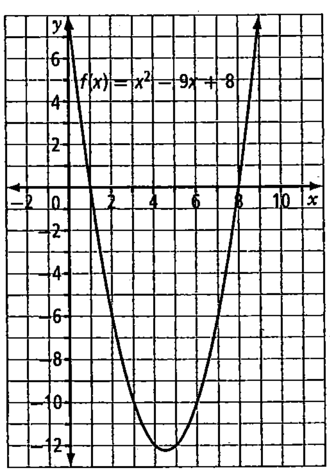


4. a) $y = -\frac{5}{16}x^2$ b) $y = -\frac{5}{16}(x-4)^2 + 5$
   c) Answers may vary. Example: The value of $a$ is the same but the values of $p$ and $q$ change.
5. a) (−4, 0), (2, 0), (0, −8)
   b) (−9, 0), (−1, 0), (0, 9)
6. a) $-\frac{3}{2}$ b) $-\frac{5}{6}$
7. a) $x = -5$, opens downward
   b) $x = \frac{2}{3}$, opens upward
8. a) $y = (x + 3)^2 + 6$, domain $\{x \mid x \in \mathrm{R}\}$, range $\{y \mid y \geq 6, y \in \mathrm{R}\}$
   b) $y = -3(x + 6)^2 + 8$, domain $\{x \mid x \in \mathrm{R}\}$, range $\{y \mid y \leq 8, y \in \mathrm{R}\}$
   c) $y = 2(x - 4)^2 - 10$, domain $\{x \mid x \in \mathrm{R}\}$, range $\{y \mid y \geq -10, y \in \mathrm{R}\}$
   d) $y = \frac{1}{2}(x - 1)^2 + \frac{5}{2}$, domain $\{x \mid x \in \mathrm{R}\}$, range $\left\{y \mid y \geq \frac{5}{2}, y \in \mathrm{R}\right\}$
9. a) (10, 105)
   b) The maximum profit of $105 occurs on the 10th day of sales.
10. a) $r = (10 + v)(120 - 5v)$
    b) The maximum revenue of $1445 occurs at a price of $17.

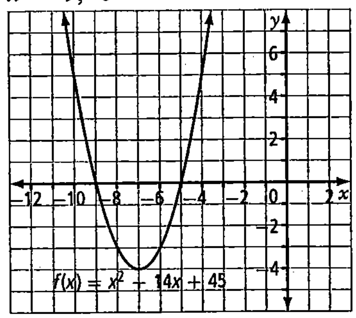
# Chapter 4

## 4.1 Graphical Solutions of Quadratic Equations, pages 151–155

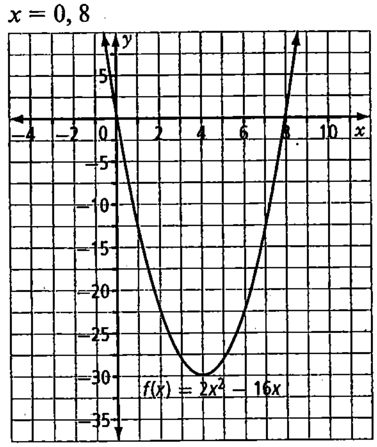
1. a) 2, because there are two $x$-intercepts; $x = -2, 2$
   b) 0, because there are no $x$-intercepts; no root
   c) 2, because there are two $x$-intercepts; $x = 0, 3$
   d) 1, because there is one $x$-intercept; $x = -5$
2. a) $x = 1, 8$



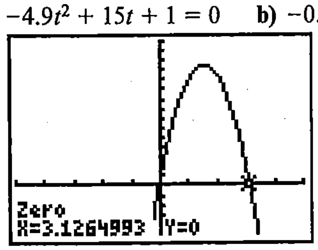

   b) $x = -9, -5$



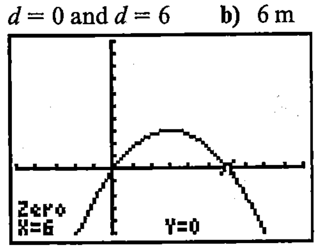

   c) $x = 0, 8$




3. a) −3, 3.33 b) −2.67, 0.75
   c) 1.5, 2.67 d) −3, −2.75
4. 4 and 8
5. a) $-4.9t^2 + 15t + 1 = 0$ b) −0.1, 3.1




   c) A negative number to represent time does not make sense in this problem.
6. a) $d = 0$ and $d = 6$ b) 6 m




7. a) $-\frac{w^2}{9} + \frac{4w}{3} = 0$ b) 12.0 m