c) $E\left(\frac{8}{11}, \frac{74}{11}\right)$;

$AE = \frac{20\sqrt{10}}{11} \doteq 5.749\,595\,746$ units;

$EC = \frac{35\sqrt{10}}{11} \doteq 10.061\,792\,56$ units;

$BE = \frac{25\sqrt{2}}{11} \doteq 3.214\,121\,733$ units;

$ED = \frac{140\sqrt{2}}{11} \doteq 17.999\,081\,7$ units;

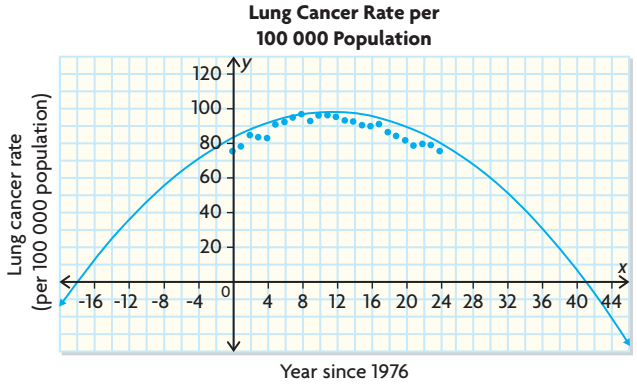
$AE \times EC = \frac{7000}{121} \doteq 57.851\,239\,7$ units;

$BE \times ED = \frac{7000}{121} \doteq 57.851\,239\,7$ units;

$AE \times EC = BE \times ED$, so AC and BD are chords of the same circle. This confirms that $ABCD$ is cyclic.

d) Any square, rectangle, or isosceles trapezoid is cyclic. Kites can be cyclic if and only if they have two right angles.

27. a)



b) Answers may vary, e.g., zeros may occur at $(-18, 0)$ and $(41, 0)$. Point $(17, 95)$ lies on the curve.

$$y = a(x + 18)(x - 41)$$
$$95 = a(17 + 18)(17 - 41)$$
$$95 = -840a$$
$$-\frac{95}{840} = a$$
$$-0.113\,095 \doteq a$$
$$y = -0.113\,095(x + 18)(x - 41)$$

c) regression equation of the curve of best fit: $y = -0.1358x^2 + 3.0681x + 77.3089$; equation of the curve of good fit: $y = -0.113\,095x^2 + 2.601\,185x + 83.464\,11$

d) If the trend continues, lung cancer rates in Canadian males will continue to decrease.

Chapter 4

Getting Started, page 194

1. **a)** i **b)** iv **c)** v **d)** vi **e)** vii **f)** iii **g)** ii **h)** viii

2. **a)** $-x + 2y$ **b)** $-9a^2 + 9b^2$ **c)** $4x - 4y + 4$ **d)** $-a - ab - 4b$

3. **a)** $14x - 35$ **b)** $-15x^3 + 20x^2 - 25x$ **c)** $-8x^2 + 12x + 2$ **d)** $d^2 - 4d - 12$ **e)** $12a^2 - 37ab + 21b^2$ **f)** $24x^3 + 24x^2 + 6x$

4. **a)** $4(2x + 5) = 8x + 20$

b) $2x(2x + 2) = 4x^2 + 4x$

c) $(x + 2)(3x + 2) = 3x^2 + 8x + 4$

d) $(x - 2)(3x + 2) = 3x^2 - 4x - 4$

5. **a)** x^{12} **b)** $-36a^7$ **c)** 6 **d)** $5z^4$

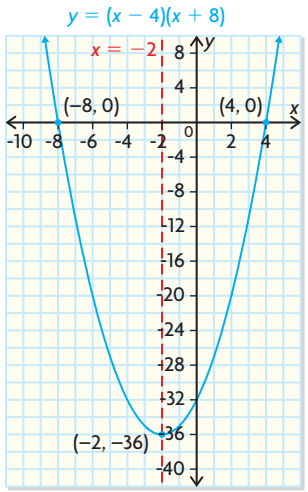
6. Answers may vary, e.g.,

a) $5x^3$ **b)** $4a + 6b$ **c)** $2x + 3y + 4$ **d)** $x^2 - 8x + 9$

7. **a)** 7 **b)** 9 **c)** 9 **d)** 4 **e)** 5 **f)** 6

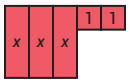
8. **a)** x-intercepts: 4, -8; equation of the axis of symmetry: $x = -2$; vertex: $(-2, -36)$

b)

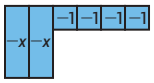


c) $y = x^2 + 4x - 32$

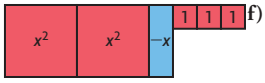
9. **a)**



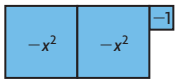
b)



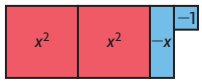
c)



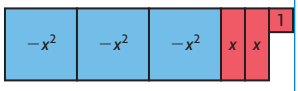
d)



e)

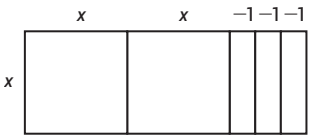


f)

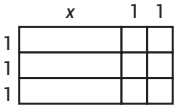


10. **a)** iii **b)** ii **c)** i

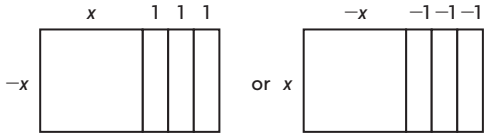
11. **a)**



b)

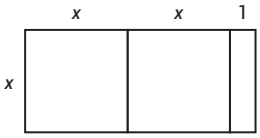


c)



Answers

d)



12. Answers may vary, e.g.,

a) Agree. All even numbers are divisible by 2, and 2 is a prime number.

b) Disagree. $6x^2y^3$ cannot be factored.
Agree. $6x^2y^3$ can be written many ways, such as $(6x^2)(y^3)$, $(2x)(3xy^3)$, $(3x)(y)(2xy^2)$, and $(2y^3)(3x)(x)$.

c) Disagree. There are many other ways to factor 100, such as 2×50, 4×25, 5×20, and $2 \times 2 \times 5 \times 5$.

Lesson 4.1, page 202

1. **a)** **i)** $4x^2 - 12x$, $2x$ **ii)** $4x$
b) **i)** $-6x^2 + 12x$, $3x$ **ii)** $6x$

2. **a)** **i)** $4x + 16$, 4 **ii)** $-4, 2, -2, 1, -1$
b) **i)** $6x^2 + 8x$, $2x$ **ii)** $-2x, x, -x, 2, -2, 1, -1$

3. **a)** $2x$ **b)** $5a^2$ **c)** ab **d)** $2x^3y^4$

4. **a)** 3 **b)** x **c)** xy **d)** $x - 1$

5. **a)** 4 **c)** $3x^2z$ **e)** $-4x^3$
b) -2 **d)** $-7a^2b^2$ **f)** $-6n^2$

6. **a)** 4 **c)** 5 **e)** -6
b) $4x - y$ **d)** $9x^2 - 8y^3$ **f)** $5a - 6$

7. **a)** 7 **c)** 4 **e)** $3d^2$
b) $3b$ **d)** $-5m$ or $5m$ **f)** y^2

8. **a)** $3(3x^2 - 2x + 6)$ **d)** $(b + 4)(2b + 5)$
b) $5a(5a - 4)$ **e)** $(c - 3)(4c - 5)$
c) $9y^3(3 - y)$ **f)** $(3x - 5)(2x + 1)$
Answers may vary, e.g., for part b), I determined the greatest number that divides into both 25 and 20, and I looked for the common factor of a^2 and a. I determined the GCF to be $5a^2$, and then I determined what I had to multiply $5a^2$ by to get the given binomial.

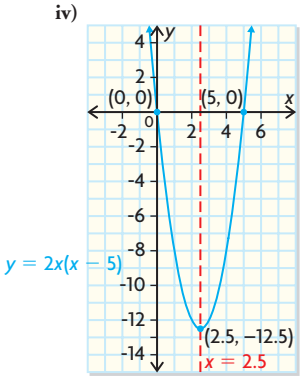
9. **a)** $d(c^2 - 2ac + 3a^2)$
b) $-5ac(2a - 4 + c^2)$ or $5ac(-2a + 4 - c^2)$
c) $5(2ac^2 - 3a^2c + 5)$
d) $2a^2c^2(c^2 - 2ac + 3a^2)$
e) $ac(3a^4c^2 - 2c + 7)$
f) $2cd(5c^2 - 4d + 1)$
The polynomials in parts a) and d) have the same trinomial factor.

10. **a)** $(x - y)(a + b)$ **d)** $(5y + t)(m + n)$
b) $(2x + 1)(5x - 3y)$ **e)** $(x - 2)(5w - 3t)$
c) $(x + y)(3m + 2)$ **f)** $(t - 4)(4mn - 1)$

11. 20

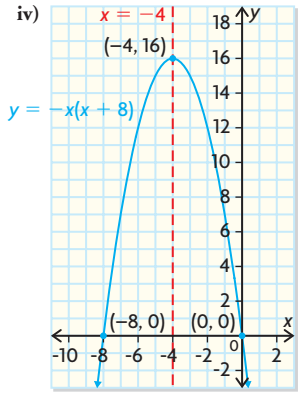
12. **a)** **i)** $y = 2x(x - 5)$
ii) zeros: 0, 5;
equation of the axis of symmetry:
$x = 2.5$
iii) vertex: $(2.5, -12.5)$

iv)



b) **i)** $y = -x(x + 8)$
ii) zeros: 0, −8;
equation of the axis of symmetry:
$x = -4$
iii) vertex: $(-4, 16)$

iv)



13. $2(lw + wh + lh)$, where l = length, w = width, and h = height

14. 100

15. **a)** Answers may vary, e.g., $20x + 5x^2 = 5x(4 + x)$, $10x^2 - 5x = 5x(2x - 1)$, $5x^2 + 50xy = 5x(x + 10y)$
b) Answers may vary, e.g., $3x^2 - 6x + 3xy = 3x(x - 2 + y)$, $9x^2 + 12x - 6xy = 3x(3x + 4 - 2y)$, $6x^2 + 3x - 3ax = 3x(2x + 1 - a)$

16. $-5x^3 + 10x^2 - 20x$ can be factored as either $-5x(x^2 - 2x + 4)$ or $5x(-x^2 + 2x - 4)$. Since both expressions are equivalent, $-5x$ and $5x$ are both acceptable greatest common factors.

17. Let x, $(x + 1)$, and $(x + 2)$ be the three consecutive integers.
$x^2 + (x + 1)^2 + (x + 2)^2 + 1$
$= x^2 + (x^2 + 2x + 1) + (x^2 + 4x + 4) + 1$
$= 3x^2 + 6x + 6$
$= 3(x^2 + 2x + 2)$
Since 3 is a common factor, the result must be divisible by 3.

18. You can expand the factored expression using the distributive property. Expanding is the opposite of factoring, so if you expand your factors correctly and get the same expression you started with, you will know that your factors are correct.

19. $r^2(4 - \pi)$

20. **a)** $\dfrac{xy(2x + 3y)}{xy} = 2x + 3y$

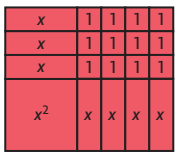
b) $\dfrac{6x^3y(1 + 2y)}{6x^3y} = 1 + 2y$

c) $\dfrac{-6x^2y^2(2x + 3y)}{6x^2y^2} = -(2x + 3y)$
or $\dfrac{6x^2y^2(-2x - 3y)}{6x^2y^2} = -2x - 3y$

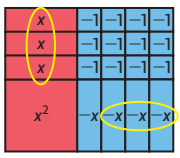
d) $\dfrac{3x^2(x^2 + 2x + 3)}{3x^2} = x^2 + 2x + 3$

Lesson 4.2, page 206

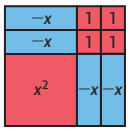
1. **a)** $(x + 3)$, $(x + 4)$



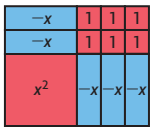
b) $(x + 3)$, $(x - 4)$
Equivalent added tiles are circled.



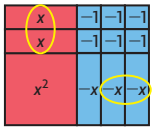
c) $(x - 2), (x - 2)$



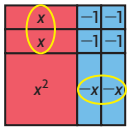
e) $(x - 2), (x - 3)$



d) $(x + 2), (x - 3)$
Equivalent added tiles are circled.

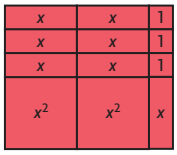


f) $(x + 2), (x - 2)$
Equivalent added tiles are circled.

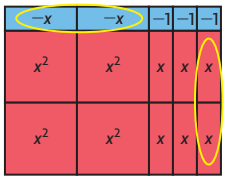


2. **a)** $(x + 3)(x + 4) = x^2 + 7x + 12$
b) $(x + 3)(x - 4) = x^2 - x - 12$
c) $(x - 2)(x - 2) = x^2 - 4x + 4$
d) $(x + 2)(x - 3) = x^2 - x - 6$
e) $(x - 2)(x - 3) = x^2 - 5x + 6$
f) $(x + 2)(x - 2) = x^2 - 4$

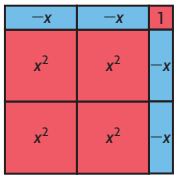
3. **a)** $(x + 3), (2x + 1)$



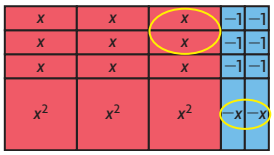
b) $(2x - 1), (2x + 3)$
Equivalent added tiles are circled.



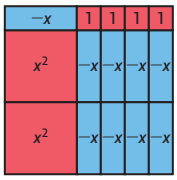
c) $(2x - 1), (2x - 1)$



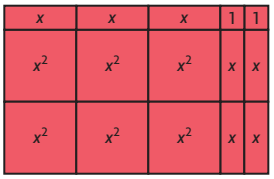
d) $(x + 3), (3x - 2)$
Equivalent added tiles are circled.



e) $(2x - 1), (x - 4)$



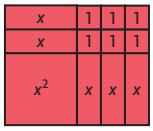
f) $(2x + 1), (3x + 2)$



4. **a)** $(x + 3)(2x + 1) = 2x^2 + 7x + 3$
b) $(2x - 1)(2x + 3) = 4x^2 + 4x - 3$
c) $(2x - 1)(2x - 1) = 4x^2 - 4x + 1$
d) $(x + 3)(3x - 2) = 3x^2 + 7x - 6$
e) $(2x - 1)(x - 4) = 2x^2 - 9x + 4$
f) $(2x + 1)(3x + 2) = 6x^2 + 7x + 2$

Lesson 4.3, page 211

1. **a)** $x^2 + 5x + 6$
b)



c) $(x + 3), (x + 2)$

2. **a)** $x^2 - x - 6 = (x - 3)(x + 2)$
b) $x^2 - 7x + 12 = (x - 4)(x - 3)$

3. **a)** $(x - 3)$ **b)** $(x + 8)$ **c)** $(x - 9)$ **d)** $(x + 5)$

4. **a)** $(x + 1)(x + 1)$
b) $(x - 1)(x - 1)$
c) $(x - 3)(x + 1)$
d) $(x + 3)(x + 3)$
e) $(x - 2)(x - 2)$
f) $(x - 6)(x + 2)$

5. **a)** $x^2 + 3x - 10 = (x + 5)(x - 2)$
b) $x^2 - 4x + 4 = (x - 2)(x - 2)$

6. **a)** $(x + 8)$
b) $(c - 8)$
c) $(a + 4)$
d) $(y - 22)$
e) $(b - 6)$
f) $(z - 9)$

7. **a)** $(x + 3)(x + 1)$
b) $(a - 5)(a - 4)$
c) $(m - 4)(m - 4)$
d) $(n + 3)(n - 2)$
e) $(x + 8)(x - 2)$
f) $(x + 16)(x - 1)$

8. **a)** $(x - 8)(x - 2)$
b) $(y + 10)(y - 4)$
c) $(a - 8)(a + 7)$
d) $(w - 7)(w + 2)$
e) $(m - 8)(m - 4)$
f) $(n + 7)(n - 6)$

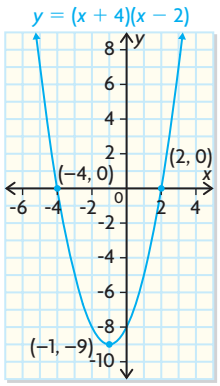
9. **a)** $3(x + 3)(x + 5)$
b) $2(y + 5)(y - 6)$
c) $3(v + 1)(v + 2)$
d) $6(n - 1)(n + 5)$
e) $x(x + 4)(x + 1)$
f) $7x^2(x + 7)(x - 3)$

10. Answers may vary, e.g.,
$x^2 - x - 2 = (x - 2)(x + 1)$;
$x^2 - 6x + 8 = (x - 2)(x - 4)$;
$x^2 - 4x + 4 = (x - 2)(x - 2)$

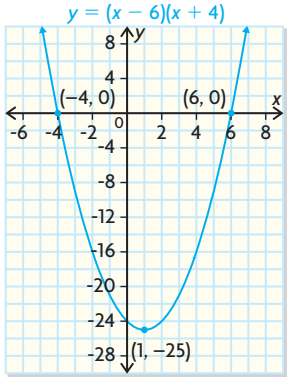
11. Answers may vary, e.g., Martina factored $x^2 - 15x + 44$ as $(4 - x)(11 - x)$. I can see that both answers are correct by multiplying each factor by -1, which gives $(-4 + x)(-11 + x)$ or $(x - 4)(x - 11)$. Since I multiplied twice by -1, and since $(-1)(-1) = 1$, I have not changed the value of the answer.

12. **a)** $(a + 3)(a + 5)$
b) $3(x - 9)(x + 2)$
c) $(z - 11)(z - 5)$
d) $(x + 10)(x - 5)$
e) $x(x - 5)(x + 2)$
f) $2x(y - 6)(y - 7)$

13. **a)** **i)** $y = (x + 4)(x - 2)$
ii) $x = -4, 2$
iii) $(-1, -9)$
iv)

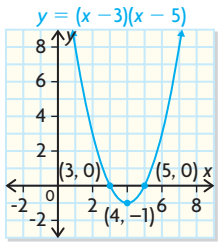


b) **i)** $y = (x - 6)(x + 4)$
ii) $x = 6, -4$
iii) $(1, -25)$
iv)



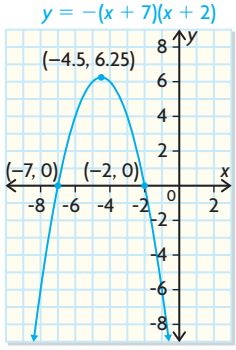
c) i) $y = (x - 3)(x - 5)$
ii) $x = 3, 5$
iii) $(4, -1)$

iv)

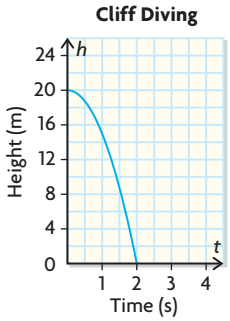


d) i) $y = -(x + 7)(x + 2)$
ii) $x = -7, -2$
iii) $(-4.5, 6.25)$

iv)



14. a)



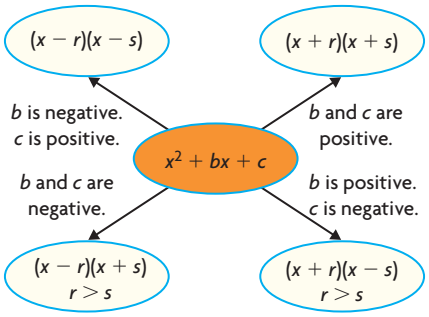
b) 20 m
c) 2 s

15. 45 m

16. a) $(m - n)(m + 5n)$
b) $(x + 7y)(x + 5y)$
c) $(a - 3b)(a + 4b)$
d) $(c - 17d)(c + 5d)$
e) $(r + s)(r + 12s)$
f) $(6p - q)(3p - q)$

17. Agree. Answers may vary, e.g., since c is negative, one factor must be positive and the other factor must be negative. Suppose that the factors are r and $-s$. If $r + (-s) = -b$, then, by multiplying each side by -1, I can show that $-r + s = b$. Therefore, the factors for $x^2 - bx - c$ and the factors for $x^2 + bx - c$ have opposite signs. For example, $(x + 2)(x - 4) = x^2 - 2x - 8$ and $(x - 2)(x + 4) = x^2 + 2x - 8$.

18. Answers may vary, e.g.,



19. a) $(x^2 + 9)(x^2 - 3)$
b) $(a^2 + 9)(a^2 + 1)$
c) $-4(m^2 - 5n^2)(m^2 + n^2)$
d) $(a - b - 13)(a - b - 2)$

20. a) $\frac{(x - 4)(x - 2)}{(x - 4)} = x - 2$
b) $\frac{(a + 4)(a - 7)}{(a + 4)} = a - 7$
c) $\frac{(x - 5)(x + 6)}{(x - 5)} = x + 6$
d) $\frac{2(x - 8)(x - 4)}{2(x - 8)} = x - 4$

Mid-Chapter Review, page 216

1. a) 12
b) x^2
c) $5y$
d) $-4ab$
e) c^3d
f) $9m^2n^2$

2. a) 7
b) $2x - 3y$
c) 12
d) $x - y^3$
e) -3
f) $ab - 1$

3. a) $9x + 6$, GCF $= 3$
b) $-4x^2 + 12x$, GCF $= -4x$

4. a) $7(z + 5)$
b) $-4x^2(7 - x)$
c) $5(m^2 - 2mn + 1)$
d) $xy(xy^3 - y + x^2)$

5. Answers may vary, e.g., factor the right side of the equation to get $5x(x - 3)$. Determine the zeros from the factors: $x = 0$ and $x = 3$. The x-value of the vertex must be halfway between these two numbers, so the vertex is at $x = 1.5$. Substitute this value into the original equation to determine the y-value of the vertex: $y = 5(1.5)^2 - 15(1.5) = -11.25$. The vertex is at $(1.5, -11.25)$.

6. a) $(5y - 2)(3x + 5)$
b) $(b + 6)(4a - 3)$
c) $(2x - 1)(3t - y)$
d) $(b + c)(4a - b)$

7. a) $x^2 + 6x + 8 = (x + 2)(x + 4)$
b) $x^2 - 2x - 3 = (x - 3)(x + 1)$

8. a) ■ $= 4$; ◆ $= 7$
b) ■ $= 6$; ◆ $= 9$
c) ■ $= 36$; ◆ $= 6$
d) ■ $= 4$; ◆ $= 12$

9. a) $(x - 3)(x + 11)$
b) $(n - 2)(n + 9)$
c) $(b - 11)(b + 1)$
d) $(x - 9)(x - 5)$
e) $(c + 7)(c - 2)$
f) $(y - 9)(y - 8)$

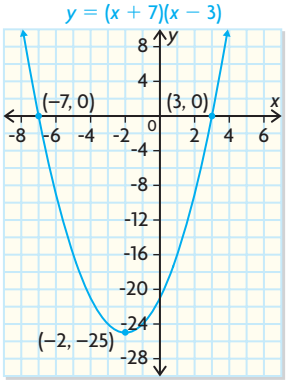
10. a) $3(a - 4)(a + 3)$
b) $x(x - 8)(x + 2)$
c) $2(x + 12)(x - 5)$
d) $4(b - 6)(b - 3)$
e) $-d(d - 6)(d + 5)$
f) $xy(y + 1)(y + 1)$

11. a) 75 m
b) 1 s
c) 80 m

12. Answers may vary, e.g., there are usually fewer factors for c to consider than there are addends for b, so it makes sense to consider the value of c first. This allows you to use a guess-and-check strategy more efficiently. Using $x^2 + 6x + 5$ as an example, there are many pairs of numbers that add up to 6 (such as 3, 3; 2, 4; 1, 5; 0, 6; -1, 7), but only one pair of numbers that multiply together to equal 5 (1, 5).

13. a) $y = (x + 7)(x - 3)$
b) zeros: -7, 3;
vertex: $(-2, -25)$

c)



Lesson 4.4, page 222

1. **a)** $2x^2 + 3x + 1$ **c)** $(2x + 1)(x + 1)$

b)

x	1
x^2	x
x^2	x

2. **a)** $2x^2 + 5x + 2 = (2x + 1)(x + 2)$
b) $6x^2 - 5x + 1 = (2x - 1)(3x - 1)$
c) $8x^2 + 26x + 15 = (2x + 5)(4x + 3)$
d) $15x^2 + 13x - 6 = (3x - 1)(5x + 6)$

3. **a)** $2c - 1$ **b)** $4z + 3$ **c)** $2y - 1$ **d)** $3p - 1$

4. **a)** ■ = 1; ◆ = 16 **c)** ■ = 1; ◆ = 1
b) ■ = 1; ◆ = 6 **d)** ■ = 4; ◆ = 12

5. **a)** $(2x - 3)(x + 2)$ **d)** $(2x - 5)(2x - 3)$
b) $(3n + 1)(n - 4)$ **e)** $(2c - 3)(c + 4)$
c) $(5a - 1)(2a + 1)$ **f)** $(3x + 1)(2x + 1)$

6. **a)** $(3x - 2)(2x - 3)$ **d)** $(2x - 5)(2x - 5)$
b) $(2m - 1)(5m + 3)$ **e)** $(5d - 4)(d - 2)$
c) $(2a - 3)(a - 4)$ **f)** $2(3n - 2)(n + 5)$

7. **a)** $(5x - 2)(3x + 2)$ **d)** $(7x + 3)(5x - 6)$
b) $(6m - 5)(3m + 2)$ **e)** $3(21n^2 + 42n + 16)$
c) $2(a - 2)(8a - 9)$ **f)** $(4d - 7)(6d - 5)$

8. Answers may vary, e.g.,
$3x^2 - x - 4 = (3x - 4)(x + 1)$
$3x^2 - 13x + 12 = (3x - 4)(x - 3)$
$6x^2 + 13x - 28 = (3x - 4)(2x + 7)$

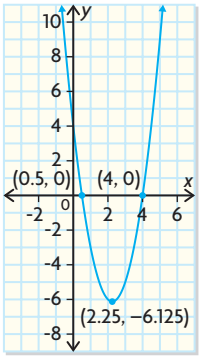
9. **a)** The length is $(6x - 1)$ and the width is $(x + 3)$, or vice versa.
b) The length is $(4x - 3)$ and the width is $(2x - 5)$, or vice versa.

10. Answers may vary, e.g.,
a) $k = 2, 3,$ or -3
b) $k = 4, 12, 44, -12,$ or -4
c) $k = 3, 7, 8,$ or -8

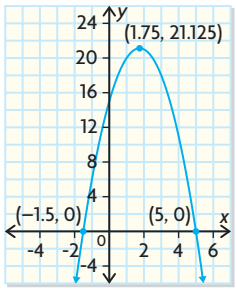
11. **a)** $2(3x - 1)(x + 6)$ **d)** $b(5b - 2)(b - 3)$
b) $3(2v + 5)(3v - 2)$ **e)** $3x(9y + 1)(y - 2)$
c) $4(2c - 5)(6c - 5)$ **f)** $-(a + 5)(7a - 6)$

12. **a)** $(k + 13)(k - 4)$; no **d)** $-(3k - 5)(5k + 2)$; no
b) $4k(k + 3)(k + 5)$; yes **e)** $(7k - 6)(k + 5)$; yes
c) $(2k + 7)(3k + 1)$; no **f)** $5(k + 5)(2k + 3)$; yes
Polynomials b), e), and f) have $(k + 5)$ as a factor.

13. **a)** **i)** $y = (2x - 1)(x - 4)$ **iv)** $y = (2x - 1)(x - 4)$
ii) $x = 0.5, 4$
iii) $(2.25, -6.125)$



b) **i)** $y = (2x + 3)(-x + 5)$ **iv)** $y = (2x + 3)(-x + 5)$
ii) $x = -1.5, 5$
iii) $(1.75, 21.125)$

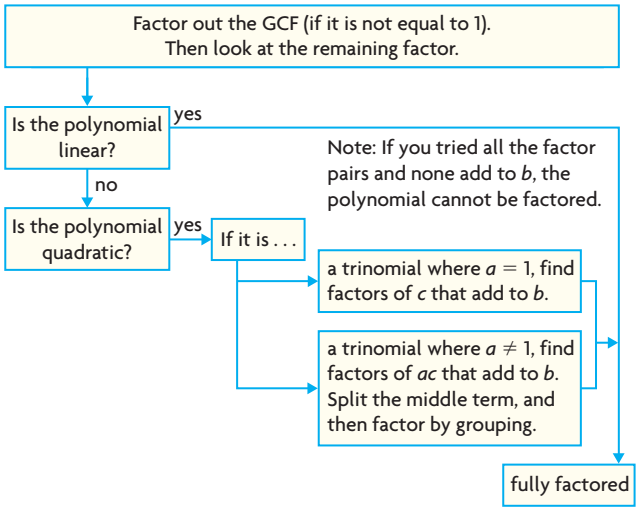


14. **a)** 0.5 hundred thousand games, 4.5 hundred thousand games
b) \$16 million
c) 2.5 hundred thousand games or 250 000 games

15. **a)** $(8x - 5y)(x - y)$ **d)** $(4c^2 + 3)(4c^2 + 13)$
b) $(5a - 2b)(a - 3b)$ **e)** $(7v^3 - 9)(2v^3 - 3)$
c) $-(4s + 7r)(3s - 5r)$ **f)** $cd(cd - 2)(cd + 4)$

16. Answers may vary, e.g.,

Factoring a Polynomial



17. **a)** $(3a + 3b + 1)(2a + 2b + 3)$
b) $(5x - 5y + 3)(x - y - 2)$
c) $(4x + 3)(2x - 1)$
d) $4(3a^2 - 12a + 10)(a^2 - 4a + 9)$

18. Yes. Answers may vary, e.g., if $b^2 - 4ac$ is a perfect square, then the expression will be factorable. For example, $6x^2 + 11x + 3$ implies that $b^2 - 4ac = 11^2 - 4(6)(3) = 49$. This is a perfect square, and the expression is factorable as $(3x + 1)(2x + 3)$.

Lesson 4.5, page 229

1. **a)** $x^2 - 9$ **c)** $(x + 3)(x - 3)$

b)

x	−1	−1	−1
x	−1	−1	−1
x	−1	−1	−1
x^2	$-x$	$-x$	$-x$

2. **a)** $9x^2 - 4 = (3x - 2)(3x + 2)$
b) $36x^2 + 60x + 25 = (6x + 5)(6x + 5)$ or $(6x + 5)^2$

3. **a)** $x - 10$ **c)** $9a + 4$ **e)** $5m - 7$
b) $n + 5$ **d)** 5 **f)** $3x - 4$

4. **a)** ◆ = 20; ■ = 5
b) ◆ = 9; ■ = 5
c) ◆ = 72; ■ = 9
d) Answers may vary, e.g., ◆ = 9; ■ = 8

5. **a)** $(x - 5)(x + 5)$ **d)** $(2c - 7)(2c + 7)$
b) $(y - 9)(y + 9)$ **e)** $(3x - 2)(3x + 2)$
c) $(a - 6)(a + 6)$ **f)** $(5d - 12)(5d + 12)$

6. **a)** $(x + 5)^2$ **c)** $(m - 2)^2$ **e)** $(4p + 9)^2$
b) $(b + 4)^2$ **d)** $(2c - 11)^2$ **f)** $(5z - 3)^2$

7. **a)** $(7a + 4)^2$ **d)** $4(a - 8)(a + 8)$
b) $(2x - 5)(2x + 5)$ **e)** $(15 - 4x)(15 + 4x)$
c) $-2(5x + 2)^2$ **f)** $(x + 2)^2$

8. **a)** $64^2 - 60^2 = (64 - 60)(64 + 60) = 4 \times 124 = 496$
b) $18^2 - 12^2 = (18 - 12)(18 + 12) = 6 \times 30 = 180$

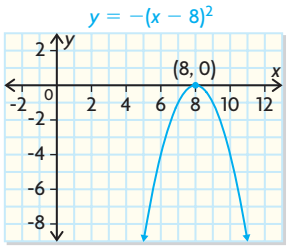
9. **a)** Answers may vary, e.g., this cannot be factored as a perfect square because the coefficient of x^2 is not a perfect square.
b) Answers may vary, e.g., this cannot be factored as a difference of squares because the coefficient of x^2 is not a perfect square. Also, since the expression has three terms, it cannot be a difference of squares.

10. **a)** $(x^2 - 6)^2$ **d)** $3(2x - 5)^2$
b) $(a - 2)(a + 2)(a^2 + 4)$ **e)** $(x^2 - 12)^2$
c) $(7x - 10)(7x + 10)$ **f)** $(17x^3 - 9)(17x^3 + 9)$

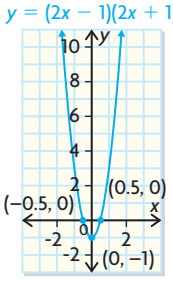
11. **a)** $(x - 8y)^2$ **d)** $(1 - 3ab^2)(1 + 3ab^2)$
b) $(6x - 5y)(6x + 5y)$ **e)** $-2(3x - 2y)^2$
c) $(4x - 9y)^2$ **f)** $2x(5x - 2y)(5x + 2y)$

12. **a)** $(x - 4 - c)(x - 4 + c)$; Answers may vary, e.g., first I noticed that $x^2 - 8x + 16$ could be factored as a perfect square. Second, I noticed that the result, $(x - 4)^2 - c^2$, could be factored as a difference of squares.
b) $(2c - a - 3b)(2c + a + 3b)$; Answers may vary, e.g., first I noticed that I could factor out a -1 term in $-a^2 - 6ab - 9b^2$, so the trinomial could be factored as a perfect square. Second, I noticed that the result, $4c^2 - (a + 3b)^2$, could be factored as a difference of squares.

13. **a)** **i)** $y = -(x - 8)^2$
ii) $x = 8$
iii) (8, 0)
iv)



b) **i)** $y = (2x - 1)(2x + 1)$
ii) $x = -0.5, 0.5$
iii) $(0, -1)$
iv)



14. **a)** $15x^2 + 44x + 21 = (3x + 7)(5x + 3)$
b) $8\pi x^2 + 10\pi x + 3\pi = \pi(2x + 1)(4x + 3)$

15. Answers may vary, e.g.,

a)

Definition: A trinomial that has identical binomial factors	Characteristics: The first and last terms are perfect squares. The product of their square roots is doubled to get the number in the middle term.
Perfect Square	
Examples: $x^2 + 6x + 9$, $4y^2 - 8yz + z^2$	Non-examples: $x^2 - 6x - 9$, $8y^2 - 8yz + z^2$

b)

Definition: A binomial that has similar binomial factors; one contains a + sign, and the other contains a − sign	Characteristics: Both terms are perfect squares, separated by a subtraction sign.
Difference of Squares	
Examples: $x^2 - 36$, $4c^2 - 9d^2$	Non-examples: $x^2 - 35$, $4c^2 + 9d^2$

16. **a)** $a^3 + b^3$
b) Any sum of cubes such as $a^3 + b^3$ can be factored into $(a + b)(a^2 - ab + b^2)$.
c) **i)** $(x + 2)(x^2 - 2x + 4)$ **iii)** $(2x + 1)(4x^2 - 2x + 1)$
ii) $(x + 3)(x^2 - 3x + 9)$ **iv)** $(3x + 2)(9x^2 - 6x + 4)$

17. **a)** $a^3 - b^3$
b) Any difference of cubes of the form $a^3 - b^3$ can be factored into $(a - b)(a^2 + ab + b^2)$.
c) **i)** $(x - 3)(x^2 + 3x + 9)$ **iii)** $(2x - 5)(4x^2 + 10x + 25)$
ii) $(x - 4)(x^2 + 4x + 16)$ **iv)** $(4x - 3)(16x^2 + 12x + 9)$

Lesson 4.6, page 236

1. **a)** trinomial; common factor
b) trinomial, $a \neq 1$; decomposition
c) polynomial with four or more terms; grouping strategy
d) binomial; difference of squares pattern
e) trinomial, $a \neq 1$; common factor, sum/product pattern
f) trinomial, $a = 1$; sum/product pattern

2. **a)** $2xy(3 + 6xy - 2x^2y^2)$ **d)** $(7y - 3)(7y + 3)$
b) $(5x - 1)(4x + 3)$ **e)** $3(x + 5)(x - 6)$
c) $(3x - 2)(x + a)$ **f)** $(x - 6)(x - 7)$

3. Answers may vary, e.g.,
a) **i)** $x^2 - 6x + 9$
ii) $x^2 + 11x - 12$
iii) $4x^2 - 36y^2$
iv) $10x^2 - x - 2$
v) $4m^2 + 8$
vi) $3ab + 6a - 4b - 8$
b) **i)** $x^2 - 6x + 9 = (x - 3)^2$
ii) $x^2 + 11x - 12 = (x - 1)(x + 12)$
iii) $4x^2 - 36y^2 = (2x - 6y)(2x + 6y)$
iv) $10x^2 - x - 2 = (2x - 1)(5x + 2)$
v) $4m^2 + 8 = 4(m^2 + 2)$
vi) $3ab + 6a - 4b - 8 = (3a - 4)(b + 2)$

4. **a)** ◆ = 2; ■ = 3
b) ◆ = 2; ■ = 9
c) ◆ = 49; ■ = 5; ● = 7
d) ● = 11; ■ = 5; ◆ = 3

5. Answers may vary, e.g., ▲ = 3; ● = 5; ■ = 1; ◆ = 2

6. **a)** $(4x - 5)(4x + 5)$
b) $-3b^2(2a + 3b - 5)$
c) $(c - 7)(c - 5)$
d) $(7d + 1)^2$
e) $(6x - 7)(2x + 3)$
f) $(2w - 5)(z + 3)$

7. **a)** $(5x - 1)(2x + 1)$
b) $(12a^2 - 11)(12a^2 + 11)$
c) $(8c + 7)(3a - 1)$
d) $x(x - 9)(x - 2)$
e) $2(3x + 5)^2$
f) $y(x - 2)(x + 2)$

8. **a)** $2(s - 1)(s + 3)$
b) $(7 + w)(2 - w)$
c) $(z - 3)(z + 3)(z - 2)(z + 2)$
d) $2(2s - 5r)(2s + 5r)$
e) $(6 - 7g)^2$
f) $(x + 5 - 4y)(x + 5 + 4y)$

9. **a)** $x^2 - 1$ can be factored as $(x - 1)(x + 1)$.
b) $x^2 - 9x + 20$ can be factored as $(x - 5)(x - 4)$.
c) The coefficients of the $(5x + 2y)$ terms can be grouped to get $(5x + 2y)(3x - 1)$.
d) $16a^4 - b^4$ can be factored as $(2a - b)(2a + b)(4a^2 + b^2)$.

10. **a)** $(x - t)(y + s)$
b) $(4y - 5x)(4y + 5x)$
c) $(a - 2)(a + 2)(a - 3)(a + 3)$
d) $(x - y - 1)(x + y + 1)$
e) $(2a + 2b + 3)(a + b + 1)$
f) $x(3x + 7)(2x - 9)$

11. **a)** length = $4x + 7$ and width = $2x + 1$, or vice versa
b) length = 19 cm and width = 7 cm, or vice versa; area = 133 cm^2

12. **a)** radius = $x + 5$
b) radius = 15 cm; area = 225π cm^2 (about 707 cm^2)

13. **a)** The three dimensions are $2x$, $x + 4$, and $x + 3$.
b) 10 cm, 9 cm, 8 cm; volume = 720 cm^3

14. **a)** No. The expression can be factored as $3xy(3x - 1)$.
b) Yes. The expression can be factored as $x(x + y)(x - y)(x^2 + 1)$.
c) No. The expression can be factored as $2y(x - 3)(x - 1)$.
d) Yes. The expression can be factored as $(x + y)(x + 3)(x + 2)$.

15. Answers may vary, e.g.,

Factoring a Polynomial

Factor out all common monomial factors.

↓

Check for a difference of squares:
$a^2 - b^2 = (a - b)(a + b)$

↓

Check for a perfect square:
$a^2 + 2ab + b^2 = (a + b)^2$ or
$a^2 - 2ab + b^2 = (a - b)^2$

↓

Check for the form:
$x^2 + bx + c = (x + r)(x + s)$, where $rs = c$ and $r + s = b$

↓

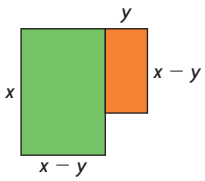
Check for the form:
$ax^2 + bx + c = (px + r)(qx + s)$,
where $pq = a$, $rs = c$, and $ps + qr = b$

↓

If there are four or more terms, try a grouping strategy.

16. **a)** $\left(\frac{x}{3} - \frac{1}{2}\right)\left(\frac{x}{3} + \frac{1}{2}\right)$
b) $(10 - a + 5)(10 + a - 5)$
c) No factoring is possible.
d) $\left(\frac{5a}{8} - \frac{3b}{7}\right)\left(\frac{5a}{8} + \frac{3b}{7}\right)$
e) $(x + y)(x - y + 6)$
f) $[2(c - 5)^2 + 3]^2$ or $(2c^2 - 20c + 53)^2$

17. Answers may vary, e.g., I divided the remaining area into two parts as follows:



The large rectangle has an area of $x(x - y)$, and the small rectangle has an area of $y(x - y)$. Adding these areas gives $(x + y)(x - y)$. Since the combined area is equal to the area of the large square minus the area of the small square, $x^2 - y^2 = (x + y)(x - y)$.

Chapter Review, page 240

1. **a)** $6x - 9 = 3(2x - 3)$
b) $2x^2 + 8x = 2x(x + 4)$

2. **a)** $4x(5x - 1)$
b) $3(n^2 - 2n + 5)$
c) $-2x(x^2 - 3x - 2)$
d) $(3 - 7a)(6a - 5)$

3. **a)** Answers may vary, e.g., length = 8 and width = $2x^2 - 3$, or vice versa
b) Yes. The area expression may be factored differently to give different dimensions; for example, length = 2 and width = $8x^2 - 12$, or length = $4x^2 - 6$ and width = 4.

4. **a)** Answers may vary, e.g., $4x^3y + 12x^4yz$; $16x^3yz + 12x^3y$; $8x^5y^2 - 4x^3yz + 40x^3y^3$
b) $4x^3y + 12x^4yz = 4x^3y(1 + 3xz)$; $8x^5y^2 - 4x^3yz + 40x^3y^3 = 4x^3y(2x^2y - z + 10y^2)$; $16x^3yz + 12x^3y = 4x^3y(4z + 3)$

5. **a)** $x^2 + 3x - 4 = (x + 4)(x - 1)$
b) $2x^2 + 5x - 3 = (x + 3)(2x - 1)$

6. **a)** $(x + 9)(x + 7)$
b) $(x - 12)(x + 5)$
c) $(x + 9)(x - 3)$
d) $5(x - 5)(x + 4)$

7. **a)** $y = (x + 4)(x + 3)$
b) $(-3, 0)$, $(-4, 0)$
c) $(-3.5, -0.25)$
d) The minimum value is $y = -0.25$, and it occurs at $x = -3.5$.

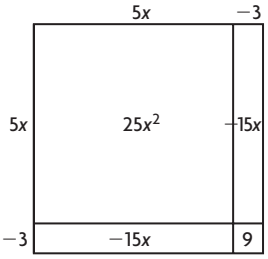
8. **a)** $x^2 + 18x + 80 = (x + 10)(x + 8)$
b) $10x^2 - 39x + 14 = (2x - 7)(5x - 2)$

9. Answers may vary, e.g., decomposition.
a) Look for factors of the form $(px + r)(qx + s)$, with $rs = -4$, $pq = 15$, and $ps + qr = -4$.
b) Look for factors of the form $(px + r)(qx + s)$, with $rs = -2$, $pq = 20$, and $ps + qr = 3$.
c) Look for factors of the form $(pa + r)(qa + s)$, with $rs = -16$, $pq = 7$, and $ps + qr = 6$.
d) Look for factors of the form $(py + r)(qy + s)$, with $rs = -10$, $pq = 20$, and $ps + qr = -17$.

10. **a)** $(7x + 2)(x - 3)$ **c)** $(2x - 1)(6x - 5)$
b) $(4a + 3)(a + 5)$ **d)** $(2n - 5y)(3n + 2y)$
11. **a)** 10 and 50 watches **b)** \$800
12. **a)** $4x^2 + 12x + 9 = (2x + 3)^2$
b) $64x^2 - 9 = (8x - 3)(8x + 3)$
13. **a)** $(12x - 5)(12x + 5)$ **d)** $(2x - 9)^2$
b) $(6a + 1)^2$ **e)** $(x + 5 - y)(x + 5 + y)$
c) $2x(3x^2 - 16y)(3x^2 + 16y)$ **f)** $(x - 3 - 2y)(x - 3 + 2y)$
14. No. Answers may vary, e.g., $x^2 + 25$ cannot be factored because it has two terms and no common factors, and it is not a difference of squares.
15. Expanding an algebraic expression is the reverse of factoring it. Answers may vary, e.g., expanding $(x + 2)(x - 4)$ gives $x^2 - 2x - 8$, while factoring $x^2 - 2x - 8$ gives $(x + 2)(x - 4)$.
16. **a)** $(7x + 2)(x - 4)$ **d)** $4y(x - 9)(x - 2)$
b) $(8a^3 - 5)(8a^3 + 5)$ **e)** $(4x + 5)(5x + 9)$
c) $(3c - 2)(6a - 5)$ **f)** $(z^2 - 8)(z^2 - 5)$
17. **a)** $(2s + 5)(s - 1)$ **d)** $(4s - 11r)(4s + 11r)$
b) $(5 + w)(3 - w)$ **e)** $(3 - 5g)^2$
c) $(z^2 - 8)(z^2 + 4)$ **f)** $(x + 8 - 5y)(x + 8 + 5y)$
18. **a)** The three dimensions are $2x + 5$, $3x + 1$, and $3x - 1$.
b) The three dimensions are 9 cm, 7 cm, and 5 cm; the volume is 315 cm^3.
19. **a)** $(5, -1)$ **c)** $(0, 500)$ **e)** $(-2, -16)$
b) $(6, 0)$ **d)** $(1.75, -10.125)$ **f)** $(-5, 0)$

Chapter Self-Test, page 242

1. **a)** ◆ = 1; ■ = 8
b) Answers may vary, e.g., ◆ = 9; ■ = 4; ● = 3
c) ◆ = 3; ■ = 1; ● = 23
d) Answers may vary, e.g., ◆ = 7; ■ = 5; ● = 70
2. **a)** $4x^2 - 10x + 6 = (2x - 3)(2x - 2)$
b) $2x^2 + 7x - 4 = (2x - 1)(x + 4)$
3. **a)** $10x^3(2x^2 - 3)$ **c)** $(3b + 5)(2a + 7)$
b) $-2yc(4c^2 - 2y + 3)$ **d)** $(t + 3)(2s + 5)$
4. **a)** Answers may vary, e.g.,
i) using a perfect square pattern: $(5x - 3)^2$
ii) using an area diagram:



b) Answers may vary, e.g., I prefer the perfect-square method because it is more direct.
5. **a)** $(x + 11)(x - 7)$ **c)** $3(x - 2)^2$
b) $(a - 5)(a + 2)$ **d)** $m(m + 4)(m - 1)$
6. **a)** $(2x + 1)(3x - 2)$ **c)** $(3x + 2)^2$
b) $2(2n - 1)(2n + 3)$ **d)** $a(3x + 4)(2x - 1)$
7. Answers may vary, e.g.,
a) length $= 2x + 3$, width $= x + 4$
b) length $= 2x + 5$, width $= 2x + 8$; expression for area: $4x^2 + 26x + 40$
c) length $= 6x + 9$, width $= 3x + 12$
8. **a)** $(15x - 2)(15x + 2)$ **c)** $(x^3 - 2y)(x^3 + 2y)$
b) $(3a - 8)^2$ **d)** $(3 + n - 5)^2 = (n - 2)^2$
9. Answers may vary, e.g., first, I factor the equation as $y = (2x - 1)(x - 5)$. This gives me zeros at $x = 0.5$ and $x = 5$. I know that the x-value of the vertex is halfway between these values, so it is 2.75. I substitute this value into the equation above to solve for the y-value: $y = (2 \times 2.75 - 1)(2.75 - 5) = -10.125$. Therefore, the vertex is located at $(2.75, -10.125)$.

Chapter 5

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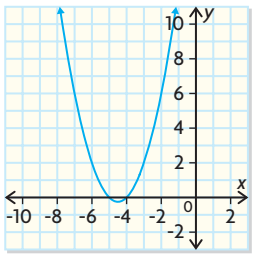
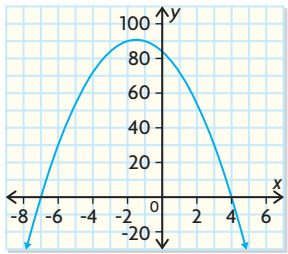
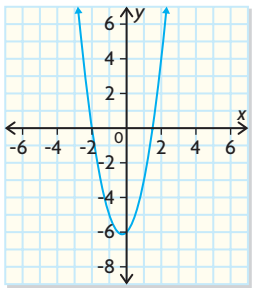
1. **a)** ii **c)** v **e)** i
b) iii **d)** vi **f)** iv
2. **a)** figure C; each square of figure A is translated 6 units left and 6 units down.
b) figure D; each square of figure A is reflected in the x-axis.
c) figure B; each square of figure A is reflected in the y-axis.
3. **a)** 13 **b)** 0
4. **a)** zeros: -5, 3; equation of the axis of symmetry: $x = -1$; vertex: $(-1, -16)$
b) zeros: 4, -1; equation of the axis of symmetry: $x = 1.5$; vertex: $(1.5, -12.5)$
c) zeros: 0, -3; equation of the axis of symmetry: $x = -1.5$; vertex: $(-1.5, 9)$
5. **a)** (1, 9) **b)** (3, −8) **c)** (0, 0) **d)** (3, 5)
6. **a)** translation 5 units right and 3 units down
b) translation 3 units right and 6 units down
c) translation 2 units left and 3 units down
7. **a)** zeros: -1, 2; equation of the axis of symmetry: $x = 0.5$; vertex: $(0.5, -9)$
b) zeros: -3, 0; equation of the axis of symmetry: $x = -1.5$; vertex: $(-1.5, 2)$
8. **a)** $y = x^2 + 9x + 20$ **c)** $y = -3x^2 - 9x + 84$
b) $y = 2x^2 + x - 6$ **d)** $y = x^2 + 10x + 25$
9. **a)**



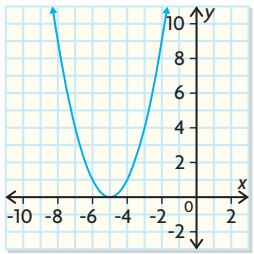
c)



b)



d)



10. $y = 2(x + 4)(x - 6)$; -50