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Shape and Structure
Forms of Quadratic Functions

Vocabulary

Write an example for each form of quadratic function and tell whether the form helps determine the *x*-intercepts, the *y*-intercept, or the vertex of the graph. Then describe how to determine the concavity of a parabola.

1. Standard form:

2. Factored form:

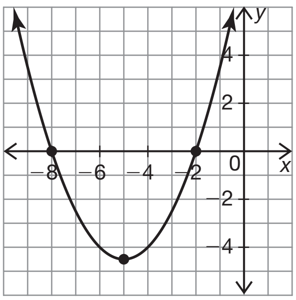
3. Vertex form:

4. Concavity of a parabola:

Problem Set

Circle the function that matches each graph. Explain your reasoning.

1.



$f(x) = 6(x - 2)(x - 8)$

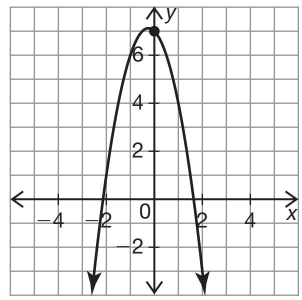
$f(x) = -\frac{1}{2}(x + 2)(x + 8)$

$f(x) = \frac{1}{2}(x + 2)(x + 8)$

$f(x) = \frac{1}{2}(x - 2)(x - 8)$

The a–value is positive so the parabola opens up. Also, the roots are at -2 and -8.

2.



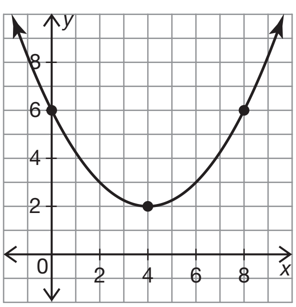
$f(x) = 2x^2 - x + 7$

$f(x) = -2x^2 - x + 7$

$f(x) = -x^2 - 2x + 7$

$f(x) = -2x^2 - x - 2$

3.



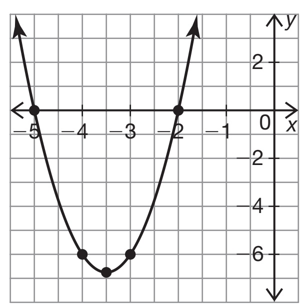
$f(x) = 0.25(x - 4)^2 + 2$

$f(x) = 4(x - 2)^2 - 2$

$f(x) = -0.25(x + 4)^2 + 2$

$f(x) = 0.25(x - 2)^2 + 4$

4.



$f(x) = -3(x + 2)(x - 5)$

$f(x) = 3(x + 2)(x + 5)$

$f(x) = 3(x - 2)(x - 5)$

$f(x) = -3(x - 2)(x - 5)$

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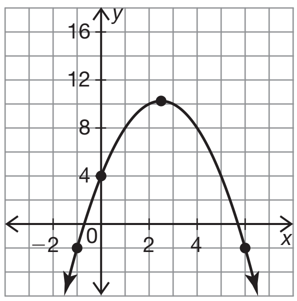
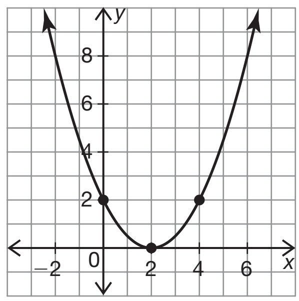
5. 

$f(x) = x^2 + 5x - 4$

$f(x) = -x^2 + 5x + 10$

$f(x) = x^2 + 5x + 4$

$f(x) = -x^2 + 5x + 4$

6. 

$f(x) = -\frac{1}{2}(x - 2)^2$

$f(x) = \frac{1}{2}(x - 2)^2 + 2$

$f(x) = \frac{1}{2}(x - 2)^2$

$f(x) = \frac{1}{2}(x + 2)^2$

Use the given information to determine the most efficient form you could use to write the quadratic function. Write standard form, factored form, or vertex form.

7. vertex (3, 7) and point (1, 10)
   vertex form

8. points (1, 0), (4, −3), and (7, 0)

9. y-intercept (0, 3) and axis of symmetry $-\frac{3}{8}$

10. points (−1, 12), (5, 12), and (−2, −2)

11. roots (−5, 0), (13, 0) and point (−7, 40)

12. maximum point (−4, −8) and point (−3, −15)

2

Convert each quadratic function in factored form to standard form.

13. $f(x) = (x + 5)(x - 7)$

$f(x) = x^2 - 7x + 5x - 35$

$= x^2 - 2x - 35$

14. $f(x) = (x + 2)(x + 9)$

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

16. $f(x) = -3(x - 1)(x - 3)$

17. $f(x) = \frac{1}{3}(x + 6)(x + 3)$

18. $f(x) = -\frac{5}{8}(x - 6)(x + 2)$

Convert each quadratic function in vertex form to standard form.

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

$f(x) = 3(x^2 - 8x + 16) + 7$

$= 3x^2 - 24x + 55$

20. $f(x) = -2(x + 1)^2 - 5$

21. $f(x) = 2\left(x + \frac{7}{2}\right)^2 - \frac{3}{2}$

22. $f(x) = -(x - 6)^2 + 4$

23. $f(x) = -\frac{1}{2}(x - 10)^2 - 12$

24. $f(x) = \frac{1}{20}(x + 100)^2 + 60$

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Write a quadratic function to represent each situation using the given information.

25. Cory is training his dog, Cocoa, for an agility competition. Cocoa must jump through a hoop in the middle of a course. The center of the hoop is 8 feet from the starting pole. The dog runs from the starting pole for 5 feet, jumps through the hoop, and lands 4 feet from the hoop. When Cocoa is 1 foot from landing, Cory measures that she is 3 feet off the ground. Write a function to represent Cocoa's height in terms of her distance from the starting pole.

$h(d) = a(d - r_1)(d - r_2)$

$3 = a(11 - 5)(11 - 12)$

$3 = a(6)(-1)$

$3 = -6a$

$\frac{3}{-6} = a$

$-0.5 = a$

$h(d) = -0.5(d - 5)(d - 12)$

26. Sasha is training her dog, Bingo, to run across an arched ramp, which is in the shape of a parabola. To help Bingo get across the ramp, Sasha places a treat on the ground where the arched ramp begins and one at the top of the ramp. The treat at the top of the ramp is a horizontal distance of 2 feet from the first treat, and Bingo is 6 feet above the ground when he reaches the top of the ramp. Write a function to represent Bingo's height above the ground as he walks across the ramp in terms of his distance from the beginning of the ramp.

27. Ella's dog, Doug, is performing in a special tricks show. Doug can fling a ball off his nose into a bucket 20 feet away. Ella places the ball on Doug's nose, which is 2 feet off the ground. Doug flings the ball through the air into a bucket sitting on a 4-foot platform. Halfway to the bucket, the ball is 10 feet in the air. Write a function to represent the height of the ball in terms of its distance from Doug.

28. A spectator in the crowd throws a treat to one of the dogs in a competition. The spectator throws the treat from the bleachers 19 feet above ground. The treat amazingly flies 30 feet and just barely crosses over a hoop which is 7.5 feet tall. The dog catches the treat 6 feet beyond the hoop when his mouth is 1 foot from the ground. Write a function to represent the height of the treat in terms of its distance.

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29. Hector's dog, Ginger, competes in a waterfowl jump. She jumps from the edge of the water, catches a toy duck at a horizontal distance of 10 feet and a height of 2 feet above the water, and lands in the water at a horizontal distance of 15 feet. Write a function to represent the height of Ginger's jump in terms of her horizontal distance.

30. Ping is training her dog, TinTin, to jump across a row of logs. He takes off from a platform that is 7 feet high with a speed of 18 feet per second. Write a function to represent TinTin's height in terms of time as he jumps across the logs.

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Function Sense
Translating Functions

Vocabulary

Complete each sentence with the correct term from the word bank.

transformation	reference point
translation	argument of a function

1. A(n) ____________________ is one of a set of key points that help identify the basic function.

2. The mapping, or movement, of all the points of a figure in a plane according to a common operation is called a(n) ____________________.

3. The ____________________ is the variable, term, or expression on which the function operates.

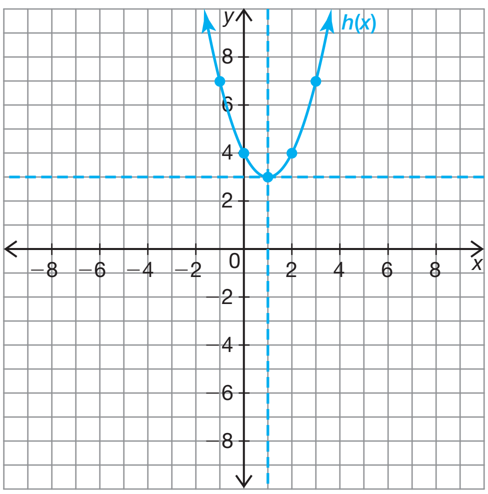
4. A(n) ____________________ is a type of transformation that shifts an entire figure or graph the same distance and direction.

Problem Set

Given $f(x) = x^2$, complete the table and graph $h(x)$.

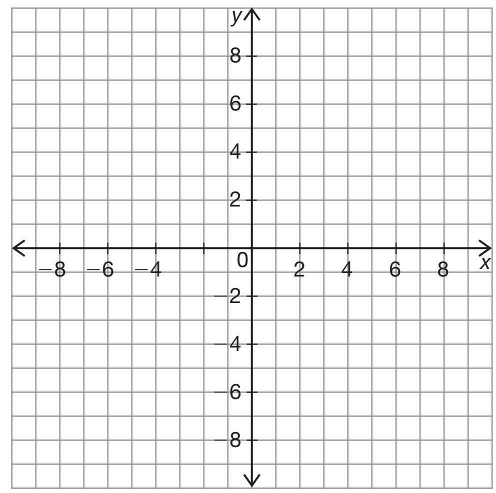
1. $h(x) = (x - 1)^2 + 3$

Reference Points on $f(x)$	$\rightarrow$	Corresponding Points on $h(x)$
(0, 0)	$\rightarrow$	(1, 3)
(1, 1)	$\rightarrow$	(2, 4)
(2, 4)	$\rightarrow$	(3, 7)



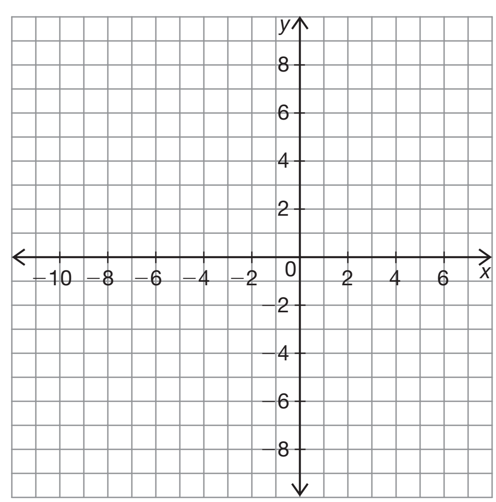
2. $h(x) = (x + 2)^2 - 1$

Reference Points of $f(x)$	$\rightarrow$	Corresponding Points on $h(x)$
(0, 0)	$\rightarrow$	
(1, 1)	$\rightarrow$	
(2, 4)	$\rightarrow$	



3. $h(x) = (x + 7)^2$

Reference Points of $f(x)$	$\rightarrow$	Corresponding Points on $h(x)$
(0, 0)	$\rightarrow$	
(1, 1)	$\rightarrow$	
(2, 4)	$\rightarrow$	



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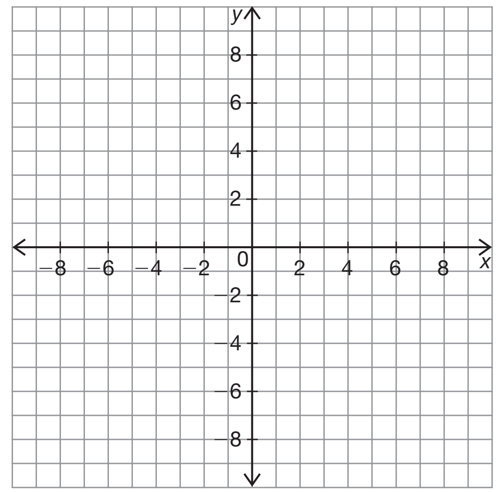
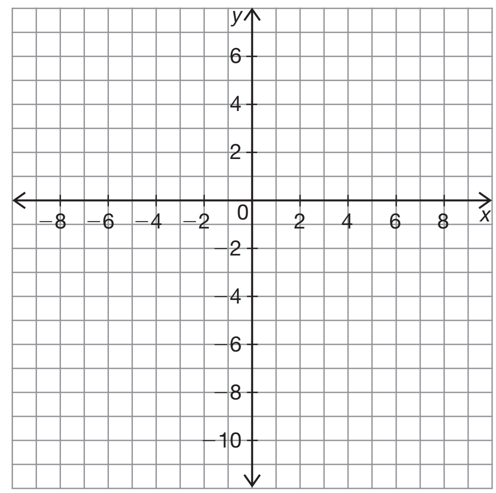
4. $h(x) = (x - 3)^2 + 4$

Reference Points of $f(x)$	$\rightarrow$	Corresponding Points on $h(x)$
(0, 0)	$\rightarrow$	
(1, 1)	$\rightarrow$	
(2, 4)	$\rightarrow$	



5. $h(x) = x^2 - 9$

Reference Points of $f(x)$	$\rightarrow$	Corresponding Points on $h(x)$
(0, 0)	$\rightarrow$	
(1, 1)	$\rightarrow$	
(2, 4)	$\rightarrow$	



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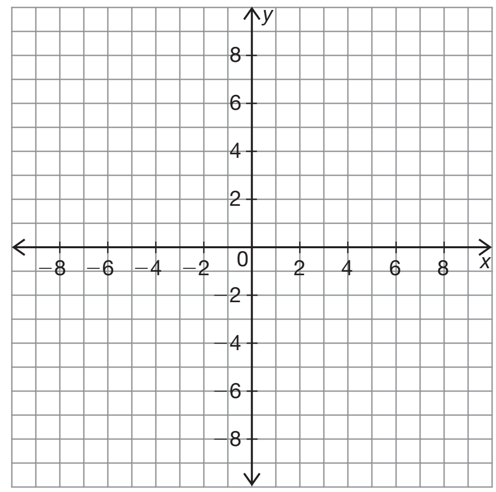
6. $h(x) = (x + 4)^2 - 4$

Reference Points of $f(x)$	$\rightarrow$	Corresponding Points on $h(x)$
(0, 0)	$\rightarrow$	
(1, 1)	$\rightarrow$	
(2, 4)	$\rightarrow$	



Each given function is in transformational function form $g(x) = Af(B(x - C)) + D$, where $f(x) = x^2$. Identify the values of C and D for the given function. Then, describe how the vertex of the given function compares to the vertex of $f(x)$.

7. $g(x) = f(x - 4) + 12$

The *C*–value is 4 and the *D*–value is 12, so the vertex will be shifted 4 units to the right and 12 units up to (4, 12).

8. $g(x) = f(x + 8) - 9$

9. $g(x) = f(x - 5) - 11$

10. $g(x) = f(x - 6) + 10$

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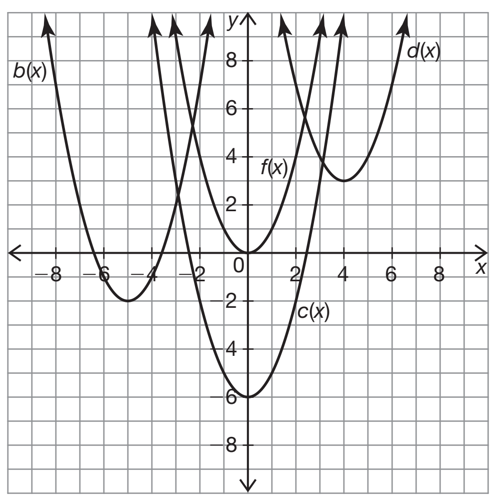
11. $g(x) = f(x + 2) + 3$

12. $g(x) = f(x + 4) - 2$

Analyze the graphs of $b(x)$, $c(x)$, $d(x)$, and $f(x)$. Write each function in terms of the indicated function.



13. Write $b(x)$ in terms of $f(x)$.

$b(x) = f(x + 5) - 2$

14. Write $c(x)$ in terms of $f(x)$.

15. Write $d(x)$ in terms of $f(x)$.

16. Write $d(x)$ in terms of $b(x)$.

17. Write $c(x)$ in terms of $b(x)$.

18. Write $b(x)$ in terms of $c(x)$.

2

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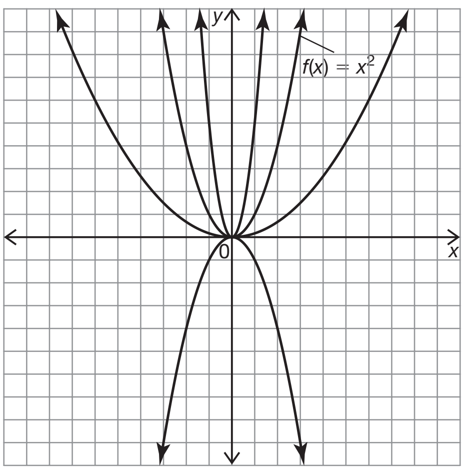
Up and Down
Vertical Dilations of Quadratic Functions

Vocabulary

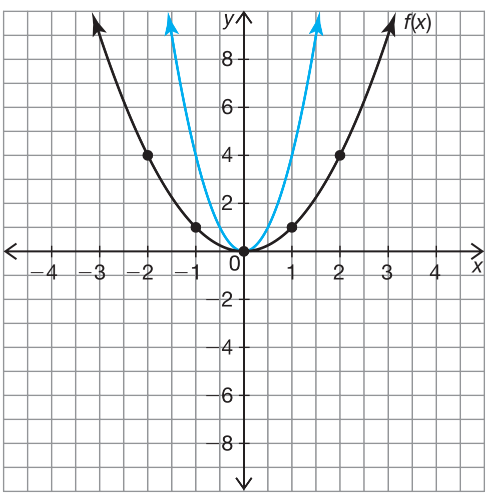
1. Label the graph to identify the vertical dilations (vertical compression and vertical stretching) and the reflection of the function $f(x) = x^2$. Also label the line of reflection.



Problem Set

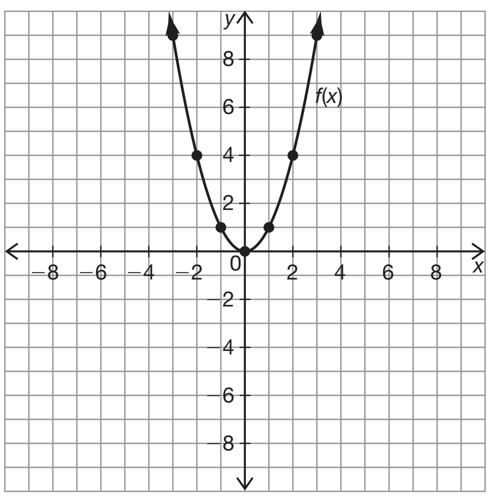
Graph each vertical dilation of $f(x) = x^2$ and tell whether the transformation is a vertical stretch or a vertical compression and if the graph includes a reflection.

1. $g(x) = 4x^2$



vertical stretch

2. $p(x) = \frac{1}{8}x^2$



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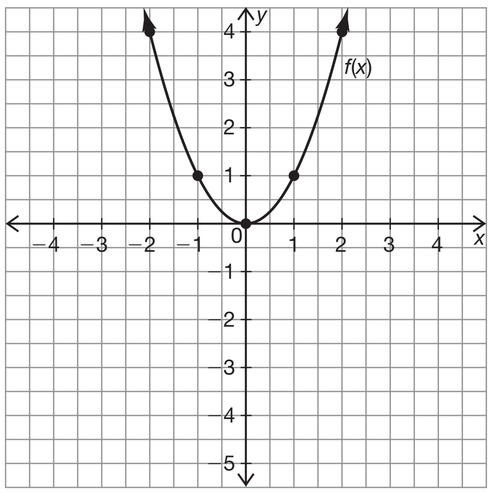
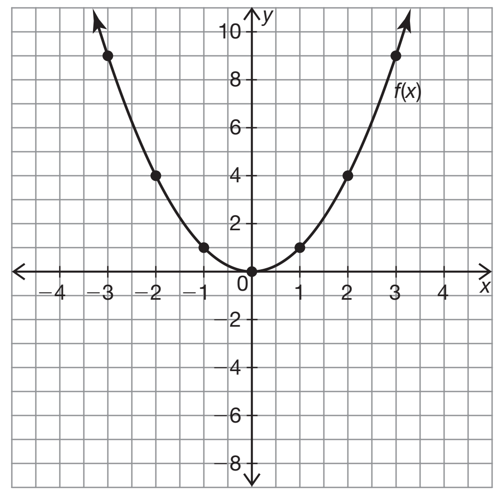
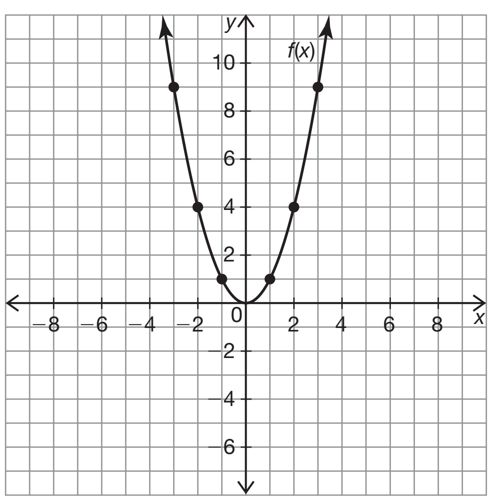
3. $h(x) = -5x^2$



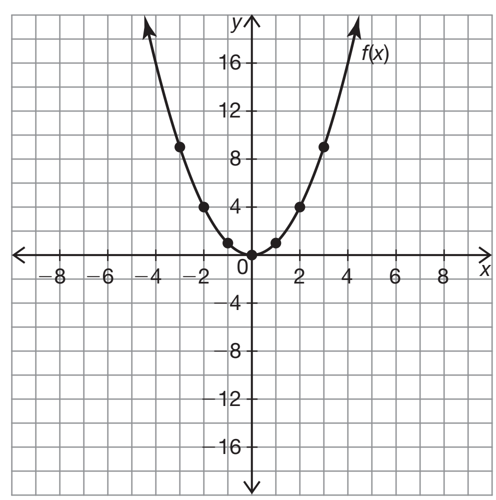
4. $m(x) = 2.5x^2$



5. $d(x) = \frac{2}{5}x^2$



6. $g(x) = -\frac{1}{2}x^2 - 3$



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Each given function is in transformational function form $g(x) = Af(B(x - C)) + D$, where $f(x) = x^2$. Describe how $g(x)$ compares to $f(x)$. Then, use coordinate notation to represent how the A-, C-, and D-values transform $f(x)$ to generate $g(x)$.

7. $g(x) = -3(f(x)) - 1$

The A–value is -3, so the graph will have a vertical stretch by a factor of 3 and will be reflected about the line $y = -1$. The C–value is 0 and the D–value is -1 so the vertex will be shifted 1 unit down to $(0, -1)$.

$(x, y) \rightarrow (x, -3y - 1)$

8. $g(x) = \frac{1}{4}(f(x)) + 8$

9. $g(x) = -4(f(x + 3))$

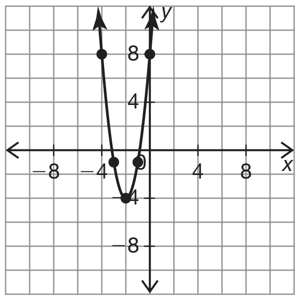
10. $g(x) = \frac{1}{3}f(x - 6) - 3$

11. $g(x) = -0.75f(x + 4) - 2$

12. $g(x) = \frac{4}{3}f\left(x - \frac{1}{3}\right) + \frac{2}{3}$

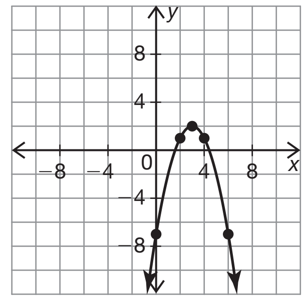
Write the function that represents each graph.

13.



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

14.



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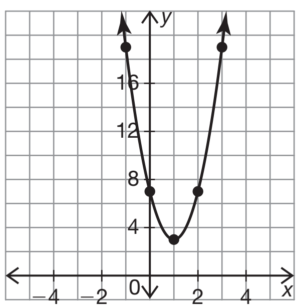

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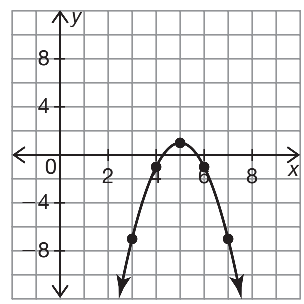

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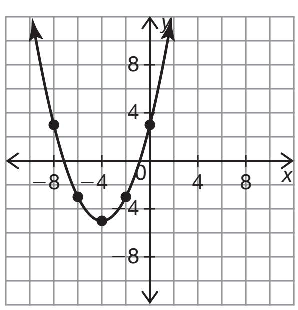
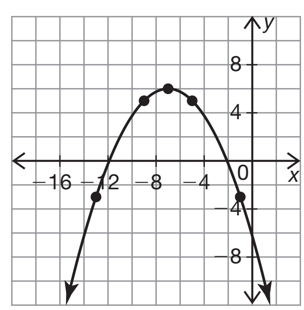


18.



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Side to Side

Horizontal Dilations of Quadratic Functions

Vocabulary

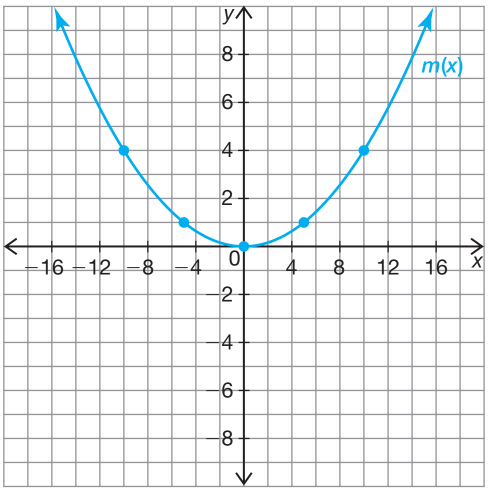
1. Explain the differences and similarities between horizontal dilation, horizontal stretching, and horizontal compression of a quadratic function.

Problem Set

Complete the table and graph $m(x)$. Then, describe how the graph of $m(x)$ compares to the graph of $f(x)$.

1. $f(x) = x^2$; $m(x) = f\left(\frac{1}{5}x\right)$

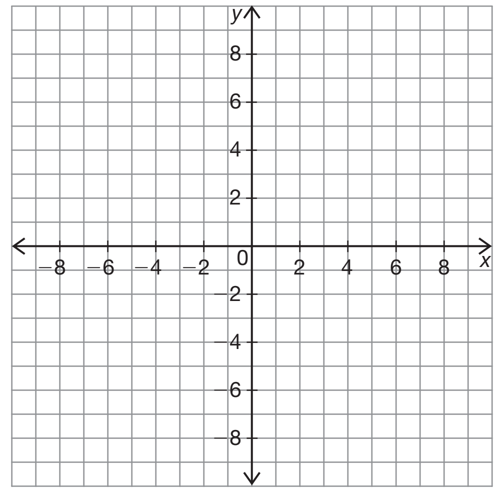
Reference Points on $f(x)$	$\rightarrow$	Corresponding Points on $m(x)$
(0, 0)	$\rightarrow$	(0, 0)
(5, 25)	$\rightarrow$	(5, 1)
(10, 100)	$\rightarrow$	(10, 4)
(15, 225)	$\rightarrow$	(15, 9)



The function $m(x)$ is a horizontal stretch of $f(x)$ by a factor of 5.

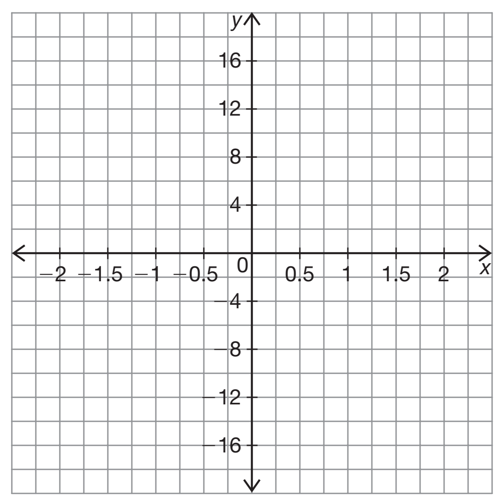
2. $f(x) = x^2$; $m(x) = f(1.5x)$

Reference Points on $f(x)$	$\rightarrow$	Corresponding Points on $m(x)$
(0, 0)	$\rightarrow$	
(1, 1)	$\rightarrow$	
(2, 4)	$\rightarrow$	
(4, 16)	$\rightarrow$	



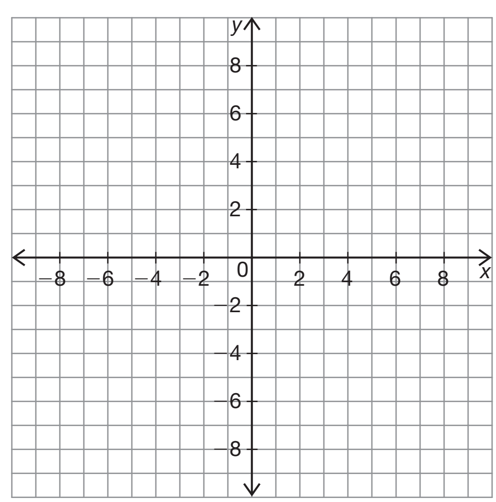
3. $f(x) = x^2$; $m(x) = f(4x)$

Reference Points on $f(x)$	$\rightarrow$	Corresponding Points on $m(x)$
(0, 0)	$\rightarrow$	
(0.5, 0.25)	$\rightarrow$	
(1, 1)	$\rightarrow$	
(2, 4)	$\rightarrow$	



4. $f(x) = x^2$; $m(x) = f(0.25x)$

Reference Points on $f(x)$	$\rightarrow$	Corresponding Points on $m(x)$
(0, 0)	$\rightarrow$	
(4, 16)	$\rightarrow$	
(8, 64)	$\rightarrow$	
(12, 144)	$\rightarrow$	



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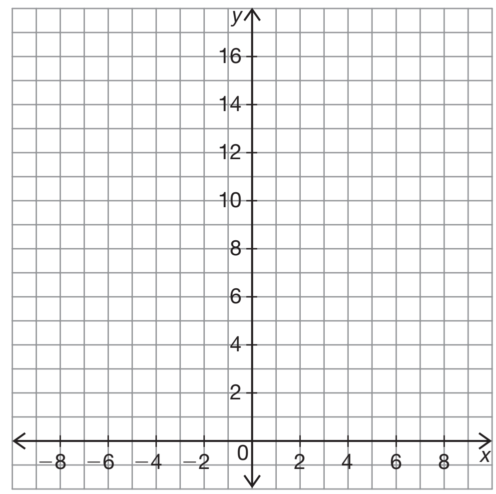
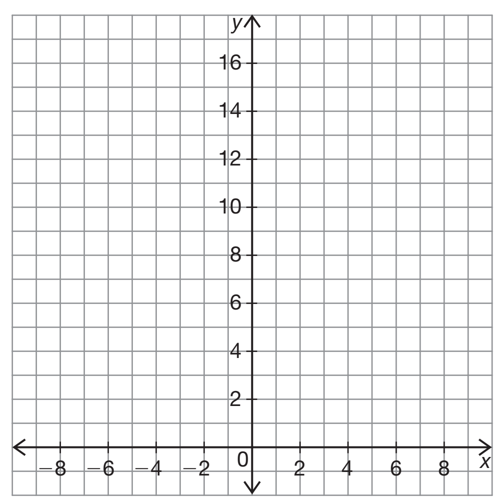
5. $f(x) = x^2$; $m(x) = f\left(\frac{2}{3}x\right)$

Reference Points on $f(x)$	$\rightarrow$	Corresponding Points on $m(x)$
(0, 0)	$\rightarrow$	
(3, 9)	$\rightarrow$	
(6, 36)	$\rightarrow$	
(9, 81)	$\rightarrow$	



6. $f(x) = x^2$; $m(x) = f(2x)$

Reference Points on $f(x)$	$\rightarrow$	Corresponding Points on $m(x)$
(0, 0)	$\rightarrow$	
(1, 1)	$\rightarrow$	
(2, 4)	$\rightarrow$	
(3, 9)	$\rightarrow$	



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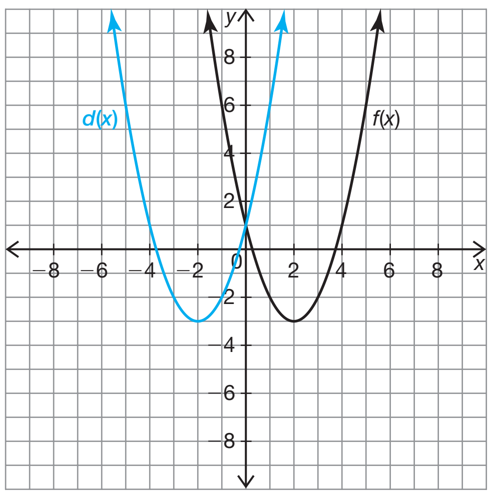
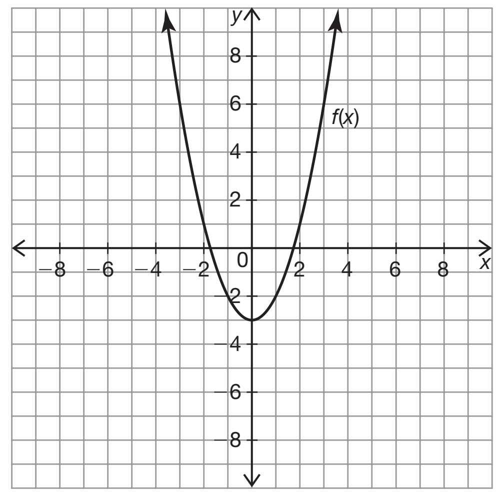
The graph of $f(x)$ is shown. Sketch the graph of the given transformed function.

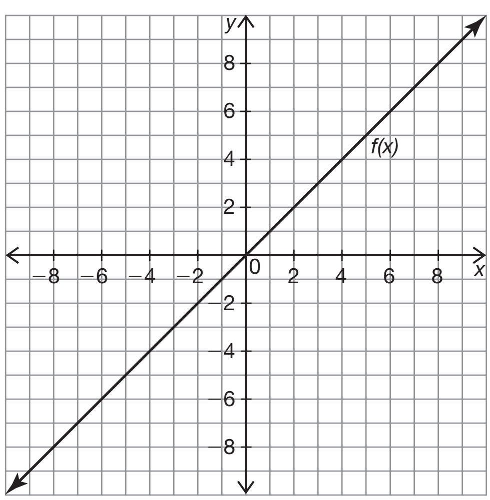
7. $d(x) = f(-x)$



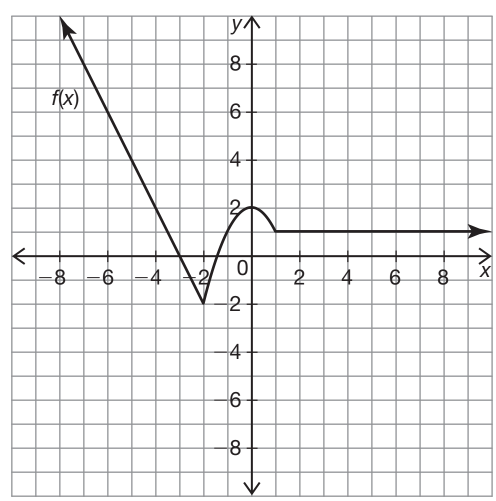
8. $t(x) = -f(x - 4)$



9. $m(x) = -2f(x + 3) + 5$



10. $g(x) = (-x + 1) - 4$



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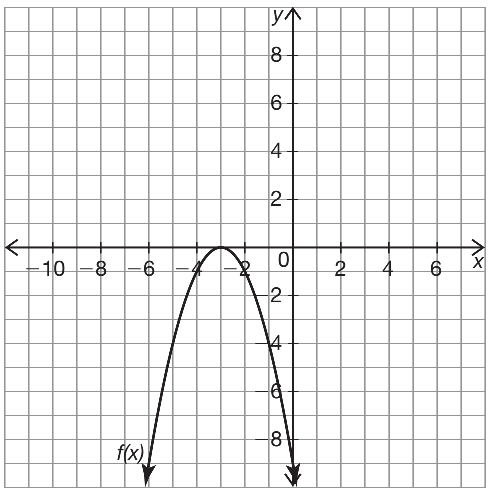
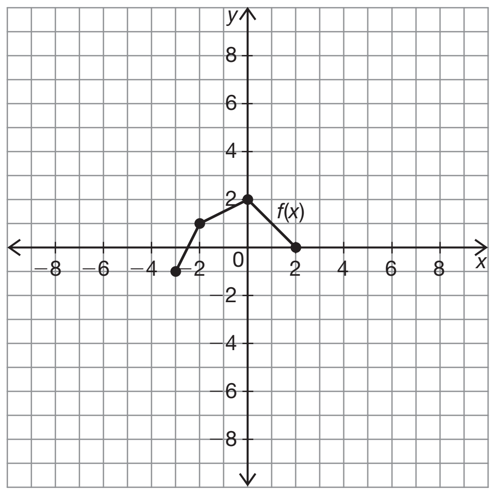
11. $r(x) = f\left(\frac{1}{2}x - 1\right) + 2$

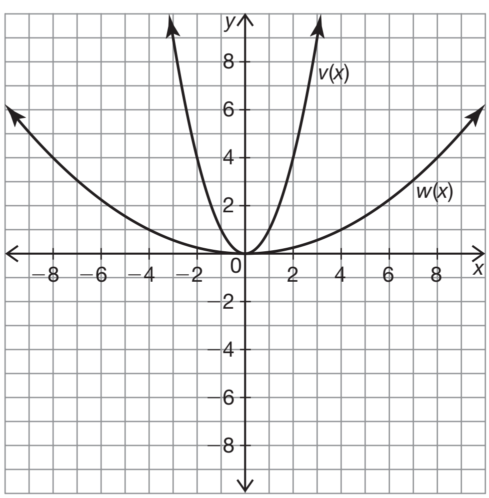


12. $p(x) = -f(x + 1) - 3$



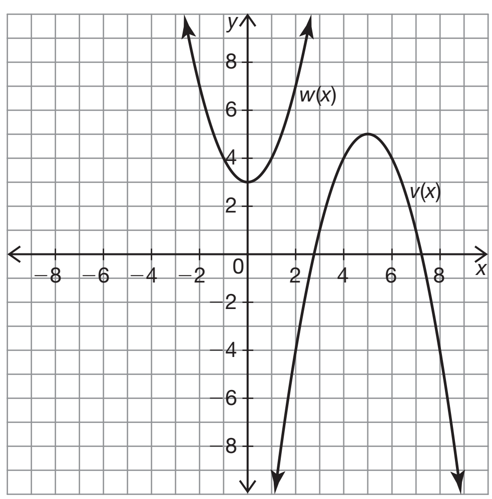
Write an equation for $w(x)$ in terms of $v(x)$.

13.



$w(x) = v\left(\frac{1}{4}x\right)$

14.



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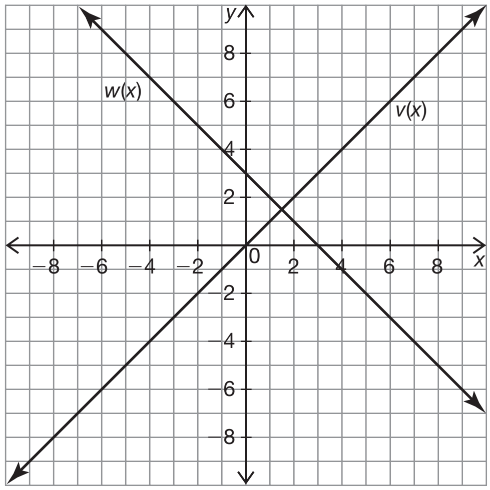

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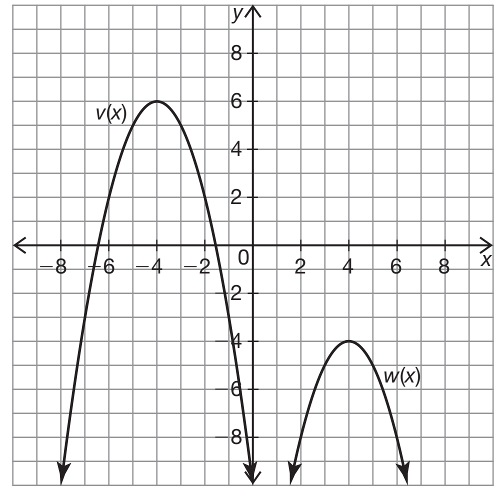

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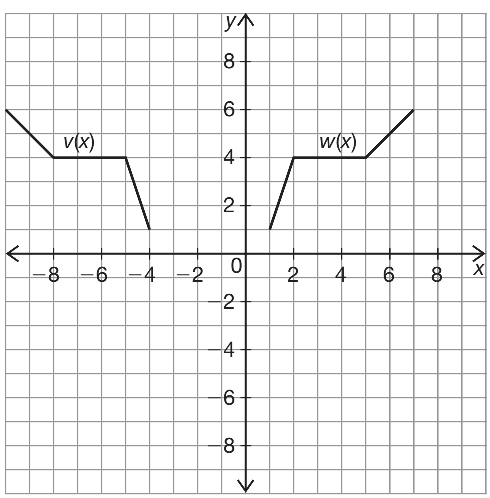
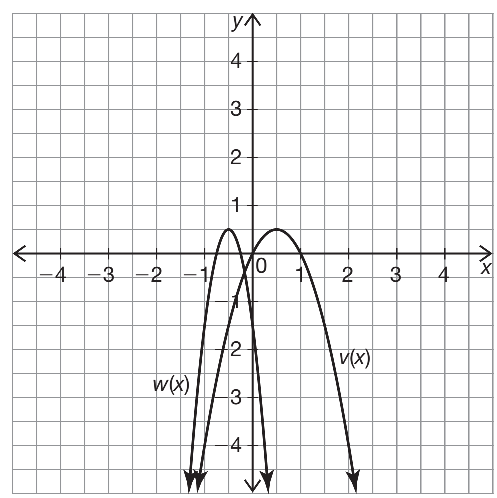


18.



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What's the Point?
Deriving Quadratic Functions

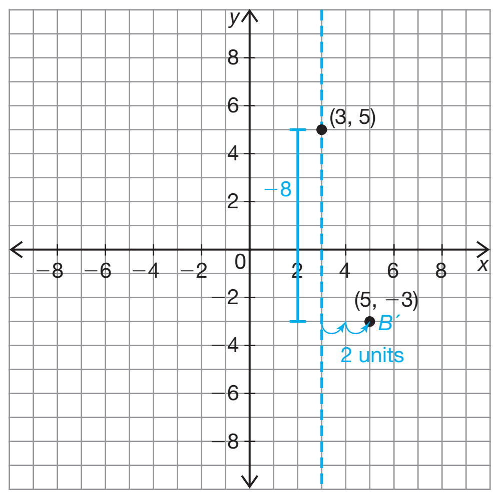
Problem Set

Use your knowledge of reference points to write an equation for the quadratic function that satisfies the given information. Use the graph to help solve each problem.

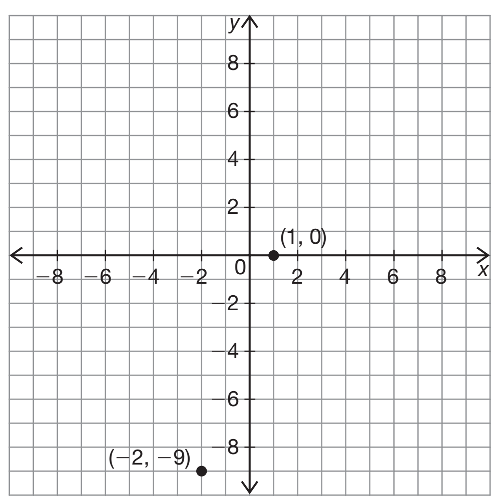
1. Given: vertex (3, 5) and point (5, −3)

$f(x) = -2(x - 3)^2 + 5$

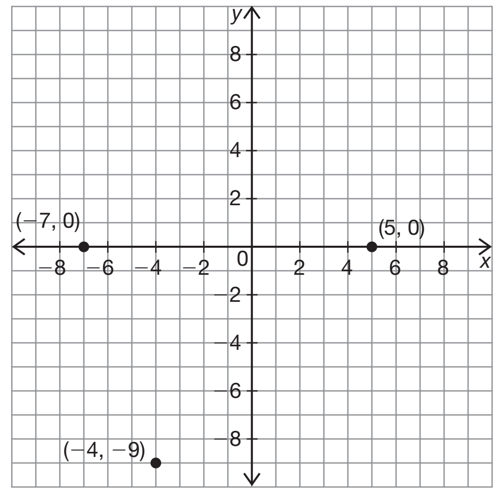
Point (5, −3) is point *B*′ because it is 2 units from the axis of symmetry. The range between the vertex and point *B* on the basic function is 4. The range between the vertex and point *B*′ is 4 × (−2), therefore the *a*-value must be −2.



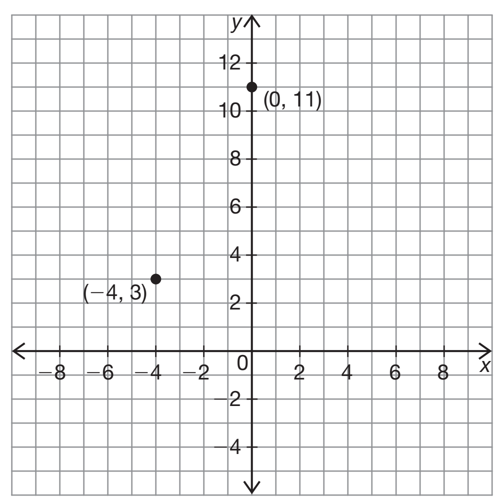
2. Given: vertex (−2, −9) and one of two *x*-intercepts (1, 0)



3. Given: two x-intercepts $(-7, 0)$ and $(5, 0)$ and one point $(-4, -9)$



4. Given: vertex $(-4, 3)$ and y-intercept $(0, 11)$



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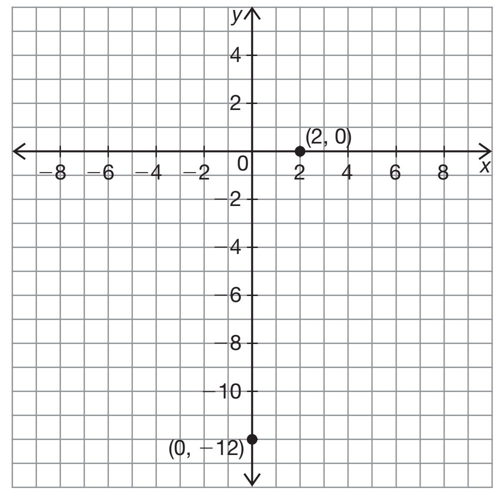
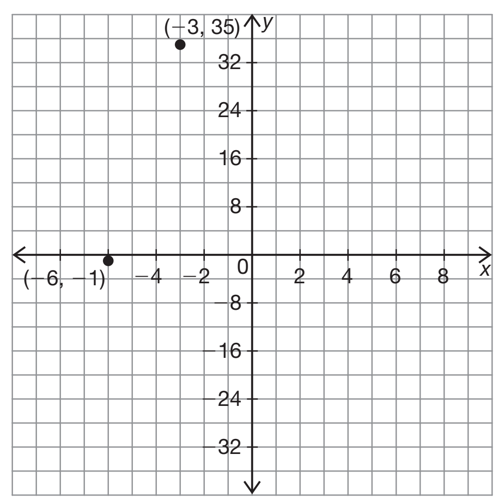
5. Given: exactly one x-intercept (2, 0) and y-intercept (0, -12)



6. Given: vertex (-6, -1) and point (-3, 35)



Use a graphing calculator to determine the quadratic equation for each set of three points that lie on a parabola.

7. $(-4, 12), (-2, -14), (2, 6)$

$f(x) = 3x^2 + 5x - 16$

8. $(5, -56), (1, -4), (-10, -26)$

9. $(-8, 8), (-4, 6), (4, 38)$

10. $(-2, 3), (2, -9), (5, -60)$

11. $(0, 3), (-5, -2.4), (15, -7.8)$

12. $(-2, 13), (1, -17), (7, 31)$

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Create a system of equations and use algebra to write a quadratic equation for each set of three points that lie on a parabola.

13. (−3, 12), (0, 9), (3, 24)

Equation 1: $12 = 9a - 3b + c$

Equation 2: $9 = c$

Equation 3: $24 = 9a + 3b + c$

Substitute equation 2 into equation 1 and solve for *a*.

$$12 = 9a - 3b + 9$$
$$3 = 9a - 3b$$
$$3 + 3b = 9a$$
$$a = \frac{1}{3} + \frac{1}{3}b$$

Substitute the value for *a* in terms of *b* and the value for *c* into equation 3 and solve for *b*.

$$24 = 9\left(\frac{1}{3} + \frac{1}{3}b\right) + 3b + 9$$
$$24 = 3 + 3b + 3b + 9$$
$$15 = 3 + 6b$$
$$12 = 6b$$
$$b = 2$$

Substitute the values for *b* and *c* into equation 1 and solve for *a*.

$$12 = 9a - 3(2) + 9$$
$$15 = 9a + 3$$
$$9 = 9a$$
$$a = 1$$

Substitute the values for *a*, *b*, and *c* into a quadratic equation in standard form.

$f(x) = x^2 + 2x + 9$

14. $(-2, -2), (1, -5), (2, -18)$

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15. (2, 9), (0, −5), (−10, −15)

16. $(-1, 2), (4, 27), (-3, 20)$

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17. $(5, -6)$, $(-2, 8)$, $(3, 4)$

18. (1, 17), (−1, −9), (2, 105)

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Now It's Getting Complex . . . But It's Really Not Difficult!
Complex Number Operations

Vocabulary

Match each term to its corresponding definition.

1. the number i
2. imaginary number
3. pure imaginary number
4. complex number
5. real part of a complex number
6. imaginary part of a complex number
7. complex conjugates
8. monomial
9. binomial
10. trinomial

A. a number in the form $a + bi$ where a and b are real numbers and b is not equal to 0

B. term a of a number written in the form $a + bi$

C. a polynomial with two terms

D. pairs of numbers of the form $a + bi$ and $a - bi$

E. a number such that its square equals -1

F. a number in the form $a + bi$ where a and b are real numbers

G. a polynomial with three terms

H. a number of the form bi where b is not equal to 0

I. term bi of a number written in the form $a + bi$

J. a polynomial with one term

Problem Set

Calculate each power of i.

1. i^{48}

$$i^{48} = (i^4)^{12}$$
$$= 1^{12}$$
$$= 1$$

2. i^{361}

3. i^{55}

4. i^{1000}

5. i^{-22}

6. i^{-7}

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Rewrite each expression using *i*.

7. $\sqrt{-72}$

$\sqrt{-72} = \sqrt{36(2)(-1)}$

$= 6\sqrt{2}i$

8. $\sqrt{-49} + \sqrt{-23}$

9. $38 - \sqrt{-200} + \sqrt{121}$

10. $\sqrt{-45} + 21$

11. $\dfrac{\sqrt{-48} - 12}{4}$

12. $\dfrac{1 + \sqrt{4} - \sqrt{-15}}{3}$

13. $-\sqrt{-28} + \dfrac{\sqrt{21}}{3} - \dfrac{\sqrt{12}}{6}$

14. $\dfrac{\sqrt{-75} + \sqrt{80}}{10}$

Simplify each expression.

15. $(2 + 5i) - (7 - 9i)$

$$\begin{aligned}(2 + 5i) - (7 - 9i) &= 2 + 5i - 7 + 9i \\ &= (2 - 7) + (5i + 9i) \\ &= -5 + 14i\end{aligned}$$

16. $-6 + 8i - 1 - 11i + 13$

17. $-(4i - 1 + 3i) + (6i - 10 + 17)$

18. $22i + 13 - (7i + 3 + 12i) + 16i - 25$

19. $9 + 3i(7 - 2i)$

20. $(4 - 5i)(8 + i)$

21. $-0.5(14i - 6) - 4i(0.75 - 3i)$

22. $\left(\frac{1}{2}i - \frac{3}{4}\right) + \left(\frac{1}{8} - \frac{3}{4}i\right)$

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Determine each product.

23. $(3 + i)(3 - i)$

$$\begin{aligned}(3 + i)(3 - i) &= 9 - 3i + 3i - i^2 \\ &= 9 - (-1) \\ &= 10\end{aligned}$$

24. $(4i - 5)(4i + 5)$

25. $(7 - 2i)(7 + 2i)$

26. $\left(\frac{1}{3} + 3i\right)\left(\frac{1}{3} - 3i\right)$

27. $(0.1 + 0.6i)(0.1 - 0.6i)$

28. $-2[(-i - 8)(-i + 8)]$

Identify each expression as a monomial, binomial, or trinomial. Explain your reasoning.

29. $4xi + 7x$

The expression is a monomial because it can be rewritten as $(4i + 7)x$, which shows one x term.

30. $-3x + 5 - 8xi + 1$

31. $6x^2i + 3x^2$

32. $8i - x^3 + 7x^2i$

33. $xi - x + i + 2 - 4i$

34. $-3x^3i - x^2 + 6x^3 + 9i - 1$

Simplify each expression, if possible.

35. $(x - 6i)^2$

$$\begin{aligned}(x - 6i)^2 &= x^2 - 6xi - 6xi + 36i^2 \\ &= x^2 - 12xi + 36(-1) \\ &= x^2 - 12xi - 36\end{aligned}$$

36. $(2 + 5xi)(7 - xi)$

37. $3xi - 4yi$

38. $(2xi - 9)(3x + 5i)$

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39. $(x + 4i)(x - 4i)(x + 4i)$

40. $(3i - 2xi)(3i - 2xi) + (2i - 3xi)(2 - 3xi)$

For each complex number, write its conjugate.

41. $7 + 2i$

$7 - 2i$

42. $3 + 5i$

43. $8i$

44. $-7i$

45. $2 - 11i$

46. $9 - 4i$

47. $-13 - 6i$

48. $-21 + 4i$

2

Calculate each quotient.

49. $\dfrac{3 + 4i}{5 + 6i}$

$$\frac{3 + 4i}{5 + 6i} = \frac{3 + 4i}{5 + 6i} \cdot \frac{5 - 6i}{5 - 6i} = \frac{15 - 18i + 20i - 24i^2}{25 - 30i + 30i - 36i^2}$$

$$= \frac{15 + 2i + 24}{25 + 36} = \frac{39 + 2i}{61} = \frac{39}{61} + \frac{2}{61}i$$

50. $\dfrac{8 + 7i}{2 + i}$

51. $\dfrac{-6 + 2i}{2 - 3i}$

52. $\dfrac{-1 + 5i}{1 - 4i}$

53. $\dfrac{6 - 3i}{2 - i}$

54. $\dfrac{4 - 2i}{-1 + 2i}$

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You Can't Spell "Fundamental Theorem of Algebra" without F-U-N!

Quadratics and Complex Numbers

Vocabulary

Write a definition for each term in your own words.

1. imaginary roots

2. discriminant

3. imaginary zeros

4. degree of a polynomial equation

5. Fundamental Theorem of Algebra

6. double root

Problem Set

Use the Quadratic Formula to solve an equation of the form $f(x) = 0$ for each function.

1. $f(x) = x^2 - 2x - 3$

$x^2 - 2x - 3 = 0$

$a = 1, b = -2, c = -3$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(-3)}}{2(1)}$

$x = \frac{2 \pm \sqrt{16}}{2}$

$x = \frac{2 \pm 4}{2}$

$x = 3, x = -1$

2. $f(x) = x^2 + 4x + 4$

3. $f(x) = 4x^2 - 9$

4. $f(x) = -x^2 - 5x - 6$

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5. $f(x) = x^2 + 2x + 10$

6. $f(x) = -3x^2 - 6x - 11$

Use the discriminant to determine whether each function has real or imaginary zeros.

7. $f(x) = x^2 + 12x + 35$

$$\begin{aligned} b^2 - 4ac &= 12^2 - 4(1)(35) \\ &= 144 - 140 \\ &= 4 \end{aligned}$$

The discriminant is positive, so the function has real zeros.

8. $f(x) = -3x + x - 9$

9. $f(x) = x^2 - 4x + 7$

10. $f(x) = 9x^2 - 12x + 4$

11. $f(x) = -\frac{1}{4}x^2 + 3x - 8$

12. $f(x) = x^2 + 6x + 9$

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Use the vertex form of a quadratic equation to determine whether the zeros of each function are real or imaginary. Explain how you know.

13. $f(x) = (x - 4)^2 - 2$

Because the vertex $(4, -2)$ is below the x-axis and the parabola is concave up ($a > 0$), it intersects the x-axis. So, the zeros are real.

14. $f(x) = -2(x - 1)^2 - 5$

15. $f(x) = \frac{1}{3}(x - 2)^2 + 7$

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

17. $f(x) = -(x - 6)^2$

18. $f(x) = \frac{3}{4}(x + 4)^2 - 6$

2

Factor each function over the set of real or imaginary numbers. Then, identify the type of zeros.

19. $k(x) = x^2 - 25$

$k(x) = (x + 5)(x - 5)$

$x = -5, x = 5$

The function $k(x)$ has two real zeros.

20. $n(x) = x^2 - 5x - 14$

21. $p(x) = -x^2 - 8x - 17$

22. $g(x) = x^2 + 6x + 10$

23. $h(x) = -x^2 + 8x - 7$

24. $m(x) = \frac{1}{2}x^2 + 8$