8.4 Start Thinking

Consider the functions $f(x) = 3x$ and $g(x) = x^2 + 1$. Replace x with $-x$ in each function and simplify to find $f(-x)$ and $g(-x)$.

Compare the output values of $f(x)$ and $f(-x)$. Make the same comparison for $g(x)$ and $g(-x)$.

8.4 Warm Up

Find the coordinates of the vertex.

1. $y = x^2$

2. $y = x^2 + 2$

3. $y = -\frac{2}{3}x^2$

4. $y = x^2 - 5x$

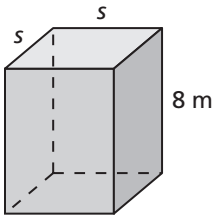
5. $y = -x^2$

6. $y = 3x^2 + x + 2$

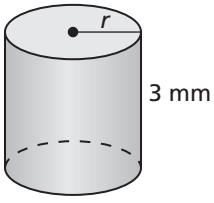
8.4 Cumulative Review Warm Up

Tell whether the volume of the solid is a linear or nonlinear function of the missing dimension(s). Explain.

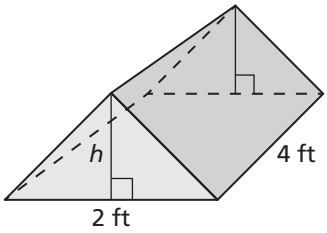
1.



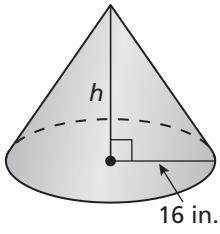
2.



3.



4.



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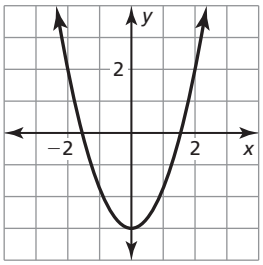
8.4 Practice A

In Exercises 1–3, determine whether the function is *even*, *odd*, or *neither*.

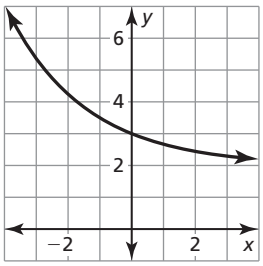
1. $g(x) = 4^x - 1$ **2.** $f(x) = 2x - 5$ **3.** $h(x) = 2x^2 + 5$

In Exercises 4 and 5, determine whether the function represented by the graph is *even*, *odd*, or *neither*.

4.



5.



In Exercises 6–8, find the vertex and the axis of symmetry of the graph of the function.

6. $f(x) = 4(x + 2)^2$ **7.** $f(x) = \frac{1}{3}(x - 3)^2$ **8.** $y = -5(x + 7)^2$

In Exercises 9–11, graph the function. Compare the graph to the graph of $f(x) = x^2$.

9. $g(x) = 2(x + 1)^2$ **10.** $g(x) = 3(x - 2)^2$ **11.** $g(x) = \frac{1}{4}(x + 6)^2$

In Exercises 12–14, find the vertex and the axis of symmetry of the graph of the function.

12. $y = -5(x + 3)^2 - 2$ **13.** $f(x) = 2(x - 2)^2 + 5$ **14.** $y = -3(x + 5)^2 - 4$

In Exercises 15 and 16, graph the function. Compare the graph to the graph of $f(x) = x^2$.

15. $g(x) = (x - 3)^2 + 2$ **16.** $g(x) = -(x + 2)^2 - 4$

In Exercises 17 and 18, rewrite the quadratic function in vertex form.

17. $y = 2x^2 + 4x - 1$ **18.** $f(x) = 3x^2 - 12x + 4$

19. The graph of $y = x^2$ is translated 4 units left and 3 units down. Write an equation for the function in vertex form and in standard form. Describe advantages of writing the function in each form.

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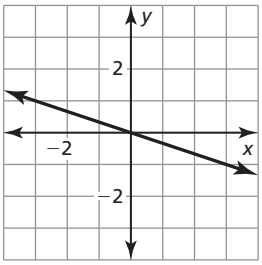
8.4 Practice B

In Exercises 1–3, determine whether the function is *even*, *odd*, or *neither*.

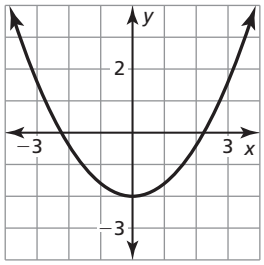
1. $f(x) = 3x^2 + 2x$ **2.** $g(x) = \frac{2}{3}x$ **3.** $h(x) = \frac{1}{3}x^2 - 2$

In Exercises 4 and 5, determine whether the function represented by the graph is *even*, *odd*, or *neither*.

4.



5.



In Exercises 6–8, find the vertex and the axis of symmetry of the graph of the function.

6. $f(x) = -\frac{1}{3}(x + 6)^2$ **7.** $f(x) = 9(x - 4)^2$ **8.** $y = -10(x + 9)^2$

In Exercises 9–11, graph the function. Compare the graph to the graph of $f(x) = x^2$.

9. $g(x) = 4(x + 2)^2$ **10.** $g(x) = \frac{1}{3}(x - 5)^2$ **11.** $g(x) = \frac{1}{6}(x - 1)^2$

In Exercises 12–14, find the vertex and the axis of symmetry of the graph of the function.

12. $y = 6(x - 4)^2 - 3$ **13.** $f(x) = -4(x + 1)^2 + 5$ **14.** $y = -(x + 3)^2 - 2$

In Exercises 15 and 16, graph the function. Compare the graph to the graph of $f(x) = x^2$.

15. $g(x) = 3(x + 2)^2 - 1$ **16.** $g(x) = -\frac{1}{2}(x - 1)^2 + 3$

In Exercises 17 and 18, rewrite the quadratic function in vertex form.

17. $y = 5x^2 - 10x + 2$ **18.** $f(x) = -2x^2 + 8x + 5$

19. The graph of $y = x^2$ is reflected in the x-axis and translated 3 units right and 2 units up. Write an equation for the function in vertex form and in standard form. Describe advantages of writing the function in each form.

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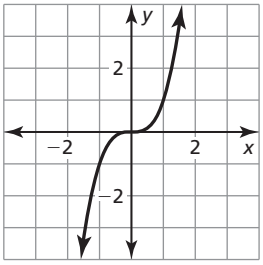
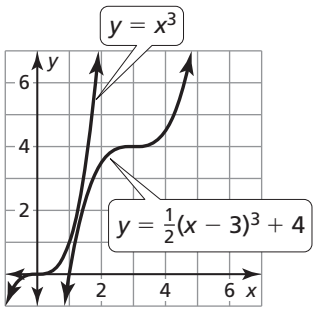
8.4 Enrichment and Extension

Cubic Functions Using the Parent Graph

Similar to quadratic functions in vertex form, cubic functions can shift up and down and left and right using the same properties. Use the parent function to the right to shift the following function.



Example: Graph $y = \frac{1}{2}(x - 3)^3 + 4$.



Graph the equation using the parent function as a reference.

1. $y = (x + 2)^3$

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

3. $y = -x^3 + 2$

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

5. $y = 2(x - 4)^3$

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

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8.4 Puzzle Time

How Do You Make Sure You Pass A Geometry Test?

Write the letter of each answer in the box containing the exercise number.

Determine whether the function is *even*, *odd*, or *neither*.

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

2. $c(x) = -\frac{3}{4}x$

3. $g(x) = 6x - 9$

Find the vertex and the axis of symmetry of the graph of the function.

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

5. $r(x) = -7(x + 5)^2 - 6$

6. $h(x) = 2(x - 8)^2 + 12$

7. $s(x) = -9(x - 3)^2 + 7$

Compare the graph of the function to the graph of $f(x) = x^2$.

8. $b(x) = 3(x + 4)^2$

9. $w(x) = -(x - 1)^2 - 9$

10. $k(x) = \frac{1}{8}(x - 6)^2$

11. $m(x) = (x + 7)^2 + 10$

Write a quadratic function in vertex form whose graph has the given vertex and passes through the given point.

12. vertex: $(-4, -2)$; passes through $(-7, 7)$

13. vertex: $(2, 3)$; passes through $(4, 11)$

14. vertex: $(-4, 6)$; passes through $(0, -26)$

15. vertex: $(8, 1)$; passes through $(10, 13)$

16. A portion of a ski slope in the shape of a parabola has a vertex of $(45, 125)$ and passes through the point $(70, 0)$.

Answers

A. odd

G. even

W. neither

E. $(8, 12)$; $x = 8$

S. $(-2, 0)$; $x = -2$

A. $(3, 7)$; $x = 3$

L. $(-5, -6)$; $x = -5$

K. $f(x) = 2(x - 2)^2 + 3$

L. $f(x) = -\frac{1}{5}(x - 45)^2 + 125$

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

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

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

T. reflection in the x-axis, translation 1 unit right and 9 units down

N. translation 7 units left and 10 units up

L. translation 4 units left, and a vertical stretch by a factor of 3

E. translation 6 units right, and a vertical shrink by a factor of $\frac{1}{8}$

13	11	15	3		2	16	5		9	12	6		7	14	1	8	10	4

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