

For any positive number  $k$ , graphing  $y = \sqrt{x} + k$  translates the graph of  $y = \sqrt{x}$  up  $k$  units. Graphing  $y = \sqrt{x} - k$  translates the graph of  $y = \sqrt{x}$  down  $k$  units.

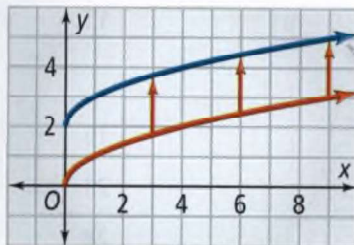
### Think

Is this similar to a problem you've seen before?

Yes. You have graphed functions of the form  $y = |x| + k$  by translating the graph of  $y = |x|$ .

### Problem 3 Graphing a Vertical Translation

What is the graph of  $y = \sqrt{x} + 2$ ?



For the graph of  $y = \sqrt{x} + 2$ , the graph of  $y = \sqrt{x}$  is shifted 2 units up.

**Got It?** 3. What is the graph of  $y = \sqrt{x} - 3$ ?

For any positive number  $h$ , graphing  $y = \sqrt{x+h}$  translates the graph of  $y = \sqrt{x}$  to the left  $h$  units. Graphing  $y = \sqrt{x-h}$  translates the graph of  $y = \sqrt{x}$  to the right  $h$  units.

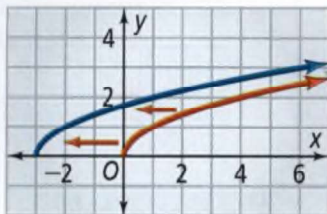
### Think

Is there another way to solve this problem?

Yes. You could make a table of ordered pairs that satisfy the equation and then plot them.

### Problem 4 Graphing a Horizontal Translation

What is the graph of  $y = \sqrt{x+3}$ ?



For the graph of  $y = \sqrt{x+3}$ , the graph of  $y = \sqrt{x}$  is shifted 3 units to the left.

**Got It?** 4. What is the graph of  $y = \sqrt{x-3}$ ?

## Lesson Check

### Do you know HOW?

1. What is the domain of the function  $y = \sqrt{x+3}$ ?

Graph each function.

2.  $y = 2\sqrt{x}$
3.  $y = \sqrt{x} - 6$

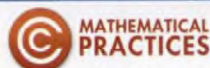
### Do you UNDERSTAND?



4. **Vocabulary** Is  $y = x\sqrt{5}$  a square root function? Explain.
5. **Writing** Explain how the graph of  $y = \sqrt{x-1}$  is related to the graph of  $y = \sqrt{x}$ .
6. **Reasoning** Can the domain of a square root function include negative numbers? Explain.



# Practice and Problem-Solving Exercises



## A Practice

Find the domain of each function.

7.  $y = \frac{1}{2}\sqrt{x}$

8.  $y = \sqrt{x} + 2$

9.  $y = \sqrt{x-7}$

10.  $y = 3\sqrt{\frac{x}{3}}$

11.  $y = 2.7\sqrt{x+2} + 11$

12.  $y = \sqrt{4x-13}$

13.  $y = \frac{4}{7}\sqrt{18-x}$

14.  $y = \sqrt{3x+9} - 6$

15.  $y = \sqrt{3(x-4)}$

See Problem 1.

Make a table of values and graph each function.

16.  $y = \sqrt{2x}$

17.  $f(x) = 4\sqrt{x}$

18.  $y = \sqrt{4x-8}$

19.  $y = \sqrt{3x}$

20.  $f(x) = 3\sqrt{x}$

21.  $y = -3\sqrt{x}$

22.  $f(x) = \frac{1}{3}\sqrt{x}$

23.  $y = \sqrt{\frac{x}{2}}$

24.  $y = 2\sqrt{x-3}$

See Problem 2.

- STEM** 25. **Physics** The function  $v = \sqrt{19.6h}$  models an object's velocity  $v$  in meters per second after it has fallen  $h$  meters, ignoring the effects of air resistance. Make a table and graph the function. For what values of  $h$  will the object's velocity be more than 10 m/s?

Match each function with its graph.

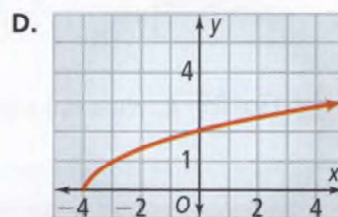
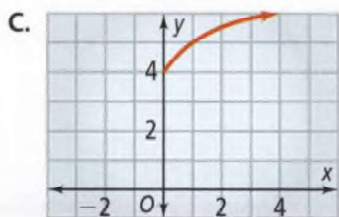
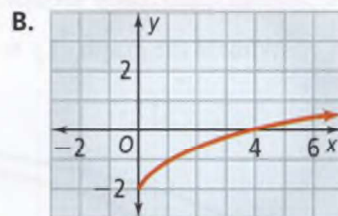
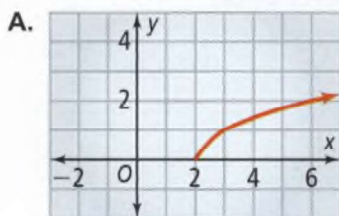
26.  $y = \sqrt{x+4}$

27.  $y = \sqrt{x-2}$

28.  $y = \sqrt{x} + 4$

29.  $y = \sqrt{x} - 2$

See Problems 3 and 4.



Graph each function by translating the graph of  $y = \sqrt{x}$ .

30.  $y = \sqrt{x} + 5$

31.  $y = \sqrt{x} - 5$

32.  $y = \sqrt{x} - 1$

33.  $y = \sqrt{x+2}$

34.  $f(x) = \sqrt{x-5}$

35.  $f(x) = \sqrt{x-4}$

36.  $y = \sqrt{x} + 1$

37.  $y = \sqrt{x+1}$

38.  $y = \sqrt{x-1}$

## B Apply

39. What are the domain and the range of the function  $y = \sqrt{2x-8}$ ?

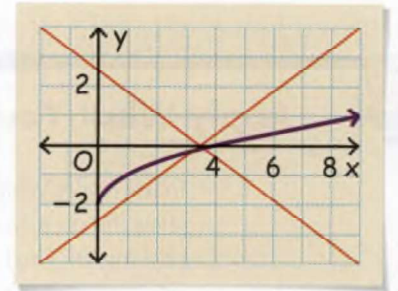
40. What are the domain and the range of the function  $y = \sqrt{8-2x}$ ?



41. **Firefighting** When firefighters are trying to put out a fire, the rate at which they can spray water on the fire depends on the nozzle pressure. You can find the flow rate  $f$  in gallons per minute using the function  $f = 120\sqrt{p}$ , where  $p$  is the nozzle pressure in pounds per square inch.

- Graph the function.
- What nozzle pressure gives a flow rate of 800 gal/min?

42. **Error Analysis** A student graphed the function  $y = \sqrt{x-2}$  at the right. What mistake did the student make? Draw the correct graph.



43. **Think About a Plan** The velocity  $v$  in meters per second of a 2,000,000-kg rocket is given by the function  $v = \sqrt{E}$ , where  $E$  is the rocket's kinetic energy in megajoules (MJ). When the rocket's kinetic energy is 8,000,000 MJ, what is its velocity?
- How can you use a graph to solve the problem?
  - How can you check your answer?

Make a table of values and graph each function.

44.  $y = \sqrt{x-2.5}$

45.  $f(x) = 4\sqrt{x}$

46.  $y = \sqrt{x+6}$

47.  $y = \sqrt{0.5x}$

48.  $y = \sqrt{x-2} + 3$

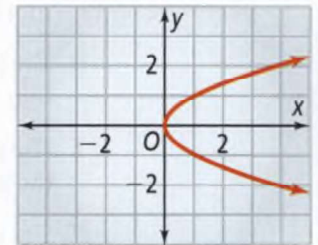
49.  $f(x) = \sqrt{x+2} - 4$

50.  $y = \sqrt{2x} + 3$

51.  $y = \sqrt{2x+6} + 1$

52.  $y = \sqrt{3x-3} - 2$

53. The graph of  $x = y^2$  is shown at the right.
- Is this the graph of a function?
  - How does  $x = y^2$  relate to the square root function  $y = \sqrt{x}$ ?
  - Reasoning** What is a function for the part of the graph that is shown in Quadrant IV? Explain.



54. **Reasoning** Without graphing, determine which graph rises more steeply,  $y = \sqrt{3x}$  or  $y = 3\sqrt{x}$ . Explain your answer.

Graph each function by translating the graph of  $y = \sqrt{x}$ .

55.  $y = \sqrt{x+4} - 1$

56.  $y = \sqrt{x+1} + 5$

57.  $y = \sqrt{x-3} - 2$

58.  $y = \sqrt{x-6} + 3$

59.  $y = \sqrt{x+2.5} - 1$

60.  $y = \sqrt{x-4.5} + 1.5$



61. a. Graph  $y = \sqrt{x^2} + 5$ .  
b. Write a function for the graph you drew that does not require a radical.

62. In parts (a)-(d), graph each function.

a.  $y = \sqrt{4x}$

b.  $y = \sqrt{5x}$

c.  $y = \sqrt{6x}$

d.  $y = \sqrt{-6x}$

- e. **Reasoning** Describe how the graph of  $y = \sqrt{nx}$  changes as the value of  $n$  varies.