6 Integers and the Coordinate Plane

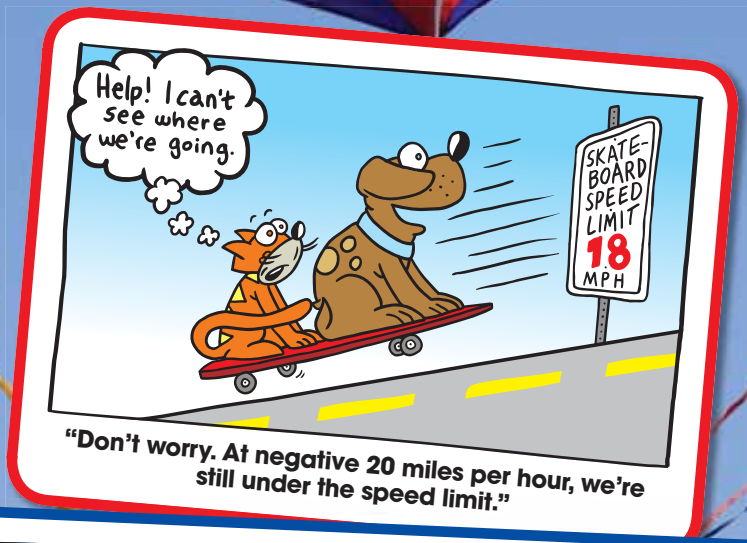
6.1 Integers

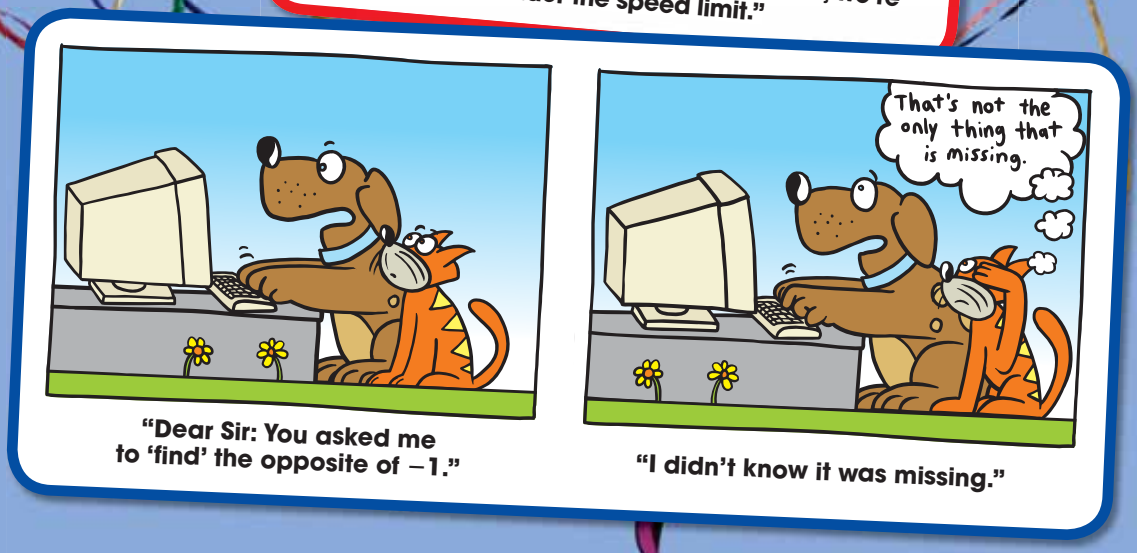
6.2 Comparing and Ordering Integers

6.3 Fractions and Decimals on the Number Line

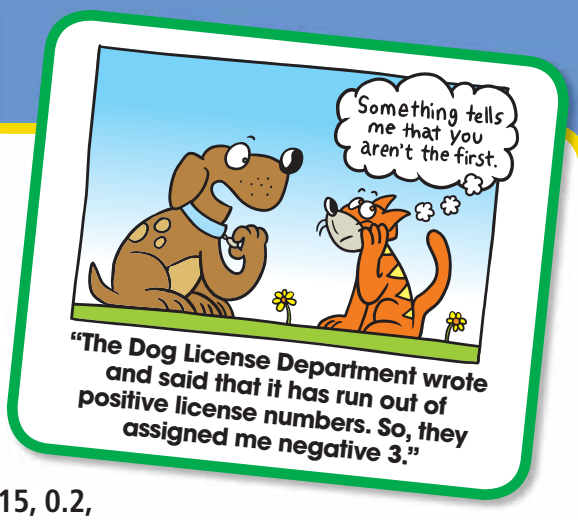
6.4 Absolute Value

6.5 The Coordinate Plane



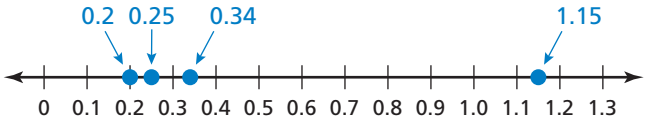


What You Learned Before



Ordering Decimals

Example 1 Use a number line to order 0.25, 1.15, 0.2, and 0.34 from least to greatest.



Try It Yourself

Use a number line to order the numbers from least to greatest.

1. 0.01, 0.42, 0.2, 0.5

2. 1.05, 0.95, 0.75, 1.01

Comparing Numbers

Complete the number sentence with <, >, or =.

Example 2 $10 \square 15$

On a number line, 10 is closer to zero than 15.

∴ So, $10 < 15$.

Example 3 $0.875 \square \frac{7}{8}$

$$0.875 = \frac{875}{1000} = \frac{875 \div 125}{1000 \div 125} = \frac{7}{8}$$

∴ So, $0.875 = \frac{7}{8}$.

Example 4 Find three numbers that make the number sentence $1\frac{2}{5} \leq \square$ true.

∴ *Sample answer:* $1\frac{3}{5}$, $\frac{5}{2}$, 2

Try It Yourself

Complete the number sentence with <, >, or =.

3. $2.01 \square 2.001$

4. $4.5 \square \frac{9}{2}$

5. $3.18 \square 3.2$

Find three numbers that make the number sentence true.

6. $\frac{17}{2} \leq \square$

7. $1\frac{1}{2} > \square$

8. $0.75 \geq \square$

6.1 Integers

Essential Question How can you represent numbers that are less than 0?

1 ACTIVITY: Reading Thermometers

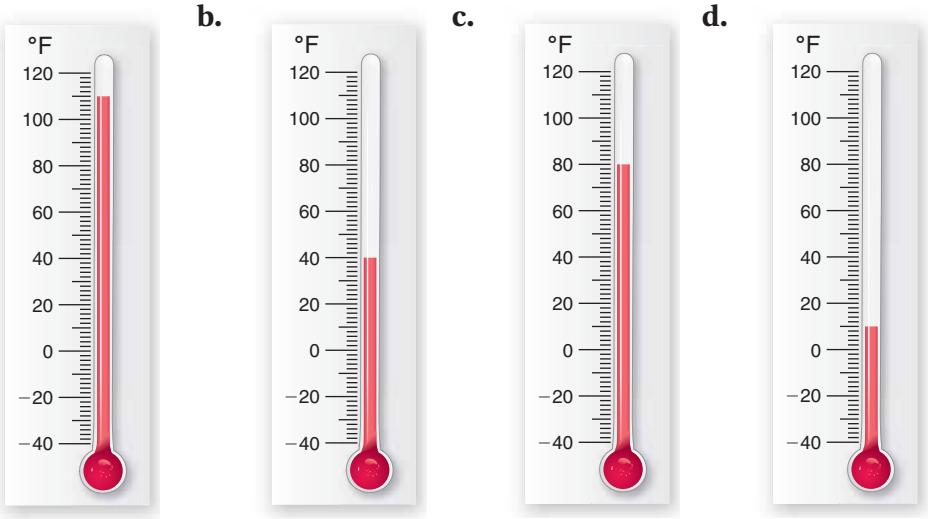
Work with a partner. The thermometers show the temperatures in four cities.

Honolulu, Hawaii *Anchorage, Alaska*

Death Valley, California *Seattle, Washington*

Write each temperature. Then match each temperature with its most appropriate location.

a. **b.** **c.** **d.**



e. How would you describe all the temperatures in relation to 0°F?

2 ACTIVITY: Describing a Temperature

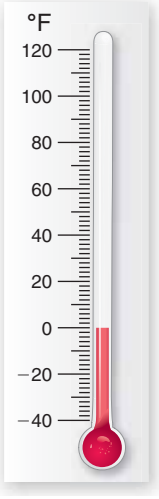
Work with a partner. The thermometer shows the coldest temperature ever recorded in Seattle, Washington.

a. What is the temperature?

b. How do you write temperatures that are colder than this?

c. Suppose the record for the coldest temperature in Seattle is broken by 10 degrees. What is the new coldest temperature? Draw a thermometer that shows the new coldest temperature.

d. How is the new coldest temperature different from the temperatures in Activity 1?



Integers

In this lesson, you will

- understand positive and negative integers and use them to describe real-life situations.
- graph integers on a number line.

3 ACTIVITY: Extending the System of Whole Numbers

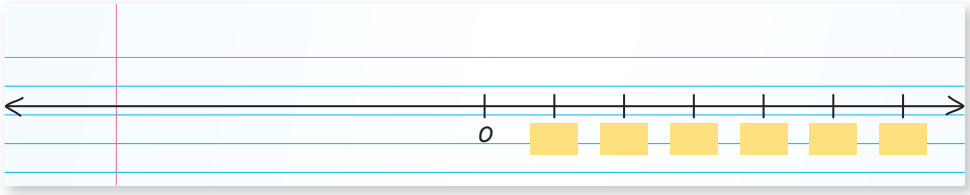
Math Practice

Maintain Oversight

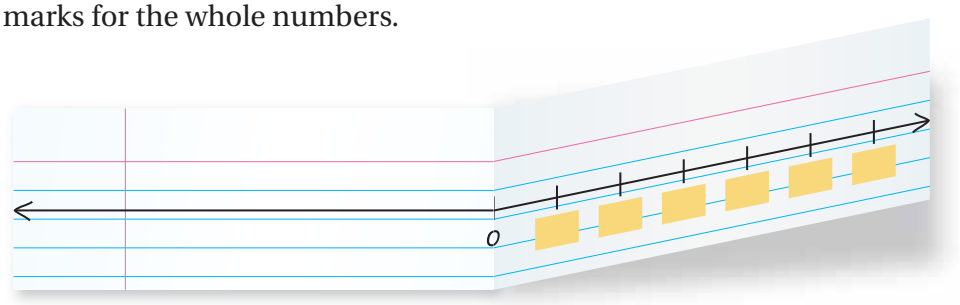
How does this activity help you represent numbers less than 0?

Work with a partner.

a. Copy and complete the number line using whole numbers only.



b. Fold the paper with your number line around 0 so that the lines overlap. Make tick marks on the other side of the number line to match the tick marks for the whole numbers.



c. **STRUCTURE** Compare this number line to the thermometers from Activities 1 and 2. What do you think the new tick marks represent? How would you label them?

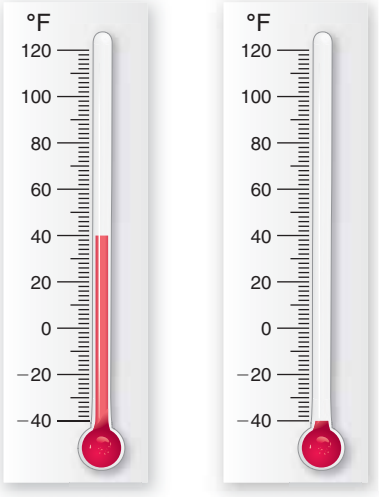
What Is Your Answer?

4. **IN YOUR OWN WORDS** How can you represent numbers that are less than 0?

5. Describe another real-life example that uses numbers that are less than 0.

6. **REASONING** How are the temperatures shown by the thermometers at the right similar? How are they different?

7. **WRITING** The temperature in a town on Thursday evening is 25°F. On Sunday morning, the temperature drops below 0°F. Write a story to describe what may have happened in the town. Be sure to include the temperatures for each day.



Practice Use what you learned about positive and negative numbers to complete Exercises 4–7 on page 252.

6.1 Lesson

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Key Vocabulary
positive numbers, *p. 250*
negative numbers, *p. 250*
opposites, *p. 250*
integers, *p. 250*

Positive numbers are greater than 0. They can be written with or without a positive sign (+).

$+1$ $\quad$ 5 $\quad$ $+20$ $\quad$ $10{,}000$

Negative numbers are less than 0. They are written with a negative sign (−).

-1 $\quad$ -5 $\quad$ -20 $\quad$ $-10{,}000$

Two numbers that are the same distance from 0 on a number line, but on opposite sides of 0, are called **opposites**. The opposite of 0 is 0.

The Meaning of a Word

Opposite

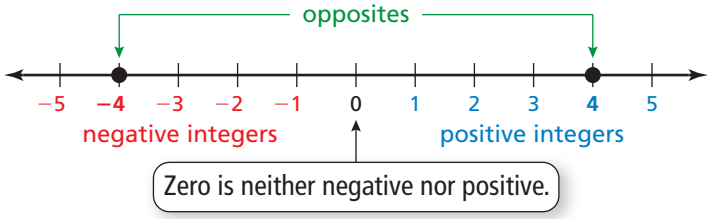
When you sit across from your friend at the lunch table, you sit **opposite** your friend.

Key Idea

Integers

Words **Integers** are the set of whole numbers and their opposites.

Graph



EXAMPLE 1 Writing Positive and Negative Integers

Write a positive or negative integer that represents the situation.

a. A contestant gains 250 points on a game show.

Gains indicates a number greater than 0. So, use a positive integer.

∴ $+250$, or 250

b. Gasoline freezes at 40 degrees below zero.

Below zero indicates a number less than 0. So, use a negative integer.

∴ -40

On Your Own

Now You're Ready
Exercises 8–13

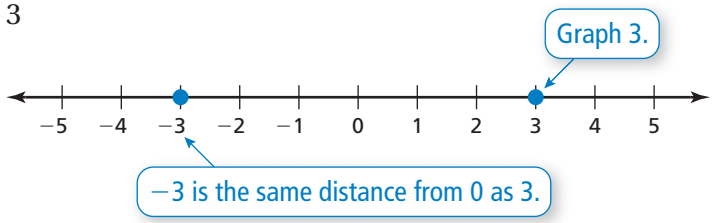
Write a positive or negative integer that represents the situation.

1. A hiker climbs 900 feet up a mountain.
2. You have a debt of $24.
3. A student loses 5 points for being late to class.
4. A savings account earns $10.

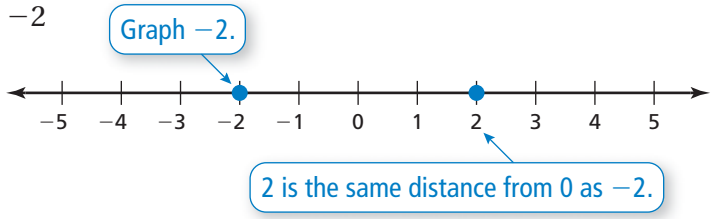
EXAMPLE 2 Graphing Integers

Graph each integer and its opposite.

a. 3



b. −2



Reading

You can think of the negative sign (−) as referring to the opposite of a number. In Example 2(b), you can read −2 as "the opposite of 2."

EXAMPLE 3 Real-Life Application

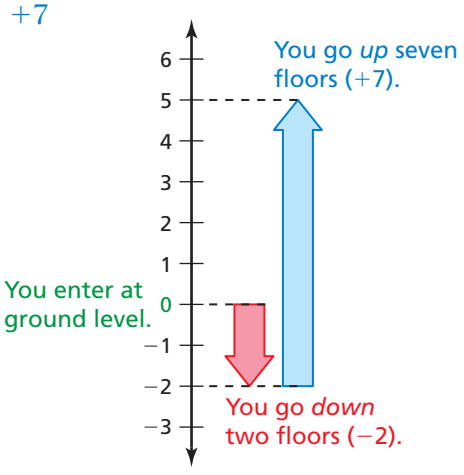
You deliver flowers to an office building. You enter at ground level and go down 2 floors to make the first delivery. Then you go up 7 floors to make the second delivery.

a. Write an integer that represents each position.

Position	*Integer*
You enter at ground level.	0
You go down 2 floors.	−2
You go up 7 floors.	+7

b. Write an integer that represents how you return to ground level.

Use a number line to model your movement, as shown.



The second delivery is on the fifth floor. You must go down 5 floors to return to ground level.

∴ The integer representing "down 5 floors" is −5.

On Your Own

Now You're Ready
Exercises 16–23

Graph the integer and its opposite.

5. 6 **6.** −4 **7.** −12 **8.** 1

9. WHAT IF? In Example 3, you go up 9 floors to make the second delivery. Write an integer that represents how you return to ground level.

6.1 Exercises

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Vocabulary and Concept Check

1. **VOCABULARY** Which of the following numbers are integers?

$$8, -4.1, -9, \frac{1}{6}, 1.75, 22$$

2. **OPEN-ENDED** Describe a real-life example that you can represent by -1200.

3. **VOCABULARY** List three words or phrases used in real life that indicate negative numbers.

Practice and Problem Solving

Graph the number that represents the situation on a number line.

4. A football team loses 3 yards.
5. The temperature is 6 degrees below zero.
6. A person climbs 600 feet up a mountain.
7. You earn \$15 raking leaves.

Write a positive or negative integer that represents the situation.

1 8. You withdraw \$42 from an account.
9. An airplane climbs to 37,500 feet.
10. The temperature rises 17 degrees.
11. You lose 56 points in a video game.
12. A ball falls 350 centimeters.
13. You receive 5 bonus points in class.

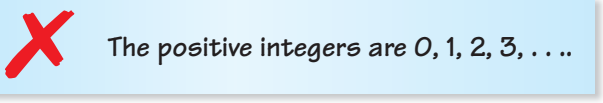
14. **STOCK MARKET** A stock market gains 83 points. The next day, the stock market loses 47 points. Write each amount as an integer.

15. **SCUBA DIVING** The world record for scuba diving is 318 meters below sea level. Write this as an integer.

Graph the integer and its opposite.

2 16. -5
17. -8
18. 14
19. 9
20. 30
21. -150
22. -32
23. 400

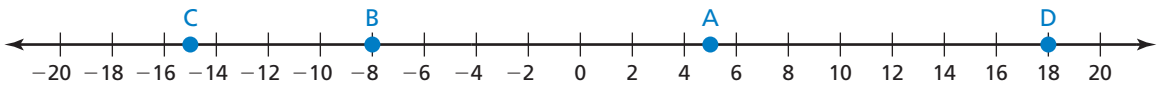
24. **ERROR ANALYSIS** Describe and correct the error in describing positive integers.



25. **TEMPERATURE** The highest temperature in February is 25°F. The lowest temperature in February is the opposite of the highest temperature. Graph both temperatures.

Identify the integer represented by the point on the number line.

26. A **27.** B **28.** C **29.** D



30. **TIDES** Use the information below.

- Low tide is 1 foot below the average water level.
- High tide is 5 feet higher than low tide.

Write an integer that represents the average water level relative to high tide.

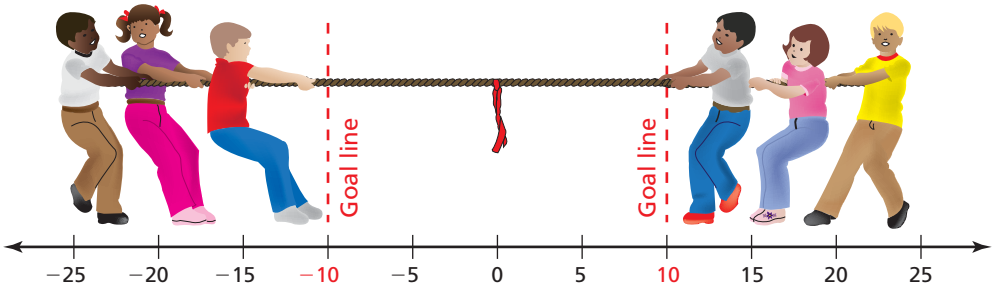
31. **REPEATED REASONING** Choose any positive integer.

a. Find the opposite of the integer. **b.** Find the opposite of the integer in part (a).

c. What can you conclude about the opposite of the opposite of the integer? Is this true for all integers? Use a number line to justify your answer.

d. Describe the meaning of $-(-(-6))$. Find its value.

32. Number Sense In a game of tug-of-war, a team wins by pulling the flag over its goal line. The flag begins at 0. During a game, the flag moves 8 feet to the right, 12 feet to the left, and 13 feet back to the right. Did a team win? Explain.



Fair Game Review What you learned in previous grades & lessons

Order the numbers from least to greatest. *(Skills Review Handbook)*

33. $\frac{7}{8}, \frac{1}{2}, \frac{3}{8}, \frac{3}{4}$

34. 4.5, 4.316, 4.32, 4.312

35. **MULTIPLE CHOICE** The height of a statue is 276 inches. What is the height of the statue in meters? Round your answer to the nearest hundredth. *(Section 5.7)*

Ⓐ 1.09 m Ⓑ 7.01 m Ⓒ 108.66 m Ⓓ 701.04 m

6.2 Comparing and Ordering Integers

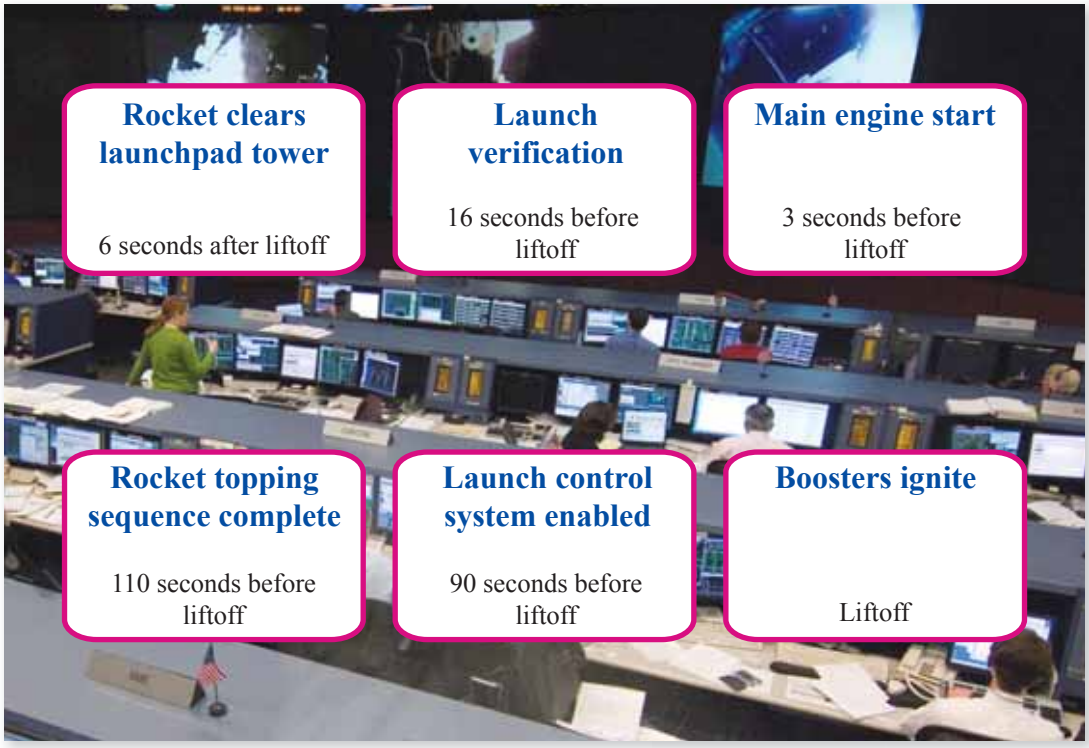
Essential Question How can you use a number line to order real-life events?

1 ACTIVITY: Seconds to Takeoff

Work with a partner. You are listening to a command center before the liftoff of a rocket.

You hear the following:

> **"T minus 10 seconds . . . go for main engine start . . . T minus 9 . . . 8 . . . 7 . . . 6 . . . 5 . . . 4 . . . 3 . . . 2 . . . 1 . . . we have liftoff."**



a. Draw a number line. Then locate the events shown above at appropriate points on the number line.

b. Which event occurs at zero on your number line? Explain.

c. Which of the events occurs first? Which of the events occurs last? How do you know?

d. List the events in the order they occurred.

Integers

In this lesson, you will

- use a number line to compare positive and negative integers.
- use a number line to order positive and negative integers for real-life situations.

2 ACTIVITY: Being Careful with Terminology

Work with a partner.

a. Use a number line to show that the phrase "3 seconds away from liftoff" can have two meanings.

b. Reword the phrase "3 seconds away from liftoff" in two ways so that each meaning is absolutely clear.

c. Explain why you must be very careful with terminology if you are working in the command center for a rocket launch.

3 ACTIVITY: A Day in the Life of an Astronaut

Math Practice

Recognize the Usefulness of Tools

Which sources would give you the most accurate information? How do you know you can trust the information you find?

Make a time line that shows a day in the life of an astronaut. Use the Internet or another reference source to gather information.

- Use a number line with units representing hours. Start at 12 hours before liftoff and end at 12 hours after liftoff. Locate the liftoff at 0. Assume liftoff occurs at noon.
- Include at least five events before liftoff, such as when the astronauts suit up.
- Include at least five events after liftoff, such as when the rocket enters Earth's orbit.
- How do you determine where each event occurs on the number line?

What Is Your Answer?

4. **IN YOUR OWN WORDS** How can you use a number line to order real-life events?

5. Describe how you can use a number line to create a time line.

Practice Use what you learned about number lines to complete Exercises 4–7 on page 258.

6.2 Lesson

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On a horizontal number line, numbers to the left are less than numbers to the right. Numbers to the right are greater than numbers to the left.

EXAMPLE 1 Comparing Integers on a Horizontal Number Line

Compare 2 and −6.

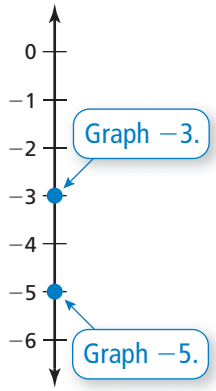
∴ 2 is to the right of −6. So, $2 > -6$.

On a vertical number line, numbers below are less than numbers above. Numbers above are greater than numbers below.

EXAMPLE 2 Comparing Integers on a Vertical Number Line

Compare −5 and −3.

∴ −5 is below −3. So, $-5 < -3$.



On Your Own

Now You're Ready
Exercises 4–11

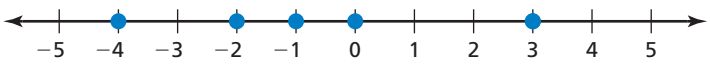
Copy and complete the statement using < or >.

1. $0 \square -4$ **2.** $-5 \square 5$ **3.** $-8 \square -7$

EXAMPLE 3 Ordering Integers

Order −4, 3, 0, −1, −2 from least to greatest.

Graph each integer on a number line.



Write the integers as they appear on the number line from left to right.

∴ So, the order from least to greatest is −4, −2, −1, 0, 3.

EXAMPLE 4 Reasoning with Integers

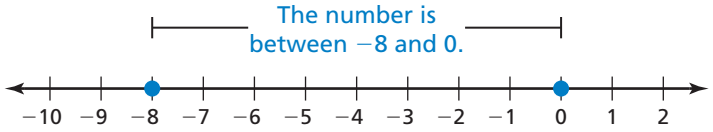
A number is greater than −8 and less than 0. What is the greatest possible integer value of this number?

Ⓐ −10 Ⓑ −7 Ⓒ −1 Ⓓ 2

Study Tip

In Example 4, you can eliminate Choices A and D because −10 is to the left of −8 and 2 is to the right of 0.

The number is greater than −8 and less than 0. So, the number must be to the right of −8 and to the left of 0 on a horizontal number line.

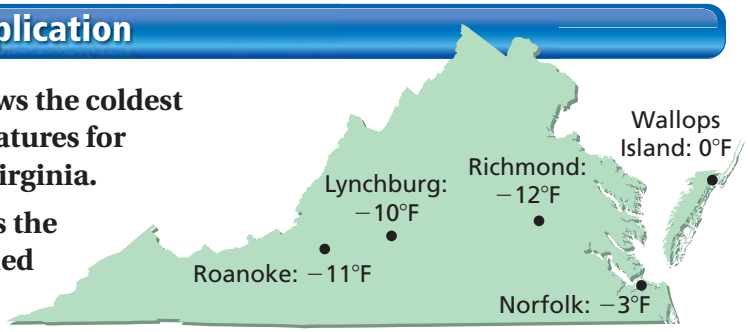


The greatest possible integer value between −8 and 0 is the integer farthest to the right on the number line between these values, which is −1.

∴ So, the correct answer is Ⓒ.

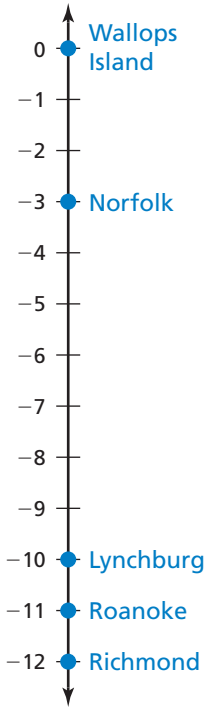
EXAMPLE 5 Real-Life Application

The diagram shows the coldest recorded temperatures for several cities in Virginia.



a. Which city has the coldest recorded temperature?

Graph each integer on a vertical number line.



∴ −12 is the lowest on the number line. So, Richmond has the coldest recorded temperature.

b. Has a negative Fahrenheit temperature ever been recorded on Wallops Island? Explain.

∴ The coldest recorded temperature on Wallops Island is 0°F, which is greater than every negative temperature. So, a negative temperature has never been recorded on Wallops Island.

Now You're Ready
Exercises 14–19 and 22

On Your Own

Order the integers from least to greatest.

4. −2, −3, 3, 1, −1 **5.** 4, −7, −8, 6, 1

6. In Example 4, what is the least possible integer value of the number?

7. In Example 5, Norfolk recorded a new record low last night. The new record low is greater than the record low in Lynchburg. What integers can represent the new record low in Norfolk?

6.2 Exercises

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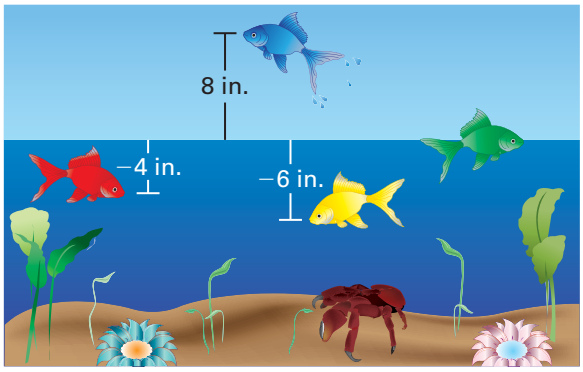
Vocabulary and Concept Check

1. **WRITING** Explain how to use a number line to compare two integers.

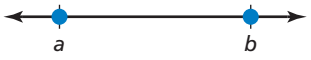
2. **REASONING** The positions of four fish are shown.



   a. Use red, blue, yellow, and green dots to graph the positions of the fish on a horizontal number line and a vertical number line.

   b. Explain how to use the number lines from part (a) to order the positions from least to greatest.

3. **NUMBER SENSE** a and b are negative integers. Compare a and b. Explain your reasoning.



Practice and Problem Solving

Copy and complete the statement using < or >.

1 2 **4.** $3 \square 0$ **5.** $-2 \square 0$ **6.** $6 \square -6$ **7.** $3 \square -4$

8. $-1 \square 4$ **9.** $-7 \square -8$ **10.** $-3 \square -2$ **11.** $-5 \square -10$

ERROR ANALYSIS **Describe and correct the error in comparing the negative numbers.**

12.

✗ Compare −3 and −1.
3 > 1. So, −3 > −1.

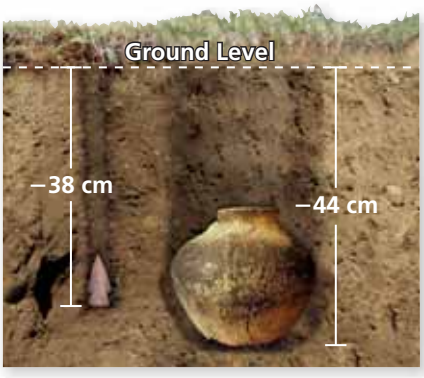
13.

✗ Compare −7 and −3.
Because −7 < −3, −7 is to the right of −3 on a number line.

Order the integers from least to greatest.

3 **14.** 0, −1, 2, 3, −3 **15.** −4, −2, −3, 2, 1 **16.** −2, 3, −3, −4, 4

17. −7, 2, 6, −4, 3 **18.** 10, −10, 30, −30, −50 **19.** −5, 15, −10, −20, 25



20. **ARCHAEOLOGY** An archaeologist discovers the two artifacts shown.

   a. What integer represents ground level?

   b. A dinosaur bone is found 42 centimeters below ground level. Is it deeper than both of the artifacts?

21. **TEMPERATURE** The freezing temperature of nitrogen is −210°C, and the freezing temperature of oxygen is −223°C. Which temperature is colder?

22. REASONING A number is between −2 and −10. What is the least possible integer value of this number? What is the greatest possible integer value of this number?

Tell whether the statement is *always*, *sometimes*, or *never* true. Explain.

23. A positive integer is greater than its opposite.

24. An integer is less than its opposite and greater than 0.

25. ELEVATION The table shows the highest and lowest elevations for five states.

State	Highest Elevation (feet)	Lowest Elevation (feet)
Arkansas	2,753	55
California	14,494	−282
Florida	345	0
Louisiana	535	−8
Tennessee	6,643	178

a. Order the states by their highest elevations, from least to greatest.

b. Order the states by their lowest elevations, from least to greatest.

c. What does the lowest elevation for Florida represent?

26. NUMBER LINE Point A is on a number line halfway between −17 and 5. Point B is halfway between point A and 0. What integer does point B represent?

27. TEMPERATURE Eleven Fahrenheit temperatures are shown on a map during a weather report. When the temperatures are ordered from least to greatest, the middle temperature is below 0°F. Do you know exactly how many of the temperatures are represented by negative numbers? Explain.

28. Puzzle Nine students choose integers. Here are seven of them:

5, −8, 10, −1, −12, −20, and 1.

a. When all nine integers are ordered from least to greatest, the middle integer is 1. Describe the integers chosen by the other two students.

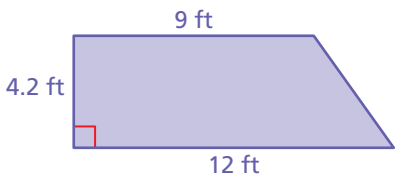
b. When all nine integers are ordered from least to greatest, the middle integer is –3. Describe the integers chosen by the other two students.

Fair Game Review What you learned in previous grades & lessons

Graph the decimal on a number line. *(Skills Review Handbook)*

29. 2.4 **30.** 1.3 **31.** 0.65 **32.** 2.45

33. MULTIPLE CHOICE What is the area of the trapezoid? *(Section 4.3)*



Ⓐ 6.3 ft^2 Ⓑ 44.1 ft^2

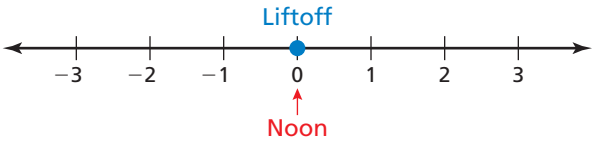
Ⓒ 50.4 ft^2 Ⓓ 88.2 ft^2

6.3 Fractions and Decimals on the Number Line

Essential Question How can you use a number line to compare positive and negative fractions and decimals?

1 ACTIVITY: Locating Fractions on a Number Line

On your time line for "A Day in the Life of an Astronaut" from Activity 3 in Section 6.2, include the following events. Represent each using a fraction or a mixed number.



a. Radio Transmission: 10:30 A.M.

b. Space Walk: 7:30 P.M.

c. Physical Exam: 4:45 A.M.

d. Photograph Taken: 3:15 A.M.

e. Float in the Cabin: 6:20 P.M.

f. Eat Dinner: 8:40 P.M.

Fractions and Decimals

In this lesson, you will

- understand positive and negative numbers and use them to describe real-life situations.
- graph numbers on a number line.

2 ACTIVITY: Fractions and Decimals on a Number Line

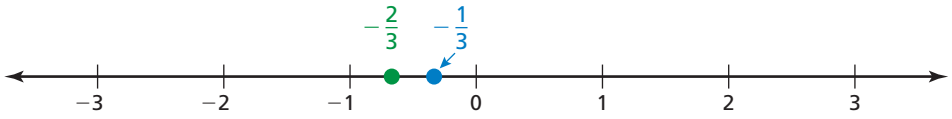
Math Practice

Make a Plan

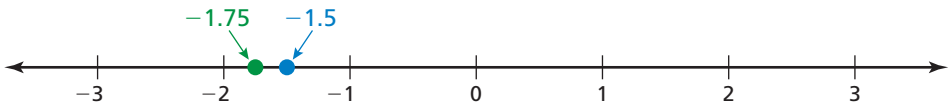
How can you find a number between two given numbers?

Work with a partner. Find a number that is between the two numbers. The number must be greater than the green number *and* less than the blue number.

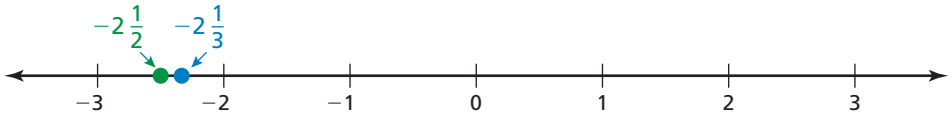
a.



b.



c.



3 ACTIVITY: Decimals on a Number Line

Work with a partner.

Snorkeling: −5 meters

Scuba diving: −50 meters

Deep-sea diving: −700 meters

a. Write the position of each diver in kilometers.

b. **CHOOSE TOOLS** Would a horizontal or a vertical number line be more appropriate for representing these data? Why?

c. Use a number line to order the positions from deepest to shallowest.

What Is Your Answer?

4. **IN YOUR OWN WORDS** How can you use a number line to compare positive and negative fractions and decimals?

5. Draw a number line. Graph and label three values between −2 and −1.

Practice

Use what you learned about fractions and decimals on a number line to complete Exercises 4 and 5 on page 264.

6.3 Lesson

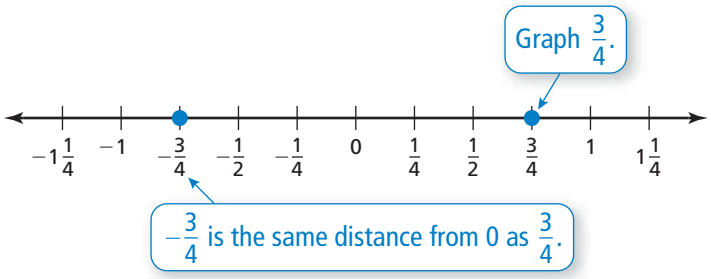
Check It Out
Lesson Tutorials
BigIdeasMath.com

In Section 6.1, you learned that integers can be negative. Fractions and decimals can also be negative.

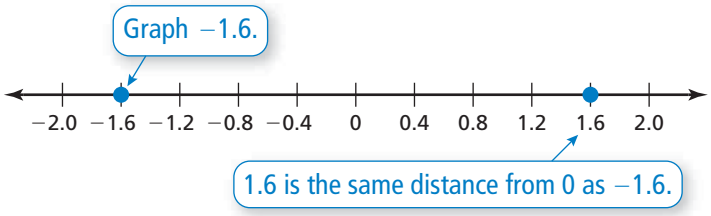
EXAMPLE 1 Graphing Negative Fractions and Decimals

Graph each number and its opposite.

a. $\frac{3}{4}$



b. -1.6



On Your Own

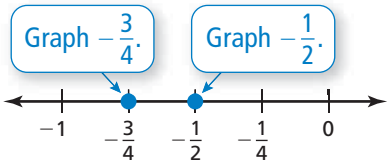
Now You're Ready
Exercises 6–9

Graph the number and its opposite.

1. $2\frac{1}{2}$ **2.** $-\frac{4}{5}$ **3.** -3.5 **4.** 5.25

EXAMPLE 2 Comparing Fractions and Mixed Numbers

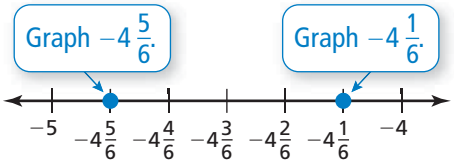
a. Compare $-\frac{1}{2}$ and $-\frac{3}{4}$.



$-\frac{1}{2}$ is to the right of $-\frac{3}{4}$.

$\therefore$ So, $-\frac{1}{2} > -\frac{3}{4}$.

b. Compare $-4\frac{5}{6}$ and $-4\frac{1}{6}$.

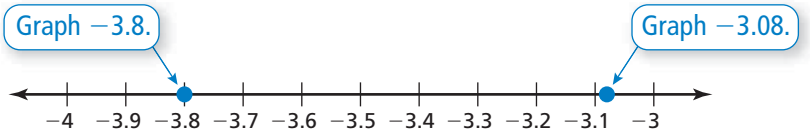


$-4\frac{5}{6}$ is to the left of $-4\frac{1}{6}$.

$\therefore$ So, $-4\frac{5}{6} < -4\frac{1}{6}$.

EXAMPLE 3 Comparing Decimals

Compare -3.08 and -3.8.

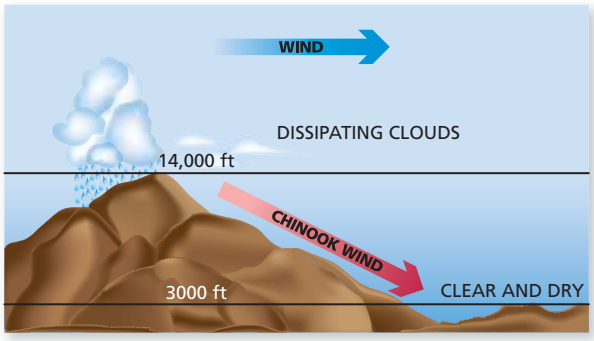


-3.08 is to the right of -3.8.

∴ So, $-3.08 > -3.8$.

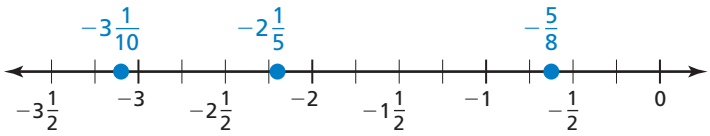
EXAMPLE 4 Real-Life Application

A *Chinook wind* is a warm mountain wind that can cause rapid temperature changes. The table shows three of the greatest temperature drops ever recorded after a Chinook wind occurred. On which date did the temperature drop the fastest? Explain.



Date	Temperature Change
January 10, 1911	$-3\frac{1}{10}$°F per minute
November 10, 1911	$-\frac{5}{8}$°F per minute
January 22, 1943	$-2\frac{1}{5}$°F per minute

Graph the numbers on a number line.



$-3\frac{1}{10}$ is farthest to the left.

∴ So, the temperature dropped the fastest on January 10, 1911.

On Your Own

Now You're Ready
Exercises 10–18 and 20–23

Copy and complete the statement using < or >.

5. $-\frac{4}{7} \square -\frac{1}{7}$ **6.** $-1\frac{2}{3} \square -1\frac{5}{6}$ **7.** $-0.5 \square 0.3$

8. WHAT IF? In Example 4, a temperature change of $-3\frac{2}{5}$°F per minute is recorded. How does this temperature change compare with the other temperature changes? Explain.

6.3 Exercises

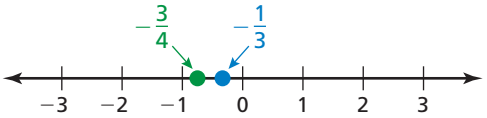
Check It Out
Help with Homework
BigIdeasMath.com

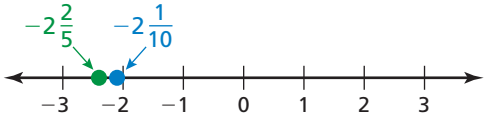
Vocabulary and Concept Check

1. **NUMBER SENSE** Which statement is *not* true?
   - **a.** On a number line, $-2\frac{1}{6}$ is to the left of $-2\frac{2}{3}$.
   - **b.** $-2\frac{2}{3}$ is less than $-2\frac{1}{6}$.
   - **c.** $-2\frac{1}{6}$ is greater than $-2\frac{2}{3}$.
   - **d.** On a number line, $-2\frac{2}{3}$ is to the left of $-2\frac{1}{6}$.
2. **NUMBER SENSE** Is a negative decimal *always*, *sometimes*, or *never* equal to a positive decimal? Explain.
3. **NUMBER SENSE** On a number line, is -2.06 or -2.6 farther to the left?

Practice and Problem Solving

Find a fraction or mixed number that is between the two numbers.

4.


5.


Graph the number and its opposite.

1 **6.** $\frac{2}{3}$ **7.** $-2\frac{1}{4}$ **8.** -3.8 **9.** 2.15

Copy and complete the statement using < or >.

2 3 **10.** $-3\frac{1}{3}$ ☐ $-3\frac{2}{3}$ **11.** $-\frac{1}{2}$ ☐ $-\frac{1}{6}$ **12.** $-\frac{3}{4}$ ☐ $\frac{5}{8}$

13. $-2\frac{2}{3}$ ☐ $-2\frac{1}{2}$ **14.** $-1\frac{5}{6}$ ☐ $-1\frac{3}{4}$ **15.** -4.6 ☐ -4.8

16. -0.12 ☐ -0.05 **17.** 2.41 ☐ -3.16 **18.** -3.524 ☐ -3.542

19. SAND DOLLARS In rough water, a small sand dollar burrows $-\frac{1}{2}$ centimeter into the sand. A larger sand dollar burrows $-1\frac{1}{4}$ centimeters into the sand. Which sand dollar burrowed farther?

Order the numbers from least to greatest.

20. $-2\frac{3}{10}, -2\frac{2}{5}, -2, -2\frac{1}{2}, -3$

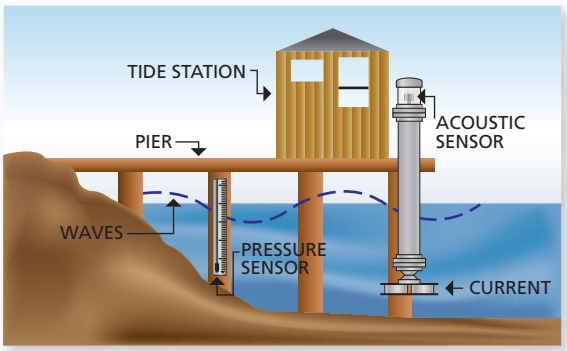
21. $-\frac{1}{20}, -\frac{5}{8}, 0, -1, -\frac{3}{4}$

22. $1.3, -2, -1.8, 0, -1.75$

23. $-4, -4.35, -4.9, -5, -4.3$

24. STARS The *apparent magnitude* of a star measures how bright the star appears as seen from Earth. The brighter the star, the lesser the number. Which star is the brightest?

Star	Alpha Centauri	Antares	Canopus	Deneb	Sirius
Apparent Magnitude	−0.27	0.96	−0.72	1.25	−1.46



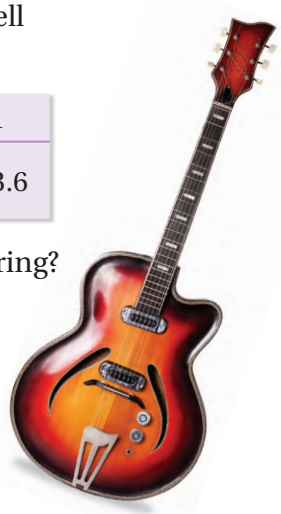
25. LOW TIDE The daily water level is recorded for seven straight days at a tide station on the Big Marco River in Florida. On which days is the water level higher than on the previous day? On which days is it lower?

Day	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Water Level of the Day (feet)	$-\frac{3}{25}$	$-\frac{7}{20}$	$-\frac{27}{50}$	$-\frac{13}{20}$	$-\frac{16}{25}$	$-\frac{53}{100}$	$-\frac{1}{3}$

26. PROBLEM SOLVING A guitar tuner allows you to tune a guitar string to its correct pitch. The units on a tuner are measured in *cents*. The units tell you how far the string tone is above or below the correct pitch.

STEM VIDEO

Guitar String	6	5	4	3	2	1
Number of Cents Away from the Correct Pitch	−0.3	1.6	−2.3	2.8	2.4	−3.6



a. What number on the tuner represents a correctly tuned guitar string?

b. Which strings have a pitch below the correct pitch?

c. Which string has a pitch closest to its correct pitch?

d. Which string has a pitch farthest from its correct pitch?

e. The tuner is rated to be accurate to within 0.5 cent of the true pitch. Which string could possibly be correct?

27. Number Sense What integer values of x make the statement $-\frac{3}{x} < -\frac{x}{3}$ true?

Fair Game Review What you learned in previous grades & lessons

Graph the integer and its opposite. *(Section 6.1)*

28. -7 **29.** 40 **30.** 100 **31.** -15

32. MULTIPLE CHOICE You pay \$48 for 8 pounds of chicken. Which is an equivalent rate? *(Section 5.3)*

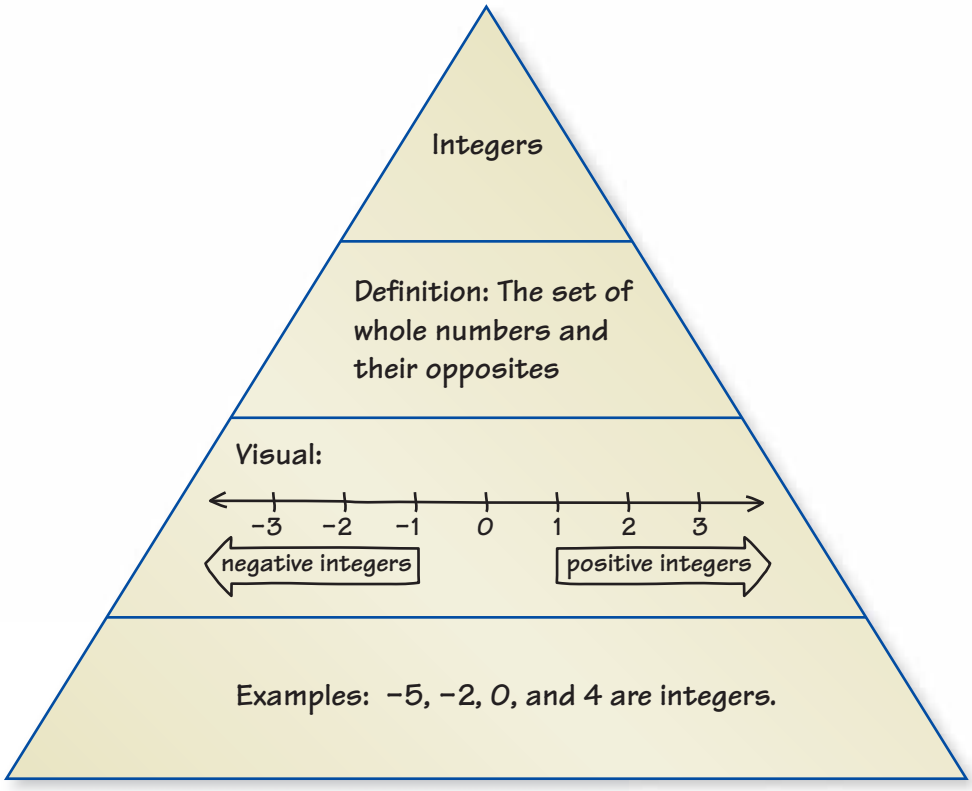
(A) \$44 for 4 pounds (B) \$28 for 4 pounds

(C) \$15 for 3 pounds (D) \$30 for 5 pounds

6 Study Help

Check It Out
Graphic Organizer
BigIdeasMath.com

You can use a **summary triangle** to explain a concept. Here is an example of a summary triangle for integers.



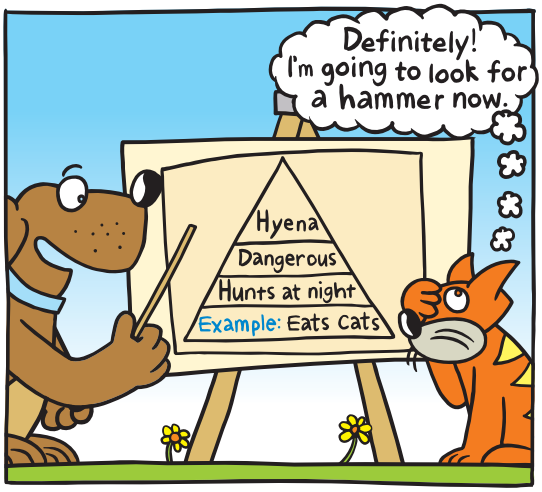
On Your Own

Make summary triangles to help you study these topics.

1. positive integers
2. negative integers
3. opposites

After you complete this chapter, make summary triangles for the following topics.

4. absolute value
5. coordinate plane
6. origin
7. quadrants



"I'm posting my new summary triangle on my daily blog. Do you think it will get me more hits?"

6.1–6.3 Quiz

Check It Out
Progress Check
BigIdeasMath.com

Write a positive or negative integer that represents the situation. *(Section 6.1)*

1. The price of a stock goes up $2.

2. You descend 15 feet.

Graph the integer and its opposite. *(Section 6.1)*

3. 8

4. −3

Copy and complete the statement using < or >. *(Section 6.2)*

5. $-5 \square 0$

6. $-7 \square -9$

Order the integers from least to greatest. *(Section 6.2)*

7. 3, −2, 0, −1, −5

8. −6, 5, 3, −8, 7

Graph the number and its opposite. *(Section 6.3)*

9. $\frac{3}{5}$

10. −1.4

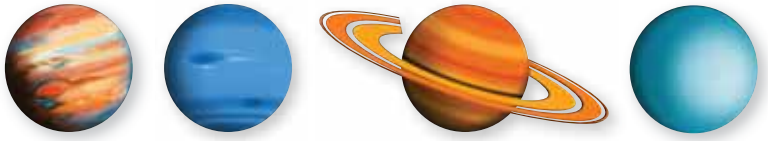
Copy and complete the statement using < or >. *(Section 6.3)*

11. $-2\frac{2}{5} \square -2\frac{1}{4}$

12. $-3.28 \square -3.72$

13. **ROLLER COASTER** At the top of a roller coaster hill, you are 210 feet above ground. At the bottom of the hill, you are 15 feet above ground. Write an integer that represents the change in height from the top to the bottom. *(Section 6.1)*

14. **PLANETS** The table shows the average surface temperatures of four planets. Which planet is the coldest? Explain. *(Section 6.2)*



Planet	Jupiter	Neptune	Saturn	Uranus
Temperature (°C)	−150	−220	−180	−214

15. **STOCK** The table shows the changes in the value of a stock over several days. Order the numbers from least to greatest. *(Section 6.3)*

Day	Change (dollars)
1	−0.42
2	0.26
3	−0.45
4	0.37

6.4 Absolute Value

Essential Question How can you describe how far an object is from sea level?

1 ACTIVITY: Sea Level

Work with a partner. Write an integer that represents the elevation of each object. How far is each object from sea level? Explain your reasoning.

a. Boeing 747

b. Seaplane

c. Bald eagle

d. Leatherback turtle

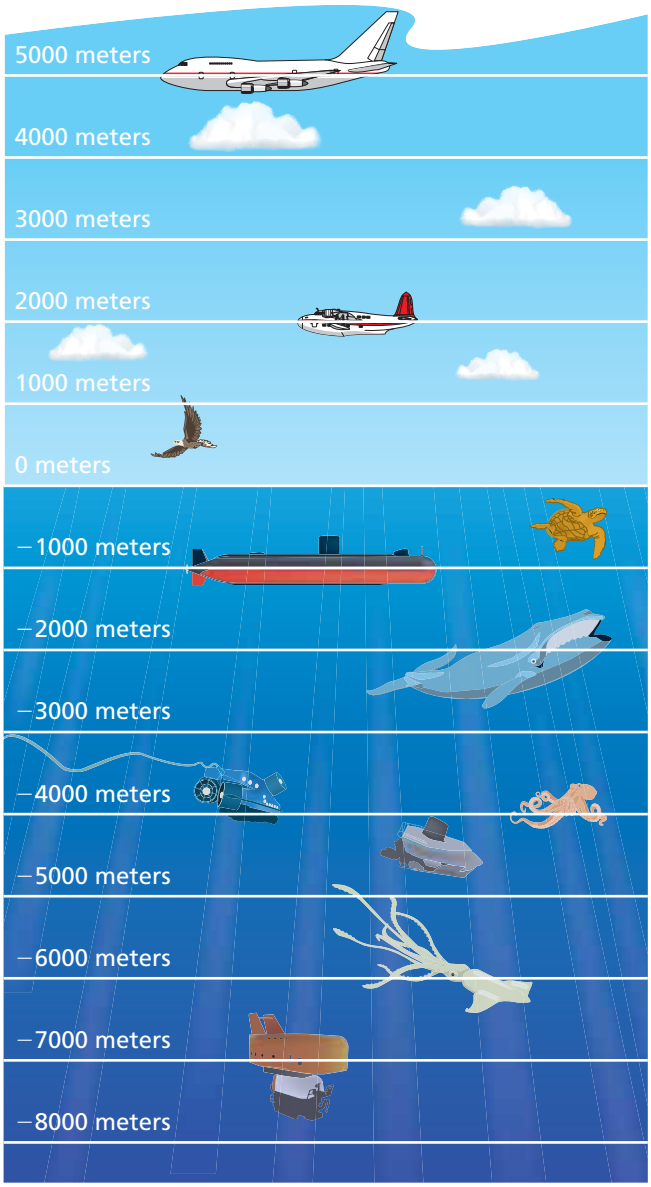
e. U.S.S. Dolphin

f. Whale

g. Jason Jr.

h. Alvin

i. Kaiko



Absolute Value

In this lesson, you will

- find the absolute value of numbers.
- use absolute value to compare numbers in real-life situations.

2 ACTIVITY: Finding a Distance

Work with a partner. Use the diagram in Activity 1.

a. What integer represents sea level?

b. The vessel *Kaiko* ascends to the same depth as the U.S.S. *Dolphin*. About how many meters did *Kaiko* travel? Explain how you found your answer.

c. The vessel *Jason Jr.* descends to the same depth as the *Alvin*. About how many meters did *Jason Jr.* travel? Explain how you found your answer.

d. **REASONING** Which pairs of objects are the same distance from sea level? How do you know?

e. **REASONING** An airplane is the same distance from sea level as the *Kaiko*. How far is the airplane from sea level?

3 ACTIVITY: Oceanography Project

Work with a partner. Use the Internet or some other resource to write a report that describes two ways in which mathematics is used in oceanography.

Here are two possible ideas. You can use one or both of these, or you can use other ideas.

Math Practice

Use Technology to Explore

How can you find more information on oceanography? What information is useful to your report?

Diving Bell

Mine Neutralization Vehicle

What Is Your Answer?

4. **IN YOUR OWN WORDS** How can you describe how far an object is from sea level?

5. **PRECISION** In Activity 1, an object has an elevation of −7500 meters. Is −7500 greater than or less than −7000? Does this object have a depth greater than or less than 7000 meters? Explain your reasoning.

Practice Use what you learned about elevation and sea level to complete Exercises 4–6 on page 272.

6.4 Lesson

Check It Out
Lesson Tutorials
BigIdeasMath.com

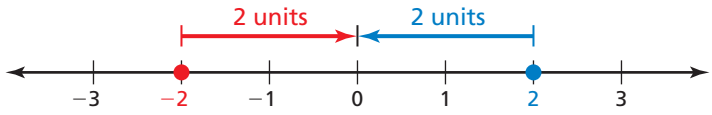
Key Vocabulary
absolute value, *p. 270*

Key Idea

Absolute Value

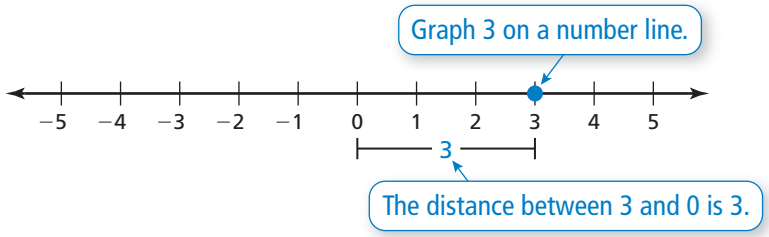
Words The **absolute value** of a number is the distance between the number and 0 on a number line. The absolute value of a number a is written as $|a|$.

Numbers $|-2| = 2$ $|2| = 2$



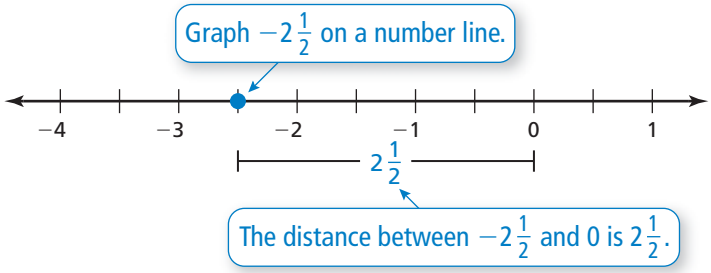
EXAMPLE 1 Finding Absolute Value

a. Find the absolute value of 3.



∴ So, $|3| = 3$.

b. Find the absolute value of $-2\frac{1}{2}$.



∴ So, $\left|-2\frac{1}{2}\right| = 2\frac{1}{2}$.

On Your Own

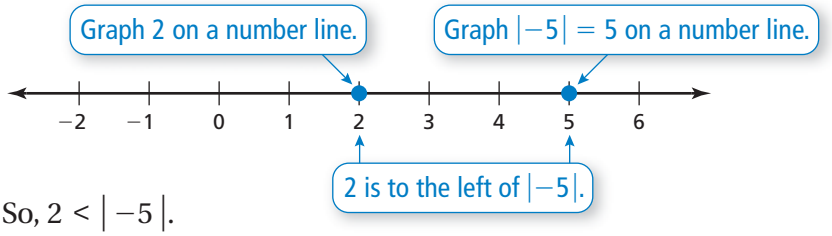
Now You're Ready
Exercises 7–14

Find the absolute value.

1. $|8|$
2. $|-6|$
3. $|0|$
4. $\left|\frac{1}{4}\right|$
5. $\left|-7\frac{1}{3}\right|$
6. $|-12.9|$

EXAMPLE 2 Comparing Values

Compare 2 and $|-5|$.



∴ So, $2 < |-5|$.

On Your Own

Now You're Ready
Exercises 17–22

Copy and complete the statement using <, >, or =.

7. $|-4|$ ____ -2

8. -5 ____ $|5|$

9. $|9|$ ____ 10

10. 3.9 ____ $|-3.9|$

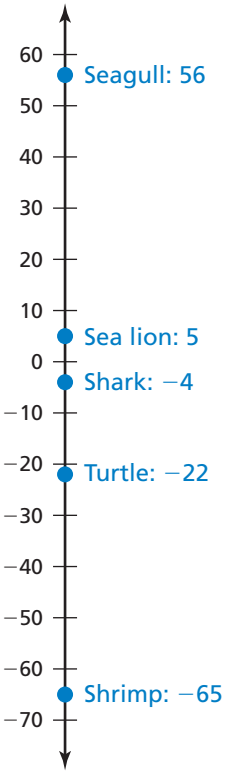
EXAMPLE 3 Real-Life Application

Animal	Elevation (ft)
Shark	−4
Sea lion	5
Seagull	56
Shrimp	−65
Turtle	−22

The table shows the elevations of several animals.

a. Which animal is the deepest? Explain.

Graph each elevation.



The lowest elevation represents the animal that is the deepest. The integer that is lowest on the number line is −65.

∴ So, the shrimp is the deepest.

b. Is the shark or the sea lion closer to sea level?

Because sea level is at 0 feet, use absolute values.

Shark: $|-4| = 4$ **Sea lion:** $|5| = 5$

∴ Because 4 is less than 5, the shark is closer to sea level than the sea lion.

On Your Own

11. Is the seagull or the shrimp closer to sea level? Explain your reasoning.

6.4 Exercises

Check It Out
Help with Homework
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Vocabulary and Concept Check

1. **VOCABULARY** Explain how to find the absolute value of an integer.
2. **REASONING** Which integer is greater, -50 or 25? Which has the greater absolute value? Explain.
3. **DIFFERENT WORDS, SAME QUESTION** Which is different? Find "both" answers.

How far is -3 from 0?

What integer is 3 units to the left of 0?

What is the absolute value of -3?

What is the distance between -3 and 0?

Practice and Problem Solving

Use a vertical number line to graph the location of each object. Then tell which object is farther from sea level.

4. Scuba diver: -15 m
   Dolphin: -22 m
5. Seagull: 12 m
   School of fish: -4 m
6. Shark: -40 m
   Flag on a ship: 32 m

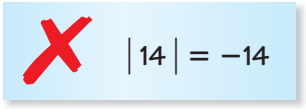
Find the absolute value.

1 7. $|-2|$ 8. $|23|$ 9. $|-8.35|$ 10. $\left|\frac{1}{6}\right|$

11. $\left|-3\frac{2}{5}\right|$ 12. $|11|$ 13. $|14.06|$ 14. $|-68|$

15. **REASONING** Write two integers that have an absolute value of 10.

16. **ERROR ANALYSIS** Describe and correct the error in finding the absolute value.



Copy and complete the statement using <, >, or =.

2 17. $6 \square |-8|$ 18. $|-3| \square 3$ 19. $|-5.5| \square |-3.1|$

20. $\frac{3}{4} \square \left|-\frac{2}{5}\right|$ 21. $|-6.8| \square |8.25|$ 22. $-12 \square |12|$

23. **CAVES** Three scientists explore a cave. Which scientist is farthest underground?

Scientist A: -48 ft Scientist B: -62 ft Scientist C: -53 ft

MATCHING Match the account balance with the debt that it represents. Explain your reasoning.

24. account balance $= -\$25$
25. account balance $< -\$25$
26. account balance $> -\$25$

A. debt $> \$25$ B. debt $= \$25$ C. debt $< \$25$

Order the values from least to greatest.

27. $5,\ 0,\ |-1|,\ |4|,\ -2$

28. $|-3|,\ |5|,\ -3,\ -4,\ |-4|$

29. $10,\ |-6|,\ 9,\ |3|,\ -11,\ 0$

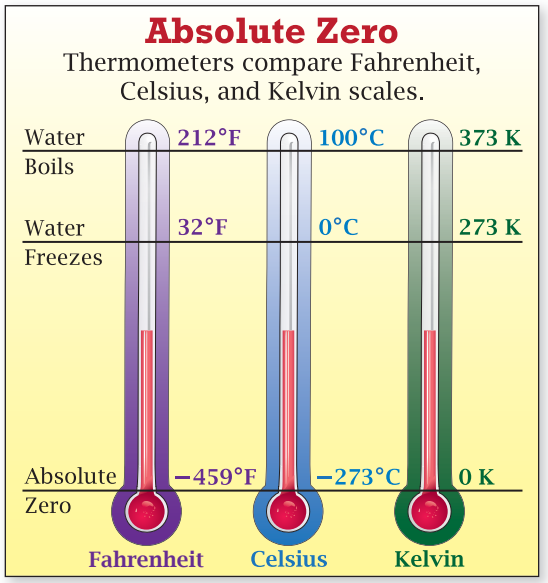
30. $-18,\ |30|,\ -19,\ |-22|,\ -20,\ |-18|$

Simplify the expression.

31. $|0|$

32. $-|6|$

33. $-|-1|$



34. **ABSOLUTE ZERO** The coldest possible temperature is called *absolute zero*. It is represented by 0 K on the Kelvin temperature scale.

a. Which temperature is closer to 0 K: 32°F or −50°C?

b. What do absolute values and temperatures on the Kelvin scale have in common?

Tell whether the statement is *always*, *sometimes*, or *never* true. Explain.

35. The absolute value of a number is greater than the number.

36. The absolute value of a negative number is positive.

37. The absolute value of a positive number is its opposite.

38. **PALINDROME** A *palindrome* is a word or sentence that reads the same forward as it does backward.

a. Graph and label the following points on a number line: $A = -2$, $C = -1$, $E = 0$, $R = -3$. Then graph and label the absolute value of each point on the *same* number line.

b. What word do the letters spell? Is this a palindrome?

c. Make up your own palindrome.

39. Critical Thinking Find values of x and y so that $|x| < |y|$ and $x > y$.

Fair Game Review What you learned in previous grades & lessons

Draw the polygon with the given vertices in a coordinate plane. *(Section 4.4)*

40. $A(1, 1), B(3, 5), C(5, 0)$

41. $D(0, 6), E(2, 1), F(6, 3)$

42. $P(2, 1), Q(4, 4), R(8, 4), S(6, 1)$

43. $W(1, 6), X(9, 6), Y(9, 1), Z(4, 1)$

44. **MULTIPLE CHOICE** Which expression represents "6 less than the product of 4 and a number x"? *(Section 3.2)*

A $(6 - 4)x$ **B** $6 - 4x$ **C** $\frac{6}{4x}$ **D** $4x - 6$

6.5 The Coordinate Plane

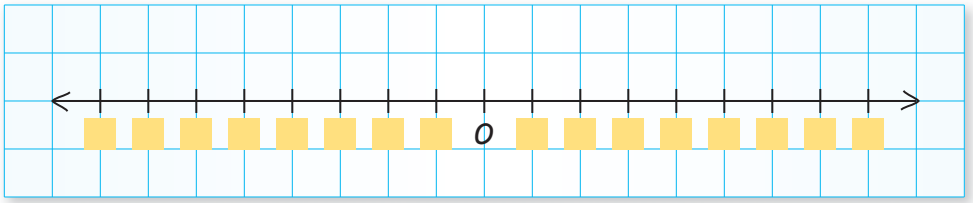
Essential Question How can you graph and locate points that contain negative numbers in a coordinate plane?

You have already graphed points and polygons in one part of the coordinate plane. In Activity 1, you will form the *entire* coordinate plane.

1 ACTIVITY: Forming the Entire Coordinate Plane

Work with a partner.

a. In the middle of a sheet of grid paper, construct a horizontal number line as shown. Label the tick marks. On a different sheet of grid paper, construct and label a similar vertical number line.



b. Cut out the vertical number line and tape it on top of the horizontal number line so that the zeros overlap. Make sure the number lines are perpendicular to one another. How many regions did you form by doing this?

c. **REASONING** What ordered pair represents the point where the number lines intersect? Why do you think this point is called the *origin*? Explain.

2 ACTIVITY: Describing Points in the Coordinate Plane

Work with a partner. Use your perpendicular number lines from Activity 1.

a. Plot and label (3, 2) on your coordinate plane. Shade this region in your coordinate plane. What do you notice about the integers along the number lines that surround (3, 2)?

b. Can you plot a point in your coordinate plane so that it is surrounded by negative numbers on the axes? If so, where is this point? Use a different color to shade this region in your coordinate plane.

c. What do you notice about the integers along the number lines for points in the regions that are not shaded?

d. **STRUCTURE** Describe how you would plot $(-3, -2)$. How is plotting this point similar to plotting (3, 2)? Plot $(-3, -2)$ in your coordinate plane.

e. **REASONING** Where in your coordinate plane do you plot $(2, -4)$? Where do you plot $(-2, 4)$? Explain your reasoning.

Coordinate Plane

In this lesson, you will

- describe the locations of points in the coordinate plane.
- plot points in the coordinate plane given ordered pairs.
- find distances between points in the coordinate plane.

3 ACTIVITY: Plotting Points in a Coordinate Plane

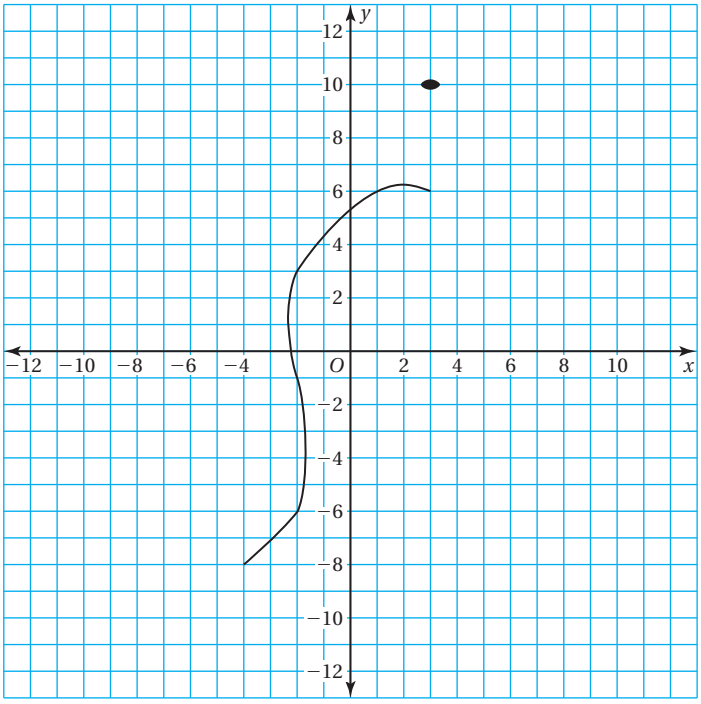
Math Practice

Check Progress

How can you check your progress to make sure you are accurately drawing the picture?

Work with a partner. Plot and connect the points to make a picture. Describe and color the picture when you are done.

1(6, 9)	**2**(4, 11)	**3**(2, 12)	**4**(0, 11)	**5**(−2, 9)
6(−6, 2)	**7**(−9, 1)	**8**(−11, −3)	**9**(−7, 0)	**10**(−5, −1)
11(−5, −5)	**12**(−4, −8)	**13**(−6, −10)	**14**(−3, −9)	**15**(−3, −10)
16(−4, −11)	**17**(−4, −12)	**18**(−3, −11)	**19**(−2, −12)	**20**(−2, −11)
21(−1, −12)	**22**(−1, −11)	**23**(−2, −10)	**24**(−2, −9)	**25**(1, −9)
26(2, −8)	**27**(2, −10)	**28**(1, −11)	**29**(1, −12)	**30**(2, −11)
31(3, −12)	**32**(3, −11)	**33**(4, −12)	**34**(4, −11)	**35**(3, −10)
36(3, −8)	**37**(4, −6)	**38**(6, 0)	**39**(9, −3)	**40**(9, −1)
41(8, 1)	**42**(5, 3)	**43**(3, 6)	**44**(3, 7)	**45**(4, 8)



What Is Your Answer?

4. IN YOUR OWN WORDS How can you graph and locate points that contain negative numbers in a coordinate plane?

5. Make up your own "dot-to-dot" picture. Use at least 20 points. Your picture should have at least two points in each region of the coordinate plane.

Practice Use what you learned about the coordinate plane to complete Exercise 4 on page 279.

6.5 Lesson

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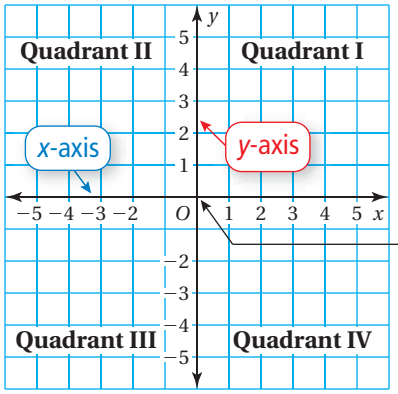
Key Vocabulary
coordinate plane, *p. 276*
origin, *p. 276*
quadrants, *p. 276*

Previously, you plotted points with positive coordinates. Now you will plot points with positive and negative coordinates.

Key Idea

The Coordinate Plane

A **coordinate plane** is formed by the intersection of a horizontal number line and a vertical number line. The number lines intersect at the **origin** and separate the coordinate plane into four regions called **quadrants**.



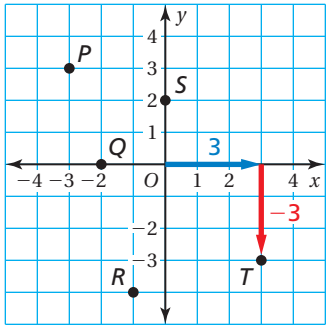
An *ordered pair* is used to locate a point in a coordinate plane.

ordered pair: (4, −2)
x-coordinate
y-coordinate

EXAMPLE 1 Identifying an Ordered Pair

Which ordered pair corresponds to point *T*?

Ⓐ (−3, −3) Ⓑ (−3, 3)
Ⓒ (3, −3) Ⓓ (3, 3)



Point *T* is 3 units to the right of the origin and 3 units down. So, the *x*-coordinate is 3 and the *y*-coordinate is −3.

∴ The ordered pair (3, −3) corresponds to point *T*. The correct answer is Ⓒ.

On Your Own

Now You're Ready
Exercises 5–14

Use the graph in Example 1 to write an ordered pair corresponding to the point.

1. Point *P*
2. Point *Q*
3. Point *R*
4. Point *S*

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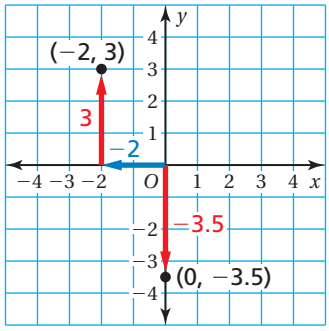
EXAMPLE 2 Plotting Ordered Pairs



Plot (a) (−2, 3) and (b) (0, −3.5) in a coordinate plane. Describe the location of each point.

a. Start at the origin. Move 2 units left and 3 units up. Then plot the point.

∴ The point is in Quadrant II.

b. Start at the origin. Move 3.5 units down. Then plot the point.

∴ The point is on the *y*-axis.

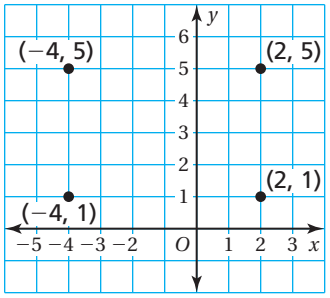
On Your Own

Now You're Ready
Exercises 15–22

Plot the ordered pair in a coordinate plane. Describe the location of the point.

5. (3, −1) **6.** (−5, 0) **7.** (−2.5, −1) **8.** $\left(-1\frac{1}{2}, \frac{1}{2}\right)$

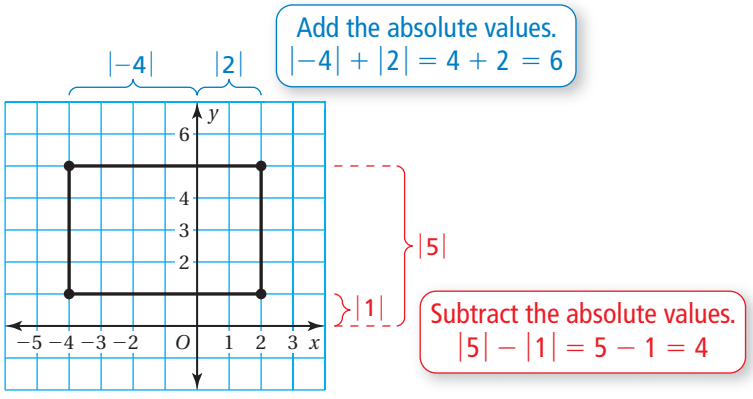
EXAMPLE 3 Finding Distances in the Coordinate Plane



An *archaeologist* divides an area using a coordinate plane in which each unit represents 1 meter. The corners of a secret chamber are shown in the graph. What are the dimensions of the secret chamber?

The length of the chamber is the distance between (−4, 5) and (2, 5). The width of the chamber is the distance between (2, 5) and (2, 1).

You can use absolute values to find the distances between the points.



Reading

An **archaeologist** studies ancient ruins and objects to learn about people and cultures.

∴ The secret chamber is 6 meters long and 4 meters wide.

On Your Own

Now You're Ready
Exercises 25–30

9. In Example 3, the archaeologist finds a gold coin at (−1, 4), a silver coin at (−4, 2), and pottery at (−4, 4). How much closer is the pottery to the silver coin than to the gold coin?

You can use line graphs to display data that is collected over a period of time. Graphing and connecting the ordered pairs can show patterns or trends in the data. This type of line graph is also called a *time series graph*.

EXAMPLE 4 Real-Life Application

A blizzard hits a town at midnight. The table shows the hourly temperatures from midnight to 8:00 A.M.

Hours after Midnight, x	0	1	2	3	4	5	6	7	8
Temperature, y	7°F	5°F	3°F	0°F	−1°F	−4°F	−5°F	−2°F	2°F

a. Display the data in a line graph.

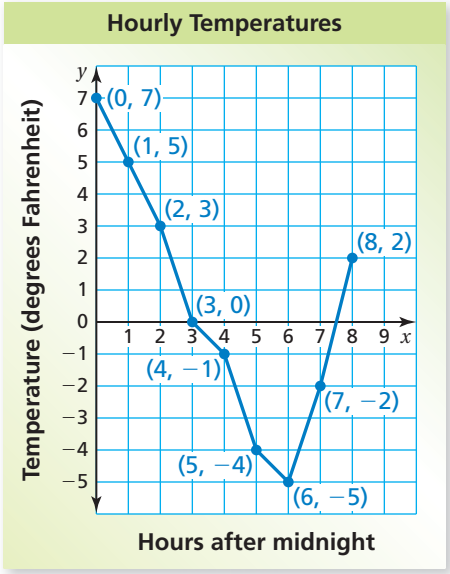
Write the ordered pairs.

(0, 7) (1, 5) (2, 3)

(3, 0) (4, −1) (5, −4)

(6, −5) (7, −2) (8, 2)

Plot and label the ordered pairs. Then connect the ordered pairs with line segments.



b. Make three observations from the graph.

Three possible observations follow:

- The hourly temperatures decrease from midnight to 6:00 A.M.
- The hourly temperatures increase from 6:00 A.M. to 8:00 A.M.
- The greatest decrease in hourly temperatures from one hour to the next is 3°F. This happens twice: from 2:00 A.M. to 3:00 A.M. and from 4:00 A.M. to 5:00 A.M.

Study Tip

The observations given in Example 4(b) are sample answers. You can make many other correct observations.

On Your Own

10. In Example 4, the blizzard hits another town at noon. The table shows the hourly temperatures from noon to 6:00 P.M.

Hours after Noon	0	1	2	3	4	5	6
Temperature	6°F	7°F	5°F	1°F	1°F	0°F	−3°F

a. Display the data in a line graph.

b. Make three observations from the graph.

6.5 Exercises

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Vocabulary and Concept Check

1. **VOCABULARY** How many quadrants are in a coordinate plane?
2. **VOCABULARY** Is the point $(0, -7)$ on the x-axis or the y-axis?
3. **WHICH ONE DOESN'T BELONG?** Which point does *not* belong with the other three? Explain your reasoning.

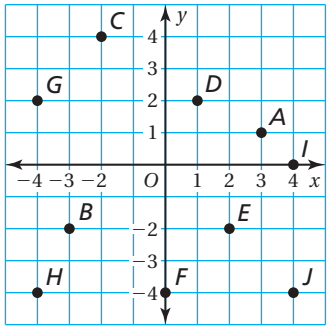
$(-2, 1)$ $(-4, 5)$ $(2, -3)$ $(-1, 3)$

Practice and Problem Solving

4. Plot and connect the points to make a picture.

1 $(5, 0)$ **2** $(2, -3)$ **3** $(2, -2)$ **4** $(0, -2)$ **5** $(-3, -2)$
6 $(-3, 0)$ **7** $(-3, 2)$ **8** $(0, 2)$ **9** $(2, 2)$ **10** $(2, 3)$

Write an ordered pair corresponding to the point.



1
5. Point A
6. Point B
7. Point C
8. Point D
9. Point E
10. Point F
11. Point G
12. Point H
13. Point I
14. Point J

Plot the ordered pair in a coordinate plane. Describe the location of the point.

2
15. $K(4, 3)$
16. $L(-1, 2)$
17. $M(0, -6)$
18. $N(3.5, -1.5)$
19. $P(2, -4)$
20. $R(-4, 1)$
21. $S\left(2\frac{1}{2}, 0\right)$
22. $T(-4, -5)$

ERROR ANALYSIS **Describe and correct the error in the solution.**

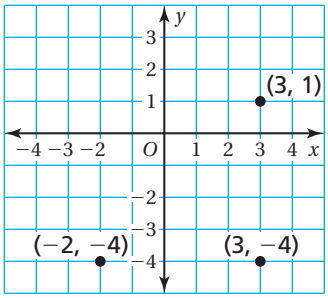
23. To plot (4, 5), start at (0, 0) and move 5 units right and 4 units up.

24. To plot (−6, 3), start at (0, 0) and move 6 units right and 3 units down.

Plot the points and find the distance between the points.

3
25. $(2, -3), (6, -3)$
26. $(4, 2), (4, -1)$
27. $(-1, 1), (-1, 7)$
28. $(-5, -2), (4, -2)$
29. $(-3, 4), (5, 4)$
30. $(-2, -4), (-2, 1)$

31. REASONING The coordinates of three vertices of a square are shown in the figure. What are the coordinates of the fourth vertex?



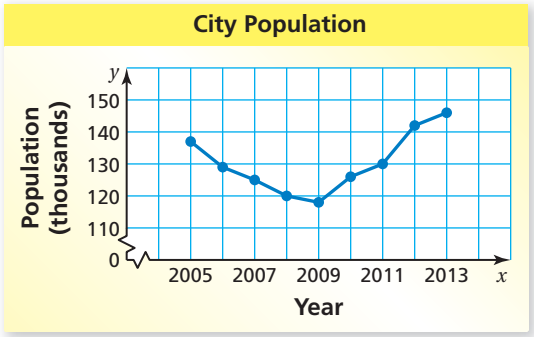
Draw the figure with the given vertices in a coordinate plane. Find the perimeter and the area of the figure.

32. $D(1, 1), E(1, -2), F(-2, -2), G(-2, 1)$

33. $P(-2, 3), Q(5, 3), R(5, -1), S(-2, -1)$

34. $W(-3, 2), X(2, 2), Y(2, -7), Z(-3, -7)$

35. POPULATION The line graph shows the population of a city from 2005 to 2013.



a. Estimate the population of the city in 2012.

b. Between which two years did the population increase the most?

c. Estimate the total change in population from 2005 to 2013.

36. MODELING The table shows the total miles run through 18 weeks for a marathon training program.

Week	1	2	3	4	5	6	7	8	9
Total Miles	22	46	72	96	124	151	181	211	244

Week	10	11	12	13	14	15	16	17	18
Total Miles	279	317	357	397	437	473	506	530	544

a. Create a table for the distance run during each week of training.

b. Display the data from part (a) in a line graph.

c. Make three observations from the graph.

d. Explain the pattern shown in the graph.

37. PROFITS The table shows the profits of a company from 2007 to 2013.

Years since 2000, x	7	8	9	10	11	12	13
Profit (millions of dollars), y	0.6	−0.2	−1.2	1.2	0.8	1	−0.6

a. Display the data in a line graph.

b. Make three observations from the graph.

c. What was the total profit from 2007 to 2013?

d. How could you include profits from the years 1990 to 2006 on your graph? Explain.

Describe the possible location(s) of the point (x, y).

38. $x > 0, y > 0$

39. $x < 0, y < 0$

40. $x > 0, y < 0$

41. $x > 0$

42. $y < 0$

43. $x = 0, y = 0$

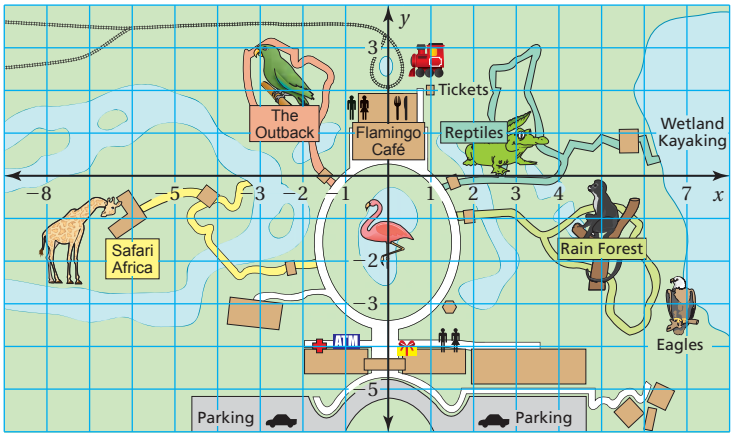
Tell whether the statement is *sometimes*, *always*, or *never* true. Explain your reasoning.

44. The x-coordinate of a point on the x-axis is zero.

45. The y-coordinates of points in Quadrant III are positive.

46. The x-coordinate of a point in Quadrant II has the same sign as the y-coordinate of a point in Quadrant IV.

ZOO In Exercises 47–51, use the map of the zoo.



47. Which exhibit is located at (2, 1)?

48. Name an attraction on the positive y-axis.

49. Is parking available in Quadrant II? If not, name a quadrant in which you can park.

50. Write two different ordered pairs that represent the location of the Rain Forest.

51. Which exhibit is closest to $(-8, -3)$?

52. NUMBER SENSE Name the ordered pair that is 5 units right and 2 units down from $(-3, 4)$.

53. OPEN-ENDED The vertices of triangle ABC are $A(-6, -3)$ and $B(2, -3)$. List four possible coordinates of the third vertex so that the triangle has an area of 24 square units.

54. Reasoning Your school is located at $(2, -1)$, which is 2 blocks east and 1 block south of the center of town. To get from your house to the school, you walk 5 blocks west and 2 blocks north.

a. What ordered pair corresponds to the location of your house?

b. Is your house or your school closer to the center of town? Explain.

c. You can only walk along streets that are north and south or streets that are east and west. You are at the center of town and decide to take the shortest path home that passes by the school. When you are at the school, what percent of the walk home remains?

Fair Game Review What you learned in previous grades & lessons

Write the phrase as an expression. *(Section 3.2)*

55. 4 less than a number y

56. the product of 18 and a number b

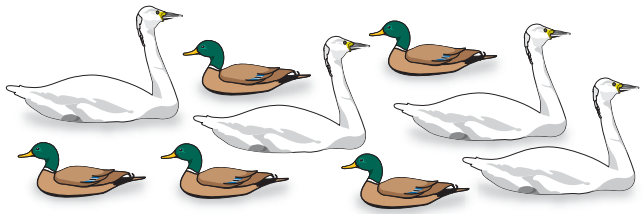
57. a number x increased by 9

58. a number w divided by 3

59. MULTIPLE CHOICE What is the ratio of ducks to swans? *(Section 5.1)*

Ⓐ 4 : 9 Ⓑ 4 : 5

Ⓒ 5 : 4 Ⓓ 5 : 9



Extension 6.5 Reflecting Points in the Coordinate Plane

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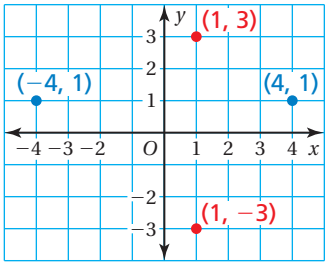
You can *reflect* a point in the x-axis, in the y-axis, or in both axes.



The red points are mirror images of each other in the x-axis because the x-coordinates are the same and the y-coordinates are opposites. So, the red points are 3 units from the x-axis in opposite directions. The red points represent a *reflection in the x-axis*.

The blue points are mirror images of each other in the y-axis because the y-coordinates are the same and the x-coordinates are opposites. So, the blue points are 4 units from the y-axis in opposite directions. The blue points represent a *reflection in the y-axis*.

Key Idea

Reflecting a Point in the Coordinate Plane

- To reflect a point in the x-axis, use the same x-coordinate and take the opposite of the y-coordinate.
- To reflect a point in the y-axis, use the same y-coordinate and take the opposite of the x-coordinate.

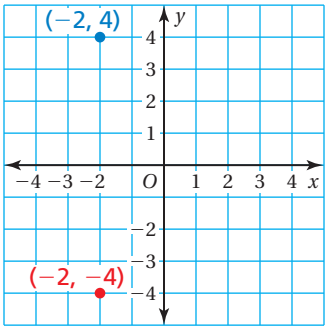
EXAMPLE 1 Reflecting Points in One Axis

a. Reflect $(-2, 4)$ in the x-axis.

Plot $(-2, 4)$.

To reflect $(-2, 4)$ in the x-axis, use the same x-coordinate, -2, and take the opposite of the y-coordinate. The opposite of 4 is -4.

∴ So, the reflection of $(-2, 4)$ in the x-axis is $(-2, -4)$.

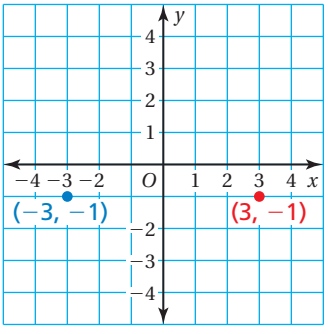


b. Reflect $(-3, -1)$ in the y-axis.

Plot $(-3, -1)$.

To reflect $(-3, -1)$ in the y-axis, use the same y-coordinate, -1, and take the opposite of the x-coordinate. The opposite of -3 is 3.

∴ So, the reflection of $(-3, -1)$ in the y-axis is $(3, -1)$.



Coordinate Plane

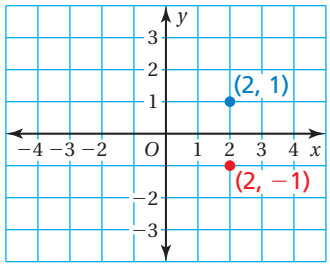
In this extension, you will

- understand reflections of points in the coordinate plane.

EXAMPLE 2 Reflecting a Point in Both Axes

Reflect (2, 1) in the *x*-axis followed by the *y*-axis.

Step1: First, plot (2, 1).

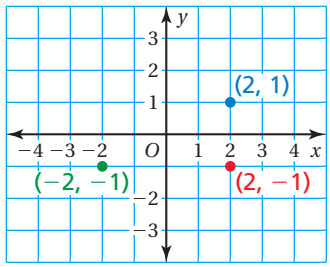


Step 2: Next, reflect (2, 1) in the *x*-axis. Use the same *x*-coordinate, 2, and take the opposite of the *y*-coordinate. The opposite of 1 is −1.

The point (2, 1) reflected in the *x*-axis is (2, −1).

Step 3: Finally, reflect (2, −1) in the *y*-axis. Use the same *y*-coordinate, −1, and take the opposite of the *x*-coordinate. The opposite of 2 is −2.

The point (2, −1) reflected in the *y*-axis is (−2, −1).



∴ So, (2, 1) reflected in the *x*-axis followed by the *y*-axis is (−2, −1).

Common Error

When reflecting a second time, be sure to use the reflected point and not the original point.

Practice

Reflect the point in (a) the *x*-axis and (b) the *y*-axis.

1. (3, 2)
2. (−4, 4)
3. (−5, −6)
4. (4, −7)
5. (0, −1)
6. (−8, 0)
7. (2.5, 4.5)
8. $\left(-5\frac{1}{2}, 3\right)$

Reflect the point in the *x*-axis followed by the *y*-axis.

9. (4, 5)
10. (−1, 7)
11. (−2, −2)
12. (6.5, −10.5)

13. **REASONING** A point is reflected in the *x*-axis. The reflected point is (3, −9). What is the original point? What is the distance between the points?

14. **REASONING** A point is reflected in the *y*-axis. The reflected point is (5.75, 0). What is the original point? What is the distance between the points?

15. **a.** **STRUCTURE** In Exercises 9–12, reflect the point in the *y*-axis followed by the *x*-axis. Do you get the same results? Explain.

b. **LOGIC** Make a conjecture about how to use the coordinates of a point to find its reflection in both axes.

16. **GEOMETRY** The vertices of a triangle are (−1, 3), (−5, 3), and (−5, 7). How would you reflect the triangle in the *x*-axis? in the *y*-axis? Give the coordinates of the reflected triangle for each case.

6.4–6.5 Quiz

Check It Out
Progress Check
BigIdeasMath.com

Find the absolute value. *(Section 6.4)*

1. $|-12|$ **2.** $|4|$

Copy and complete the statement using <, >, or =. *(Section 6.4)*

3. $5 \square |-9|$ **4.** $|-11| \square |-10|$

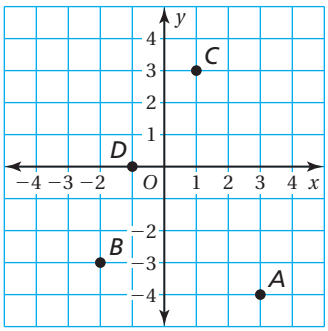
Write an ordered pair corresponding to the point. *(Section 6.5)*

5. Point A

6. Point B

7. Point C

8. Point D



Plot the ordered pair in a coordinate plane. Describe the location of the point. *(Section 6.5)*

9. $Q(2, 5)$ **10.** $R(1, -4)$ **11.** $S(-2.5, 3.5)$ **12.** $T\left(0, -1\frac{1}{2}\right)$

Reflect the point in (a) the x-axis and (b) the y-axis. *(Section 6.5)*

13. $(1, 3)$ **14.** $(-2, 6)$

Reflect the point in the x-axis followed by the y-axis. *(Section 6.5)*

15. $(3, -2)$ **16.** $(-4, -5)$

17. HIKING The table shows the elevations of several checkpoints along a hiking trail. *(Section 6.4)*

Checkpoint	Elevation (feet)
1	110
2	38
3	−24
4	12
5	−142

a. Which checkpoint is farthest from sea level?

b. Which checkpoint is closest to sea level?

c. Is Checkpoint 2 or Checkpoint 3 closer to sea level? Explain.

18. GEOMETRY The points $A(-4, 2)$, $B(1, 2)$, $C(1, -1)$, and $D(-4, -1)$ are the vertices of a figure. *(Section 6.5)*

a. Draw the figure in a coordinate plane.

b. Find the perimeter of the figure.

c. Find the area of the figure.

6 Chapter Review

Check It Out
Vocabulary Help
BigIdeasMath.com

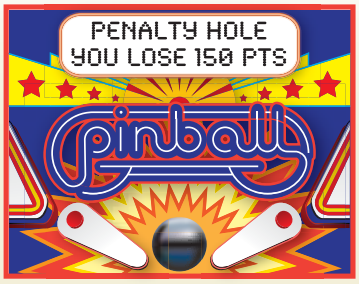
Review Key Vocabulary

positive numbers, *p. 250*
negative numbers, *p. 250*
opposites, *p. 250*
integers, *p. 250*
absolute value, *p. 270*
coordinate plane, *p. 276*
origin, *p. 276*
quadrants, *p. 276*

Review Examples and Exercises

6.1 Integers *(pp. 248–253)*

Write a positive or negative integer to represent losing 150 points in a pinball game.



"Lose" indicates a number less than 0. So, use a negative integer.

∴ -150

Exercises

Write a positive or negative integer that represents the situation.

1. An elevator goes down 8 floors.

2. You earn \$12.

Graph the integer and its opposite.

3. -7

4. 13

5. 4

6. -100

6.2 Comparing and Ordering Integers *(pp. 254–259)*

Order $-3, -4, 2, 0, -1$ from least to greatest.

Graph each integer on a number line.

Write the integers as they appear on the number line from left to right.

∴ So, the order from least to greatest is $-4, -3, -1, 0, 2$.

Exercises

Order the integers from least to greatest.

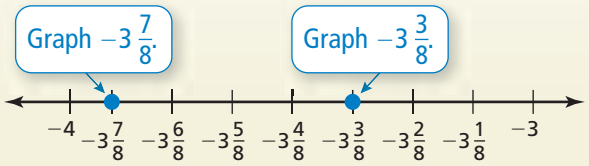
7. $-5, 4, 2, -3, -1$

8. $5, -20, -10, 10, 15$

9. Order the temperatures $-3°C$, $8°C$, $-12°C$, $-7°C$, and $0°C$ from coldest to warmest.

6.3 Fractions and Decimals on the Number Line *(pp. 260–265)*

Compare $-3\frac{7}{8}$ and $-3\frac{3}{8}$.



$-3\frac{7}{8}$ is to the left of $-3\frac{3}{8}$.

∴ So, $-3\frac{7}{8} < -3\frac{3}{8}$.

Exercises

Graph the number and its opposite.

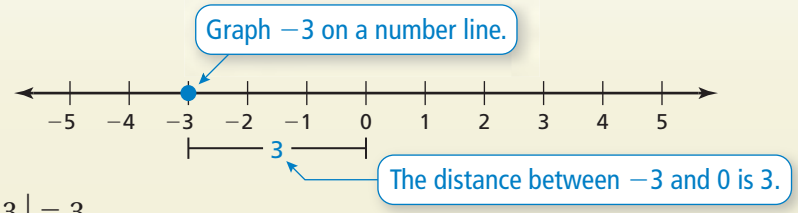
10. $-\frac{2}{5}$ **11.** $1\frac{3}{4}$ **12.** -1.2 **13.** 2.75

Copy and complete the statement using < or >.

14. $-2\frac{1}{6}$ ☐ $-2\frac{5}{6}$ **15.** $-\frac{1}{3}$ ☐ $-\frac{1}{8}$ **16.** -3.27 ☐ -2.68

6.4 Absolute Value *(pp. 268–273)*

Find the absolute value of -3.



∴ So, $|-3| = 3$.

Exercises

Find the absolute value.

17. $|-8|$ **18.** $|13|$ **19.** $\left|3\frac{6}{7}\right|$ **20.** $|-1.34|$

Copy and complete the statement using <, >, or =.

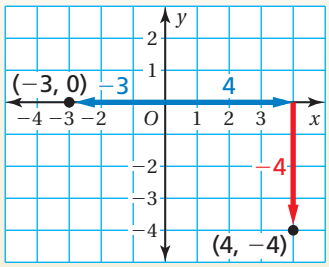
21. $|-2|$ ☐ 2 **22.** $|4.4|$ ☐ $|-2.8|$ **23.** $\left|\frac{1}{6}\right|$ ☐ $\left|-\frac{2}{9}\right|$

6.5 The Coordinate Plane *(pp. 274–283)*

a. Plot (−3, 0) and (4, −4) in a coordinate plane. Describe the location of each point.

To plot (−3, 0), start at the origin. Move 3 units left. Then plot the point.

To plot (4, −4), start at the origin. Move 4 units right and 4 units down. Then plot the point.

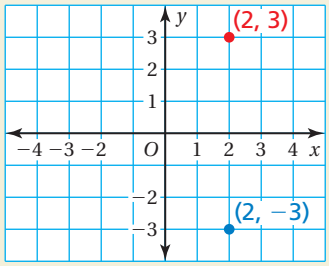


∴ The point (−3, 0) is on the x-axis.
The point (4, −4) is in Quadrant IV.

b. Reflect (2, −3) in the x-axis.

Plot (2, −3).

To reflect (2, −3) in the x-axis, use the same x-coordinate, 2, and take the opposite of the y-coordinate. The opposite of −3 is 3.

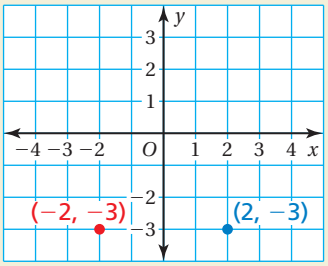


∴ So, the reflection of (2, −3) in the x-axis is (2, 3).

c. Reflect (2, −3) in the y-axis.

Plot (2, −3).

To reflect (2, −3) in the y-axis, use the same y-coordinate, −3, and take the opposite of the x-coordinate. The opposite of 2 is −2.



∴ So, the reflection of (2, −3) in the y-axis is (–2, –3).

Exercises

Plot the ordered pair in a coordinate plane. Describe the location of the point.

24. $A(1, 3)$

25. $B(0, -3)$

26. $C(-4, -2)$

27. $D(-1, 2)$

Reflect the point in (a) the x-axis and (b) the y-axis.

28. (4, 1)

29. (−2, 3)

30. (2, −5)

31. (−3.5, −2.5)

Reflect the point in the x-axis followed by the y-axis.

32. (1, 2)

33. (−4, 6)

34. (3, −4)

35. (−3, −3)

6 Chapter Test

Check It Out
Test Practice
BigIdeasMath.com

Order the integers from least to greatest.

1. $0, -2, 3, 1, -4$

2. $-8, -3, 5, 4, -5$

Graph the number and its opposite.

3. 14

4. -40

5. $-1\frac{1}{3}$

6. 1.75

Find the absolute value.

7. $|-7|$

8. $|-11|$

Copy and complete the statement using <, >, or =.

9. $-\frac{2}{3} \square -\frac{3}{5}$

10. $1.55 \square -2.46$

11. $|-6| \square -3$

12. $-2.5 \square |2.5|$

Plot the ordered pair in a coordinate plane. Describe the location of the point.

13. $J(4, 0)$

14. $K(-3, 5)$

15. $L(1.5, -3.5)$

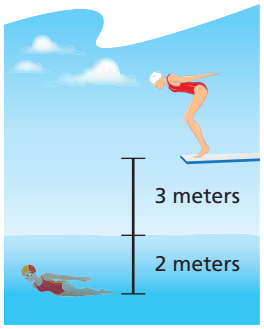
16. $M(-2, -3)$

Reflect the point in the *x*-axis followed by the *y*-axis.

17. $(2, 4)$

18. $(-5, 1)$

19. **POOL** A diver is on a springboard that is 3 meters above the surface of a pool. Another diver is 2 meters below the surface of the pool.



a. Write an integer for the position of each diver relative to the surface of the pool.

b. Find the absolute value of each integer.

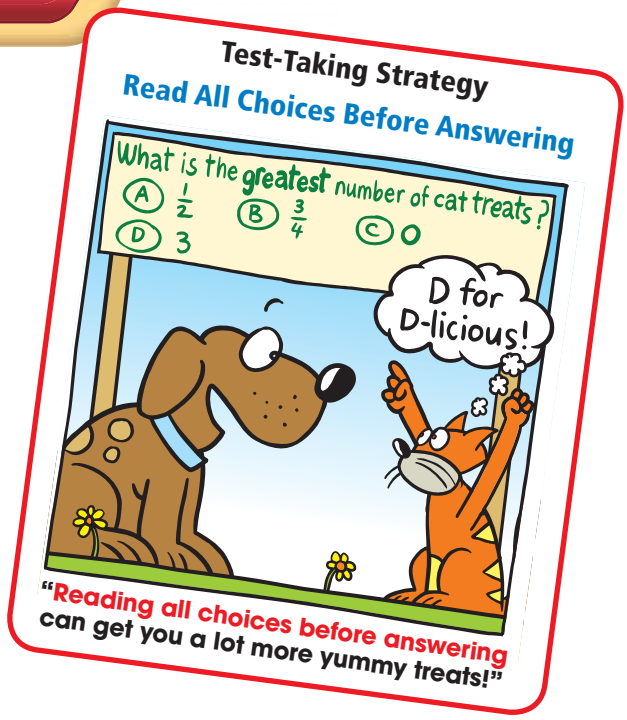
c. Who is farther from the surface of the pool?

20. **OPEN-ENDED** Two vertices of a triangle are $F(1, -4)$ and $G(6, -4)$. List two possible coordinates of the third vertex so that the triangle has an area of 20 square units.

21. **MELTING POINT** The table shows the melting points (in degrees Celsius) of several elements. Compare the melting point of mercury to the melting point of each of the other elements.

Element	Mercury	Radon	Bromine	Cesium	Francium
Melting Point (°C)	−38.83	−71	−7.2	28.5	27

6 Cumulative Assessment



1. What is the value of the expression below when $a = 6$, $b = 5$, and $c = 4$?

$$8a - 3c + 5b$$

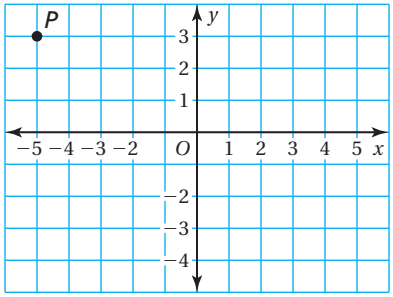
A. 11

B. 53

C. 61

D. 107

2. Point P is plotted in the coordinate plane below.



What are the coordinates of point P?

F. $(-5, -3)$

G. $(-5, 3)$

H. $(-3, -5)$

I. $(3, -5)$

3. What is the value of the expression below?

$$4\frac{1}{8} \div 5\frac{1}{2}$$

4. Which list of numbers is in order from least to greatest?

A. $2, |-3|, |4|, -6$

B. $-6, |4|, 2, |-3|$

C. $-6, |-3|, 2, |4|$

D. $-6, 2, |-3|, |4|$

5. Which percent is equivalent to $\frac{4}{5}$?

F. 20%

G. 45%

H. 80%

I. 125%

6. Which property is illustrated by the statement below?

$$4 + (6 + n) = (4 + 6) + n$$

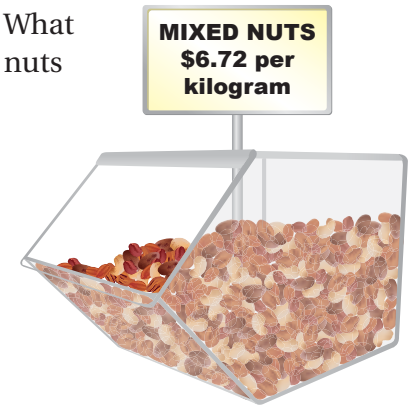
A. Associative Property of Addition

B. Commutative Property of Addition

C. Associative Property of Multiplication

D. Distributive Property

7. You bought 0.875 kilogram of mixed nuts. What was the total cost, in dollars, of the mixed nuts that you bought?



8. On Saturday, you earned $35 mowing lawns. This was x dollars more than you earned on Thursday. Which expression represents the amount, in dollars, you earned mowing lawns on Thursday?

F. $35x$

G. $x + 35$

H. $x - 35$

I. $35 - x$

9. Helene was finding the percent of a number in the box below.

75% of 24 is what number?

$$75\% \text{ of } 24 = 24 \div \frac{3}{4}$$

$$= 32$$

What should Helene do to correct the error that she made?

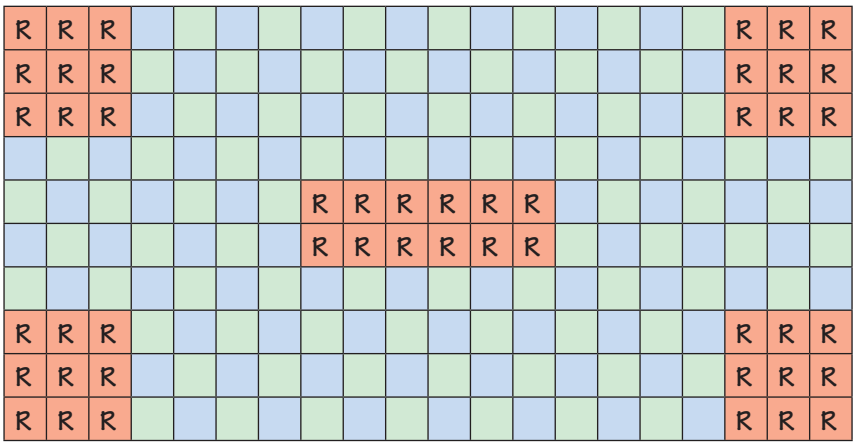
A. Divide 24 by 75.

B. Divide $\frac{3}{4}$ by 24.

C. Multiply 24 by 75.

D. Multiply 24 by $\frac{3}{4}$.

10. In the mural below, the squares that are painted red are marked with the letter R.



What percent of the mural is painted red?

F. 24%

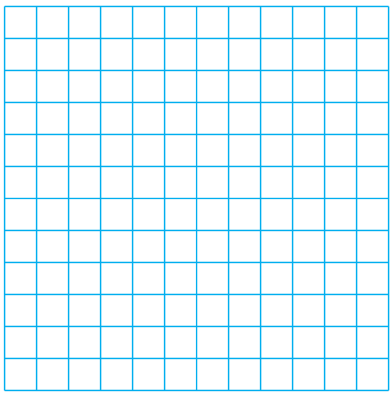
G. 25%

H. 48%

I. 50%

11. Use grid paper to complete the following.

Think
Solve
Explain



Part A Draw an x-axis and a y-axis in the coordinate plane. Then plot and label the point $(2, -3)$.

Part B Plot and label *four* points that are 3 units away from $(2, -3)$.

12. Which expression is equivalent to the expression below?

$$k \div 3\frac{1}{3}$$

A. $k \cdot \frac{3}{10}$

B. $k \cdot \frac{10}{3}$

C. $k \div \frac{3}{10}$

D. $k \div \frac{7}{3}$