

# 8.1 Writing and Graphing Inequalities

**Essential Question** How can you use a number line to represent solutions of an inequality?

## 1 ACTIVITY: Understanding Inequality Statements

Work with a partner.

- a. Consider the statement “Your friend is **more than** 3 minutes late.”

Circle each number that makes the statement true.

–3   –2   –1   0   1   2   3   4   5   6

- Write four other numbers that make the statement true.



- b. Consider the statement “The temperature is **at most** 2 degrees.”

- Can the temperature be exactly 2 degrees? Explain.
- Circle each number that makes the statement true.

–5   –4   –3   –2   –1   0   1   2   3   4

- Write four other numbers that make the statement true.



- c. Consider the statement “You need **at least** 4 pieces of paper for your math homework.”

- Can you have exactly 4 pieces of paper? Explain.
- Circle each number that makes the statement true.

–3   –2   –1   0   1   2   3   4   5   6

- Write four other numbers that make the statement true.



- d. Consider the statement “After playing a video game for 20 minutes, you have **fewer than** 6 points.”

- Circle each number that makes the statement true.

–2   –1   0   1   2   3   4   5   6   7

- Write four other numbers that make the statement true.



## 2 ACTIVITY: Understanding Inequality Symbols

Work with a partner.

a. Consider the statement “ $x$  is a number such that  $x < 2$ .”

- Can the number be exactly 2? Explain.
- Circle each number that makes the statement true.

–5    –4    –3    –2    –1    0    1    2    3    4

- Write four other numbers that make the statement true.

b. Consider the statement “ $x$  is a number such that  $x \geq 1$ .”

- Can the number be exactly 1? Explain.
- Circle each number that makes the statement true.

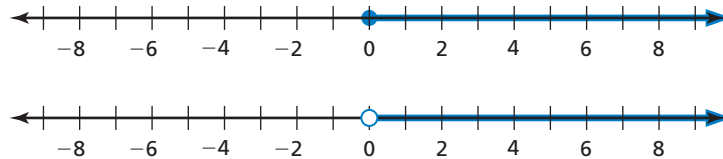
–5    –4    –3    –2    –1    0    1    2    3    4

- Write four other numbers that make the statement true.

## 3 ACTIVITY: How Close Can You Come to 0?

Work with a partner.

a. Which number line shows  $x > 0$ ? Which number line shows  $x \geq 0$ ? Explain your reasoning.



b. Write the least positive number you can think of that is still a solution of the inequality  $x > 0$ . Explain your reasoning.

## What Is Your Answer?

4. **IN YOUR OWN WORDS** How can you use a number line to represent solutions of an inequality?
5. Write an inequality. Graph all solutions of your inequality on a number line.

### Practice

Use what you learned about graphing inequalities to complete Exercises 17–20 on page 333.

**Key Vocabulary**

inequality, p. 330  
 solution of an inequality, p. 331  
 solution set, p. 331  
 graph of an inequality, p. 332

An **inequality** is a mathematical sentence that compares expressions. It contains the symbols  $<$ ,  $>$ ,  $\leq$ , or  $\geq$ . To write an inequality, look for the following phrases to determine where to place the inequality symbol.

Inequality Symbols				
Symbol	$<$	$>$	$\leq$	$\geq$
Key Phrases	<ul style="list-style-type: none"> <li>is less than</li> <li>is fewer than</li> </ul>	<ul style="list-style-type: none"> <li>is greater than</li> <li>is more than</li> </ul>	<ul style="list-style-type: none"> <li>is less than or equal to</li> <li>is at most</li> <li>is no more than</li> </ul>	<ul style="list-style-type: none"> <li>is greater than or equal to</li> <li>is at least</li> <li>is no less than</li> </ul>

**EXAMPLE 1** Writing Inequalities

**Write the word sentence as an inequality.**

- a. A number  $c$  is less than 4.

A number  $c$  is less than 4.

$$c < 4$$

∴ An inequality is  $c < 4$ .

- b. A number  $k$  plus 5 is greater than or equal to 8.

A number  $k$  plus 5 is greater than or equal to 8.

$$k + 5 \geq 8$$

∴ An inequality is  $k + 5 \geq 8$ .

- c. Four times a number  $q$  is at most 16.

Four times a number  $q$  is at most 16.

$$4q \leq 16$$

∴ An inequality is  $4q \leq 16$ .

**On Your Own**

**Write the word sentence as an inequality.**

- A number  $n$  is greater than 1.
- Twice a number  $p$  is fewer than 7.
- A number  $w$  minus 3 is less than or equal to 10.
- A number  $z$  divided by 2 is at least 6.

**Now You're Ready**  
 Exercises 5–10

A **solution of an inequality** is a value that makes the inequality true. An inequality can have more than one solution. The set of all solutions of an inequality is called the **solution set**.

### Reading

The symbol  $\nless$  means "is not less than or equal to."



Value of $x$	$x + 3 \leq 7$	Is the inequality true?
3	$3 + 3 \stackrel{?}{\leq} 7$ $6 \leq 7$ ✓	yes
4	$4 + 3 \stackrel{?}{\leq} 7$ $7 \leq 7$ ✓	yes
5	$5 + 3 \stackrel{?}{\leq} 7$ $8 \nless 7$ ✗	no

## EXAMPLE 2 Checking Solutions

Tell whether the given value is a solution of the inequality.

a.  $x + 1 > 7$ ;  $x = 8$

$$x + 1 > 7$$

Write the inequality.

$$8 + 1 \stackrel{?}{>} 7$$

Substitute 8 for  $x$ .

$$9 > 7$$
 ✓

Add. 9 is greater than 7.

∴ So, 8 is a solution of the inequality.

b.  $7y < 27$ ;  $y = 4$

$$7y < 27$$

Write the inequality.

$$7(4) \stackrel{?}{<} 27$$

Substitute 4 for  $y$ .

$$28 \nless 27$$
 ✗

Multiply. 28 is *not* less than 27.

∴ So, 4 is *not* a solution of the inequality.

c.  $\frac{z}{3} \geq 5$ ;  $z = 15$

$$\frac{z}{3} \geq 5$$

Write the inequality.

$$\frac{15}{3} \stackrel{?}{\geq} 5$$

Substitute 15 for  $z$ .

$$5 \geq 5$$
 ✓

Divide. 5 is greater than or equal to 5.

∴ So, 15 is a solution of the inequality.

### On Your Own

Tell whether 3 is a solution of the inequality.

5.  $b + 4 < 6$

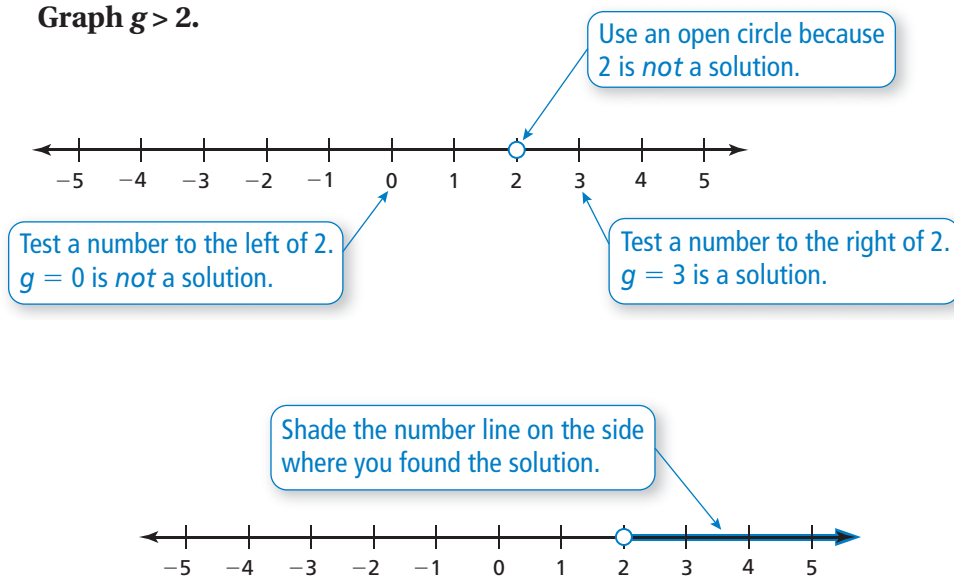
6.  $9 - n \geq 6$

7.  $18 \div x \leq 10$

The **graph of an inequality** shows all of the solutions of the inequality on a number line. An open circle  $\circ$  is used when a number is *not* a solution. A closed circle  $\bullet$  is used when a number is a solution. An arrow to the left or right shows that the graph continues in that direction.

### EXAMPLE 3 Graphing an Inequality

Graph  $g > 2$ .



### EXAMPLE 4 Real-Life Application



The NASA Solar Probe can withstand temperatures up to and including  $2600^{\circ}\text{F}$ . Write and graph an inequality that represents the temperatures the probe can withstand.

**Words** temperatures up to and including  $2600^{\circ}\text{F}$

**Variable** Let  $t$  be the temperatures the probe can withstand.

**Inequality**  $t \leq 2600$

$\therefore$  An inequality is  $t \leq 2600$ .



### On Your Own

Graph the inequality on a number line.

8.  $a < 4$       9.  $f \leq 7$       10.  $n > 0$       11.  $p \geq -3$

Write and graph an inequality for the situation.

12. A cruise ship can carry at most 3500 passengers.  
13. A board game is designed for ages 12 and up.

**Now You're Ready**  
Exercises 25–36

# 8.1 Exercises

## Vocabulary and Concept Check

- VOCABULARY** How are “greater than” and “greater than or equal to” similar? How are they different?
- DIFFERENT WORDS, SAME QUESTION** Which is different? Write “both” inequalities.

A number  $n$  is at most 3.

A number  $n$  is at least 3.

A number  $n$  is less than or equal to 3.

A number  $n$  is no more than 3.

- WRITING** Explain how the graph of  $x \leq 6$  is different from the graph of  $x < 6$ .
- WRITING** Are the graphs of  $x \leq 5$  and  $5 \geq x$  the same or different? Explain.

## Practice and Problem Solving

Write the word sentence as an inequality.

5. A number  $k$  is less than 10.
6. A number  $a$  is more than 6.
7. A number  $z$  is fewer than  $\frac{3}{4}$ .
8. A number  $b$  is at least  $-3$ .
9. One plus a number  $y$  is no more than 13.
10. A number  $x$  divided by 3 is at most 5.

Tell whether the given value is a solution of the inequality.

11.  $x - 1 \leq 7$ ;  $x = 6$
12.  $y + 5 < 13$ ;  $y = 17$
13.  $3z > 6$ ;  $z = 3$
14.  $\frac{b}{2} \geq 6$ ;  $b = 10$
15.  $c + 2.5 < 4.3$ ;  $c = 1.8$
16.  $a \leq 0$ ;  $a = -5$

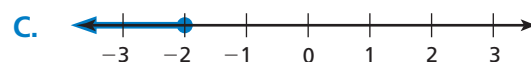
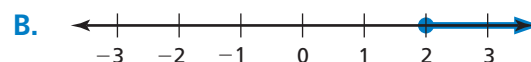
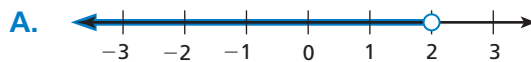
Match each inequality with its graph.

17.  $x \geq 2$

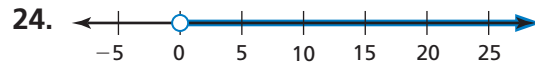
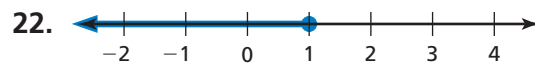
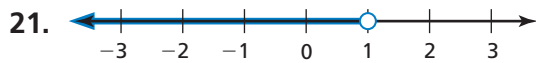
18.  $x < 2$

19.  $x > -2$

20.  $x \leq -2$



Write an inequality and a word sentence that represent the graph.



Graph the inequality on a number line.

3 25.  $a > 4$

26.  $n \geq 8$

27.  $3 \geq x$

28.  $y < \frac{1}{2}$

29.  $x < \frac{2}{9}$

30.  $-3 \geq c$

31.  $m > -5$

32.  $b \geq 0$

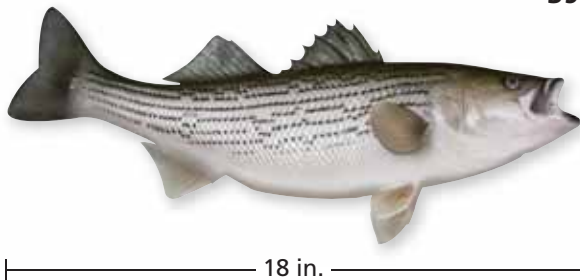
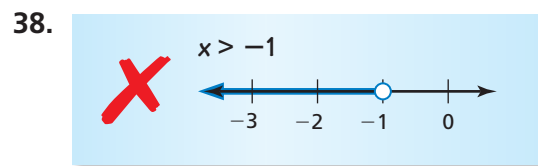
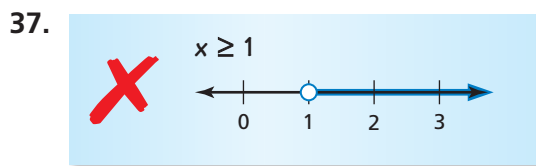
33.  $f < 1.5$

34.  $t \geq -\frac{1}{2}$

35.  $p > -1.6$

36.  $z \leq -\frac{7}{3}$

**ERROR ANALYSIS** Describe and correct the error in graphing the inequality.



39. **FISHING** You are fishing and are allowed to catch at most 3 striped bass. Each striped bass must be no less than 18 inches in length.

- Write and graph an inequality to represent the number of striped bass you are allowed to catch.
- Write and graph an inequality to represent the length of each striped bass you are allowed to catch.

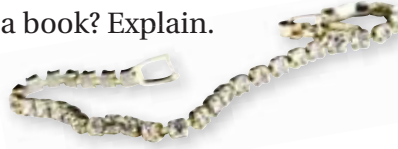
40. **LOW SODIUM** For a food to be labeled *low sodium*, there must be no more than 140 milligrams of sodium per serving.

- Write and graph an inequality to represent the amount of sodium in a low sodium serving.
- Write and graph an inequality to represent the amount of sodium in a serving that does not qualify as low sodium.
- Does the food represented by the label qualify as a low sodium food? Explain.

Nutrition Facts	
Serving Size $\frac{1}{2}$ cup (114g)	
Servings Per Container 4	
Amount Per Serving	
<b>Calories</b> 90	Calories from fat 30
% Daily Value*	
<b>Total Fat</b> 3g	<b>5%</b>
Saturated Fat 0g <b>0%</b>	
<b>Cholesterol</b> 0mg	<b>0%</b>
<b>Sodium</b> 300mg	<b>13%</b>
<b>Total Carbohydrate</b> 13g	<b>4%</b>
Dietary Fiber 3g <b>12%</b>	
Sugars 3g	
<b>Protein</b> 3g	
Vitamin A 80% • Vitamin C 60%	
Calcium 4% • Iron 4%	

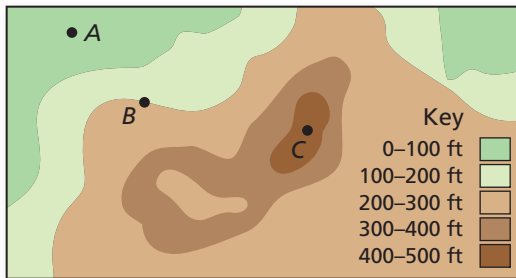
41. **SHOPPING** You have \$33. You want to buy a necklace and one other item from the list.
- Write an inequality to represent the situation.
  - Can the other item be a T-shirt? Explain.
  - Can the other item be a book? Explain.

Item	Price (with tax)
T-shirt	\$ 15
Book	\$ 20
DVD	\$ 13
Necklace	\$ 16



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

42. A number that is a solution of the inequality  $x > 5$  is also a solution of the inequality  $x \geq 5$ .
43. A number that is a solution of the inequality  $5 \leq x$  is also a solution of the inequality  $x > 5$ .
44. **BUS RIDE** A bus ride costs \$1.50. A 30-day bus pass costs \$36. Write an inequality to represent the number of bus rides you would need to take for the bus pass to be a better deal.
45. **MOVIE THEATER** Fifty people are seated in a movie theater. The maximum capacity of the theater is 425 people. Write an inequality to represent the number of additional people who can still be seated.
46. **Critical Thinking** The map shows the elevations above sea level for an area of land.



- Graph the possible elevations of A. Write the set of elevations as two inequalities.
- Graph the possible elevations of C. How can you write this set of elevations as a single inequality? Explain.
- What is the elevation of B? Explain.



## Fair Game Review What you learned in previous grades & lessons

Solve the equation. Check your solution.

47.  $x + 3 = 12$       48.  $x - 6 = 8$       49.  $16 + x = 44$       50.  $7.6 = x - 6.5$

51. **MULTIPLE CHOICE** A stack of boards is 24 inches high. Each board is  $\frac{3}{8}$  of an inch thick. How many boards are in the stack?

(A)  $\frac{1}{6}$

(B)  $\frac{1}{9}$

(C) 9

(D) 64