Dear Family,

This week your student is learning how to write and graph inequalities with a variable. An inequality compares two values using one of these inequality symbols.

$<$ less than $>$ greater than

$\leq$ less than or equal to $\geq$ greater than or equal to

A **solution of an inequality** is a value that can be substituted for a variable in the inequality to make it true. Solutions can be represented on a number line.

This number line shows the solutions of $x \geq 10$.

Any number that is shaded, such as 10, 15, or 12.5, is a solution of $x \geq 10$.

Any number that is not shaded, such as 9.9 or $6\frac{1}{2}$, is not a solution of $x \geq 10$.

Your student will be learning to solve problems like the one below.

> Students in a karate class must be taller than 5 feet. The inequality $x > 5$, where x is a number of feet, represents the heights of students who can attend the class. Which values in the set {4.5, 5, 5.5} are solutions of the inequality $x > 5$?

➤ **ONE WAY** to check solutions of an inequality is with a number line.

The number **5.5** is in the shaded part of the number line, but **4.5** and **5** are not.

➤ **ANOTHER WAY** is to substitute each value in the set to check whether the value makes the inequality true.

$$x > 5$$

$x = 4.5$	$4.5 > 5$	← **False**
$x = 5$	$5 > 5$	← **False**
$x = 5.5$	$5.5 > 5$	← **True**

Using either method, 5.5 is the only value in the set {4.5, 5, 5.5} that is a solution of the inequality $x > 5$.

Use the next page to start a conversation about inequalities.

Activity Thinking About Inequalities Around You

➤ **Do this activity together to investigate inequalities in the real world.**

Have you ever seen weight limit signs on the side of the road? The phrase *Weight Limit 5 Tons* means that only vehicles that weigh 5 tons or less can travel on that road. Roads need to have weight limits because overly heavy vehicles can cause damage.

You can represent a weight limit of 5 tons with the inequality $x \leq 5$, where x is the weight in tons of any vehicle allowed to travel on that road.

WEIGHT LIMIT
5T
20T
27T
28T
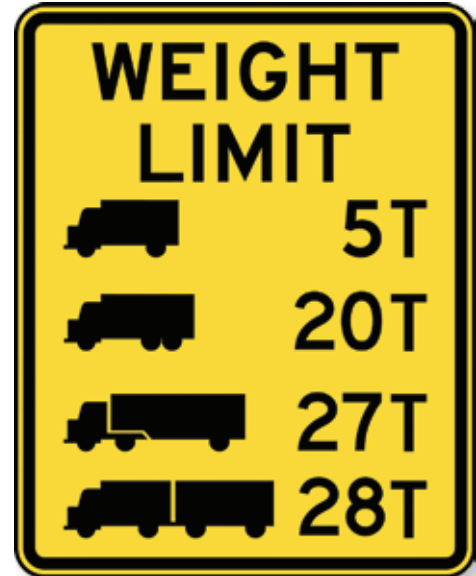
? Where else do you see inequalities in the world around you?

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Explore One-Variable Inequalities

Previously, you learned about one-variable equations.
In this lesson, you will learn about one-variable inequalities.

➤ **Use what you know to try to solve the problem below.**

The thermostat in an office is set to turn the heat on any time the temperature drops below 15°C. What are all the temperatures at which the heat is on? Use words, symbols, or pictures to describe all the temperatures.
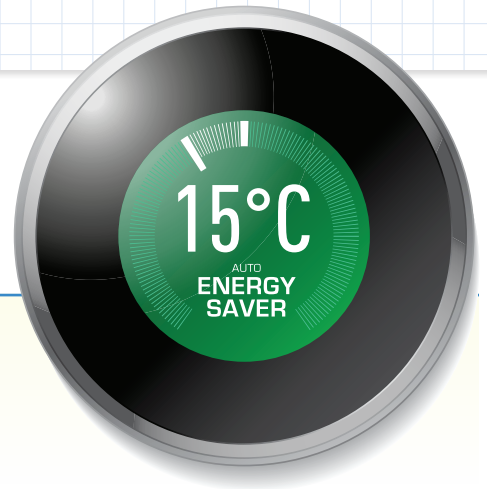
TRY IT

✎ **Math Toolkit** number lines

DISCUSS IT

Ask: How can you restate the given information in your own words?

Share: The given information says . . .

Learning Targets   SMP 1, SMP 2, SMP 3, SMP 4, SMP 5, SMP 6, SMP 8
• Use substitution to determine whether a given number in a specified set makes an inequality true.
• Write an inequality of the form $x > c$ or $x < c$ to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form $x > c$ or $x < c$ have infinitely many solutions; represent solutions of such inequalities on number line diagrams.

CONNECT IT

1 **Look Back** What are different ways to describe all the temperatures at which the heat is on?

2 **Look Ahead** You can describe a range of values using an inequality with a variable.

all values greater than 10   any value less than 3

$x > 10$ $a < 3$

a. Circle each value of n that makes the inequality $n > 2$ a true statement.

$$-2 \qquad -1\frac{1}{2} \qquad 0 \qquad 2 \qquad 2.5 \qquad 5 \qquad 6 \qquad 7\frac{1}{2}$$

b. A **solution of an inequality** is a value of a variable that makes the inequality true. Graph the solutions of $n > 2$ that you found in problem 2a.

c. Name three more solutions of the inequality $n > 2$.

Between 6 and 7: _____   Less than 4: _____   Greater than 8: _____

d. What would your number line in problem 2b look like if you graphed *all* the solutions of $n > 2$?

3 **Reflect** There is no limit to how many solutions you could list for $n > 2$. There are *infinitely many* solutions. Explain why the equation $t = 15$ has one solution, but the inequality $t < 15$ has infinitely many solutions.

Prepare for Writing and Graphing One-Variable Inequalities

1 Think about what you know about comparing and ordering numbers. Fill in each box. Use words, numbers, and pictures. Show as many ideas as you can.

What Is It?	What I Know About It

inequality

Examples	Examples

2 On a horizontal number line, $-\frac{7}{9}$ is to the right of $-\frac{4}{5}$. Write two inequalities, using $<$ and $>$, to compare the values.

3 Many visitors to Yellowstone National Park see the geyser Old Faithful.
The waiting time between eruptions is more than 59 min.

a. What are all of the possible waiting times between eruptions? Show your work.

SOLUTION _____

_____

b. On a particular day, the waiting time between one eruption and the next is
72.5 min. Explain how this helps you know that your answer to problem 3a
is reasonable.

Develop Representing Inequalities

➤ **Read and try to solve the problem below.**

Andre and his friends are participating in a gumbo cook-off.
The rules for each team are shown below.

Rule 1: Each team must prepare more than 20 qt of gumbo.

Rule 2: The width of each team's booth must be under 10 ft.

Use words, symbols, or pictures to describe all of the values that are possible for each rule.
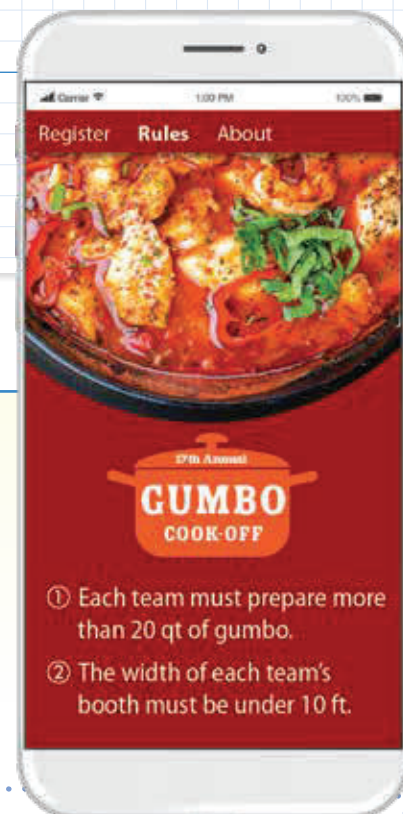
TRY IT

✎ **Math Toolkit** number lines

DISCUSS IT

Ask: What are the advantages and disadvantages in your way of describing the values?

Share: In my way, the advantages are . . . The disadvantages are . . .

➤ **Explore different ways to represent inequality situations.**

> Andre and his friends are participating in a gumbo cook-off.
> The rules are shown below.
>
> **Rule 1:** Each team must prepare more than 20 qt of gumbo.
>
> **Rule 2:** The width of each team's booth must be under 10 ft.
>
> Use words, symbols, or pictures to describe all of the values that are possible for each rule.

Many gumbo recipes include okra.

Picture It

You can draw a graph to show all values greater than or less than a given value.

Rule 1

Shade all values that are *more than 20.*

An open circle shows that 20 is not on the graph.
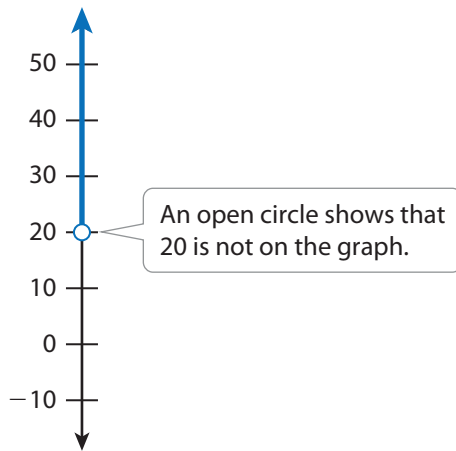
Rule 2

Shade all values that are *under 10.*

An open circle shows that 10 is not on the graph.
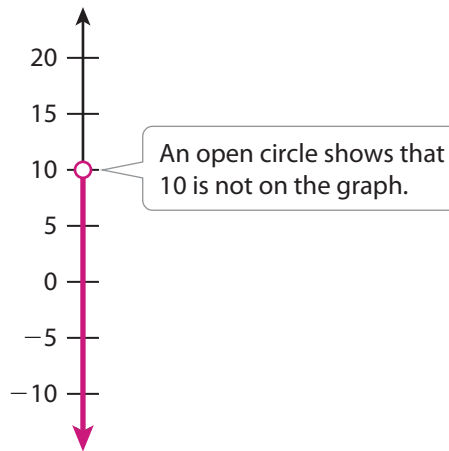
Model It

You can write an inequality with a variable.

Rule 1

Let *g* be a number of quarts of gumbo.

g must be more than 20.

   g **is greater than** 20.

      $g > 20$

Rule 2

Let *w* be the width of a booth in feet.

w must be under 10.

   w **is less than** 10.

      $w < 10$

CONNECT IT

➤ **Use the problem from the previous page to help you understand how to represent inequality situations.**

1 Look at Rule 1 in **Picture It**. List at least five numbers that are *more than 20*. Why is the number line shaded above 20? Why is the graph shown as an arrow?

2 How do the graph and the inequality for Rule 2 represent the same numbers?

3 The graph for Rule 2 represents all of the solutions of the inequality $w < 10$. Why is 10 not a point on the graph?

4 Cece wrote the inequality for Rule 1 as $20 < g$. Write this inequality in words. Why is $20 < g$ also an inequality that represents all numbers greater than 20?

5 Write the inequality for Rule 2 using the symbol $>$.

6 Think about how graphs and inequalities represent all numbers greater than or less than a given value. What are the advantages of a graph? What are the advantages of an inequality?

7 **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand how to solve the **Try It** problem.

Apply It

➤ **Use what you learned to solve these problems.**

8 At a farm stand, every basket of strawberries weighs more than $\frac{3}{4}$ lb. Draw a graph and write an inequality to represent the weight in pounds, *w*, of a basket of strawberries.

9 Which of the following can be represented by the inequality $x < 3$? Select all that apply.

A The price decreases by $3.

B The temperature is below 3°F.

C The airplane's elevation is higher than 3 mi.

D

E
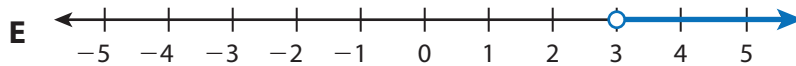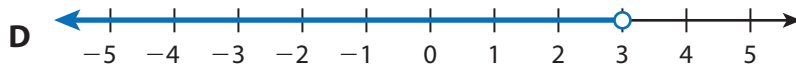
10 A state park has several campsites. All of the campsites are at an elevation of less than 6 m. An elevation of 0 m represents sea level. Use an inequality and a graph to represent the possible elevations of a campsite in the park.

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Practice Representing Inequalities

➤ **Study the Example showing how to represent an inequality.**
Then solve problems 1–5.

Example

An elevation of 0 m represents sea level. At a marine reserve, the elevation of every coral reef is higher than −10 m. Draw a graph and write an inequality to represent the possible elevations of a coral reef.

The elevation in meters can be any value that is greater than −10.

Use a number line to draw a graph.

Shade all values **greater than** −10. These are all values **above** −10.

Use a variable to write an inequality.

Let e = the elevation in meters of a coral reef.

e **is greater than** −10.

$$e > -10$$

Use an open circle to show that −10 is not on the graph.
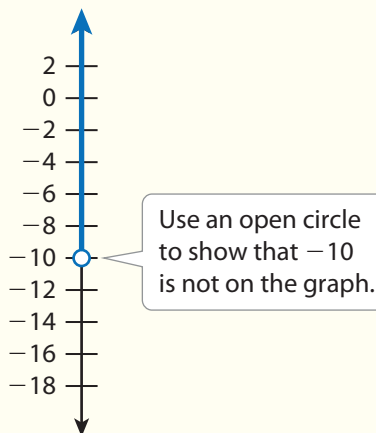
1   In the Example, suppose all of the coral reefs are below an elevation of −10 m.

   a. Describe how you could change the graph in the Example to show the possible elevations of a coral reef.

   b. Describe how you could change the inequality in the Example to show the possible elevations of a coral reef. Write the inequality.

2   Write an inequality for the graph. Use the variable y.

   SOLUTION _____

Vocabulary
inequality
a mathematical statement that uses an inequality symbol to show the relationship between values of expressions.

3 A skyscraper has an observation deck. There are always 5 employees on the deck. At any time, there must be fewer than 40 people on the deck.

a. Write an inequality that represents the number of visitors, v, who can be on the deck at any time. Show your work.

An observation deck

SOLUTION _____

b. Graph the inequality you wrote in problem 3a.

4 Which of these values would be on a graph of the inequality $45 > n$? Select all that apply.

A 50

B -75

C 0

D 15

E 45

F -5

5 A laboratory has several freezers. The temperature in every freezer is less than $-2\frac{1}{2}°F$. Draw a graph and write an inequality to represent the possible temperatures in a freezer.

Develop Writing and Graphing One-Variable Inequalities

➤ **Read and try to solve the problem below.**

Sea level is at an elevation of 0 ft. Some parts of a cave are below sea level. Visitors to the cave can choose from two different tours. The sign shows the elevations visitors explore on each tour. Use words, symbols, or pictures to describe all of the elevations that visitors may explore on each tour.

TRY IT

Math Toolkit number lines

Mystery Cave TOURS

Standard
Elevations: 16 m or less

Advanced
Elevations: less than −8 m

DISCUSS IT

Ask: How does your strategy or model describe *all* the possible elevations on each tour?

Share: My strategy or model includes . . .

➤ **Explore different ways to write and graph one-variable inequalities.**

Sea level is at an elevation of 0 ft. Some parts of a cave are below sea level. Visitors to the cave can choose from two different tours. The table shows the elevations visitors explore on each tour. Use words, symbols, or pictures to describe all of the elevations that visitors may explore on each tour.

Tour	Elevations
Standard	16 m or less
Advanced	Less than -8 m

Model It

You can use symbols to write an inequality with a variable.

Standard Tour

Let *s* be an elevation in meters on the tour.

Either   *s* **is less than** 16   or   *s* **is equal to** 16.

$$s < 16 \quad \text{or} \quad s = 16$$

$$s \leq 16$$

less than or equal to

Advanced Tour

Let *a* be an elevation in meters on the tour.

a **is less than** -8.

$$a < -8$$

Model It

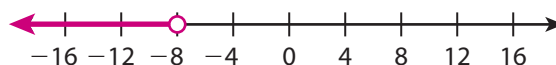You can use a number line graph to show the solutions of an inequality.

Standard Tour

$s \leq 16$

Advanced Tour

$a < -8$

➤ **Use the problem from the previous page to help you understand how to write and graph one-variable inequalities.**

1 Look at the first **Model It**. The inequality for the Standard tour uses a symbol that combines the less than symbol ($<$) with the equal sign ($=$). Why do you need to use *equal to*, as well as *less than*, when describing all possible values for *s*?

2 Why does the inequality for the Advanced tour use only the *less than* symbol?

3 Look at the second **Model It**. Why does one graph have a closed circle at the end of the arrow, while the other graph has an open circle?

4 Raúl uses a *greater than or equal to* symbol ($\geq$) to write the inequality $16 \geq s$. Does this inequality also represent the graph for the Standard tour? Explain.

5 When you write an inequality with a variable, how do you decide which inequality symbol to use ($<$, $>$, $\leq$, or $\geq$)?

6 **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand how to write and graph one-variable inequalities.

Apply It

➤ **Use what you learned to solve these problems.**

7 Leah plans to drive from Memphis to Jackson. She looks up driving routes between the cities. She finds that there is no driving route with a distance under 208 mi. Write an inequality that represents the number of miles, m, Leah might drive. Show your work.
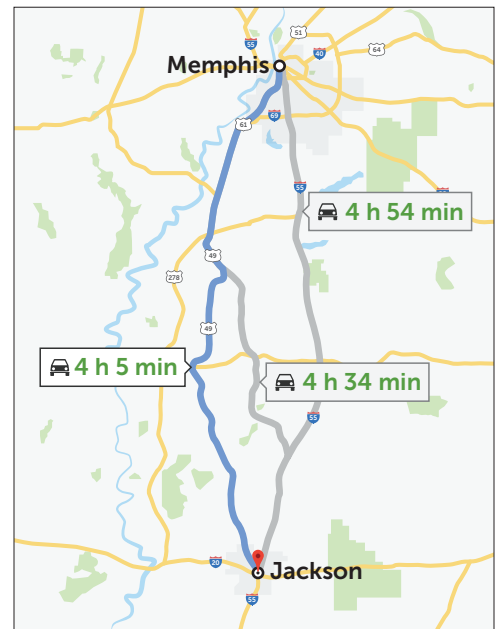
SOLUTION _____

8 Which inequality describes the values shown on the number line?
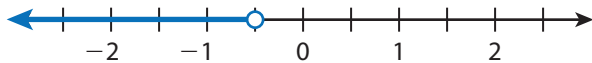
A $\frac{1}{2} > x$

B $-\frac{1}{2} > x$

C $\frac{1}{2} \geq x$

D $-\frac{1}{2} \geq x$

9 At a theme park, visitors must be at least 36 in. tall to ride the roller coaster alone. Write and graph an inequality to show the heights of visitors who may ride the roller coaster alone.

Practice Writing and Graphing One-Variable Inequalities

➤ **Study the Example showing how to write and graph an inequality.
Then solve problems 1–5.**

Example

Kazuko's score on a game show is no more than −15. Write and graph an inequality to show Kazuko's possible scores.

Let s be a possible score.

The phrase *no more than* means that s could be −15, but s could not be greater than −15.

So, s must be less than or equal to −15.

$\quad s \leq -15$

Graph the inequality $s \leq -15$. Use a solid circle at −15 because it is included as a solution of the inequality.
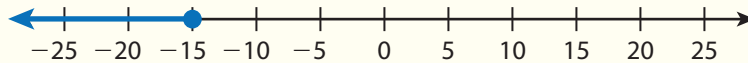
1 **a.** Write the inequality from the Example so that the variable s is on the right side of the inequality.

b. Does writing the inequality with the variable on the right change the values that are solutions of the inequality? Explain.

2 Chase buys 200 yd of thread. He uses some of the thread to make a costume. Write an inequality to show the possible lengths of thread that Chase has left. Show your work.

SOLUTION _____

3 There are at least 12 people on a bus.

   a. Write and graph an inequality to show the number of people who may be on the bus.

   b. Three people get on the bus at the next stop and no one gets off. Write an inequality that represents the number of people who may be on the bus now. Explain your thinking.

4 The possible values for the variable *n* are shown on the number line. Write an inequality for values of *n* so that the variable appears on the right side of the inequality. Show your work.

```
←——+———+———●———+———+———+———+———+———+———+———→
  −11  −10  −9   −8   −7   −6   −5   −4   −3   −2   −1
```

SOLUTION _____

5 At Central Theatre, the cost of a matinee movie is under $5.50. The cost of a popcorn is exactly $2.25. Write an inequality for the possible total cost, *c*, of a movie and popcorn. Show your work.

SOLUTION _____

Develop Using Substitution to Identify Solutions of Inequalities

➤ **Read and try to solve the problem below.**

Pilar has a gift card for a sporting goods store. She has $42.50 left on the card. She plans to buy one pair of yoga socks for $8. There are four other items that she is looking at. Use the inequality $x + 8 \leq 42.50$, where x is the price of an item, to determine which of the other four items Pilar can buy.

Yoga Socks $8.00 ★★★ BUY NOW

Bike Helmet $30.00 ★★★★ BUY NOW

Baseball Bat $38.50 ★★★★ BUY NOW

Running Shoes $35.50 ★★★ BUY NOW

Swim Goggles $28.50 ★★★ BUY NOW
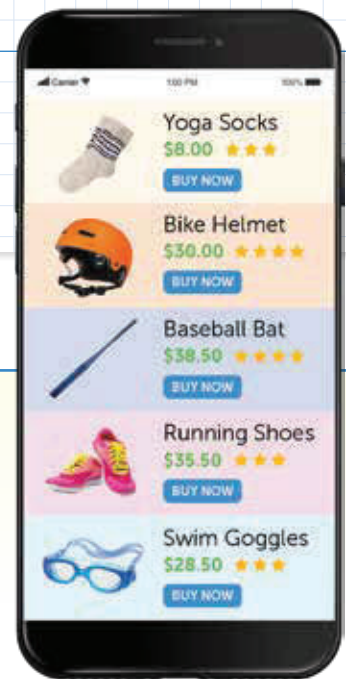
TRY IT   **Math Toolkit** number lines

DISCUSS IT

Ask: How did you use the inequality when solving the problem?

Share: I used the inequality by . . .

➤ **Explore different ways to identify solutions of an inequality.**

Pilar has a gift card for a sporting goods store. She has $42.50 left on the card. She plans to buy one pair of yoga socks for $8. The table shows four other items that she is looking at. Use the inequality $x + 8 \leq 42.50$, where x is the price of an item, to determine which of the other four items Pilar can buy.

Item	Price
Bike helmet	$30.00
Baseball bat	$38.50
Running shoes	$35.50
Swim goggles	$28.50

Model It

You can use substitution to decide whether a value is a solution of an inequality.

Substitute the price of each item for x in the inequality $x + 8 \leq 42.50$.

Item	Swim goggles	Bike helmet	Running shoes	Baseball bat
Price	**28.50**	**30.00**	**35.50**	**38.50**
Inequality	**28.50** + 8 ≤ 42.50 36.50 ≤ 42.50	**30.00** + 8 ≤ 42.50 38.00 ≤ 42.50	**35.50** + 8 ≤ 42.50 43.50 ≤ 42.50	**38.50** + 8 ≤ 42.50 46.50 ≤ 42.50
True or False?	**True**	**True**	**False**	**False**

Analyze It

You can use an equation and a graph to identify solutions of an inequality.

Think: For what value of x is $x + 8 = 42.50$?

$$x + 8 = 42.50$$
$$x + 8 - 8 = 42.50 - 8$$
$$x = \textbf{34.50}$$

If x is a value less than 34.50, $x + 8$ will be less than 42.50.

If x is a value greater than 34.50, $x + 8$ will be greater than 42.50.
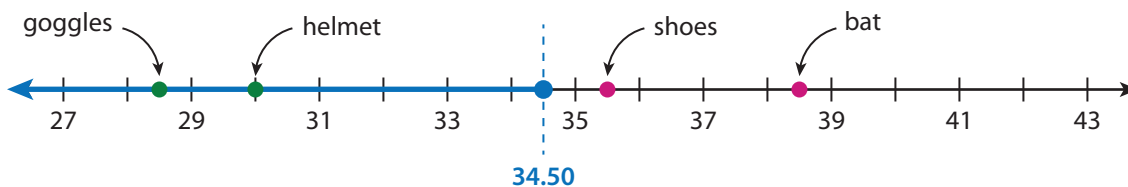
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➤ **Use the problem from the previous page to help you understand how to identify solutions of an inequality.**

1 Look at **Model It**. How do you know if a value is a solution of an inequality?

2 Which numbers in the set {28.5, 30, 35.5, 38.5} are solutions of the inequality $x + 8 \leq 42.50$? Which of the items at the sporting goods store can Pilar buy?

3 The table shows the items listed in order from least price to greatest price. How does organizing the information this way relate to the graph in **Analyze It**? Where would an item with a price of $34.50 be in the table?

4 How does solving the equation $x + 8 = 42.50$ help you identify solutions of the inequality $x + 8 < 42.50$?

5 Suppose you are given the inequality $10 > 2.5x$ along with a set of 20 values. Describe how you could decide which values are solutions of the inequality.

6 **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand how to identify solutions of an inequality.

Apply It

➤ **Use what you learned to solve these problems.**

7 Aimee works up to 50 hours a month and earns $12 per hour. She wants to save more than $240 to buy a computer. The inequality $12h > 240$, where h is the number of hours Aimee works this month, models this situation. Which values from 0 to 50 are solutions of the inequality? What do the solutions mean in this situation? Explain your reasoning.

8 Which of the following values of c are solutions of the inequality $c - 2 < 16$? Select all that apply.

A 2   **B** 16

C 17.5   **D** 18

E 20

9 Hiroaki has 23 keychains in his collection. He has a goal of collecting at least 30 keychains. He uses the inequality $30 \leq 23 + x$, where x is a number of keychains, to represent how he can reach his goal. Which values in the set {6, 7, 8} are solutions of Hiroaki's inequality? Show your work.

SOLUTION _____

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Practice Using Substitution to Identify Solutions of Inequalities

➤ **Study the Example showing how to use substitution to identify solutions of an inequality. Then solve problems 1–5.**

Example

Fadil's car travels 26 mi per gallon of gas used. He plans to drive less than 400 mi this week. The inequality $26g < 400$, where g is a number of gallons of gas models this situation. Which values in the set {12, 15, 18} are solutions of the inequality? What do the solutions mean in this situation?

Substitute the given values for g. Determine whether each value makes a true or false statement.

$$26 \cdot g \ < 400$$

$g = 12$	$26 \cdot 12 < 400$	$312 < 400$	← **True**
$g = 15$	$26 \cdot 15 < 400$	$390 < 400$	← **True**
$g = 18$	$26 \cdot 18 < 400$	$468 < 400$	← **False**

The values 12 and 15 are solutions of the inequality $26g < 400$.

Fadil can use 12 gal or 15 gal of gas and still drive less than 400 mi.

1 Show that 20 is not a solution of the inequality in the Example. Explain what this means about Fadil's driving this week.

2 Is 4.5 a solution of the inequality $13 < 3x$? Show your work.

Vocabulary

solution of an inequality
a value that can be substituted for a variable to make an inequality true.

SOLUTION _____

3 Ellie needs more than 10 packs of thread to make friendship bracelets for her classmates. She already has 6 packs of thread. She models this situation with the inequality $6 + p > 10$, where p is a number of packs of thread. Which values in the set {4, 5, 6, 7} are solutions of Ellie's inequality? Show your work.

SOLUTION

4 Noah writes the inequality $y + 3 > -2$. He says that every positive value of y is a solution of the inequality. Is he correct? Explain.

5 A shower uses 2.5 gal of water each minute. Yolanda wants to be sure each shower she takes uses no more than 15 gal of water. She writes the inequality $2.5m \leq 15$, where m is a number of minutes. Which values from 0 to 100 are solutions of the inequality? What do the solutions tell you? Explain your reasoning.

2.5 gallons per minute

Refine Writing and Graphing One-Variable Inequalities

➤ **Complete the Example below. Then solve problems 1–9.**

Example

A city bus tour only runs if there are more than 15 passengers. The bus can hold a total of 65 passengers. Write two inequalities to describe the number of passengers, *p,* on a bus tour.

Look at how you could use a graph to show the possible numbers of passengers.

p must be greater than 15.

p must also be less than or equal to 65.

SOLUTION _____

CONSIDER THIS . . .
The graph shows all values of *p* that make both inequalities true.

PAIR/SHARE
What is an example of a value for *p* that is a solution of one of the inequalities but not both inequalities?

Apply It

1. Which values in the set {1, 1.5, 2, 2.5} are solutions of the inequality $8 + 12h \leq 35$? Show your work.

CONSIDER THIS . . .
Think about the order of operations when testing if each value from the set is a solution.

PAIR/SHARE
How would your answer be different if you replaced 35 with 30 in the inequality?

SOLUTION _____

2 Each week, Patrick buys more than 2 pounds of apples. Apples cost $1.37 per pound. Draw a graph that represents the possible amounts of money, *m*, that Patrick spends on apples in a week. Then write an inequality that represents your graph. Show your work.

CONSIDER THIS . . .
Since Patrick buys more than 2 pounds of apples, he must spend more than the cost of 2 pounds of apples.

PAIR/SHARE
How can you write a different inequality by reversing the inequality symbol?

SOLUTION _____

3 Tiana cannot read traffic signs that are more than 50 m away. Which inequality represents the distances, *d*, at which Tiana *can* read traffic signs?

A $d > 50$

B $d \geq 50$

C $d < 50$

D $d \leq 50$

Erik chose A as the correct answer. How might he have gotten that answer?

CONSIDER THIS . . .
You can use a number line to represent the distances at which Tiana can read traffic signs.

PAIR/SHARE
How can you check that you chose the correct inequality?

4 Every Sunday, Sarah makes trail mix for the week. She always makes more than $3\frac{1}{2}$ cups of the mix. Then she divides it equally into 7 bags. Write an inequality for the number of cups of trail mix, x, in each bag. Show your work.

SOLUTION

5 Which values are solutions of the inequality $|y| < 3$? Select all that apply.

A -4 **B** -3

C -1.5 **D** 2

E 2.4 **F** 3

6 Every student at Ria's school lives no more than $4\frac{1}{2}$ mi from the school. Tell whether each inequality represents this situation. Choose *Yes* or *No*.

	Yes	No
a. $4\frac{1}{2} > x$	○	○
b. $4\frac{1}{2} \geq x$	○	○
c. $x \leq 4\frac{1}{2}$	○	○
d. $x > 4\frac{1}{2}$	○	○

7 Pedro wants to make a square pen for his goats. He plans that the pen will have a perimeter of at most 60 ft and that a side of the pen will be at least 10 ft long. He has enough money to buy fencing for a pen as large as 40 ft on a side.

a. The inequality $4n \leq 60$ models the amount of fence Pedro will use for a pen with side length n ft. Which values from 10 to 40 are solutions of the inequality? Write your answer using two inequalities.

SOLUTION _____

b. What do the solutions mean about the amount of fence Pedro will buy?

8 A student says that the inequality $0 \leq |z|$ is true for all values of z. Is the student correct? Explain.

9 **Math Journal** Write an inequality with a variable on one side, a negative integer on the other side, and one of the inequality symbols ($<$, $>$, $\leq$, or $\geq$) in between. Give a value that is a solution of the inequality and a value that is not a solution of the inequality. Then show how to graph the inequality.

✓ **End of Lesson Checklist**

☐ **INTERACTIVE GLOSSARY** Find the entry for *solution of an inequality*. Tell how solutions of inequalities and solutions of equations are alike.

☐ **SELF CHECK** Go back to the Unit 6 Opener and see what you can check off.

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