

Explain It!

Selena and Martin are waiting at the bus stop. The number lines show the possible wait times in minutes, t , for Selena and Martin.

Lesson 5-4

Solve Inequalities Using Addition or Subtraction

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I can...
solve inequalities using addition or subtraction.

Selena's Possible Wait Time

Martin's Possible Wait Time

A. Construct Arguments Who anticipates a longer wait? Justify your response with a mathematical explanation.

B. If Selena and Martin both wait 10 minutes for the bus, whose possible wait time was closer to his or her actual wait time? Explain.

Focus on math practices

Be Precise If Selena and Martin both wait exactly 15 minutes for the bus, whose possible wait time was closer to his or her actual wait time? Explain.

273

Essential Question How is solving inequalities with addition and subtraction similar to and different from solving equations with addition and subtraction?

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EXAMPLE 1 Solve Inequalities That Involve Addition

On the airline that Raul is using, the weight limit for both suitcases combined is 50 pounds. How much can Raul's second bag weigh without going over the limit?

Reasoning Is there more than one possible weight for Raul's second bag?

Write an inequality to represent the situation. Then solve the inequality to find the weight of the second bag, p .

$$\begin{aligned} \text{Weight of first bag} + \text{Weight of second bag} &= \text{Baggage weight limit} \\ 38 + p &= 50 \end{aligned}$$

Solve the inequality as you would an equation.

$$\begin{aligned} 38 + p &\leq 50 \\ 38 + p - 38 &\leq 50 - 38 \\ p &\leq 12 \end{aligned}$$

Use the inverse relationship between addition and subtraction to isolate the variable.

The **Subtraction Property of Inequality** is like the Subtraction Property of Equality: subtracting the same number from both sides maintains the inequality.

Use a number line to show all of the possible solutions to $p \leq 12$.

If the second bag weighs 10 pounds, the total weight is $38 + 10 = 48$, which is ≤ 50 .

The second bag can weigh at most 12 pounds.

Raul's second bag must weigh 12 pounds or less to avoid going over the weight limit for both suitcases combined.

Try It!

Kyoko has completed 26 hours of community service. Her goal is to complete at least 90 hours this semester. Write and solve an inequality to show how many more hours, h , Kyoko needs to complete to meet her goal. Use the number line to graph the solutions.

$$h + \square \geq 90$$

$$h + \square - \square \geq 90 - \square$$

$$h \geq \square$$

Convince Me! Is there more than one solution to the problem about Kyoko? Explain. Give one value that is a solution and one value that is not a solution.

274 5-4 Solve Inequalities Using Addition or Subtraction

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EXAMPLE 2 Solve Inequalities That Involve Subtraction

The weather forecast predicted that the evening temperature could get as low as -12.5°F . Between afternoon and evening, the temperature dropped by 7.5°F , which was consistent with the forecast. What could the afternoon temperature, t , have been?


Write an inequality to represent the situation. Then solve as you would an equation.

$$t - 7.5 \geq -12.5$$


$$t - 7.5 + 7.5 \geq -12.5 + 7.5$$

$$t \geq -5$$

The *Addition Property of Inequality* is like the Addition Property of Equality: adding the same number to both sides maintains the inequality.



Look for Relationships How is the Addition Property of Inequality similar to the Subtraction Property of Inequality?



The afternoon temperature could have been -5°F or warmer.

Try It!

The speed limit on a road drops down to 15 miles per hour around a curve. Mr. Gerard slows down by 10 miles per hour as he drives around the curve. He never drives above the speed limit. At what speed was Mr. Gerard driving before the curve? Graph the solution.

EXAMPLE 3 Solve More Inequalities

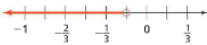
Solve the inequality $x - \frac{1}{2} < -\frac{2}{3}$. Then graph the solution.

$$x - \frac{1}{2} < -\frac{2}{3}$$

$$x - \frac{1}{2} + \frac{1}{2} < -\frac{2}{3} + \frac{1}{2}$$

$$x < -\frac{1}{6}$$

Remember to isolate the variable.



Try It!

Solve the inequality $n - 1\frac{3}{4} \leq -\frac{5}{8}$. Then graph the solution.

KEY CONCEPT

Solving inequalities with addition and subtraction is the same as solving equations with addition and subtraction. Use the inverse relationship between addition and subtraction to isolate the variable.

$$x + 15.76 > 26.05$$

$$x + 15.76 - 15.76 > 26.05 - 15.76$$

$$x > 10.29$$

Remember: The Addition and Subtraction Properties of inequality are like the Addition and Subtraction Properties of Equality.

$$-6\frac{1}{2} + y = 3\frac{1}{10}$$

$$-6\frac{1}{2} + y + 6\frac{1}{2} = 3\frac{1}{10} + 6\frac{1}{2}$$


$$y = 9\frac{6}{10}$$

Do You Understand?

- Generalize** How is solving inequalities with addition and subtraction similar to and different from solving equations with addition and subtraction?
- Be Precise** How do the solutions of the two inequalities differ? Are any of the solutions the same? Explain.
 - $x + 5 < 8$ and $x + 5 > 8$
 - $x + 5 \leq 8$ and $x + 5 = 8$
- Reasoning** Write two different inequalities in which one of the solutions is the same as the solution to $x - 23 = 191$.

Do You Know How?

- Solve each inequality. Then graph the solution.
 - $x + 5 > 3$
 - $x + 5 \leq 3$
 - $x - \frac{3}{2} < -3$
- Elanor is driving below the speed limit on a highway.
 - Write the inequality to show how much faster Elanor can drive without going over the speed limit.
 - Solve the inequality you wrote. By how much can Elanor increase her speed?



$$E \leq 55 - 43.5 \quad \text{or}$$

$$43.5 + E \leq 55 \quad \text{+} \quad -43.5 \quad \text{=} \quad 11.5$$

$$E \leq 11.5$$

Elanor can increase her speed by 11.5 mph or less

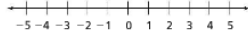
Name: _____

Practice & Problem Solving

Leveled Practice In 6 and 7, fill in the boxes to solve each inequality. Then graph the solutions.

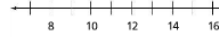
6. $x + 5 < 7$

$x + 5 - \square < 7 - \square$
 $x < \square$



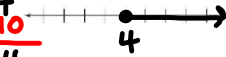
7. $x - 4 \geq 12$

$x - 4 + \square \geq 12 + \square$
 $x \geq \square$



8. Solve $x + 10 \geq 14$. Then graph the solution.

~~$x + 10 \geq 14$~~
 ~~$+ -10 = + -10$~~
 ~~$x \geq +4$~~



9. Solve $x - 20 \leq -11$. Then graph the solution.



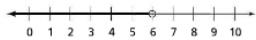
10. The maximum number of students in a classroom is 26. If there are 16 students signed up for the art class, how many more students can join the class without exceeding the maximum?

11. **Higher Order Thinking** The inequality $x + c > -2.55$ has the solution $x > 4.85$. What is the value of c ? How do you know?

12. Rina is climbing a mountain. She has not yet reached base camp. Write an inequality to show the remaining distance, d , in feet she must climb to reach the peak.



13. On a math test, students must solve the inequality $x - 5 < 11$ and then graph the solution. Mason said the solution is $x < 6$ and graphed the solution as shown below.



- a. What error did Mason make?
- b. Show the correct solution on the number line.



14. **Model with Math** Dani's neighbors paid her to take care of their bird during their vacation. Dani spent \$4 of her earnings on an afternoon snack and \$16 on a new book. Afterward, she had at least \$8 left. Write an inequality to represent how much Dani's neighbors paid her.

15. **Reasoning** The temperature in a greenhouse should be **at least 67°F or higher**. One morning, the heater stopped working. The temperature dropped 4 degrees before someone fixed the heater. The temperature was still **at least 67°F** when the heater started working again. How can you best describe the temperature in the greenhouse before the heater stopped working?



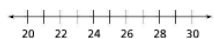
$t - 4 \geq 67$

~~$t + 4 \geq 67$~~
 ~~$+ +4 = +4$~~

$t \geq 71$

Assessment Practice

16. Solve the inequality $47 \geq x + 21$. Then graph the solution.



17. Kendra has \$7.35 in her purse. She needs at least \$2.87 more to buy a special bead. What is the total amount, x , she needs for the bead? Which inequalities can be used to represent the situation? Select all that apply.

- $x + 7.35 \leq 2.87$
- $x - 7.35 \leq 2.87$
- $x + 7.35 \geq 2.87$
- $x - 7.35 \geq 2.87$
- $x \geq 10.22$
- $x \leq 2.87$
- $x \leq 10.22$
- $x \geq 4.48$

