

# 3-4

## Solving Multi-Step Inequalities



### Vocabulary

#### Review

- Multiple Choice** You must *reverse* the direction of an inequality symbol when you multiply both sides of an inequality by a number that is ?.
  - (A) less than 0
  - (B) greater than 0
  - (C) less than or equal to 0
  - (D) greater than or equal to 0
- Write *reverse* if the inequality symbol will change when you solve the inequality. Write *same* if the symbol will remain the same.

$3t < 6$

$-8s < 4$

$5x \leq -10$

$-4 \leq -2a$

#### Vocabulary Builder

**at least** (adverbial phrase) **at least;** **at most** (adverbial phrase) **at most**

**Main Idea:** The phrase **at least** describes the least possible number that can be used. The phrase **at most** describes the greatest possible number that can be used.

**Using Symbols:** The inequality  $x \geq 5$  means “ $x$  is **at least** 5.” The inequality  $x \leq 5$  means “ $x$  is **at most** 5.”

#### Use Your Vocabulary

- Complete each sentence with the words *at least* or *at most*.

You must be ? 18 years of age to vote in a national election.

An elevator can safely carry ? 15 people.

When water boils, you know the temperature is ? 212°F.

If all books cost \$3 and Jane has \$20, she can buy ? 6 books.

- Use your answers to Exercise 3. Complete each inequality with  $\leq$  or  $\geq$ .

$y \quad \square \quad 18$

$e \quad \square \quad 15$

$w \quad \square \quad 212$

$3b \quad \square \quad 20$



## Problem 1 Using More Than One Step

**Got It?** What are the solutions of the inequality  $-6a - 7 \leq 17$ ?

Check your solutions.

5. Circle the first step in solving the inequality. Then underline the second step.

Add 7 to each side.

Divide each side by 6.

Divide each side by  $-6$   
and reverse the inequality.

Subtract 7 from each side.

Multiply each side by 6.

Multiply each side by  $-6$   
and reverse the inequality.

6. Use your answers to Exercise 5 to solve the inequality.

7. Check the endpoint by substituting into the related equation,  $-6a - 7 = 17$ .

8. Check the inequality symbol by substituting into the original inequality,  $-6a - 7 \leq 17$ .



## Problem 2 Writing and Solving a Multi-Step Inequality

**Got It?** You want to make a rectangular banner that is 18 ft long. You have no more than 48 ft of trim for the banner. What are the possible widths of the banner?

9. Circle the formula for the perimeter of a rectangle.

$$C = 2\pi r$$

$$A = \ell w$$

$$d = rt$$

$$P = 2\ell + 2w$$

10. Write an algebraic expression to describe the distance around a rectangular banner with a length of 18 ft and a width of  $w$  ft.

11. The distance around the banner should be at least / at most 48 feet.

12. Use the expression you wrote in Exercise 10 and the information from Exercise 11. Write an inequality to represent the situation described in the problem. Then solve your inequality.

13. The width of the banner should be at most      feet.



### Problem 3 Using the Distributive Property

**Got It?** What are the solutions of  $15 < 5 - 2(4m - 1) < 7$ ? Check your solutions.

14. Use the justifications at the right to solve the inequality.

$15 < 5 - 2(4m - 1) < 7$	Write the original inequality.
$15 < 5 - 2 \square - 2 \square$	Distributive Property
$15 < 28m - 2 \square$	Subtract.
$15 - 1 \square < 28m - 2 \square - 9 - 1 \square$	Addition Property of Inequality
$24 < \square$	Add.
$\frac{24}{\square} < \frac{28m}{\square}$	Division Property of Inequality
$2 < 3 \square m$	Simplify.

15. Check your solutions by following the steps below.

$15 < 5 - 2(4 \square - 1) < 7$	Substitute one of your solutions to Exercise 14.
$15 < 5 - 2(\square - 1) < 7$	Multiply within parentheses.
$15 < 5 - 2 \square + 2 < 7$	Add within parentheses.
$15 < 5 - 2 \square < 7$	Multiply.
$15 < \square < 7$	Simplify.



### Problem 4 Solving an Inequality With Variables on Both Sides

**Got It?** What are the solutions of  $3b - 1 < 27 - 2b$ ? Check your solutions.

16. The inequality is solved below. Write a justification for each step.

$3b - 1 < 27 - 2b$	<input type="text"/>
$2b - 1 + 3b - 1 < 27 - 2b + 1 - 2b$	<input type="text"/> Property of Inequality
$5b - 1 - 2 < 27 - 2 - 2$	<input type="text"/> Property of Inequality
$\frac{5b}{5} < \frac{15}{5}$	<input type="text"/> Property of Inequality
$b < 3$	<input type="text"/>

17. Check your solutions in the original inequality.

18. Are your solutions correct?

Yes / No



### Problem 5 Inequalities With Special Solutions

**Got It?** What are the solutions of the inequality  $9 \leq 5n \leq 1$ ?

19. Solve the inequality  $9 \leq 5n \leq 1$ .

20. The inequality  $9 \leq 5n \leq 1$  is **always / never** true.

So, **the solution is all real numbers / there is no solution**.



### Lesson Check • Do you UNDERSTAND?

**Error Analysis** Your friend says that the solutions of the inequality  $2(3 - x) \leq 2x - 6$  are all real numbers. Do you agree with your friend? Explain. What if the inequality symbol were  $\geq$ ?

21. The inequality  $2(3 - x) \leq 2x - 6$  is solved below. Write a justification from the box for each step.

$$2(3 - x) \leq 2x - 6$$

$$2 - 1 - 2x \leq 2x - 6$$

$$2 - 1 - 2x + 2x \leq 2x - 6 + 2x$$

$$2 - 1 \leq 2 - 6$$

Distributive Property  
Simplify.  
Subtraction Property of Inequality  
Write the original inequality.

Yes / No

22. Look at the final inequality in Exercise 21. Is the inequality ever true?

23. Do you agree with your friend? Explain. What if the inequality symbol were  $\geq$ ?

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### Math Success

Check off the vocabulary words that you understand.

- multi-step inequalities
  properties of inequality
  solutions

Rate how well you can solve multi-step inequalities.

