

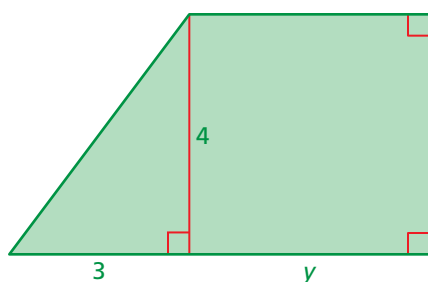
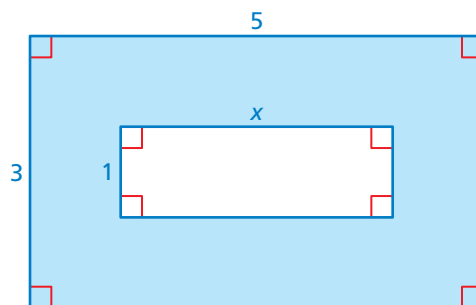
3.4 Solving Multi-Step Inequalities

Essential Question How can you use an inequality to describe the area and perimeter of a composite figure?

1 ACTIVITY: Areas and Perimeters of Composite Figures

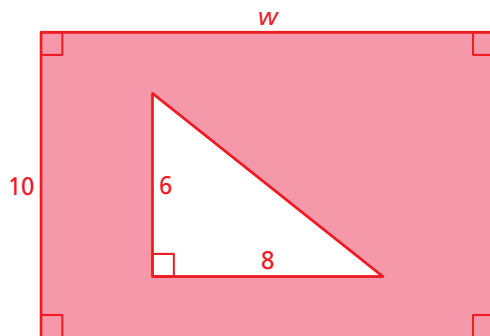
Work with a partner.

- For what values of x will the area of the blue region be greater than 12 square units?
- For what values of x will the sum of the inner and outer perimeters of the blue region be greater than 20 units?

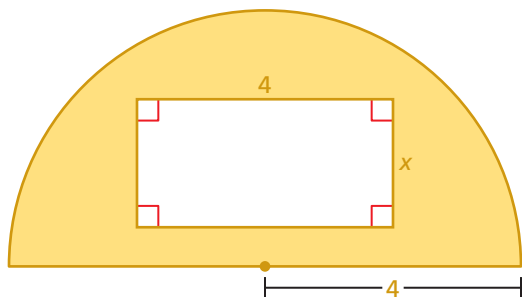


- For what values of y will the area of the trapezoid be less than or equal to 10 square units?
- For what values of y will the perimeter of the trapezoid be less than or equal to 16 units?

- For what values of w will the area of the red region be greater than or equal to 36 square units?
- For what values of w will the sum of the inner and outer perimeters of the red region be greater than 47 units?



- For what values of x will the area of the yellow region be less than 4π square units?
- For what values of x will the sum of the inner and outer perimeters of the yellow region be less than $4\pi + 20$ units?



COMMON CORE

Solving Inequalities

In this lesson, you will

- write and solve multi-step inequalities.
- solve real-life problems.

Learning Standards

- A.CED.1
- A.CED.3
- A.REI.3

2 ACTIVITY: Volume and Surface Area of a Composite Solid

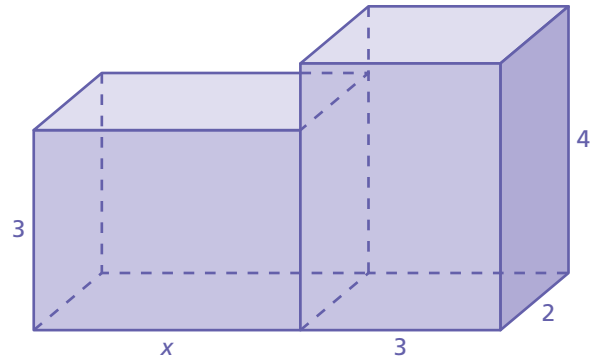
Math Practice 2

Use Operations

Which operations will you use to find the volume and surface area of the composite solid?

Work with a partner.

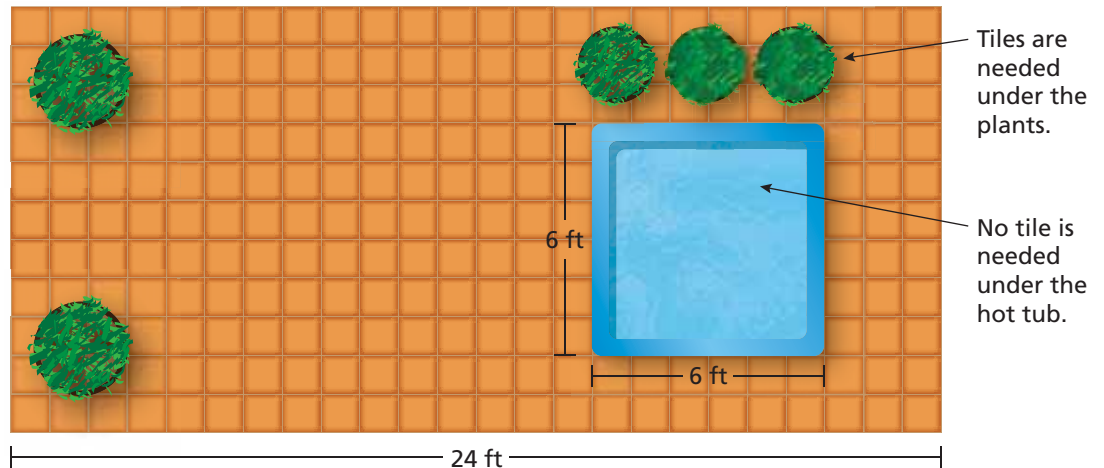
- For what values of x will the volume of the solid be greater than or equal to 42 cubic units?
- For what values of x will the surface area of the solid be greater than 72 square units?



3 ACTIVITY: Planning a Budget

Work with a partner.

You are building a patio. You want to cover the patio with Spanish tile that costs \$5 per square foot. Your budget for the tile is \$1700. How wide can you make the patio without going over your budget?



What Is Your Answer?

- IN YOUR OWN WORDS** How can you use an inequality to describe the area and perimeter of a composite figure? Give an example. Include a diagram with your example.

Practice

Use what you learned about solving multi-step inequalities to complete Exercises 3 and 4 on page 130.

You can use the properties of inequality to solve multi-step inequalities the same way you use the properties of equality to solve multi-step equations.

EXAMPLE 1 Solving a Multi-Step Inequality

Solve $\frac{y}{-6} + 7 < 9$. Graph the solution.

$$\frac{y}{-6} + 7 < 9$$

Write the inequality.

Undo the addition. $\rightarrow \frac{\cancel{-7}}{-6} - \cancel{7} < 9 - \cancel{7}$

Subtract 7 from each side.

$$\frac{y}{-6} < 2$$

Simplify.

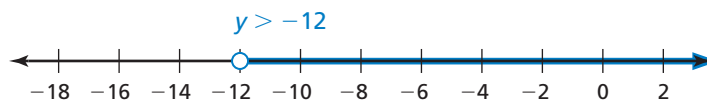
Undo the division. $\rightarrow -6 \cdot \frac{y}{-6} > -6 \cdot 2$

Multiply each side by -6 . Reverse the inequality symbol.

$$y > -12$$

Simplify.

••• The solution is $y > -12$.



On Your Own

Solve the inequality. Graph the solution.

1. $4b - 1 < 7$

2. $8 + 9c \geq -28$

3. $\frac{n}{-2} + 11 > 12$

Now You're Ready
Exercises 5–10

When solving an inequality, if you obtain an inequality that is true, such as $-5 < 0$, then the solution is the set of *all real numbers*. If you obtain an inequality that is false, such as $3 \leq -2$, then the inequality has *no solutions*.

EXAMPLE 2 Solving an Inequality with No Solution

Solve $8x - 3 > 4(2x + 3)$.

$$8x - 3 > 4(2x + 3)$$

Write the inequality.

$$8x - 3 > 8x + 12$$

Distributive Property

$$\begin{array}{r} \cancel{-8x} & \cancel{-8x} \\ -3 & > 12 \end{array} \quad \times$$

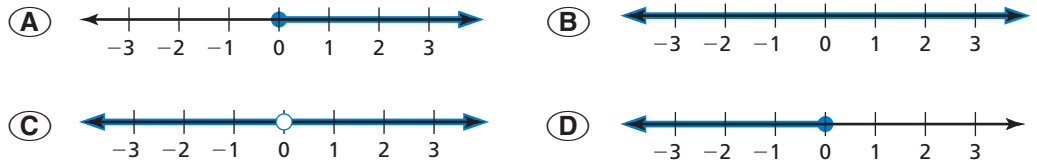
Subtract $8x$ from each side.

Simplify.

••• The inequality $-3 > 12$ is false. So, there are no solutions.

EXAMPLE 3 Solving an Inequality with Infinitely Many Solutions

Which graph represents the solution of $2(5x - 1) \leq 7 + 10x$?



Study Tip

The graph of the set of all real numbers is the entire number line.

$$2(5x - 1) \leq 7 + 10x \quad \text{Write the inequality.}$$

$$10x - 2 \leq 7 + 10x \quad \text{Distributive Property}$$

$$\underline{-10x} \quad \underline{-10x} \quad \text{Subtract } 10x \text{ from each side.}$$

$$-2 \leq 7 \quad \text{Simplify.}$$

∴ The inequality $-2 \leq 7$ is true. So, the solution is the set of all real numbers. The correct answer is **(B)**.

EXAMPLE 4 Real-Life Application

Trivia Challenge

Your Scores

- 95 **Game 1:** Very impressive!
- 91 **Game 2:** Good job!
- 77 **Game 3:** You can do better!
- 89 **Game 4:** Nice work!

You need a mean score of at least 90 to advance to the next round of the trivia game. What score do you need on the fifth game to advance?

Use the definition of mean to write and solve an inequality. Let x be the score on the fifth game.

$$\frac{95 + 91 + 77 + 89 + x}{5} \geq 90$$

The meaning of the phrase "at least" is greater than or equal to.

$$\frac{352 + x}{5} \geq 90 \quad \text{Simplify.}$$

$$5 \cdot \frac{352 + x}{5} \geq 5 \cdot 90 \quad \text{Multiply each side by 5.}$$

$$352 + x \geq 450 \quad \text{Simplify.}$$

$$\underline{-352} \quad \underline{-352} \quad \text{Subtract 352 from each side.}$$

$$x \geq 98 \quad \text{Simplify.}$$

∴ You need at least 98 points to advance to the next round.

Remember

The mean in Example 4 is equal to the sum of the game scores divided by the number of games.

On Your Own

Solve the inequality, if possible.

4. $2(k - 5) < 2k + 5$

5. $-4(3n - 1) > -12n + 5.2$

6. **WHAT IF?** In Example 4, you need a mean score of at least 88 to advance to the next round of the trivia game. What score do you need on the fifth game to advance?

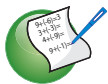
Now You're Ready
Exercises 12–20

3.4 Exercises



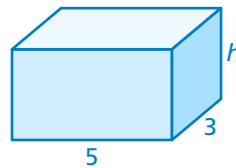
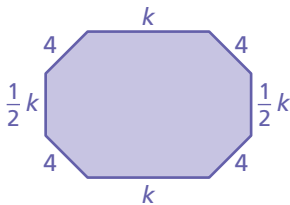
Vocabulary and Concept Check

- WRITING** Compare and contrast solving multi-step inequalities and solving multi-step equations.
- WRITING** How do you know when an inequality has no solutions? How do you know when the solution of an inequality is the set of all real numbers?



Practice and Problem Solving

- For what values of k will the perimeter of the octagon be less than or equal to 64 units?
- For what values of h will the surface area of the solid be greater than 46 square units?



Solve the inequality. Graph the solution.

- $5. 7b + 4 \geq 11$
- $6. 2v - 4 < 8$
- $7. 1 - \frac{m}{3} \leq 6$
- $8. \frac{4}{5} < 3w - \frac{11}{5}$
- $9. 1.8 < 0.5 - 1.3p$
- $10. -2.4r + 9.6 \geq 4.8$

- ERROR ANALYSIS** Describe and correct the error in solving the inequality.

X

$$\frac{x}{4} + 6 \geq 3$$

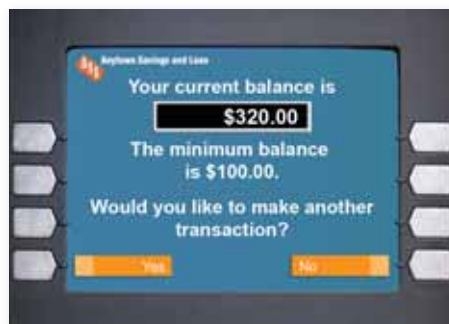
$$x + 6 \geq 12$$

$$x \geq 6$$

Solve the inequality, if possible.

- $12. 6(g + 2) \leq 18$
- $13. 4(y - 2) \geq 4y - 9$
- $14. -10 \geq \frac{5}{3}(h - 3)$
- $15. -\frac{1}{3}(u + 2) > 5$
- $16. 2.7 > 0.9(n - 1.7)$
- $17. 10 > -2.5(z - 3.1)$
- $18. 5(w + 4) \leq 5w + 20$
- $19. -(6 - x) < x - 7.5$
- $20. 12c - 5 > 3(4c + 1)$

- ATM** Write and solve an inequality that represents the number of \$20 bills you can withdraw from the account without going below the minimum balance.



Solve the inequality. Graph the solution.

22. $5x - 2x + 7 \leq 15 + 10$

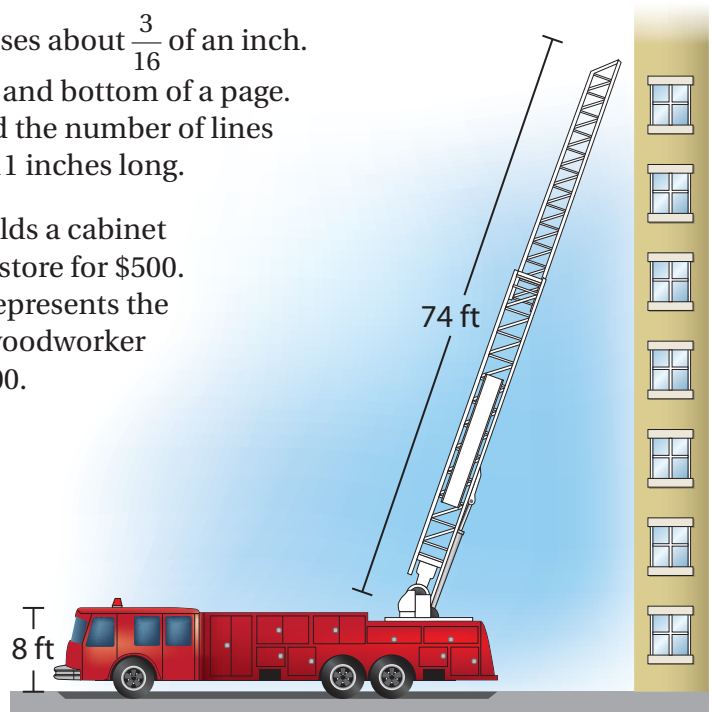
23. $7b - 12b + 1.4 > 8.4 - 22$

24. **TYPING** One line of text on a page uses about $\frac{3}{16}$ of an inch.

There are 1-inch margins at the top and bottom of a page. Write and solve an inequality to find the number of lines that can be typed on a page that is 11 inches long.

25. **WOODWORKING** A woodworker builds a cabinet in 20 hours. The cabinet is sold at a store for \$500. Write and solve an inequality that represents the hourly wage the store can pay the woodworker and still make a profit of at least \$100.

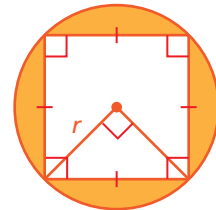
26. **FIRE TRUCK** The height of one story of a building is about 10 feet. The bottom of the ladder on the fire truck must be at least 24 feet away from the building. Write and solve an inequality to find the number of stories the ladder can reach.



27. **REASONING** A drive-in movie theater charges \$3.50 per car.

- a. The drive-in has already admitted 100 cars. Write and solve an inequality to find how many more cars the drive-in needs to admit to earn at least \$500.
- b. The theater increases the price by \$1 per car. How does this affect the total number of cars needed to earn \$500? Explain.

28. **Challenge** For what values of r will the area of the shaded region be greater than or equal to $9(\pi - 2)$?



Fair Game Review What you learned in previous grades & lessons

Graph the linear equation. (Section 2.1)

29. $y = 4x - 1$

30. $y = -4$

31. $x = 5$

32. $y = -\frac{1}{2}x + 3$

33. **MULTIPLE CHOICE** Which of the following is shown in the graph? (Section 2.4)

(A) $3x + 4y = -12$

(B) $3x - 4y = -12$

(C) $3x + 4y = 12$

(D) $3x - 4y = 12$

