# 8.4 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.

a. For what values of x will the area of the blue region be greater than 12 square units?

b. For what values of x will the sum of the inner and outer perimeters of the blue region be greater than 20 units?
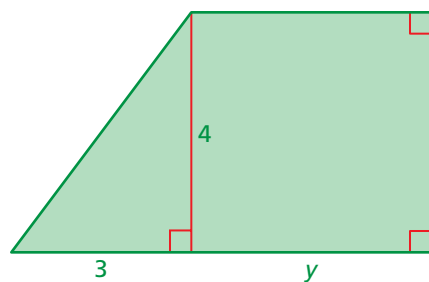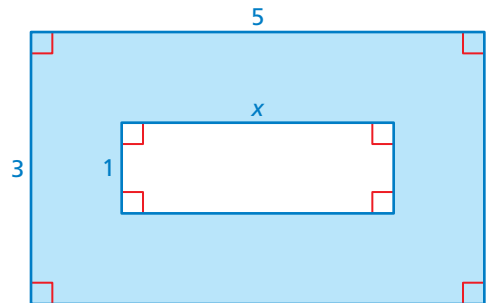
c. For what values of y will the area of the trapezoid be less than or equal to 10 square units?

d. For what values of y will the perimeter of the trapezoid be less than or equal to 16 units?

e. For what values of w will the area of the red region be greater than or equal to 36 square units?

f. For what values of w will the sum of the inner and outer perimeters of the red region be greater than 47 units?
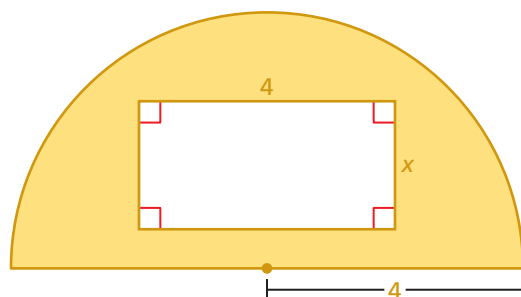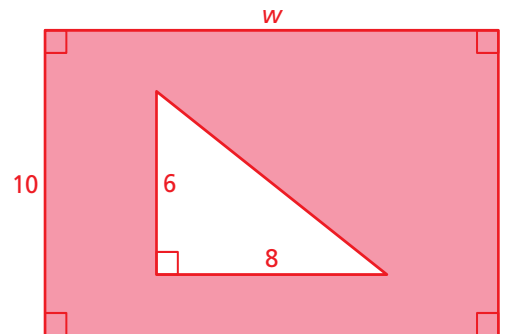

g. For what values of x will the area of the yellow region be less than 4π square units?

h. 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?

2 ACTIVITY: Volume and Surface Area of a Composite Solid

Work with a partner.

a. For what values of x will the volume of the solid be greater than or equal to 42 cubic units?

b. For what values of x will the surface area of the solid be greater than 72 square units?
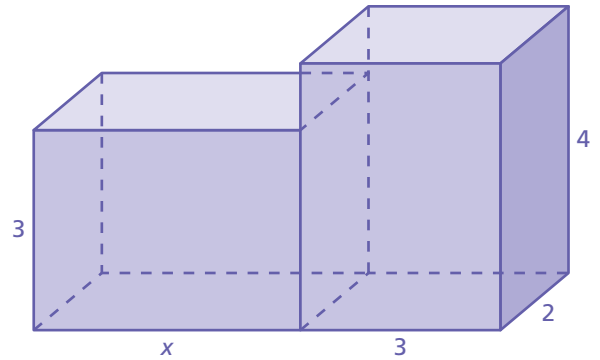
3 ACTIVITY: Planning a Budget

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?

Tiles are needed under the plants.

No tile is needed under the hot tub.

6 ft

6 ft

24 ft
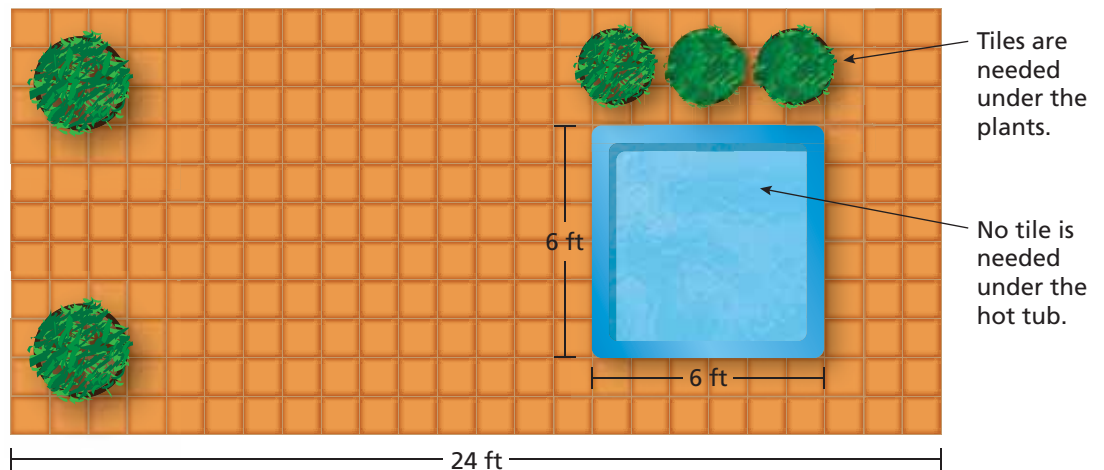
What Is Your Answer?

4. **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 338.

You can solve multi-step inequalities the same way you solve multi-step equations.

EXAMPLE **1** **Solving Two-Step Inequalities**

a. Solve $5x - 4 \geq 11$. Graph the solution.

$$5x - 4 \geq 11 \qquad \text{Write the inequality.}$$

Step 1: Undo the subtraction. $\longrightarrow$ $\underline{+4 \quad +4}$ Add 4 to each side.

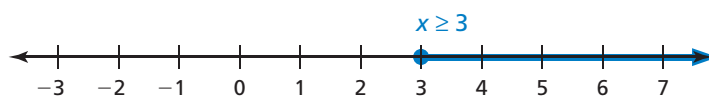$$5x \geq 15 \qquad \text{Simplify.}$$

Step 2: Undo the multiplication. $\longrightarrow$ $\dfrac{5x}{5} \geq \dfrac{15}{5}$ Divide each side by 5.

$$x \geq 3 \qquad \text{Simplify.}$$

∴ The solution is $x \geq 3$.

$x \geq 3$

Check: $x = 0$ is *not* a solution.

Check: $x = 4$ is a solution.

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

$$\frac{y}{-6} + 7 < 9 \qquad \text{Write the inequality.}$$

$$\underline{-7 \quad -7} \qquad \text{Subtract 7 from each side.}$$

$$\frac{y}{-6} < 2 \qquad \text{Simplify.}$$

$$-6 \cdot \frac{y}{-6} > -6 \cdot 2 \qquad \begin{array}{l}\text{Multiply each side by } -6. \text{ Reverse the} \\ \text{inequality symbol.}\end{array}$$

$$y > -12 \qquad \text{Simplify.}$$

∴ The solution is $y > -12$.

$y > -12$

On Your Own

Solve the inequality. Graph the solution.

1. $4b - 1 < 7$ **2.** $8 + 9c \geq -28$ **3.** $\dfrac{n}{-2} + 11 > 12$

Which graph represents the solution of $-7(x + 3) \le 28$?

(A)
```
←——+——+——+——●——+——+——+——→
 -10  -9  -8  -7  -6  -5  -4
```

(B)
```
←——+——+——+——●━━━━━━━━→
 -10  -9  -8  -7  -6  -5  -4
```

(C)
```
←━━━━━━━━●——+——+——+——→
   4   5   6   7   8   9  10
```

(D)
```
←——+——+——+——●━━━━━━━━→
   4   5   6   7   8   9  10
```
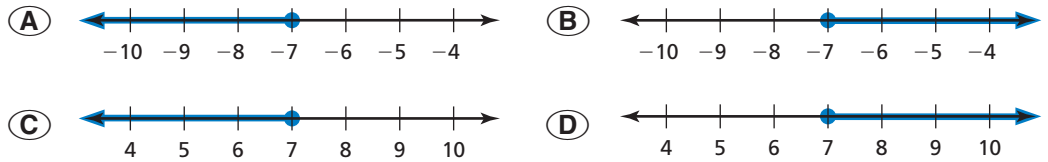
$$-7(x + 3) \le 28 \qquad \text{Write the inequality.}$$

$$-7x - 21 \le 28 \qquad \text{Use Distributive Property.}$$

$$\underline{+ 21 \qquad + 21} \qquad \text{Add 21 to each side.}$$

$$-7x \le 49 \qquad \text{Simplify.}$$

$$\frac{-7x}{-7} \ge \frac{49}{-7} \qquad \begin{array}{l} \text{Divide each side by } -7. \text{ Reverse the} \\ \text{inequality symbol.} \end{array}$$

$$x \ge -7 \qquad \text{Simplify.}$$

∴ The correct answer is (B).

Trivia Challenge

Your Scores

95 Round 1: Very impressive!

91 Round 2: Good job!

77 Round 3: You can do better!

89 Round 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.

> The phrase "at least" means greater than or equal to.

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

$$\frac{352 + x}{5} \ge 90 \qquad \text{Simplify.}$$

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

$$352 + x \ge 450 \qquad \text{Simplify.}$$

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

$$x \ge 98 \qquad \text{Simplify.}$$

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

Remember

The mean in Example 3 is equal to the sum of the game scores divided by the number of games.

🔴 **On Your Own**

Now You're Ready
Exercises 12–17

Solve the inequality. Graph the solution.

4. $2(k - 5) < 6$ **5.** $-4(n - 10) < 32$ **6.** $-3 \le 0.5(8 + y)$

7. WHAT IF? In Example 3, 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?
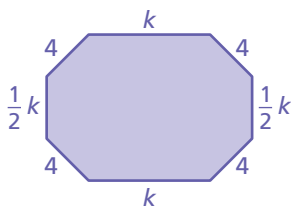
✔️ Vocabulary and Concept Check

1. **WRITING** Compare and contrast solving multi-step inequalities and solving multi-step equations.

2. **OPEN-ENDED** Describe how to solve the inequality $3(a + 5) < 9$.

📝 Practice and Problem Solving

3. For what values of k will the perimeter of the octagon be less than or equal to 64 units?

4. For what values of h will the surface area of the solid be greater than 46 square units?
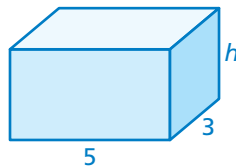
Solve the inequality. Graph the solution.

① 5. $7b + 4 \geq 11$

6. $2v - 4 < 8$

7. $1 - \dfrac{m}{3} \leq 6$

8. $\dfrac{4}{5} < 3w - \dfrac{11}{5}$

9. $1.8 < 0.5 - 1.3p$

10. $-2.4r + 9.6 \geq 4.8$

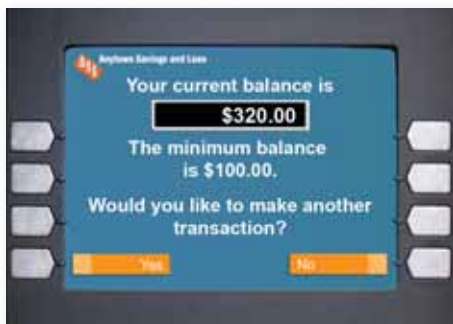11. **ERROR ANALYSIS** Describe and correct the error in solving the inequality.

❌
$$\dfrac{x}{4} + 6 \geq 3$$
$$x + 6 \geq 12$$
$$x \geq 6$$

Solve the inequality. Graph the solution.

② 12. $6(g + 2) \leq 18$

13. $2(y - 5) \leq 16$

14. $-10 \geq \dfrac{5}{3}(h - 3)$

15. $-\dfrac{1}{3}(u + 2) > 5$

16. $2.7 > 0.9(n - 1.7)$

17. $10 > -2.5(z - 3.1)$

Anytown Savings and Loan
Your current balance is
$320.00
The minimum balance is $100.00.
Would you like to make another transaction?
Yes   No

18. **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.

19. $5x - 2x + 7 \leq 15 + 10$

20. $7b - 12b + 1.4 > 8.4 - 22$

**21.** **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.

22. **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.

23. **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.

74 ft

8 ft
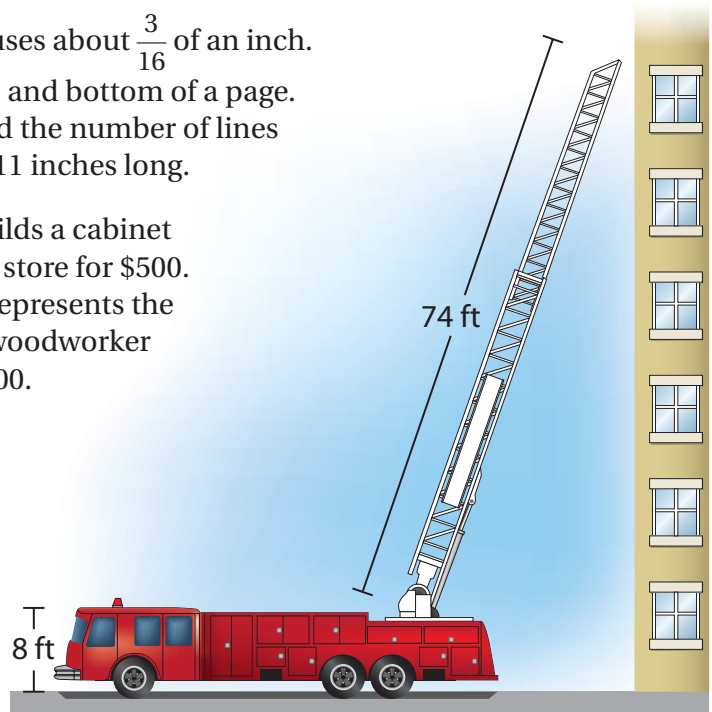
24. **DRIVE-IN** A drive-in movie theater charges $3.50 per car. The drive-in has already admitted 100 cars. Write and solve an inequality to find the number of cars the drive-in needs to admit to make at least $500.

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

r
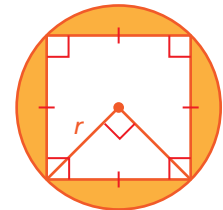
Fair Game Review *What you learned in previous grades & lessons*
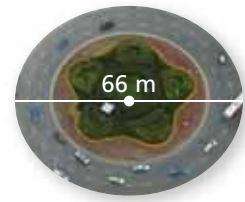
Find the area of the circle.

26.

10 mm

27.

25 in.

28.

66 m

29. **MULTIPLE CHOICE** What is the volume of the cube?
Ž

　Ⓐ 8 ft^3 Ⓑ 16 ft^3

　Ⓒ 24 ft^3 Ⓓ 32 ft^3

2 ft