

# 3.1 Solving Two-Step Equations

Objective: Solve two-step equations.

## Example 1: Using Subtraction and Division to Solve

Solve the equations. Check your solution.

$$1. \quad 4x + 9 = -7$$

$$\begin{array}{r} -9 \quad -9 \\ \hline 4x = -16 \\ \hline \frac{4x}{4} = \frac{-16}{4} \end{array}$$

$$\boxed{x = -4}$$

$$4(-4) + 9 = -7$$

$$-16 + 9 = -7$$

$$-7 = -7 \checkmark$$

$$2. \quad 3x + 8 = 26$$

$$\begin{array}{r} -8 \quad -8 \\ \hline 3x = 18 \\ \hline \frac{3x}{3} = \frac{18}{3} \end{array}$$

$$\boxed{x = 6}$$

$$3(6) + 8 = 26$$

$$18 + 8 = 26$$

$$26 = 26 \checkmark$$

$$3. \quad -21 = 4x + 7$$

$$\begin{array}{r} -7 \quad -7 \\ \hline -28 = 4x \\ \hline \frac{-28}{4} = \frac{4x}{4} \end{array}$$

$$\boxed{x = -7}$$

$$-21 = 4(-7) + 7$$

$$-21 = -28 + 7$$

$$-21 = -21 \checkmark$$

$$4. \quad 5 + 2x = 25$$

$$\begin{array}{r} -5 \quad -5 \\ \hline 2x = 20 \\ \hline \frac{2x}{2} = \frac{20}{2} \end{array}$$

$$\boxed{x = 10}$$

$$5 + 2(10) = 25$$

$$5 + 20 = 25$$

$$25 = 25 \checkmark$$

## Example 2: Using Addition and Multiplication to Solve

Solve the equations. Check your solution.

$$1. \quad \frac{x}{3} - 4 = -1$$

$$\begin{array}{r} +4 \quad +4 \\ \hline 3 \cdot \frac{x}{3} = 3 \cdot 3 \end{array}$$

$$\boxed{x = 9}$$

$$\frac{9}{3} - 4 = -1$$

$$3 - 4 = -1$$

$$-1 = -1 \checkmark$$

$$2. \quad \frac{x}{4} - 7 = 2$$

$$\begin{array}{r} +7 \quad +7 \\ \hline 4 \cdot \frac{x}{4} = 4 \cdot 9 \end{array}$$

$$\boxed{x = 36}$$

$$\frac{36}{4} - 7 = 2$$

$$9 - 7 = 2$$

$$2 = 2 \checkmark$$

$$3. \quad 8 = \frac{x}{3} - 3$$

$$\begin{array}{r} +3 \quad +3 \\ \hline 3 \cdot 11 = \frac{x}{3} \cdot 3 \end{array}$$

$$\boxed{x = 33}$$

$$8 = \frac{33}{3} - 3$$

$$8 = 11 - 3$$

$$8 = 8 \checkmark$$

$$4. \quad \frac{x}{2} - 1 = -5$$

$$\begin{array}{r} +1 \quad +1 \\ \hline 2 \cdot \frac{x}{2} = -4 \cdot 2 \end{array}$$

$$\boxed{x = -8}$$

$$\frac{-8}{2} - 1 = -5$$

$$-4 - 1 = -5$$

$$-5 = -5 \checkmark$$

### Example 3: Solving an Equation with Negative Coefficients

Solve the equations. Check your solution.

1.  $+2 - 3x = 17$

$$\begin{array}{r} -2 \quad -2 \\ \hline -3x = 15 \\ \hline \frac{-3x}{-3} = \frac{15}{-3} \end{array}$$

$$\boxed{x = -5}$$

$$2 - 3(-5) = 17$$

$$2 - (-15) = 17$$
$$17 = 17 \checkmark$$

2.  $+3 - 2y = 19$

$$\begin{array}{r} -3 \quad -3 \\ \hline -2y = 16 \\ \hline \frac{-2y}{-2} = \frac{16}{-2} \end{array}$$

$$\boxed{y = -8}$$

$$3 - 2(-8) = 19$$

$$3 - (-16) = 19$$
$$19 = 19 \checkmark$$

3.  $-5 = +4 - m$

$$\begin{array}{r} -4 \quad -4 \\ \hline -9 = -m \\ \hline \frac{-9}{-1} = \frac{-m}{-1} \end{array}$$

$$\boxed{m = 9}$$

$$-5 = 4 - 9$$

$$-5 = -5 \checkmark$$

4.  $7 = -3a - 2$

$$\begin{array}{r} +2 \quad +2 \\ \hline 9 = -3a \\ \hline \frac{9}{-3} = \frac{-3a}{-3} \end{array}$$

$$\boxed{a = -3}$$

$$7 = -3(-3) - 2$$

$$7 = 9 - 2$$

$$7 = 7 \checkmark$$

### Check It Out!

Solve the equations. Check your solution.

1.  $9b + 8 = 80$

$$\begin{array}{r} -8 \quad -8 \\ \hline 9b = 72 \\ \hline \frac{9b}{9} = \frac{72}{9} \end{array}$$

$$\boxed{b = 8}$$

$$9(8) + 8 = 80$$

$$72 + 8 = 80$$
$$80 = 80 \checkmark$$

2.  $\frac{z}{7} - 5 = -3$

$$\begin{array}{r} +5 \quad +5 \\ \hline 7 \cdot \frac{z}{7} = 2 \cdot 7 \end{array}$$

$$\boxed{z = 14}$$

$$\frac{14}{7} - 5 = -3$$

$$2 - 5 = -3$$

$$-3 = -3 \checkmark$$

3.  $-10 = +20 - 6c$

$$\begin{array}{r} -20 \quad -20 \\ \hline -30 = -6c \\ \hline \frac{-30}{-6} = \frac{-6c}{-6} \end{array}$$

$$\boxed{c = 5}$$

$$-10 = 20 - 6(5)$$

$$-10 = 20 - 30$$

$$-10 = -10 \checkmark$$

4.  $+11 - \frac{b}{6} = 23$

$$\begin{array}{r} -11 \quad -11 \\ \hline -6 \cdot \frac{b}{6} = 12 \cdot -6 \end{array}$$

$$\boxed{b = -72}$$

$$11 - \frac{-72}{6} = 23$$

$$11 - (-12) = 23$$

$$23 = 23 \checkmark$$

### 3.2 Solving Equations Having Like Terms & Parentheses

**Objective:** Solve equations using the distributive property.

#### Example 1: Solving Equations Using the Distributive Property

Solve the equations. Check your solution.

- |  |   |  |   |
|--|---|--|---|
| <p>1. <math>-24 = 6(2 - x)</math></p> $\begin{array}{r} -24 = 12 - 6x \\ -12 \quad -12 \\ \hline -36 = -6x \\ \frac{-6}{-6} \quad \frac{-6}{-6} \\ \hline x = 6 \end{array}$ | <p><math>-24 = 6(2 - 6)</math></p> $\begin{array}{r} -24 = 6(-4) \\ -24 = -24 \checkmark \end{array}$ | <p>2. <math>-2(7 - 4x) = 10</math></p> $\begin{array}{r} -14 + 8x = 10 \\ +14 \quad +14 \\ \hline 8x = 24 \\ \frac{8}{8} \quad \frac{24}{8} \\ \hline x = 3 \end{array}$ | <p><math>-2(7 - 4(3)) = 10</math></p> $\begin{array}{r} -2(7 - 12) = 10 \\ -2(-5) = 10 \\ 10 = 10 \checkmark \end{array}$ |
| <p>3. <math>-20 = 5(3 - x)</math></p> $\begin{array}{r} -20 = 15 - 5x \\ -15 \quad -15 \\ \hline -35 = -5x \\ \frac{-5}{-5} \quad \frac{-5}{-5} \\ \hline x = 7 \end{array}$ | <p><math>-20 = 5(3 - 7)</math></p> $\begin{array}{r} -20 = 5(-4) \\ -20 = -20 \checkmark \end{array}$ | <p>4. <math>-3(6 - 2x) = 12</math></p> $\begin{array}{r} -18 + 6x = 12 \\ +18 \quad +18 \\ \hline 6x = 30 \\ \frac{6}{6} \quad \frac{30}{6} \\ \hline x = 5 \end{array}$ | <p><math>-3(6 - 2(5)) = 12</math></p> $\begin{array}{r} -3(6 - 10) = 12 \\ -3(-4) = 12 \\ 12 = 12 \checkmark \end{array}$ |

#### Example 2: Combining Like Terms After Distributing

Solve the equations. Check your solution.

- |   |  |   |  |
|---|--|---|--|
| <p>1. <math>6x - 4(x - 1) = 14</math></p> $\begin{array}{r} 6x - 4x + 4 = 14 \\ 2x + 4 = 14 \\ -4 \quad -4 \\ \hline 2x = 10 \\ \frac{2}{2} \quad \frac{2}{2} \\ \hline x = 5 \end{array}$  | <p><math>6(5) - 4(5 - 1) = 14</math></p> $\begin{array}{r} 30 - 4(4) = 14 \\ 30 - 16 = 14 \\ 14 = 14 \checkmark \end{array}$ | <p>2. <math>4y - 14 + 3y = 28</math></p> $\begin{array}{r} 7y - 14 = 28 \\ +14 \quad +14 \\ \hline 7y = 42 \\ \frac{7}{7} \quad \frac{42}{7} \\ \hline y = 6 \end{array}$                 | <p><math>4(6) - 14 + 3(6) = 28</math></p> $\begin{array}{r} 24 - 14 + 18 = 28 \\ 10 + 18 = 28 \\ 28 = 28 \checkmark \end{array}$ |
| <p>3. <math>5x - 2(x - 3) = 30</math></p> $\begin{array}{r} 5x - 2x + 6 = 30 \\ 3x + 6 = 30 \\ -6 \quad -6 \\ \hline 3x = 24 \\ \frac{3}{3} \quad \frac{24}{3} \\ \hline x = 8 \end{array}$ | <p><math>5(8) - 2(8 - 3) = 30</math></p> $\begin{array}{r} 40 - 2(5) = 30 \\ 40 - 10 = 30 \\ 30 = 30 \checkmark \end{array}$ | <p>4. <math>3 + 4(x + 1) = 35</math></p> $\begin{array}{r} 3 + 4x + 4 = 35 \\ 4x + 7 = 35 \\ -7 \quad -7 \\ \hline 4x = 28 \\ \frac{4}{4} \quad \frac{28}{4} \\ \hline x = 7 \end{array}$ | <p><math>3 + 4(7 + 1) = 35</math></p> $\begin{array}{r} 3 + 4(8) = 35 \\ 3 + 32 = 35 \\ 35 = 35 \checkmark \end{array}$          |

## Check It Out!

Solve the equations. Check your solution.

1.  $-8(5 - 7c) = 184$       $-8(5 - 7(4)) = 184$   
 $-40 + 56c = 184$       $-8(5 - 28) = 184$   
 $+40$       $+40$   
 $\frac{56c}{56} = \frac{224}{56}$       $-8(-23) = 184$   
 $\frac{56c}{56} = \frac{224}{56}$       $184 = 184 \checkmark$   
 **$C = 4$**

2.  $-2(7 - 11v) = 96$       $-2(7 - 11(5)) = 96$   
 $-14 + 22v = 96$       $-2(7 - 55) = 96$   
 $+14$       $+14$   
 $\frac{22v}{22} = \frac{110}{22}$       $-2(-48) = 96$   
 $\frac{22v}{22} = \frac{110}{22}$       $96 = 96 \checkmark$   
 **$V = 5$**

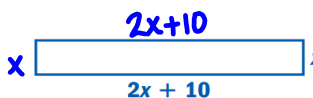
3.  $10a + 5(2a + 1) = 65$       $10(3) + 5(2(3) + 1) = 65$   
 $10a + 10a + 5 = 65$       $30 + 5(6 + 1) = 65$   
 $20a + 5 = 65$       $30 + 5(7) = 65$   
 $-5$       $-5$   
 $\frac{20a}{20} = \frac{60}{20}$       $30 + 35 = 65$   
 $\frac{20a}{20} = \frac{60}{20}$       $65 = 65 \checkmark$   
 **$A = 3$**

4.  $11z - 3(z - 9) = 123$   
 $11z - 3z + 27 = 123$   
 $8z + 27 = 123$       $11(12) - 3(12 - 9) = 123$   
 $-27$       $-27$       $132 - 3(3) = 123$   
 $\frac{8z}{8} = \frac{96}{8}$       $132 - 9 = 123$   
 $\frac{8z}{8} = \frac{96}{8}$       $123 = 123 \checkmark$   
 **$Z = 12$**

## Example 3: Solving Equations with Geometry

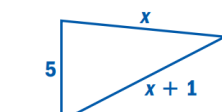
Find the value of  $x$  for the given geometric shape.

1. Perimeter = 32 units



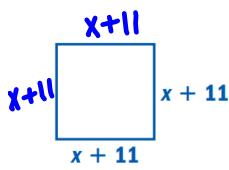
$32 = 6x + 20$   
 $-20$       $-20$   
 $\frac{12}{6} = \frac{6x}{6}$   
 **$X = 2$**

2. Perimeter = 22 units



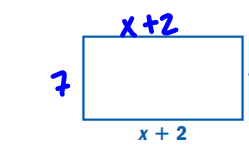
$22 = 2x + 6$   
 $-6$       $-6$   
 $\frac{16}{2} = \frac{2x}{2}$   
 **$X = 8$**

3. Perimeter = 104 units



$104 = 4x + 44$   
 $-44$       $-44$   
 $\frac{60}{4} = \frac{4x}{4}$   
 **$X = 15$**

4. Perimeter = 40 units



$40 = 2x + 18$   
 $-18$       $-18$   
 $\frac{22}{2} = \frac{2x}{2}$   
 **$X = 11$**

### 3.3 Solving Equations with Variables on Both Sides

**Objective:** Solve equations with variables on both sides.

#### Example 1: Solving an Equation with the Variable on Both Sides

Solve the equations. Check your solution.

1.  $5n - 7 = 9n + 21$       $5(-7) - 7 = 9(-7) + 21$      2.  $3n - 6 = 5n + 20$       $3(-13) - 6 = 5(-13) + 20$

$$\begin{array}{r} -5n \\ \hline -7 = 4n + 21 \\ -21 \quad -21 \\ \hline -28 = 4n \\ \frac{-28}{4} \quad \frac{4n}{4} \\ \hline n = -7 \end{array}$$

$$\begin{array}{r} -35 - 7 = -63 + 21 \\ -42 = -42 \checkmark \end{array}$$

$$\begin{array}{r} -3n \\ \hline -6 = 2n + 20 \\ -20 \quad -20 \\ \hline -26 = 2n \\ \frac{-26}{2} \quad \frac{2n}{2} \\ \hline n = -13 \end{array}$$

$$\begin{array}{r} -39 - 6 = -65 + 20 \\ -45 = -45 \checkmark \end{array}$$

3.  $24z - 35 = 55 - 21z$      4.  $5x - 19 = 20 - 8x$

$$\begin{array}{r} +21z \\ \hline 45z - 35 = 55 \\ +35 \quad +35 \\ \hline 45z = 90 \\ \frac{45z}{45} \quad \frac{90}{45} \\ \hline z = 2 \end{array}$$

$$\begin{array}{r} 24(2) - 35 = 55 - 21(2) \\ 48 - 35 = 55 - 42 \\ 13 = 13 \checkmark \end{array}$$

$$\begin{array}{r} +8x \\ \hline 13x - 19 = 20 \\ +19 \quad +19 \\ \hline 13x = 39 \\ \frac{13x}{13} \quad \frac{39}{13} \\ \hline x = 3 \end{array}$$

$$\begin{array}{r} 5(3) - 19 = 20 - 8(3) \\ 15 - 19 = 20 - 24 \\ -4 = -4 \checkmark \end{array}$$

#### Example 2: An Equation with No Solution

Solve the equations. Check your solution.

1.  $3(2x + 1) = 6x$      2.  $12x = 4(3x - 1)$

$$\begin{array}{r} 6x + 1 = 6x \\ -6x \quad -6x \\ \hline 1 \neq 0 \\ \hline \text{No Solution} \end{array}$$

$$\begin{array}{r} 12x = 12x - 4 \\ -12x \quad -12x \\ \hline 0 \neq -4 \\ \hline \text{No Solution} \end{array}$$

3.  $3(2 - x) = 5 - 3x$      4.  $3(14x + 3) = 6(7x + 1)$

$$\begin{array}{r} 6 - 3x = 5 - 3x \\ +3x \quad +3x \\ \hline 6 \neq 5 \\ \hline \text{No Solution} \end{array}$$

$$\begin{array}{r} 42x + 9 = 42x + 6 \\ -42x \quad -42x \\ \hline 9 \neq 6 \\ \hline \text{No Solution} \end{array}$$

### Example 3: Solving an Equation with All Numbers as Solutions

Solve the equations. Check your solution.

$$1. 4(x + 2) = 4x + 8$$

$$\begin{array}{r} 4x + 8 = 4x + 8 \\ -4x \quad -4x \\ \hline 8 = 8 \end{array}$$

All real numbers

$$2. 3(2n + 4) = 2(3n + 6)$$

$$\begin{array}{r} 6n + 12 = 6n + 12 \\ -6n \quad -6n \\ \hline 12 = 12 \end{array}$$

All real numbers

$$3. 4 - 3(2t + 12) = -2 - 2(15 + 3t)$$

$$\begin{array}{r} 4 - 6t - 36 = -2 - 30 - 6t \\ -6t - 32 = -6t - 32 \\ +6t \quad +6t \\ \hline -32 = -32 \end{array}$$

All real numbers

$$4. 3(14x + 3) = 6(7x + 1) + 3$$

$$\begin{array}{r} 42x + 9 = 42x + 6 + 3 \\ 42x + 9 = 42x + 9 \\ -42x \quad -42x \\ \hline 9 = 9 \end{array}$$

All real numbers

### Check It Out!

Solve the equations. Check your solution.

$$1. 13x + 9 = 11x + 13$$

$$\begin{array}{r} 13x + 9 = 11x + 13 \\ -11x \quad -11x \\ \hline 2x + 9 = 13 \\ -9 \quad -9 \\ \hline 2x = 4 \\ \frac{2x}{2} = \frac{4}{2} \end{array}$$

$$x = 2$$

$$\begin{array}{r} 13(2) + 9 = 11(2) + 13 \\ 26 + 9 = 22 + 13 \\ 35 = 35 \checkmark \end{array}$$

$$2. -3k - 25 = 5k - 1$$

$$\begin{array}{r} -3k - 25 = 5k - 1 \\ +3k \quad +3k \\ \hline -25 = 8k - 1 \\ +1 \quad +1 \\ \hline -24 = 8k \\ \frac{-24}{8} = \frac{8k}{8} \end{array}$$

$$k = -3$$

$$\begin{array}{r} -3(-3) - 25 = 5(-3) - 1 \\ 9 - 25 = -15 - 1 \\ -16 = -16 \checkmark \end{array}$$

### Example 4: Writing a Verbal Sentence as an Equation

Write the verbal sentence as an equation. Then solve the equation.

1. Nine plus 2 times a number is equal to 2 less than 3 times the number.

$$9 + 2x = 3x - 2$$

$$\begin{array}{r} 9 + 2x = 3x - 2 \\ -2x \quad -2x \\ \hline 9 = x - 2 \\ +2 \quad +2 \end{array}$$

$$x = 11$$

2. Twelve less than -9 times a number is equal to 8 minus 4 times the number.

$$-9x - 12 = 8 - 4x$$

$$\begin{array}{r} -9x - 12 = 8 - 4x \\ +9x \quad +9x \\ \hline -12 = 8 + 5x \\ -8 \quad -8 \\ \hline -20 = 5x \end{array}$$

$$\frac{-20}{5} = \frac{5x}{5}$$

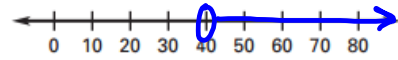
$$x = -4$$

# 3.4 Solving Inequalities Using Addition or Subtraction

**Objective:** Solve inequalities using addition or subtraction.

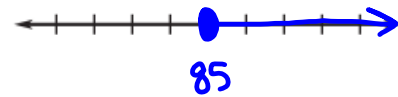
## Example 1: Writing and Graphing Inequalities

1. An airline allows passengers to carry on-board one piece of luggage. Luggage that exceeds 40 pounds cannot be carried on-board. Write and graph an inequality that gives the weight of the luggage that cannot be carried on-board.



$$W > 40$$

2. You need at least 85 points on the final exam to get an A in your math class.



$$p \geq 85$$

**Addition and Subtraction Properties of Inequality**

**Words** Adding or subtracting the same number on each side of an inequality produces an equivalent inequality.

**Algebra** If  $a < b$ , then  $a + c < b + c$  and  $a - c < b - c$ .  
If  $a > b$ , then  $a + c > b + c$  and  $a - c > b - c$ .

## Example 2: Solving Inequalities using Subtraction

Solve the inequalities. Graph and check your solution.

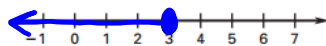
$$1. \quad m + 9 \leq 12$$

$$\quad \quad \quad \begin{array}{r} -9 \quad -9 \\ \hline \end{array}$$

$$m \leq 3$$

$$2 + 9 \leq 12$$

$$11 \leq 12 \checkmark$$



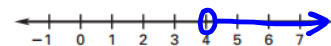
$$2. \quad x - 11 > -7$$

$$\quad \quad \quad \begin{array}{r} +11 \quad +11 \\ \hline \end{array}$$

$$x > 4$$

$$5 - 11 > -7$$

$$-6 > -7 \checkmark$$



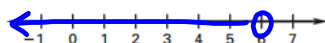
$$3. \quad m + 7 < 13$$

$$\quad \quad \quad \begin{array}{r} -7 \quad -7 \\ \hline \end{array}$$

$$m < 6$$

$$5 + 7 < 13$$

$$12 < 13 \checkmark$$



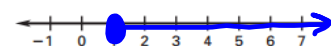
$$4. \quad a + 4 \geq 5$$

$$\quad \quad \quad \begin{array}{r} -4 \quad -4 \\ \hline \end{array}$$

$$a \geq 1$$

$$5 + 4 \geq 5$$

$$9 \geq 5 \checkmark$$



### Example 3: Solving Inequalities using Addition

Solve the inequalities. Graph and check your solution.

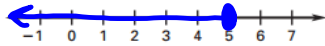
1.  $3 \geq x - 2$

$$\begin{array}{r} +2 \quad +2 \\ \hline \end{array}$$

$$5 \geq x$$

$$\boxed{x \leq 5}$$

$$\begin{array}{r} 3 \geq 4 - 2 \\ 3 \geq 2 \checkmark \end{array}$$



2.  $4 \leq a - 5$

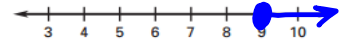
$$\begin{array}{r} +5 \quad +5 \\ \hline \end{array}$$

$$9 \leq a$$

$$\boxed{a \geq 9}$$

$$4 \leq 10 - 5$$

$$4 \leq 5 \checkmark$$



3.  $-6 < z - 7$

$$\begin{array}{r} +7 \quad +7 \\ \hline \end{array}$$

$$1 < z$$

$$\boxed{z > 1}$$

$$\begin{array}{r} -6 < 2 - 7 \\ -6 < -5 \checkmark \end{array}$$



4.  $-7 > c - 9$

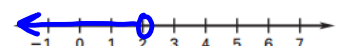
$$\begin{array}{r} +9 \quad +9 \\ \hline \end{array}$$

$$2 > c$$

$$\boxed{c < 2}$$

$$-7 > 1 - 9$$

$$-7 > -8 \checkmark$$



### Check It Out!

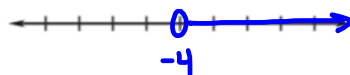
Solve the inequalities. Graph and check your solution.

1.  $y + 11 > 7$

$$\begin{array}{r} -11 \quad -11 \\ \hline \end{array}$$

$$\boxed{y > -4}$$

$$\begin{array}{r} 0 + 11 > 7 \\ 11 > 7 \checkmark \end{array}$$

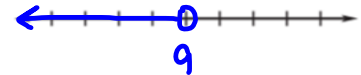


2.  $u - 31 < -22$

$$\begin{array}{r} +31 \quad +31 \\ \hline \end{array}$$

$$\boxed{u < 9}$$

$$\begin{array}{r} 0 - 31 < -22 \\ -31 < -22 \checkmark \end{array}$$



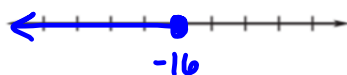
3.  $-9 \geq m + 7$

$$\begin{array}{r} -7 \quad -7 \\ \hline \end{array}$$

$$-16 \geq m$$

$$\boxed{m \leq -16}$$

$$\begin{array}{r} -9 \geq -20 + 7 \\ -9 \geq -13 \checkmark \end{array}$$



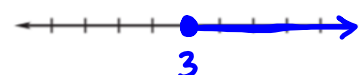
4.  $-3 \leq x - 6$

$$\begin{array}{r} +6 \quad +6 \\ \hline \end{array}$$

$$3 \leq x$$

$$\boxed{x \geq 3}$$

$$\begin{array}{r} -3 \leq 4 - 6 \\ -3 \leq -2 \checkmark \end{array}$$





# 3.5 Solving Inequalities Using Multiplication or Division

**Objective:** Solve inequalities using multiplication or division.

**Multiplication Property of Inequality**

**Words** Multiplying each side of an inequality by a *positive* number produces an equivalent inequality.

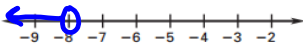

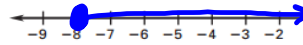
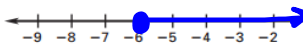
Multiplying each side of an inequality by a *negative* number and *reversing the direction of the inequality symbol* produces an equivalent inequality.

**Algebra** If  $a < b$  and  $c > 0$ , then  $ac < bc$ .

If  $a < b$  and  $c < 0$ , then  $ac > bc$ .

## Example 1: Solving an Inequality Using Multiplication

Solve the inequities. Graph and check your solution.

<p>1. <math>-4 \cdot \frac{m}{-4} &gt; 2 \cdot -4</math></p> <p style="text-align: center;"><math>\boxed{m &lt; -8}</math></p>	<p style="text-align: center;"><math>\frac{-12}{-4} &gt; 2</math> <math>3 &gt; 2 \checkmark</math></p> 	<p>2. <math>5 \cdot \frac{t}{5} &lt; 3 \cdot 5</math></p> <p style="text-align: center;"><math>\boxed{t &lt; 15}</math></p>	<p style="text-align: center;"><math>\frac{10}{5} &lt; 3</math> <math>2 &lt; 3 \checkmark</math></p> 
<p>3. <math>-8 \cdot \frac{b}{-8} \leq 1 \cdot -8</math></p> <p style="text-align: center;"><math>\boxed{b \geq -8}</math></p>	<p style="text-align: center;"><math>\frac{0}{-8} \leq 1</math> <math>0 \leq 1 \checkmark</math></p> 	<p>4. <math>3 \cdot \frac{x}{3} \geq -2 \cdot 3</math></p> <p style="text-align: center;"><math>\boxed{x \geq -6}</math></p>	<p style="text-align: center;"><math>\frac{-3}{3} \geq -2</math> <math>-1 \geq -2 \checkmark</math></p> 

**Division Property of Inequality**

**Words** Dividing each side of an inequality by a *positive* number produces an equivalent inequality.

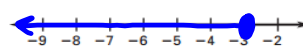
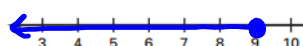
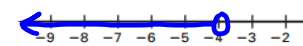
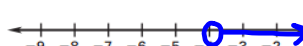
Dividing each side of an inequality by a *negative* number and *reversing the direction of the inequality symbol* produces an equivalent inequality.

**Algebra** If  $a < b$  and  $c > 0$ , then  $\frac{a}{c} < \frac{b}{c}$ .

If  $a < b$  and  $c < 0$ , then  $\frac{a}{c} > \frac{b}{c}$ .

## Example 2: Solving an Inequality Using Division

Solve the inequities. Graph and check your solution.

<p>1. <math>\frac{-11t}{-11} \geq \frac{33}{-11}</math></p> <p style="text-align: center;"><math>\boxed{t \leq -3}</math></p>	<p style="text-align: center;"><math>-11(-4) \geq 33</math> <math>44 \geq 33 \checkmark</math></p> 	<p>2. <math>\frac{4y}{4} \leq \frac{36}{4}</math></p> <p style="text-align: center;"><math>\boxed{y \leq 9}</math></p>	<p style="text-align: center;"><math>4(8) \leq 36</math> <math>32 \leq 36 \checkmark</math></p> 
<p>3. <math>\frac{-3x}{-3} &gt; \frac{12}{-3}</math></p> <p style="text-align: center;"><math>\boxed{x &lt; -4}</math></p>	<p style="text-align: center;"><math>-3(-5) &gt; 12</math> <math>15 &gt; 12 \checkmark</math></p> 	<p>4. <math>\frac{12a}{12} &gt; \frac{-48}{12}</math></p> <p style="text-align: center;"><math>\boxed{a &gt; -4}</math></p>	<p style="text-align: center;"><math>12(-3) &gt; -48</math> <math>-36 &gt; -48</math></p> 

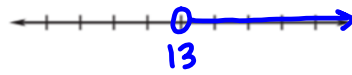
### Check It Out!

Solve the inequities. Graph and check your solution.

1.  $\frac{-8x}{-8} < \frac{-104}{-8}$

$x > 13$

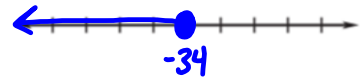
$-8(20) < -104$   
 $-160 < -104 \checkmark$



2.  $17 \cdot \frac{y}{17} \leq -2 \cdot 17$

$y \leq -34$

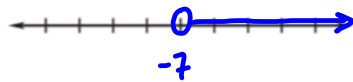
$\frac{-51}{17} \leq -2$   
 $-3 \leq -2 \checkmark$



3.  $\frac{5u}{5} > \frac{-35}{5}$

$u > -7$

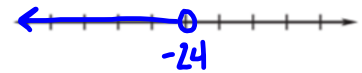
$5(0) > -35$   
 $0 > -35 \checkmark$



4.  $6 \cdot \frac{h}{6} < -4 \cdot 6$

$h < -24$

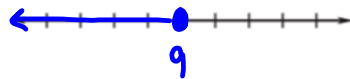
$\frac{-30}{6} < -4$   
 $-5 < -4 \checkmark$



5.  $\frac{-7y}{-7} \geq \frac{-63}{-7}$

$y \leq 9$

$-7(0) \geq -63$   
 $0 \geq -63 \checkmark$

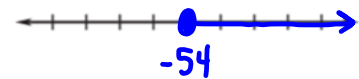


6.  $-3 \cdot 18 \geq \frac{x}{-3} \cdot -3$

$-54 \leq x$

$x \geq -54$

$18 \geq \frac{0}{-3}$   
 $18 \geq 0 \checkmark$

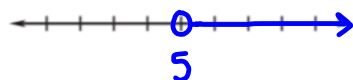


7.  $\frac{-30}{-6} > \frac{-6x}{-6}$

$5 < x$

$x > 5$

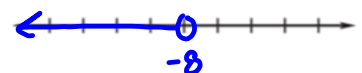
$-30 > -6(6)$   
 $-30 > -36 \checkmark$



8.  $2 \cdot \frac{n}{2} < -4 \cdot 2$

$n < -8$

$\frac{-10}{2} < -4$   
 $-5 < -4 \checkmark$



# 3.6 Solving Multi-Step Inequalities

Objective: Solve multi-step inequalities.

## Example 1: Writing and Solving a Multi-Step Inequality

1. You are participating in a charity walk. You want to raise at least \$500 for the charity. you already have \$175 by asking people to pledge \$25 each. How many more \$25 pledges do you need?

$$\text{\$ already raised} + \text{amount per pledge} \times \text{additional pledges} \geq \text{minimum desired amount}$$

$$\begin{array}{r} 175 + 25p \geq 500 \\ -175 \quad -175 \\ \hline 25p \geq 325 \\ \frac{25p}{25} \geq \frac{325}{25} \end{array}$$

$$p \geq 13$$

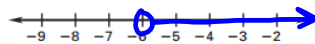
$\therefore$  You need at least 13 more \$25 pledges.

## Example 2: Solving a Multi-Step Inequality

Solve the inequalities. Graph and check your solution.

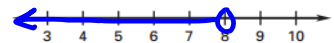
$$\begin{array}{r} 1. \quad \frac{x}{-3} - 9 < -7 \\ \quad \quad +9 \quad +9 \\ \hline -3 \cdot \frac{x}{-3} < 2 \cdot -3 \end{array}$$

$$x > -6$$



$$\begin{array}{r} 2. \quad 2x + 9 < 25 \\ \quad \quad -9 \quad -9 \\ \hline 2x < 16 \\ \frac{2x}{2} < \frac{16}{2} \end{array}$$

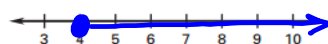
$$x < 8$$



$$\begin{array}{r} 3. \quad -3 \geq \frac{x}{-4} - 2 \\ \quad \quad +2 \quad +2 \\ \hline -4 \cdot -1 \geq \frac{x}{-4} \cdot -4 \end{array}$$

$$4 \leq x$$

$$x \geq 4$$

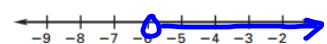


$$\begin{array}{r} 4. \quad 2 > -4 - x \\ \quad \quad +4 \quad +4 \\ \hline 6 > -x \\ \frac{6}{-1} > \frac{-x}{-1} \end{array}$$

$$-6 < x$$

$$x > -6$$

$$\begin{array}{r} 2 > -4 - (-4) \\ 2 > -4 + 4 \\ 2 > 0 \end{array}$$



### Check It Out!

Solve the inequities. Graph and check your solution.

$$1. \frac{x}{2} + 4 \leq 9$$
$$\begin{array}{r} -4 \quad -4 \\ \hline \end{array}$$

$$2 \cdot \frac{x}{2} \leq 5 \cdot 2$$

$$\boxed{x \leq 10}$$

$$\frac{6}{2} + 4 \leq 9$$

$$3 + 4 \leq 9$$

$$7 \leq 9 \checkmark$$

$$2. 2 + 3k > 35$$

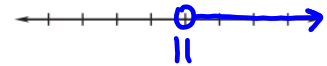
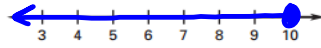
$$\begin{array}{r} -2 \quad -2 \\ \hline \end{array}$$
$$\frac{3k}{3} > \frac{33}{3}$$

$$\boxed{k > 11}$$

$$2 + 3(20) > 35$$

$$2 + 60 > 35$$

$$62 > 35 \checkmark$$



$$3. 12 \leq 9 - \frac{m}{3}$$
$$\begin{array}{r} -9 \quad -9 \\ \hline \end{array}$$

$$-3 \cdot 3 \leq \frac{m}{-3} \cdot -3$$

$$-9 \geq m$$

$$\boxed{m \leq -9}$$

$$12 \leq 9 - \frac{-12}{3}$$

$$12 \leq 9 - (-4)$$

$$12 \leq 13 \checkmark$$

$$4. 2 > 5 - 3x$$

$$\begin{array}{r} -5 \quad -5 \\ \hline \end{array}$$
$$-3 > -3x$$
$$\frac{-3}{-3} > \frac{-3x}{-3}$$

$$1 < x$$

$$\boxed{x > 1}$$

$$2 > 5 - 3(2)$$

$$2 > 5 - 6$$

$$2 > -1 \checkmark$$

