Pre-Algebra  
7-5  
Solving Equations with Variables on Both Sides

Objectives:  
1.  
2.  

Collecting the Variable on One Side

**STEPS FOR SOLVING MULTI-STEP EQUATIONS**

**Step 1**  Use the Distributive Property.  
**Step 2**  Combine like terms on each side.  
**Step 3**  Move the variables to one side of the equation.  
**Step 4**  Undo addition or subtraction.  
**Step 5**  Undo multiplication or division.

**EXAMPLE 1**  Collecting the Variable on One Side  
Solve each equation.

1.  \[9x + 2 = 4x - 18\]
   
   **STEPS**
   
   1.  Subtract 4x from each side.
   
   2.  Simplify.
   
   3.  Subtract 2 from each side.
   
   4.  Simplify.
   
   5.  Divide each side by 5.
   

2.  \[4x + 4 = 2x + 36\]
   
3.  \[-15 + 6b = -8b + 13\]
   
4.  \[4c + 3 = 15 - 2c\]
Using Equations With Variables on Both Sides

EXAMPLE 1  Using the Distributive Property and Combine Like Terms First

Solve each equation.

1. \(-2(y + 6) = y + 3 + 2y\)

   STEPS
   1. Distribute the -2.
   2. Combine Like Terms.
   3. Subtract 3y from both sides.
   4. Simplify
   5. Add 12 to both sides.
   6. Simplify
   7. Divide both sides by -5.
   8. Simplify.

   1. \(-2(y + 6) = y + 3 + 2y\)
   - Distribute: \(-2y - 12 = y + 3 + 2y\)
   - Combine Like Terms: \(-3y - 12 = 3\)
   - Subtract 3y from both sides: \(0 = 15\)
   - Add 12 to both sides: \(0 = 15\)
   - Divide both sides by -5: \(y = -3\)

   2. \(7a - 4 + 2a = 3a - 2\)
   - Combine Like Terms: \(9a - 4 = 3a - 2\)
   - Subtract 3a from both sides: \(6a - 4 = -2\)
   - Add 4 to both sides: \(6a = 2\)
   - Divide both sides by 6: \(a = \frac{1}{3}\)

   3. \(7x + 9 = 4x\)
   - Subtract 4x from both sides: \(3x + 9 = 0\)
   - Subtract 9 from both sides: \(3x = -9\)
   - Divide both sides by 3: \(x = -3\)
4. $8m - 5 = 5m + 7$
   \[
   \begin{align*}
   & \quad 8m - 5m = 5 + 7 \\
   \hline
   & 3m = 12 \\
   \hline
   & \quad m = 4
   \end{align*}
   \]

5. $x + 7x + 15x = 29x + 18$
   \[
   \begin{align*}
   & \quad 29x = -29x + 18 \\
   \hline
   & -6x = 18 \\
   \hline
   & \quad x = -3
   \end{align*}
   \]

6. $8(7 - p) - 8 = -16(p - 2)$
   \[
   \begin{align*}
   & \quad 56 - 8p - 8 = -16p + 32 \\
   \hline
   & 48 - 8p = -16p + 32 \\
   \hline
   & +16p \quad +16p \\
   \hline
   & 48 + 8p = 32 \\
   \hline
   & -48 \quad -48 \\
   \hline
   & +8p = -16 \\
   \hline
   & \quad p = -2
   \end{align*}
   \]

7. $k + k + k = k + 18$
   \[
   \begin{align*}
   & \quad 3k = k + 18 \\
   \hline
   & -k \quad -k \\
   \hline
   & 2k = 18 \\
   \hline
   & \quad k = 9
   \end{align*}
   \]

8. $3(n - 5) = -2n$
   \[
   \begin{align*}
   & \quad 3n - 15 = -2n \\
   \hline
   & +15 \quad +15 \\
   \hline
   & 3n = -2n + 15 \\
   \hline
   & +2n \quad +2n \\
   \hline
   & 5n = 15 \\
   \hline
   & \quad n = 3
   \end{align*}
   \]

9. $4(y - 9) = 3(2y - 8)$
   \[
   \begin{align*}
   & \quad 4y - 36 = 6y - 24 \\
   \hline
   & -6y \quad .6y \\
   \hline
   & -2y - 36 = -24 \\
   \hline
   & +36 \quad +36 \\
   \hline
   & -2y = 12 \\
   \hline
   & \quad y = -6
   \end{align*}
   \]

10. $6(z - 2) + 3 = 3z - 15$
    \[
    \begin{align*}
    & \quad 6z - 12 + 3 = 3z - 15 \\
    \hline
    & 6z - 9 = 3z - 15 \\
    \hline
    & -3z \quad -3z \\
    \hline
    & 3z - 9 = -6 \\
    \hline
    & +9 \quad +9 \\
    \hline
    & 3z = -6 \\
    \hline
    & \quad z = -2
    \end{align*}
    \]

11. $-2x + 7 = x - 8$
    \[
    \begin{align*}
    & \quad -2x = x - 15 \\
    \hline
    & -3x + 7 = -8 \\
    \hline
    & -7 \quad -7 \\
    \hline
    & -3x = -15 \\
    \hline
    & \quad x = 5
    \end{align*}
    \]

12. $7(v - 4) = 3(3 + v) - 1$
    \[
    \begin{align*}
    & \quad 7v - 28 = 9 + 3v - 1 \\
    \hline
    & 7v - 28 = 8 + 3v \\
    \hline
    & -3v \quad -3v \\
    \hline
    & 4v - 28 = 8 \\
    \hline
    & +28 \quad +28 \\
    \hline
    & 4v = 36 \\
    \hline
    & \quad v = 9
    \end{align*}
    \]
Pre-Algebra Objectives 7.5

The student should be able....

1. To solve equations with variables on both sides.

2. To use equations with variables on both sides.