Algebraic expressions and equations can be used to represent real-world situations. Solving the resulting equations helps you determine answers to real-life problems.

**EXAMPLE 1**
Write an equation that represents this question: What number do you add to 15 to get 23?

**Step 1:** Write an equation from the information in the question.

15 + number = 23

**Step 2:** Write the equation using a variable for the unknown number.

15 + x = 23

**EXAMPLE 2**
Rick and Jan went out to lunch. The bill for their lunches came to $18.94. Rick knows that his lunch cost $11.95. How much does Jan’s lunch cost?

**Step 1:** To write an equation to represent this situation, start with a verbal model.

Rick wrote this model:

Cost of Rick’s Meal + Cost of Jan’s Meal = Total bill

Jan wrote this model:

Total bill − Cost of Rick’s Meal = Cost of Jan’s Meal

**Step 2:** Write the variable or number that represents each part of the verbal model.

Cost of Rick’s Meal = 11.95
Cost of Jan’s Meal = p
Total bill = 18.94

**Step 3:** Replace each part of the verbal model with a number or variable to create an equation.

Rick’s equation: 11.95 + p = 18.94

Jan’s equation: 18.94 − 11.95 = p
TRY THESE A
Write equations for each of the following.

a. What number do you subtract from 39 to get 31?

b. What number do you multiply by 4 to get 36?

c. What number do you divide by 5 to get 8?

The value of the variable that makes an equation a true statement is called the solution to the equation. You can find the solution for some equations using mental math.

EXAMPLE 3
Solve \( p - 5 = 32 \) using mental math.

Step 1: Think of a question to help you solve the equation.

From what number can you subtract 5 and get 32?

Step 2: Find the value that makes the equation true.

Solution: \( p = 37 \)

Whenever you solve an equation, always check your solution. To check a solution, substitute it for the variable in the original equation. If you get a true statement, the solution is correct.

Check: \( p - 5 = 32 \)

\[
(37) - 5 = 32 \\
32 = 32 \checkmark
\]

TRY THESE B
Write your answers in the My Notes space. Write a verbal question for each equation and solve using mental math. Check your solutions.

a. \( x + 14 = 27 \)  

b. \( 3p = 27 \)  

c. \( \frac{42}{y} = 7 \)

d. \( 31 - b = 28 \)  

e. \( z - 7 = 28 \)
When solving equations, it helps to have a systematic way to solve them. What do you notice about both sides of a scale when the scale is balanced?

Suppose you want to solve the equation $x + 2 = 5$. Since you want to find the value of $x$, you need to get the $x$ to one side of the scale by itself. This is called “isolating the variable.”

A scale is balanced when the two sides are equal. How can you keep the scale balanced if you add something to one side? If you subtract something from one side? If you add or subtract something from one side, you must also add or subtract the same thing from the other side.

You can subtract 2 from the left side to isolate the $x$, because $+2$ and $-2$ are a zero pair. To keep the scale balanced, you must also subtract 2 from the right side.

Use the additive identity to simplify $x + 0$.

Math Tip
When you “isolate the variable,” you put it by itself on one side of the equation.

Math Tip
A zero pair is a pair of numbers that add up to zero.
$+3$ and $-3$ are a zero pair.
$+12$ and $-12$ are a zero pair.
ACTIVITY 3.3  Solving One-Step Equations
Becoming Undone

My Notes

SUGGESTED LEARNING STRATEGIES: Create Representations, Work Backward

The solution is $x = 3$. Check it as shown in the Math Tip.

Check: $x + 2 = 5$
(3) + 2 = 5
5 = 5 ✓

You do not have to draw a scale to solve every equation. Just imagine that the equal sign in the equation is the center of a balance. Work through Question 1 to solve $w + 4 = 11$.

1. Fill in each circle with an operation and each box with a number so that you keep the scale balanced and isolate the $w$. Be sure to check your answer.

$$w + 4 = 11$$

$w + 4 \bigcirc \boxed{= 11} \bigcirc \boxed{\phantom{11}}$

$w + \boxed{\phantom{4}} = \boxed{\phantom{11}}$

$w = \boxed{\phantom{w}}$

2. Solve the equation $y - 8 = 5$ and check your solution.

$$y - 8 = 5$$

$y - 8 \bigcirc \boxed{= 5} \bigcirc \boxed{\phantom{5}}$

$y - \boxed{\phantom{8}} = \boxed{\phantom{5}}$

$y = \boxed{\phantom{y}}$

3. Compare the operations you used in Questions 1 and 2. Explain why you did or did not use the same operations.
You can also use flowcharts to solve equations by putting each expression in the equation into a flowchart and then working backward to find the value of each variable.

**EXAMPLE 4**

Solve the equation $x + 5 = 26$.

If you know that the expression $x + 5$ equals 26, you can work backward to find the value of $x$ that makes this true.

**Step 1:** Start with the flowchart that you would use to evaluate the expression.

You already know that $x + 5 = 26$ so you can work backward to find $x$. To “undo” the “plus 5” you subtract 5.

**Step 2:** Complete the flow chart to find the value of $x$.

Solution: $x = 21$.

To check, substitute this value back into the equation and see whether the equation is true.

**TRY THESE C**

Write your answers in the My Notes space. Show your work. Draw and use a flowchart to solve each equation. Check your solutions.

a. $x + 119 = 321$

b. $7.2x = 21.6$

c. $\frac{1}{3}b = 15$
Instead of using flowcharts, you can also solve equations algebraically.

**EXAMPLE 5**

Find the value of \( x \) if \( x - 15 \) equals 25.

*Step 1:* Write the problem.

\[
x - 15 = 25
\]

*Step 2:* Add 15 to both sides to isolate \( x \).

\[
x - 15 + 15 = 25 + 15
\]

Solution:

\[
x = 40
\]

Solve and check \( 23n = 115 \).

*Step 1:* Write the problem.

\[
23n = 115
\]

*Step 2:* Divide by 23 to undo multiplying by 23.

\[
\frac{23n}{23} = \frac{115}{23}
\]

*Step 3:* Simplify each side of the equation.

\[
1n = 5
\]

Solution: Use the multiplicative identity to isolate \( n \).

\[
n = 5
\]

Check:

\[
23n = 115
\]

\[
23 \times 5 = 115
\]

\[
115 = 115
\]

**TRY THESE D**

Solve each equation. Then check your solution.

a. \( 27x = 1377 \)  

b. \( \frac{3.72}{1.5} = y \)

c. \( 2.48 = 3.1z \)  

d. \( \frac{3}{4}x = 6 \)

4. Your school’s cheerleaders are raising money to buy new uniforms. Their goal is to earn $1257.50. So far, they have $625.76. Write and solve an equation to determine how much more the cheerleaders must earn to reach their goal.

5. Two thirds of the Patel family came to the family picnic. If 34 family members came to the picnic, how many people are in the Patel family?
6. More people came to the Jackson family picnic than to the Patel family picnic. How many people could have come to the Jackson picnic?

An inequality is a mathematical statement that compares two quantities using $<$, $>$, $\geq$, or $\leq$.

7. Write an inequality that compares the number of people who came to the Jackson family picnic to the number of people who came to the Patel family picnic. Let the variable $x$ represent the number of people who came to the Jackson family picnic.

You can use inverse operations to solve inequalities.

**EXAMPLE 6**

Find the value of $n$ if $n + 16$ is less than 57.

**Step 1:** Write the problem. $n + 16 < 57$

**Step 2:** Subtract 16 from both sides to isolate $n$. $n + 16 - 16 < 57 - 16$

Solution: $n < 41$

You can represent the solution $n < 41$ on a number line.

There is an open circle on 41 because it is not part of the solution. The ray to the left of 41 means all numbers less than 41. If the solution had been $n \leq 41$ the circle would be filled in.

You can check your solution by choosing any number less than 41 and substituting it in the original inequality. If the resulting statement is true, the solution checks. For example, choose 39 and substitute it for $n$.

$n + 16 < 57$
$39 + 16 \leq 57$
$55 < 57$

**TRY THESE E**

Solve and graph each inequality. Check your work.

a. $y - 28 > 42$

b. $x + 13 \leq 36$
EXAMPLE 7

Find the value of $x$ if $\frac{x}{6}$ is greater than or equal to 8. Graph the solution.

**Step 1:** Write the problem.

**Step 2:** Multiply both sides by 6 to undo dividing by 6.

$\frac{x}{6} \geq 8$

$x \geq 48$

Solution:

Check: Choose any number greater than or equal to 48, such as 54, and substitute it for $x$ in the original inequality.

$\frac{54}{6} \geq 8$

$9 \geq 8$

**TRY THESE F**

Solve and graph each inequality. Check your work.

1. $7x < 9.1$
2. $\frac{3}{4}x > 27$

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**CHECK YOUR UNDERSTANDING**

Write your answers on notebook paper. Show your work.

1. Write a question that will help solve each equation. Then use mental math to solve.
   - $43 - x = 35$
   - $w + 9 = 17$
   - $9p = 36$

2. Write an equation for each question. Solve the equation and check your solution.
   - What number can you divide by 4 to get 6?
   - What number is added to 13 to get 63?

3. Solve and check each equation.
   - $w - 1.23 = 4.72$
   - $2.7x = 8.64$
   - $\frac{2}{3}x = 18$
   - $\frac{7}{6} = y + \frac{2}{3}$
   - $\frac{w + 1.5}{5} < 5$
   - $29 = \frac{p}{14}$

4. The Math Club wants to buy math history books for the library. The total cost is $105. So far they have raised $72. How much more do they need to buy the books?
   - Write a verbal model.
   - Use numbers and variables to write expressions.
   - Write an equation.
   - How much more money does the Math Club need to earn?

5. Solve and graph each inequality.
   - $1.2x \leq 9.6$
   - $y - 11 > 11$
   - $\frac{w}{4} \geq 8$

6. **Mathematical Reflection** Why is it important to have a systematic way to solve equations rather than just relying on “mental math”?