2-2 Solve Addition and Subtraction Equations

Objective To solve and check addition equations using the Subtraction Property of Equality • To solve and check subtraction equations using the Addition Property of Equality • To justify the steps of the solution process for addition and subtraction equations

Sara has put aside some money to buy a new instrument case. She needs to save $4 more to make the purchase. If the case costs $15, how much has she saved?

To find how much Sara has saved, write and solve an algebraic equation. First, define the variable. Then write two equivalent expressions.

Let d = the number of dollars Sara has saved.

$d + 4$ ← an expression for the number of dollars Sara has saved *plus* the $4-amount she will need

15 ← the expression showing the total cost

$d + 4 = 15$ ← an algebraic equation showing *equal expressions* for the total cost

► An equation that contains only the operation of addition such as $d + 4 = 15$, is called an *addition equation*. To solve the equation, find all the values of the variable that make the equation a *true* statement. The set containing all these values is the solution set.

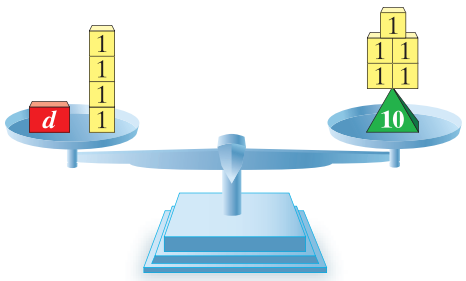
To solve an addition equation, you can use the Subtraction Property of Equality.

Key Concept

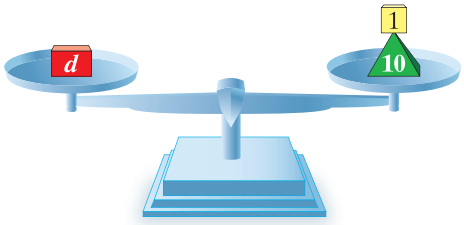
Subtraction Property of Equality
For real numbers a, b, and c, if $a = b$, then $a - c = b - c$.

To use this property, isolate the unknown term—that is, get the unknown term by itself. Then by using the inverse operation, subtraction, "undo" the addition operation in the given equation.

► An equation is like a balance. To keep the balance level, whatever you do to one side of the equation, you must do to the other so that you are forming *equations that have the same solution*. Such equations are called equivalent equations.



$d + 4 = 15$



$d + 4 - 4 = 15 - 4$ ← Use the Subtraction Property of Equality.

$d = 11$ ← equivalent equation

Think
$d + 4 = 15$ and $d = 11$ are equivalent equations.

So 11 is in the solution set of the equation $d + 4 = 15$.
Sara has saved $11.

▶To solve an equation, you may use *either* a vertical or a horizontal display.

Solve: $26.3 = y + 3.58$

Method 1 Solve vertically.

$$\begin{aligned} 26.3 &= y + 3.58 \\ -\ 3.58 &\quad -\ 3.58 \quad \leftarrow \text{Use the Subtraction Property of Equality. Subtract 3.58 to isolate } y. \\ 22.72 &= y \end{aligned}$$

Method 2 Solve horizontally.

$$\begin{aligned} 26.3 &= y + 3.58 \\ 26.3 - 3.58 &= y + 3.58 - 3.58 \quad \leftarrow \text{Use the Subtraction Property of Equality. Subtract 3.58 to isolate } y. \\ 22.72 &= y \end{aligned}$$

Always check a solution of an equation. Substitute each solution for the variable into the *original equation*.

Check: $26.3 = y + 3.58$

$26.3 \stackrel{?}{=} 22.72 + 3.58$ ← Substitute 22.72 for y; simplify.

$26.3 = 26.3$ True

Solution set: {22.72}

Examples

Solve each equation. Then check your solution.

1 **Solve:** $-9 = z - 4 + 16$

$-9 = z - 4 + 16$ ← Identify like terms.

$-9 = z + 12$ ← Combine like terms.

$-9 - 12 = z + 12 - 12$ ← Use the Subtraction Property of Equality. Subtract 12 from both sides to isolate z.

$-21 = z$ ← solution

Check: $-9 = z - 4 + 16$

$-9 \stackrel{?}{=} -21 - 4 + 16$ ← Substitute -21 for z; simplify.

$-9 = -9$ True

Solution set: {−21}

2 **Solve:** $m - 2\frac{3}{4} + 4 = -1\frac{1}{2}$

$m - 2\frac{3}{4} + 4 = -1\frac{1}{2}$ ← Identify like terms.

$m + 1\frac{1}{4} = -1\frac{1}{2}$ ← Combine like terms.

$m + 1\frac{1}{4} - 1\frac{1}{4} = -1\frac{1}{2} - 1\frac{1}{4}$ ← Use the Subtraction Property of Equality.

$m = -2\frac{3}{4}$ ← solution

Solution set: $\left\{-2\frac{3}{4}\right\}$

Check: $m - 2\frac{3}{4} + 4 = -1\frac{1}{2}$

$-2\frac{3}{4} - 2\frac{3}{4} + 4 \stackrel{?}{=} -1\frac{1}{2}$

$-5\frac{1}{2} + 4 \stackrel{?}{=} -1\frac{1}{2}$

$-1\frac{1}{2} = -1\frac{1}{2}$ True

Continue Lesson ➡

An equation that contains only the operation of subtraction, such as $w - 6.37 = -1.4$, is called a *subtraction equation*. To solve a subtraction equation, you can use the Addition Property of Equality.

Key Concept

Addition Property of Equality
For real numbers a, b, and c, if $a = b$, then $a + c = b + c$.

Solve: $w - 6.37 = -1.4$

Method 1 Solve vertically.

$w - 6.37 = -1.4$
$+ 6.37 \quad + 6.37$ ← Add 6.37 to isolate w.
$w = 4.97$ ← solution

Method 2 Solve horizontally.

$w - 6.37 = -1.4$
$w - 6.37 + 6.37 = -1.4 + 6.37$ ← Add 6.37 to isolate w.
$w = 4.97$ ← solution

Check: $w - 6.37 = -1.4$
$4.97 - 6.37 \stackrel{?}{=} -1.4$ ← Substitute 4.97 for w.
$-1.4 = -1.4$ True

Solution set: {4.97}

Examples

1 **Solve:** $-9\frac{2}{5} + 4.3 = h - 3\frac{1}{2}$

$-9\frac{2}{5} + 4.3 = h - 3\frac{1}{2}$ ← Combine like terms.
$-9.4 + 4.3 = h - 3.5$ ← $-9\frac{2}{5} = 9.4$ and $3\frac{1}{2} = 3.5$
$-5.1 = h - 3.5$ ← Simplify.
$-5.1 + 3.5 = h - 3.5 + 3.5$ ← Use the Addition Property of Equality.
$-1.6 = h$ ← solution

Solution set: {−1.6}

Check: $-9\frac{2}{5} + 4.3 = h - 3\frac{1}{2}$

$-9.4 + 4.3 \stackrel{?}{=} -1.6 - 3.5$ ← Substitute; rename fractions as decimals.
$-5.1 = -5.1$ True

2 The difference between the ages of two brothers is 6 years. If the younger brother is 12 years old, how old is the other brother?

Let x = the age of the older brother.
$x - 6$ = the age of the younger brother

Solve: $x - 6 = 12$
$x - 6 + 6 = 12 + 6$ ← Use the Subtraction Property of Equality.
$x = 18$ ← solution

Check: Use the words of the problem. Does the solution make sense? If the older brother is 18, then the younger brother is $18 - 6 = 12$, which is the given value.

So the older brother is 18.

You can use the Addition Property of Equality to solve an addition equation or a subtraction equation. Along with other familiar properties and definitions, you can justify the steps of the solution process.

Solve: $n + 2\frac{1}{2} = 7$. Write a justification for each step in the solution process.

$$n + 2\tfrac{1}{2} + \left(-2\tfrac{1}{2}\right) = 7 + \left(-2\tfrac{1}{2}\right)$$ ← Use the Addition Property of Equality.

$$n + \left[2\tfrac{1}{2} + \left(-2\tfrac{1}{2}\right)\right] = 7 + \left(-2\tfrac{1}{2}\right)$$ ← Use the Associative Property of Addition.

$$n + 0 = 7 + \left(-2\tfrac{1}{2}\right)$$ ← Use the Additive Inverse Property.

$$n = 7 + \left(-2\tfrac{1}{2}\right)$$ ← Use the Additive Identity Property.

$$n = 4\tfrac{1}{2}$$ ← solution

Solution set: $\left\{4\frac{1}{2}\right\}$

Check: $n + 2\frac{1}{2} = 7$

$4\frac{1}{2} + 2\frac{1}{2} \stackrel{?}{=} 7$

$7 = 7$ True

Try These

Solve each equation. Check your solution.

1. $z - 19 = -28$ **2.** $h + \frac{1}{6} = 4\frac{1}{2} + 3$ **3.** $-8.7 = p - 16.4 + 6.2$

Write a justification for each step of the given solution process.

4. Solve: $w - 13 = -4$

a. $w - 13 = -4$

b. $w - 13 + 13 = -4 + 13$

c. $w + (-13) + 13 = -4 + 13$

d. $w + [(-13) + 13] = -4 + 13$

e. $w + 0 = -4 + 13$

f. $w = -4 + 13$

g. $w = 9$

5. Solve: $-8 + p = -8$

a. $-8 + p = -8$

b. $-8 + 8 + p = -8 + 8$

c. $[-8 + 8] + p = -8 + 8$

d. $0 + p = -8 + 8$

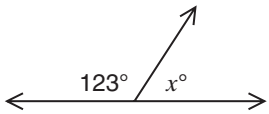
e. $p = -8 + 8$

f. $p = 0$

Solve each equation. Write a justification for each step. Check your solution.

6. $b + 29 = -29$ **7.** $a - 19 = -25$ **8.** $-1 = d - 1 + 4.8$

9. Two angles are supplementary and the measure of one of these angles is 123°. Write and solve an equation that can be used to find the measure of the other angle. *Hint*: The sum of the measures of two supplementary angles is 180°.



10. Discuss and Write When 15 is decreased by a number n, the result is -3. Write an equation that can be used to find n. Explain how to solve this equation. Show that your solution is correct.

Go to PRACTICE BOOK Lesson 2-2 for exercise sets.