

Solving Equations Using Inverse Properties of Addition and Multiplication

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1.3 Solving Equations Using Inverse Properties of Addition and Multiplication

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[Figure 1]

You have \$58 dollars to spend on a pair of jeans and two T-shirts. The jeans cost \$32. How much will the T-shirts have to be?

In this concept, you will solve equations involving **inverse** properties of **subtraction** and **multiplication**.

Inverse Properties of Adding and Multiplying

To solve a **two-step equation**, you will need to use more than one **inverse operation**. When you perform inverse **operations** to find the value of a **variable**, you work to get the variable alone on one side of the equals. This is called isolating the variable. It is one strategy for **solving equations**. You can use isolating the variable whether you are solving one-step or **two-step equations**.

For example, solve for x in the following **equation**:

$$2x - 9 = 17$$

Notice that there are two **terms** on the left side of the equation, $2x$ and 9.

First, use inverse operations to get the **term** that includes a variable, $2x$, by itself on one side of the equal sign. In the equation, 9 is subtracted from $2x$. So, you can use the inverse of subtraction — **addition**.

$$\begin{aligned} 2x - 9 &= 17 \\ 2x - 9 + 9 &= 17 + 9 \\ 2x &= 26 \end{aligned}$$

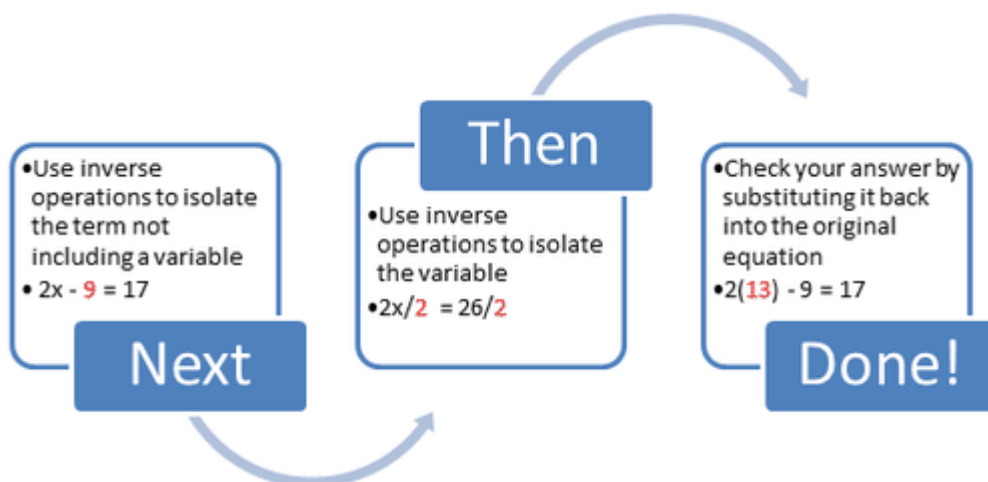
The number +9 in this solution is the **additive inverse**, or opposite, of -9.

Next, use inverse operations to get the x by itself. Since $2x$ means $2 \cdot x$, you can use the inverse of multiplication—**division**. So you can divide both sides of the equation by 2.

$$\begin{aligned} 2x &= 26 \\ \frac{2x}{2} &= \frac{26}{2} \\ x &= 13 \end{aligned}$$

The answer is 13.

Let's review the steps for solving this two-step equation.



[Figure 2]

Examples

Example 1

Earlier, you were given a problem about shopping budget.

You only have \$58 to spend on two T-shirts and a pair of jeans that cost \$32.

First, walk through the words to write the equation.

$$2x + 32 = 58$$

Next, **isolate the variable** by using the inverse of addition – subtraction.

$$\begin{aligned}2x + 32 &= 58 \\2x + 32 - 32 &= 58 - 32 \\2x &= 26\end{aligned}$$

Then, solve for x by using the inverse of multiplication – division.

$$\begin{aligned}2x &= 26 \\ \frac{2x}{2} &= \frac{26}{2} \\ x &= 13\end{aligned}$$

The answer is 13.

Each T-shirt must cost \$13.

Example 2

Eight times a number minus four is equal to ninety - two. Write a two-step equation and solve for the missing variable.

First, walk through the words to write the equation.

$$8x - 4 = 92$$

Next, isolate the variable by using the inverse of subtraction – addition.

$$\begin{aligned}8x - 4 &= 92 \\8x - 4 + 4 &= 92 + 4 \\8x &= 96\end{aligned}$$

Then, solve for x by using the inverse of multiplication – division.

$$\begin{aligned}8x &= 96 \\ \frac{8x}{8} &= \frac{96}{8} \\ x &= 12\end{aligned}$$

The answer is 12.

Example 3

$$9x - 5 = 40$$

First, isolate the variable by using the inverse of subtraction – addition.

$$\begin{aligned}9x - 5 &= 40 \\9x - 5 + 5 &= 40 + 5 \\9x &= 45\end{aligned}$$

Then, solve for x by using the inverse of multiplication – division.

$$\begin{aligned}9x &= 45 \\ \frac{9x}{9} &= \frac{45}{9} \\ x &= 5\end{aligned}$$

The answer is 5.

Example 4

$$9y - 6 = 66$$

First, isolate the variable by using the inverse of subtraction – addition.

$$\begin{aligned}9y - 6 &= 66 \\9y - 6 + 6 &= 66 + 6 \\9y &= 72\end{aligned}$$

Then, solve for y by using the inverse of multiplication – division.

$$\begin{aligned}9y &= 72 \\ \frac{9y}{9} &= \frac{72}{9} \\ y &= 8\end{aligned}$$

The answer is 8.

Example 5

$$12a - 4 = 44$$

First, isolate the variable by using the inverse of subtraction – addition.

$$\begin{aligned}12a - 4 &= 44 \\12a - 4 + 4 &= 44 + 4 \\12a &= 48\end{aligned}$$

Then, solve for a by using the inverse of multiplication – division.

$$\begin{aligned}12a &= 48 \\ \frac{12a}{12} &= \frac{48}{12} \\ a &= 4\end{aligned}$$

The answer is 4.

Review

Solve each two-step equation that has multiplication and subtraction in it.

1. $4x - 3 = 13$

2. $5y - 8 = 22$

3. $7x - 11 = 31$

4. $8y - 15 = 25$

5. $9x - 12 = 42$

6. $12y - 9 = 99$

7. $2y - 3 = 23$

8. $3x - 8 = 19$

9. $5y - 2 = 28$

10. $7x - 11 = 38$

11. $5y - 9 = 51$

12. $6a - 12 = 30$

13. $9x - 14 = 13$

14. $12x - 23 = 49$

15. $13y - 3 = 23$

16. $18x - 12 = 42$

Review (Answers)

To see the review answers, return to the [Table of Contents](#) and select 'Other Versions' or 'Resources'.



Resources

The image shows two handwritten equations and their solutions on a yellow background. The first equation is $3. \quad -2x = 23$. Below it, -9 is written under $-2x$ and -9 is written under 23 . A horizontal line is drawn, and below it, $-2x = 14$ is written. Below that, -2 is written under $-2x$ and -2 is written under 14 . A horizontal line is drawn, and below it, $x = -7$ is written. The second equation is $4. \quad -11 = 4x - 43$. Below it, $+43$ is written under -11 and $+43$ is written under -43 . A horizontal line is drawn.

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