Solve One-Step Equations Using Inverse Properties of Addition and Multiplication

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1.1 Solve One-Step Equations Using Inverse Properties of Addition and Multiplication

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[Figure 1]

The marching band at Floyd Middle School is undergoing some changes. They currently have 140 students, plus the drum major, and will be adding four new students this year. This means they will need to redo their formation for the big finale into eight even rows. Band member Anica announces that she can figure out the number of students in each row with an equation.

In this concept, you will solve equations involving the inverse properties of addition and multiplication.

Inverse Properties of Adding and Multiplying

An **equation** is a statement with an equal sign where the quantity on one side of the equals is the same as the quantity on the other side of the equals.

Here is a simple equation:

$$x + 11 = 15$$

You have an equation with a variable where x is the unknown quantity. To solve this perform an inverse operation or opposite operation. You would subtract eleven from 15 to give you 4. That is the value of the variable.

Most of the time, you don't even think about performing an inverse operation, your mind naturally solves the problem in this way.

When you have an equation with one variable, it is called a **one-step equation**. It only takes one operation or one inverse operation to solve it.

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 equal sign. 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.

Let's look at an example.

Solve for a:

$$3a + 12 = 45$$

You can call each piece of the equation a term. There is a term with a variable and there is a term without a variable. Notice that there are two terms on the left side of the equation, $3a$ and 12.

First, use inverse operations to get the term that includes a variable, $3a$, by itself on one side of the equal sign. In equations, you would always leave the term that holds the variable until the end in order to isolate the variable. So, in the equation above, 12 is added to $3a$. You can use the inverse of addition, which is subtraction as your first step. We can subtract 12 from both sides of the equation.

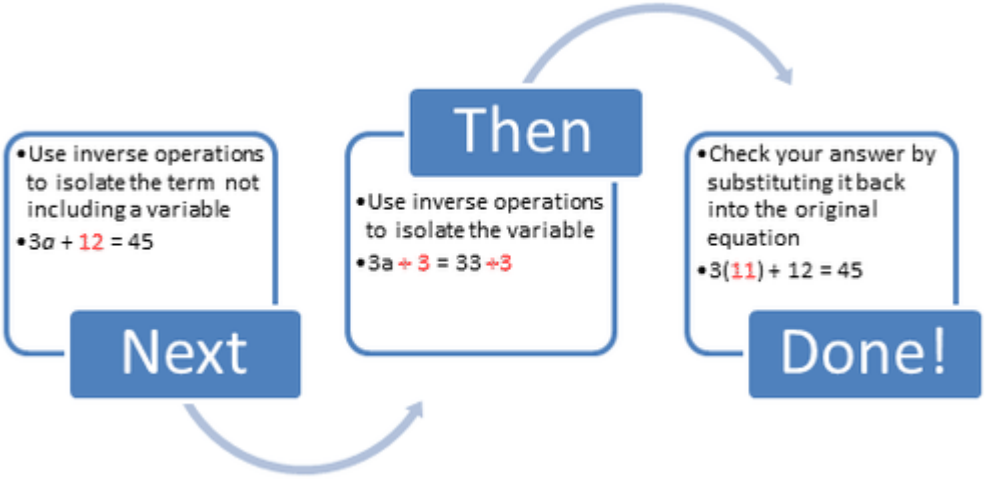
$$\begin{aligned} 3a + 12 - 12 &= 45 - 12 \\ 3a &= 33 \end{aligned}$$

Next, use inverse operations to get the a by itself. Since $3a$ means $3 \times a$, you can use the inverse of multiplication, which is division. You can divide both sides of the equation by 3 to isolate the variable.

$$\begin{aligned} \frac{3a}{3} &= \frac{33}{3} \\ a &= 11 \end{aligned}$$

The answer is 11.

Let's review your steps to solving this two-step equation. Your goal is to isolate your variable so you first need to get this variable term alone on one side of the equal sign.



[Figure 2]

Examples

Example 1

Earlier, you were given a problem about the marching band's new configuration.

First, let's look at the given information.

There are 144 students in the band. There is also one drum major. The students need to be organized into eight even rows.

Here is our equation.

$$8x = 144$$

Notice that the drum major is not included. The drum major is not included in the lines as the drum major is in the lead.

Next, you only have a one-step equation.

$$\begin{aligned} \frac{8x}{8} &= \frac{144}{8} \\ x &= 8 \end{aligned}$$

The answer is 18.

There will be 18 students in each row.

Example 2

A gardener charges $20 for each gardening job plus $15 for each hour worked. He charged $80 for a gardening job he did yesterday.

a. Write an algebraic equation to represent h, the number of hours that the gardener worked on that $80 job.

b. Find the number of hours that the gardener worked on that $80 job.

First, in order to solve part a, you need to write an equation. In this problem, you are looking for number of hours, so let $h =$ the number of hours.

Use a number, an operation sign, a variable, or an equal sign to represent each part of the problem. The gardener earned $15 for each hour worked on that job, so you could multiply $15 by h, the number of hours worked, to find how much money the gardener charged for his work time.

$$\begin{array}{llllll} \underline{\$20} \text{ for each gardening job } \underline{\text{plus } \$15 \text{ for each hour}} \text{ worked.} \ldots \underline{\text{charged } \$80} \text{ for one... job.} \\ \downarrow & & \downarrow & \downarrow & \downarrow & \downarrow \\ 20 & & + & 15h & = & 80 \end{array}$$

So, the equation to use for this problem is:

$$20 + 15h = 80$$

Next, solve part *b*. You need to use your equation from part 'a' to find the number of hours the gardener worked on that job.

$$\begin{aligned} 20 - 20 + 15h &= 80 - 20 \\ 15h &= 60 \end{aligned}$$

Then, since 15 is multiplied by the variable, h, you can use the inverse of multiplication which is division. Divide both sides by 15.

$$\begin{aligned} \frac{15h}{15} &= \frac{60}{15} \\ h &= 4 \end{aligned}$$

The answer is 4.

The gardener worked four hours.

Example 3

$$4x + 5 = 29$$

First, use inverse operations (subtraction) to get the term that includes a variable, $4x$, by itself on one side of the equal sign.

$$\begin{aligned} 4x + 5 - 5 &= 29 - 5 \\ 4x &= 24 \end{aligned}$$

Next, use inverse operations (division) to get the x by itself.

$$\begin{aligned} \frac{4x}{4} &= \frac{24}{4} \\ x &= 6 \end{aligned}$$

The answer is $x = 6$.

Example 4

$$3y + 7 = 43$$

First, use inverse operations (subtraction) to get the term that includes a variable, $3y$, by itself on one side of the equal sign.

$$\begin{aligned} 3y + 7 - 7 &= 43 - 7 \\ 3y &= 36 \end{aligned}$$

Next, use inverse operations (division) to get the 'y' by itself.

$$\begin{aligned} \frac{3y}{36} &= \frac{36}{3} \\ y &= 12 \end{aligned}$$

The answer is $y = 12$.

Example 5

$$6x + 8 = 71$$

First, use inverse operations (subtraction) to get the term that includes a variable, $6x$, by itself on one side of the equal sign.

$$\begin{aligned} 6x + 8 - 8 &= 71 - 8 \\ 6x &= 63 \end{aligned}$$

Next, use inverse operations (division) to get the 'x' by itself.

$$\begin{aligned} \frac{6x}{6} &= \frac{63}{6} \\ x &= 9 \end{aligned}$$

The answer is $x = 9$.

Review

Solve the following two-step equations that have addition and multiplication in them.

1. $3x + 4 = 22$
2. $4y + 3 = 15$
3. $6x + 5 = 35$
4. $7x + 2 = 16$
5. $9y + 8 = 80$
6. $12x + 15 = 51$

7. $14y + 2 = 30$
8. $7y + 5 = 40$
9. $2x + 4 = 48$
10. $6x + 3 = 39$
11. $8x + 2 = 10$
12. $8x + 7 = 95$
13. $9x + 9 = 90$
14. $3x + 5 = 50$
15. $7x + 12 = 61$

Review (Answers)

To see the review answers, return to the Table of Contents and select 'Other Versions' or 'Resources'.

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