Addition Property of Equality

We can use property of equalities to help us solve equations.

Let's look at the following number sentences:

$4 + 5 = 9$ and $4 + 5 - 5 = 9 - 5$

Are the two number sentences equivalent? Why or why not?

Now, let's look at two equations:

$x - 4 = 3$ and $x - 4 + 4 = 3 + 4$

Are these equations equivalent? Why or why not?

What do you notice in both the second number sentence and second equation?

This means that when a number is added to or subtracted from both sides of the equation, the solution to the equation does not ____________.

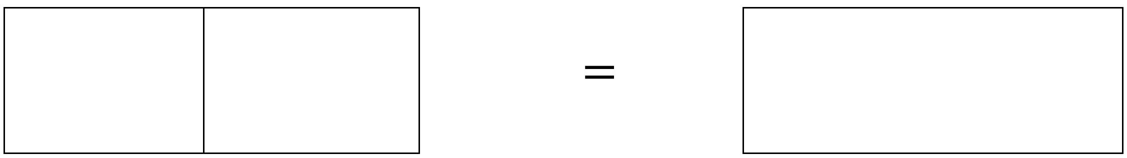
This is called the **Addition Property of Equality**!

$$a + c = b + c$$

Consider the equation:

$$a + 2 = 10$$

Fill in the boxes to represent the equation.



In order to find the value of a, we need to find the difference between 10 and 2.

This means that in order to find the value of a, we need to __________________ 2 from 10.

So a = ______.

Now, let's look at it algebraically.

$$a + 2 = 10$$

Again, if we want to find the value of a, we need to find the difference between 10 and 2 which means we would subtract ___ from ____.

Remember that in order to have the same solution as the original equation, we must apply the Addition Property of Equality!

This means that we must also subtract ____ from ____.

Let's solve another equation algebraically.

$$b - 5 = 8$$

What number would you combine with -5 to equal 0?

This means that you would ________ _____ to both sides of the equation.

So b = ________

Let's Practice

What operation would solve the equation for w?

$$w - 3 = 14$$

A) -3

B) $+3$

C) $\div 3$

D) $* 3$

Multiplication Property of Equality (Integers)

We can use property of equalities to help us solve equations.

Let's look at the following number sentences:

$6 = 6$ and $6 * 1 = 6 * 1$

Are the two number sentences equivalent? Why or why not?

Multiplying by 1 is referred to as **Multiplicative Identity Property.** This property just says that any time you multiple a number by 1, the result (the product), is the original number.

Now that we know that, let's think:

Is $\frac{4}{4} = 1$*? Why?*

Is $4 * \frac{1}{4} = \frac{4}{4}$*? Why?*

Is $4 * \frac{1}{4} = 1$*? Why?*

Since the product of 4 and $\frac{1}{4}$ is _____, 4 and $\frac{1}{4}$ are

_______________ ___________.

The **Multiplication Property of Equality** states that if you multiply both sides of an equation by the same number, the solution to the equation does not ____________.

$$a * c = b * c$$

We can apply this property and use multiplicative inverses to solve equations!

Consider the following equation:

$$4x = 20$$

Fill in the boxes to model the equation.

	=	

The expression, $4x$ can be broken into four equal sections of x length.

	=	

The value, 20 is ___________ into 4 ___________ sections.

This operation is represented symbolically in two ways:

______________________ and _________________________

We can also solve this equation algebraically using the Multiplication Property of Equality.

$$4x = 20$$

Let's Practice

Which of the following would solve $15x = 45$?
Select all that apply.

☐	$* 15$	☐	$+15$
☐	$\div 15$	☐	-15
☐	-45	☐	$+45$
☐	$\div 45$	☐	$* 45$
☐	$* \dfrac{1}{15}$	☐	$* \dfrac{1}{45}$

Multiplication Property of Equality (Rational Numbers)

We can also use the Multiplication Property of Equality to solve equations with rational numbers, or ___________.

Let's look at the following equation:

$$\frac{2}{3}x = 50$$

This equation can be read as:

How do we determine what number will make this equation true?

We can use_________________ inverses to simplify a number to _____.

The multiplicative inverse of $\frac{2}{3}$ is:

We can apply the Multiplication Property of Equality and use this multiplicative inverse to help us find the value of our mystery number!

Recall that multiplying an equation by the same value on both sides will not change the solution to our equation.

$$\frac{2}{3}x = 50$$

Let's look at another equation:

$$\frac{x}{2} = 25$$

Recall that a fraction represents ___________.

What is another way we could write this equation?

So this equation, can be read two ways:

A number, divided by 2*, equals* 25.
A number, multiplied by $\frac{1}{2}$*, equals* 25.
Again we can use the Multiplication Property of Equality to determine the value of the missing number.

What is the multiplicative inverse of $\frac{1}{2}$?

Let's solve $\frac{x}{2} = 25$

Let's Practice

Which of the following operations would solve the equation

$$\frac{3}{7}x = 27$$

A) $\div \frac{7}{3}$

B) $\div \frac{1}{3}$

C) $* \frac{3}{7}$

D) $* \frac{7}{3}$

Solving Equations (Addition)

The **Addition Property of Equality** allows us to ____________ for unknown values.

Remember, this is the **Addition Property of Equality:**

$$a + c = b + c$$

Let's apply the Addition Property of Equality.

Sarah has $54 dollars, which is $17 dollars more than Cascada has. How much money does Cascada have?

Write an equation that models the situation.

What is the inverse operation we need to use in order to determine how much money Cascada has?

How much money does Cascada have?

Let's Practice

Baylor has 117 friends on Friendbook, which is 54 more than Melena's number of friends. The number of friends that Melena is modeled by the equation, $54 + m = 117$, where m is the number of Melena's friends on Friendbook.

How many friends does Melena have?

<u>Solving Equations (Multiplication of Integers)</u>

The **Multiplication Property of Equality** allows us to _____________ for unknown values.

Remember, this is the **Multiplication Property of Equality:**

$$a * c = b * c$$

Apply the multiplication property of equality to the following situation:

SpaceX owns 9 rockets that have a combined value of 117 billion dollars.

Write an equation that models the total value of the 9 *rockets.*

What is the inverse operation needed to find the value of each rocket?

What is the monetary value of each rocket?

Let's Practice

Michael has 14 cats that have a combined weight of 112 pounds. The total cat weight is modeled by the equation, $14c = 112$, where c is the average weight per cat.

What is the average weight of each cat?

Solving Equations (Multiplication of Rational Numbers)

Let's apply the **Multiplication Property of Equality** to solve equations with rational numbers.

Remember, this is the **Multiplication Property of Equality:**

$$a * c = b * c$$

Consider the sentence, $\frac{2}{5}$ of a number is 42.

Let's break down what that sentence means!

There is an unknown number, let's call it "____", that is divided evenly _____ times _____ of those evenly split sections is equal to _____.

We can also break it down by drawing a picture.

Algebraically, the sentence, " $\frac{2}{5}$ of a number is 42 ", can be symbolically written as

$$\frac{2}{5}x = 42$$

Now, we can find the multiplicative inverse and apply the Multiplication Property of Equality to find x.

Let's Practice

Solve $-\frac{4}{3}x = 220$.

Solving Two-Step Equations (Integers)

For more complex math equations, we can combine both the **Addition and Multiplication Properties of Equality** to solve for an unknown number.

What value of z would make the following a true statement?

$$-4z + 15 = 27$$

Let's break down what we know.

"Some number" plus 15 *is* 27*. What does that number have to be?*

That "number" is also written as $-4z$*.*

That means we can read it as -4 *times "something else" equals ________. What is that "something else"?*

Check to see if your solution creates a true statement.

We just solved for z*!* $z =$ ______

What did we do each step to find the mystery or unknown value?

Now, let's solve the equation algebraically applying the Properties of Equality.

$$-4z + 15 = 27$$

Is there a different way we can do this?

Although we arrived at the same answer when starting with both properties, which property was easier to start with?

Let's Practice

Solve for y in the following equation: $3y - 5 = -26$

Solving Two-Step Equations (Rational Numbers)

We can also apply the Addition and Multiplication Properties of Equality to equations with rational numbers, orequation with ______________.

Let’s solve the following equation by applying the Properties of Equality and our knowledge of fractions:

$$\frac{2}{9}a - \frac{4}{7} = \frac{1}{3}$$

When there are fractions in our equations, we can also solve this equation by first finding the least denominator among all of the fractions.

$$\frac{2}{9}a - \frac{4}{7} = \frac{1}{3}$$

Is there a least common denominator? If so, what is the least common denominator (LCD) among all terms?

Multiply __________ term by the LCD.

What happened to each fraction when we multiplied by the LCD? Why did this happen?

Now, let's solve our equation.

What is the difference between the first method and the second method?

Be careful! Sometimes it may be easier to solve using one method over another.

Let's Practice

Solve for b, $\frac{b}{8}+\frac{4}{5}=\frac{7}{40}$.

Solving Two-Step Real-World Equations

We can use equations to help us solve real world problems!

Cole's music service, CheapDL, charges a monthly service fee of $15 plus $1.15 for every song downloaded. If Cole has $38 to spend a month on music downloads, then determine how many songs Cole can download each month.

We can apply the problem-solving strategy, C.U.B.E.S., to help us solve this problem.

C = ______________ the numbers

U = ______________ the question

B = ______________ the math action words

E = ______________ what is not needed

S = ______________ the problem

What is the equation that represents this problem?

How many songs can Cole download each month?

Let's Practice

Walter has $\$25$ to spend at the fall festival. The festival has a $\$10$ admission fee plus charges $\$0.75$ per ride.

How many rides can Walter enjoy at the festival?

Solving Multi-Step Equations

Some equations require more than just two steps to solve. We still use the Addition and Multiplication Properties of Equality to solve.

Solve for f:

$$5 + 4(f + 9) = -8(f - 3) + 2$$

Step 1: Eliminate groupings by using the distributive property.

Step 2: Combine like terms on each side.

Step 3: Notice that we have like terms on both sides of our equation. What inverse operation can we use to combine these?

Step 4: In order to solve for our variable, we need to isolate it on one side of the equal sign.

Step 5: We know that 12 *multiplied by* f *equals* 15*. What is the inverse operation we should use to find* f*?*

Step 6: Can we simplify our fraction? Remember that the solution should always be in most simplified form!

Step 7: Let's verify that our solution makes the equation a true statement.

Let's Practice

Solve for d in the following equation:

$$9(d+3) = 4(d-7) + 6$$

Solving Equations with No Solutions

Remember that when we are solving an equation, we are looking for the number or numbers that make(s) the statement _________.

Consider the equation $4 = 7$.

Is this a true statement?

Can it ever be made a true statement by applying the addition or multiplication property of equality?

Draw a picture to show the value of 4 *and* 7.

$4 = 7$ *is a ____________ statement.*

Let's solve the following equation:

$$6v + 8 - v = 5(v + 3)$$

Let's Practice

Which of the following equations result in *no solution*?

A) $2(w-5)=7w+4$
B) $2(w-5)=7w-10-5w$
C) $2(w-5)=7w-10$
D) $2(w-5)=7w+4-5w$

<u>Solving Equations with Infinitely Many Solutions</u>

When we are solving an equation, we are looking for the number or numbers that make(s) the statement _________.

Let's consider the equation $4 = 4$.

Is this a true statement?

Will this always be a true statement after applying the addition and multiplication property of equality?

Draw a picture to show the values of 4 and 4.

$4 = 4$ *is called an* ____________________.This means that this statement will always be true.

Consider the following equation:

$$-4 + 6p + 18 + 3p = 9(p + 1) + 5$$

First, let's use the distributive property and combine like terms.

What do you notice about each side of the equation?

Can $p = 4$*? Why or why not?*

Can $p = -\frac{1}{2}$*? Why or why not?*

Can $p = -2000$*? Why or why not?*

Is there any number that p cannot equal?

Let's solve the equation to find out.

What happened to p when we applied the inverse operation?

This means we are left with an ___________________.

This means that this equation has _________________ many solutions!

Let's Practice

Which of the following results in infinitely many solutions?

A) $8y - 3 - 4y = 4(y - 3)$
B) $8y - 12 - 4y = 4(y - 3)$
C) $-4y - 12 + 8y = 8(y - 3)$
D) $-4y - 12 = 4(y - 3)$