**Essential Question:** How can we use the properties of equality to solve equations?

**Do Now:** Compare and Contrast A and B.

A. $2x - 5 + 3x$

$5x - 5$

B. $2x - 5 + 3x = 25$

$5x - 5 = 25$

$5x = 30$

$x = 6$

| Compare | Contrast |
|---|---|
| Both have an expression that can be simplified | the equation can be solved<br>(A) expression<br>(B) equation |

## Solving Equations

The **properties of equality** justify the series of **inverse operations** that are performed in order to solve an equation.

| | |
|---|---|
| Addition Property of Equality | If a = b, then a + c = b + c |
| Subtraction Property of Equality | If a = b, then a - c = b - c |
| Multiplication Property of Equality | If a = b, then ac = bc |
| Division Property of Equality | If a = b, then $\frac{a}{c} = \frac{b}{c}$, c ≠ 0 |

**Examples:**

| Equation | Justification | Check |
|---|---|---|
| $x + 9 = 17$<br>$-9 \quad -9$<br>$x = 8$ | subtraction property of equality | $x + 9 = 17$<br>$8 + 9 = 17$<br>$17 = 17$ ✓ |
| $x - 10 = 50$<br>$+10 \quad +10$<br>$x = 60$ | addition property of equality | $x - 10 = 50$<br>$60 - 10 = 50$<br>$50 = 50$<br>✓ |

| Equation | Justification | Check |
|---|---|---|
| $\frac{4x}{4} = \frac{68}{4}$<br>$x = 17$ | division property of equality | $4x = 68$<br>$4(17) = 68$<br>$68 = 68$ ✓ |
| $\frac{x}{-3} = 2$<br>$-3\left(\frac{x}{-3}\right) = (2)(-3)$<br>$x = -6$ | multiplication property of equality | $\frac{x}{-3} = 2$<br>$\frac{-6}{-3} = 2$<br>$2 = 2$ ✓ |

**More Examples:**

* 1. $-y = 8$

$\frac{-y}{-1} = \frac{8}{-1}$

$y = -8$

2. $\frac{3}{4}x = 18$

$\frac{4}{3}\left(\frac{3}{4}\right)x = \frac{4}{3}(18)^{6}$

$x = 24$

3. $-5x - 4 = 16$

$+4 \quad +4$

$\frac{-5x}{-5} = \frac{20}{-5}$

$x = -4$

4. $2(3x - 5) = -4$

$6x - 10 = -4$

$+10 \quad +10$

$\frac{6x}{6} = \frac{6}{6}$

$x = 1$

5. $\frac{1}{2}m + 4 - \frac{5}{2}m = -3$

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

$-4 \quad -4$

$\frac{-2m}{-2} = \frac{-7}{-2}$

$m = \frac{7}{2}$

or $3.5$

6. $5x - 3(x - 1) = -15$

$5x - 3x + 3 = -15$

$2x + 3 = -15$

$-3 \quad -3$

$\frac{2x}{2} = \frac{-18}{2}$

$x = -9$

# THINK ABOUT THIS....

The equation, $7(x - 9) = -42$ is solved in two different ways. Examine each method below.

**1st Method**

$7(x - 9) = -42$ → distributed

$7x - 63 = -42$

$+63 \quad +63$ → addition property of equality

$\frac{7x}{7} = \frac{21}{7}$ → division property of equality

$x = 3$

**2nd Method**

$\frac{7(x - 9)}{7} = \frac{-42}{7}$ → division property of equality

$x - 9 = -6$

$+9 \quad +9$ → addition property of equality

$x = 3$

What steps were taken in each method? Does performing the steps in a different order affect the solution?

Looking at the second method used to solve the equation, how might this method help you solve the equation below?

$\frac{3}{7}(5x-2)=12$ divide by $\frac{3}{7}$ (which is the same as multiplying by its reciprocal, $\frac{7}{3}$)

$\frac{7}{3} \cdot \frac{3}{7}(5x-2) = \frac{4}{12}\left(\frac{7}{\cancel{3}_1}\right)$

$5x - 2 = 28$

$+2 \quad +2$

$5x = 30$

$x = 6$

check

$\frac{3}{7}(5x-2) = 12$

$\frac{3}{7}(5 \cdot 6 - 2) = 12$

$\frac{3}{7}(30 - 2) = 12$

$\frac{3}{\cancel{7}_1}\left(\frac{4}{\cancel{28}}\right) = 12$ $\quad 12 = 12$ ✓

**TODAY'S TAKE AWAY...**

We use properties of equality to solve equations. The solution set to an equation is the value(s) of the variable that makes the equation a true statement.