

Solving Equations

Part 2: Multi-Step Equations

J. Garvin



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Solving Simple Equations

Recap

Solve $-4x - 11 = 17$ algebraically.Add 11 to each side, then divide both sides by -4 .

$$\begin{aligned} -4x - \cancel{11} + \cancel{11} &= 17 + 11 \\ \frac{-4x}{-4} &= \frac{28}{-4} \\ x &= -7 \end{aligned}$$

Since $-4(-7) - 11 = 17$, the solution is $x = -7$.J. Garvin — Solving Equations
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Solving Multi-Step Equations

To date, we have dealt with equations that have been fairly straightforward to solve, generally requiring only one or two steps to isolate x .

More complicated equations may involve terms with variables on both sides of the equation, or those that require expansion using the distributive property.

The goal in these cases is to simplify these equations using algebra, so that they become similar to those that were previously solved using basic techniques.

Remember that at all times, an equation must remain balanced. This means applying the same operation to both sides of the equation.

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Solving Multi-Step Equations

Example

Solve $7x - 15 = 2x + 35$.

Collect all variable terms on the left, constants on the right.

$$\begin{aligned} 7x - 2x - 15 &= \cancel{2x} - \cancel{2x} + 35 \\ 5x - 15 &= 35 \\ 5x - \cancel{15} + \cancel{15} &= 35 + 15 \\ 5x &= 50 \end{aligned}$$

Divide both sides by 5.

$$\begin{aligned} \frac{5x}{5} &= \frac{50}{5} \\ x &= 10 \end{aligned}$$

The solution is $x = 10$.J. Garvin — Solving Equations
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Solving Multi-Step Equations

Example

Solve $2x + 15 = 5x - 27$.

As before, collect all like terms on their respective sides.

$$\begin{aligned} 2x - 5x + \cancel{15} - \cancel{15} &= \cancel{5x} - \cancel{5x} - 27 - 15 \\ -3x &= -42 \end{aligned}$$

Divide both sides by -3 .

$$\begin{aligned} \frac{-3x}{-3} &= \frac{-42}{-3} \\ x &= 14 \end{aligned}$$

The solution is $x = 14$.J. Garvin — Solving Equations
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Solving Multi-Step Equations

Example

Solve $4(x - 2) - (x + 3) = 16$.

Use the distributive property to expand the left hand side.

$$\begin{aligned} 4x - 8 - x - 3 &= 16 \\ 3x - 11 &= 16 \end{aligned}$$

Now isolate x as in the previous examples.

$$\begin{aligned} 3x - \cancel{11} + \cancel{11} &= 16 + 11 \\ 3x &= 27 \\ \frac{3x}{3} &= \frac{27}{3} \\ x &= 9 \end{aligned}$$

The solution is $x = 9$.J. Garvin — Solving Equations
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Solving Multi-Step Equations

Example

Solve $3(x - 2) = 5(x + 1)$.

Use the distributive property to expand each side, then collect like terms as before.

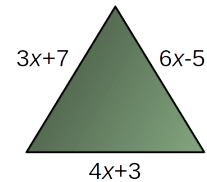
$$\begin{aligned} 3x - 6 &= 5x + 5 \\ 3x - 5x - 6 + 6 &= \cancel{5x} - \cancel{5x} + 5 + 6 \\ -2x &= 11 \\ \frac{-2x}{-2} &= \frac{11}{-2} \\ x &= -\frac{11}{2} \end{aligned}$$

The fraction cannot be reduced, so the solution is $x = -\frac{11}{2}$.

Solving Multi-Step Equations

Example

For the triangle below, is there a value of x that makes it an equilateral triangle?



Solving Multi-Step Equations

Recall that an equilateral triangle is one in which the three sides have the same length.

Therefore, for the triangle to be equilateral the following two conditions must be met:

- $3x + 7 = 4x + 3$, and
- $4x + 3 = 6x - 5$

It is not necessary to check if $3x + 7 = 6x - 5$, since if $a = b$ and $b = c$, then $a = c$.

If we obtain the same value of x for both conditions, then the triangle is equilateral.

Solving Multi-Step Equations

Test the first condition.

Test the second condition.

$$\begin{aligned} 3x - 4x + 7 - 7 &= \cancel{4x} - \cancel{4x} + 3 - 7 & 4x - 6x + 3 - 3 &= \cancel{6x} - \cancel{6x} - 5 - 3 \\ -x &= -4 & -2x &= -8 \\ \frac{-x}{-1} &= \frac{-4}{-1} & \frac{-2x}{-2} &= \frac{-8}{-2} \\ x &= 4 & x &= 4 \end{aligned}$$

Since we obtained the same value for both conditions, the triangle will be equilateral if $x = 4$, resulting in a triangle with side lengths of 19 units.

Questions?

