

Solving Multi-Step Inequalities

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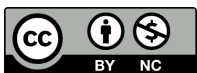
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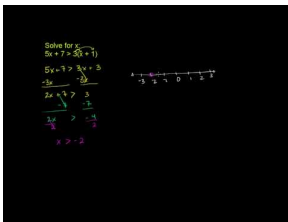
CHAPTER 1

Solving Multi-Step Inequalities

Here you will solve more complicated inequalities involving variables on both sides and the Distributive Property.

Adding antifreeze to a car's cooling system can lower the freezing point of the water-based liquids that enable the vehicle to run. (It also raises the boiling point of these liquids.) You added enough antifreeze to lower the freezing point of the liquids to at most -35°C (in Celsius). Write the inequality in Fahrenheit.

Watch This



MEDIA

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[Khan Academy: Multi-Step Inequalities 2](#)

Guidance

Like multi-step equations, multi-step inequalities can involve having variables on both sides, the Distributive Property, and combining like terms. Again, the only difference when solving inequalities is the sign must be flipped when multiplying or dividing by a negative number.

Example A

Is $x = -3$ a solution to $2(3x - 5) \leq x + 10$?

Solution: Plug in -3 for x and see if the inequality is true.

$$2(3(-3) - 5) \leq (-3) + 10$$

$$2(-9 - 5) \leq 7$$

$$2 \cdot -14 \leq 7$$

$$-28 \leq 7$$

This is a true inequality statement. -3 is a solution.

Example B

Solve and graph the inequality from Example A.

Solution: First, distribute the 2 on the left side of the inequality.

$$2(3x - 5) \leq x + 10$$

$$6x - 10 \leq x + 10$$

Now, subtract the x on the right side to move it to the left side of the inequality. You can also add the 10's together and solve.

$$6x - 10 \geq x + 10$$

$$\frac{-x + 10}{-x + 10} \frac{-x + 10}{-x + 10}$$

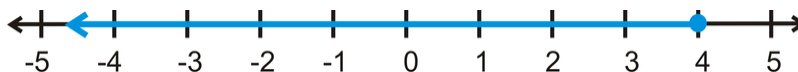
$$\frac{5x}{5} \leq \frac{20}{5}$$

$$x \leq 4$$

Test a solution, $x = 0$: $2(3(0) - 5) \leq 0 + 10$ ✓

$$-10 \leq 10$$

The graph looks like:



Example C

Solve $8x - 5 - 4x \geq 37 - 2x$

Solution: First, combine like terms on the left side. Then, solve for x .

$$8x - 5 - 4x \geq 37 - 2x$$

$$4x - 5 \geq 37 - 2x$$

$$\frac{+2x + 5}{+2x + 5} \frac{+2x + 5}{+2x + 5}$$

$$\frac{6x}{6} \geq \frac{42}{6}$$

$$x \geq 7$$

Test a solution, $x = 10$: $8(10) - 5 - 4(10) \geq 37 - 2(10)$

$$80 - 5 - 40 \geq 37 - 20$$

$$35 \geq 17$$
 ✓

Intro Problem Revisit Recall that the conversion formula for Celsius to Fahrenheit is $C = \frac{5}{9}(F - 32)$. The temperature can be equal to or greater than -35°C .

$$\frac{5}{9}(F - 32) \geq -35$$

$$F - 32 \geq -35 \cdot 9$$

$$F - 32 \geq -63$$

$$F \geq -31$$

So, the temperature can be equal to or higher than -31°F .

Guided Practice

1. Is $x = 12$ a solution to $-3(x - 10) + 18 \geq x - 25$?

Solve and graph the following inequalities.

2. $-(x + 16) + 3x > 8$

3. $24 - 9x < 6x - 21$

Answers

1. Plug in 12 for x and simplify.

$$\begin{aligned} -3(12 - 10) + 18 &\geq 12 - 25 \\ -3 \cdot 2 + 18 &\geq -13 \\ -6 + 18 &\geq -13 \end{aligned}$$

This is true because $12 \geq -13$, so 12 is a solution.

2. Distribute the negative sign on the left side and combine like terms.

$$\begin{aligned} -(x + 16) + 3x &> 8 \\ -x - 16 + 3x &> 8 \\ 2x - 16 &> 8 \\ &+ 16 + 16 \\ \hline 2x &> 24 \\ \frac{2x}{2} &> \frac{24}{2} \\ x &> 12 \end{aligned}$$

Test a solution, $x = 15$:

$$\begin{aligned} -(15 + 16) + 3(15) &> 8 \\ -31 + 45 &> 8 \\ 14 &> 8 \end{aligned}$$

3. First, add $9x$ to both sides and add 21 to both sides.

$$\begin{aligned} 24 - 9x &< 6x - 21 \\ +9x + 9x & \\ \hline 24 &< 15x - 21 \\ +21 & \quad +21 \\ \hline 45 &< 15x \\ \frac{45}{15} &< \frac{15x}{15} \\ 3 &< x \end{aligned}$$

Test a solution, $x = 10$:

$$24 - 9(10) < 6(10) - 21$$

$$24 - 90 < 60 - 21$$

$$-66 < 39$$

Explore More

Determine if the following numbers are solutions to $-7(2x - 5) + 12 > -4x - 13$.

1. $x = 4$
2. $x = 10$
3. $x = 6$

Solve and graph the following inequalities.

4. $2(x - 5) \geq 16$
5. $-4(3x + 7) < 20$
6. $15x - 23 > 6x - 17$
7. $5x + 16 + 2x \leq -19$
8. $4(2x - 1) \geq 3(2x + 1)$
9. $11x - 17 - 2x \leq -(x - 23)$

Solve the following inequalities.

10. $5 - 5x > 4(3 - x)$
11. $-(x - 1) + 10 < -3(x - 3)$
12. Solve $5x + 4 \leq -2(x + 3)$ by adding the $2x$ term on the right to the left-hand side.
13. Solve $5x + 4 \leq -2(x + 3)$ by *subtracting* the $5x$ term on the left to the right-hand side.
14. Compare your answers from 12 and 13. What do you notice?
15. **Challenge** Solve $3x - 7 > 3(x + 3)$. What happens?