

INDEPENDENT VARIABLE

IDV WORKSHEETS



SOLVING THREE-STEP EQUATIONS

VARIABLES ON BOTH SIDES | NEGATIVES | SPECIAL CASES

ANIMATED
POWERPOINT:
DOES THE WORK
FOR YOU!

FULL ANSWER
KEYS
INCLUDED

ALONG • FOLLOW-ALONG SHEET, BOX 4

Solving the Three-Step Equation

is a two-step equation.

$$-2x + 9 = 5x - 5$$

INVERSE 1 Get rid of the smallest variable term, to both sides.

REWRITE Rewrite the equation: $9 = 7x - 5$. Now it is a two-step equation.

INVERSE 2 Get rid of the number by the variable, -5 ; add 5 to both sides.

REWRITE Rewrite the equation: $14 = 7x$.

INVERSE 3 Isolate x : it is multiplied by 7, so divide both sides by 7.

REWRITE Rewrite: $2 = x$.

CHECK Substitute 2 for x in the original equation. Both sides match ✓

KEY IDEA

When the x's Disappear

Sometimes Step 1 gets rid of EVERY variable term. Then read what is left.

NO SOLUTION

$$-8x + 6 = -17 + -8x$$

ALL SOLUTIONS

$$8x + 6 = 6 + 8x$$

False statement: no solution. True statement: all solutions

6 EXAMPLE
PROBLEMS
5 PRACTICE
SHEETS

LEVELED
PRACTICE,
FIND THE
MISTAKE +
MAZE

MORE PRACTICE. LESS PREP. BETTER OUTCOMES.

Inside the Animated Lesson

INDEPENDENT VARIABLE

GRADES 7-8 • PRE-ALGEBRA

SOLVING THREE-STEP EQUATIONS

VARIABLES ON BOTH SIDES | NEGATIVES | NO SOLUTION & ALL SOLUTIONS

Animated PowerPoint lesson

6 animated worked problems • follow-along sheet

Practice A, B, C • Find the Mistake • maze

$$\begin{array}{r}
 15 + 3x = 9 + 6x \\
 -3x \quad -3x \\
 \hline
 15 = 9 + 3x
 \end{array}$$

MORE PRACTICE. LESS PREP. BETTER OUTCOMES.

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LESSON OVERVIEW

Today's Goals

I CAN...

- Solve multi-step equations when there are variables on both sides of the equation.
- Get the variables on one side first, then solve the two-step equation that is left.
- Recognize an equation with no solution or with all numbers as solutions, and check my answer.

KEY VOCABULARY

Variable term a number times the variable: the $3x$ in $15 + 3x$	Like terms terms with the same variable: $6x - 3x = 3x$
Constant a number by itself, with no variable: the 15 in $15 + 3x$	Additive inverse the opposite: $3x + (-3x) = 0$
No solution no number works: the equation ends as something false, like $1 = 2$	All solutions every number works: it ends as something true, like $6 = 6$

STANDARDS

CCSS 8.EE.C.7a CCSS 8.EE.C.7b

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ENTRY TASK

Can You Read My Mind?

I'm thinking of a number. If I triple it and add 1, it's the same as if I tripled it and added 2. What is it?

THINK ABOUT IT

Try a number. If it is 5:

$$3 \cdot 5 + 1 = 16$$

$$3 \cdot 5 + 2 = 17$$

Tripled numbers match, so +1 and +2 never can. No number works!

AS AN EQUATION

$$\begin{array}{r}
 3x + 1 = 3x + 2 \\
 -3x \quad -3x \\
 \hline
 1 = 2
 \end{array}$$

No solution

WRITE IT DOWN. IT COUNTS!

YOU MUST SHOW MATH!

Subtract $3x$: $1 = 2$.
Never true: **no solution**.
Today: **x on BOTH sides**.

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KEY IDEA

Which Variable Term Do I Move?

Step 1: get rid of the **SMALLEST** variable term, so the variables are on one side.

STEP 1: COLLECT THE VARIABLES

$$\begin{array}{r}
 15 + 3x = 9 + 6x \\
 -3x \quad -3x \\
 \hline
 15 = 9 + 3x
 \end{array}$$

$3x$ is the smallest variable term, so subtract $3x$ from both sides. **The x term that is left stays positive: $3x$.**

NOW IT IS A TWO-STEP EQUATION

$$15 = 9 + 3x$$

Step 2: get rid of the number by the variable, 9: subtract 9 from both sides.
Step 3: isolate the variable (divide by 3), $x = 2$
Moving $6x$ instead works too, but then you divide by a negative.

Get the variables on ONE side first. Then it is a two-step equation.

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HOW THIS LESSON WORKS

Three Inverses. Rewrite Each Time. Check.

Three steps to solve. Rewrite after each step, then check, every time.

INVERSE 1 Get rid of the smallest variable term (additive inverse) on **BOTH** sides.

REWRITE Rewrite. The variables are on one side: a two-step equation.

INVERSE 2 Get rid of the number by the variable (additive inverse).

REWRITE Rewrite the new, shorter equation.

INVERSE 3 Isolate the variable: divide by the coefficient (multiplicative inverse).

REWRITE Rewrite as $x = \underline{\hspace{1cm}}$. Reduce fractions if you can.

CHECK Put your answer into the **ORIGINAL** equation. Both sides must match.

EXAMPLE

$$\begin{array}{r}
 15 + 3x = 9 + 6x \\
 -3x \quad -3x \\
 \hline
 15 = 9 + 3x \\
 -9 \quad -9 \\
 \hline
 6 = 3x \\
 \frac{6}{3} \quad \frac{3}{3} \\
 2 = x
 \end{array}$$

CHECK

$$15 + 3 \cdot 2 = 9 + 6 \cdot 2$$

$$21 = 21 \checkmark$$

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FOLLOW-ALONG • FOLLOW-ALONG SHEET, BOX 1

Solve the Three-Step Equation

Now it is a two-step equation.

$$\begin{array}{r}
 1 + 5x = 19 + 2x \\
 -2x \quad -2x \\
 \hline
 1 + 3x = 19
 \end{array}$$

INVERSE 1 Get rid of the smallest variable term, $2x$: subtract $2x$ from both sides.

REWRITE Rewrite the equation: $1 + 3x = 19$. Now it is a two-step equation.

STEP 1 GOAL: get the variables on **ONE** side. Then it is a two-step equation.

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FOLLOW-ALONG • FOLLOW-ALONG SHEET, BOX 4

Solve the Three-Step Equation

Now it is a two-step equation.

$$\begin{array}{r}
 -2x + 9 = 5x - 5 \\
 +2x \quad +2x \\
 \hline
 9 = 7x - 5 \\
 +5 \quad +5 \\
 \hline
 14 = 7x \\
 \frac{14}{7} \quad \frac{7}{7} \\
 2 = x
 \end{array}$$

INVERSE 1 Get rid of the smallest variable term, $-2x$: add $2x$ to both sides.

REWRITE Rewrite the equation: $9 = 7x - 5$. Now it is a two-step equation.

INVERSE 2 Get rid of the number by the variable, -5 : add 5 to both sides.

REWRITE Rewrite the equation: $14 = 7x$.

INVERSE 3 Isolate x : it is multiplied by 7, so divide both sides by 7.

REWRITE Rewrite: $2 = x$.

CHECK Substitute 2 for x in the original equation. Both sides match $\checkmark$

$$-2 \cdot 2 + 9 = 5 \cdot 2 - 5$$

$$5 = 5 \checkmark$$

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KEY IDEA

When the x's Disappear

Sometimes Step 1 gets rid of **EVERY** variable term. Then read what is left.

NO SOLUTION

$$\begin{array}{r}
 -8x + 6 = -17 + -8x \\
 +8x \quad +8x \\
 \hline
 6 = -17 \\
 \text{No solution}
 \end{array}$$

$6 = -17$ is never true. No value of x works.

ALL SOLUTIONS

$$\begin{array}{r}
 8x + 6 = 6 + 8x \\
 -8x \quad -8x \\
 \hline
 6 = 6 \\
 \text{All solutions}
 \end{array}$$

$6 = 6$ is always true. Every value of x works.

False statement: no solution. True statement: all solutions.

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Directions: Getting started. Whole numbers, positive answers. Get rid of the smallest variable term first, then the number by the variable, then the coefficient. Check each answer.

PRACTICE A • GETTING STARTED

Example: basic

$$4 + 4x = 12 + 2x$$
$$\quad -2x \quad -2x$$
$$4 + 2x = 12$$
$$\quad -4 \quad -4$$
$$\frac{2x}{2} = \frac{8}{2}$$
$$x = 4$$

Step 1: get rid of the smallest variable term

Step 2: get rid of the number by the variable

Step 3: multiplicative inverse; reduce if you can

Example: mixed operations

$$4 - 4x = 12 - 2x$$
$$\quad +4x \quad +4x$$
$$4 = 12 + 2x$$
$$\quad -12 \quad -12$$
$$\frac{-8}{2} = \frac{2x}{2}$$
$$-4 = x$$

Step 1: get rid of the smallest variable term

Step 2: get rid of the number by the variable

Step 3: multiplicative inverse; reduce if you can

1. $19 + 7x = 7 + 9x$	2. $4 + 4x = 25 + x$	3. $21 + 6x = 13 + 8x$
4. $7x + 6 = 5x + 24$	5. $2x + 25 = 4x + 9$	6. $8x + 2 = 2x + 14$
7. $2 + 9x = 24 + 7x$	8. $9x + 5 = 5x + 17$	9. $1 + 4x = 21 + 2x$
10. $9 + 3x = 45 + x$	11. $1 + 3x = 25 + x$	12. $2x + 22 = 4x + 12$

Directions: Each student made ONE mistake. Circle the first wrong line, explain what went wrong, then solve it correctly.

1. *Jamie solved:*

$$7x + 4 = 3x + 20$$

$$10x + 4 = 20$$

$$10x = 16$$

$$x = 8/5$$

What went wrong?

Solve it correctly:

2. *Quinn solved:*

$$3x + 10 = 5x - 4$$

$$10 = 5x - 4$$

$$14 = 5x$$

$$x = 14/5$$

What went wrong?

Solve it correctly:

3. *Riley solved:*

$$5x - 8 = 2x + 7$$

$$3x - 8 = 7$$

$$3x = -1$$

$$x = -1/3$$

What went wrong?

Solve it correctly:

4. *Avery solved:*

$$-4x + 7 = 2x - 11$$

$$7 = -2x - 11$$

$$18 = -2x$$

$$x = -9$$

What went wrong?

Solve it correctly:

5. *Alex solved:*

$$2x + 9 = 5x + 3$$

$$-3x + 9 = 3$$

$$-3x = -6$$

$$x = -2$$

What went wrong?

Solve it correctly:

6. *Taylor solved:*

$$8x + 3 = 2x + 5$$

$$6x + 3 = 5$$

$$6x = 2$$

$$x = 3$$

What went wrong?

Solve it correctly:

Directions: Solve the problem in each box. Follow the connector labeled with your answer to the next box. Trace your path from **START** to **STOP**.

START

1. $26 + 8x = 31 + 13x$			2. $7x - 49 = -16x - 26$			3. $-4x + 32 = -11x + -24$			4. $48 + 11x = 40 + 7x$			STOP								
-1			37			6			37			11			20			1		
5. $-22x + 50 = -24x + -8$			6. $-22x - 19 = -16x + 47$			7. $10 + 9x = -30 + 11x$			8. $-31 + 12x = 1 + 20x$											
-29			-25			20			20			1			-6			-1		
9. $-8 + 15x = 14 + 13x$			10. $5x + 34 = -18x + -35$			11. $-2 + 22x = -44 + 15x$			12. $-12x + 38 = -2x + 18$											
-4			-3			37			1			11			-8			17		
13. $-4x + 7 = -10x + 43$			14. $-37 + -15x = 38 + -12x$			15. $-34 + -11x = 40 + -13x$			16. $-12x - 47 = -17x + 38$											
6						-25			37											