



PRINTABLES
PREMIUM EDUCATIONAL RESOURCES

Solving Linear Equations in One Variable

Complete Unit - One, Infinite & No Solution

GRADE 8

ALIGNED TO COMMON CORE STATE STANDARDS

CCSS.MATH.CONTENT.8.EE.C.7

Solve linear equations in one variable (a , b)

WHAT'S INSIDE THIS UNIT

5 Topic Progressions - Guided Notes & Reference Boxes

115+ Practice Problems with Full Worked Solutions

Three-Case Flowchart - One, None, or Infinite Solutions

Cumulative Review - 2 Quizzes - Comprehensive Unit Test

Topic 1 - Properties of Equality

CCSS.MATH.CONTENT.8.EE.C.7 - Solve linear equations in one variable.

Solving any equation rests on a single idea: an equation is a balance scale, and we may modify both sides in the same way without breaking the balance. The four **Properties of Equality** formalize exactly which modifications preserve truth. Every algebraic step in the rest of this unit is justified by one of these properties, and naming that property as we go is the heart of mathematical rigor at Grade 8.

Why do we bother naming the property at every step? Because the answer " $x = 5$ " is not mathematics - the *reasoning* that takes us from the original equation to that answer is the mathematics. By stating the property used at each step, students build a habit of justification that transfers directly to geometric proofs in high school and to formal reasoning in every later course. The four properties below are the foundation of all equation solving.

The Four Properties of Equality

Addition Property of Equality

Formally: If $a = b$, then $a + c = b + c$ for any real number c .

$$a = b \Rightarrow a + c = b + c$$

Example: If $x - 4 = 9$, then $x - 4 + 4 = 9 + 4$, so $x = 13$.

Subtraction Property of Equality

Formally: If $a = b$, then $a - c = b - c$ for any real number c .

$$a = b \Rightarrow a - c = b - c$$

Example: If $x + 7 = 12$, then $x + 7 - 7 = 12 - 7$, so $x = 5$.

Multiplication Property of Equality

Formally: If $a = b$, then $a * c = b * c$ for any nonzero real number c .

$$a = b \Rightarrow a * c = b * c \quad (c \neq 0)$$

Example: If $x / 3 = 5$, then $3 * (x / 3) = 3 * 5$, so $x = 15$.

Division Property of Equality

Formally: If $a = b$, then $a / c = b / c$ for any nonzero real number c .

$$a = b \Rightarrow a / c = b / c \quad (c \neq 0)$$

Example: If $4x = 20$, then $4x / 4 = 20 / 4$, so $x = 5$.

Worked Example 3

$$5w = 35$$

$$5w = 35$$

Given

$$5w / 5 = 35 / 5$$

Division Property of Equality

$$w = 7$$

*Simplify***Solution: $w = 7$** **Verify by Substitution:**

$$\text{LHS} = 5 * 7 = 35$$

$$\text{RHS} = 35 = 35$$

*LHS = RHS = 35. $w = 7$ is correct.***Worked Example 4**

$$p / 4 = 8$$

$$p / 4 = 8$$

Given

$$4 * (p / 4) = 4 * 8$$

Multiplication Property of Equality (by 4)

$$p = 32$$

*Simplify***Solution: $p = 32$** **Verify by Substitution:**

$$\text{LHS} = 32 / 4 = 8$$

$$\text{RHS} = 8 = 8$$

*LHS = RHS = 8. $p = 32$ is correct.***Worked Example 5**

$$3x - 7 = 14$$

$$3x - 7 = 14$$

Given

$$3x - 7 + 7 = 14 + 7$$

Addition Property of Equality

$$3x = 21$$

Simplify

$$3x / 3 = 21 / 3$$

Division Property of Equality

$$x = 7$$

*Simplify***Solution: $x = 7$** **Verify by Substitution:**

$$\text{LHS} = 3(7) - 7 = 21 - 7 = 14$$

$$\text{RHS} = 14 = 14$$

LHS = RHS = 14. $x = 7$ is correct.

30-Problem Drill - One-Step & Two-Step Equations

Solve each equation. Show your work and verify by substitution. Full worked solutions with property labels begin on the next page.

Set A - One-Step Equations (10 problems)

1. $x + 7 = 12$

2. $y - 4 = 9$

3. $6w = 42$

4. $p / 5 = 8$

5. $k - 11 = 3$

6. $9 = m + 4$

7. $4t = -24$

8. $r / 3 = -7$

9. $-5n = 35$

10. $b + 2.5 = 7.5$

Set B - Two-Step Equations, Integer Coefficients (10 problems)

11. $2x + 5 = 13$

12. $3y - 7 = 14$

13. $4w + 1 = 17$

14. $5p - 2 = 18$

15. $k/2 + 3 = 10$

16. $2x - 9 = -1$

17. $3 + 4m = 19$

18. $10 - 2y = 4$

19. $7w + 3 = 31$

20. $n/3 - 5 = 1$

Set C - Fractional & Negative Coefficients (10 problems)

21. $(1/2)x = 6$

22. $(1/3)y = -9$

23. $(2/3)w = 8$

24. $-3p = 18$

25. $-(1/4)k = 5$

26. $(2/5)x + 1 = 7$

27. $(3/4)y - 2 = 4$

28. $-2x + 3 = 11$

29. $(1/2)(w - 5) = 4$

30. $-(x + 4) = 7$

Full Worked Solutions - Topic 2 Drill

Each solution shows every step on a new line, the property of equality applied in the teal margin, and verification by substitution.

Set A - One-Step Equations (10 problems) - Solutions

Problem 1. $x + 7 = 12$

$$x + 7 = 12$$

Given

$$x + 7 - 7 = 12 - 7$$

Subtraction Property of Equality

$$x = 5$$

Simplify

Answer: $x = 5$

$$\text{LHS} = 5 + 7 = 12$$

$$\text{RHS} = 12 = 12$$

LHS = RHS = 12. $x = 5$ is correct.

Problem 2. $y - 4 = 9$

$$y - 4 = 9$$

Given

$$y - 4 + 4 = 9 + 4$$

Addition Property of Equality

$$y = 13$$

Simplify

Answer: $y = 13$

$$\text{LHS} = 13 - 4 = 9$$

$$\text{RHS} = 9 = 9$$

LHS = RHS = 9. $y = 13$ is correct.

Problem 3. $6w = 42$

$$6w = 42$$

Given

$$6w / 6 = 42 / 6$$

Division Property of Equality

$$w = 7$$

Simplify

Answer: $w = 7$

$$\text{LHS} = 6 * 7 = 42$$

$$\text{RHS} = 42 = 42$$

LHS = RHS = 42. $w = 7$ is correct.

Problem 4. $p / 5 = 8$

$$p / 5 = 8$$

Given

$$5 * (p / 5) = 5 * 8$$

Multiplication Property of Equality (by 5)

$$p = 40$$

Simplify

Answer: $p = 40$

$$\text{LHS} = 40 / 5 = 8$$

$$\text{RHS} = 8 = 8$$

LHS = RHS = 8. $p = 40$ is correct.

Topic 3 - Multi-Step Equations

CCSS.MATH.CONTENT.8.EE.C.7b - Including the distributive property and like terms.

A **multi-step equation** requires three or more algebraic steps to isolate the variable. The defining feature is that the variable appears in a more complex expression - perhaps inside parentheses that must be expanded using the Distributive Property, perhaps in two or more like terms that must be combined, or perhaps on both sides of the equation simultaneously. The strategy remains the same as for two-step equations: simplify each side first, then isolate the variable by undoing operations in reverse order.

Multi-Step Strategy (4 Moves)

Move 1 - Distribute: Use the Distributive Property $a(b + c) = ab + ac$ to remove parentheses. **Move 2 - Combine Like Terms:** Add the coefficients of like terms on each side. **Move 3 - Variables to One Side:** Add or subtract the smaller variable term from both sides so the variable ends up on one side only. **Move 4 - Isolate:** Use addition/subtraction then multiplication/division to isolate the variable. **Move 5 - Verify:** Substitute back into the original equation.

Worked Examples

Worked Example 1

$$3(x + 4) = 21$$

$$3(x + 4) = 21$$

Given

$$3x + 12 = 21$$

Distributive Property

$$3x + 12 - 12 = 21 - 12$$

Subtraction Property of Equality

$$3x = 9$$

Simplify

$$3x / 3 = 9 / 3$$

Division Property of Equality

$$x = 3$$

Simplify

Solution: $x = 3$

Verify by Substitution:

$$\text{LHS} = 3(3 + 4) = 3(7) = 21$$

$$\text{RHS} = 21 = 21$$

LHS = RHS = 21. $x = 3$ is correct.

Topic 4 - Equations with Rational Coefficients

CCSS.MATH.CONTENT.8.EE.C.7b - Solve with rational number coefficients.

When an equation contains **fractions** or **decimals**, the arithmetic is more error-prone and the steps are harder to read. The standard strategy is to begin by *clearing* the fractions or decimals - multiplying both sides of the equation by a carefully chosen value that converts every coefficient into an integer. After clearing, the equation is solved exactly as in Topic 3. The Multiplication Property of Equality justifies the clearing step: multiplying both sides of an equation by the same nonzero number produces an equivalent equation with the same solution set.

Strategy - Clearing Fractions with the LCD

To clear fractions, identify the **Least Common Denominator (LCD)** of all the fractions in the equation. The LCD is the smallest number that every denominator divides into evenly. Then multiply both sides of the equation by the LCD. Because each denominator divides the LCD evenly, every fraction simplifies to an integer after the multiplication. This converts the equation into one with integer coefficients while preserving the solution set.

Strategy - Clearing Decimals with Powers of 10

To clear decimals, count the greatest number of decimal places appearing in any single coefficient or constant. Multiply both sides by the corresponding power of 10 - by 10 if the most decimal places is one, by 100 if two, by 1000 if three, and so on. This shifts every decimal into an integer. For example, $0.4x + 0.7 = 1.5$ has at most one decimal place, so we multiply both sides by 10 to obtain $4x + 7 = 15$.

Decision Rule - LCD or Power of 10?

If the equation has fractions (denominators like 2, 3, 4, 5, 6, 8): find the LCD of the denominators and multiply both sides by it. **If the equation has decimals** (coefficients like 0.4, 0.05, 1.25): multiply both sides by 10, 100, or 1000 - whichever matches the greatest number of decimal places. **If the equation has both**, pick the approach that handles both: usually multiplying by a power of 10 that is also a multiple of the LCD (for example, multiply by 10 when denominators are 2 and 5 and decimals have one place).

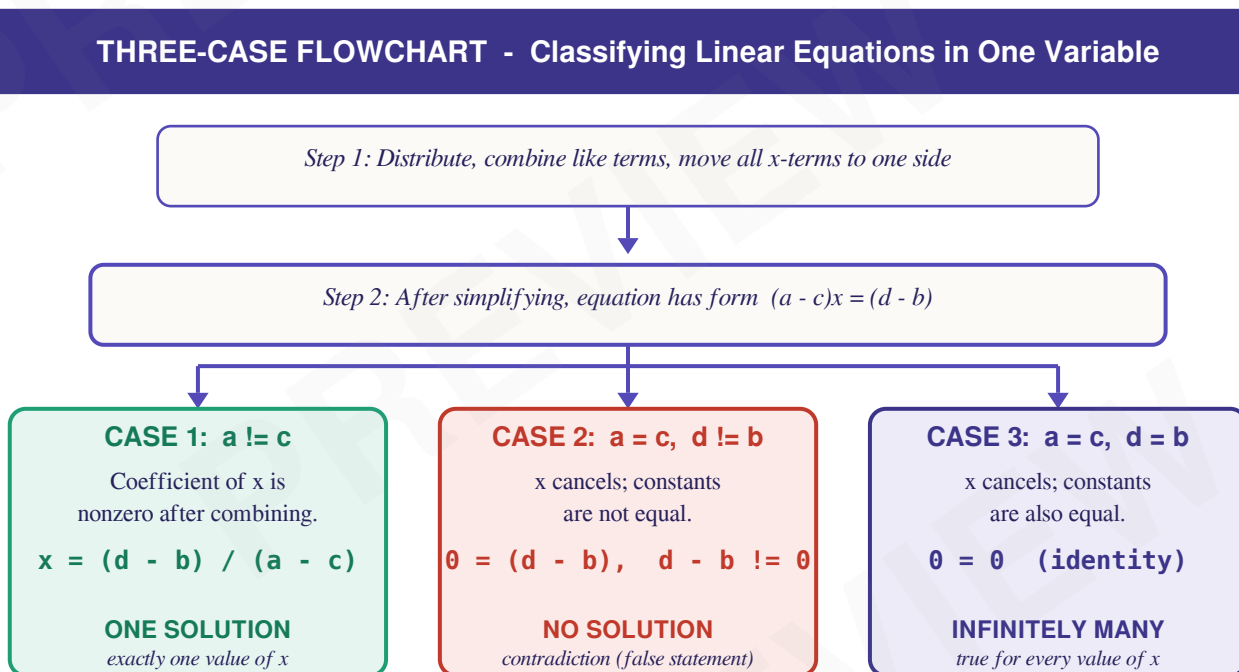
Worked Examples

Case 3 - Infinitely Many Solutions (Identity)

When $a = c$ and $d = b$, the x terms cancel and we are left with a true numerical statement such as $5 = 5$ or $0 = 0$. Because the statement is true regardless of x , **every** real number is a solution. We say the equation has **infinitely many solutions**, and we call such an equation an **identity**. **Graphically**: the two lines have the same slope and the same y-intercept, so they are coincident - they lie on top of each other at every point. **Real-world analogy**: two trains traveling at the same speed on the same track in the same direction, having started at the same place, will always be at the same position at every moment.

Three-Case Flowchart

Use this flowchart to classify any linear equation in one variable after distributing, combining like terms, and moving all variable terms to one side.



Worked Examples - Identifying the Three Cases

Comprehensive Unit Test

CCSS.MATH.CONTENT.8.EE.C.7, 8.EE.C.7a, 8.EE.C.7b - All topics, 70 points.

Time: 60 minutes - **Points:** 70 - **Calculator:** basic four-function permitted. Show all work for full credit. Partial credit is awarded for correct methods with arithmetic errors.

Part I - Multiple Choice (5 x 2 = 10 points)

1. Which property justifies: if $x + 4 = 9$, then $x + 4 - 4 = 9 - 4$?
 - A. Addition Property
 - B. Subtraction Property
 - C. Multiplication Property
 - D. Division Property
2. The equation $2x + 3 = 2x + 5$ has:
 - A. One solution
 - B. No solution
 - C. Infinitely many solutions
 - D. Two solutions
3. To clear fractions in $x/3 + x/6 = 4$, multiply both sides by:
 - A. 3
 - B. 6
 - C. 9
 - D. 12
4. The solution to $3(x - 2) = 12$ is:
 - A. $x = 2$
 - B. $x = 4$
 - C. $x = 6$
 - D. $x = 8$
5. Which equation has infinitely many solutions?
 - A. $2x + 1 = 2x + 3$
 - B. $3x - 1 = 3x - 1$
 - C. $4x = 12$
 - D. $x + 5 = 0$

Part II - Solve, Showing Work (6 x 4 = 24 points)

6. $5x - 7 = 18$

Teacher Answer Key - Comprehensive Unit Test

Full worked solutions for every test question, with point allocations noted for partial credit. Use this key to grade the test.

Part I - Multiple Choice

#	Answer	Brief Reason
1	B	Subtracting 4 from both sides is the Subtraction Property of Equality.
2	B	Subtracting $2x$ from both sides yields $3 = 5$, a contradiction. The equation has no solution.
3	B	The LCD of $\{3, 6\}$ is 6. Multiplying by 6 clears both fractions.
4	C	Distribute: $3x - 6 = 12$, then add 6 to get $3x = 18$, then divide by 3 to get $x = 6$.
5	B	$3x - 1 = 3x - 1$ reduces to $-1 = -1$, an identity true for every x .

Part II - Solve, Showing Work

Problem 6. $5x - 7 = 18$

$$5x - 7 = 18$$

Given

$$5x - 7 + 7 = 18 + 7$$

Addition Property of Equality

$$5x = 25$$

Simplify

$$5x / 5 = 25 / 5$$

Division Property of Equality

$$x = 5$$

Simplify

Answer: $x = 5$

$$\text{LHS} = 5(5) - 7 = 25 - 7 = 18$$

$$\text{RHS} = 18 = 18$$

$$\text{LHS} = \text{RHS} = 18. x = 5 \text{ is correct.}$$

Full credit: 1 pt setup, 1 pt add 7, 1 pt divide by 5, 1 pt correct answer + check.

Problem 7. $(1/3)x + 2 = 6$

$$(1/3)x + 2 = 6$$

Given

$$(1/3)x + 2 - 2 = 6 - 2$$

Subtraction Property of Equality

$$(1/3)x = 4$$

Simplify

$$3 * (1/3)x = 3 * 4$$

Multiplication Property of Equality (by 3 - reciprocal)

$$x = 12$$

Simplify

Answer: $x = 12$

$$\text{LHS} = (1/3)(12) + 2 = 4 + 2 = 6$$

$$\text{RHS} = 6 = 6$$

$$\text{LHS} = \text{RHS} = 6. x = 12 \text{ is correct.}$$



FULL RESOURCE OVERVIEW

What's Inside the Full Unit?

Grade 8 • Solving Linear Equations in One Variable • CCSS.MATH.CONTENT.8.EE.C.7

1

Properties of Equality

Formal statements and reference boxes for Addition, Subtraction, Multiplication, and Division Properties; Symmetric and Substitution Properties; mini-exercise for naming the property.

2

One-Step & Two-Step Equations

6 worked examples plus a 30-problem drill covering one-step, two-step, fractional, and negative coefficients, followed by full worked solutions with property labels and substitution checks.

3

Multi-Step Equations

Distributive Property, combining like terms, and variables on both sides; worked examples plus a 35-problem drill with full worked solutions.

4

Equations with Rational Coefficients

Clearing fractions using the LCD and clearing decimals using powers of 10; worked examples plus a 30-problem drill with explicit clearing steps and full solutions.

5

Three Cases: One, Infinite & No Solution

Algebraic and graphical treatment of the three cases, a color-coded flowchart, worked examples, and a 20-problem Identify & Explain set with case reasoning.

ALSO INCLUDED

- **Cumulative Review** 25 mixed problems, self-assessment checklist, and answer key.
- **Unit Quiz 1** 12 questions covering Topics 1-3, with teacher answer key.
- **Unit Quiz 2** 12 questions covering Topics 4-5, with teacher answer key.
- **Comprehensive Unit Test** 20 questions, 5 parts, 70 points, with teacher answer key.
- **Resource Support Pages** How to Use This Resource and CCSS Standards Mapping.

96

PAGES

115

TOPIC PRACTICE ITEMS

5

TOPICS

2 + 1

QUIZZES + UNIT TEST

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