Solving Linear Equations in One Variable

Linear Equations: Equivalent Steps and Solution Types

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QUICK REVIEW

Keep an equation balanced by applying the same operation to both sides. Distribute before combining like terms: $3(x+2)=3x+6$. Collect variable terms and constants, then divide by the remaining coefficient. A statement such as $0=5$ means no solution; $0=0$ means every real number works. Substitute a proposed value into both original sides to verify it.

Worked example

Solve $3(x+2)=x+14$.

1. Distribute 3 across the parentheses: $3(x+2)=3x+6$. The original equation is equivalent to $3x+6=x+14$.

2. Collecting variable terms on the left and constants on the right gives $(3-1)x=14-(6)$, or $2x=8$.

3. Divide by 2: $x=4$. In the reduced equation, both sides equal 18, confirming the solution.

Answer: $x=4$.

Practice Problems

Show your thinking.

1. Solve $5x-7=18$.

2. Solve $4x+3=2x+15$.

3. Solve $2(x-4)=10$.

4. Solve $5-3(x+1)=11$.

5. Solve $\frac{x}{3}+2=7$.

6. Solve $0.5x+1.2=4.7$.

7. Solve $3(x+2)=3x+6$ and classify its solutions.

8. Solve $2(x+3)=2x+9$ and classify its solutions.

9. Solve $\frac{x-1}{2}=\frac{x+5}{3}$.

10. Does $x=-2$ solve $4x+5=-3$? Show substitution.

Answer Key

1. $x = 5$.
2. $x = 6$.
3. $x = 9$.
4. $x = -3$.
5. $x = 15$.
6. $x = 7$.
7. Infinitely many solutions.
8. No solution.
9. $x = 13$.
10. Yes; both sides are -3.

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. The variable term is $5x$, and the constant on its side is -7. Adding 7 to both sides gives $5x = 25$.

2. Collecting variable terms on the left and constants on the right gives $(5 - 0)x = 18 - (-7)$, or $5x = 25$.

3. Divide by 5: $x = 5$. In the reduced equation, both sides equal 18, confirming the solution.

Problem 2

1. Both sides contain variable terms. Subtracting $2x$ from both sides gives $2x + 3 = 15$, preserving exactly the same solutions.

2. Collecting variable terms on the left and constants on the right gives $(4 - 2)x = 15 - (3)$, or $2x = 12$.

3. Divide by 2: $x = 6$. In the reduced equation, both sides equal 27, confirming the solution.

Problem 3

1. Distribute the factor 2: $2(x - 4) = 2x - 8$. Thus the equation becomes $2x - 8 = 10$, with the subtraction included in the product.

2. Collecting variable terms on the left and constants on the right gives $(2 - 0)x = 10 - (-8)$, or $2x = 18$.

3. Divide by 2: $x = 9$. In the reduced equation, both sides equal 10, confirming the solution.

Problem 4

1. Distribute the negative factor: $-3(x + 1) = -3x - 3$. Combine $5 - 3 = 2$ to obtain $-3x + 2 = 11$.

2. Collecting variable terms on the left and constants on the right gives $(-3 - 0)x = 11 - (2)$, or $-3x = 9$.

3. Divide by -3: $x = -3$. In the reduced equation, both sides equal 11, confirming the solution.

Problem 5

1. The coefficient of x is $\frac{1}{3}$. Subtracting 2 from each side gives $\frac{x}{3} = 5$, an equivalent equation with no added constant.

2. Collecting variable terms on the left and constants on the right gives $(\frac{1}{3} - 0)x = 7 - (2)$, or $\frac{1}{3}x = 5$.

3. Divide by $\frac{1}{3}$: $x = 15$. In the reduced equation, both sides equal 7, confirming the solution.

Problem 6

1. Subtract 1.2 from both sides: $0.5x = 4.7 - 1.2 = 3.5$. The decimals terminate, so this subtraction can be performed exactly.

2. Collecting variable terms on the left and constants on the right gives $(\frac{1}{2} - 0)x = \frac{47}{10} - (\frac{6}{5})$, or $\frac{1}{2}x = \frac{7}{2}$.

3. Divide by $\frac{1}{2}$: $x = 7$. In the reduced equation, both sides equal $\frac{47}{10}$, confirming the solution.

Problem 7

1. Distribute on the left to get $3x + 6 = 3x + 6$. The two sides are already identical expressions for every real input.

2. Collecting terms gives $(3 - 3)x = 6 - (6)$, which simplifies to $0 = 0$ after the variable terms cancel.

3. The statement $0 = 0$ is true for every real x. Therefore every real number satisfies the original equation; there are infinitely many solutions.

Problem 8

1. Distribute on the left: $2x + 6 = 2x + 9$. The variable coefficients match, but the constant terms differ by $9 - 6 = 3$.

2. Collecting terms gives $(2 - 2)x = 9 - (6)$, which simplifies to $0 = 3$ after the variable terms cancel.

3. The statement $0 = 3$ is false, regardless of x. Therefore no real number can satisfy the original equation, and the solution set is empty.

Problem 9

1. Multiply both sides by 6: $3(x - 1) = 2(x + 5)$. Distributing gives $3x - 3 = 2x + 10$ without changing the solution set.

2. Collecting variable terms on the left and constants on the right gives $(3 - 2)x = 10 - (-3)$, or $1x = 13$.

3. Divide by 1: $x = 13$. In the reduced equation, both sides equal 36, confirming the solution.

Problem 10

1. Evaluate the left side at the proposed input: $4(-2) + 5 = -8 + 5 = -3$. Multiplication is completed before the addition.

2. The right side of the equation is already -3. Substitution therefore produces the true equality $-3 = -3$, with both sides matching.

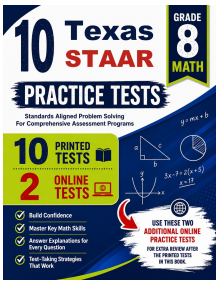
3. Thus $x = -2$ is a solution. Solving independently gives $4x = -8$ and $x = -2$, confirming the substitution check.

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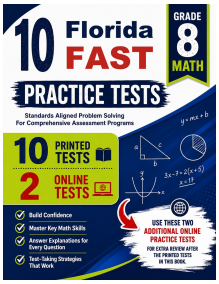
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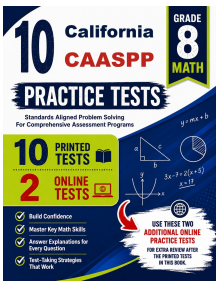
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