Equations with Special Solutions

Name: _____	Date: _____	Score: _____ / 24

Quick Review

Most linear equations have **exactly one solution**, but two special things can happen. If your steps lead to a statement that is *always true*, like $5 = 5$, the equation has **infinitely many solutions** — every number works, because both sides are really the same expression. If your steps lead to a statement that is *never true*, like $3 = 7$, the equation has **no solution**. The way to tell: simplify both sides, gather the variable terms, and see whether the variable *survives* or *cancels out*.

◇ **Example:** Solve $2(x + 3) = 2x + 6$.

⇒ Let's just simplify and see what happens. Distribute the 2 on the left side: $2x + 6 = 2x + 6$. Now we notice both sides are *identical*. If we try to gather the variable terms by subtracting $2x$ from both sides, the x's vanish completely and we're left with $6 = 6$ — a statement that is always true. That tells us *every* value of x makes the equation work, so there are infinitely many solutions.

Answer: infinitely many solutions

PRACTICE

Solve each equation. Some have one solution, no solution, or infinitely many.

1. $x + 4 = x + 4$ _____
2. $x + 2 = x + 9$ _____
3. $2x + 1 = 2x + 1$ _____
4. $3x = 3x + 5$ _____
5. $5x - 2 = 5x - 2$ _____
6. $4x + 7 = 4x - 1$ _____
7. $2(x + 1) = 2x + 2$ _____
8. $3(x + 2) = 3x + 5$ _____
9. $2x + 5 = 11$ _____
10. $4(x - 1) = 4x - 4$ _____
11. $5x + 3 = 5x$ _____
12. $6x - 2 = 2(3x - 1)$ _____
13. $3x + 8 = 20$ _____
14. $7x + 1 = 7x + 1$ _____
15. $2(x + 4) = 2x + 7$ _____
16. $5(x - 2) = 5x - 10$ _____
17. $4x - 9 = 4x + 3$ _____
18. $8x = 8x$ _____
19. $6x + 2 = 3x + 17$ _____
20. $3(2x + 1) = 6x + 3$ _____

Word Problems

21. Sam claims that doubling the sum of a number and 4 always equals twice the number plus 8. Is he right? Solve $2(x + 4) = 2x + 8$. _____
22. A puzzle says: "A number plus 5 equals the same number plus 2." Solve $x + 5 = x + 2$ and explain what it means. _____
23. Two phone plans cost the same: plan A is $3x + 10$ dollars and plan B is $3x + 25$ dollars for x months. For what x are they equal? _____
24. A teacher writes $4(x + 3) = 4x + 12$ and asks which values of x make it true. What is the answer? _____

Answer Keys

1. infinitely many
2. no solution
3. infinitely many
4. no solution
5. infinitely many
6. no solution
7. infinitely many
8. no solution
9. $x = 3$
10. infinitely many
11. no solution
12. infinitely many
13. $x = 4$
14. infinitely many
15. no solution
16. infinitely many
17. no solution
18. infinitely many
19. $x = 5$
20. infinitely many
21. infinitely many solutions; Sam is right
22. no solution
23. no solution; never equal
24. all real numbers

Step-by-Step Explanations

1. Both sides are identical, so every value of x works.
2. Subtract x: $2 = 9$ is never true, so there is no solution.
3. The two sides match exactly, so all numbers are solutions.
4. Subtract $3x$: $0 = 5$ is false, so no solution.
5. Identical sides means infinitely many solutions.
6. Subtract $4x$: $7 = -1$ is false, so no solution.
7. Distribute: $2x + 2 = 2x + 2$ — identical, so infinitely many.
8. Distribute: $3x + 6 = 3x + 5$; subtract $3x$: $6 = 5$ is false.
9. Subtract 5: $2x = 6$, then divide by 2: $x = 3$ (one solution).
10. Distribute: $4x - 4 = 4x - 4$ — identical, infinitely many.
11. Subtract $5x$: $3 = 0$ is false, so no solution.
12. Right side is $6x - 2$, matching the left, so infinitely many.
13. Subtract 8: $3x = 12$, then divide by 3: $x = 4$.
14. The sides are identical, so all values work.
15. Distribute: $2x + 8 = 2x + 7$; subtract $2x$: $8 = 7$ is false.
16. Distribute: $5x - 10 = 5x - 10$ — identical sides.
17. Subtract $4x$: $-9 = 3$ is false, so no solution.
18. Both sides are exactly the same, so every number is a solution.
19. Subtract $3x$: $3x + 2 = 17$, subtract 2: $3x = 15$, so $x = 5$.
20. Distribute: $6x + 3 = 6x + 3$ — identical, infinitely many.
21. Distribute the left side: $2x+8 = 2x+8$. The sides match for every number, so Sam's claim is always true.
22. Subtract x from both sides: $5 = 2$, which is never true. No number can make this work.
23. Set them equal: $3x + 10 = 3x + 25$. Subtract $3x$: $10 = 25$ is false, so the plans are never the same cost.
24. Distribute the left side: $4x + 12 = 4x + 12$. Both sides are identical, so every value of x is a solution.

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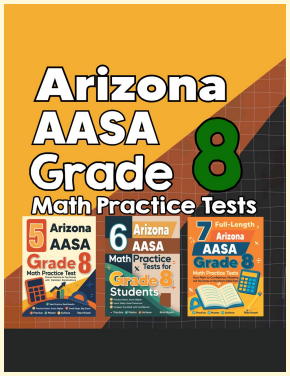

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