3.4 Solve Equations with Variables on Both Sides

Goal • Solve equations with variables on both sides.

Your Notes

VOCABULARY

Identity An equation that is true for all values of the variable

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Example 1   *Solve an equation with variables on both sides*

Solve $15 + 4a = 9a - 5$.

Solution

> Collect variables on one side of the equation and constant terms on the other to solve equations with variables on both sides.

$$15 + 4a = 9a - 5$$ Write original equation.

$$15 + 4a - \underline{4a} = 9a - \underline{4a} - 5$$ Subtract $\underline{4a}$ from each side.

$$15 = \underline{5a} - 5$$ Simplify.

$$15 + \underline{5} = \underline{5a} - 5 + \underline{5}$$ Add $\underline{5}$ to each side.

$$\underline{20} = \underline{5a}$$ Simplify.

$$\frac{\boxed{20}}{\boxed{5}} = \frac{\boxed{5a}}{\boxed{5}}$$ Divide each side by $\underline{5}$.

$$\underline{4} = a$$ Simplify.

The solution is $\underline{4}$.

CHECK

$$15 + 4a = 9a - 5$$ Write original equation.

$$15 + 4(\underline{4}) \stackrel{?}{=} 9(\underline{4}) - 5$$ Substitute $\underline{4}$ for a.

$$15 + \underline{16} \stackrel{?}{=} \underline{36} - 5$$ Multiply.

$$\underline{31} = \underline{31} \ ✓$$ Solution checks.

Example 2   *Solve an equation with grouping symbols*

Solve $4t - 12 = 6(t + 3)$.

Solution

$4t - 12 = 6(t + 3)$	Write original equation.
$4t - 12 = \underline{6t} + \underline{18}$	Distributive property
$-12 = \underline{2t} + \underline{18}$	Subtract $\underline{4t}$ from each side.
$\underline{-30} = \underline{2t}$	Subtract $\underline{18}$ from each side.
$\underline{-15} = t$	Divide each side by $\underline{2}$.

✔ *Checkpoint* Solve the equation. Check your solution.

1. $3b + 7 = 8b + 2$	**2.** $6d - 6 = \frac{3}{4}(4d + 8)$
$b = 1$	$d = 4$

Example 3   *Identify the number of solutions of an equation*

Solve the equation, if possible.

a. $4x + 5 = 4(x + 5)$ **b.** $6x - 3 = 3(2x - 1)$

Solution

a. $4x + 5 = 4(x + 5)$	Original equation
$4x + 5 = \underline{4x + 20}$	Distributive property

The equation $4x + 5 = \underline{4x + 20}$ is $\underline{\text{not true}}$ because the number $4x$ $\underline{\text{cannot be}}$ equal to 5 more than itself and $\underline{20}$ more than itself. So, the equation has $\underline{\text{no}}$ solution.

b. $6x - 3 = 3(2x - 1)$	Original equation
$6x - 3 = \underline{6x - 3}$	Distributive property

The statement $6x - 3 = \underline{6x - 3}$ is $\underline{\text{true}}$ for all values of x. So, the equation is an $\underline{\text{identity}}$.

✓ *Checkpoint* **Solve the equation, if possible.**

3. $\frac{1}{2}(4t - 6) = 2t$

no solution

4. $10m - 4 = -2(2 - 5m)$

identity

STEPS FOR SOLVING LINEAR EQUATIONS

Step 1 **Use** the __distributive property__ to remove any grouping symbols.

Step 2 __Simplify__ the expression on each side of the equation.

Step 3 **Use** the properties of equality to collect the __variable__ terms on one side of the equation and the __constant__ terms on the other side of the equation.

Step 4 **Use** the properties of equality to solve for the __variable__.

Step 5 **Check** your __solution__ in the original equation.

Homework