Lesson 7-2
Solve Equations with Variables on Both Sides

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I can...
solve equations with variables on both sides of the equal sign.

Solve & Discuss It!

Jaxson and Bryon collected an equal amount of money during a car wash. They collected cash and checks as shown below. If each check is written for the same amount, x, what is the total amount of money collected by both boys? Explain.

Reasoning How can you use an equation to show that expressions are equal?

Focus on math practices

Model with Math What expressions can you write to represent the amount of money collected by each boy? How can you use these expressions to write an equation?

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Essential Question How do you use inverse operations to solve equations with variables on both sides?

EXAMPLE 1 Solve Equations with Fractional Coefficients

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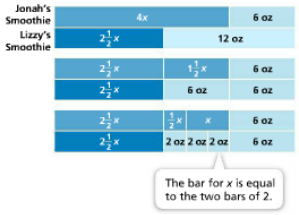
Jonah and Lizzy are making smoothies that have the same number of fluid ounces. Jonah uses 4 containers of yogurt to make his smoothie. Lizzy uses $2\frac{1}{2}$ containers of yogurt to make her smoothie. How many ounces of yogurt, x, are in each container?

ONE WAY Draw a bar diagram to represent the situation. Use the diagram to solve for x.



The bar for x is equal to the two bars of 2.

ANOTHER WAY Write an equation and use inverse operations to solve for x.

$4x + 6 = 2\frac{1}{2}x + 12$

$4x - 2\frac{1}{2}x + 6 = 2\frac{1}{2}x - 2\frac{1}{2}x + 12$ — Subtract $2\frac{1}{2}x$ from both sides to get the variable terms on one side of the equation.

$1\frac{1}{2}x + 6 = 12$

$1\frac{1}{2}x + 6 - 6 = 12 - 6$ — Subtract 6 from both sides to get all of the constant terms on one side of the equation.

$1\frac{1}{2}x = 6$

$\frac{2}{3} \cdot \frac{3}{2}x = \frac{2}{3} \cdot 6$

$x = 4$

There are 4 ounces of yogurt in each container.

Try It!

Class A was given a sunflower with a height of 8 centimeters that grows at a rate of $3\frac{1}{2}$ centimeters per week. Class B was given a sunflower with a height of 10 centimeters that grows at a rate of $3\frac{1}{4}$ centimeters per week. After how many weeks are the sunflowers the same height?

Let w = the number of weeks.

$\square w + 8 = \square w + 10$

$\square w + 8 = 10$

$\square w = \square$

$w = \square$

The sunflowers are the same height after $\square$ weeks.

Convince Me! How can you check your work to make sure the value of the variable makes the equation true? Explain.

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EXAMPLE 2 Solve Equations with Decimal Coefficients

Teresa earns a weekly salary of $925 and a 5% commission on her total sales. Ramón earns a weekly salary of $1,250 and a 3% commission on sales. What amount of sales, x, will result in them earning the same amount for the week?

$0.05x$	925
$0.03x$	1,250

$$0.05x + 925 = 0.03x + 1{,}250$$
$$0.05x - 0.03x + 925 = 0.03x - 0.03x + 1{,}250$$
$$0.02x + 925 = 1{,}250$$
$$0.02x + 925 - 925 = 1{,}250 - 925$$
$$0.02x = 325$$
$$0.02x \div 0.02 = 325 \div 0.02$$
$$x = 16{,}250$$

Use inverse operations to combine like terms on both sides of the equals sign.

Teresa and Ramón each need $16,250 of sales in order to earn the same amount for the week.

EXAMPLE 3 Solve Equations with Negative Coefficients

Kelsey withdraws $25 per week from her bank account. Each week, Kris deposits $15 of his allowance and $20 earned from dog walking into his bank account. After how many weeks will they have the same amount of money in the bank?

Kelsey's amount after x weeks

Kris's amount after x weeks

$$550 - 25x = 10 + 15x + 20x$$
$$550 - 25x = 10 + 35x$$
$$550 - 25x + 25x = 10 + 35x + 25x$$
$$550 = 10 + 60x$$
$$550 - 10 = 10 - 10 + 60x$$
$$540 = 60x$$
$$540 \div 60 = 60x \div 60$$
$$9 = x$$

Combine like terms.

After 9 weeks, Kelsey and Kris will have the same amount of money in their bank accounts.

Bank Statement

DATE	DESCRIPTION	WITHDRAWAL	DEPOSIT	BALANCE
	PREVIOUS BALANCE			$550.00
WEEK 1	WITHDRAWAL	-$25.00		$525.00
WEEK 2	WITHDRAWAL	-$25.00		$500.00
WEEK 3	WITHDRAWAL	-$25.00		$475.00

Bank Statement

DATE	DESCRIPTION	WITHDRAWAL	DEPOSIT	BALANCE
	PREVIOUS BALANCE			$10.00
WEEK 1	DEPOSIT		$35.00	$45.00
WEEK 2	DEPOSIT		$35.00	$80.00
WEEK 3	DEPOSIT		$35.00	$115.00

Try It!

Solve the equation $96 - 4.5y - 3.2y = 5.6y + 42.80$.

KEY CONCEPT

When two expressions represent equal quantities, they can be set equal to each other. Then you can use inverse operations and properties of equality to combine like terms and solve for the unknown.

$3x$	15
$4x$	12

$$3x + 15 = 4x + 12$$
$$3x - 3x + 15 = 4x - 3x + 12$$
$$15 = x + 12$$
$$15 - 12 = x + 12 - 12$$
$$3 = x$$

Do You Understand?

1. **Essential Question** How do you use inverse operations to solve equations with variables on both sides?

2. **Reasoning** Why are inverse operations and properties of equality important when solving equations? Explain.

3. **Model with Math** Cynthia earns $680 in commissions and is paid $10.25 per hour. Javier earns $410 in commissions and is paid $12.50 per hour. What will you find if you solve for x in the equation $10.25x + 680 = 12.5x + 410$?

Do You Know How?

4. Maria and Liam work in a banquet hall. Maria earns a 20% commission on her food sales. Liam earns a weekly salary of $625 plus a 10% commission on his food sales. What amount of food sales will result in Maria and Liam earning the same amount for the week?

$20\% \cdot f = 10\% \cdot f + 625$

$0.2f = 0.1f + 625$

see notes

5. Selma's class is making care packages to give to victims of a natural disaster. Selma packs one box in 5 minutes and has already packed 12 boxes. Her friend Trudy packs one box in 7 minutes and has already packed 18 boxes. How many more minutes does each need to work in order to have packed the same number of boxes?

6. Solve the equation $-\frac{2}{5}x + 3 = \frac{2}{3}x + \frac{1}{3}$.

7. Solve the equation $-2.6b + 4 = 0.9b - 17$.

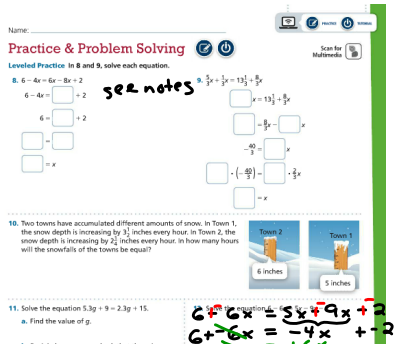
4) $0.2f = 0.1f + 625$

$-0.1f \quad = -0.1f$

$0.1f = 625$

$\frac{0.1f}{0.1} = \frac{625}{0.1}$

$f = 6{,}250$



Name:

Practice & Problem Solving

Leveled Practice In 8 and 9, solve each equation.

8. $6 - 4x = 6x - 8x + 2$ see notes

9. $\frac{3}{4}x + \frac{1}{2}x = 13\frac{1}{2} + \frac{5}{8}x$

10. Two towns have accumulated different amounts of snow. In Town 1, the snow depth is increasing by $3\frac{1}{2}$ inches every hour. In Town 2, the snow depth is increasing by $2\frac{1}{2}$ inches every hour. In how many hours will the snowfalls of the towns be equal?

Town 2: 6 inches; Town 1: 5 inches

11. Solve the equation $5.3g + 9 = 2.3g + 15$.

a. Find the value of g.

b. Explain how you can check that the value you found for g is correct. If your check does not work, does that mean that your result is incorrect? Explain.

13. Model with Math A town's population is 43,425. About 125 people move out of the town each month. Each month, 200 people on average move into town. A nearby town has a population of 45,000. It has one person move out of the town each month. Instead, how many months will the population of the towns be equal? Write an equation that represents this situation and solve.

$6 + 6x = 5x + 9x + 2$

$6 + 6x = -4x + 2$

$+6x \quad = +6x$

$6 = 2x + 2$

$-2 \quad = \quad -2$

$\frac{4}{2} = \frac{2x}{2}$

$x = 4$

Town A

Town B

$m =$

Town A

Town B

$43{,}425 + 200m + 125m = 45{,}000 + 150m$

$43{,}425 + 75m = 45000 + 150m$

$+150m \quad = \quad +150m$

$43{,}425 + 225m = 45000$

$-43{,}425 \quad = -43{,}425$

$\frac{225m}{225} = \frac{1575}{225}$

$m = 7$

In 7 months, the population of both towns will be equal.

8) $6 + -4x = +6x + -8x + 2$

$6 + -4x = -2x + 2$

$+ +2x = + +2x$

$6 + -2x = + 2$

$+ -6 = + -6$

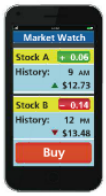
$-2x = -4$

$\frac{-2x}{-2} = \frac{-4}{-2}$

$x = +2$

14. Veronica is choosing between two health clubs. After how many months will the total cost for each health club be the same?

15. **Higher Order Thinking** The price of Stock A at 9 A.M. was $12.73. Since then, the price has been increasing at the rate of $0.06 per hour. At noon, the price of Stock B was $13.48. It begins to decrease at the rate of $0.14 per hour. If the stocks continue to increase and decrease at the same rates, in how many hours will the prices of the stocks be the same?



Assessment Practice

16. In an academic contest, correct answers earn 12 points and incorrect answers lose 5 points. In the final round, School A starts with 165 points and gives the same number of correct and incorrect answers. School B starts with 65 points and gives no incorrect answers and the same number of correct answers as School A. The game ends with the two schools tied.

PART A

Which equation models the scoring in the final round and the outcome of the contest?

Ⓐ $12x + 5x - 165 = -12x + 65$

Ⓑ $12x - 5x + 165 = 12x + 65$

Ⓒ $5x - 12x + 165 = 12x + 65$

Ⓓ $12x - 5x - 165 = 12x + 65$

PART B

How many answers did each school get correct in the final round?