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7.4 Solving Two-Step Equations

STATE STANDARDS
MA.6.A.3.2

Essential Question What is a "two-step" equation? How can you solve a two-step equation?

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Sir Isaac Newton's Third Law of Motion

For every action, there is an equal and opposite reaction.

A teddy bear
Sits in a chair.
Down pushes Teddy.

Chair says "I'm ready".
With a confident "Yup"
The chair pushes up.

Sir Isaac Newton
(1642–1727)

Because $5 - 5 = 0$, neither the bear nor the chair moves.

1 ACTIVITY: Identifying Inverse Operations

Work with a partner. Describe how you can "undo" the operation in blue.

a. Sample: $3x + 5 = 14$

Subtract 5 from each side. →

$$\begin{array}{rr} 3x + 5 = & 14 \\ -5 & -5 \\ \hline 3x = & 9 \end{array}$$

b. $2n - 6 = 4$ **c.** $2(m + 3) = 6$ **d.** $\frac{x - 2}{4} = 1$

2 ACTIVITY: Solving Two-Step Equations

Work with a partner. Solve each equation in Activity 1. Use substitution to check your answer.

a. $3x + 5 = 14$ **b.** $2n - 6 = 4$

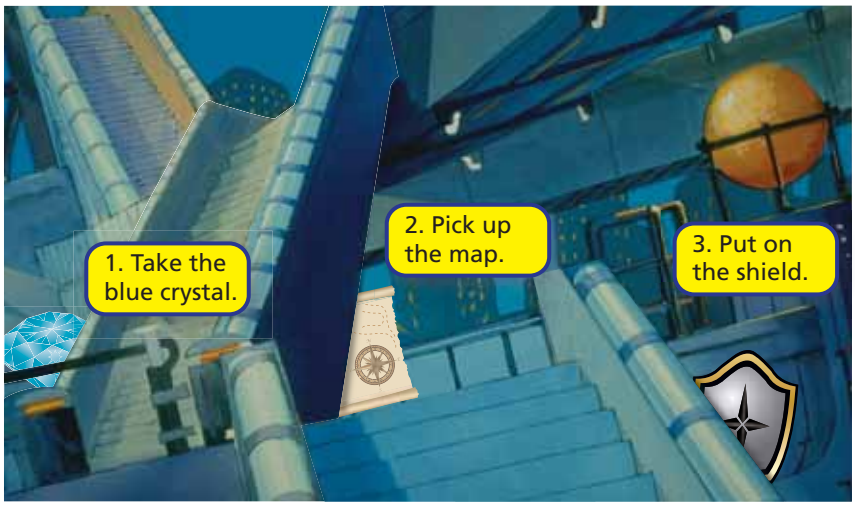
c. $2(m + 3) = 6$ **d.** $(x - 2) \div 4 = 1$

3 ACTIVITY: Analyzing a Video Game

Work with a partner. For Level 1 in a video game, you have to accomplish a sequence of challenges. Then, you have to leave the level by undoing the challenges in reverse order.

a. Describe the challenges in order.

b. Describe the order of challenges to get out of the level.



c. This is Level 1. Make up challenges for Level 2. Draw the level and describe the reverse order to get back out of the level.

What Is Your Answer?

4. **IN YOUR OWN WORDS** What is a "two-step" equation? How can you solve a two-step equation? Give an example to show how your procedure works.

"Hey, it says 'Close this flap first,' but they closed it last!"

Practice Use what you learned about solving two-step equations to complete Exercises 5–7 on page 301.

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7.4 Lesson

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Key Vocabulary
two-step equation, *p. 298*
terms, *p. 300*
like terms, *p. 300*

Key Idea

Solving Two-Step Equations

A **two-step equation** is an equation that contains two different operations. To solve a two-step equation, use inverse operations to isolate the variable.

EXAMPLE 1 Solving Two-Step Equations

a. Solve $2x - 5 = 13$.

	$2x - 5 = 13$	Write the equation.
Step 1: Undo the subtraction. →	$+5 \quad +5$	Add 5 to each side.
	$2x = 18$	Simplify.
Step 2: Undo the multiplication. →	$\frac{2x}{2} = \frac{18}{2}$	Divide each side by 2.
	$x = 9$	Simplify.

∴ The solution is $x = 9$.

Check

$2x - 5 = 13$

$2(9) - 5 \stackrel{?}{=} 13$

$18 - 5 \stackrel{?}{=} 13$

$13 = 13$ ✓

Common Error

Do not get confused when the variable is on the right side of the equation. The equation $4 = \frac{y}{8} + 1$ is solved the same way as the equation $\frac{y}{8} + 1 = 4$.

b. Solve $4 = \frac{y}{8} + 1$.

	$4 = \frac{y}{8} + 1$	Write the equation.
	$-1 \quad -1$	Subtract 1 from each side.
	$3 = \frac{y}{8}$	Simplify.
	$3 \cdot 8 = \frac{y}{8} \cdot 8$	Multiply each side by 8.
	$24 = y$	Simplify.

∴ The solution is $y = 24$.

Check

$4 = \frac{y}{8} + 1$

$4 \stackrel{?}{=} \frac{24}{8} + 1$

$4 \stackrel{?}{=} 3 + 1$

$4 = 4$ ✓

On Your Own

Now You're Ready
Exercises 5–16

Solve the equation. Check your solution.

1. $5c - 1 = 14$
2. $\frac{h}{4} + 9 = 20$
3. $3(x - 1) = 9$

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EXAMPLE 2 Standardized Test Practice

You pay \$80 for a game system. The monthly rental fee for games is m dollars. Your cost for the year is \$188. Using the equation $12m + 80 = 188$, how much is your monthly fee?

Ⓐ \$8 Ⓑ \$9 Ⓒ \$12 Ⓓ \$22

$12m + 80 = 188$ Write the equation.

$-80 \quad -80$ Subtract 80 from each side.

$12m = 108$ Simplify.

$\frac{12m}{12} = \frac{108}{12}$ Divide each side by 12.

$m = 9$ Simplify.

Your monthly fee is \$9. The correct answer is Ⓑ.

EXAMPLE 3 Real-Life Application

You and your friend rent a tandem bike. Your total cost is \$42. Write and solve an equation to find the number of extra hours you rented the bike.

Words The cost for three hours plus the cost for each extra hour times the number of extra hours is the total cost.

Variable Let h be the number of extra hours.

Equation $24 + 4.5 \cdot h = 42$

$24 + 4.5h = 42$ Write the equation.

$-24 \quad -24$ Subtract 24 from each side.

$4.5h = 18$ Simplify.

$\frac{4.5h}{4.5} = \frac{18}{4.5}$ Divide each side by 4.5.

$h = 4$ Simplify.

You rented the bike for 4 extra hours.

On Your Own

Now You're Ready
Exercises 19 and 20

4. You and your friend rent a kayak. It costs \$40 for the first 4 hours and \$7.50 for each extra hour. Your total cost is \$62.50. Write and solve an equation to find the number of extra hours you rented the kayak.

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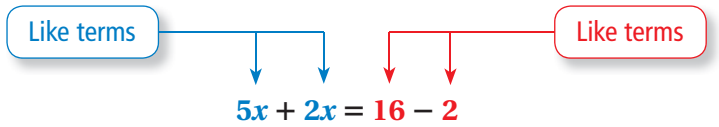
Key Idea

Terms and Like Terms

In the equation $5x + 2x = 16 - 2$, $5x$, $2x$, 16, and 2 are called **terms**. $5x$ and $2x$ are called **like terms**. 16 and 2 are also like terms.



To solve, use the Distributive Property to *combine* like terms.

EXAMPLE 4 Solving Equations by Combining Like Terms

a. Solve the equation $3x + 6x = 45$.

$3x + 6x = 45$ Write the equation.

$(3 + 6)x = 45$ Use the Distributive Property to combine like terms.

$9x = 45$ Simplify.

$\frac{9x}{9} = \frac{45}{9}$ Divide each side by 9.

$x = 5$ Simplify.

∴ The solution is $x = 5$.

Check

$3x + 6x = 45$

$3(5) + 6(5) \stackrel{?}{=} 45$

$15 + 30 \stackrel{?}{=} 45$

$45 = 45$ ✓

b. Solve the equation $5a - 2a = 6$.

$5a - 2a = 6$ Write the equation.

$(5 - 2)a = 6$ Use the Distributive Property to combine like terms.

$3a = 6$ Simplify.

$\frac{3a}{3} = \frac{6}{3}$ Divide each side by 3.

$a = 2$ Simplify.

∴ The solution is $a = 2$.

Check

$5a - 2a = 6$

$5(2) - 2(2) \stackrel{?}{=} 6$

$10 - 4 \stackrel{?}{=} 6$

$6 = 6$ ✓

On Your Own

Now You're Ready
Exercises 21–29

Solve the equation. Check your solution.

5. $2x + 5x = 7$ **6.** $7c + 4c = 22$ **7.** $3w - 2w = 9$

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7.4 Exercises

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Vocabulary and Concept Check

1. **VOCABULARY** Why is the equation $5x - 12 = 23$ called a *two-step equation*?
2. **VOCABULARY** Identify the *like terms* in the equation $3x + 4x = 21$. Explain why they are like terms.
3. **WHICH ONE DOESN'T BELONG?** Which one does *not* belong with the other three? Explain your reasoning.

$16x - 5x = 22$ | $11x = 22$ | $11(x - 1) = 22$ | $(16 - 5)x = 22$

4. **WRITING** Describe a process you can use to combine the like terms in the equation $16x - 5x = 22$.

Practice and Problem Solving

Solve the equation. Check your solution.

1 5. $8 + \frac{z}{4} = 23$

6. $\frac{a}{3} - 9 = 12$

7. $4c - 7 = 17$

8. $6 + \frac{x}{5} = 31$

9. $4b - 12 = 0$

10. $12w - 8 = 28$

11. $\frac{t}{19} - 9 = 13$

12. $131 = 7s + 12$

13. $42 + \frac{t}{9} = 54$

14. $2.4a + 8 = 27.2$

15. $\frac{s}{3} - 0.6 = 1.2$

16. $5t - 17.2 = 16.3$

ERROR ANALYSIS **Describe and correct the error in solving the equation.**

17.

$$4 = \frac{y}{8} + 1$$
$$32 = y + 1$$
$$31 = y$$

18.

$$28y + 7 = 21$$
$$28y = 28$$
$$y = 1$$

2 3 19. **HIKING** You go on a hike with your uncle. Your backpack weighs 25 pounds. Your uncle is a math teacher and he tells you that your pack is 7 pounds less than twice as heavy as his pack. Use the equation $2p - 7 = 25$ to find the weight of your uncle's backpack.

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20. HELICOPTER TOUR You pilot a helicopter tour from Orlando to West Palm Beach along the coast. On the return trip, you fly straight back to Orlando at a steady speed in 1.3 hours. The total distance is 313 miles. Write and solve an equation to find your speed from West Palm Beach to Orlando.

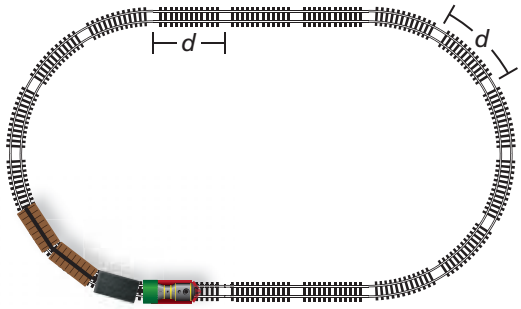
Solve the equation. Check your solution.

21. $c + 3c = 16$ **22.** $2x + 6x = 24$ **23.** $51 = 15y + 2y$

24. $6z - 5z = 20$ **25.** $18 = 8a - 5a$ **26.** $7t - t = 54$

27. $3.2x - 1.2x = 8$ **28.** $4.8 = 1.8n + 0.6n$ **29.** $15 = 3.5s - 2s$

30. COMPUTERS You help the owner of a computer store load monitors into a truck. You load 10 monitors and the owner loads 7 monitors. The total weight of the monitors is 765 pounds. Write and solve an equation to find the weight of each monitor.



31. MODEL TRAIN The model train track has 6 straight sections and 12 curved sections. The total length of the track is 351 centimeters. Each section is d centimeters long. Write and solve an equation to find the length of each section of the track.

Solve the equation. Check your solution.

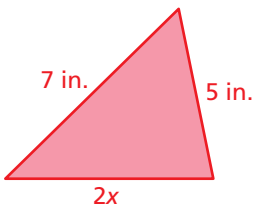
32. $32y + 10 - 2 = 24$ **33.** $11 + \frac{g}{4} - 3 = 12$ **34.** $9.2 = 5.7 + \frac{h}{6} + 0.4$

35. $125 = 5(3 + x)$ **36.** $12(z - 7) = 60$ **37.** $\frac{z - 3}{10} = 10$

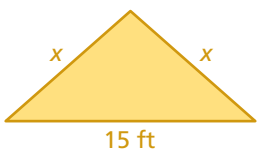
38. $7 = \frac{(5 + a)}{4}$ **39.** $6(11 + s) = 96$ **40.** $15 = \frac{22 + t}{3}$

Write and solve an equation to find x.

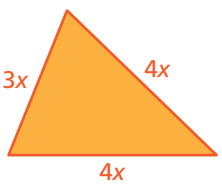
41. Perimeter = 18 inches



42. Perimeter = 35 feet



43. Perimeter = 132 yards



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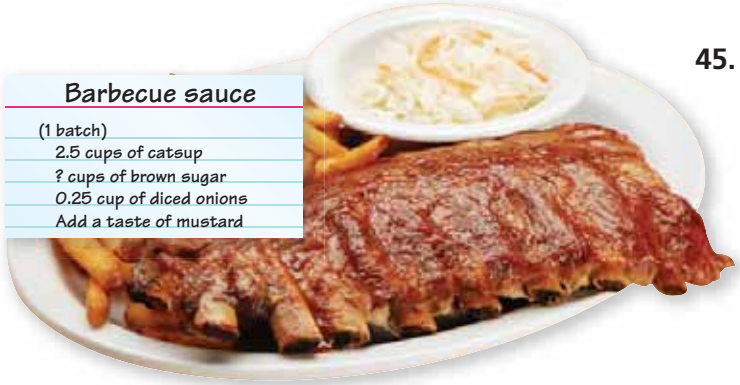
44. **TRADING CARDS** You have 80 trading cards. Your friend says that you have 16 less than 4 times the number of cards that she has. You say that you have 8 more than 3 times as many cards as she has. Can you both be right? Explain.



45. **RECIPE** You want to make 3 batches of barbecue sauce, but you can't remember how much brown sugar you need. You know that 4 batches make about 17 cups of sauce. How much brown sugar do you need for 3 batches?

46. **TESTS** After four 100-point tests, you have 365 points.

a. How many points do you need to score on your next 100-point test to have a mean score of 92 points?

b. Would a mean score of 92 points after 5 tests be *greater than* or *less than* your mean score after 4 tests?

c. Your score on each test is a whole number. Is it possible that your mean score does *not* change after the fifth test? Explain.

47. **HARDCOVER BOOK** Each page of the book has the same thickness t.

a. What other piece of information do you need to find the thickness of one page?

b. Choose a reasonable number for the missing piece of information.

c. Use the number from part (b) to write and solve an equation to find the thickness t of one page. Does your answer seem reasonable?

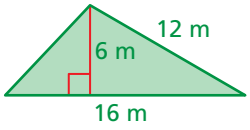
48. **Puzzle** A teacher has a box of pens and pencils. There are 8 more pencils than pens. After students take 1 pen and 5 pencils from the box, there are 26 pens and pencils left in the box. How many pens are in the box now? How many pencils?

Fair Game Review What you learned in previous grades & lessons

Write the percent as a fraction or mixed number in simplest form. SECTION 4.1

49. 85% **50.** 86% **51.** 128% **52.** 0.75%

53. **MULTIPLE CHOICE** Use a formula to find the area of the triangle. SECTION 1.5



Ⓐ 36 m^2 Ⓑ 48 m^2 Ⓒ 72 m^2 Ⓓ 96 m^2