

Solve Problems with Equations

You know how to compute with rational numbers and write and solve one-step equations. Take a look at this problem.

Mr. Lombardo took his two children to a water park. He used the coupon shown below to buy one adult ticket. The price of admission for all three family members was \$76. What was the price of each child's ticket?

This coupon is good for one adult ticket to
World of Water at a price of \$28.00.

You save \$4.00!

Explore It

Use the math you already know to solve the problem.

- What ticket price do you know? How much is that ticket? Explain.

- What other information is given in the problem?

- How can you find the price of the two children's tickets? Show how to find the answer.

- If you know the price of two children's tickets, how can you find the price of one child's ticket?

- What is the price for each child's ticket? Show your work.



Find Out More

You can also solve the problem from the previous page by writing and solving an equation. You know that the price of the adult ticket plus the price of two children's tickets is \$76.

$$(\text{price of adult ticket}) + (\text{number of children}) \cdot (\text{price of child's ticket}) = \text{total cost}$$

$$\begin{array}{ccccccc} \downarrow & & \downarrow & & \downarrow & & \downarrow \\ \$28 & + & 2 & \cdot & p & = & \$76 \end{array}$$

You can write this as $28 + 2p = 76$. This equation includes two operations, so it is a two-step equation.

Solve the equation for p , and compare to the operations used in the arithmetic solution on the previous page.

$28 + 2p = 76$ $28 - 28 + 2p = 76 - 28$ $2p = 48$	Using arithmetic, the first operation was to subtract the price of the adult ticket from the total cost. In the equation, subtract 28 from both sides and simplify.
$2p \div 2 = 48 \div 2$ $p = 24$	The second operation was to divide the price for two tickets (\$48) by 2 to find the price for 1 ticket. In the equation, divide both sides by 2 and simplify.

To solve an equation, you perform operations so that the variable ends up alone on one side. Remember, the expressions on opposite sides of the equal sign are equivalent. If you perform an operation that changes the value of the expression on one side, you need to perform the same operation on the other side.



Reflect

- 1 Explain the steps you could use to solve $3y + 6 = 30$ to find y .



Read the problem below. Then explore different ways to solve two-step problems that involve fractions.

Marvin made some candles that each weighed $\frac{3}{4}$ pound. He shipped them in a box that weighed 3 pounds. The total weight of the box filled with candles was 12 pounds. How many candles did Marvin ship in the box?

**Picture It**

You can use arithmetic to solve a two-step problem that involves fractions.

Total weight of box and candles: 12 lb

Weight of box: 3 lb

Weight of all candles: $12 \text{ lb} - 3 \text{ lb} = 9 \text{ lb}$

Weight of all candles \div weight of one candle: $9 \div \frac{3}{4} = 9 \cdot \frac{4}{3}$, or 12

There are 12 candles in the box.

**Model It**

You can write an equation to solve a two-step problem that involves fractions.

Let c = the number of candles that Marvin shipped in the box.

$$\begin{array}{ccccccc} \text{(weight of 1 candle)} \cdot \text{(number of candles)} + \text{(weight of box)} & = & \text{total weight} & & & & \\ \downarrow & & \downarrow & & \downarrow & & \downarrow \\ \frac{3}{4} & \cdot & c & + & 3 & = & 12 \end{array}$$

To find the value of c , get c by itself on one side of the equation.

$$\frac{3}{4}c + 3 = 12$$

$$\frac{3}{4}c + 3 - 3 = 12 - 3$$

$$\frac{3}{4}c = 9$$

$$\frac{3}{4}c \cdot \frac{4}{3} = 9 \cdot \frac{4}{3}$$

$$c = 12$$



Connect It

Now you will analyze the solution from the previous page.

- 2 What is the first operation performed in the arithmetic solution and in solving the equation? _____
- 3 How does the first operation get you closer to isolating c on one side of the equation?

- 4 Why do you multiply both sides by $\frac{4}{3}$ next?

- 5 What does multiplying 9 by $\frac{4}{3}$ represent in the arithmetic solution?

- 6 Explain how to solve an equation that includes a variable with a coefficient added to a constant.



Try It

Use what you just learned to solve these problems. Show your work.

- 7 Solve the equation. Show all steps in the solution.

$$\frac{2}{3}x + 1 = 5$$

- 8 The formula to convert degrees Celsius to degrees Fahrenheit is $\frac{9}{5}C + 32 = F$. Use this equation to find the Celsius equivalent of 86°F .



Read the problem below. Then explore different ways to solve multi-step problems that involve decimals.

Lydia is saving money for her vacation. So far she has \$82.50. Each week she sets aside 25% of her paycheck for the vacation. After 8 weeks, Lydia has \$338.50 saved for vacation. What is the amount of Lydia's weekly paycheck?

**Model It**

You can use arithmetic to solve a multi-step problem that involves decimals.

Total amount saved: \$338.50

Amount already saved: \$82.50

Amount she saved from 8 paychecks: $\$338.50 - \$82.50 = \$256$

Amount she saved each week: $\$256 \div 8 = \32

Amount of weekly paycheck: 25% is $\frac{1}{4}$, so Lydia's weekly paycheck is $4 \times \$32$, or \$128.

**Model It**

You can write an equation to help solve a multi-step problem that involves decimals.

amount already saved + (number of weeks)(savings each week) = total amount saved

$$\begin{array}{ccccccc} & \downarrow & & \downarrow & & \downarrow & & \downarrow \\ & \$82.50 & + & 8 & (0.25 \cdot x) & = & \$338.50 \end{array}$$

$$82.5 + 8(0.25x) = 338.5$$

$$82.5 + 2x = 338.5$$

25% of paycheck
(unknown)



Connect It

Now you will solve the equation for the problem on the previous page.

- 9 What can you do to get $2x$ alone on the left side of the equation? Fill in the blanks to show how, and then simplify.

$$82.5 - \underline{\hspace{2cm}} + 2x = 338.5 - \underline{\hspace{2cm}}$$

$$\underline{\hspace{2cm}}x = \underline{\hspace{2cm}}$$

- 10 What can you do to get the x alone on the left side of the equation? Fill in the blanks to show how, and then simplify.

$$2x \div \underline{\hspace{2cm}} = 256 \div \underline{\hspace{2cm}}$$

$$x = \underline{\hspace{2cm}}$$

- 11 Compare the arithmetic solution to solving with the equation. How are the methods similar? How are they different?

- 12 Describe how to solve an equation with two or more steps.



Try It

Use what you just learned to solve these problems. Show your work.

- 13 Solve. Show each step.

$$0.06x - 0.18 = 0.12$$

- 14 Solve. Show each step.

$$5.4 - 6x = -6$$



The student analyzed the information in the problem and then wrote and solved an equation.



Pair/Share

How can you check that your answer is correct?

Make sure you define the variable before you write an equation.



Pair/Share

How much more money would Mark need if he wants to ride 10 rides?

Study the student model below. Then solve problems 15–17.

Student Model

Josh walked a total of 5 miles today. First he walked 1 mile from his house to the park. Then he walked laps around the $\frac{3}{4}$ -mile trail at the park. Finally, he walked back home. How many laps did Josh walk around the trail?

You can use an equation to solve the problem.

1 mile to park + 1 mile home = 2 miles, x = number of laps

$$2 + \frac{3}{4}x = 5$$

$$2 - 2 + \frac{3}{4}x = 5 - 2$$

$$\frac{3}{4}x = 3$$

$$\frac{3}{4}x \cdot \frac{4}{3} = 3 \cdot \frac{4}{3}$$

$$x = 4$$

Solution: Josh walked 4 laps around the trail.

- 15** An amusement park reduced its admission price to \$15.50 per day, but now charges \$1.50 per ride. Mark has \$26 to spend on admission and rides. Write and solve an equation to find how many rides Mark can ride in one day.

Show your work.

Solution: _____



- 16 Theo made a donation to a charity. His grandfather agreed to add \$4.00 to Theo’s donation amount and then donate half of that sum. Theo’s grandfather donated \$4.25. Write and solve an equation to find the amount of Theo’s donation.

Show your work.

Solution: _____

- 17 The Hair Care Salon charges a stylist \$30 per day to rent a station at the salon. Rhonda, a stylist, makes \$10.50 on each haircut. Which equation will help her decide how many haircuts she must give in one day to make \$138 after paying rent for her station? Circle the correct answer.

- A $30h - 10.5 = 138$
- B $10.5h + 30 = 138$
- C $30h + 10.5 = 138$
- D $10.5h - 30 = 138$

Lonnie chose **B** as the correct answer. How did he get that answer?

Will you use a decimal or a fraction to represent one half?



Pair/Share

Can you solve the problem in a different way? Discuss.

When a business is charged rent to operate, how does it affect the amount of money made?



Pair/Share

Talk about how you would find the correct answer, and then identify what Lonnie might have done incorrectly.



Solve the problems. Mark your answers to problems 1–3 on the Answer Form to the right. Be sure to show your work.

Answer Form

1 (A) (B) (C) (D)

2 (A) (B) (C) (D)

3 (A) (B) (C) (D)

Number
Correct

/ 3

- 1** A rectangular garden sits next to a house. Three sides of the garden are fenced, and the fourth side is the house. The length of the garden is 9 meters. A total of 21.5 meters of fencing is used. If w stands for the width of the garden in meters, which equation can be used to find its width?
- A** $2w + 9 = 21.5$
- B** $2w + 18 = 21.5$
- C** $2w - 21.5 = 9$
- D** $2w + 21.5 = 18$
- 2** If 10 is first subtracted from both sides of the equation $\frac{3}{4}x + 10 = 25$, what would you do next to solve for x ?
- A** Subtract $\frac{4}{3}$ from both sides of the equation.
- B** Multiply $\frac{4}{3}$ by $\frac{3}{4}x$ and by 15.
- C** Subtract $\frac{3}{4}$ from both sides of the equation.
- D** Multiply $\frac{3}{4}$ by $\frac{3}{4}x$ and by 15.
- 3** Lane stacks some books in a storage crate that weighs 5 pounds. Each book weighs $1\frac{3}{8}$ pounds. The total weight of the crate with all the books in it is 53 pounds. Which equation CANNOT be used to find n , the number of books in the crate?
- A** $1\frac{3}{8}n = 48$
- B** $1.375n + 5 = 53$
- C** $1\frac{3}{8}n - 5 = 53$
- D** $1.375n = 48$



- 4** Banners at the school store were on sale for \$3 off the regular price. Louis bought 4 banners on sale and paid a total of \$18. Write and solve an equation to find the regular price of one banner.

Show your work.

Answer _____

- 5** The length of each of the two congruent sides of an isosceles triangle is $2x + 3$. The length of the third side is $2x$. Its perimeter is 36 centimeters. Draw and label this triangle. Write an equation that could be used to find the value of x . Solve for x and then find the length of all three sides.

Show your work.

Answer _____



Self Check

Go back and see what you can check off on the Self Check on page 125.

Solve Problems With Equations

LESSON OBJECTIVES

- Solve problems involving rational numbers.
- Convert among fractions, decimals, and percents as needed to solve the problem.
- Estimate the reasonableness of answers.
- Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p , q , and r are integers, fractions, or decimals.
- Solve using estimates for the fractions and decimals first to get an estimated solution.

PREREQUISITE SKILLS

- Fluently compute with rational numbers.
- Convert among forms of rational numbers.
- Estimate/discuss reasonableness of answers.
- Solve one-step equations.

VOCABULARY

There is no new vocabulary.

THE LEARNING PROGRESSION

In Grade 6, students solved one-step real-world and mathematical problems leading to equations of the form $x + p = q$ and $px = q$, for cases where x , p , and q were all nonnegative rational numbers.

In this lesson, students solve multi-step problems leading to equations of the form $px + q = r$ and $p(x + q) = r$ without the restrictions they had in Grade 6.

In Grade 8, students will solve real-world and mathematical problems leading to linear equations and also to two linear equations in two variables.

Ready Toolbox

Teacher-Toolbox.com

	Prerequisite Skills	7.EE.4.a 7.EE.3
Ready Lessons	✓	✓
Tools for Instruction		✓
Interactive Tutorials	✓	✓

CCLS Focus

7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies.

7.EE.4. Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations to solve problems by reasoning about the quantities.

- a.** Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p , q , and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach.

ADDITIONAL STANDARDS: 7.NS.3, 7.G.6 (see page A32 for full text)

STANDARDS FOR MATHEMATICAL PRACTICE: SMP 1–7 (see page A9 for full text)

**AT A GLANCE**

Students read a two-step word problem and answer a series of questions designed to help them solve it using arithmetic.

STEP BY STEP

- Tell students that this page models how to solve a two-step word problem.
- Have students read the problem at the top of the page.
- Work through Explore It as a class.
- Ask, *How does the phrase “You save \$4.00” apply to the problem?* [It does not.] Have students name the other information given in the problem.
- Ask student pairs or groups to explain their answers for the remaining questions.

SMP Tip: As students solve a variety of problems, they develop skills in making sense of problems and persevering in solving them (*SMP 1*). Encourage them to read the problem carefully, list the information given, and state what they need to find out. Then help them decide how they can apply the math they already know to solve it.

Lesson 16 Part 1: Introduction

Solve Problems with Equations

 CCL5
 7.EE.3
 7.EE.4.a

You know how to compute with rational numbers and write and solve one-step equations. Take a look at this problem.

Mr. Lombardo took his two children to a water park. He used the coupon shown below to buy one adult ticket. The price of admission for all three family members was \$76. What was the price of each child's ticket?

This coupon is good for one adult ticket to
World of Water at a price of \$28.00.
You save \$4.00!

Explore It

Use the math you already know to solve the problem.

- What ticket price do you know? How much is that ticket? Explain.
Mr. Lombardo used a coupon that says the price for an adult ticket is \$28.
- What other information is given in the problem?
The price for all three tickets is \$76.
- How can you find the price of the two children's tickets? Show how to find the answer.
Subtract the price of the adult ticket from the total cost to find the cost of two children's tickets: $\$76 - \$28 = \$48$.
- If you know the price of two children's tickets, how can you find the price of one child's ticket?
Divide the price for two tickets by 2 to find the price of one ticket.
- What is the price for each child's ticket? Show your work.
 $\$48 \div 2 = \24 ; Each child's ticket cost \$24.

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Mathematical Discourse

- *Once you figure out the price of a child's ticket, how can you check your answer?*
Students should describe how they would double the price of a child's ticket and then add the price of an adult ticket. If the total is \$76, the answer is correct.
- *Why is it important to check your work?*
Students' responses will vary.

**AT A GLANCE**

Students use an equation to solve the problem from the previous page.

STEP BY STEP

- Read Find Out More as a class.
- Have students state a word equation that shows how to find the total cost of the tickets. Write it on the board. Ask, *Which quantity are you trying to find?* [the cost of 1 child's ticket] Circle it.
- Compare the word equation with the equation shown. Have students explain how they are related.
- Work through the solution of the equation. Compare it with the arithmetic solution on the previous page.
- Students should notice that the equation in the reflect question has two steps, so their explanation should include two steps.

Hands-On Activity**Use a concrete model to solve an equation.**

Materials: paper clips, sticky notes, paper

- Write $3x + 2 = 8$ on the board. Have students write an equal sign on their paper and model the equation using 3 sticky notes and 2 paper clips on the left of it and 8 paper clips on the right of it.
- Note that the equal sign means that both sides must be treated equally. Have students remove 2 paper clips from the left side of the equal sign and then from the right side. Say that if you divide the sticky notes into 3 parts, you must divide the remaining paper clips into 3 parts. Have students explain why x must equal 2.
- Check the equation by rebuilding the model and placing 2 paper clips on each sticky note. Have students confirm that both sides have the same number of paper clips.
- Repeat with equations such as $2x + 7 = 15$ [$x = 4$] and $5x + 3 = 18$. [$x = 3$]

Find Out More

You can also solve the problem from the previous page by writing and solving an equation. You know that the price of the adult ticket plus the price of two children's tickets is \$76.

$$(\text{price of adult ticket}) + (\text{number of children}) \cdot (\text{price of child's ticket}) = \text{total cost}$$

$$\begin{array}{ccccccc} \downarrow & & \downarrow & & \downarrow & & \downarrow \\ \$28 & + & 2 & \cdot & p & = & \$76 \end{array}$$

You can write this as $28 + 2p = 76$. This equation includes two operations, so it is a two-step equation.

Solve the equation for p , and compare to the operations used in the arithmetic solution on the previous page.

$\begin{array}{l} 28 + 2p = 76 \\ 28 - 28 + 2p = 76 - 28 \\ 2p = 48 \end{array}$	Using arithmetic, the first operation was to subtract the price of the adult ticket from the total cost. In the equation, subtract 28 from both sides and simplify.
$\begin{array}{l} 2p \div 2 = 48 \div 2 \\ p = 24 \end{array}$	The second operation was to divide the price for two tickets (\$48) by 2 to find the price for 1 ticket. In the equation, divide both sides by 2 and simplify.

To solve an equation, you perform operations so that the variable ends up alone on one side. Remember, the expressions on opposite sides of the equal sign are equivalent. If you perform an operation that changes the value of the expression on one side, you need to perform the same operation on the other side.

Reflect

- 1 Explain the steps you could use to solve $3y + 6 = 30$ to find y .

Possible answer: First, subtract 6 from both sides of the equation and simplify:

$$3y + 6 - 6 = 30 - 6; 3y = 24. \text{ Next, divide both sides of the equation by 3 and}$$

$$\text{simplify: } 3y \div 3 = 24 \div 3; y = 8.$$

Real-World Connection

Encourage students to think about everyday situations in which people must solve real-world problems using mathematics.

Examples: building contractors figuring out how much of the materials are needed, pharmacists figuring out dosages, store managers figuring out how much to charge for merchandise, accountants figuring out taxes, engineers figuring out designs

**AT A GLANCE**

Students read a word problem and explore two methods to solve it.

STEP BY STEP

- Read the problem at the top of the page as a class.
- Have students list the information given and state what the problem is asking for.
- Look at the solution shown in Picture It. Have students read through the steps, explaining why each operation is used.
- Study the solution shown in Model It. Ask students to explain why the equation reflects the information in the problem.
- Work through the solution of the equation. Discuss why multiplying both sides by $\frac{4}{3}$ is the same as dividing both sides by $\frac{3}{4}$.
- Compare the answers in Picture It and in Model It.



Read the problem below. Then explore different ways to solve two-step problems that involve fractions.

Marvin made some candles that each weighed $\frac{3}{4}$ pound. He shipped them in a box that weighed 3 pounds. The total weight of the box filled with candles was 12 pounds. How many candles did Marvin ship in the box?

Picture It

You can use arithmetic to solve a two-step problem that involves fractions.

Total weight of box and candles: 12 lb

Weight of box: 3 lb

Weight of all candles: $12 \text{ lb} - 3 \text{ lb} = 9 \text{ lb}$

Weight of all candles \div weight of one candle: $9 \div \frac{3}{4} = 9 \cdot \frac{4}{3}$, or 12

There are 12 candles in the box.

Model It

You can write an equation to solve a two-step problem that involves fractions.

Let c = the number of candles that Marvin shipped in the box.

$$\begin{array}{ccccccc} \text{(weight of 1 candle)} \cdot \text{(number of candles)} + \text{(weight of box)} & = & \text{total weight} \\ \downarrow & & \downarrow & & \downarrow & & \downarrow \\ \frac{3}{4} & \cdot & c & + & 3 & = & 12 \end{array}$$

To find the value of c , get c by itself on one side of the equation.

$$\frac{3}{4}c + 3 = 12$$

$$\frac{3}{4}c + 3 - 3 = 12 - 3$$

$$\frac{3}{4}c = 9$$

$$\frac{3}{4}c \cdot \frac{4}{3} = 9 \cdot \frac{4}{3}$$

$$c = 12$$

Mathematical Discourse

- How is the order in which you do the operations the same in both methods shown?

Students should say that in both you subtract first. Then you divide in the arithmetic method and multiply by the reciprocal in the algebra method.

- The order of operations says to multiply and divide before you add and subtract. Why do you subtract before you multiply when you solve the equation?

Students should point out that the order of operations is used to simplify expressions, not solve equations. When you solve an equation, you use inverse or opposite operations. You also use the opposite order of the order of operations.

**AT A GLANCE**

Students revisit the problem on page 148 and analyze the solution.

STEP BY STEP

- Read Connect It as a class. Be sure to point out that the questions refer to the problem on page 148.
- As you work through the steps of solving the equation, concentrate on both the inverse operations and the order in which they must be performed.
- Give students a few minutes to think about the answer to the last question. When you have students share their responses, ask questions that help them clarify their language. As a class, develop a set of clear and concise instructions for solving two-step equations.

SMP Tip: When students write and refine a set of directions for solving two-step equations, they are constructing viable arguments and critiquing the reasoning of others (SMP 3). As students discuss the best way to state the instructions, emphasize that they not only must be clear and accurate, but they also must be simple to follow.

Connect It

Now you will analyze the solution from the previous page.

- 2 What is the first operation performed in the arithmetic solution and in solving the equation? Subtract 3.
- 3 How does the first operation get you closer to isolating c on one side of the equation?
It gets rid of the 3 in the expression involving c , and leaves you with the variable and its coefficient.
- 4 Why do you multiply both sides by $\frac{4}{3}$ next?
Multiplying $\frac{3}{4}$ by $\frac{4}{3}$ leaves you with a coefficient of 1 for c .
- 5 What does multiplying 9 by $\frac{4}{3}$ represent in the arithmetic solution?
It means dividing the weight of all candles by the weight of one candle to find the number of candles.
- 6 Explain how to solve an equation that includes a variable with a coefficient added to a constant.
First subtract the constant from both sides of the equation. Then divide both sides by the coefficient.

Try It

Use what you just learned to solve these problems. Show your work.

- 7 Solve the equation. Show all steps in the solution.
 $\frac{2}{3}x + 1 = 5$
 $\frac{2}{3}x + 1 - 1 = 5 - 1$; $\frac{2}{3}x = 4$; $\frac{2}{3}x \cdot \frac{3}{2} = 4 \cdot \frac{3}{2}$; $x = 6$
- 8 The formula to convert degrees Celsius to degrees Fahrenheit is $\frac{9}{5}C + 32 = F$. Use this equation to find the Celsius equivalent of 86°F .
 $\frac{9}{5}C + 32 = 86$; $C = 30^\circ\text{C}$

TRY IT SOLUTIONS

7 Solution: $x = 6$; Students may subtract 1 from both sides of the equation and then either multiply both sides by $\frac{3}{2}$ or divide both sides by $\frac{2}{3}$.

ERROR ALERT: Students who wrote $\frac{8}{3}$ or $2\frac{2}{3}$ multiplied both sides of the equation by $\frac{2}{3}$ instead of $\frac{3}{2}$.

8 Solution: $C = 30$; Students may subtract 32 from both sides of the equation and then either multiply both sides by $\frac{5}{9}$ or divide both sides by $\frac{9}{5}$.

**AT A GLANCE**

Students read a word problem and explore how to solve it using arithmetic as well as writing an equation.

STEP BY STEP

- Read the problem at the top of the page as a class.
- Have students explain the problem in their own words.
- Look at the solution shown in the first Model It. Have students read through it step by step. Ask students why they would multiply the amount saved each week by 4 to find the total earned each week.
- Study the equation shown in the second Model It. Ask students to explain why the equation models the problem.
- Have students tell why the two equations on the bottom of the page are equivalent.

VISUAL MODEL

- Tell students that they can use color to help them focus on the steps used to solve an equation.
- Write $\frac{3}{4}c + 3 = 12$ on the board using one color for $\frac{3}{4}$ and another for $+ 3$. As you solve the equation, use the same color for $- 3$ as you did for $+ 3$ and the same color for $\frac{4}{3}$ as you did for $\frac{3}{4}$.
- Continue to use color as you demonstrate how to solve other equations.



Read the problem below. Then explore different ways to solve multi-step problems that involve decimals.

Lydia is saving money for her vacation. So far she has \$82.50. Each week she sets aside 25% of her paycheck for the vacation. After 8 weeks, Lydia has \$338.50 saved for vacation. What is the amount of Lydia's weekly paycheck?

Model It

You can use arithmetic to solve a multi-step problem that involves decimals.

Total amount saved: \$338.50

Amount already saved: \$82.50

Amount she saved from 8 paychecks: $\$338.50 - \$82.50 = \$256$

Amount she saved each week: $\$256 \div 8 = \32

Amount of weekly paycheck: 25% is $\frac{1}{4}$, so Lydia's weekly paycheck is $4 \times \$32$, or \$128.

Model It

You can write an equation to help solve a multi-step problem that involves decimals.

amount already saved + (number of weeks)(savings each week) = total amount saved

$$\begin{array}{ccccccc} \downarrow & & \downarrow & & \downarrow & & \downarrow \\ \$82.50 & + & 8 & (0.25 \cdot x) & = & \$338.50 \end{array}$$

$$82.5 + 8(0.25x) = 338.5$$

$$82.5 + 2x = 338.5$$

25% of paycheck (unknown)

Mathematical Discourse

- *Why do the two methods shown result in the same answer?*
Students' explanations should note that when they solve the equation, they use the same steps they used for the arithmetic method.
- *What are the advantages of each method? Which do you like better? Why?*
Students may say that the arithmetic method goes step by step, but the equation has you think about the whole situation first and then solve it step by step. Preferences may vary.

**AT A GLANCE**

Students revisit the problem on page 150 and review how to solve the equation.

STEP BY STEP

- Read Connect It as a class. Be sure to point out that the questions refer to the problem on page 150.
- Ask students why they would want to get $2x$ alone on the left side of the equation. Have them explain why they use inverse operations to solve for x .
- As students compare the two solutions, encourage them to explain the processes in the context of the problem.
- Stress that it is important for students to check their work. Show how to use substitution as a way to check their answers.

SMP Tip: When students check their work, they are attending to precision (SMP 6). Each time you demonstrate a problem, show how you check it as a way to reinforce that accuracy is important.

Concept extension**Explore ways of solving equations involving parentheses.**

- Write $3(x + 4) = 27$ on the board. Ask students how it is different from the other equations in this lesson. Brainstorm ways of solving it.
- Have students explain how to use the distributive property to rewrite the equation as $3x + 12 = 27$. Ask a volunteer to solve it, explaining the steps, one by one. Check the answer, $x = 5$, using substitution.
- Ask if you could divide both sides by 3 first. Show the solution step by step.

$$3(x + 4) = 27 \Rightarrow \frac{3(x + 4)}{3} = \frac{27}{3} \Rightarrow x + 4 = 9$$

$$\Rightarrow x = 5$$

- Discuss why the two solutions are equivalent.

Connect It

Now you will solve the equation for the problem on the previous page.

9 What can you do to get $2x$ alone on the left side of the equation? Fill in the blanks to show how, and then simplify.

$$82.5 - \frac{82.5}{2} + 2x = 338.5 - \frac{82.5}{2}$$

$$x = 256$$

10 What can you do to get the x alone on the left side of the equation? Fill in the blanks to show how, and then simplify.

$$2x \div \frac{2}{2} = 256 \div \frac{2}{2}$$

$$x = 128$$

- 11 Compare the arithmetic solution to solving with the equation. How are the methods similar? How are they different?

Possible answer: The computation for both methods is almost the same; first subtract and then divide. The arithmetic solution finds the amount saved each week and then calculates the weekly check amount. The equation leads straight to finding the weekly check amount.

- 12 Describe how to solve an equation with two or more steps.

Possible answer: To solve an equation, you must get the variable alone on one side of the equation. To do this, you perform the same computations on both sides of the equation. Use inverse operations to undo the operations in the expression that has the variable.

Try It

Use what you just learned to solve these problems. Show your work.

- 13 Solve. Show each step.

$$0.06x - 0.18 = 0.12$$

$$0.06x - 0.18 + 0.18 = 0.12 + 0.18$$

$$0.06x = 0.3$$

$$0.06x \div 0.06 = 0.3 \div 0.06$$

$$x = 5$$

- 14 Solve. Show each step.

$$5.4 - 6x = -6$$

$$5.4 - 5.4 - 6x = -6 - 5.4$$

$$-6x = -11.4$$

$$-6x \div (-6) = -11.4 \div (-6)$$

$$x = 1.9$$

TRY IT SOLUTIONS

- 13 **Solution:** $x = 5$; Students may add 0.18 to both sides of the equation and then divide by 0.06.
- 14 **Solution:** $x = 1.9$; Students may subtract 5.4 from both sides of the equation and then divide by -6 .

ERROR ALERT: Students who wrote -1.9 for the answer may have divided by 6 instead of -6 because they wrote the middle step as $6x = -11.4$ instead of $-6x = -11.4$.



The student analyzed the information in the problem and then wrote and solved an equation.



Study the student model below. Then solve problems 15–17.

Student Model

Josh walked a total of 5 miles today. First he walked 1 mile from his house to the park. Then he walked laps around the $\frac{3}{4}$ -mile trail at the park. Finally, he walked back home. How many laps did Josh walk around the trail?

You can use an equation to solve the problem.

1 mile to park + 1 mile home = 2 miles, x = number of laps

$$2 + \frac{3}{4}x = 5$$

$$2 - 2 + \frac{3}{4}x = 5 - 2$$

$$\frac{3}{4}x = 3$$

$$\frac{3}{4}x \cdot \frac{4}{3} = 3 \cdot \frac{4}{3}$$

$$x = 4$$

Solution: Josh walked 4 laps around the trail.

Pair/Share

How can you check that your answer is correct?

Make sure you define the variable before you write an equation.



15 An amusement park reduced its admission price to \$15.50 per day, but now charges \$1.50 per ride. Mark has \$26 to spend on admission and rides. Write and solve an equation to find how many rides Mark can ride in one day.

Show your work.

Let r = the number of rides that Mark rides in one day.

$$1.5r + 15.5 = 26$$

$$1.5r + 15.5 - 15.5 = 26 - 15.5$$

$$1.5r = 10.5$$

$$1.5r \div 1.5 = 10.5 \div 1.5$$

$$r = 7$$

Solution: Mark can ride 7 rides in one day.

Pair/Share

How much more money would Mark need if he wants to ride 10 rides?

16 Theo made a donation to a charity. His grandfather agreed to add \$4.00 to Theo's donation amount and then donate half of that sum. Theo's grandfather donated \$4.25. Write and solve an equation to find the amount of Theo's donation.

Show your work.

Let d = Theo's donation.

$$\frac{1}{2}(d + 4) = 4.25$$

$$\frac{1}{2}d + 2 = 4.25$$

$$\frac{1}{2}d + 2 - 2 = 4.25 - 2$$

$$\frac{1}{2}d = 2.25$$

$$\frac{1}{2}d \cdot 2 = 2.25 \cdot 2$$

$$d = 4.5$$

Solution: Theo's donation amount was \$4.50.

17 The Hair Care Salon charges a stylist \$30 per day to rent a station at the salon. Rhonda, a stylist, makes \$10.50 on each haircut. Which equation will help her decide how many haircuts she must give in one day to make \$138 after paying rent for her station? Circle the correct answer.

A $30h - 10.5 = 138$

B $10.5h + 30 = 138$

C $30h + 10.5 = 138$

D $10.5h - 30 = 138$

Lonnie chose B as the correct answer. How did he get that answer?

He did not take into account that paying rent is an expense and must be subtracted from earnings.

Will you use a decimal or a fraction to represent one half?



Pair/Share

Can you solve the problem in a different way? Discuss.

When a business is charged rent to operate, how does it affect the amount of money made?



Pair/Share

Talk about how you would find the correct answer, and then identify what Lonnie might have done incorrectly.

AT A GLANCE

Students write and solve equations to solve word problems.

STEP BY STEP

- Ask students to solve the problems individually using an equation and to then check their answers.
- When students have completed each problem, have them Pair/Share to discuss their solutions with a partner or in a group.

SOLUTIONS

- Ex** An equation is shown as one way to solve the problem. Students could also solve the problem using arithmetic.
- 15** Solution: 7 rides; Students could solve the problem by using the equation $1.5r + 15.5 = 26$.
- 16** Solution: \$4.50; Students could solve the problem by using the equation $\frac{1}{2}(d + 4) = 4.25$.
- 17** Solution: D; Subtract the \$30 station fee from the total amount earned from the haircuts.
- Explain to students why the other two answer choices are not correct:
- A** is not correct because the station fee and cost of haircuts are reversed.
- C** is not correct because the stylist does not earn \$30 per haircut plus \$10.50 for working there.



Solve the problems. Mark your answers to problems 1–3 on the Answer Form to the right. Be sure to show your work.

Answer Form		Number Correct
1	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D	
2	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D	/ 3
3	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D	

- 1 A rectangular garden sits next to a house. Three sides of the garden are fenced, and the fourth side is the house. The length of the garden is 9 meters. A total of 21.5 meters of fencing is used. If w stands for the width of the garden in meters, which equation can be used to find its width?

A $2w + 9 = 21.5$
 B $2w + 18 = 21.5$
 C $2w - 21.5 = 9$
 D $2w + 21.5 = 18$

- 2 If 10 is first subtracted from both sides of the equation $\frac{3}{4}x + 10 = 25$, what would you do next to solve for x ?

A Subtract $\frac{4}{3}$ from both sides of the equation.
 B Multiply $\frac{4}{3}$ by $\frac{3}{4}x$ and by 15.
 C Subtract $\frac{3}{4}$ from both sides of the equation.
 D Multiply $\frac{3}{4}$ by $\frac{3}{4}x$ and by 15.

- 3 Lane stacks some books in a storage crate that weighs 5 pounds. Each book weighs $1\frac{3}{8}$ pounds. The total weight of the crate with all the books in it is 53 pounds. Which equation CANNOT be used to find n , the number of books in the crate?

A $1\frac{3}{8}n = 48$
 B $1.375n + 5 = 53$
 C $1\frac{3}{8}n - 5 = 53$
 D $1.375n = 48$

- 4 Banners at the school store were on sale for \$3 off the regular price. Louis bought 4 banners on sale and paid a total of \$18. Write and solve an equation to find the regular price of one banner.

Show your work.

Possible student work:

Let p = the regular price of one banner.

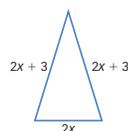
$$\begin{aligned} 4(p - 3) &= 18 \\ 4p - 12 &= 18 \\ 4p - 12 + 12 &= 18 + 12 \\ 4p &= 30 \\ 4p \div 4 &= 30 \div 4 \\ p &= 7.50 \end{aligned}$$

Answer The regular price of one banner is \$7.50.

- 5 The length of each of the two congruent sides of an isosceles triangle is $2x + 3$. The length of the third side is $2x$. Its perimeter is 36 centimeters. Draw and label this triangle. Write an equation that could be used to find the value of x . Solve for x and then find the length of all three sides.

Show your work.

Possible drawing:



Answer $2x + 3 + 2x + 3 + 2x = 36$ OR $6x + 6 = 36$; $x = 5$; sides are 13 cm, 13 cm, 10 cm

Self Check Go back and see what you can check off on the Self Check on page 125.

AT A GLANCE

Students write and solve equations to solve word problems that might appear on a mathematics test.

STEP BY STEP

- First, tell students that they will write and solve equations to solve word problems. Then have students read the directions and answer the questions independently. Remind students to fill in the correct answer choices on the Answer Form.
- After students have completed the Common Core Practice problems, review and discuss correct answers. Have students record the number of correct answers in the box provided.

SOLUTIONS

- Solution: A;** Sketch a picture or visualize the situation to see the dimensions of the garden.
- Solution: B;** Multiplying $\frac{3}{4}x$ by its reciprocal $\frac{4}{3}$ will result in x by itself.
- Solution: C;** The weight of the crate is part of the total weight.
- Solution: \$7.50;** See possible student work above.
- Solution: $6x + 6 = 36$; $x = 5$; 13 cm, 13 cm, 10 cm;** See possible student work above.

Assessment and Remediation

- Ask students to use an equation to solve this problem: Gustavo has 6 red pens and 3 packages of blue pens. Altogether he has 45 pens. How many pens are in a package? [$3p + 6 = 45$; $p = 13$]
- For students who are struggling, use the chart below to guide remediation.
- After providing remediation, check students' understanding. Ask students to solve this problem: When the 288 seventh graders sit 8 to a table, there are 8 students left without a place to sit. How many tables are there? [35]
- If a student is still having difficulty, use **Ready Instruction, Level 6**, Lesson 19.

If the error is ...	Students may ...	To remediate ...
5	have used the equation $6p + 3p = 45$.	Point out that he has 6 red pens, not 6 boxes of red pens.
7	have used the equation $6p + 3 = 45$.	Ask students to write an expression to represent 3 boxes, each containing p pens and then use the expression to write the equation.
9	divided 45 by 3 and then subtracted 6.	Discuss which operation they should "undo" first.

Hands-On Activity

Act out the solution to an equation.

Materials: 14 books, 4 large Xs

Say, *A teacher has 14 books. He gives 1 book each to 2 students. He divides the remaining books equally among 4 other students. How many books does each of the 4 students get?*

Call 4 students to the front, giving each an X to hold. Call up 2 more students. Place 14 books next to them. Have the class suggest an equation that describes the situation. Write $4x + 2 = 14$ on the board.

Have the students without Xs each take a book and sit down. Have the class revise the equation to reflect the new situation. Write $4x = 12$ under the first equation. Have the remaining students divide the books equally to solve the problem. Write $x = 3$.

Compare the acted out solution with the steps for solving an equation.

Challenge Activity

Write and solve problems using an equation.

Direct students to write a two-step equation on a sheet of paper. Collect the papers and redistribute them so that students have a problem they did not write. Ask students to think of a word problem that can be modeled by the equation. Have them write the problem and then solve it using the equation. Have them check the answer in the context of the problem to make sure it makes sense.