Lesson 16 Part 1: Introduction
Solve Problems with Equations

CCLS
7.EE.B.3
7.EE.B.4a

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.

(price of adult ticket) + (number of children) • (price of child's ticket) = total cost

$28 + 2 • p = $76

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 lb − 3 lb = 9 lb

Weight of all candles ÷ 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.

(weight of 1 candle) • (number of candles) + (weight of box) = total weight

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

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 ÷ 8 = $32

Amount of weekly paycheck: 25% is $\frac{1}{4}$, so Lydia's weekly paycheck is 4 × $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

$82.50 + 8 (0.25 • x) = $338.50

25% of paycheck (unknown)

$82.5 + 8(0.25x) = 338.5$

$82.5 + 2x = 338.5$

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.

$82.5 - \_\_\_\_\_ + 2x = 338.5 - \_\_\_\_\_$

$\_\_\_\_\_x = \_\_\_\_\_$

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.

$2x \div \_\_\_\_\_ = 256 \div \_\_\_\_\_$

$x = \_\_\_\_\_$

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.

$5.4 - 6x = -6$

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

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?

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 loop 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.**

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?

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: _____

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

Pair/Share

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

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?

_____

_____

_____

_____

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.

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 along the house 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 Charlie makes $34 an hour and will get a 20% raise starting next week. Choose True or False for each statement.

A	Next week, Charlie's new hourly wage will be 120% of his original wage.	☐ True	☐ False
B	Next week, Charlie's new hourly wage will be $40.80.	☐ True	☐ False
C	Next week, Charlie will be making $6.80 less than his current hourly wage.	☐ True	☐ False
D	Next week, Charlie will be earning an additional 20 cents per hour.	☐ True	☐ False

3 Sammy incorrectly solves the equation $\frac{1}{3}(x + 9) = 8$. Her work is shown below.

a. Which step shows an error based on the equation only from the previous step? Select all that apply.

A Step 1: $\frac{1}{3}x + 9 = 8$

B Step 2: $\frac{1}{3}x = 8 + 9$

C Step 3: $\frac{1}{3}x = 17$

D Step 4: $x = 17 \div 3$

E Step 5: $x = 5\frac{2}{3}$

b. What is the correct solution to the original equation? _____

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.*