

Solve & Discuss It!

Elizabeth wrote the following clues. What is the relationship between the shapes?

Use Structure How can you use properties of equality to reason about these equations?

Lesson 5-2

Solve Two-Step Equations

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I can...
solve a problem with a two-step equation.

Focus on math practices

Look for Relationships Complete the equation with only triangles using the relationships from the clues shown above.

259

Essential Question

How is solving a two-step equation similar to solving a one-step equation?

INTERACTIVE ANIMATIONS ASSESS

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EXAMPLE 1

Solve Two-Step Equations Using Models

Nala and two friends spent \$21 on movie tickets and a box of popcorn. How could they figure out how much each movie ticket costs?

Use Structure Two-step equations can be solved in two steps by using two different properties of equality.

Use a bar diagram and an equation to represent the situation.

total spent			
\$21			
m	m	m	\$6
↑		↑	
cost of one movie ticket		cost of popcorn	

Total spent = 3 · Cost of one movie ticket + Cost of popcorn

$$21 = 3 \cdot m + 6$$

Use the Subtraction Property of Equality to isolate the term containing the variable.

\$15		\$6
m	m	m

$$21 = 3m + 6$$

$$21 - 6 = 3m + 6 - 6$$

$$15 = 3m$$

Use the Division Property of Equality to **isolate the variable**, or get the variable by itself on one side of the equation.

\$5	\$5	\$5	\$6
m	m	m	\$6

$$15 = 3m$$

$$\frac{15}{3} = \frac{3m}{3}$$

$$5 = m$$

So, each movie ticket costs \$5.

Try It!

Andrew rents bowling shoes for \$4. He bowls 2 games. Andrew spent a total of \$22. How much was the cost of each game, b ?

Complete the bar diagrams, and then solve the problem.

total spent			
\$22			
\$4	b	b	b
↑		↑	
shoe rental		cost per game	

Each game cost .

Convince Me! What were the two steps you used to solve this equation?

260 5-2 Solve Two-Step Equations

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EXAMPLE 2 Solve Two-Step Equations Algebraically

Jon has a \$21.61 balance on a gift card that can be used to purchase online music. He bought some songs that each cost \$1.29. Now he has \$10 left. How many songs did Jon purchase? Write and solve a two-step equation.

Let d represent the number of songs Jon purchased.

Balance on gift card - Cost of one song · Number of songs = \$10 balance

$$21.61 - 1.29 \cdot d = 10$$

$$21.61 - 1.29d = 10$$

$$21.61 - 1.29d - 21.61 = 10 - 21.61$$

$$-1.29d = -11.61$$

$$\frac{-1.29d}{-1.29} = \frac{-11.61}{-1.29}$$

$$d = 9$$

Jon purchased 9 songs.

Use inverse operations and the Subtraction Property of Equality to isolate the term with the variable.

Use the inverse operations and the Division Property of Equality to isolate the variable.

EXAMPLE 3 Compare Algebraic and Arithmetic Solutions

The number of trumpet players is 2 more than $\frac{1}{4}$ of the entire band. How many students are in the band?

An algebraic and an arithmetic solution are shown to find b , the total number of students in the band.

Algebraic Solution

$$\frac{1}{4}b + 2 = 18$$

$$\frac{1}{4}b + 2 - 2 = 18 - 2 \quad \text{Subtract 2.}$$

$$\frac{1}{4}b = 16$$

$$\frac{4}{4} \cdot \frac{1}{4}b = \frac{4}{4} \cdot 16 \quad \text{Multiply by 4.}$$

$$b = 64$$

Arithmetic Solution

$$4 \cdot (18 - 2)$$

$$4 \cdot (16)$$

$$64$$

So, there are 64 students in the band.

18 students play the trumpet in the band.



Try It!

Kirsty ran 24 laps in a charity run and then walked 0.2 kilometer to the presentation table. The total distance Kirsty traveled was 29.6 kilometers. What was the distance of each lap? Explain how you solved the problem.

KEY CONCEPT

The properties of equality can be applied the same way when solving two-step equations as when solving one-step equations.

The inverse relationship between operations determines the property of equality needed to "undo" the operations in the equation.

$$\begin{aligned} 5x + 27 &= 122 \\ 5x + 27 - 27 &= 122 - 27 \\ \frac{5x}{5} &= \frac{95}{5} \\ x &= 19 \end{aligned}$$

Do You Understand?

- Essential Question** How is solving a two-step equation similar to solving a one-step equation?
- Use Structure** Preston uses the bar diagram below to represent $4x - 3 = 13$. How would you use the bar diagram to solve for x ?

Total			
	13		3
x	x	x	x
- Clara has solved the problem $6p - 12 = 72$ and says that $p = 14$. How can you check to see if Clara is correct?

Do You Know How?

- Clyde is baking, and the recipe requires $1\frac{1}{3}$ cups of flour. Clyde has 2 cups of flour, but he is doubling the recipe to make twice as much. How much more flour does Clyde need?



- Write an equation to represent the problem. Let c represent the amount of flour Clyde needs.
 - Solve the equation.
- Four times a number, n , added to 3 is 47.
 - Write an equation that you can use to find the number.
 - What is the number represented by n ?

Name: _____

Practice & Problem Solving

6. Use the bar diagram to help you solve the equation $4x - 12 = 16$.

Total			
16	12		
x	x	x	x

7. Complete the steps to solve the equation.

$$\frac{1}{3}t + 2 - \square = 17 - \square$$

$$\frac{1}{3}t = \square$$

$$\square \cdot \frac{3}{1}t = \square$$

$$t = \square$$

8. Use the bar diagram to write an equation and solve for x.

Total			
7	5		
x	x	x	x

9. While shopping for clothes, Tracy spent \$38 less than 3 times what Daniel spent. Write and solve an equation to find how much Daniel spent. Let x represent how much Daniel spent.

Tracy spent \$10.

10. Solve the equation $0.5p - 3.45 = -1.2$.

11. Solve the equation $\frac{1}{10} + 7 = 10$.

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5-2 Solve Two-Step Equations 263

Start $3x + 5 = 7$

$+ -5 = + -5$

$3x = 2$

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

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

* flip/switch order

$$3x - 38 = 10$$

see notes

9)

Start

PEMDAS

$3x + 38 = 10$

$+ -38 = + -38$

$3x = -28$

$\frac{3x}{3} = \frac{-28}{3}$

$x = -\frac{28}{3}$

Daniel spent \$16 on clothing.

$2 \div 3$

$\frac{2}{3}$

$3 \overline{) 48}$

$\underline{- 36}$

12

$\underline{- 12}$

0

12. A group of 4 friends went to the movies. In addition to their tickets, they bought a large bag of popcorn to share for \$6.25. The total was \$44.25.
- Write and solve an equation to find the cost of one movie ticket, m .
 - Draw a model to represent the equation.

14. Use the equation $4.9x - 1.9 = 27.5$.
- Make Sense and Persevere** What two properties of equality do you need to use to solve the equation?
 - The solution is $x = \square$

13. Oliver incorrectly solved the equation $2x + 4 = 10$. He says the solution is $x = 7$.
- What is the correct solution?
 - What mistake might Oliver have made?

15. Higher Order Thinking

At a party, the number of people who ate meatballs was 11 fewer than $\frac{1}{3}$ of the total number of people.



Five people ate meatballs.

- Write and solve an equation to find the number of people at the party. Let x represent the number of people at the party.
- Write a one-step equation that has the same solution.

flip or switch*

$$\frac{1}{3} \text{ of } x - 11 = 5$$

$$\frac{1}{3} \cdot x + 11 = 5$$

$$+11 = +11$$

$$\frac{1}{3} \cdot x = 16$$

$$\times 3 = 3 \cdot 16$$

$$x = 48$$

There were 48 people at the party.

Assessment Practice

16. In a week, Tracy earns \$12.45 less than twice the amount Kayla earns. Tracy earns \$102.45. Write and solve an algebraic equation to show how to find the amount that Kayla earns.

17. Solve the equation $2x + 4\frac{1}{2} = 9$. Explain the steps and properties you used.



