

Write Two-Step Equations



Real-World Link

Robotics You want to attend a two-week robotic day camp that costs \$700. Your parents will pay the deposit of \$400 if you pay the rest in weekly payments of \$15. Use the questions below to help you find the number of weeks you will need to make payments.

- Complete the table below. How much is paid after 2, 3, and 4 weeks?

Payments	Amount Paid
0	$400 + 15(0) = 400$
1	$400 + 15(1) = 415$
2	$400 + 15(2) = 430$
3	$400 + 15(3) = 445$
4	$400 + 15(4) = 460$



Essential Question

WHAT is equivalence?



Common Core State Standards

Content Standards

8.EE.7, 8.EE.7a, 8.EE.7b



Mathematical Practices

1, 2, 3, 4

- It will take a long time to solve the problem with a table. Instead, write and solve an equation to find the number of payments p you will need to make.

$$400 + 15p = 700$$

- How many payments will you make? 20

- Suppose you received \$75 in birthday money that you want to use towards the camp. Write and solve an equation to find the number of payments p you will

need to make. $400 + 75 + 15p = 700$

$$\begin{array}{r} 400 + 75 + 15p = 700 \\ -475 \qquad -475 \\ \hline 15p = 225 \\ \hline p = 15 \end{array}$$

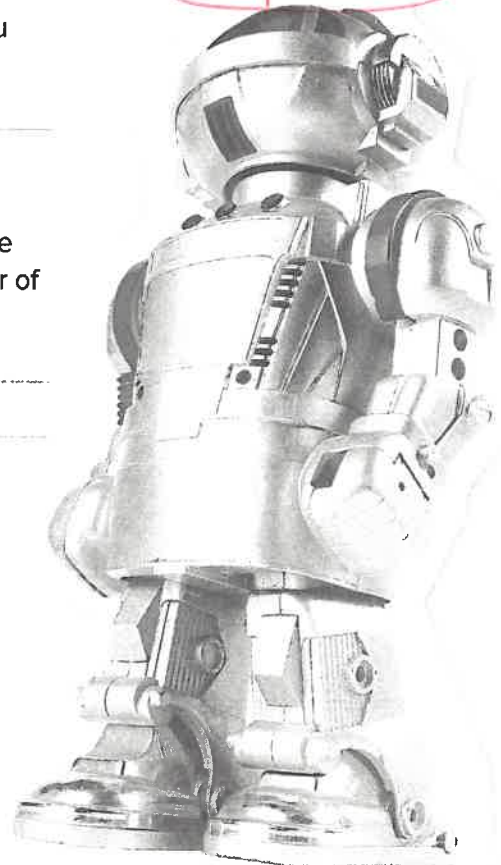
$$\begin{array}{r} 15p = 225 \\ \hline 15 \quad 15 \\ \hline p = 15 \end{array}$$

Which **MP** Mathematical Practices did you use?

Shade the circle(s) that applies.

- | | |
|--|---|
| <input type="checkbox"/> ① Persevere with Problems | <input type="checkbox"/> ⑤ Use Math Tools |
| <input type="checkbox"/> ② Reason Abstractly | <input type="checkbox"/> ⑥ Attend to Precision |
| <input type="checkbox"/> ③ Construct an Argument | <input type="checkbox"/> ⑦ Make Use of Structure |
| <input type="checkbox"/> ④ Model with Mathematics | <input type="checkbox"/> ⑧ Use Repeated Reasoning |

$$\begin{array}{r} 400 + 15p = 700 \\ -400 \qquad -400 \\ \hline 15p = 300 \\ \hline 15 \quad 15 \\ \hline p = 20 \end{array}$$



Translate Sentences into Equations

There are three steps to writing a two-step equation.

- Words** Describe the situation. Use only the most important words.
- Variable** Define a variable to represent the unknown quantity.
- Equation** Translate your verbal model into an algebraic equation.

You know how to write verbal sentences as one-step equations. Some verbal sentences translate into two-step equations.

Examples



Translate each sentence into an equation.

- 1. Eight less than three times a number is -23 .**

- Words** Eight less than three times a number is -23 .
- Variable** Let n represent the number.
- Equation** $3n - 8 = -23$

- 2. Thirteen is 7 more than one-fifth of a number.**

- Words** Thirteen is 7 more than one-fifth of a number.
- Variable** Let n represent the number.
- Equation** $13 = \frac{1}{5}n + 7$

Got it? Do these problems to find out.

- a. Fifteen equals three more than six times a number.
- b. Ten increased by the quotient of a number and 6 is 5.
- c. The difference between 12 and $\frac{2}{3}$ of a number is 18.

and Reflect

Name 3 words that indicate an addition statement.

a. $15 = 6n + 3$

b. $10 + \frac{n}{6} = 5$

c. $12 - \frac{2}{3}n = 18$

Show your work



Examples

Tutor

- 3.** You buy 3 books that each cost the same amount and a magazine, all for \$55.99. You know that the magazine costs \$1.99. How much does each book cost?

Words Three books and a magazine cost \$55.99.

Variable Let b represent the cost of one book.

Equation $3b + 1.99 = 55.99$

$$\begin{array}{r} 3b + 1.99 = 55.99 \\ - 1.99 = - 1.99 \\ \hline 3b = 54.00 \\ \frac{3b}{3} = \frac{54.00}{3} \\ b = 18 \end{array}$$

Write the equation.
Subtraction Property of Equality
Simplify.
Division Property of Equality
Simplify.

So, the books each cost \$18.

- 4.** A personal trainer buys a weight bench for \$500 and w weights for \$24.99 each. The total cost of the purchase is \$849.86. How many weights were purchased?

Words Bench plus \$24.99 per weight equals \$849.86

Variable Let w represent the number of weights.

Equation $500 + 24.99 \cdot w = 849.86$

$$\begin{array}{r} 500 + 24.99w = 849.86 \\ - 500 = - 500 \\ \hline 24.99w = 349.86 \\ \frac{24.99w}{24.99} = \frac{349.86}{24.99} \\ w = 14 \end{array}$$

Write the equation.
Subtraction Property of Equality
Simplify.
Division Property of Equality
Simplify.

So, 14 weights were purchased.

Got it? Do this problem to find out.

- d. The current temperature is 54°F. It is expected to rise 2.5°F each hour. In how many hours will the temperature be 84°F?

$$\begin{array}{r} 54 + 2.5h = 84 \\ - 54 \quad \quad - 54 \\ \hline 2.5h = 30 \\ \frac{2.5h}{2.5} = \frac{30}{2.5} \\ h = 12 \end{array}$$

Show your work.

d. $h = 12$



Example

Watch

Tutor



Defining the Variable

When the equation is solved, you can refer back to the definition of the variable to see if the question is answered or if additional steps are needed.

5. Your and your friend's lunch cost \$19. Your lunch cost \$3 more than your friend's. How much was your friend's lunch?

Words Your friend's lunch plus your lunch equals \$19.

Variable Let f represent the cost of your friend's lunch.

Equation $f + f + 3 = 19$

$$f + f + 3 = 19 \quad \text{Write the equation.}$$

$$2f + 3 = 19 \quad f + f = 2f$$

$$\underline{-3 = -3} \quad \text{Subtraction Property of Equality}$$

$$2f = 16 \quad \text{Simplify.}$$

$$\frac{2f}{2} = \frac{16}{2} \quad \text{Division Property of Equality}$$

$$f = 8 \quad \text{Simplify.}$$

Your friend spent \$8.

Guided Practice

Check



Translate each sentence into an equation. (Examples 1 and 2)

1. One more than three times a number is 7. $3n + 1 = 7$

2. Seven less than one-fourth of a number is -1 . $\frac{1}{4}n - 7 = -1$

3. The quotient of a number and 5, less 10, is 3. $\frac{n}{5} - 10 = 3$

4. You already owe \$4.32 in overdue rental fees and are returning a movie that is 4 days late. Now you owe \$6.48. Define a variable. Then write and solve an equation to find the daily fine for an overdue movie. (Examples 3–5)

$$\begin{array}{r} 6.48 = 4f + 4.32 \\ -4.32 \quad -4.32 \\ \hline \end{array}$$

$$2 \cdot \frac{16}{4} = \frac{4f}{4}$$

$$f = 0.54$$

fee is \$0.54 per day

5. **Building on the Essential Question** Why is it important to define a variable before writing an equation?

Assigning a variable to an unknown helps you when translating the verbal model into an algebraic equation.

Rate Yourself!

I understand how to write two-step equations.

Great! You're ready to move on!

I still have some questions about writing two-step equations.

No Problem! Go online to access a Personal Tutor.



Independent Practice

Go online for Step-by-Step Solutions



Translate each sentence into an equation. (Examples 1 and 2)

1. Four less than five times a number is equal to 11. $5n - 4 = 11$

2. Fifteen more than half a number is 9. $\frac{n}{2} + 15 = 9$ or $\frac{1}{2}n + 15 = 9$

3. Six less than seven times a number is equal to -20. $7n - 6 = -20$

4. Eight more than four times a number is -12. $4n + 8 = -12$

Define a variable. Then write and solve an equation to solve each problem. (Examples 3-5)

5. **Financial Literacy** The cost for a certain music plan is \$9.99 per year plus \$0.25 per song you download. If you paid \$113.74 one year, find the number of songs you downloaded.

$$\begin{aligned} 0.25s + 9.99 &= 113.74 \\ -9.99 &- 9.99 \\ \hline 0.25s &= 103.75 \\ \frac{0.25s}{0.25} &= \frac{103.75}{0.25} \\ s &= 415 \end{aligned}$$

415 songs

6. Amy has saved \$725 for a new guitar and lessons. Her guitar costs \$475, and guitar lessons are \$25 per hour. Determine how many hours of lessons she can afford.

$$\begin{aligned} 725 &= 25h + 475 \\ -475 &- 475 \\ \hline 250 &= 25h \end{aligned}$$

$$\begin{aligned} \frac{250}{25} &= \frac{25h}{25} \\ 10 &= h \end{aligned}$$

10 hours of lessons

7. From ground level to the tip of the torch, the Statue of Liberty and its pedestal are 92.99 meters tall. The pedestal is 0.89 meter taller than the statue. How tall is the Statue of Liberty?

Statue is 46.05 meters

$$s + s + 0.89 = 92.99$$

$$\begin{aligned} 2s + 0.89 &= 92.99 \\ -0.89 &- 0.89 \\ \hline 2s &= 92.10 \end{aligned}$$

$$\frac{2s}{2} = \frac{92.10}{2}$$

$$s = 46.05$$



8. **MP Reason Abstractly** Elsie would like to take snowboarding lessons at Powder Mountain. She has saved \$550 for lessons and a junior season pass. How many more semi-private lessons than private lessons can she take? 2 lessons

$$\begin{aligned} 550 &= 45s + 315 \\ -315 &- 315 \\ \hline 235 &= 45s \end{aligned}$$

$$\frac{235}{45} = \frac{45s}{45}$$

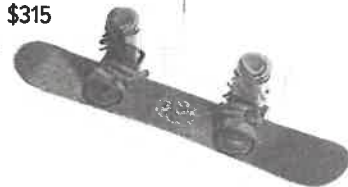
$$5.22 = s$$

$$\begin{aligned} 550 &= 60p + 315 \\ -315 &- 315 \\ \hline 235 &= 60p \end{aligned}$$

$$\frac{235}{60} = \frac{60p}{60}$$

$$3.92 = p$$

Powder Mountain Ski Resort Snowboarding Lessons	
Semi-Private	\$45/lesson
Private	\$60/lesson
Junior Season Pass	\$315



9. When diving, the peregrine falcon can reach speeds of up to 175 miles per hour. Write and solve equations to find each of the following.

a. The top speed of a peregrine falcon is 20 miles per hour less than three times the top speed of a cheetah. What is the cheetah's

top speed? $3c - 20 = 175$ $\frac{3c}{3} = \frac{195}{3}$
 $\quad \quad \quad +20 \quad +20$
 $3c = 195$ $c = 65$
 65mph

b. A sailfish can swim up to 1 mile per hour less than one fifth the top speed of a peregrine falcon. Find the top speed that a sailfish can swim.

$\frac{1}{5}(175) - 1 = s$ 34mph
 $35 - 1 = s$

c. The peregrine falcon can reach speeds about 13 miles per hour more than 6 times the speed of the fastest human. What is the

approximate top speed of the fastest human? 27mph
 $6h + 13 = 175$ $\frac{6h}{6} = \frac{162}{6}$
 $\quad \quad \quad -13 \quad -13$
 $6h = 162$ $h = 27$



H.O.T. Problems Higher Order Thinking

10. **MP Model with Mathematics** If 12 less than 4 times a number is 8, the number is 5. Write a different sentence where the unknown number is also 5. *EX: 6 times a number plus 5 equals 35*

11. **MP Persevere with Problems** The ages of three siblings combined is 27. The oldest is twice the age of the youngest. The middle child is 3 years older than the youngest. Write and solve an equation to find the ages of each sibling.

$a + 2a + a + 3 = 27$ $4a + 3 = 27$
 $2a + 2a + 3 = 27$ $\quad \quad \quad -3 \quad -3$
 $4a + 3 = 27$ $\frac{4a}{4} = \frac{24}{4}$

ages are 6, 9, 12

12. **MP Model with Mathematics** Write about a real-world situation that can be solved using a two-step equation. Then write the equation and solve the problem. *many possible answers...*

13. **MP Model with Mathematics** Describe two real-world situations that can be represented by the same two-step equation. *many possible answers...*

Situation 1: _____

Situation 2: _____

Extra Practice

isolate each sentence into an equation.

14. Twenty-two less than three times a number is -70 . $3n - 22 = -70$

Words Twenty-two less than three times a number is -70 .

Variable Let n represent the number.

Equation $3n - 22 = -70$

15. The product of a number and 4 increased by 16 is -2 . $4n + 16 = -2$

16. Twelve less than the one-fifth of a number is -7 . $\frac{1}{5}n - 12 = -7$ or $\frac{n}{5} - 12 = -7$

17. Six more than nine times a number is 456. $9n + 6 = 456$

Define a variable. Then write and solve an equation to solve each problem.

18. It costs \$13 for admission to an amusement park, plus \$1.50 for each ride. If you have a total of \$35.50 to spend, what is the greatest number of rides you can go on?

$r = \#$ of rides 15 rides

$$\begin{array}{r} 1.50r + 13 = 35.50 \\ -13 \quad -13 \\ \hline 1.5r = 22.50 \\ \frac{1.5}{1.5} \quad \frac{22.50}{1.5} \\ \hline r = 15 \end{array}$$

19. They went to the batting cages to practice hitting. He rented a helmet for \$4 and paid \$0.75 for each group of 20 pitches. If he spent a total of \$7 at the batting cages, how many groups of pitches did he pay for?

$$\begin{array}{r} 0.75p + 4 = 7 \\ -4 \quad -4 \\ \hline 0.75p = 3 \\ \frac{0.75}{0.75} \quad \frac{3}{0.75} \\ \hline p = 4 \end{array}$$

$p =$ groups of pitcher

4 groups of pitcher

20. **MP Make a Conjecture** Hunter and Amado are each trying to save \$600 for a summer trip. Hunter started with \$150 and earns \$7.50 per hour working at a grocery store. Amado has nothing saved, but he earns \$12 per hour painting houses.

a. Make a conjecture about who will take longer to save enough money for the trip. Justify your reasoning. *Hunter, although he has more money saved makes significantly less money each hour. Hunter will have to work longer.*

b. Write and solve two equations to check your conjecture.

Hunter $7.50h + 150 = 600$

$$\begin{array}{r} 7.50h + 150 = 600 \\ -150 \quad -150 \\ \hline 7.5h = 450 \\ \frac{7.5}{7.5} \quad \frac{450}{7.5} \\ \hline h = 60 \end{array}$$

Amado $12h = 600$

$$\begin{array}{r} 12h = 600 \\ \frac{12}{12} \quad \frac{600}{12} \\ \hline h = 50 \end{array}$$



Power Up! Common Core Test Practice

21. Use the figure to fill in each blank to make a true statement.

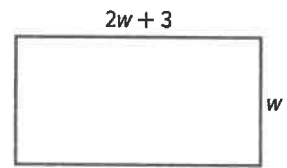
$$\begin{array}{r} 6w + 6 = 36 \\ -6 \quad -6 \\ \hline 6w = 30 \\ \frac{6w}{6} = \frac{30}{6} \\ \hline w = 5 \end{array}$$

The simplified expression for the perimeter of the rectangle is

$6w + 6$

An equation that can be used to find w is $6w + 6 = 36$. The width of the rectangle is 5 units .

$$2w + 3 + 2w + 3 + w + w$$



22. Model each situation below with an equation. Select the correct equation for each situation. Then solve each problem.

$$\begin{array}{r} 6m + 72 = 144 \\ -72 \quad -72 \\ \hline 6m = 72 \\ \frac{6m}{6} = \frac{72}{6} \\ \hline m = 12 \end{array}$$

a. A company employs 72 workers. It plans to increase the number of employees by 6 per month until it has twice its current workforce. How many months will it take to double the number of employees?

$6m + 72 = 96$	$144 - 72m = 6$
$6m + 72 = 144$	$144 - 6m = 96$

Equation: $6m + 72 = 144$ Solution: 12 months

b. Nathan's fish tank holds 144 gallons of water. To clean the tank, he drains the water at a rate of 6 gallons per minute until the level is two-thirds its original level. How many minutes does it take to drain the tank for cleaning?

$$\begin{array}{r} 144 - 6m = 96 \\ +6m \quad +6m \\ \hline 144 = 6m + 96 \\ -96 \quad -96 \\ \hline 48 = 6m \\ \frac{48}{6} = \frac{6m}{6} \\ \hline 8 = m \end{array}$$

Equation: $144 - 6m = 96$ Solution: 8 minutes



Common Core Spiral Review

Solve each equation. Check your solution. 7.EE.4

23. $\frac{y}{7} = 22 \cdot 7$
 $y = 154$

24. $\frac{a}{6} = -108 \cdot 6$
 $a = -648$

25. $-6 = \frac{n}{8} + 1$
 $-7 = \frac{n}{8}$
 $-56 = n$

26. $-15 = -4p + 9$
 $-24 = -4p$
 $6 = p$

27. In a recent NFL game, the Green Bay Packers scored 14 points less than the Tennessee Titans. Write and solve an equation to find the total points the Tennessee Titans scored. 6.EE.7

$$\begin{array}{r} p - 14 = 17 \\ +14 \quad +14 \\ \hline p = 31 \end{array}$$

31 points

Preseason Week 4	
Team	Total Points
Packers	17
Titans	p