Essential Question How can you use a system of linear equations to model and solve a real-life problem?

1 ACTIVITY: Writing a System

Work with a partner.

- Peak Valley Middle School has 1200 students. Its enrollment is decreasing by 30 students per year.

- Southern Tier Middle School has 500 students. Its enrollment is increasing by 40 students per year.

- In how many years will the two schools have equal enrollments?

Peak Valley

FALCONS

a. USE A TABLE Use a table to answer the question.

Now

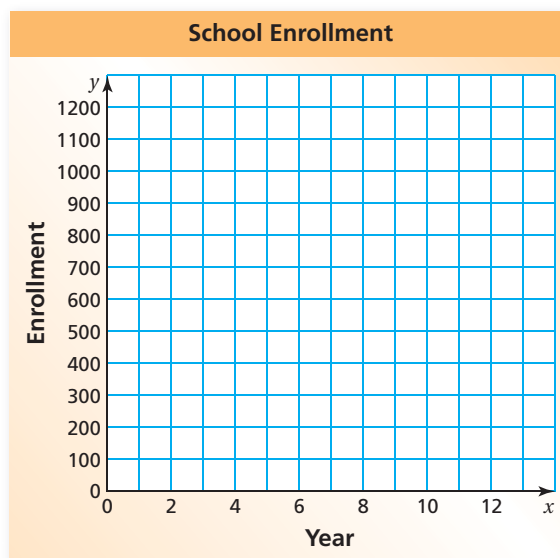| Year, x	0	1	2	3	4	5	6	7	8	9	10
Peak Valley MS, P	1200										
Southern Tier MS, S	500										

b. USE A GRAPH Write a linear equation that represents each enrollment.

$P =$

$S =$

Then graph each equation and find the point of intersection to answer the question.

c. USE ALGEBRA Answer the question by setting the expressions for P and S equal to each other and solving for x.

School Enrollment

Enrollment

Year

Work with a partner. The table shows the enrollments of Sizemore Middle School and Wright Middle School for 7 years.

| Year, x	0	1	2	3	4	5	6
Sizemore MS, S	1500	1438	1423	1350	1308	1247	1204
Wright MS, W	825	854	872	903	927	946	981

From the enrollment pattern, do you think the two schools will ever have the same enrollment? If so, when?

a. Plot the enrollments of each middle school.

b. Draw a line that approximately fits the points for each middle school.

c. Estimate the year in which the schools will have the same enrollment.

d. Write an equation for each line.

$$S = \underline{\hspace{3cm}}$$

$$W = \underline{\hspace{3cm}}$$

School Enrollment
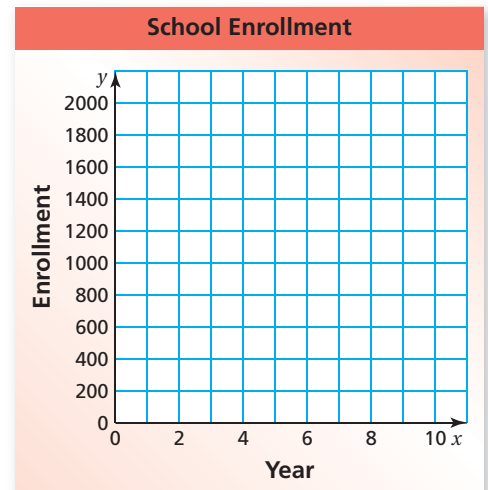
e. **USE ALGEBRA** Answer the question by setting the expressions for S and W equal to each other and solving for x.

What Is Your Answer?

3. **IN YOUR OWN WORDS** How can you use a system of linear equations to model and solve a real-life problem?

4. **PROJECT** Use the Internet, a newspaper, a magazine, or some other reference to find two sets of real-life data that can be modeled by linear equations.

  a. List the data in a table.

  b. Graph the data. Find a line to represent each data set.

  c. If possible, estimate when the two quantities will be equal.

Practice

Use what you learned about writing systems of linear equations to complete Exercises 4 and 5 on page 136.

EXAMPLE 1 Writing a System of Linear Equations

A bank teller is counting $20 bills and $10 bills. There are 16 bills that total $200. Write and solve a system of equations to find the number x of $20 bills and the number y of $10 bills.

Words	Number of $20 bills	plus	number of $10 bills	is	the total number of bills.

Equation 1 → **Equation**
$$x + y = 16$$

Words	Twenty times	the number of $20 bills	plus ten times	the number of $10 bills	is	the total value.

Equation 2 → **Equation**
$$20 \cdot x + 10 \cdot y = 200$$

The linear system is $x + y = 16$ and $20x + 10y = 200$.

Solve each equation for y. Then make a table of values to find the x-value that gives the same y-value for both equations.

x	0	1	2	3	4
y = 16 − x	16	15	14	13	12
y = 20 − 2x	20	18	16	14	12

The solution is (4, 12).

So, there are 4 twenty-dollar bills and 12 ten-dollar bills.

Check

Equation 1	Equation 2
$x + y = 16$	$20x + 10y = 200$
$4 + 12 \overset{?}{=} 16$	$20(4) + 10(12) \overset{?}{=} 200$
$16 = 16$ ✓	$200 = 200$ ✓

On Your Own

1. The length ℓ of the rectangle is 1 more than 3 times the width w. Write and solve a system of linear equations to find the dimensions of the rectangle.

ℓ

w

Perimeter = 42 cm
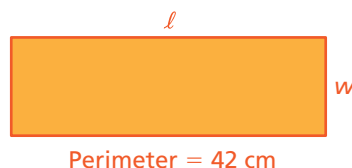
EXAMPLE 2   **Standardized Test Practice**

The sum of two numbers is 35. The second number y is equal to 4 times the first number x. Which system of linear equations represents the two numbers?

   (A) $x + y = 35$ **(B)** $x + y = 35$ **(C)** $x + y = 35$ **(D)** $x - y = 35$

          $x = y + 4$ $y = 4x$ $y = -4x$ $y = 4x$

	Words	First number	plus	second number	is	35.
Equation 1 →	**Equation**	x	$+$	y	$=$	35

	Words	Second number	is equal to 4 times the	first number.
Equation 2 →	**Equation**	y	$= \quad 4 \cdot$	x

∴ The system is $x + y = 35$ and $y = 4x$. The correct answer is **(B)**.

EXAMPLE 3   **Writing a System of Linear Equations**

x	Airbus A320, A	Boeing 777, B
0	0	9000
1	1000	8500
2	2000	8000
3	3000	7500
4	4000	7000

The table shows the altitudes (in feet) of two jets after x minutes. After how many minutes do the jets have the same altitude?

Method 1: Plot the points and draw each line. The graphs appear to intersect at (6, 6000).

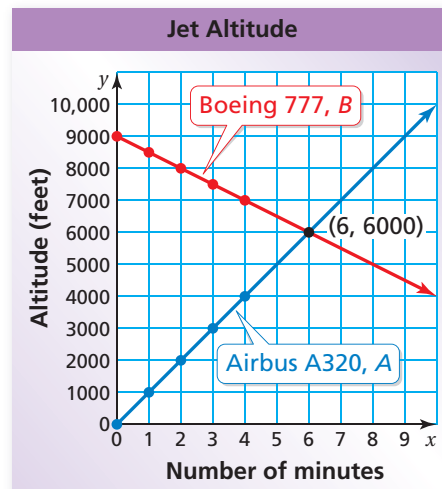∴ So, the jets have the same altitude after 6 minutes.

Method 2: Use the slopes and y-intercepts to write equations for A and B. Set the equations equal to each other and solve for x.

$A = 1000x$ $B = -500x + 9000$

$1000x = -500x + 9000$

$1500x = 9000$

$x = 6$

∴ The jets have the same altitude after 6 minutes.

Jet Altitude

On Your Own

2. The sum of two numbers is 20. The second number is 3 times the first number. Write and solve a system of equations to find the two numbers.

3. **WHAT IF?** In Example 3, the altitude of the Boeing 777 decreases 800 feet each minute. After how many minutes do the jets have the same altitude? Solve using both methods.

✓ Vocabulary and Concept Check

1. **VOCABULARY** Why is the equation $2x - y = 4$ called a *linear* equation?

2. **VOCABULARY** What must be true for an ordered pair to be a solution of a system of two linear equations?

3. **WRITING** Describe three ways to solve a system of linear equations.

Practice and Problem Solving

In Exercises 4–6, (a) write a system of linear equations to represent the situation. Then, answer the question using (b) a table, (c) a graph, and (d) algebra.

①②③ 4. ATTENDANCE The first football game has 425 adult fans and 225 student fans. The adult attendance A decreases by 15 each game. The student attendance S increases by 25 each game. After how many games x will the adult attendance equal the student attendance?

Adults: Attendence each game | is | 425 | minus 15 times | number of games.

Students: Attendence each game | is | 225 | plus 25 times | number of games.

5. **BOUQUET** A bouquet of lilies and tulips has 12 flowers. Lilies cost $3 each and tulips cost $2 each. The bouquet costs $32. How many lilies x and tulips y are in the bouquet?

Number of flowers: Number of lilies | plus | Number of tulips | is | 12.

Cost of bouquet: $3 times | number of lilies | plus $2 times | number of tulips | is | $32.

6. **CHORUS** There are 63 students in a middle school chorus. There are 11 more boys than girls. How many boys x and girls y are in the chorus?

Number of students: Number of boys | plus | number of girls | is | 63.

Boys and girls: Number of boys | equals | number of girls | plus | 11.

7. WHAT IS MISSING? You have dimes and nickels in your pocket with a total value of $0.95. There are more dimes than nickels. How many of each coin do you have?

   a. Do you have enough information to write a system of equations to answer the question? If not, what else do you need to know?

   b. Find one possible solution.

x	Account A	Account B
0	420	465
1	426	468
2	432	471
3	438	474
4	444	477

8. INTEREST The table shows the balances (in dollars) of two accounts earning simple interest for x years. After how many years will the accounts have the same balance?

9. CRITICAL THINKING Is it possible for a system of two linear equations to have exactly two solutions? Explain.

10. DINNER How much does it cost for two specials and two glasses of milk?

GUEST CHECK

4 Specials
2 Glasses
of milk
$28.00

GUEST CHECK

3 Specials
4 Glasses
of milk
$26.25
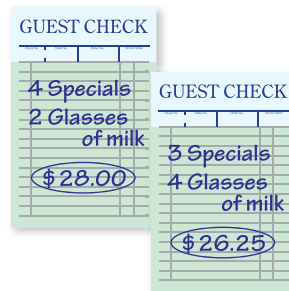
11. REASONING A system of two linear equations has more than one solution. Describe the graph of the system.

Scottish Team

Puerto Rican Team

12. WORLD CUP The global competition for the World Cup is broken up into six continental zones. The number of teams in the Scottish team's zone is 17 less than twice the number of teams in the Puerto Rican team's zone. There is a total of 88 teams in both zones. How many teams are in each zone?

13. **Algebra** The graphs of the three equations form a triangle. Use algebra to find the coordinates of the vertices of the triangle.

$$x + y = 1 \qquad x + 7y = 1 \qquad x - 2y = -8$$

Fair Game Review What you learned in previous grades & lessons

Write an equation of the line that passes through the points.

14. $(0, -1), (1, 1)$

15. $(-4, -3), (4, -1)$

16. $(2, 1), (3, -1)$

17. MULTIPLE CHOICE Which function rule relates x and y for the set of ordered pairs (2, 4), (4, 5), (6, 6)?

Ⓐ $y = x - 2$
Ⓑ $y = \frac{1}{2}x + 3$
Ⓒ $y = 2x + 1$
Ⓓ $y = \frac{1}{2}x - 3$