

# Chapter 5

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# Chapter 5 Systems of Linear Equations

Dear Family,

Some people have a side business to supplement their income: delivering papers, selling crafts, or running a website, to name a few. The goal is to make a *profit*—to have more income than expenses.

The *break-even point* is where the income equals the expenses. Making a graph is a good way to keep track of income and expenses and will show at a glance when the business will break even. On a graph, the break-even point is where the income line crosses the expense line.

Have your student help you make a plan for a small business. A few basic steps will get your business plan started.

- How much money will you need for supplies to get started? This represents your *initial investment*. Plot this point on your graph.
- How much does it cost you to produce each item? This is the *unit cost*. Use this to plot more points on the graph to make an expense line.
- What price will you charge for each item? Starting at the origin of the graph, use this unit price to make an income line.
- Do the two lines cross? This is your break-even point—the number of items you must sell to pay for your expenses.

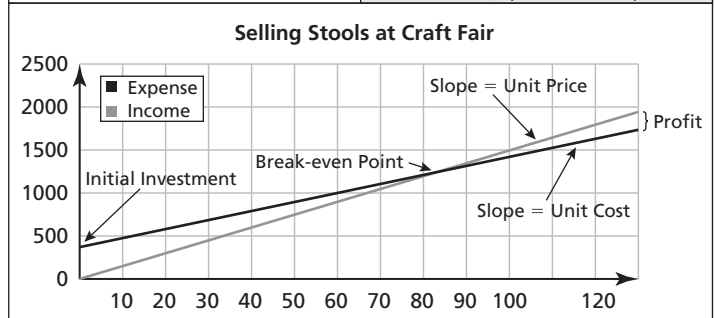
If the two lines do not cross, you will have to make some changes. Can you increase your unit price? You may not be able to charge more than your competitors. In that case, you will have to find a way to cut expenses.

What effect do changes to your initial investment have on the break-even point? What effect do changes to the unit cost have on the break-even point? Ask your student which one has a greater impact over time.

May your collaboration be a profitable one!

My Woodworking Business

Selling Stools at Craft Fair		Units	Expense	Income
		0	\$370.00	\$0.00
Craft Fair Booth:	\$160.00	10	\$475.00	\$149.50
Business Cards:	\$85.00	20	\$580.00	\$299.00
New Tools:	\$125.00	30	\$685.00	\$448.50
Initial Investment:	\$370.00	40	\$790.00	\$598.00
		50	\$895.00	\$747.50
Electricity:	\$0.50	60	\$1,000.00	\$897.00
Rough Lumber:	\$3.00	70	\$1,105.00	\$1,046.50
Fasteners & Glue:	\$0.75	80	\$1,210.00	\$1,196.00
Stain & Sandpaper:	\$1.25	90	\$1,315.00	\$1,345.50
My Time:	\$5.00	100	\$1,420.00	\$1,495.00
Unit Cost:	\$10.50	110	\$1,525.00	\$1,644.50
		120	\$1,630.00	\$1,794.00
Unit Price:	\$14.95	130	\$1,735.00	\$1,943.50



**Capítulo**  
**5**

**Sistemas de ecuaciones lineales**

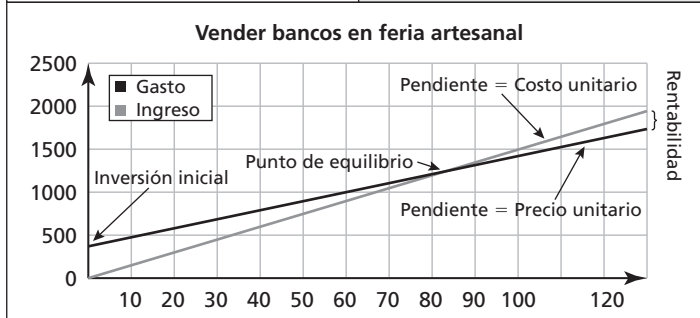
Estimada Familia:

Algunas personas tienen un negocio para complementar sus ingresos: repartir el diario, vender artesanías, administrar un sitio web, por nombrar algunos ejemplos. El objetivo es generar utilidades—tener más ingresos que gastos.

El punto de equilibrio se da cuando los ingresos son iguales a los egresos. Hacer un gráfico es una buena manera de monitorear los ingresos y gastos y muestra a simple vista cuando un negocio alcanza este punto. En un gráfico el punto de equilibrio se da cuando la línea de ingresos cruza la línea de gastos.

**Mi negocio de carpintería**

Vender bancos en feria artesanal		Unidades	Gastos	Ingresos
		0	\$370.00	\$0.00
Stand en la feria:	\$160.00	10	\$475.00	\$149.50
Tarjetas de presentación:	\$85.00	20	\$580.00	\$299.00
Herramientas nuevas:	\$125.00	30	\$685.00	\$448.50
Inversión inicial:	\$370.00	40	\$790.00	\$598.00
		50	\$895.00	\$747.50
Electricidad:	\$0.50	60	\$1,000.00	\$897.00
Madera:	\$3.00	70	\$1,105.00	\$1,046.50
Grapas y adhesivos:	\$0.75	80	\$1,210.00	\$1,196.00
Barniz y lijas:	\$1.25	90	\$1,315.00	\$1,345.50
Tiempo:	\$5.00	100	\$1,420.00	\$1,495.00
Costo unitario:	\$10.50	110	\$1,525.00	\$1,644.50
		120	\$1,630.00	\$1,794.00
Precio unitario:	\$14.95	130	\$1,735.00	\$1,943.50



Haga que su estudiante lo ayude a preparar un plan para un pequeño negocio. Con unos cuantos pasos básicos empezarán su plan de negocios.

- ¿Cuánto dinero necesitarán para comenzar? Esto representa su inversión inicial. Ubiquen este punto en su gráfico.
- ¿Cuánto les costará producir cada artículo? Este es el costo unitario. Con este dato, coloquen más puntos con el fin de trazar una línea de gastos.
- ¿Qué precio cobrarán por cada artículo? Comenzando en el origen del gráfico, utilicen este precio unitario para dibujar la línea de ingresos.
- ¿Se cruzan estas dos líneas? Este es su punto de equilibrio—el número de artículos que deben vender para cubrir sus gastos.

Si las dos líneas no se cruzan deberán hacer ciertos cambios. ¿Pueden aumentar su precio unitario? Tal vez no puedan cobrar más que la competencia. En ese caso, tendrán que hallar un modo de recortar los gastos.

¿Cómo afectan al punto de equilibrio las modificaciones en su inversión inicial? ¿Cómo afectan al punto de equilibrio las modificaciones del costo unitario? Pregunte a su estudiante cuál tiene mayor impacto a largo plazo.

**Activity  
5.1****Start Thinking!**

For use before Activity 5.1

Can you find an ordered pair  $(x, y)$  that is a solution to both of the equations below?

$$x + y = 5$$

$$x = y + 1$$

Can you find more than one solution to both equations? What method did you use to find a solution? Can you think of any other methods for finding the solution of a set of two equations?

**Activity  
5.1****Warm Up**

For use before Activity 5.1

**Graph the linear equation.**

1.  $y = \frac{1}{2}x - 2$

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

3.  $y = -2x + 1$

4.  $y = 3x - 7$

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

6.  $y = -\frac{1}{5}x + 5$

**Lesson  
5.1****Start Thinking!**

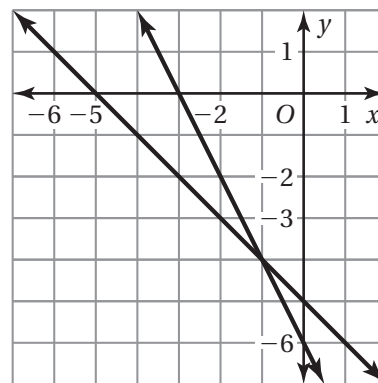
For use before Lesson 5.1

The table and graph below relate to the system of equations at the right.

$$y = -x - 5$$

$$y = -2x - 6$$

<b>x</b>	-3	-2	-1	0	1	2	3
<b>-x - 5</b>	-2	-3	-4	-5	-6	-7	-8
<b>-2x - 6</b>	0	-2	-4	-6	-8	-10	-12



What is the solution of the system? Is it easier to see the solution of the system using the table or the graph? In general, is using a table or graph a better method? Explain.

**Lesson  
5.1****Warm Up**

For use before Lesson 5.1

**Use a table to find the break-even point.  
Check your solution.**

**1.**  $C = 15x + 100$

$R = 65x$

**3.**  $C = 25x + 80$

$R = 45x$

**5.**  $C = 8x + 24$

$R = 12x$

**2.**  $C = 10x + 30$

$R = 16x$

**4.**  $C = 8x + 21$

$R = 15x$

**6.**  $C = 11x + 6$

$R = 12.5x$

# 5.1

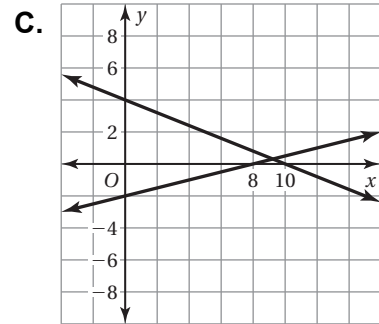
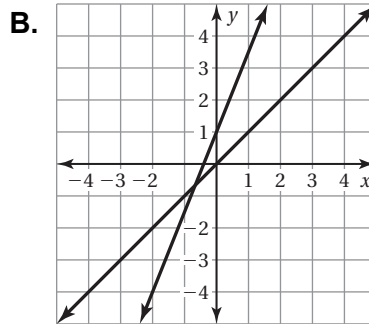
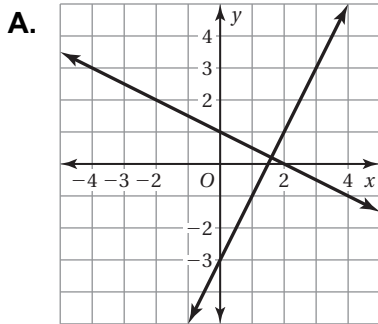
## Practice A

Match the system of linear equations with the corresponding graph. Use the graph to estimate the solution. Check your solution.

1.  $y = 2.5x + 1$   
 $y = x$

2.  $y = 2x - 3$   
 $y = -\frac{1}{2}x + 1$

3.  $y = \frac{1}{4}x - 2$   
 $y = -\frac{2}{5}x + 4$



Solve the system of linear equations by graphing.

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

5.  $y = x - 7$   
 $y = -4x + 3$

6.  $y = -x - 1$   
 $y = -3x + 9$

7. The cost  $C$  (in dollars) for beads to make bracelets is  $C = 4x + 180$ , where  $x$  is the number of bracelets. Each bracelet sells for \$34.
- Write an equation for the revenue  $R$  in terms of the number of bracelets.
  - How many bracelets need to be sold for the business to break even?
8. You have a total of 21 pens and pencils on your desk. You have 3 more pens than pencils.
- Write a system of linear equations that represents this situation.
  - How many of each do you have?

**5.1 Practice B**

Solve the system of linear equations by graphing.

1.  $x + y = 18$   
 $y = x + 12$
  2.  $y = 6x - 1$   
 $x - y = 11$
  3.  $y + x = 6$   
 $y = -1.5x + 10$
4. The cost  $C$  (in dollars) to rent the convention hall is  $C = 10x + 1500$ , where  $x$  is the number of admission tickets. Admission tickets to the convention are \$16 each.
- a. Write an equation for the revenue  $R$  in terms of the number of admission tickets.
  - b. How many admission tickets need to be sold in order for the convention to break even?

Use a graphing calculator to solve the system of linear equations.

5.  $x + 1.2y = 12.4$   
 $-1.5x + 2y = 8$
  6.  $3.4x + 1.5y = 0.4$   
 $3x - 2.4y = 7.8$
  7.  $-1.2x + 3.3y = 3.6$   
 $2.5x - 4y = -7.5$
8. A building has a total of 60 one-bedroom and two-bedroom apartments. There are twice as many one-bedroom apartments as two-bedroom apartments. How many apartments of each type are in the building? Use a system of linear equations to justify your answer.
9. Is it possible for a system of two linear equations to have no solution? Explain your reasoning.
10. The hare challenged the tortoise to a race from the water fountain to the park bench. In order to ensure a fair race, the tortoise will start 100 feet in front of the hare. The tortoise is walking at a rate of 2 feet per minute. The hare is walking at a rate of 6 feet per minute.
- a. How long will it take for the hare to catch up to the tortoise?
  - b. How long did the hare wait before walking (in order for the tortoise to walk 100 feet)?
  - c. The distance from the water fountain to the park bench is 130 feet. Who won the race?

# 5.1 Enrichment and Extension

## Solving Systems Game

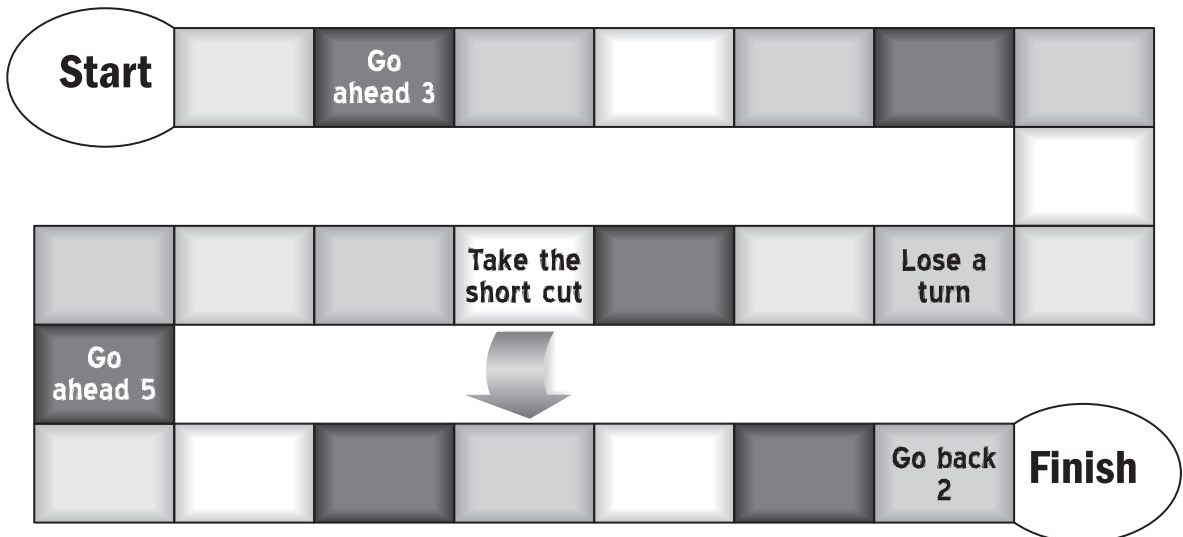
### Set Up

With a partner, create game cards with each system of equations below on a separate card. Make or find game pieces for each player.

$y = x$ $y = \frac{1}{2}x$	$y = -x + 7$ $y = 2x - 2$	$y = -2x - 1$ $x + y = 6$	$y = 2x + 3$ $y = \frac{1}{2}x + 4$	$y = -x$ $y = x + 4$
$y = \frac{3}{2}x$ $y = \frac{1}{2}x + 4$	$y = \frac{3}{5}x - 5$ $y = -\frac{1}{5}x - 1$	$y = x$ $y = 3x - 4$	$y = -x + 1$ $-y = 8x$	$y = 3x + 7$ $y = 3x - 1$
		$y = 2x + 1$ $y = -2x + 5$		$y = -x + 3$ $y = \frac{2}{3}x - 2$

### How to Play

1. The first player chooses a card, graphs the two equations, and finds the solution of the system.
2. The player calculates the sum of the  $x$ - and  $y$ -coordinates of the solution, and moves ahead that number of spaces.  
*\*\*Bonus: If there is no solution, the player can move ahead 5 spaces.\*\**
3. The players take turns. The first player to reach or pass the finish space wins.







## Puzzle Time

### Why Did The Student Eat His Homework?

A	B	C	D	E	F
G	H	I	J		

Complete each exercise. Find the answer in the answer column. Write the word under the answer in the box containing the exercise letter.

(-4, 4) <b>STUDENT</b>	<p><b>Solve the system of linear equations by graphing.</b></p> <p><b>A.</b> <math>y = x</math> <math>y = -x</math></p> <p><b>B.</b> <math>y = x + 1</math> <math>y = -x - 3</math></p> <p><b>C.</b> <math>y = 2x</math> <math>y = 4x + 2</math></p> <p><b>D.</b> <math>y = -4x + 2</math> <math>y = 2x + 2</math></p> <p><b>E.</b> <math>y = -\frac{1}{4}x + \frac{3}{4}</math> <math>y = \frac{1}{4}x - \frac{3}{4}</math></p> <p><b>F.</b> <math>y = \frac{1}{2}x - 1</math> <math>y = -x + 2</math></p> <p><b>G.</b> <math>x + y = 3</math> <math>y = x - 1</math></p> <p><b>H.</b> <math>4x + y = 12</math> <math>y = 4x + 4</math></p> <p><b>I.</b> <math>-x + y = -3</math> <math>4x + y = 2</math></p> <p><b>J.</b> At a grocery store, Candy buys 2 cantaloupes at <math>x</math> dollars each and 1 watermelon at <math>y</math> dollars. Her total bill is \$9. Chip goes to the same grocery store and buys 1 cantaloupe at <math>x</math> dollars and 1 watermelon at <math>y</math> dollars. His total bill is \$6. Write and solve a system of linear equations by graphing to find the cost <math>x</math> of a cantaloupe and the cost <math>y</math> of a watermelon.</p>	(-1, -2) <b>TOLD</b>
(0, 0) <b>THE</b>		(1, -2) <b>OF</b>
(1, 8) <b>PIECE</b>		(5, 0) <b>HERSELF</b>
(-2, 1) <b>DOG</b>		(2, 0) <b>WAS</b>
(3, 0) <b>IT</b>		(8, 1) <b>ATE</b>
(5, -3) <b>HER</b>		(2, 1) <b>A</b>
(3, 3) <b>CAKE</b>		(0, -6) <b>HOMEWORK</b>
(-3, 5) <b>ICING</b>		(-2, -1) <b>TEACHER</b>
(0, 2) <b>HIM</b>		(7, 7) <b>SAID</b>

**Activity**  
**5.2****Start Thinking!**

For use before Activity 5.2

Amelia is 3 years older than Caleb, and Caleb is 2 years more than half of Amelia's age. The system of equations represents this situation.

$$A = 3 + C$$

$$C = 2 + 0.5A$$

Solve the system of equations to find the ages of the children. Instead of graphing the equations to solve, try substituting  $2 + 0.5A$  for  $C$  into the first equation.

How old is Amelia? How old is Caleb?

**Activity**  
**5.2****Warm Up**

For use before Activity 5.2

**Complete the following exercises.**

1. Solve  $2x + y = 5$  for  $y$ .
2. Solve  $a - b = 3$  for  $b$ .
3. Solve  $5y - x = 12$  for  $x$ .
4. Solve  $3c - 7d = 12$  for  $c$ .
5. Solve  $4x + 3y = 24$  for  $y$ .
6. Solve  $2x + 3y = 4$  for  $x$ .

Solve each system first by graphing and then by substitution. Which system is easier to solve by graphing? Which system is easier to solve by substitution? Explain.

$$2x + y = 5$$

$$3x + 5y = 18$$

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

$$y = -\frac{3}{4}x - 2$$

**Write a system of linear equations that has the ordered pair as its solution.**

1.  $(1, 1)$

2.  $(4, 5)$

3.  $(6, 2)$

4.  $(2, 4)$

5.  $(5, 6)$

6.  $(3, 1)$

**5.2 Practice A**

Tell which equation you would choose to solve for one of the variables when solving the system by substitution. Explain your reasoning.

- |                 |                   |                           |
|-----------------|-------------------|---------------------------|
| 1. $y = 5x - 2$ | 2. $3x - 7y = 12$ | 3. $\frac{1}{5}x + y = 8$ |
| $2x + 9y = 10$  | $3x - 12y = 6$    | $4x - 3y = 1$             |

Solve the system of linear equations by substitution. Check your solution.

- |                |                 |                 |
|----------------|-----------------|-----------------|
| 4. $y = x + 3$ | 5. $y = 3x - 1$ | 6. $x = 5y + 2$ |
| $y = 5x - 5$   | $y = x - 7$     | $x - 4y = 5$    |

7. The gym has a total of 25 treadmills and stationary bikes. There are 7 more stationary bikes than treadmills.
- Write a system of linear equations that represents this situation.
  - How many treadmills are in the gym?
  - How many stationary bikes are in the gym?

Solve the system of linear equations by substitution. Check your solution.

- |                |                   |                   |
|----------------|-------------------|-------------------|
| 8. $x - y = 9$ | 9. $2x + 3y = 25$ | 10. $3x - 6y = 2$ |
| $2x + 5y = 4$  | $4x - y = 15$     | $4x + 3y = -1$    |

11. A drawer contains 24 spoons and forks. There are three times as many spoons as forks.
- Write a system of linear equations that represents this situation.
  - How many spoons are in the drawer?
  - How many forks are in the drawer?
12. The perimeter of a rectangle is 34 centimeters. The length is two more than twice the width. Write and solve a system of linear equations to find the length and the width of the rectangle.
13. A parking lot has a total of 60 cars and trucks. The ratio of cars to trucks is 7 : 3. How many cars are in the parking lot? How many trucks are in the parking lot? Justify your answers.

**5.2 Practice B**

Solve the system of linear equations by substitution. Check your solution.

1.  $x + 4y = -1$   
 $-3x - 14 = y$

2.  $3y = -2x$   
 $y = x - 5$

3.  $\frac{1}{2}x + 2y = 3$   
 $6y + 1 = x$

4. The revenue for a vehicle rental store is \$5460. There were 208 cars and 52 vans rented. A van rents for \$10 more than a car.
- Write a system of equations that represents this situation.
  - What is the cost of the car rental?
  - What is the cost of the van rental?

Solve the system of linear equations by substitution. Check your solution.

5.  $2x - y = 6$   
 $x = y - 1$

6.  $2x + 4y = -4$   
 $x - 3y = -12$

7.  $4x + 2y = 8$   
 $6x - 4y = 5$

8. The sum of the digits of a two-digit number is 11. The tens digit is one less than three times the ones digit. Find the original number.
9. The farmers' market has a total of 98 tents. The ratio of food tents to retail tents is 9 : 5.
- Write a system of linear equations that represents this situation.
  - How many food tents are at the farmers' market?
  - How many retail tents are at the farmers' market?
10. Forty-five children attend a preschool. The number of two-year-olds is one half the number of three-year-olds. The number of four-year-olds is the same as the number of three-year-olds.
- How many two-year-olds attend the preschool?
  - How many three-year-olds attend the preschool?
  - How many four-year-olds attend the preschool?

**5.2** Enrichment and Extension**Solving Systems of Linear Equations**

In Exercises 1–12, choose a pair of equations from the list of equations below that has the given solution.

$y = x$

$y = 2x$

$y = 3x + 4$

$y = x + 2$

$x = -2$

$y = 4x + 1$

$y = 6$

$y = -x + 6$

$y = 2x - 2$

$y = -x + 12$

$x = 1$

$y = -x$

1.  $(0, 0)$
2.  $(-2, -4)$
3.  $(6, 6)$
4.  $(-2, 14)$
5.  $(2, 4)$
6.  $(3, 3)$
7.  $(-2, 0)$
8.  $(5, 7)$
9.  $(1, 3)$
10.  $(4, 8)$
11.  $(3, 13)$
12.  $(1, 5)$
13. Write a system of equations whose solution is  $(-120, 52)$ .

# 5.2 Puzzle Time

## Where Do High Jumpers Store Their Valuables?

Write the letter of each answer in the box containing the exercise number.

Solve the system of linear equations by substitution.

1.  $y = x$   
 $y = 2x - 1$

2.  $y = -x$   
 $y = 3x - 4$

3.  $y = 5x - 6$   
 $y = 4x - 2$

4.  $x + y = 7$   
 $7x + y = 1$

5.  $-8x + y = 9$   
 $5x - y = 3$

6.  $x - y = 0$   
 $9x + y = 0$

7.  $x + y = 5$   
 $3x - y = 7$

8.  $3x - 2y = 12$   
 $4x + 2y = 16$

9.  $\frac{1}{2}x + y = 2$   
 $-x + y = 2$

10.  $\frac{1}{2}x + \frac{1}{4}y = 2$   
 $x + y = 1$

11.  $6x - y = 24$   
 $6x + y = -12$

12. There are a total of 52 students on the soccer team and the field hockey team. The field hockey team has 12 more students than the soccer team. Write a system of linear equations that fits this situation. How many students are on the soccer team  $x$  and the field hockey team  $y$ ?

Answers	
P.	(20, 32)
V.	(0, 0)
L.	(7, -6)
I.	(-1, 8)
T.	(4, 0)
U.	(4, 14)
A.	(1, -18)
N.	(1, -1)
E.	(-4, -23)
O.	(0, 2)
A.	(3, 2)
L.	(1, 1)

4	2		11		12	9	1	5		6	7	3	10	8
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**Activity**  
**5.3****Start Thinking!**

For use before Activity 5.3

Consider the following equations:  $3 + 7 = 10$

$$2 + 4 = 6$$

Add the equations.  $3 + 7 = 10$

$$\begin{array}{r} 2 + 4 = 6 \\ \hline \end{array}$$

$$5 + 11 = 16$$

Perform the operation on the given equations.

1. Subtract the second equation from the first.
2. Multiply both sides of the first equation by 2 and add it to the second equation.

Are the resulting equations true?

How can you use this method to solve the following system?

$$x + y = 10$$

$$x - y = 4$$

**Activity**  
**5.3****Warm Up**

For use before Activity 5.3

**Solve the equation.**

**1.**  $6y = 90$

**2.**  $-17x = 102$

**3.**  $9x = -144$

**4.**  $-11y = -209$

**5.**  $4x + 20 = 4$

**6.**  $-2y + 4 = -10$



**Lesson  
5.3****Start Thinking!**

For use before Lesson 5.3

Students were asked to solve the system by using elimination.

$$2x + 3y = 10$$

$$x + y = 4$$

Compare and contrast the students' work.

Maddie

$$\begin{array}{r} 2x + 3y = 10 \\ -2(x + y = 4) \\ \hline 2x + 3y = 10 \\ -2x - 2y = -8 \\ \hline y = 2 \end{array}$$

$$\begin{array}{r} 2x + 3(2) = 10 \\ 2x = 4 \\ x = 2 \end{array}$$

The solution is (2, 2).

Sophie

$$\begin{array}{r} 2x + 3y = 10 \\ -3(x + y = 4) \\ \hline 2x + 3y = 10 \\ -3x - 3y = -12 \\ \hline -x = -2 \\ x = 2 \end{array}$$

$$\begin{array}{r} 2(2) + 3y = 10 \\ 3y = 6 \\ y = 2 \end{array}$$

The solution is (2, 2).

**Lesson  
5.3****Warm Up**

For use before Lesson 5.3

**Solve the system by adding or subtracting the equations.**

1.  $x + y = 10$

$$x - y = 7$$

3.  $2x - 3y = 14$

$$2x + 4y = 21$$

2.  $x + 2y = 8$

$$-x + 2y = 20$$

4.  $3x + y = -5$

$$2x - y = 10$$

**5.3 Practice A**

**Solve the system of linear equations by elimination. Check your solution.**

1.  $x - y = 4$   
 $x + y = 2$
  2.  $x + 3y = 5$   
 $2x - 3y = 1$
  3.  $4x - y = 7$   
 $4x - 2y = 2$
4. You purchase 5 pounds of apples and 2 pounds of oranges for \$9. Your friend purchases 5 pounds of apples and 6 pounds of oranges for \$17.
- a. Write a system of linear equations that represents this situation.
  - b. What is the price per pound for apples?
  - c. What is the price per pound for oranges?

**Solve the system of linear equations by elimination. Check your solution.**

5.  $2x + 3y = -2$   
 $3x - y = -14$
  6.  $x - 3y = 1$   
 $4x + 5y = 4$
  7.  $3x - 5y = 9$   
 $6x - 6y = 6$
8. A 100-point test contains a total of 20 questions. The multiple choice questions are worth 3 points each and the short response questions are worth 8 points each.
- a. Write a system of linear equations that represents this situation.
  - b. How many multiple choice questions are on the test?
  - c. How many short response questions are on the test?
  - d. If the teacher changed the test to 15 questions, then how many of each type of question would be on the test?
9. One customer purchases 8 bags of cat food and 2 bags of dog food. The total weight of the purchase is 44 pounds. Another customer purchases 5 bags of cat food and 2 bags of dog food. The total weight of the purchase is 35 pounds.
- a. You write the following system of linear equations to represent this situation. Is your answer correct?  
$$8x + 2y = 44$$
$$5x + 2y = 35$$
  - b. Your answer for the next step is  $13x = 79$ , which is incorrect. Explain the error.

**5.3 Practice B**

Solve the system of linear equations by elimination. Check your solution.

1.  $3x - y = 0$                       2.  $2x - 4y = -2$                       3.  $x + 3y = 17$   
 $-3x + 5y = 0$                        $2x + 3y = -16$                        $-2x + 3y = -7$

4. You and your friend are selling magazine subscriptions. You sell 8 fewer magazine subscriptions than your friend. Together you sell 42 magazine subscriptions.
- Write a system of linear equations that represents this situation.
  - How many magazine subscriptions did you sell?
  - How many magazine subscriptions did your friend sell?

Solve the system of linear equations by elimination. Check your solution.

5.  $2x + 5y = -3$                       6.  $2y = -5x - 3$                       7.  $3y = x - 6$   
 $3x - y = 21$                        $4x - 2 = -6y$                        $2x = 3y + 3$

8. For what values of  $a$  and  $b$  should you solve the system by elimination?
- $3x + 5y = 10$   
 $2x + ay = 4$
  - $-4x - 3y = 9$   
 $bx + 7y = 2$
9. Your friend rents 10 chairs and 2 tables for \$300. Another friend rents 8 chairs and 4 tables for \$360. You want to rent 12 chairs and 3 tables. How much do you expect to pay?
10. One equation in a system of linear equations is  $x - 3y = 1$ . The solution of the system of linear equations is  $(4, 1)$ .
- Find the value of  $a$  such that the equation  $2x + ay = 5$  is the second equation in the system.
  - Find the value of  $b$  such that the equation  $bx + 5y = 1$  is the second equation in the system.
  - Find the value of  $c$  such that the equation  $2x - 7y = c$  is the second equation in the system.

## 5.3 Enrichment and Extension

### Which Method is Best?

You have learned about three different methods to solve systems of linear equations: graphing, substitution, and elimination. Complete the following exercises.

1. Explain when it is best to use each method.
2. Discuss the advantages and disadvantages of each method.
3. Which method is your favorite? Explain your answer.

Tell which method—*graphing, substitution, or elimination*—is best to solve the system. Then find the solution using that method.

4.  $y = 2x + 5$   
 $y = -x + 2$

6.  $-6x - y = -6$   
 $-2x + 14 = y$

8.  $2x - 3y = -18$   
 $-2x + 5y = 26$

10.  $x + 2y = -15$   
 $3x - y = -17$

5.  $3x + 4y = 36$   
 $-2x + 2y = 4$

7.  $y = x$   
 $y = 2x - 3$

9.  $2x - 3y = 15$   
 $-4x + 3y = -9$

11.  $y = x + 1$   
 $2x - 3y = -3$



## Puzzle Time

### Does It Take Longer To Run From First Base To Second Base Or From Second Base To Third Base?

A	B	C	D	E	F
G	H	I	J		

Complete each exercise. Find the answer in the answer column. Write the word under the answer in the box containing the exercise letter.

(2, 9) <b>BECAUSE</b>	<p><b>Solve the system of linear equations by elimination.</b></p> <p><b>A.</b> <math>x + y = 6</math> <math>x - y = 2</math></p> <p><b>B.</b> <math>x + 5y = 15</math> <math>-x - 2y = 0</math></p> <p><b>C.</b> <math>3x + 4y = 5</math> <math>3x - 4y = -11</math></p> <p><b>D.</b> <math>-x - 2y = 9</math> <math>x + 4y = 9</math></p> <p><b>E.</b> <math>x - 6y = -11</math> <math>8x + 6y = 20</math></p> <p><b>F.</b> <math>3x + 2y = 24</math> <math>-x + 2y = 16</math></p> <p><b>G.</b> <math>4x + 9y = -12</math> <math>4x - 7y = 20</math></p> <p><b>H.</b> <math>3x + 7y = 9</math> <math>4x - 7y = 12</math></p> <p><b>I.</b> <math>2x + 5y = 4</math> <math>4x + 7y = 11</math></p> <p><b>J.</b> The local theater is showing a matinee and offering a special deal for the community. A ticket for an adult costs \$11 and a ticket for a child costs \$6. The theater sells a total of 60 tickets and collects \$460. How many adult tickets <math>x</math> and children tickets <math>y</math> are sold?</p>	(-1, 2) <b>TO</b>
$(\frac{9}{2}, -1)$ <b>A</b>		(0, 0) <b>BAT</b>
(-2, 1) <b>REFEREE</b>		(6, 0) <b>HOMERUN</b>
(4, 2) <b>SECOND</b>		(1, 2) <b>BASE</b>
(5, 5) <b>CATCHER</b>		(20, 40) <b>SHORTSTOP</b>
(-27, 9) <b>THIRD</b>		(2, 4) <b>MITT</b>
(0, 3) <b>FIRST</b>		$(\frac{3}{2}, -2)$ <b>THERE</b>
(-9, 8) <b>BALL</b>		(5, -6) <b>FOUL</b>
(3, 0) <b>IS</b>		(-10, 5) <b>BASE</b>

**Activity**  
**5.4****Start Thinking!**

For use before Activity 5.4

Consider the system:

$$x + y = 2$$

$$x + y = 5$$

Are there any two numbers  $x$  and  $y$  that add up to 2 *and* add up to 5? Is there a solution to the system?

Can you write a different system of equations that has no solution?

**Activity**  
**5.4****Warm Up**

For use before Activity 5.4

**Tell whether the lines are *parallel*, *coincide*, or *intersect at one point*.**

**1.**  $y = x - 3$

$y = x + 1$

**2.**  $x + 3y = 9$

$2x + 6y = 18$

**3.**  $y = 2x + 5$

$2x + y = 5$

**4.**  $-8x = 4y + 12$

$3y = -6x - 9$

**5.**  $-4x + 2y = 4$

$2x + 4y = -4$

**6.**  $6x = -9y + 18$

$10x + 15y = 15$

How is solving a linear equation with no solution similar to solving a system of linear equations with no solution? How is it different?

How is solving a linear equation whose solution is all real numbers similar to solving a system of linear equations with infinitely many solutions? How is it different?

**Let  $x$  and  $y$  be two numbers. Find the solution of the puzzle.**

- $y$  is 10 more than twice  $x$ .  
The difference of  $16x$  and  $8y$  is 12.
- $x$  is 3 less than  $y$ .  
The sum of  $2x$  and  $2y$  is 4.
- The sum of  $x$  and  $y$  is 10.  
The difference of  $2x$  and 20 is equal to twice  $y$ .
- 5 less than  $2y$  is  $6x$ .  
 $y$  is 2 more than  $3x$ .

**5.4 Practice A**

Without graphing, determine whether the system of linear equations has *one solution*, *infinitely many solutions*, or *no solution*. Explain your reasoning.

1.  $y - 3x = 5$   
 $y = 3x + 5$

2.  $y = 6x + 2$   
 $y = 6x - 2$

3.  $y = 5x + 9$   
 $y = 3x - 2$

Solve the system of linear equations. Check your solution.

4.  $y = 4x - 5$   
 $y + 2 = 4x$

5.  $y = 2 - 3x$   
 $2x - y = 13$

6.  $y = \frac{2}{3}x - 3$   
 $2x - 3y = 9$

7. A gift basket has 2 soaps and 5 lotions and costs \$20. A second gift basket has 6 soaps and 15 lotions and costs \$50. Is it possible to determine the price of the soap?
8. Both equations in a system of linear equations have  $y$ -intercepts at  $(0, 2)$ .
- Is it possible for this system to have only *one solution*? Explain your reasoning.
  - Is it possible for this system to have *no solution*? Explain your reasoning.
  - Is it possible for this system to have *infinitely many solutions*? Explain your reasoning.
9. For a given two-digit number, the second digit is 2 more than 5 times the first digit. Also, 5 times the first digit is 3 more than the second digit. Find the two-digit number.
10. Find the values of  $a$  and  $b$  so the system shown has infinitely many solutions.
- $$2x + 9y = 3$$
- $$4x + ay = b$$



**5.4 Practice B**

Solve the system of linear equations. Check your solution.

1.  $y = \frac{1}{4}x - 1$

$y = \frac{1}{4}x + 5$

2.  $y = -2x - 1$

$5x + 2y = -5$

3.  $3\left(x - \frac{2}{3}y\right) = 4$

$3x + 5 = 2y$

4.  $\pi x - 2y = 2\pi$

$y = \frac{\pi}{2}x - \pi$

5.  $x = 2y$

$6y + 3x = 0$

6.  $4x + 3y = 10$

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

7.  $y$  is 6 less than 3 times  $x$ .  $x$  is 2 more than one-third of  $y$ . Find the solution of the puzzle.
8. Both equations in a system of linear equations have a slope of  $\frac{1}{2}$ . Does this system have infinitely many solutions? Explain.
9. You and a friend go to a farmers' market. You spend \$13 on fruit. Then you and your friend each buy the same number of tomato plants for \$4 each.
- Write a system of linear equations that represents this situation.
  - Will you and your friend spend the same amount of money? Explain.
10. Write a system of linear equations that has infinitely many solutions.
11. Write a system of linear equations that has the solution  $(2, 1)$ .
12. Write a system of linear equations that has no solution.
13. Find the values of  $a$  and  $b$  so the system shown has no solution.

$5x = 2y + 1$

$ax = 6y + b$

**5.4** Enrichment and Extension**Solving Special Systems of Linear Equations**

Find the values of  $a$  and  $b$  so that the system shown has the given solution.

1.  $y = ax - 5$   
 $y = -2x - b$

The solution is  $(2, -3)$ .

3.  $y = 2x + b$   
 $y = ax + 3$

The solution is  $(-1, 4)$ .

5.  $y = 3x + 1$   
 $y = ax + b$

There is no solution.

7.  $x + y = b$   
 $ax + 3y = 13$

The solution is  $(4, 7)$ .

2.  $y = \frac{1}{2}x + b$

$y = ax - 2$

The system has infinitely many solutions.

4.  $y = -2x + b$   
 $y = ax - 1$

The solution is  $(1, 0)$ .

6.  $y = ax + 4$   
 $y = \frac{1}{2}x + b$

The solution is  $(6, 6)$ .

8.  $y = 12x - b$   
 $-ax + y = 4$

The system has infinitely many solutions.

9. Write a system of linear equations in  $x$  and  $y$  that contains unknown values  $a$  and  $b$  and that has infinitely many solutions. Exchange problems with a partner and see if your partner can find the values of  $a$  and  $b$ .



## 5.4 Puzzle Time

### What Should You Do When a Bull Charges You?

Write the letter of each answer in the box containing the exercise number.

**Solve the system of linear equations.**

1.  $x - y = 5$   
 $-x + y = 5$

H. infinitely many    I. no solution    J. (0, 5)    K. (5, 0)

2.  $4x - 3y = 5$   
 $-8x + 6y = -10$

A. infinitely many    B. no solution    C. (4, -3)    D. (-3, 4)

3.  $-7x - 7y = -14$   
 $x + y = -2$

L. infinitely many    M. no solution    N. (2, 0)    O. (0, 2)

4.  $2x + y = 5$   
 $x - y = 1$

W. infinitely many    X. no solution    Y. (2, 1)    Z. (1, 2)

5.  $3x + 9y = 12$   
 $-x - 3y = -4$

H. infinitely many    I. no solution    J. (3, 9)    K. (9, 3)

6.  $2x - 3y = 8$   
 $4x - 6y = 16$

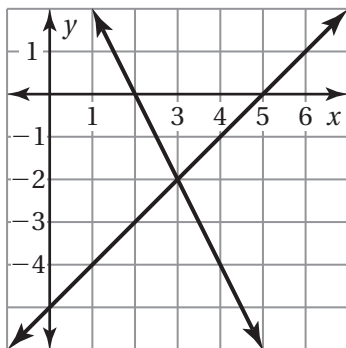
P. infinitely many    Q. no solution    R.  $\left(4, \frac{8}{3}\right)$     S.  $\left(\frac{8}{3}, 4\right)$

6	2	4		5	1	3
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**Extension**  
**5.4****Start Thinking!**

For use before Extension 5.4

How does the graph below relate to the equation  $-2x + 4 = x - 5$ ?

**Extension**  
**5.4****Warm Up**

For use before Extension 5.4

**Solve the equation. Check your solution.**

1.  $m - 8 = 2m$

2.  $3x - 5 = 2x + 1$

3.  $12 - 4p = p - 3$

4.  $2(x - 8) = -x + 5$

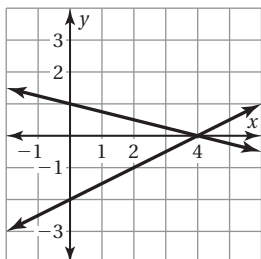
5.  $-2r - 9 = -3(r + 2)$

6.  $4(x + 8) = -2(x - 1)$

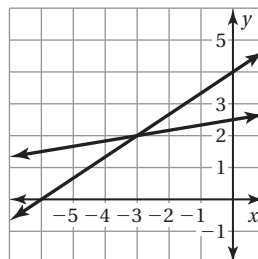
## Extension 5.4 Practice

Solve the equation algebraically and graphically.

1.  $\frac{1}{2}x - 2 = -\frac{1}{4}x + 1$



2.  $\frac{2}{3}x + 4 = \frac{1}{6}x + \frac{5}{2}$



Use a graph to solve the equation. Check your solution.

3.  $x + 4 = -2x + 7$

4.  $\frac{1}{2}x + \frac{9}{2} = -5x - 1$

5. You have  $4x + 10$  CDs and your friend has  $5x + 22$  CDs. Is it possible that you both have the same number of CDs? Explain your reasoning.

Use a graph to solve the equation. Check your solution.

6.  $0.75x = 2x - 10$

7.  $1.2x + 4.8 = -0.8x - 0.2$

8. One tank contains 50 gallons of water and another tank contains 75 gallons of water. Water is draining out of both tanks at a rate of 6 gallons per minute. Do the tanks ever have the same amount of water before either is empty? Explain.

9. You and your friend sell lemonade. You get  $\frac{1}{3}$  of the total money collected.

Your friend gets \$20 less than the total money collected.

- a. Write an equation to represent that you both earn the same amount of money.
- b. What is the total amount of money collected?
- c. How much does each of you earn?
- d. Describe a situation to explain the unclaimed money.

# Chapter 5

## Technology Connection

For use after Section 5.1

### Solving a Linear System

You can use the *intersect* feature of a graphing calculator to solve a system of two linear equations.

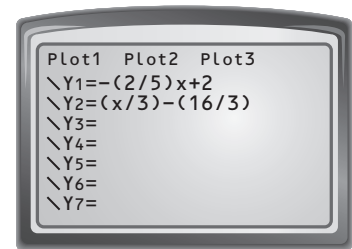
**EXAMPLE** Solve the system:  $2x + 5y = 10$   
 $x - 3y = 16$

#### SOLUTION

**Step 1** Rewrite each equation in slope-intercept form.

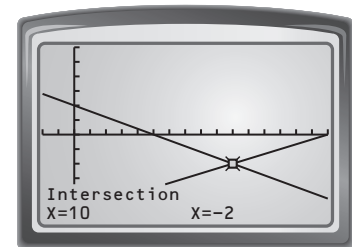
$$y = -\frac{2}{5}x + 2$$

$$y = \frac{x}{3} - \frac{16}{3}$$



**Step 2** Press  $\boxed{Y=}$  and enter the equations in Y1 and Y2.

**Step 3** Press  $\boxed{\text{GRAPH}}$  to graph the system. Adjust the viewing window until the point of intersection is visible.



**Step 4** Press  $\boxed{2\text{nd}} \boxed{[CALC]} \boxed{5}$  to use the *intersect* feature.

The solution is  $(10, -2)$ .

**Solve the system using a graphing calculator.**

1.  $y = 5x - 8$

$$y = \frac{x}{3} + 6$$

2.  $y = -3$

$$2x + 4y = -7$$

3.  $-2x + 6y = 2$

$$9x - 7y = -9$$

4.  $y - \frac{2}{3}x = 4$

$$5x + \frac{y}{2} = -62$$