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5.3 Solving Systems of Linear Equations by Elimination

For use with Exploration 5.3

Essential Question How can you use elimination to solve a system of linear equations?

1 EXPLORATION: Writing and Solving a System of Equations

Work with a partner. You purchase a drink and a sandwich for $4.50. Your friend purchases a drink and five sandwiches for $16.50. You want to determine the price of a drink and the price of a sandwich.

a. Let x represent the price (in dollars) of one drink. Let y represent the price (in dollars) of one sandwich. Write a system of equations for the situation. Use the following verbal model.

$$\begin{array}{l}\text{Number}\\ \text{of drinks}\end{array} \bullet \begin{array}{l}\text{Price}\\ \text{per drink}\end{array} + \begin{array}{l}\text{Number of}\\ \text{sandwiches}\end{array} \bullet \begin{array}{l}\text{Price per}\\ \text{sandwich}\end{array} = \begin{array}{l}\text{Total}\\ \text{price}\end{array}$$

Label one of the equations Equation 1 and the other equation Equation 2.

b. Subtract Equation 1 from Equation 2. Explain how you can use the result to solve the system of equations. Then find and interpret the solution.

2 EXPLORATION: Using Elimination to Solve Systems

Work with a partner. Solve each system of linear equations using two methods.

Method 1 **Subtract.** Subtract Equation 2 from Equation 1.Then use the result to solve the system.

Method 2 **Add.** Add the two equations. Then use the result to solve the system.

Is the solution the same using both methods? Which method do you prefer?

a. $3x - y = 6$
$3x + y = 0$

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

c. $x - 2y = -7$
$x + 2y = 5$

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3 EXPLORATION: Using Elimination to Solve a System

Work with a partner.

$2x + y = 7$ Equation 1

$x + 5y = 17$ Equation 2

a. Can you eliminate a variable by adding or subtracting the equations as they are? If not, what do you need to do to one or both equations so that you can?

b. Solve the system individually. Then exchange solutions with your partner and compare and check the solutions.

Communicate Your Answer

4. How can you use elimination to solve a system of linear equations?

5. When can you add or subtract the equations in a system to solve the system? When do you have to multiply first? Justify your answers with examples.

6. In Exploration 3, why can you multiply an equation in the system by a constant and not change the solution of the system? Explain your reasoning.

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5.3 Practice
For use after Lesson 5.3

Core Concepts

Solving a System of Linear Equations by Elimination

Step 1 Multiply, if necessary, one or both equations by a constant so at least one pair of like terms has the same or opposite coefficients.

Step 2 Add or subtract the equations to eliminate one of the variables.

Step 3 Solve the resulting equation.

Step 4 Substitute the value from Step 3 into one of the original equations and solve for the other variable.

Notes:

Worked-Out Examples

Example #1

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

$5x + 6y = 50$

$x - 6y = -26$

Step 2

$$\begin{aligned} 5x + 6y &= 50 \\ x - 6y &= -26 \\ \hline 6x + 0 &= 24 \end{aligned}$$

Step 3

$$\begin{aligned} 6x &= 24 \\ \frac{6x}{6} &= \frac{24}{6} \\ x &= 4 \end{aligned}$$

Step 4

$$\begin{aligned} x - 6y &= -26 \\ 4 - 6y &= -26 \\ -4 \quad & \quad -4 \\ -6y &= -30 \\ \frac{-6y}{-6} &= \frac{-30}{-6} \\ y &= 5 \end{aligned}$$

Check

$$\begin{aligned} 5x + 6y &= 50 \\ 5(4) + 6(5) &\stackrel{?}{=} 50 \\ 20 + 30 &\stackrel{?}{=} 50 \\ 50 &= 50 \checkmark \end{aligned} \qquad \begin{aligned} x - 6y &= -26 \\ 4 - 6(5) &\stackrel{?}{=} -26 \\ 4 - 30 &\stackrel{?}{=} -26 \\ -26 &= -26 \checkmark \end{aligned}$$

The solution is (4, 5).

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5.3 Practice (continued)

Example #2

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

$10x - 9y = 46$

$-2x + 3y = 10$

Step 1

$10x - 9y = 46$

$-2x + 3y = 10$ Multiply by 5.

Step 2

$10x - 9y = 46$

$-10x + 15y = 50$

$0 + 6y = 96$

Step 3

$6y = 96$

$\frac{6y}{6} = \frac{96}{6}$

$y = 16$

Step 4

$-2x + 3y = 10$

$-2x + 3(16) = 10$

$-2x + 48 = 10$

$-48 \quad -48$

$-2x = -38$

$\frac{-2x}{-2} = \frac{-38}{-2}$

$x = 19$

Check

$10x - 9y = 46$

$10(19) - 9(16) \stackrel{?}{=} 46$

$190 - 144 \stackrel{?}{=} 46$

$46 = 46$ ✓

$-2x + 3y = 10$

$-2(19) + 3(16) \stackrel{?}{=} 10$

$-38 + 48 \stackrel{?}{=} 10$

$10 = 10$ ✓

The solution is (19, 16).

Practice A

In Exercises 1–18, solve the system of linear equations by elimination. Check your solution.

1. $x + 3y = 17$
$-x + 2y = 8$

2. $2x - y = 5$
$5x + y = 16$

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

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

5. $5x + 2y = -28$
$-5x + 3y = 8$

6. $2x - 5y = 8$
$3x + 5y = -13$

7. $2x + y = 12$
$3x - 18 = y$

8. $4x + 3y = 14$
$2y = 6 + 4x$

9. $-4x = -2 + 4y$
$-4y = 1 - 4x$

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5.3 Practice (continued)

10. $x + 2y = 20$
$2x + y = 19$

11. $3x - 2y = -2$
$4x - 3y = -4$

12. $9x + 4y = 11$
$3x - 10y = -2$

13. $4x + 3y = 21$
$5x + 2y = 21$

14. $-3x - 5y = -7$
$-4x - 3y = -2$

15. $8x + 4y = 12$
$7x + 3y = 10$

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

17. $8x - 3y = -9$
$5x + 4y = 12$

18. $-3x + 5y = -2$
$2x - 2y = 1$

19. The sum of two numbers is 22. The difference is 6. What are the two numbers?

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Practice B

In Exercises 1–6, solve the system of linear equations by elimination. Check your solution.

1. $2x + y = 10$
$5x - y = 11$

2. $-3x + 2y = 14$
$4x - 2y = -16$

3. $x + 2y = 7$
$13 - 5y = x$

4. $10x - 11 = -3y$
$5y - 5 = -10x$

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

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

In Exercises 7–12, solve the system of linear equations by elimination. Check your solution.

7. $3x - 4y = 19$
$6x + 9y = 21$

8. $4x + 5y = 3$
$-3x + 2y = 38$

9. $8x + 2y = 22$
$5x - 3y = 35$

10. $4x + 7y = 1$
$6x - 3y = 15$

11. $21x - 11y = -9$
$-14x + 8y = 4$

12. $3x + 6y = 6$
$-2x - 9y = -24$

13. Describe and correct the error in solving for one of the variables in the linear system $4x + 5y = -10$ and $2x - 4y = 9$.

✗

Step 1 $4x + 5y = -10$
$2x - 4y = 9$

Step 2 (Multiply by 2.)
$4x + 5y = -10$
$4x - 8y = 18$

Step 3 $-3y = 8$
$y = -\frac{8}{3}$

In Exercises 14–16, solve the system of linear equations using any method. Explain why you chose the method.

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

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

16. $4x - 5y = -3$
$14x + 2y = 9$

17. You and your friend are making 30 liters of sodium water. You have liters of 10% sodium and your friend has liters of 22% sodium. How many of your liters and how many of your friend's liters should you mix to make 30 liters of 15% sodium?