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## LESSON

## 4

# Solving Systems of Equations by Substitution

Another way to solve systems of equations algebraically is the substitution method. In **substitution**, one equation is written in terms of a single variable. Then the expression equal to that variable is substituted into the other equation.

What is the solution to this system of equations?

$$\begin{cases} x - 3y = 2 \\ 2x - 5y = 2 \end{cases}$$

Set the first equation equal to  $x$ .

$$x - 3y = 2 \rightarrow x = 3y + 2$$

Substitute  $3y + 2$  for  $x$  in the second equation.

$$2(3y + 2) - 5y = 2$$

Solve the equation for  $y$ .

$$\begin{aligned} 2(3y + 2) - 5y = 2 &\rightarrow 6y + 4 - 5y = 2 \\ y + 4 &= 2 \\ y &= -2 \end{aligned}$$

Substitute  $y = -2$  into either equation in the system. Solve for  $x$ .

$$\begin{aligned} x - 3(-2) &= 2 \\ x + 6 &= 2 \\ x &= -4 \end{aligned}$$

Check that  $x = -4$  and  $y = -2$ , or  $(-4, -2)$ , is the solution.

Substitute both values into each equation. See if the equations are both true.

$$\begin{array}{ll} x - 3y = 2 & 2x - 5y = 2 \\ -4 - 3(-2) = 2 & 2(-4) - 5(-2) = 2 \\ -4 + 6 = 2 & -8 + 10 = 2 \\ 2 = 2 \text{ true} & 2 = 2 \text{ true} \end{array}$$

Both equations are true, so  $(-4, -2)$  is the solution.

It doesn't matter which equation or which variable,  $x$  or  $y$ , you choose to solve for. You should still be able to find the solution.

It is easier to solve for a variable that has 1 as a coefficient.

$$1x = x$$

Remember to fully distribute the factor into each term within the parentheses.

$$\begin{aligned} 4(2x + 7) &= 4(2x) + 4(7) \\ &= 8x + 28 \end{aligned}$$

Remember that some systems of equations can have no solution or infinitely many solutions.

For systems with no solution, the substituted equation would result in  $a = b$ , which is false.

For systems with infinitely many solutions, the substituted equation would result in  $a = a$ , which is always true.

## GUIDED PRACTICE

Read and solve each problem.

- 1 Look at this system of equations.

$$\begin{cases} y = x + 2 \\ y = 5x - 2 \end{cases}$$

What is the solution to this system?

- A (1, 3)
- B (-1, 3)
- C (3, 1)
- D (3, -1)

Set the value of  $y$  in one equation equal to the value of  $y$  in the other equation.

- 2 Which best describes the solution to  $\begin{cases} 6x + 3y = 4 \\ 2x + y = 2 \end{cases}$ ?

- A (0, 0)
- B (4, 2)
- C no solution
- D infinitely many solutions

The second equation has a  $y$ -term with a coefficient of 1, so solve the second equation for  $y$ .

- 3 What is the solution to this system of equations? Show your work.

$$\begin{cases} x + y = 5 \\ x = y + 5 \end{cases}$$

Which expression is equal to a variable in the other equation?

Answer \_\_\_\_\_

## TEST YOURSELF

Read and solve each problem.

- 1 Is  $(-5, 3)$  a solution to this system of equations?

$$\begin{cases} x + y = -2 \\ -2x + y = 13 \end{cases}$$

- A** Yes, because it is a solution to both equations.
- B** No, because it is not a solution to the first equation.
- C** No, because it is not a solution to the second equation.
- D** No, because it is not a solution to either equation.

- 2 Look at this system of equations.

$$\begin{cases} x + 4y = 3 \\ y = x - 8 \end{cases}$$

What is the solution to this system?

- A**  $(-1, -1)$                       **C**  $(1, -1)$
- B**  $(-1, 7)$                         **D**  $(7, -1)$
- 6 What is the solution to this system of equations?  
Show your work.

$$\begin{cases} -x - 2y = -3 \\ 3x + 3y = 0 \end{cases}$$

Answer \_\_\_\_\_

- 3 What is the solution to this system of equations?

$$\begin{cases} x = 2y - 1 \\ x = y + 3 \end{cases}$$

- A**  $(2, 5)$                               **C**  $(5, 2)$
- B**  $(4, 7)$                               **D**  $(7, 4)$

- 4 What is the solution to this system of equations?

$$\begin{cases} 2x = -6y + 4 \\ 3x + 9y = 6 \end{cases}$$

- A**  $(0, 0)$
- B**  $(2, 0)$
- C** no solution
- D** infinitely many solutions

- 5 What is the solution to this system of equations?

$$\begin{cases} x = -3y - 2 \\ y = x + 2 \end{cases}$$

- A**  $(2, 0)$                               **C**  $(0, 2)$
- B**  $(-2, 0)$                             **D**  $(0, -2)$

7 Look at this system of equations.

$$\begin{cases} x + y = -2 \\ 2x + y = 3 \end{cases}$$

**Part A** What is the solution to this system of equations?

**Answer** \_\_\_\_\_

**Part B** Explain how you found your answer.

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8 Lamont wrote this system of equations.

$$\begin{cases} x = 2y + 2 \\ y = x + 1 \end{cases}$$

**Part A** Lamont started to solve this system of equations using the equation  $2y + 2 = x + 1$ . Will this equation help him get the solution to this system of equations? Explain how you know.

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**Part B** What is the solution? Show your work.

**Answer** \_\_\_\_\_

