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# **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*.

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

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

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

Solve the equation for y.

$$2(3y + 2) - 5y = 2$$
  $\rightarrow$   $6y + 4 - 5y = 2$   
 $+ 4 = 2$ 

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

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

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.

$$x - 3y = 2$$
  
 $-4 - 3(-2) = 2$   
 $-4 + 6 = 2$   
 $2x - 5y = 2$   
 $2(-4) - 5(-2) = 2$   
 $-8 + 10 = 2$   
 $2 = 2$  true

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.

$$4(2x + 7) = 4(2x) + 4(7)$$
$$= 8x + 28$$

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.

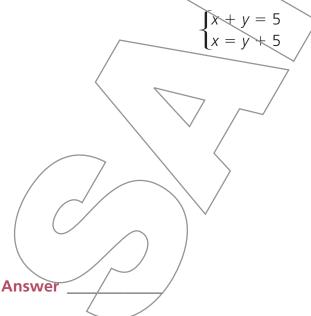
1 Look at this system of equations.

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

What is the solution to this system?

- **A** (1, 3)
- **B** (-1, 3)
- **C** (3, 1)
- **D** (3, -1)
- 2 Which best describes the solution to  $\begin{cases} 6x + 3 \\ 2x + y \end{cases}$ 
  - A (0, 0)
  - **B** (4, 2)
  - **C** no solution
  - **D** infinitely many solutions

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



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

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

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

#### 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.
- 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)
- **B** (-1, 7)

3 What is the solution to this system of equations?

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

- **A** (2, 5)
- (5, 2)
- (4, 7)
- What is the solution to this system of equations?

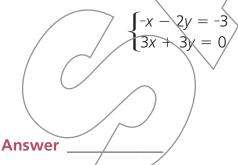
$$\begin{cases} 2x = -6y + 4 \\ 3x + 9y = 6 \end{cases}$$

- $(0, \emptyset)$
- (2, 0)
- no solution
- 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)

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



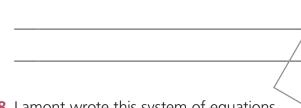
7 Look at this system of equations.

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

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

Answer \_\_\_\_

Part B Explain how you found your answer.



8 Lamont wrote this system of equations.

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

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



Part B What is the solution? Show your work.

