

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## SOLVING SYSTEMS ALGEBRAICALLY BY SUBSTITUTION

### COMMON CORE ALGEBRA I



There are a variety of ways that we solve a system of equations. In the last lesson we saw how to solve them graphically. In this lesson we will review and understand the basis for solving them by a method known as **substitution**. You have seen this technique in Common Core 8<sup>th</sup> Grade mathematics, but here we will explore it more deeply.

**Exercise #1:** Consider the system given below and its solution  $x = 4$  and  $y = 1$ .

(a) Show that  $(4, 1)$  is a solution to the system.

$$2x + y = 9$$

$$y = x - 3$$

(b) Substitute  $x - 3$  in for  $y$  in the first equation and show that the point  $(4, 1)$  is still a solution to this new equation.

(c) Solve the system by finishing the substitution from (b).

Substitution is a very important technique and we want to be very good at it. It boils down to one of the most important properties of equality:

**EQUALS MAY ALWAYS SUBSTITUTE FOR EQUALS**

**Exercise #2:** Solve the following systems of equations by substitution.

(a)  $y = 2x + 5$

(b)  $4x - 2y = 16$

$$y = -3x - 10$$

$$y = -5x + 13$$



The algebra of systems allows us to solve all sorts of problems that almost seem like riddles.

**Exercise #3:** Max and his father Kirk are comparing their ages. They know that the sum of their ages is 52 and that Kirk is seven years older than four times Max's age.

- (a) If Max's age is represented by  $m$  and Kirk's age by  $k$ , write a system of equations that describes the two relationships from the problem.
- (b) Solve the system using substitution to find both of their ages.

**Exercise #4:** Two cell phone plans offer differing text packages. The two plans are outlined below:

Plan A: \$5.00 per month charge along with a charge of \$0.03 per text.

Plan B: No per month charge, but a charge of \$0.10 per text.

Is there a certain number of texts, when the two plans cost the same amount? Determine your answer by setting up a system of equations that model the two plans.

**Exercise #5:** A man and a woman start 380 feet away from each other and walk in a straight line towards each other. If she is walking at a rate of 6 feet per second and he is walking at a rate of 2 feet per second, when will they meet?



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**SOLVING SYSTEMS BY SUBSTITUTION**  
**COMMON CORE ALGEBRA I HOMEWORK**

**FLUENCY**

1. Solve each of the following system of equations by substitution.

(a)  $y = x + 8$

$y = 4x - 1$

(b)  $y = -3x + 5$

$2x + y = 6$

(c)  $4x + 3y = 37$

$y = x - 4$

(d)  $x - 5y = -49$

$y = -2x + 1$

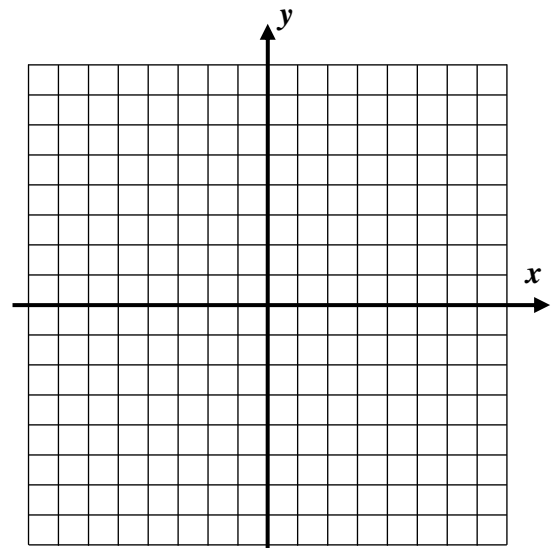
2. Given the system shown below do the following:

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

$$y = -3x + 5$$

(a) Solve this system graphically using the grid shown.

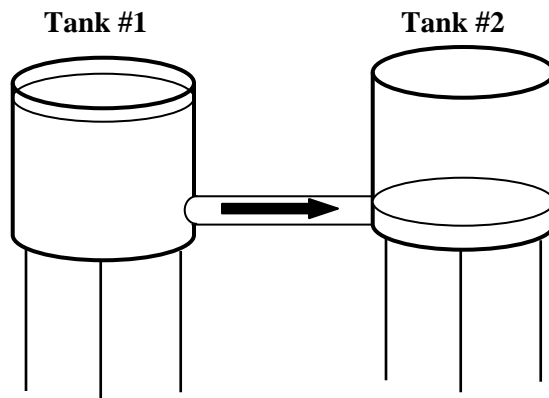
(b) Solve this system by substitution. Show your work.



## APPLICATIONS

3. Water is flowing from Tank #1 to Tank #2 as shown in the picture. Originally, Tank #1 had 1,540 gallons in it and Tank #2 had 236 gallons in it. Water is draining out of Tank #1 at a rate of 6 gallons per minute and, thus, filling Tank #2 up at a rate of 6 gallons per minute.

- (a) Write an equation for each tank that models the volume of water,  $v$  in gallons, as a function of the number of minutes,  $m$ , that the water has been flowing.



Tank #1: \_\_\_\_\_

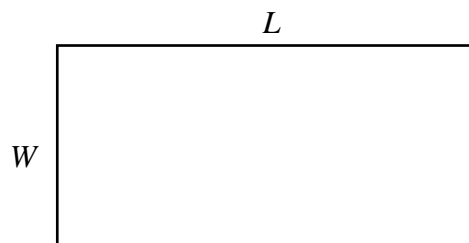
Tank #2: \_\_\_\_\_

- (b) Find out how long it takes, to the nearest minute, for the two tanks to have the same number of gallons. Will it take longer or shorter than 2 hours? Justify.

4. A rectangle has a perimeter of 42 feet. Its length,  $L$ , is three feet more than twice its width,  $W$ .

- (a) Create an equation in terms of  $L$  and  $W$  for the perimeter of the rectangle.

- (b) Create an equation that relates  $L$  and  $W$  based on the length being three feet more than twice the width.



- (c) Solve the system of equations that you just created by substitution to find the values of the length and width.

## REASONING

5. Assuming that  $a \neq c$ , find the  $x$ -value of the intersection point of the lines  $y = ax + b$  and  $y = cx + d$ .

