# 3- Solving by Substitution

January 6, 2019 6:08 PM

## 3) Solving by Substitution

**Warm-Up:** Solve the system of equations graphically and verify algebraically..

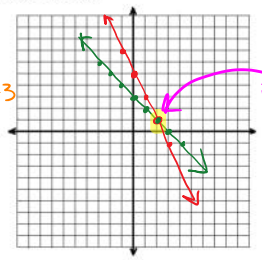
a) $\begin{cases} 2x + y = 5 \\ x + y - 3 = 0 \end{cases}$

① $2x+y=5$ $-2x$ $-2x$

$y=-2x+5$

② $x+y-3=0$ $-x$ $+3$ $+3$

$y=-x+3$



intersect = solution

Solution: $(2,1)$

Verification:

$2x+y=5$

$2(2)+(1)=5$

$4+1=5$

$5=5$ ✓

$x+y-3=0$

$(2)+(1)-3=0$

$2+1-3=0$

$0=0$ ✓

**Solving by Substitution:**

You already know how to verify your solution algebraically by substituting in the values for x and y. The process of graphing and verifying is often time consuming and an algebraic method could give the same results quicker and more accurately. This process is called **Solving by Substitution**

**Process for Solving by Substitution**

* Start with 2 equations + 2 unknowns/variables

1. Choose one equation and solve for one variable (either x or y). (set 1 equation to "y=....") → simpler equation (no coeff.)
2. Substitute your equation from step 1 into the other equation. (You should have only 1 variable now!). Solve for your variable. (this eliminates 1 of the unknowns variables)
3. Substitute the value back into one of the original equations to solve for the second variable.
4. Identify your solution. => two variables, written as a coordinate.

1

16

***Example #1:*** Solve this system using substitution. (A) $2x + y = 5$ (B) $x + y - 3 = 0$

① Solve (A), isolate 'y'

$2x + y = 5$

$-2x \quad -2x$

$y = 5 - 2x$

② Substitute $y = 5 - 2x$ into equation (B)

$x + y - 3 = 0$

$x + (5 - 2x) - 3 = 0$ (drop brackets)

$x - 2x + 5 - 3 = 0$

$-x + 2 = 0$

$-2 \quad -2$

$2 = x$

*we now have only 1 variable ... solve for x

③ Substitute $x = 2$ into equation (A) or (B)

(A) $2x + y = 5$

$2(2) + y = 5$

$+4 \quad +4 \quad -4$

$y = 1$

④ Solution (Point of intersection)

$(x, y)$

$(2, 1)$ } write as a coordinate pair

***Example #2:*** Solve this linear system using substitution. (A) $2x - 4y = 7$ (B) $4x + y - 5 = 0$

a) How do you decide which variable to isolate? Explain.

(A) $2x - 4y = 7$

$-4y = 7 - 2x$

$\frac{-4y}{-4} = \frac{7}{-4} - \frac{2x}{-4}$

$y = \frac{7}{-4} + \frac{1}{2}x$

(B) $4x + y - 5 = 0$

$-4x \quad +5$

$y = -4x + 5$

isolate the variable with a coefficient of 1 (to avoid fractions)

b) Solve for that variable.

$y = -4x + 5$

c) Substitute your solution into the unused equation. Then, solve.

(A) $2x - 4y = 7$

$2x - 4(-4x + 5) = 7$

$2x + 16x - 20 = 7 + 20$

$18x = 27$

$\frac{18x}{18} = \frac{27}{18}$

$x = \frac{27}{18} \div 9 \div 9$

$x = \frac{3}{2}$

d) You now have part of your solution, how do you get the other part? Explain.

substitute $x = \frac{3}{2}$ into EITHER (A) or (B)

e) Complete the solution.

(A) $2x - 4y = 7$

$2(\frac{3}{2}) - 4y = 7$

$3 - 4y = 7$

$-3 \quad -3$

$-4y = 7 - 3$

$-4y = 4$

$\frac{-4y}{-4} = \frac{4}{-4}$

$y = -1$

solution $x, y$

$(\frac{3}{2}, -1)$

f) Identify 2 different ways to verify your solution?

① Graph both equation - find the intersect

② Solve algebraically -> sub in $(\frac{3}{2}, -1)$ into both equations => check LHS = RHS

OR you can solve for 'y' using equation (B) either way... same solution!

(B) $4x + y - 5 = 0$

$4(\frac{3}{2}) + y - 5 = 0$

$\frac{12}{2} + y - 5 = 0$

$+6 + y - 5 = 0$

$-6 \quad +5 \quad -6 + 5$

$y = -1$

**Homework**

ASSIGNMENT # 3

pPages 12-15 Questions #50-67 (1/7)

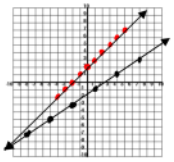
## Solving Systems of Equations (without graphing)

### Part 1: Solving By substitution.

Graph the system of equations:

$y = x + 2$

$3y = 2x - 5$



My thoughts…

If I graph each of these lines, I notice that they do not cross at a point that I can easily read on **this** graph.

Also, the second equation is not easily graphed.

I can use a different method.

**Algebra**! See My Solution Below.

51. What is the solution to a system of linear equations?

52. If a point is present on two lines, what values of that point are equal:
    a. x-values
    b. y-values
    c. both x- and y-values

Solve the system of equations:

"1" $y = x + 2$

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

I will substitute (x+2) in to equation "2" for y.

$3(x+2) = 2x - 5$
$3x+6 = 2x - 5$
$x = -11$

Then substitute x = - 11 into equation "1".

$y = (-11) + 2$
$y = -9$

Therefore the solution is (- 11, - 9)

53. Solve the following system of equation without graphing, consider the answers to the previous questions to guide you.

$$y = 2x - 1$$
$$y = -x + 1$$

54. Verify your solution above.

Solve the following systems of equations **by substitution**.

55. Solve.

$y = 2x - 1$

$y = -x + 1$

Since both $(2x - 1)$ and $(-x + 1)$ are equal to 'y', then they must be equal to each other.

$2x - 1 = -x + 1$

$3x = 2$

$x = \frac{2}{3}$

To find 'y', substitute your known 'x' into either equation.

$$y = -\left(\frac{2}{3}\right) + 1$$

$$y = \frac{1}{3}$$

Solution $\left(\frac{2}{3}, \frac{1}{3}\right)$

56. How can I check the solution to the left?

57. Check the solution to the left.

58. Solve.

$3x + y = 1$

$2x + 3y = 11$

59. Solve.

$a + c = 9$

$2a + c = 11$

60. Solve.

$3x - 4y = -15$

$5x + y = -2$

61. Solve.

$d + e = 1$

$3d - e = 11$

Solve the following systems of equations **by substitution**.

62. Solve.

$a + 6b = 9$

$3a - 2b = -23$

63. Solve.

$2t - w = 13$

$4t + 3w = 1$

64. Solve.

$3y = -6x + 15$

$5y = 5x + 10$

65. Solve.

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

$3y + 4x = 21$

66. Solve.

$3x - 2y = 4$

$3x + 4y = 10$

67. Solve.

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

$\frac{1}{4}x - \frac{1}{2}y = 0$