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NOTES: Section 7.2 – Solving Linear Systems by Substitution

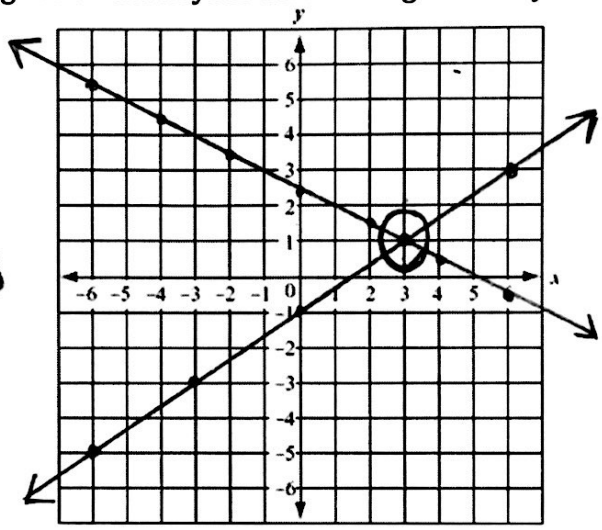
Goals: #1 - I can solve a linear system algebraically using the substitution method and then check my solution algebraically.



Homework: Section 7.2 Worksheet

Warm Up: Solve the linear system by graphing. Then check your solution algebraically.

(3, 1)



$3(3)+6(1) \stackrel{?}{=} 15$

$9+6 \stackrel{?}{=} 15$

$15 = 15$ ✓

$3x + 6y = 15$

$-3x \quad -3x$

$\frac{6y}{6} = \frac{-3x}{6} + \frac{15}{6}$

$y = -\frac{1}{2}x + 2.5$

$-2(3) + 3(1) \stackrel{?}{=} -3$

$-6 + 3 \stackrel{?}{=} -3$

$-3 = -3$ ✓

$-2x + 3y = -3$

$+2x \quad +2x$

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

$y = \frac{2}{3}x - 1$

Notes:

There are several ways to solve a linear system WITHOUT using graphs.

One algebraic method is called substitution.

1. **Step 1:** Solve one of the equations for one of its variables.
2. **Step 2:** Substitute the equation from step 1 into the other equation & solve for the other variable.
3. **Step 3:** Substitute the value from step 2 into the equation from step 1 and solve.
4. **Step 4:** Check the solution in both original equations.

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Example #1: Solve the linear system using substitution.

1. $-x + y = 1$ ①
   $2x + y = -2$ ②

2. $2x + 2y = 3$ ①
   $x - 4y = -1$ ②

Step #1: Solve for a variable.

$-x + y = 1$ ①
$+x \quad +x$

$y = 1 + x$

$x - 4y = -1$ ②
$+4y \quad +4y$

$x = -1 + 4y$

Step #2: Substitute into other equation & solve.

$2x + y = -2$ ②
$2x + (1 + x) = -2$
$2x + 1 + x = -2$
$3x + 1 = -2$
$3x = -3$
$\boxed{x = -1}$

$2x + 2y = 3$ ①
$2(-1 + 4y) + 2y = 3$
$-2 + 8y + 2y = 3$
$-2 + 10y = 3$
$10y = 5$
$\boxed{y = \frac{1}{2}}$

Step #3: Substitute into Step #1 equation & solve.

$y = 1 + x$
$y = 1 + (-1)$
$\boxed{y = 0}$

$x = -1 + 4y$
$x = -1 + 4(\frac{1}{2})$
$x = -1 + 2$
$\boxed{x = 1}$

Step #4: Check your answer

$(-1, 0)$
① $-(-1) + (0) \stackrel{?}{=} 1$
$1 + 0 \stackrel{?}{=} 1$
$1 = 1$ ✓

② $2(-1) + (0) \stackrel{?}{=} -2$
$-2 + 0 \stackrel{?}{=} -2$
$-2 = -2$ ✓

$(1, \frac{1}{2})$
① $2(1) + 2(\frac{1}{2}) \stackrel{?}{=} 3$
$2 + 1 \stackrel{?}{=} 3$
$3 = 3$ ✓

② $(1) - 4(\frac{1}{2}) \stackrel{?}{=} -1$
$1 - 2 \stackrel{?}{=} -1$
$-1 = -1$ ✓

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You practice: Solve the linear system by graphing. Check your solution.

1. $2x + y = 4$ ①
   $-x + y = 1$ ②

2. $3x + y = 3$ ①
   $7x + 2y = 1$ ②

Step #1: Solve for a variable.

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

$3x + y = 3$ ①
$-3x \quad -3x$
$y = 3 - 3x$

Step #2: substitute into other equation & solve.

$2x + y = 4$ ①
$2x + (1 + x) = 4$
$2x + 1 + x = 4$
$3x + 1 = 4$
$3x = 3$
$\boxed{x = 1}$

$7x + 2y = 1$ ②
$7x + 2(3 - 3x) = 1$
$7x + 6 - 6x = 1$
$x + 6 = 1$
$\boxed{x = -5}$

Step #3: substitute into step #1 equation & solve.

$y = 1 + x$
$y = 1 + (1)$
$y = 1 + 1$
$\boxed{y = 2}$

$y = 3 - 3x$
$y = 3 - 3(-5)$
$y = 3 + 15$
$\boxed{y = 18}$

Step #4: check your answer.

$(1, 2)$
① $2(1) + (2) \stackrel{?}{=} 4$
$2 + 2 \stackrel{?}{=} 4$
$4 = 4$ ✓

② $-(1) + (2) \stackrel{?}{=} 1$
$-1 + 2 \stackrel{?}{=} 1$
$1 = 1$ ✓

$(-5, 18)$
① $3(-5) + (18) \stackrel{?}{=} 3$
$-15 + 18 \stackrel{?}{=} 3$
$3 = 3$ ✓

② $7(-5) + 2(18) \stackrel{?}{=} 1$
$-35 + 36 \stackrel{?}{=} 1$
$1 = 1$ ✓

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Example #2: In on day the National Civil Rights Museum in Memphis, Tennessee, admitted 321 adults and children and collected $1590. The price of admission is $6 for an adult and $4 for a child. How many adults and how many children were admitted to the museum that day?

a. Write a system of linear equations

Let x = # of adults admitted
Let y = # of children admitted

$$x + y = 321 \quad (1)$$
$$6x + 4y = 1590 \quad (2)$$

Step 1:

$x + y = 321$ (1)
$-y \quad -y$
$x = 321 - y$

Step 2:

$6x + 4y = 1590$ (2)
$6(321 - y) + 4y = 1590$
$1926 - 6y + 4y = 1590$
$1926 - 2y = 1590$
$-2y = -336$
$\boxed{y = 168}$

Step 3:

$x = 321 - y$
$x = 321 - 168$
$\boxed{x = 153}$

Step 4:

(1) $(153) + (168) \stackrel{?}{=} 321$
$321 = 321$ ✓

(2) $6(153) + 4(168) \stackrel{?}{=} 1590$
$918 + 672 \stackrel{?}{=} 1590$
$1590 = 1590$ ✓