ACT Study Modules

TOPIC: Solving Systems of Equations (Substitution)

Follow this link: Solving systems of equations using substitution

Substitution is one of the algebraic methods of solving a system of equations. We will look at 2 cases of solving systems using substation and one application problem.

Case 1: When both equations are in slope-intercept form, $y = mx + b$

Step 1: Set the two '$mx + b$' sides equal to each other.

Step 2: Move the mx-term from the right side to the left side by performing the opposite operation. (Example: If the x-term is negative, add it to both sides; if it is positive, subtract it from both sides)

Step 3: Move the b-term (the constant) from the left side to the right side by performing the opposite operation. (Example: If the b-term is negative, add it to both sides; if it is positive, subtract it from both sides)

Step 4: Divide both sides of the equation by the coefficient (number in front of) the x-term.

Step 5: Substitute the x-value you got in step 4 back into one of the original equations given (you get to choose!)

Step 6: Simplify the right side of the equation to obtain the value for 'y.'

Step 7: Write your answer as an ordered pair: (x, y).

Sample Problem: Solve the system of equations

$$y = 5x + 4$$

$$y = 3x - 2$$

Step 1: Set the two '$mx + b$' sides equal to each other.

$$5x + 4 = 3x - 2$$

Step 2: Move the mx-term from the right side to the left side by performing the opposite operation.

$$\begin{array}{r} 5x + 4 = 3x - 2 \\ \underline{-3x \qquad -3x} \\ 2x + 4 = -2 \end{array}$$

Step 3: Move the b-term (the constant) from the left side to the right side by performing the opposite operation.

$$\begin{array}{r} 2x + 4 = -2 \\ \underline{-4 \qquad -4} \\ 2x = -6 \end{array}$$

Step 4: Divide both sides of the equation by the coefficient (number in front of) the x-term.

$$\frac{2x}{2} = \frac{-6}{2}$$

$$x = -3$$

Step 5: Substitute the x-value you got in step 4 back into one of the original equations given.

$$y = 5x + 4$$

$$y = 5(-3) + 4$$

Step 6: Simplify the right side of the equation to obtain the value for 'y.'

$$y = -15 + 4$$

$$y = -11$$

Step 7: Write your answer as an ordered pair: (x, y).

$$(-3, -11)$$

<u>**Case 2:**</u> When one equation is in standard form, $Ax + By = C$, and one equation is in slope-intercept form $y = mx + b$.

Step 1: Identify the equation that is already solved for y.

Step 2: Substitute the side with '$mx + b$' into the standard form equation for the y-value.

Step 3: Distribute through the parenthesis.

Step 4: Combine like terms.

Step 5: Move the constant term from the left side to the right side by performing the opposite operation.

Step 6: Divide both sides of the equation by the coefficient of the x-term.

Step 7: Substitute the x-value you got in step 4 back into the original equation that is in slope-intercept form.

Step 8: Simplify the right side of the equation to obtain the value for 'y.'

Step 9: Write your answer as an ordered pair: (x, y).

<u>**Sample Problem:**</u> Solve the system of equations

$$4x - 2y = -14$$

$$y = 3x + 5$$

Step 1: Identify the equation that is already solved for y.

$$y = 3x + 5$$

Step 2: Substitute the side with '$mx + b$' into the standard form equation for the y-value.

$$4x - 2(3x + 5) = -14$$

Step 3: Distribute through the parenthesis.

$$4x - 6x - 10 = -14$$

Step 4: Combine like terms.

$$-2x - 10 = -14$$

Step 5: Move the constant term from the left side to the right side by performing the opposite operation.

$$\begin{array}{r} -2x - 10 = -14 \\ +10 \quad +10 \end{array}$$

$$-2x = -4$$

Step 6: Divide both sides of the equation by the coefficient of the x-term.

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

$$x = 2$$

Step 7: Substitute the x-value you got in step 4 back into the original equation that is in slope-intercept form.

$$y = 3x + 5$$

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

Step 8: Simplify the right side of the equation to obtain the value for 'y.'

$$y = 6 + 5$$

$$y = 11$$

Step 9: Write your answer as an ordered pair: (x, y).

$$(2,11)$$

Practice:

Solve the systems of equations below using the substitution method

1. * $y = 6x - 11$
$-2x - 3y = -7$

$-2x - 3(6x - 11) = -7$

$-2x - 18x + 33 = -7$

$-20x + 33 = -7$
$\quad -33 \quad -33$

$\frac{-20x}{-20} = \frac{-40}{-20}$

$x = 2$

* $y = 6(2) - 11$

$y = 1$

Solution: $(2, 1)$

Check:
$-2(2) - 3(1) = -7$
$-4 - 3 = -7$
$-7 = -7$

2. * $y = -3x + 5$
$5x - 4y = -3$

$5x - 4(-3x + 5) = -3$

$5x + 12x - 20 = -3$

$17x - 20 = -3$
$\quad +20 \quad +20$

$\frac{17x}{17} = \frac{17}{17}$

$x = 1$

$y = -3(1) + 5$

$y = 2$

solution: $(1, 2)$

Check:
$5(1) - 4(2) = -3$
$5 - 8 = -3$
$-3 = -3$ ✓

3. $2x - 3y = -1$
* $y = x - 1$

$2x - 3(x - 1) = -1$

$2x - 3x + 3 = -1$

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

$\frac{-x}{-1} = \frac{-4}{-1}$

$x = 4$

$y = 4 - 1$

$y = 3$

solution: $(4, 3)$

Check:
$2(4) - 3(3) = -1$
$8 - 9 = -1$
$-1 = -1$ ✓

4. $-3x - 3y = 3$
$y = -5x - 17$

$-3x - 3(-5x - 17) = 3$

$-3x + 15x + 51 = 3$

$12x + 51 = 3$
$\quad -51 \quad -51$

$\frac{12x}{12} = \frac{-48}{12}$

$x = -4$

$-3(-4) - 3y = 3$

$12 - 3y = 3$

$-3y = -9$

$y = 3$

solution: $(-4, 3)$

Check:
$-3(-4) - 3(3) = 3$
$12 - 9 = 3$
$3 = 3$ ✓