

Solving Systems of Linear Equations by Substitution

Substitution Flow

STEP 1: Look @ the Equations

$$x + y = 0$$

$$3x + y = -8$$

Is there an isolated variable?

YES

STEP 2: Substitute the isolated equation into the OTHER equation. Then, solve for the other variable.

other eqn: $3x + y = -8$

sub: $3x + (-x) = -8$

solve:
$$\frac{2x}{2} = \frac{-8}{2}$$
$$x = -4$$

NO

Isolate a variable!
Choose which equation would be easiest to isolate a variable in. Isolate the variable. Then move to step 2.

$$x + y = 0$$

$$-x \quad -x$$

$$y = -x$$

* The y is now isolated!

STEP 3: Sub the found variable into 1st equation to solve for the 2nd variable.

1st eqn: $x + y = 0$

sub: $(-4) + y = 0$

solve:
$$\begin{array}{r} +4 \quad +4 \\ y = 4 \end{array}$$

STEP 4: Check!

$$x + y = 0$$

$$-4 + 4 = 0$$

$$0 = 0 \checkmark$$

$$3x + y = -8$$

$$3(-4) + 4 = -8$$

$$-12 + 4 = -8$$

$$-8 = -8 \checkmark$$

SOLUTION: $(-4, 4)$

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

variable is already isolated!

Other eqn: $2x - 3y = -1$
 Sub: $2x - 3(x - 1) = -1$
 Solve: $2x - 3x + 3 = -1$
 $-x + 3 = -1$
 $-3 \quad -3$
 $\frac{-x}{-1} = \frac{-4}{-1}$

1st eqn: $y = x - 1$
 Sub: $y = (4) - 1$
 Solve: $y = 3$

$x = 4$ Solution: $(4, 3)$

EX. $-4x + y = 6$
 $-5x - y = 21$

Isolate the variable: $-4x + y = 6$
 $+4x \quad +4x$
 $y = 4x + 6$

1st eqn: $-4x + y = 6$
 Sub: $-4(-3) + y = 6$
 Solve: $12 + y = 6$
 $-12 \quad -12$
 $y = -6$

Other eqn: $-5x - y = 21$
 Sub: $-5x - (4x + 6) = 21$
 Solve: $-5x - 4x - 6 = 21$
 $-9x - 6 = 21$

$-9x - 6 = 21$
 $+6 \quad +6$
 $-9x = 27$
 $\frac{-9x}{-9} = \frac{27}{-9}$
 $x = -3$ Solution: $(-3, -6)$

EX. $-3x + 3y = 4$
 $-x + y = 3$

Isolate the variable: $-x + y = 3$
 $+x \quad +x$
 $y = x + 3$

Other eqn: $-3x + 3y = 4$
 Sub: $-3x + 3(x + 3) = 4$
 Solve: $-3x + 3x + 9 = 4$
 $9 = 4$

NOT TRUE! No solution.

SUBSTITUTION

$(-3, 5)$

$$\begin{cases} 2x + y = -1 \\ x = 2y - 13 \end{cases}$$

~~2y~~
variable already isolated!

sub: $2(2y - 13) + y = -1$

$$4y - 26 + y = -1$$

$$5y - 26 = -1$$

$$+26 \quad +26$$

$$5y = 25$$

$$\frac{5y}{5} = \frac{25}{5}$$

$$y = 5$$

$$x = 2(5) - 13 = 10 - 13 = -3$$

SUBSTITUTION

NO SOLUTION!

$$\begin{cases} 4x - 3y = 15 \\ y = \frac{4}{3}x - 7 \end{cases}$$

variable already isolated!

$$4x - 3\left(\frac{4}{3}x - 7\right) = 15$$

$$4x - 4x - 7 = 15$$

$$-7 = 15$$

NOT

TRUE!

SUBSTITUTION

INFINITELY MANY SOLUTIONS!

$$\begin{cases} y = -\frac{1}{2}x + 4 \\ x + 2y = 8 \end{cases}$$

variable already isolated!

$$x + 2\left(-\frac{1}{2}x + 4\right) = 8$$

$$x - x + 8 = 8$$

$$8 = 8$$

TRUE!