# Objective

**The student will be able to:**

Solve systems of equations using Substitution.

# Solving Systems of Equations

- You can solve a system of equations using different methods. The idea is to determine which method is easiest for that particular problem.

- These notes show how to solve the system algebraically using SUBSTITUTION.

# Solving a system of equations by substitution

**Step 1: Solve an equation for one variable.**

Pick the easier equation. The goal is to get y= ; x= ; a= ; etc.

**Step 2: Substitute**

Put the equation solved in Step 1 into the other equation.

**Step 3: Solve the equation.**

Get the variable by itself.

**Step 4: Plug back in to find the other variable.**

Substitute the value of the variable into the equation.

**Step 5: Check your solution.**

Substitute your ordered pair into BOTH equations.

# 1) Solve the system using substitution

$$x + y = 5$$
$$y = 3 + x$$

| **Step 1**: Solve an equation for one variable. | The second equation is already solved for y! |
|---|---|
| **Step 2**: Substitute | $x + y = 5$<br>$x + (\mathbf{3 + x}) = 5$ |
| **Step 3**: Solve the equation. | $2x + 3 = 5$<br>$2x = 2$<br>$x = 1$ |

# 1) Solve the system using substitution

$$x + y = 5$$

$$y = 3 + x$$

**Step 4:** Plug back in to find the other variable.

$$x + y = 5$$
$$(1) + y = 5$$
$$y = 4$$

**Step 5:** Check your solution.

**(1, 4)**
$$(1) + (4) = 5 \quad ✔$$
$$(4) = 3 + (1) \quad ✔$$

The solution is (1, 4). What do you think the answer would be if you graphed the two equations?

# Which answer checks correctly?

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

1. (2, 2)
2. (5, 3)
✓ 3. (3, 5)
4. (3, -5)

# 2) Solve the system using substitution

$$3y + x = 7$$
$$4x - 2y = 0$$

**Step 1**: Solve an equation for one variable.

It is easiest to solve the first equation for x.

$$3y + x = 7$$
$$\underline{-3y \qquad -3y}$$
$$x = -3y + 7$$

**Step 2**: Substitute

$$4x - 2y = 0$$
$$4(-3y + 7) - 2y = 0$$

# 2) Solve the system using substitution

$$3y + x = 7$$

$$4x - 2y = 0$$

**Step 3:** Solve the equation.

$$-12y + 28 - 2y = 0$$
$$-14y + 28 = 0$$
$$-14y = -28$$
**y = 2**

**Step 4:** Plug back in to find the other variable.

$$4x - 2y = 0$$
$$4x - 2(\mathbf{2}) = 0$$
$$4x - 4 = 0$$
$$4x = 4$$
**x = 1**

# 2) Solve the system using substitution

$$3y + x = 7$$

$$4x - 2y = 0$$

**Step 5**: **Check your solution.**

**(1, 2)**

$3(2) + (1) = 7$ ✔

$4(1) - 2(2) = 0$ ✔

When is solving systems by substitution easier to do than graphing?

When only one of the equations has a variable already isolated (like in example #1).

If you solved the first equation for x, what would be substituted into the bottom equation.

$$2x + 4y = 4$$
$$3x + 2y = 22$$

1. -4y + 4
✔ 2. -2y + 2
3. -2x + 4
4. -2y+ 22

# 3) Solve the system using substitution

$$x = 3 - y$$

$$x + y = 7$$

**Step 1**: **Solve an equation for one variable.**

The first equation is already solved for x!

**Step 2**: **Substitute**

$$x + y = 7$$

$$(\textbf{3 – y}) + y = 7$$

**Step 3**: **Solve the equation.**

3 = 7

The variables were eliminated!!

This is a special case.

Does 3 = 7? FALSE!

When the result is FALSE, the answer is NO SOLUTIONS.

# 3) Solve the system using substitution

$$2x + y = 4$$

$$4x + 2y = 8$$

**Step 1: Solve an equation for one variable.**

The first equation is easiest to solved for y!

$$y = -2x + 4$$

**Step 2: Substitute**

$$4x + 2y = 8$$

$$4x + 2(-2x + 4) = 8$$

**Step 3: Solve the equation.**

$$4x - 4x + 8 = 8$$

$$8 = 8$$

This is also a special case.

Does 8 = 8? TRUE!

When the result is TRUE, the answer is **INFINITELY MANY SOLUTIONS**.

# What does it mean if the result is "TRUE"?

1. The lines intersect
2. The lines are parallel
3. ✔ The lines are coinciding
4. The lines reciprocate
5. I can spell my name