Warm-up:

Solve each quadratic equation by the quadratic formula.

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Step 1: Set your equation equal to zero

Step 2: list a= b= c=

Step 3: Plug a, b, c into the formula

Step 4: Simplify

1) $x^2 + 121 = -22x$

$x^2 + 22x + 121 = 0$

$a = 1 \quad b = 22 \quad c = 121$

$$\frac{-22 \pm \sqrt{484 - 4(1)(121)}}{2(1)}$$

$$\frac{-22 \pm \sqrt{484 - 484}}{2}$$

$$\frac{-22 \pm 0}{2} \rightarrow \boxed{x = -11}$$

2) $-7w + 6 = -4w^2$

$4w^2 - 7w + 6 = 0$

$a = 4 \quad b = -7 \quad c = 6$

$$\frac{7 \pm \sqrt{49 - 4(4)(6)}}{2(4)}$$

$$\frac{7 \pm \sqrt{49 - 96}}{8}$$

$$\frac{7 \pm \sqrt{-47}}{8} \rightarrow \boxed{\frac{7 \pm \sqrt{47}\, i}{8}}$$

- **Discuss with your elbow partner: what does it mean to solve a system of equations?**

  It means to find points that are on all equations

Agenda:

1) **Warm-up**
2) **Homework questions**
3) **New Lesson---3.5 Solving Nonlinear Systems**
4) **Homework/in-class activity**

Algebra 2: 3.5 Solving Nonlinear Systems:

Learning Targets for Today:

1) Solve systems of nonlinear equations.
2) Solve quadratic equations by graphing.

(A) Solving a System of Nonlinear Equations

We have solved systems of linear equations by graphing, substitution and elimination earlier in the year! You can also use these methods to solve a system of nonlinear equations. In a nonlinear system, at least one of the equations is nonlinear. Example:

$Y = 2x + 5$ (line or linear)
$Y = x^2 + 2x - 4$ (not linear…it's a quadratic)

When the graphs of the equations in a system are a line and a parabola, the graphs can intersect in zero, one, or two points.

No solution One solution Two solutions

Example: Solving a nonlinear system by graphing

$y = x^2 - 2x - 1$

$y = -2x - 1$

$Y = -2X - 1$

line

$m = \text{slope} = \frac{-2}{1}$

$b = Y\text{-int} = -1$

$Y = X^2 - 2X - 1$

Quadratic in standard form

$a = 1 \quad b = -2 \quad c = -1$

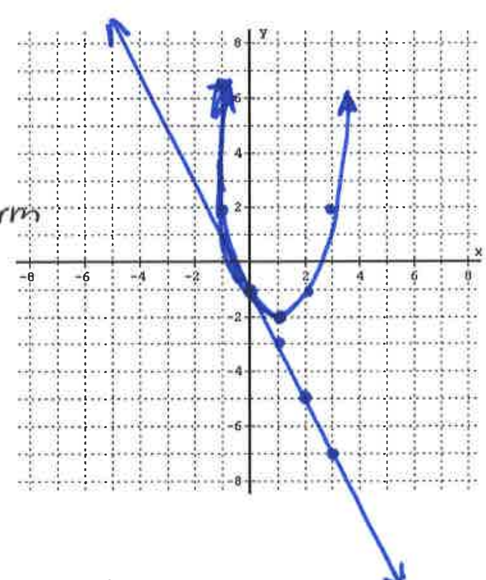
Vertex

$\frac{-b}{2a} \Rightarrow \frac{2}{2(1)} = \frac{2}{2} = 1$

$Y = (1)^2 - 2(1) - 1$

$1 - 2 - 1$

-2



Vertex $(1, -2)$

"a"-value $= 1/1$

$\Rightarrow \underline{(0, -1)}$

Try: **Solve the nonlinear system by graphing**

y = x + 2

y = ½ (x + 2)²

$Y = X + 2$

line

slope = 1/1

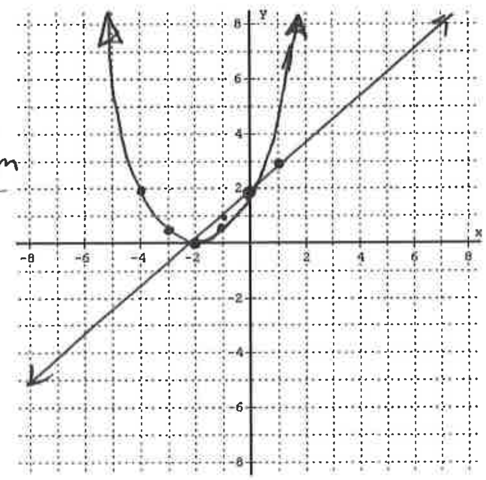
Y-int = 2

$Y = \frac{1}{2}(x+2)^2$

Quadratic in Vertex form

V (-2,0)

"a"-value = $\frac{1}{2}$



2-Solutions → (0,2) & (-2,0)

Try: **Solve the nonlinear system by graphing**

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

$$y = -3x^2 - 6x - 4$$

$Y = \frac{1}{3}x + 2$

line

Slope = 1/3

Y-int = 2

$Y = -3x^2 - 6x - 4$

Quadratic in standard

a = -3 b = -6 C = -4

Vertex

$\frac{-b}{2a} \rightarrow \frac{6}{2(-3)} \Rightarrow \frac{6}{-6} = -1$

$Y = -3(-1)^2 - 6(-1) - 4$

$-3(1) + 6 - 4$

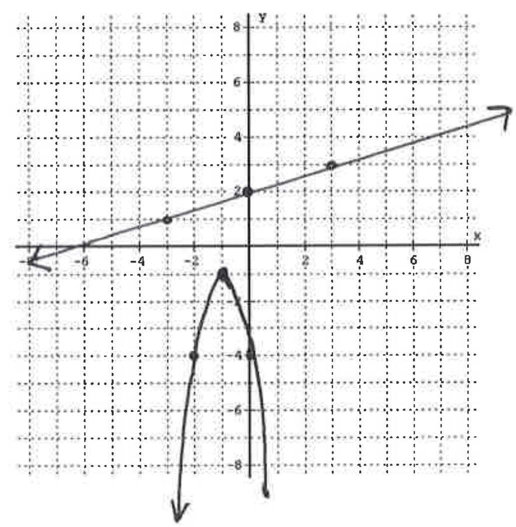
$-3 + 6 - 4$

$3 - 4$

-1

Vertex (-1,-1)

"a"-value = $-\frac{3}{1}$



$\boxed{\text{NO Solutions}}$

Example: Solving a nonlinear system by **substitution**

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

$x + y = 4$

Step 1: Solve one equation for either x or y

Step 2: Replace the letter you solved for in the other equation

Step 3: Solve your "new" one variable equation

Step1 $x + y = 4$

$y = \underbrace{-x + 4}$

Lets solve for y → b/c look how easy it is to replace the y versus the two x's . . .

Step2 $x^2 + x - (-x + 4) = -1$

Step3 $x^2 + x + x - 4 = -1$

Now solve it!

$x^2 + 2x - 3 = 0$ $\quad 3 \cdot 1$

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

$x + 3 = 0 \quad x - 1 = 0$

$x = -3 \quad x = 1$

These are the x-parts to the two solution points

$y = -x + 4$

$x = -3$

$y = -(-3) + 4$

$y = 3 + 4$

$y = 7$

$(-3, 7)$

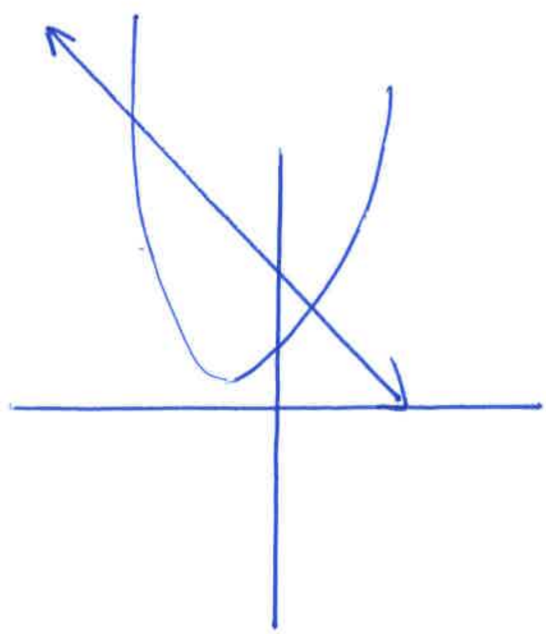
$x = 1$

$y = -(1) + 4$

$y = -1 + 4$

$y = 3$

$(1, 3)$



Try: Solving a nonlinear system by substitution

$x^2 + 2x - y = 5$

$2x + y = 7$

$\boxed{\text{Step1}}$ $y = -2x + 7$

$\boxed{\text{Step2}}$ $x^2 + 2x - (\quad) = 5$

$\boxed{\text{Step3}}$ $x^2 + 2x - (-2x + 7) = 5$

$x^2 + 2x + 2x - 7 = 5$

$x^2 + 4x - 12 = 0$

12 · 1
6 · 2
4 · 3

$(x + 6)(x - 2) = 0$

$x + 6 = 0 \qquad x - 2 = 0$

$x = -6 \qquad x = 2$

$y = -2x + 7$

$x = -6 \qquad x = 2$

$y = -2(-6) + 7 \qquad y = -2(2) + 7$

$12 + 7 \qquad y = -4 + 7$

$19 \qquad 3$

$(-6, 19) \qquad (3, 2)$

Try: Solving a nonlinear system by substitution

$x^2 + 3x + y = 0$

$2x + y = 5$

$\boxed{\text{Step1}}$ $y = -2x + 5$

$\boxed{\text{Step2}}$ $x^2 + 3x + (\quad) = 0$

$x^2 + 3x + (-2x + 5) = 0$

$x^2 + x + 5 = 0$

$\boxed{\text{Step3}}$ doesn't factor. . . .

$a = 1 \quad b = 1 \quad c = 5$

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\frac{-1 \pm \sqrt{1 - 4(1)(5)}}{2(1)}$$

$$\frac{-1 \pm \sqrt{1 - 20}}{2}$$

$$\frac{-1 \pm \sqrt{-19}}{2}$$

imaginary → $\boxed{\text{No real solutions}}$

Example: Solving a nonlinear system by elimination

$2x^2 - 5x - y = -2$

$x^2 + 2x + y = 0$

Step 1: Line your equations up (x above x, y above y, x² above x²...)

Step 2: Eliminate all x's or all y's (so your equation only has one variable0

- You might need to multiply an equation by a number to make them add to zero

Step 3: Solve the remaining one-variable equation

$\boxed{\text{Step 1}}$

$$\begin{array}{r} 2x^2 - 5x - y = -2 \\ x^2 + 2x + y = 0 \\ \hline \end{array}$$

already lined up & the y's add to zero

$\boxed{\text{Step 2}}$

$$3x^2 - 3x = -2$$

$\boxed{\text{Step 3}}$

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

$a = 3 \quad b = -3 \quad c = 2$

$$\frac{3 \pm \sqrt{9 - 4(3)(2)}}{2(3)}$$

$$\frac{3 \pm \sqrt{9 - 24}}{6}$$

$$\frac{3 \pm \sqrt{-15}}{6}$$

→ NO Solutions

Try: Solving a nonlinear system by elimination

$3x^2 + 2x - 2y = 10$

$x^2 - 6x + 2y = -12$

Step1 $3x^2 + 2x - 2y = 10$

$x^2 - 6x + 2y = -12$

Step2

$4x^2 - 4x = -2$

Step3 $4x^2 - 4x + 2 = 0$

$a = 4 \quad b = -4 \quad c = 2$

$\frac{4 \pm \sqrt{16 - 4(4)(2)}}{2(4)}$

$\frac{4 \pm \sqrt{16 - 32}}{8}$

$\frac{4 \pm \sqrt{-16}}{8}$

No Solutions

Try: Solving a nonlinear system by elimination

$2x^2 + 4x - y = -2$

$x^2 + y = 2$

Step1 $2x^2 + 4x - y = -2$

$x^2 + y = 2$

Step2

$3x^2 + 4x = 0$

Step3 $x(3x + 4) = 0$

Lets factor common Term

$x = 0 \quad 3x + 4 = 0$

$x = 0 \quad x = -4/3$

Finding Y-parts

$x^2 + y = 2$

$x = 0$

$(0)^2 + y = 2$

$y = 2$

$(0, 2)$

$x = -4/3$

$\left(-\frac{4}{3}\right)^2 + y = 2$

$\frac{16}{9} + y = 2$

$y = 2 - \frac{16}{9}$

$y = \frac{18}{9} - \frac{16}{9}$

$y = 2/9$

$\left(-\frac{4}{3}, 2/9\right)$

Homework: Pg. 136 (3-5, 11, 12, 15-17, 27-29)