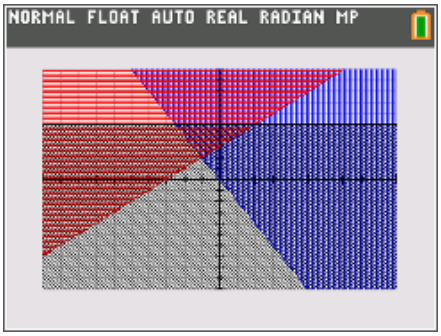
## About the Lesson

In this activity, students will first investigate linear equations that form a triangle. They will determine which vertex is a solution to a system of equations. Students will also investigate the same triangle, but formed by linear inequalities. As a result, students will:

- Determine which points are solutions to the system of inequalities.
- Compare the differences between the system of equations and the system of inequalities.




## Vocabulary

- linear equation
- linear inequality
- vertex
- systems of linear equations
- systems of linear inequalities

## Teacher Preparation and Notes

- Students should already be familiar with the concept of the intersection point as a solution to a system of linear equations. They should also be familiar with systems of two linear inequalities.
- This activity is intended to introduce systems of inequalities with difference in solutions between inequalities and equations. Students do not need to know how to solve the system algebraically.
- It would be helpful if students are familiar with graphing equations and finding intersection points of two graphs.

## Activity Materials

- Compatible TI Technologies:

  TI-84 Plus*
  TI-84 Plus Silver Edition*
  TI-84 Plus C Silver Edition
  TI-84 Plus CE

***** *with the latest operating system (2.55MP) featuring MathPrint™ functionality.*

**Tech Tips:**

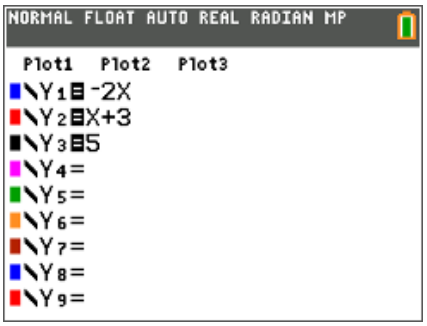
- This activity includes screen captures taken from the TI-84 Plus CE. It is also appropriate for use with the rest of the TI-84 Plus family. Slight variations to these directions may be required if using other calculator models.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

**Lesson Files:**

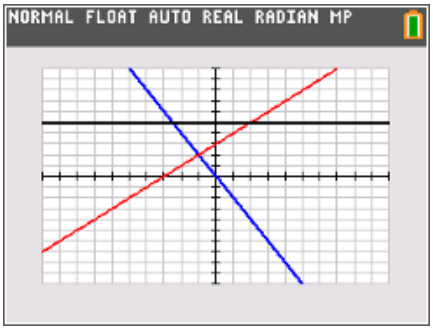
- Tri_This_Student.pdf
- Tri_This_Student.doc

**Part 1 – Systems of Linear Equations**

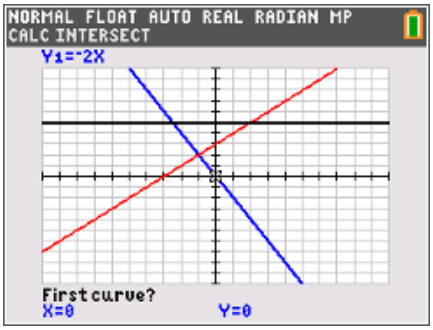
Students are first asked to graph a system of three equations and find the intersection points. To graph the equations, press [y=] and enter the first equation in $Y_1$, and so on. Once the equations have been entered, they can graph in a Standard window by pressing [zoom] and selecting **ZStandard**.

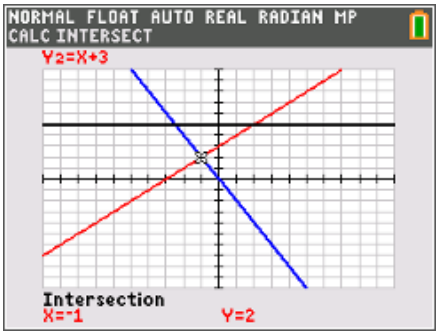



Students should see that the intersection points of these lines form a triangle. They can use the **Intersect** tool from the [2nd] [trace] [calc] menu to find the vertices of the triangle.




To find the intersection points, press [2nd] [trace] [5]. When the calculator asks for **First curve?**, make sure the upper left corner says **Y1** and press [enter]. When the calculator asks for **Second curve?**, make sure the upper left corner says **Y2**. When the calculator ask for **Guess?**, you may simply press [enter]. To find all the intersection points, students will need to change the **First curve?** and **Second curve?** input by pressing the [▲] or [▼] to select the curve needed. (**Y1** and **Y2**, **Y1** and **3**, **Y2** and **Y3**)



**1.** Identify the systems of equations and their solution(s).

**Answers:** System 1: $\begin{cases} y = -2x \\ y = x + 3 \end{cases}$ Solution(s): (–1, 2)

System 2: $\begin{cases} y = -2x \\ y = 5 \end{cases}$ Solution(s): (–2.5, 5)

System 3: $\begin{cases} y = x + 3 \\ y = 5 \end{cases}$ Solution(s): (2, 5)

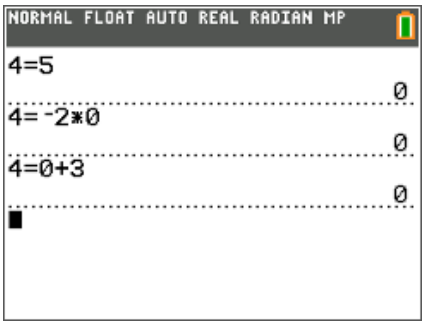
**2.** Can the point (2, 5) be a solution to the system $\begin{cases} y = -2x \\ y = x + 3 \end{cases}$? Explain your reasoning.

**Answer:** No, it cannot be a solution because that point does not satisfy the equation $y = -2x$.

Students should conclude that only one vertex of the triangle is a solution to a system of two equations, meaning the each system of two equations in this activity has only one solution.

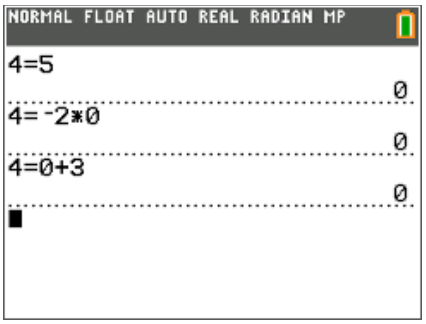
Students are asked to determine if a point inside the triangle is a solution to any of the systems. They can use the home screen to test each point in the equations.

**Note:** To enter **=**, students need to press 2nd math [test] and select it from the list.
In this example and more to follow, **1** means that the point satisfies the equation and **0** means that the point does not satisfy the equation.




The second option is to use the *x*-value as an input to the function. In the second screen, 0 is input for each function and none return 4, which should be the *y*-value output. So, students can conclude that all the equations are false for (0, 4) and is not a solution to any system.

**Note:** To select **Y1**, **Y2**, and **Y3**, press vars, arrow to the **Y-VARS** menu and choose **Function**. Then select the appropriate function from the list.



**3.** Where is the point (0, 4) in relation to the triangle? Is this point a solution to any of the three systems? Explain your reasoning.

**Answer:** The point is in the middle of the triangle. No, it does not satisfy any of the equations.

**4.** How many solutions does each system listed in Question 1 have?

**Answer:** Each system has one solution.

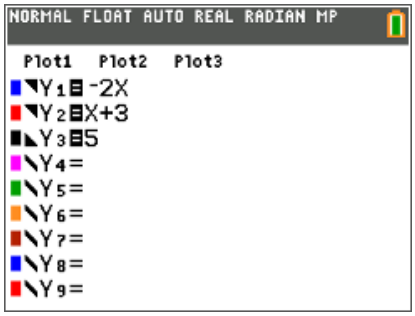
**5.** Are any of the intersection points solutions to the system of equations $\begin{cases} y = -2x \\ y = x + 3 \\ y = 5 \end{cases}$?

**Answer:** No

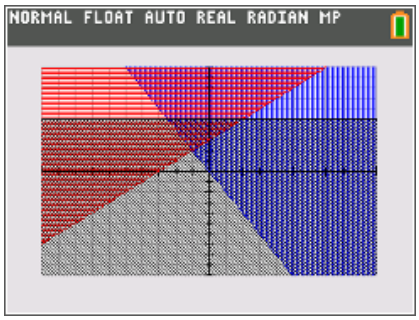
Discuss how this system would only have a solution if all three lines intersected at the same point.

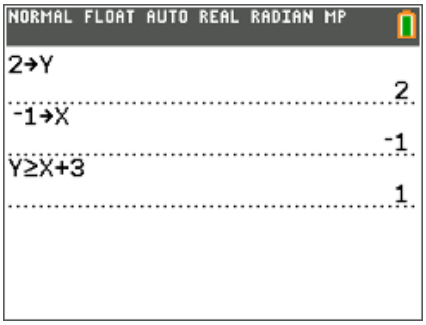
**Part 2 – System of Linear Inequalities**

In Part 2, students are asked to change the system of equations to a system of inequalities. Students move the cursor to the ◥ in front of each equation in the **Y=** screen and press enter to reach ◣ (shade below or ≤) or ◥ (shade above or ≥) until the darkest shaded region forms the same triangle in Part 1.




Students are to test each vertex in the three inequalities to determine if the point is a solution to the system. They can test the coordinates as by entering the inequality using the TEST menu. It may be easier for students to store (using sto→) the *x*- and *y*-coordinates of a point first and then enter the inequality as shown at the right.




Students should conclude that all three vertices are solutions to the system. They will then test points inside the triangle and conclude that they are also solutions to the system.

As further exploration you could also have them test points on the lines.

**6.** How many of the vertices of the triangle are solutions to the system?

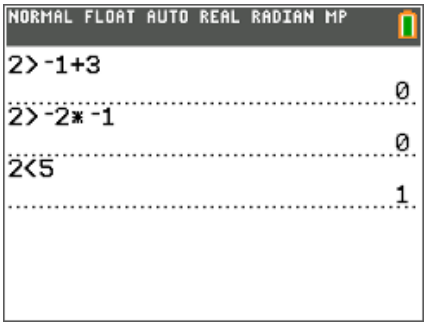
**Answer:** All three of the vertices are solutions to the system.

**7.** Test points inside the triangle as well. How many solutions are there to the system?

**Answer:** There are an infinite number of solutions.

Students are asked to determine how many of the vertices would be solutions to the system if the inequalities were changed. They should see that none of the vertices would be solutions. Again, students can use the home screen to test the points. If any test of the point in an inequality results in **0**, the point is not a solution.

Students will conclude the activity by describing any differences they found in solutions between the systems of equations and the system of inequalities.




**8.** If the inequalities of the system were changed to < and >, how many of the vertices would be solutions?

**Answer:** None of the vertices would be solutions.

**9.** What differences in the solutions did you find between systems of linear equations representing a triangle and a system of linear inequalities representing a triangle?

**Sample Answer:** One vertex of the triangle satisfies only one system of two equations, whereas three vertices satisfy the system of three inequalities with ≤ and ≥ symbols.

Points in the middle of the triangle do not satisfy any of the systems of equations, but do satisfy the system of inequalities.