TI-83/84 How To Series

Topic: Graphing Inequalities and Finding the Feasibility Region

Need to find the feasibility region for a set of linear inequalities? No problem, the TI-83/84 can handle your linear programming needs.

The easiest way to learn this is through an example. Take the following scenario:

Rei volunteers to bring origami swans and giraffes to sell at a charity crafts fair. It takes her three minutes to make a swan and six minutes to make a giraffe. She plans to sell the swans for $4 each and the giraffes for $6 each. If she has only 16 pieces of origami paper and can't spend more than one hour folding, how many of each animal should Rei make to maximize the charity's profit? (Bennett, Chanan, Bergofsky (2002) "Exploring Algebra with the Geometer's Sketchpad", Key Curriculum Press, CA)

Before we even pick up the calculator, we must decipher what the question is telling us and asking.

Steps

1. Decide what is being asked.

   How many of swans and giraffes should Rei make to maximize profit?

2. Assign variables to the unknowns. This is a very important step because it let's the reader/marker know what is what in the problem without having to read the student's mind.

   Let x = number of swans
   Let y = number of giraffes

   We have explicitly stated what the variables are and what they represent. As a student you should get into the practice of assigning and labeling variables.

3. Pull out the constraints of the problem. Constraints are the limitations of the scenario. In this case there are two:

   i. Number of pieces of origami paper
   ii. Time to fold paper into either a swan or a giraffe.

4. Assign equations to each constraint.

   i. The total number of pieces of paper to make origami swans and/or giraffes is 16. This means Rei can make at most 16 figures. If Rei wants she can make as few as 1 or as many as 16, but not more than 16. Our job is to figure out how many of each type she needs to make to maximize profit.

Let's make an equation:

$x + y \le 16$ We use $\le$ because Rei can make at most 16 figures

ii. The total time she has to make these figures is at most 1 hour. In addition we know it takes Rei 3 minutes to make each swan and 6 minutes to make each giraffe. If she make 2 swans and 3 giraffes, how many minutes has she spent making them?

Our equation is set up similar to the question posed.

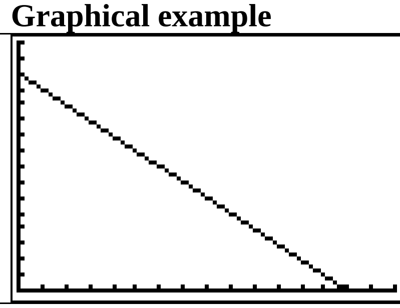
$3x + 6y \le 60$ Again we use $\le$ because Rei has at most 1 hour to make the figures. Notice how we changed the 1 hour into 60 minutes. This is because we must maintain the same units. Since everything else is measured in minutes, we just converted the 1 hour.

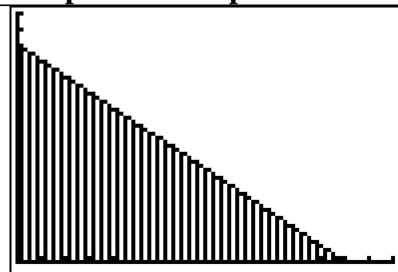
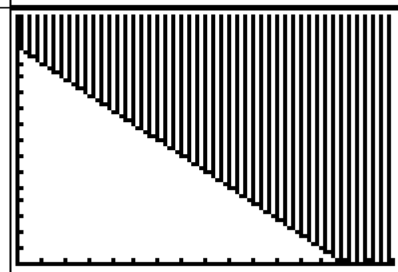
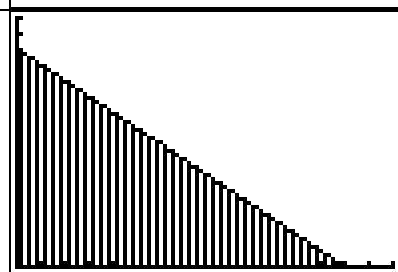
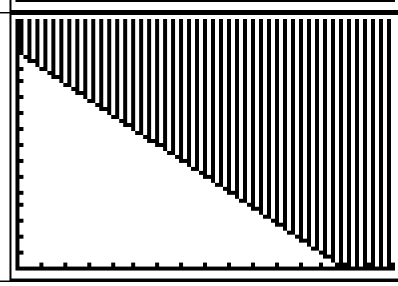
Both of these equations are known as inequalities because the $=$ has been replaced with $\le$.

5. The constraints have been set, and we can use these to graph with. However, the TI-83/84 requires the equations in the form of $y = mx + b$. Performing a little algebra (it is assumed you know how to do this), the equations become:

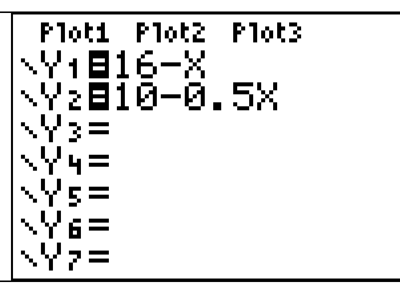
i. $y \le 16 - x$
ii. $y \le 10 - 0.5x$

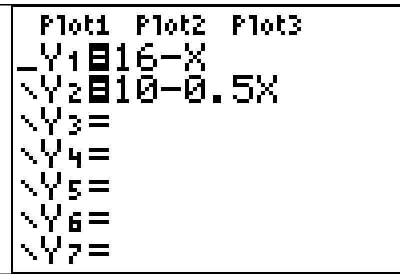
Inequalities are just like regular line equations except that instead of solutions being along the line, solutions, in this particular case, are not only along the line but below the line as well. The inequality determines whether the solutions are on the line, below the line, above the line, etc. These are known as **feasibility regions**. The following table will help clarify.

Inequality	**Feasibility Region**	**Graphical example**
=	All solutions fall on the line	

Inequality	Feasibility Region	Graphical example
≤	All solutions fall on and below the line. The shaded area plus the line.	
≥	All solutions fall on and above the line. The shaded area plus the line.	
<	All solutions fall below the line The difference between this graph and ≤ is the line is dotted to indicate it is not included in the solution set.	
>	All solutions fall above the line The difference between this graph and ≥ is the line is dotted to indicate it is not included in the solution set.	

6. We are now in a position to put these equations into our calculator.

 Enter in your two equations. Notice how we entered in the equations as y =. We have to tell the calculator to look at the region below the line to compensate for ≤ in both cases.	

<table>
<tr>
<td>Use your arrow keys to go to the left of Y1.</td>
<td>
</td>
<td></td>
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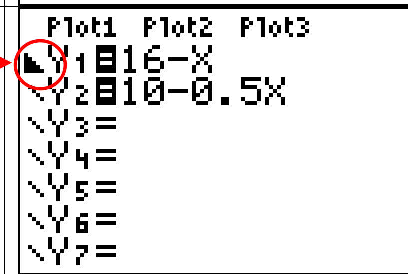
<tr>
<td>Using the ENTER key scroll through the selections until you get this symbol.

Do the same for Y2.</td>
<td>
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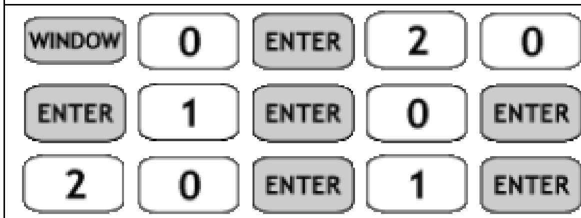
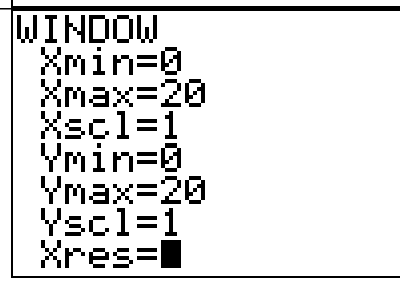
<td>

Change your window to accommodate the graph. Why did we choose these values?</td>
<td>
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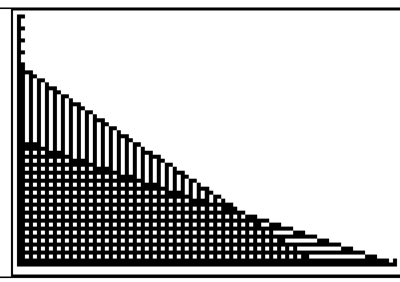
<td>

Graph your inequalities.</td>
<td></td>
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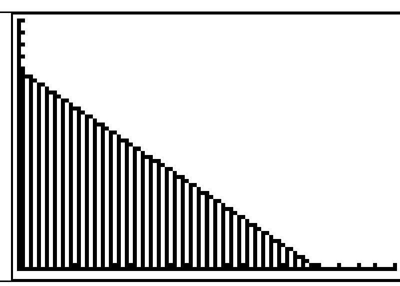
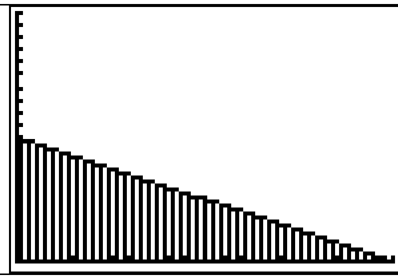
7. We are now ready to interpret the graph. Each inequality has its own feasibility region. Let's look at each equation separately.

<table>
<tr>
<td>$y \le 16 - x$

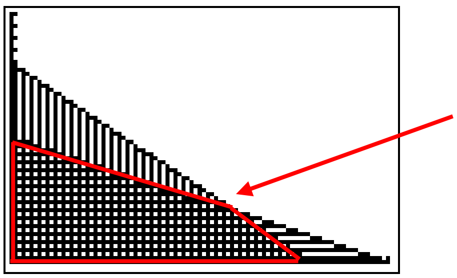
The solution set for this equation is the shaded (feasibility) region and the line.</td>
<td></td>
<td></td>
</tr>
</table>

$y \leq 10 - 0.5x$

The solution set for this equation is the shaded (feasibility) region and the line.



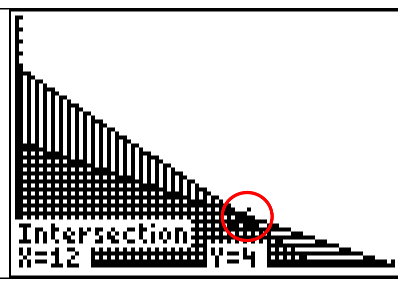
Where the two regions overlap is where both solutions are satisfied and a new feasibility region is created.



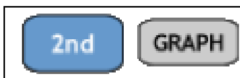
New feasibility region created that satisfies both equations

8. You can use the TRACE function to figure out where the important points are. Hint: you will always maximize your profit at a corner, never within the feasibility region itself. There are four corners on this feasibility region.

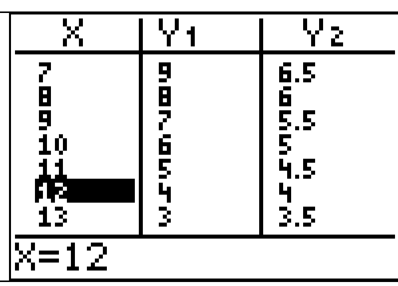
   To find where the two lines intersect, use the intersect function of the TI-83/84 calculator.



This tells us that at this point we should make 12 swans (x) and 4 giraffes (y).



We also see this in the table screen of the calculator. Just scroll down using your arrow keys and where Y1 and Y2 are equal, this tells us where the two lines intersect.



For your information: This is the point where Rei would maximize profit, but that's another lesson.