

Maximizing the Profit of a Business

Math 1010 Intermediate Algebra Group Project

In this project your group will solve the following problem:

A manufacturer produces the following two items: computer desks and bookcases. Each item requires processing in each of two departments. Department A has 55 hours available and department B has 39 hours available each week for production. To manufacture a computer desk requires 4 hours in department A and 3 hours in department B while a bookcase requires 3 hours in department A and 2 hours in department B. Profits on the items are \$72 and \$23 respectively. If all the units can be sold, how many of each should be made to maximize profits?

Let X be the number of computer desks that are sold and Y be number of bookcases sold.

1. Write down a linear inequality for the hours used in Department A

$$4x + 3y \leq 55$$

2. Write down a linear inequality for the hours used in Department B

$$3x + 2y \leq 39$$

There are two other linear inequalities that must be met. These relate to the fact that the manufacturer cannot produce negative numbers of items. These inequalities are as follows:

$$X \geq 0$$

$$Y \geq 0$$

3. Next, write down the profit function for the sale of X desks and Y bookcases:

$$P = 72(x) + 23(y)$$

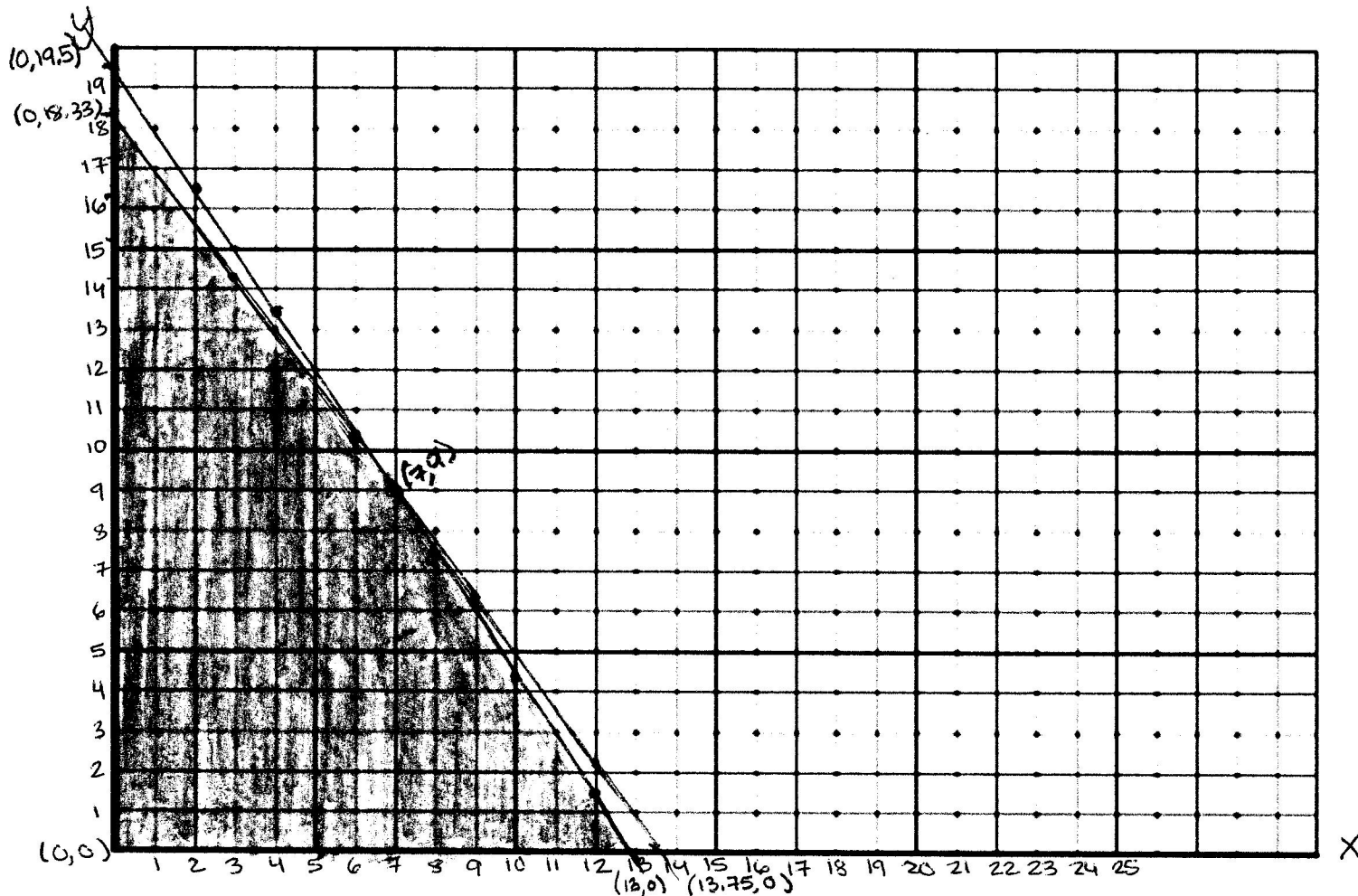
$$P(x) = \$72x + \$23y$$

You now have four linear inequalities and a profit function. These together describe the manufacturing situation. These together make up what is known mathematically as a **linear programming** problem. Write all of the inequalities and the profit function together below. This is typically written one on top of another, with the profit function last.

$$\begin{aligned} 4x + 3y &\leq 55 \rightarrow y \leq -4/3x + 55/3 \\ 3x + 2y &\leq 39 \rightarrow y \leq -3/2x + 39/2 \\ x &\geq 0 \\ y &\geq 0 \\ P(x) &= \$72x + \$23y \end{aligned}$$

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4. To solve this problem, you will need to graph the **intersection** of all four inequalities on one common XY plane. Do this on the grid below. Have the bottom left be the origin, with the horizontal axis representing X and the vertical axis representing Y.



$$\begin{array}{r} 4x + 3y \leq 55 \\ -4x \qquad -4x \\ \hline 3y \leq -4x + 55 \\ 3 \end{array}$$

$$y \leq -\frac{4}{3}x + \frac{55}{3}$$

$$\begin{array}{r} 3x + 2y \leq 39 \\ -3x \qquad -3x \\ \hline 2y \leq -3x + 39 \\ 2 \end{array}$$

$$y \leq -\frac{3}{2}x + \frac{39}{2}$$

$$x \geq 0$$

$$y \geq 0$$

intersection (7, 9)

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5. The above shape should have 4 corners. Find the coordinates of the ordered pairs that make up these corners. For the intersection of the two slanted lines you will have to solve the 2 by 2 system made up of their equations.

$$\begin{aligned} (-3) \quad & 4x + 3y \leq 55 \\ (4) \quad & 3x + 2y \leq 39 \end{aligned}$$

$$\begin{aligned} 4x + 3(9) &\leq 55 \\ 4x + 27 &\leq 55 \\ -27 \quad &-27 \end{aligned}$$

$$\begin{aligned} &(0, 19.5) \quad (13, 0) \\ &(0, 18.3\bar{3}) \quad (13.75, 0) \\ &(7, 9) \end{aligned}$$

$$\begin{aligned} -12x - 9y &\leq -165 \\ 12x + 8y &\leq 156 \end{aligned}$$

$$\frac{4x \leq 28}{4 \quad 4}$$

$$\frac{-1y \leq -9}{-1} \quad y \geq 9$$

$$x \leq 7$$

intersection (7, 9)

6. The next thing to do is to plug each of the points you found in part 5 into the profit function to determine which ordered pair gives the maximum profit. Do this and write a sentence describing how many of each type of furniture you should build and sell and what is the maximum profit you will make.

$$\begin{matrix} x & y \\ (0, & 19.5) \end{matrix}$$

$$\begin{array}{r} 23.0 \\ \times 19.5 \\ \hline 1150 \\ 2498 \\ \hline \end{array}$$

$$72(0) + 23(19.5) = \$448.5$$

$$\begin{matrix} x & y \\ (0, & 18.3\bar{3}) \end{matrix}$$

$$\begin{array}{r} 23.00 \\ \times 18.3\bar{3} \\ \hline 6900 \\ 6900 \\ 18400 \\ \hline 28000 \end{array}$$

$$72(0) + 23(18.3\bar{3}) = \$421.59$$

$$(13, 0)$$

$$72(13) + 23(0) = \$936$$

$$\begin{array}{r} 72 \\ \times 13 \\ \hline 216 \\ 720 \\ \hline 936 \end{array}$$

$$72(13.75) + 23(0) = \$990$$

$$\begin{matrix} x & y \\ (7, & 9) \end{matrix}$$

$$\begin{array}{r} 72.00 \\ \times 17.75 \\ \hline 36000 \\ 504000 \\ 2160000 \\ 7200 \\ \hline \end{array}$$

$$\begin{array}{r} 72(7) + 23(9) \\ 504 \quad 207 = \$711 \end{array}$$

$$\begin{array}{r} 72 \\ \times 7 \\ \hline 504 \end{array} \quad \begin{array}{r} 23 \\ \times 9 \\ \hline 207 \end{array}$$

The companies maximum profit is at coordinates (13.75, 0) with the profit being \$990. The company should be making 13.75 computer desks and making zero bookcases. This will make them the most profit with these products.

7. Reflective Writing.

Did this project change the way you think about how math can be applied to the real world? Write one paragraph stating what ideas changed and why. If this project did not change the way you think, write how this project gave further evidence to support your existing opinion about applying math. Be specific.

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I did find it interesting that companies can use linear inequalities and intersection points to figure where their hours are best spent and which amounts of products will give them the maximum profit. It helps the company create a plan to figure out where they should put their resources and how many materials they are going to need and the estimated demand of their product. It is easy to see how math can apply to how companies run their businesses. Without being able to use math equations, companies wouldn't have the ability to be as successful as they are and find where their time in producing products is best spent. I think math is a necessary concept in many aspects of the real world.