8

DepED
DEPARTMENT OF EDUCATION

Mathematics

Quarter 2 – Module 4:
"Solving Systems of Linear Inequalities in Two Variables"

ALTERNATIVE DELIVERY MODE
ADM

Mathematics– Grade 8
Alternative Delivery Mode
Quarter 2 – Module 4: Solving Systems of Linear Inequalities in Two Variables
First Edition, 2020

Published by the Department of Education
Secretary: Leonor Magtolis Briones
Undersecretary: Diosdado M. San Antonio

Development Team of the Module

Writer:	Merie Christ D. Luarez
Language Editor:	Vicente P. Balbuena
Content Evaluator:	Victorino S. Nimes, Myracell P. Buenaflor, Ella C. Armayan, Marie Grace O. Aparre
Layout Evaluator:	Jay R. Tinambcan
Reviewers:	Rhea J. Yparraguirre, Rhodora C. Luga, Charlie May C. Octal, Irelle B. Tesado, Mellanie G. Tuyor, Keziah Grace B. Presto
Illustrator:	Merie Christ D. Luarez
Layout Artists:	Merie Christ D. Luarez, Jake D. Fraga
Management Team:	Francis Cesar B. Bringas, Isidro M. Biol, Jr., Maripaz F. Magno, Josephine Chonie M. Obseñares, Josita B. Carmen, Celsa A. Casa, Regina Euann A. Puerto, Bryan L. Arreo, Lieu Gee Keeshia C. Guillen, Leopardo P. Cortes, Jr., Claire Ann P. Gonzaga

Printed in the Philippines by _____

Department of Education – Caraga Region

Office Address: Learning Resource Management Section (LRMS)
J.P. Rosales Avenue, Butuan City, Philippines 8600
Telefax Nos.: (085) 342-8207 / (085) 342-5969
E-mail Address: caraga@deped.gov.ph

8

Mathematics

Quarter 2 – Module 4:
"Solving Systems of Linear Inequalities in Two Variables"

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

In this module, you will be acquainted with the application of systems of linear inequalities in two variables in solving problems related to real-life. The scope of this module enables you to use it in many different learning situations. The lesson is arranged following the standard sequence of the course. But the order in which you read them can be changed corresponding with the textbook you are now using.

This module is divided into two lessons:

Lesson 1- Graphing Systems of Linear Inequalities in Two Variables
Lesson 2– Solving Problems Involving Systems of Linear Inequalities in Two Variables

After going through this module, you are expected to:

1. define systems of linear inequalities in two variables;
2. graph systems of linear inequalities in two variables; and
3. solve problems involving systems of linear inequalities in two variables.

What I Know

PRE-ASSESSMENT

Directions: Choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is a system of linear inequalities in two variables?

   A. $\begin{cases} 2x + 5y = 7 \\ x - 3y > 10 \end{cases}$

   B. $\begin{cases} 3x + 9y = -4 \\ x - 2 = 8 \end{cases}$

   C. $\begin{cases} x - 7y = 5 \\ 3x + 2y > 15 \end{cases}$

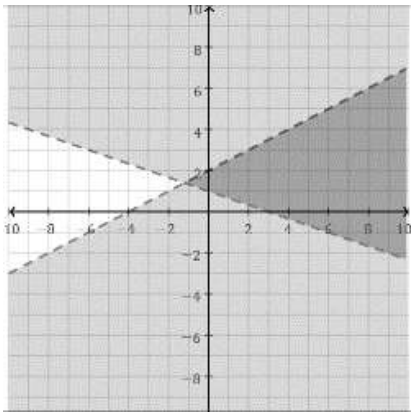
   D. $\begin{cases} 6x + 7y < 12 \\ 2y - 4x \geq 9 \end{cases}$

2. Which ordered pair satisfies the system of linear inequalities in two variables $\begin{cases} 2x - 4y < 10 \\ x + y \geq -5 \end{cases}$?

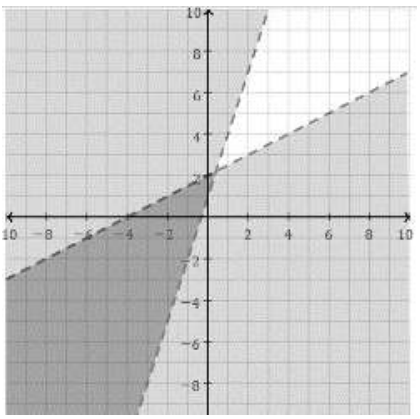
   A. (-3, -3) B. (9, 1) C. (-6, 7) D. (7, -4)

3. Which graph below illustrates the system of linear inequalities in two variables $y < \frac{1}{2}x + 2$ and $y > -\frac{1}{3}x + 1$?

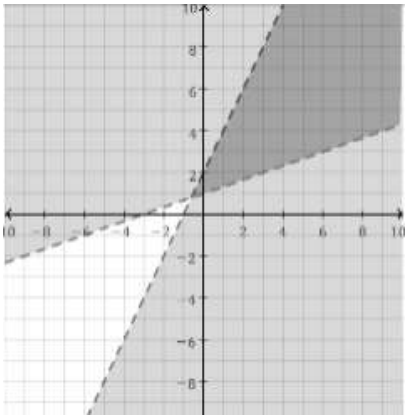
   A.



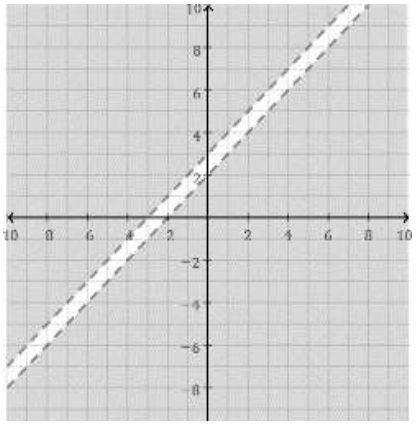
   C.



   B.



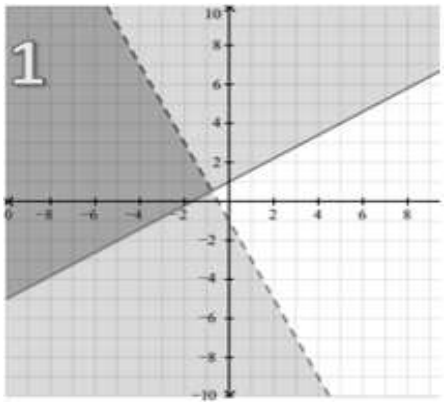
   D.

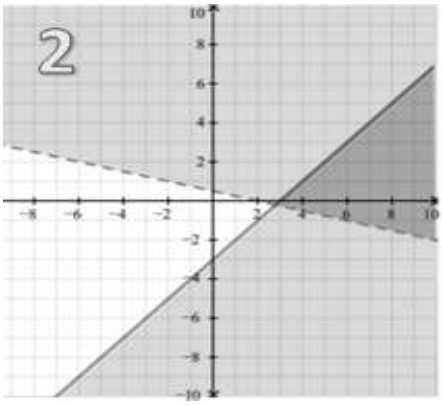


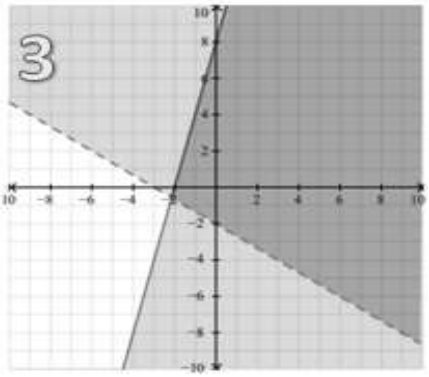
4. Which of the following is NOT a solution of the system of linear inequalities in two variables $-x + 4y \geq -5$ and $5x + 2y > 8$?

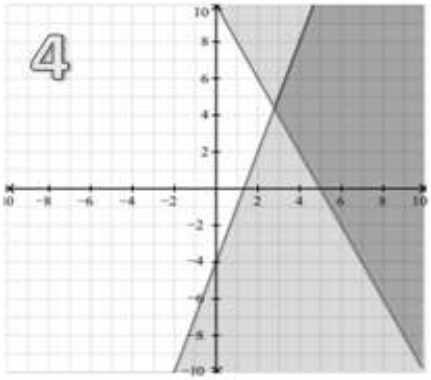
   A. (-3, -3)
   B. (2,1)
   C. (5,6)
   D. (3,0)

5. Which of the following best describes the graph of the system of linear inequalities in two variables $2x + 3y > -6$ and $y \leq 4x + 8$?









   A. Graphs 1 & 2
   B. Graph 3 only
   C. Graph 1 only
   D. Graphs 3 and 4

6. Determine the ordered pair that satisfies the solution to the system of linear inequalities in two variables $4x - 2y \leq 3$ and $y - 2x \leq 1$.

   A. $(7, 8)$
   B. $(-2, -5)$
   C. $(3, -6)$
   D. $(0, 4)$

Use this situation to answer the questions in numbers 7-8:

Sandy is buying pots and seedlings for her garden. Each pot costs $P15$ while each seedling costs $P5$. She wants to buy at least 5 seedlings. She cannot spend more than $P80$. Let x represents the number of pots and y the number of seedlings.

7. Which system of linear inequalities in two variables best describes the situation?

A. $\begin{cases} 15x + 5y \leq 80 \\ y \geq 5 \end{cases}$

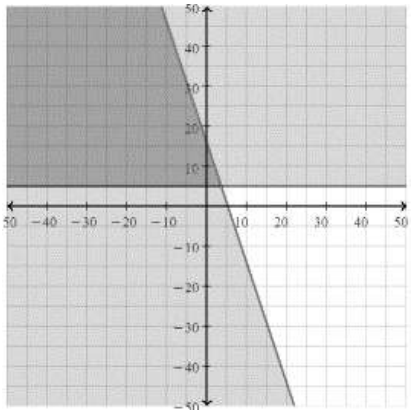
B. $\begin{cases} 15x + 5 > 80 \\ x \geq 5 \end{cases}$

C. $\begin{cases} 15x + 5y \leq 80 \\ x \geq 5 \end{cases}$

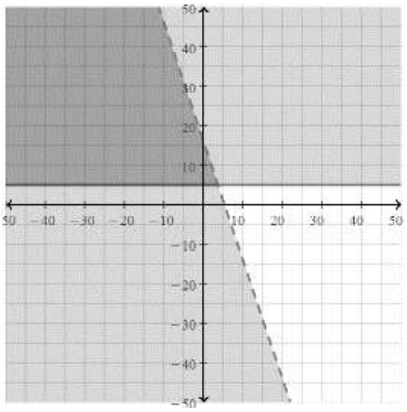
D. $\begin{cases} 15x + 5y \geq 80 \\ y < 5 \end{cases}$

8. Which of the graph below represents the system of linear inequalities in two variables in the situation?

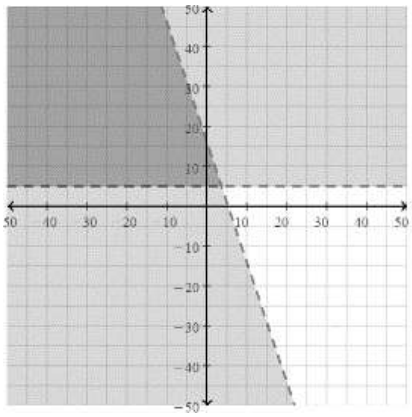
A.



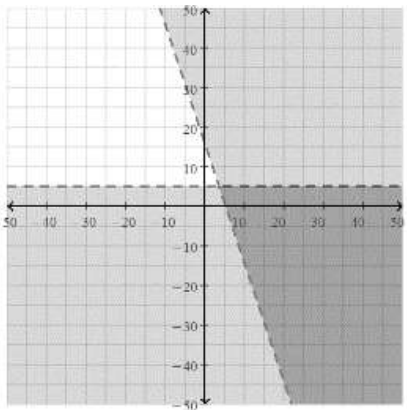
C.



B.



D.



Use this situation to answer the questions in numbers 9 and 10:

Mardy's shoe shop has no more than 50 total number of rubber and leather shoes. He also has no more than 25 leather shoes. Let x represents the number of rubber shoes and y the number of leather shoes.

9. Find the system of linear inequalities in two variables that represents the given situation.

A. $\begin{cases} x + y \leq 50 \\ y \leq 25 \end{cases}$

B. $\begin{cases} x + y \leq 50 \\ y \geq 25 \end{cases}$

C. $\begin{cases} x + y \geq 50 \\ y \leq 25 \end{cases}$

D. $\begin{cases} x + y \geq 50 \\ y \geq 25 \end{cases}$

10. Which inequality represents the number of leather shoes that Mardy's shoe shop has?

A. $y \leq 25$
B. $y \geq 50$
C. $y < 25$
D. $y \leq 50$

Use this situation to answer the questions in numbers 11 and 12:

Alice is selling bread and pudding to earn money. Each bread costs $P2$ and each pudding costs $P3$. She needs to sell at least 50 pieces of bread and needs to earn at least $P500$. Let x be the number of bread she needs to sell and y be the number of pudding.

11. Which of the following system of linear inequalities in two variables to represent the situation?

A. $\begin{cases} 2x + 3y \geq 500 \\ x \geq 50 \end{cases}$
B. $\begin{cases} x + y \leq 500 \\ x \geq 50 \end{cases}$
C. $\begin{cases} 2x + 3y \leq 500 \\ x \leq 50 \end{cases}$
D. $\begin{cases} x + y \geq 500 \\ x \leq 50 \end{cases}$

12. Which of the following system of linear inequalities in two variables to represent the situation?

A. $\begin{cases} 2x + 3y \geq 500 \\ x \geq 50 \end{cases}$
B. $\begin{cases} x + y \leq 500 \\ x \geq 50 \end{cases}$
C. $\begin{cases} 2x + 3y \leq 500 \\ x \leq 50 \end{cases}$
D. $\begin{cases} x + y \geq 500 \\ x \leq 50 \end{cases}$

13. At least how many breads and puddings can Alice sell?

A. 50 breads and 50 puddings
B. 50 breads and 100 puddings
C. 100 breads and 100 puddings
D. 75 breads and 50 puddings

Use this situation to answer the questions in numbers 13-15:

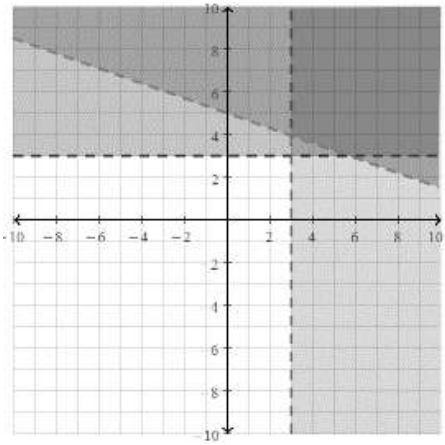
Rhea is buying burger and pizza for snacks with her friends. Each burger costs $P35$ and each box of pizza costs $P100$. Rhea wanted to spend no more than $P500$, but she needs at least 3 burgers and 2 boxes of pizza. Let x be the number of burger and y be the number of boxes of pizza.

14. Which system of linear inequalities in two variables represents the situation?

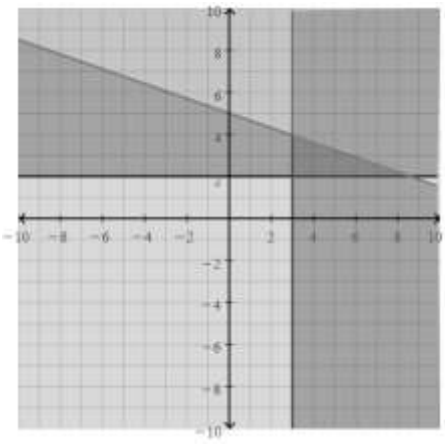
A. $\begin{cases} 35x + 100y \geq 500 \\ x \geq 3 \\ y \geq 2 \end{cases}$
B. $\begin{cases} 35x + 100y > 500 \\ x > 3 \\ y > 2 \end{cases}$
C. $\begin{cases} 35x + 100y \leq 500 \\ x \geq 3 \\ y \geq 2 \end{cases}$
D. $\begin{cases} 35x + 100y < 500 \\ x < 3 \\ y < 2 \end{cases}$

15. Which graph below represents the system of linear inequalities in two variables in the situation?

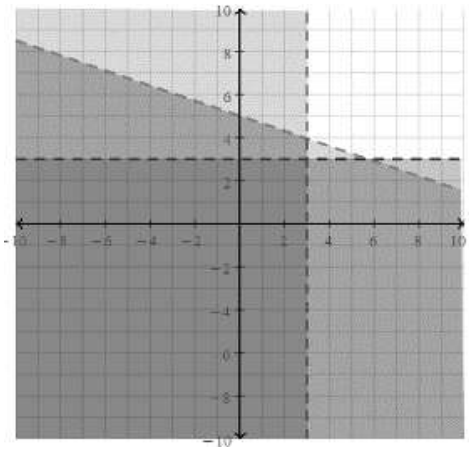
A.



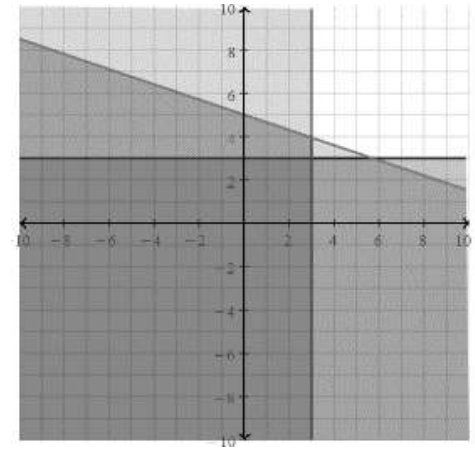
C.



B.



D.



16. Which of the following could NOT the possible number of burgers and boxes of pizza Rhea can buy?

A. 3 burgers and 2 boxes of pizza
B. 3 burgers and 3 boxes of pizza
C. 4 burgers and 4 boxes of pizza
D. 5 burgers and 3 boxes of pizza

Lesson 1 Graphing Systems of Linear Inequalities in Two Variables

What's In

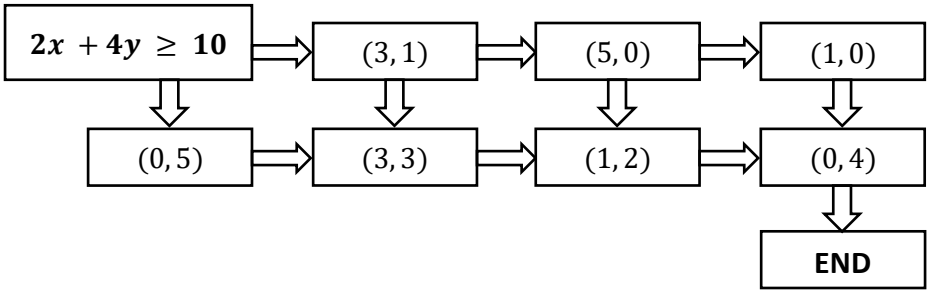
Activating prior knowledge

Let us start this lesson by reviewing the concept of linear inequalities in two variables.

Activity: Find My Pair!

Directions: Find your way through the maze. Begin your journey at the linear inequality

$2x + 4y \geq 10$. Move along the path by finding the ordered pairs that satisfy the given linear inequality in two variables. Write your answers on a separate sheet of paper.



Questions:

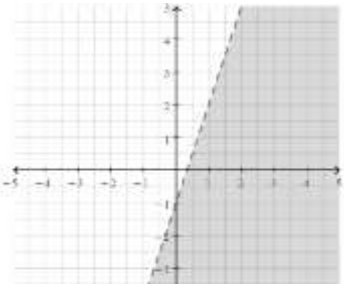
1. What are the ordered pairs that satisfy the given linear inequality in two variables?
2. How did you determine if the ordered pair satisfy the given inequality?
3. Give one possible path to reach the "End" of the maze.

What's New

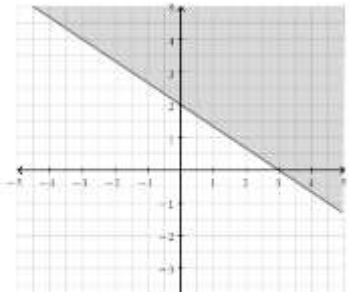
Activity: Try Me!

Directions: Consider the situation below and then answer the questions that follow. Write
your answers on a separate sheet of paper.

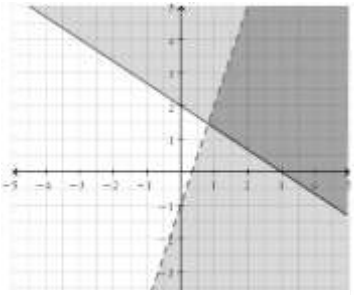
One day you are invited by a friend to accompany him to a Math exhibit in their school. As you look at each display, there were three particular frames that caught your attention:



$Frame\ 1: -3x + y < -1$



$Frame\ 2: \frac{2}{3}x + y \geq 2$



$Frame\ 3: \begin{cases} -3x + y < -1 \\ \frac{2}{3}x + y \geq 2 \end{cases}$

Questions:

1. What does the shaded region in each frame means?

2. Give at least three (3) ordered pairs in the shaded region of each frame.
   Frame 1: (____, ____), (____, ____), (____, ____)
   Frame 2: (____, ____), (____, ____), (____, ____)
   Frame 3: (____, ____), (____, ____), (____, ____)

3. How does the shaded regions in Frames 1 & 2 differ from the shaded regions in Frame 3?

4. Give an ordered pair that satisfies the following conditions:
   (a) It is in the shaded region of Frame 1 but not in Frame 2
   (b) It is in the shaded region of Frame 2 but not in Frame 1
   (c) It is in the shaded regions of both Frames 1 and 2

What Is It

The set of all solutions to a linear inequality in two variables can be presented clearly in a Cartesian coordinate system by graphing. A System of Linear Inequalities in two variables consists of at least two linear inequalities. "Solving" systems of linear inequalities means "graphing each individual inequality, then finding the solution sets or group of points which satisfy all the given inequalities". The solution sets of a system of linear inequalities in two variables is located on the shaded region common in all inequalities.

Steps in graphing systems of linear inequalities in two variables:

1. Rewrite each mathematical statement into slope-intercept form $y = mx + b$, where ***m*** is the slope and ***b*** is the y-intercept.

   Note: *Whenever you multiply or divide an inequality by a negative number, you must*
   reverse the inequality sign.

2. Graph the system of linear inequalities in two variables in a Cartesian coordinate plane.
   a. Locate the y – intercept or the point (0, b). It is the point where the graph crosses the y-axis.

   b. From the y-intercept, use the value of the slope in going up or down or running left or right to locate another point/s. The table below will be your guide:

Slope: $\frac{rise}{run}$	Sign	Movement
rise	positive	Go up
	negative	Go down
run	positive	Run right
	negative	Run Left

   c. Use broken lines for linear inequalities using < and >, and solid lines for linear inequalities using ≤ and ≥.

   d. Shade the region above the graph of $y \geq mx + b$and $y > mx + b$ and shade the region below the graph of $y \leq mx + b$ or $y < mx + b$.

e. Do the same steps in graphing the other given linear inequality in two variables.

3. Observe the shaded regions. The area where the shaded regions overlapped is where the **solutions** of the system of linear inequalities are located. It means that all the points in that area make the system of linear inequalities in two variables **true.**

Let us apply the steps in the given examples below.

Example 1. Solve the system.

$$\begin{cases} -3x + y < -1 \\ \frac{2}{3}x + y \geq 2 \end{cases}$$

Solution**:**

Step1: Rewrite each mathematical statement into slope-intercept form $y = mx + b$, where ***m*** is the slope and ***b*** is the y-intercept.

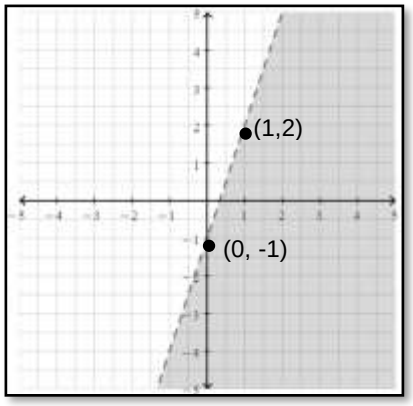
$-3x + y < -1 \longrightarrow y < 3x - 1 \longrightarrow b = -1\,;\, m = 3$

$\frac{2}{3}x + y \geq 2 \longrightarrow y \geq -\frac{2}{3}x + 2 \longrightarrow b = 2\,;\, m = \frac{-2}{3}$

Step 2: Graph the system of linear inequalities in two variables in a Cartesian coordinate plane.

For $y < 3x - 1$:

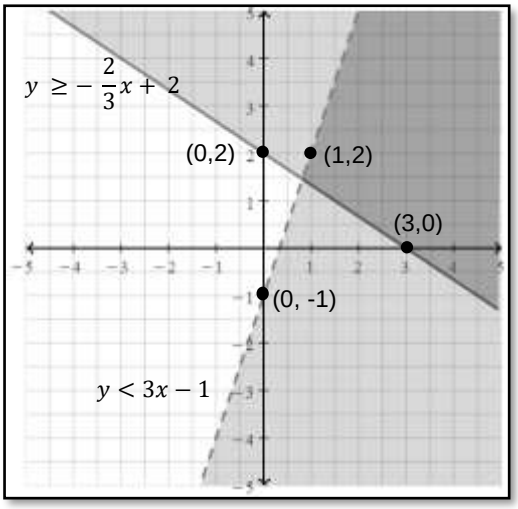
a. Locate the y – intercept or the point (0, -1).
b. From the y-intercept (0, -1), use the value of slope, m =3 = $\frac{3}{1}$. You go 3 units upward and 1 unit to the right. In doing so, you will end at point (1,2).
c. Use broken line since the linear inequality symbol is<.
d. Shade the region below the graph of $y < 3x - 1$.



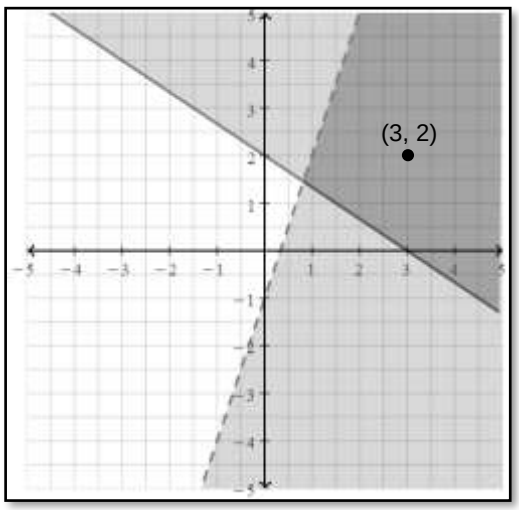
e. Apply the same steps from a to d to graph $y \geq -\frac{2}{3}x + 2$.

For $y \geq -\frac{2}{3}x + 2$

a. Locate the y – intercept or the point (0, 2).
b. From the y-intercept (0, 2), use the value of slope m = $-\frac{2}{3} = \frac{-2}{3}$. You go 2 units downward and 3 units to the right. In doing so, you will end at point (3,0).
c. Use solid line since the linear inequality symbol is ≥.
d. Shade the region above the graph of $y \geq -\frac{2}{3}x + 2$.



Step 3: Observe the double-shaded region of the graph of the systems of linear inequalities in two variables. This region contains all the ordered pairs that make both linear inequalities true. Thus, the set of all these ordered pairs is called the **solution set** of the given system of linear inequalities in two variables $\begin{cases} y < 3x - 1 \\ y \geq -\frac{2}{3}x + 2 \end{cases}$.



From the double-shaded region, choose a point say (3, 2) and substitute it to the given system of linear inequalities in two variables.

(3, 2)	
$-3x + y < -1$ $-3(3) + 2 < -1$ $-9 + 2 < -1$ $-7 < -1$ ***(TRUE)***	$y \geq -\frac{2}{3}x + 2$ $2 \geq -\frac{2}{3}(3) + 2$ $2 \geq -\frac{6}{3} + 2$ $2 \geq -2 + 2$ $2 \geq 0$ ***(TRUE)***

Therefore, point (3,2) makes the two linear inequalities true. Note that this point is just one of the many solutions to the given system of linear inequalities.

Example 2: Solve the system.

$$\begin{cases} 4x - 2y \leq 8 \\ x - 3y \geq 9 \end{cases}$$

Solution:

Step 1: Rewrite each mathematical statement into slope-intercept form $y = mx + b$, where $\boldsymbol{m}$ is the slope and $\boldsymbol{b}$is the y-intercept.

$4x - 2y \leq 8 \quad \rightarrow \quad -2y \leq -4x + 8$ *(observe that the variable y has numerical coefficient -2)*

$\rightarrow \quad \frac{-2y}{-2} \leq \frac{-4x}{-2} + \frac{8}{-2}$ *(divide both sides by -2)*

$\rightarrow \quad y \geq 2x - 4$ *(this is the new inequality)*

Therefore, $m = 2$ *and* $b = -4$

$x - 3y \geq 9 \quad \rightarrow \quad -3y \geq -x + 9$ *(observe that the variable y has numerical coefficient -3)*

$\rightarrow \quad \frac{-3y}{-3} \geq \frac{-x}{-3} + \frac{9}{-3}$ *(divide both sides by -3)*

$\rightarrow \quad y \leq \frac{1}{3}x - 3$ *(this is the new inequality)*

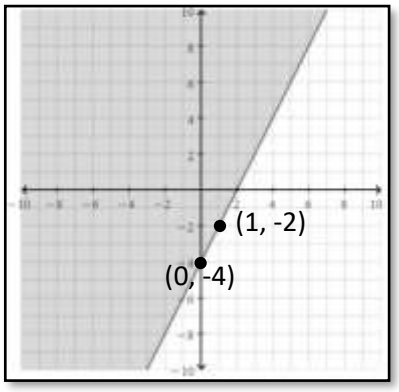
Therefore, $m = \frac{1}{3}$ *and* $b = -3$

Step 2: Graph the system of linear inequalities in two variables in a Cartesian coordinate plane.

For $y \geq 2x - 4$:

a. Locate the y – intercept or the point $(0, -4)$.
b. From the y-intercept $(0, -4)$, use the value of slope $m = 2 = \frac{2}{1}$. You go 2 units upward and 1 unit to the right. In doing so, you will end at point (1,-2).
c. Use solid line since the linear inequality symbol is ≥.

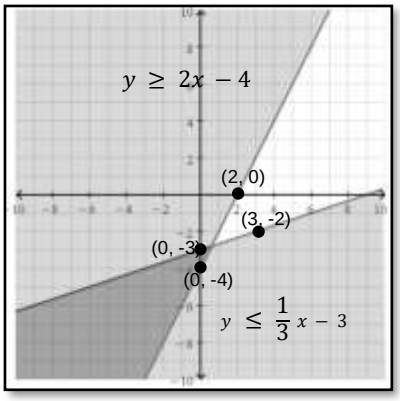
d. Shade the region above the graph of y ≥ 2x – 4.



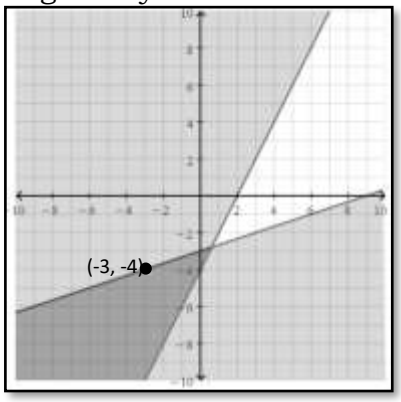
e. Apply the same steps from a to d to graph $y \leq \frac{1}{3}x - 3$.

For $y \leq \frac{1}{3}x - 3$

a. Locate the y – intercept or the point $(0, -3)$.
b. From the y-intercept $(0, -3)$, use the value ofthe slope m = $\frac{1}{3}$. You go 1 unitupward and 3 units to the right. In doing so, you will end at point $(3, -2)$.
c. Use solid line since the linear inequality symbol is ≤.
d. Shade the region below the graph of $y \leq \frac{1}{3}x - 3$.



Step 3: Observe the double-shaded region of the graph of the systems of linear inequalities in two variables. This region contains all the ordered pairs that make both linear inequalities true. Thus, the set of all these ordered pairs is called the **solution set** of the given system of linear inequalities in two variables $\begin{cases} y \geq 2x - 4 \\ y \leq \frac{1}{3}x - 3 \end{cases}$.



From the double-shaded region, choose a point say $(-3, -4)$ and substitute it to the given system of linear inequalities in two variables.

(-3, -4)	
$\boldsymbol{4x - 2y \leq 8}$ $4(-3) - 2(-4) \leq 8$ $-12 + 8 \leq 8$ $-4 \leq 8$ ***(TRUE)***	$\boldsymbol{x - 3y \geq 9}$ $-3 - 3(-4) \geq 9$ $-3 + 12 \geq 9$ $9 \geq 9$ ***(TRUE)***

In the above example, point $(-3, -4)$makes the two linear inequalities true. Note that this point is just one of the many solutions to the given system of linear inequalities.

Steps in graphing the given system of linear inequalities $\begin{cases} x < p \\ y \geq q \end{cases}$ where p and q could be any real number.

Step 1: To graph $x < p$, draw a vertical line crossing the x-axis through the point $(p, 0)$ and shade the right region if the inequality symbol is $>$ or shade the left region if the given symbol is $<$.

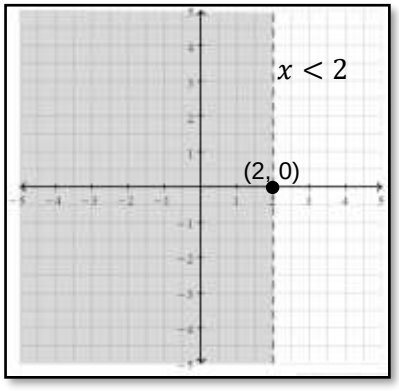
Step 2: To graph y is greater or equal to q, draw a horizontal line crossing the y-axis through the point $(0, q)$ and shade the region above if the inequality symbol is $>$ or shade the region below if the given symbol is $<$.

Step 3: Observe the double-shaded region of the graph of the systems of linear inequalities in two variables. This region contains all the ordered pairs that make both linear inequalities true.

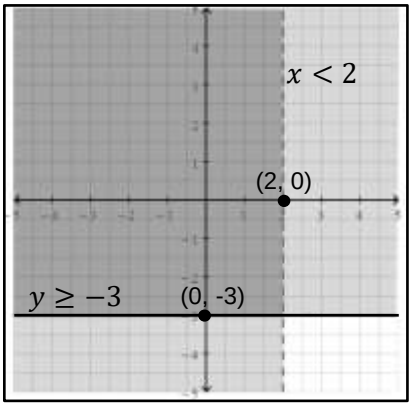
Example:

Sketch the graph of $\begin{cases} x < 2 \\ y \geq -3 \end{cases}$

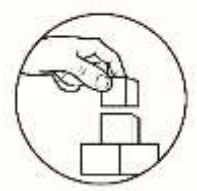
1. Draw the vertical line passing through the point (2,0) and shade the left region.



2. Draw the horizontal line passing through the point (0,-3) and shade the above region.



3. The double-shaded region of the graph contains all the ordered pairs that make both linear inequalities true. Thus, the set of all these ordered pairs is called the **solution set** of the given system of linear inequalities in two variables $\begin{cases} x < 2 \\ y \geq -3 \end{cases}$.



What's More

You have just learned how to solve systems of linear inequalities in two variables. Here are more activities for you to try on.

Activity 1: Complete the Table

Directions: Sketch the graph of the system of linear inequalities in two variables $\begin{cases} y < 2x + 2 \\ 2x + 4y \geq 2 \end{cases}$. Write your answers on a separate sheet of paper.

Step 1: Are the inequalities in the form of $y = mx + b$? If yes check the column, if no, transform.

Linear Inequality	Yes	No	Transform
$y < 2x + 2$			
$2x + 4y \geq 2$			

Step 2: Complete the table. Use your answers in step 1.

Linear Inequality	Slope (m)	rise	run	y-intercept (b)	Type of Line to be used (broken or solid)

Step 3: Graph and then shade the region.

Step 4: Give two points in the double-shaded region which satisfy the given inequalities.

Activity 2: Sketch My Graph!

Directions: Graph the given system of linear inequalities in two variables using the same steps in the examples. Write your answer on a separate sheet of graphing paper.

$$\begin{cases} 2x + y > 3 \\ y < 5 - 2x \end{cases}$$

What I Have Learned

Directions: Enumerate the steps in graphing systems of linear inequalities in two variables. Write your answers on a separate sheet of paper.
In graphing systems of linear inequalities in two variables;

First, I have to rewrite…

Second, I will plot the points using…

Third, I will use broken line if…
I will use solid line if…

Fourth, I will shade above the line if…
I will shade below the line if…

Finally, I will identify the solution set of the system by…

What I Can Do

Directions: Graph the given system of linear inequalities in a separate sheet of paper or
graphing paper. Give at least three points of the solution set of the system of inequalities.

$$\begin{cases} 2x + 3y > -6 \\ x < 0 \\ y \geq 4 \end{cases}$$

Lesson 2 Solving Problems Involving Systems of Linear Inequalities in Two Variables

What's In

Activating Prior Knowledge

Translating mathematical expressions to verbal phrases and vice versa is essential in solving word problems and application in real life situations.

Directions: Complete the table below by translating either the linear inequalities into verbal phrases or vice versa. The first item has been done for you as an example.

Linear Inequalities	Verbal Phrases
1) $x + 8y > 10$	The sum of x and the product of 8 and y is greater than 10.
2) $2x - 6y < 20$	
3)	The product of 4 and x is less than or equal to $16y$ minus 2
4) $5x - 1 \geq 2y$	
5)	The sum of a number x and the product of 12 and y is greater than or equal to 10.

What's New

Activity: Rice Please!

Directions: Read and analyze the situation below and answer the questions that follow.

In the market you can see varieties of rice at different prices. White rice costs *P*45 per kilogram and brown rice costs *P*50 per kilogram. You are planning to buy at least one

kilogram of white rice and one kilogram of brown rice. You have at most *P*200 to spend for the rice.

Questions:

1. How many variables will you use to represent each variety?
   Write representation for each variety of rice, you may use any letter as variable.
   _____
   _____
   _____

2. Using your representation in no. 1, translate each condition into linear inequality.

Statement	Inequality
Number of kilograms of white rice you are planning to buy	
Number of kilograms of brown rice you are planning to buy	
Total amount of money spent for buying the brown and white rice	

3. Based on your answers in number 2, how will you write the system of linear inequalities in two variables?

$$\begin{cases} \_\_\_\_\_ \\ \_\_\_\_\_ \\ \_\_\_\_\_ \end{cases}$$

What Is It

In the previous lesson, you have just learned how to solve systems of linear inequalities in two variables through graphing and identifying ordered pairs to test the region that satisfies the inequalities. This time, you are going to use the systems of linear inequalities in two variables in solving real-life problems.

Below are important points to consider in solving word problems.

Step 1**:** Read and analyze the problem carefully. Identify the important parts of the problem. Find the unknown and assign variables to represent them.

Step 2: Write the system of linear inequalities in two variables described in the problem. The

following are the key words you should consider in choosing the correct inequality symbols:

Key Word	**Inequality Symbol**	**Key Word**	**Inequality Symbol**
minimum	≥	less than or equal to	≤
at least	≥	not to exceed	≤
more than or equal to	≥	maximum	≤
not less than	≥	at most	≤
not below	≥	no more than	≤
more than	>	smaller than	<
above	>	below	<

Step 3: Follow the steps in graphing system of linear inequalities in two variables as presented in the previous lesson to find the solution set.

Let us now apply these steps in solving the problem presented in the previous section of this lesson.

Example 1:

In the market you can see varieties of rice at different prices. White rice costs *P*45 per kilogram and brown rice costs *P*50 per kilogram. You are planning to buy at least one kilogram of white rice and one kilogram of brown rice. You have at most *P*200 to spend for the rice.

Solution:

Step 1: Read and analyze the problem carefully. Identify the important parts of the problem. Find the unknown and assign variables to represent them

- Let $\boldsymbol{x}$ be the number of kilograms of White Rice
- Let $\boldsymbol{y}$ be the number of kilograms of Brown Rice

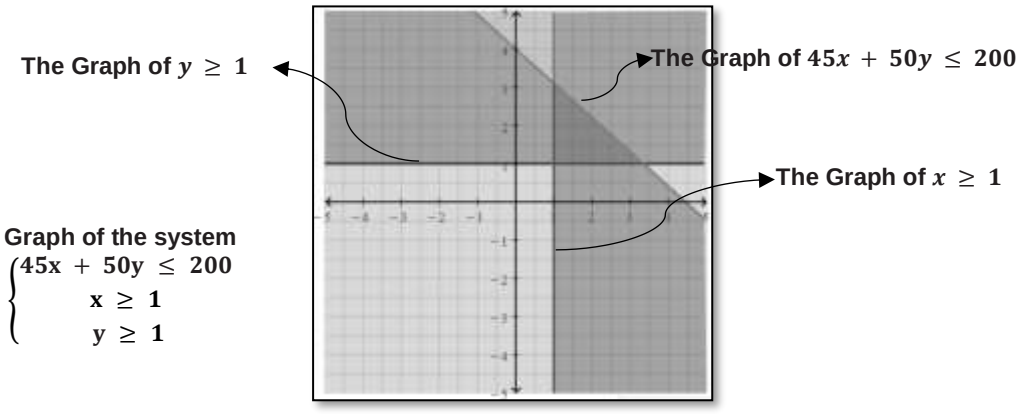
Step 2: Write the system of linear inequalities in two variables described in the problem.

- $45x + 50y \leq 200$ ⟶ ≤ (at most)

  $x \geq 1$ ⟶ you are planning to buy <u>at least</u> 1 kg of white rice

  $y \geq 1$ ⟶ you are planning to buy <u>at least</u> 1 kg of brown rice

Step 3: Follow the steps in graphing system of linear inequalities in two variables to find the
solution set.



- Choose at least one ordered pair that is located in the overlapped region to check if the mathematical statement is true.

For example: (1, 3)

$45x + 50y \leq 200$	$x \geq 1$	$y \geq 1$
$45(1) + 50(3) \leq 200$	$1 \geq 1(\boldsymbol{TRUE})$	$3 \geq 1$ $(\boldsymbol{TRUE})$
$45 + 150 \leq 200$		
$195 \leq 200(\boldsymbol{TRUE})$		

This means that you can buy 1 kilogram of white rice and 3 kilograms of brown rice, with a change of $P5$. It is also possible that you can buy 2 kilograms of white rice and 2 kilograms of brown rice. You may identify other possible combination on the number of kilograms of white and brown rice in the solution set.

Example 2:
Rebecca needs to earn at least $P1\,000$ each week to meet her children's needs. She works as a Mathematics tutor with a salary of $P200$ per hour and as an online seller where she earns $P150$ per hour. For both sources of income, she can only work no more than 40 hours per week.
Solution:

Step 1: Read and analyze the problem carefully. Identify the important parts of the problem. Find the unknown and assign variables to represent them.

- Let $\boldsymbol{x}$ be the number of hours spent as a Mathematics Tutor
- Let$\boldsymbol{y}$ be the number of hours spent as an online seller

Step 2: Write the system of linear inequalities in two variables described in the problem.

$200x + 150y \geq 1000 \longrightarrow$ (use the inequality symbol $\geq$ because of the statement "*at least* 1 000")

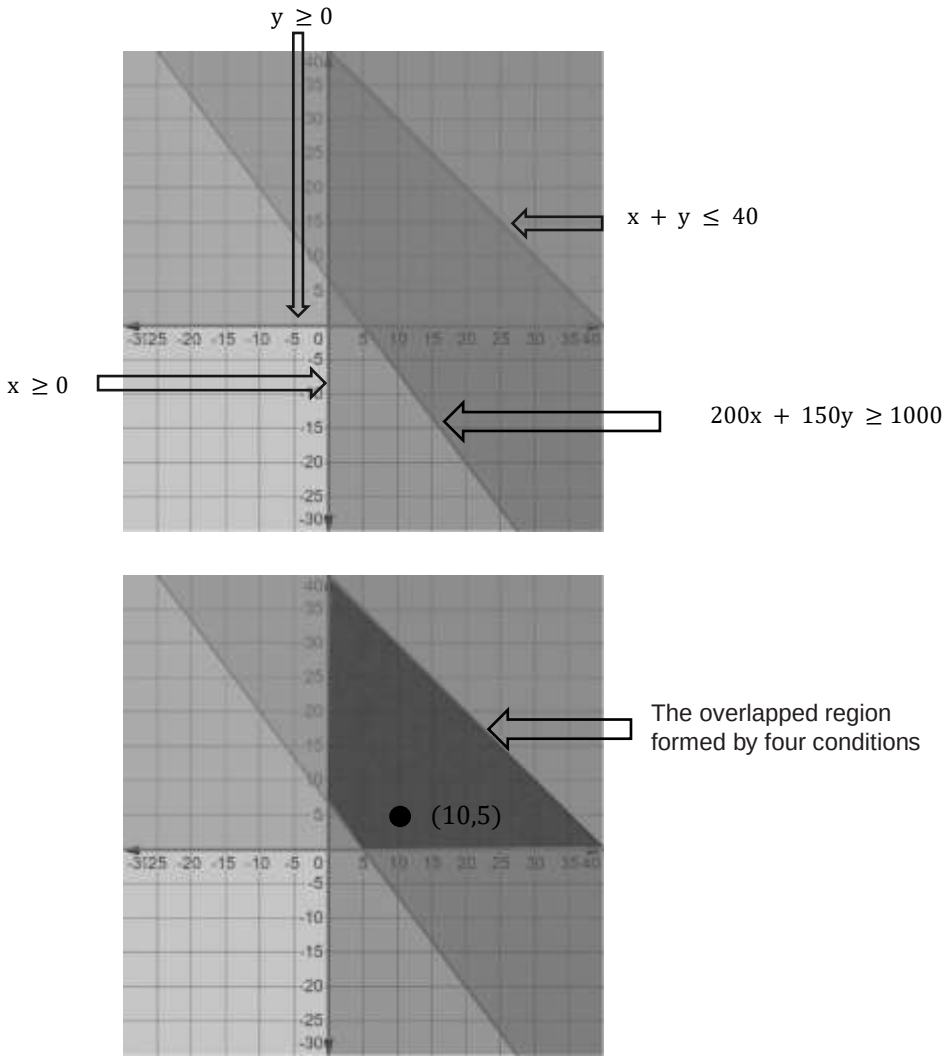
$x + y \leq 40 \longrightarrow$ (use $\leq$ because she can only work a total of *no more than* 40 hours per week)

$x \geq 0 \longrightarrow$ since time spent as Mathematics tutor is not negative

$y \geq 0 \longrightarrow$ since time spent as an online seller is not negative

Step 3: Follow the steps in graphing system of linear inequalities in two variables to find the solution set.

Graph of the system: $\begin{cases} 200x + 150y \geq 1000 \\ x + y \leq 40 \\ x \geq 0 \\ y \geq 0 \end{cases}$



- Choose at least one ordered pair that is located in the overlapped region to check if the mathematical statement is true.

For example: (10, 5)

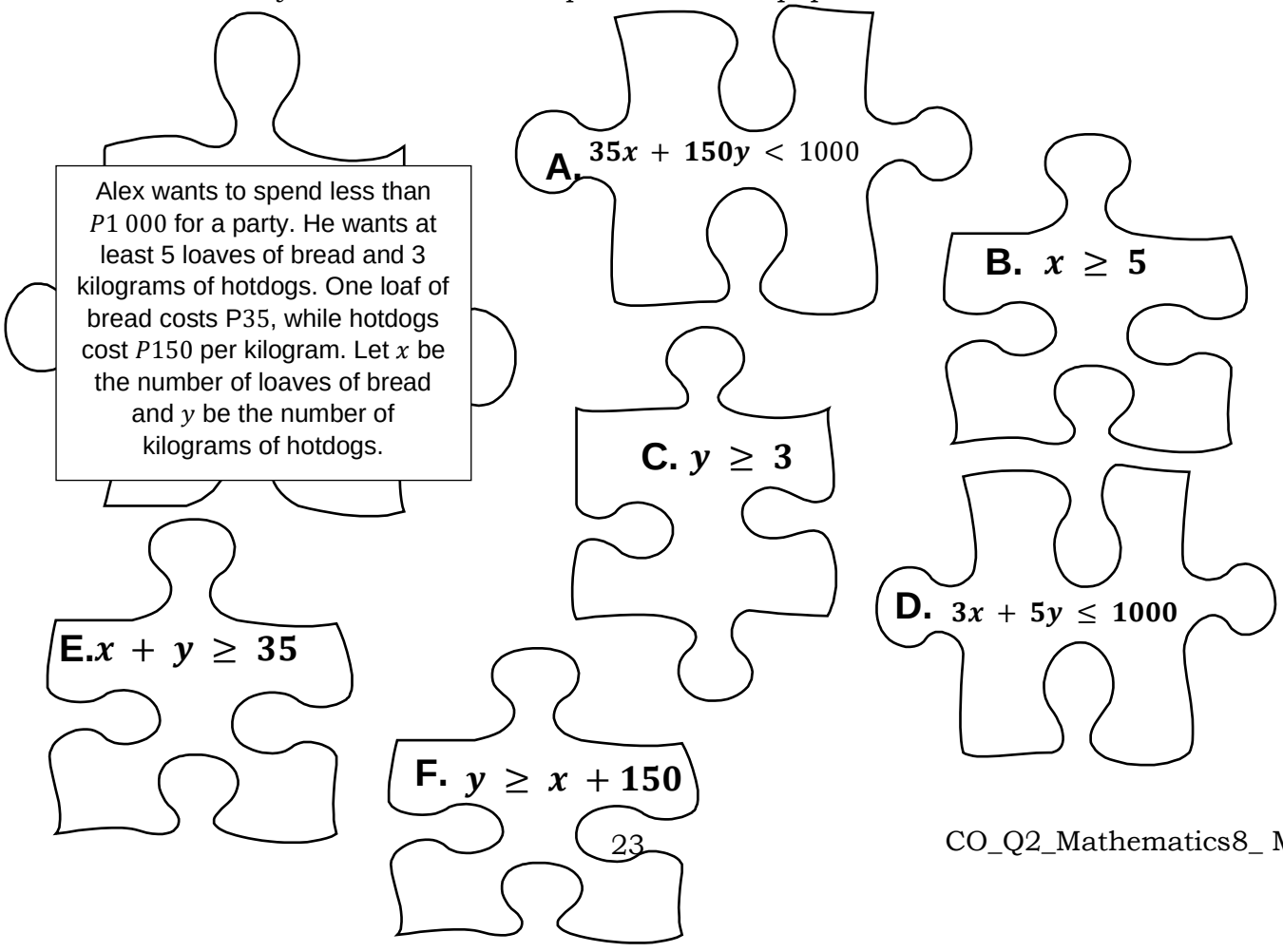
$200x + 150y \geq 1000$	$x + y \leq 40$	$\mathbf{x \geq 0}$	$\mathbf{y \geq 0}$
$200(10) + 150\,(5) \geq 1000$	$10 + 5 \leq 40$	$\mathbf{10 \geq 0}$ ***(TRUE)***	$\mathbf{5 \geq 0}$ ***(TRUE)***
$2000 + 750 \geq 1000$	$15 \leq 40$ $(\boldsymbol{TRUE})$		
$2750 \geq 1000$ $(\boldsymbol{TRUE})$			

This means that Rebecca can work 10 hours as a Mathematics tutor and 5 hours as an online seller. If Rebecca works 10 hours as Mathematics tutor and 5 hours as an online seller in a week, she will earn $P2\,750$ which can support her children's needs in a week. If she wanted to earn more than to what she needs in a week, there are many possible options shown in the solution set. One possibility is the ordered pair (20,20) which means that she can work 20 hours as a Mathematics tutor and 20 hours as an online seller. She can also earn at least $P1\,000$ a week as a Mathematics tutor even without selling online if she is able to spend 40 hours in her tutorial service. You can also determine other possible number of hours in each work as long as it satisfies the given condition.

What's More

Activity 1: The Missing Piece

Directions: Read and analyze the situation carefully. Choose the letter of the puzzle pieces containing the correct linear inequalities that best represent the given situation. Write your answers on a separate sheet of paper.



Activity 2: Satisfy Me!

Directions: Analyze the situation below and solve for what is asked. Write your answer on a separate sheet of paper or graphing paper.

Mrs. Santos wanted to prepare roasted chicken and fish *tinola* for dinner. A vendor sells chicken at *P*180 per kilogram and milk fish at *P*120 per kilogram. How many kilograms of each will she buy if the total cost is not to exceed *P*600?

1) Write the system of linear inequalities in two variables that represents the given situation.
2) Graph the system of linear inequalities in two variables.
3) Choose three (3) ordered pairs that satisfy the system of linear inequalities in two variables.
4) Check the solution set by substituting the values of x and $y$to determine whether or not it satisfies the system of linear inequalities in two variables.

What I Have Learned

Directions: Complete the 3-2-1 Chart about your discoveries in solving word problems involving systems of linear inequalities in two variables. Write your answers on a separate sheet of paper.

3

3 things I found out

1. _____
2. _____
3. _____

2

2 interesting things I learned

1. _____
2. _____

1

One thing I realized

1. _____

What I Can Do

Cite one real-life situation that involves system of linear inequalities in two variables.

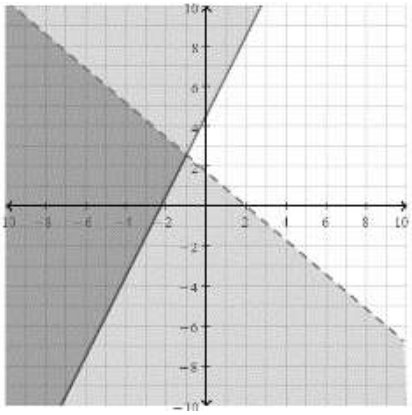
Your output will be graded according to the RUBRIC below:

4	3	2	1
The presentation of the real-life situation is clear, accurate, and practical, and the use of systems of linear inequalities in two variables and other mathematical statements are properly illustrated.	The presentation of the real-life situation is clear and practical and the use of systems of linear inequalities in two variables is illustrated.	The presentation of the real-life situation is not too clear and the use of systems of linear inequalities in two variables is not properly illustrated.	The presentation of the real-life situation is not clear and the use of systems of linear inequalities in two variables is not illustrated.

Assessment

Directions: Choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following ordered pairs satisfy the system of inequalities $\begin{cases} x - 4y \geq 6 \\ 3x + 2y > 5 \end{cases}$?
   A. (0, -3)
   B. (1, 5)
   C. (2, -2)
   D. (10, -2)
2. Which of the following systems of linear inequalities in two variables is represented by the graph?



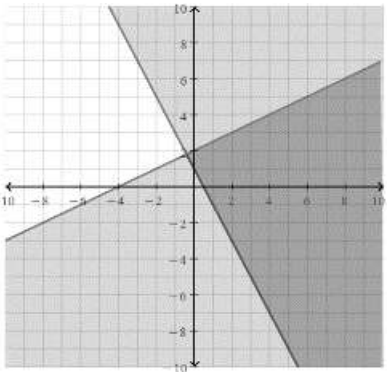
A. $\begin{cases} 2x + 5y > 7 \\ x - 3y > 10 \end{cases}$

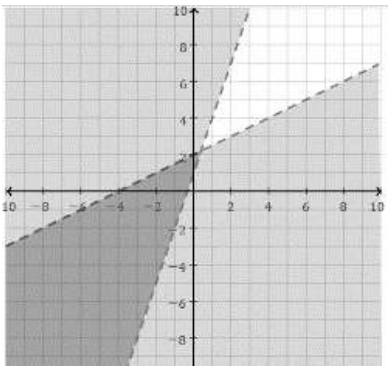
B. $\begin{cases} 3x + 9 < -4 \\ x - 2 > 8 \end{cases}$

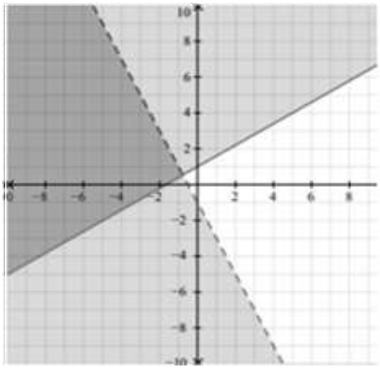
C. $\begin{cases} x - 7y \leq 5 \\ 3x + 2y > 15 \end{cases}$

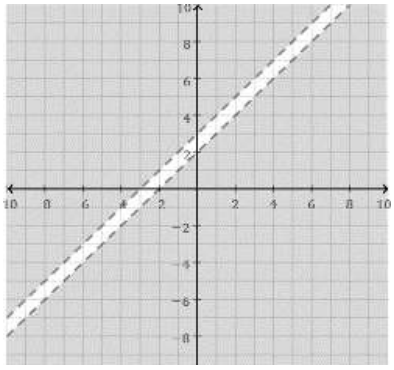
D. $\begin{cases} 6x + 7y < 12 \\ 2y - 4x \geq 9 \end{cases}$

3. Which graph below illustrates the system of linear inequalities in two variables $-x + 2y \leq 4$ and $2x + y \geq 1$?

A. 

C. 

B. 

D. 

4. Which of the following is included in the solution set of the system of inequalities in two variables $-2x + 5y \geq 3$ and $3x + 2y > 1$?

   A. (1, 2)
   B. (2,1)
   C. (4, 2)
   D. (3,0)

Use this situation to answer the questions in numbers 5 to 8:

Edwin sells *pan de sal* and *pan de coco* to earn money during vacation. Each *pan de sal* costs *P*2 and each *pan de coco* costs *P*3. Edwin needs to earn at most *P*200 per day, so he needs to sell at least 20pieces of *pan de sal* and at least 40 pieces of *pan de coco*. Assuming x is the number of *pan de sal* and y be the number of *pan de coco* Edwin needs to sell.

5. Which of the following inequality represents the number of *pan de sal* that needs to be sold?

   A. $x > 20$
   B. $x \geq 20$
   C. $x < 20$
   D. $x \leq 20$

6. Which of the following inequality represents the number of *pan de coco* that Edwin needs to sell?

   A. $y > 40$
   B. $y \geq 40$
   C. $y < 40$
   D. $y \leq 40$

7. Which systems of linear inequalities in two variables represents Edwin's situation?

A. $\begin{cases} 2x + 3y \geq 200 \\ x \leq 20 \\ y \leq 40 \end{cases}$

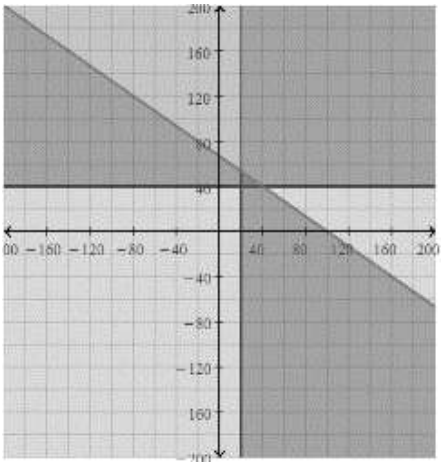
B. $\begin{cases} 2x + 3y > 200 \\ x > 20 \\ y > 40 \end{cases}$

C. $\begin{cases} 2x + 3y \leq 200 \\ x \geq 20 \\ y \geq 40 \end{cases}$

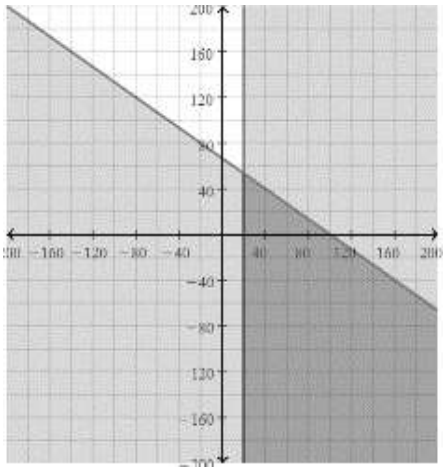
D. $\begin{cases} 2x + 3y < 200 \\ x < 20 \\ y < 40 \end{cases}$

8. Based on the given situation, which of the following graphs best describes the solution of the system of linear inequalities in two variables?

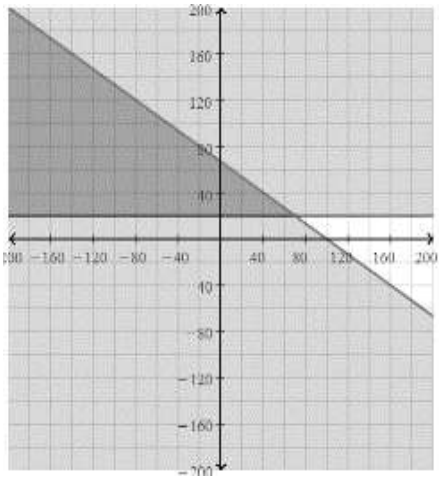
A.



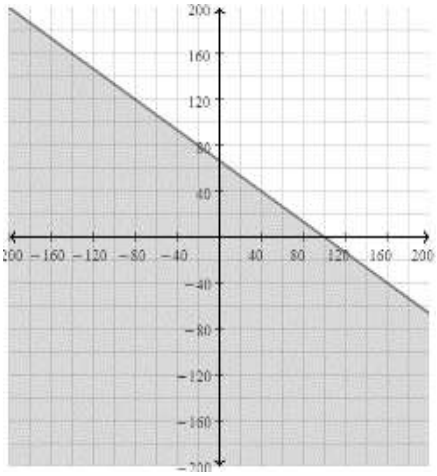
C.



B.



D.



9. Which ordered pair satisfies the system of linear inequalities in two variables $4x + 2y \leq -3$ and $2y - 2x \leq 1$.

A. (-1, 0)
B. (-2, -5)
C. (3, -6)
D. (0, 4)

Use this situation to answer the questions in numbers 10 to 11:

Jack wanted to buy pairs of shoes and socks. Each pair of shoes is sold at $P500$ and each pair of socks costs $P100$.

10. If the total cost is not to exceed $P1\,000$, which system of linear inequalities in two variables illustrates the situation?

A. $\begin{cases} 500x + 100y \leq 1000 \\ x > 0 \\ y > 0 \end{cases}$

B. $\begin{cases} 500x + 100y > 1000 \\ x < 0 \\ y < 0 \end{cases}$

C. $\begin{cases} 500x + 100y \leq 1000 \\ x \geq 0 \\ y \geq 0 \end{cases}$

D. $\begin{cases} 500x + 100y \geq 1000 \\ x > 0 \\ y > 0 \end{cases}$

11. How many pairs of shoes and pairs of socks that will maximize the $P1\,000$?
    A. A pair of shoes and 2 pairs of socks
    B. A pair of shoes and 5 pairs of socks
    C. 2 pairs of shoes and a pair of socks
    D. 2 pairs of shoes and 2 pairs of socks

Use the situation below to answer the questions in numbers 12 to15:

Joseph wants to prepare dessert for his birthday. A can of fruit cocktail costs $P135$ while a can of condensed milk costs $P45$. He wants to buy at least 2 cans of fruit cocktails and 4 cans of condensed milk with costs no more than $P1\,000$. Let x be the number of cans of fruit cocktails and y be the number of condensed milk.

12. Which system of linear inequalities in two variables represents the situation?

A. $\begin{cases} 135x + 45y \leq 1000 \\ x \geq 2 \\ y \geq 4 \end{cases}$

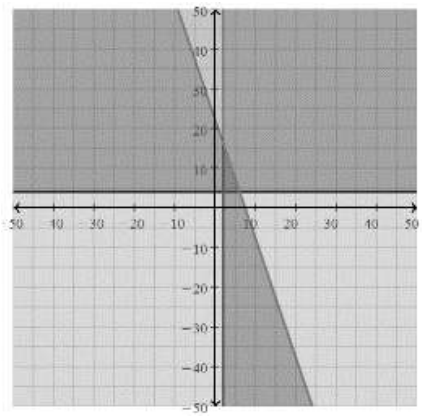
B. $\begin{cases} 135x + 45y > 1000 \\ x \geq 2 \\ y \geq 4 \end{cases}$

C. $\begin{cases} 135x + 45y \leq 1000 \\ x < 2 \\ y < 4 \end{cases}$

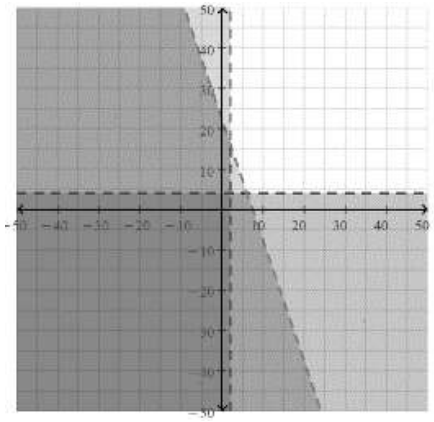
D. $\begin{cases} 135x + 45y \geq 1000 \\ x > 2 \\ y > 4 \end{cases}$

13. Which graph below represents the system of linear inequalities in two variables in the situation?

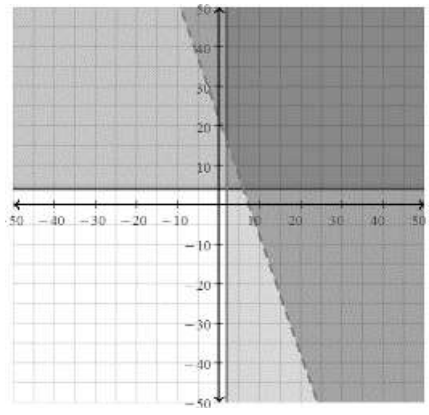
A



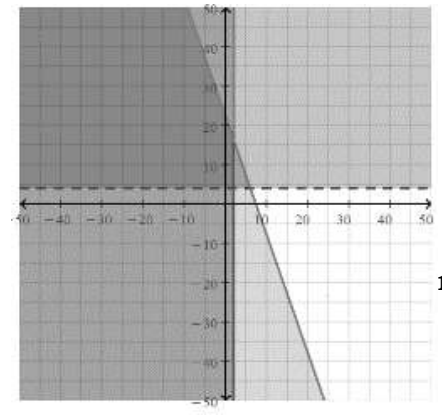
C



B



D



14. Which ordered pair represents the possible numbers of fruit cocktails and condensed milk Joseph bought?

A. (3, 1) B. (-1, 2) C. (2, 4) D. (2, -5)

15. Which of the following situations is NOT possible for Joseph to buy?

A. 3 cans of fruit cocktail and 5 cans of condensed milk
B. 4 cans of fruit cocktail and 4 cans of condensed milk
C. 5 cans of fruit cocktail and 4 cans of condensed milk
D. 6 cans of fruit cocktail and 5 cans of condensed milk

Additional Activities

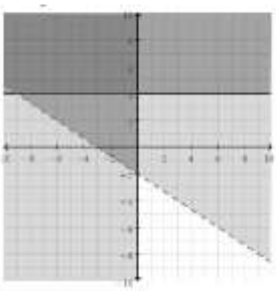
Directions: Write the system of linear inequalities that best describes the situation.

You are taking your online periodical test and need to complete at least 20 algebra and statistics problems within 2 hours. It will take you 25 minutes to answer statistics problems and 15 minutes to solve algebra problems.

Answer Key

Lesson 1: What I Can Do

1.



2. **(-1,6), (-2,5) and (-3,6)** are of some the solutions of given system of linear inequalities in two variables. There are still other set of ordered pairs that can be found in the double shaded region.

Lesson 1
What's In: Find My Pair

1. (3,1), (5,0), (3,3), (0,4), (0,5), (1,2)
2. By substituting the values of x and y into the given inequality
3.

Lesson 1:
What's More: Activity 1

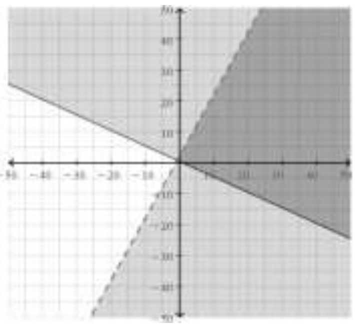
Step 1: Are the inequalities in the form of $y = mx + b$? If yes check the column, if no, transform.

Linear Inequality	Yes	No	Transform
$y < 2x + 2$	✓		
$2x + 4y \geq 2$		✓	$y \geq -\frac{1}{2}x + \frac{1}{2}$

Step 2: Complete the table. Use your answers in step 1.

Linear Inequality	Slope (m)	rise	run	y-intercept (b)	Type of Line to be used (broken or solid)
$y < 2x + 2$	2	2	1	2	broken
$y \geq -\frac{1}{2}x + \frac{1}{2}$	$-\frac{1}{2}$	-1 or 1	-2 or 2	$\frac{1}{2}$	solid

Step 3



Step 4: (9,9) and (9,10) are ordered pairs that satisfies the given inequalities. There are still other set of ordered pairs that can be found in the double shaded region.

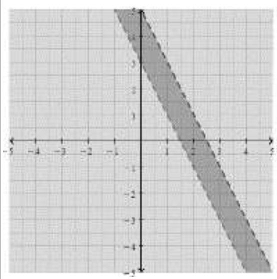
Lesson 1
What I Have Learned

In graphing systems of linear inequalities in two variables;

- **First I have to rewrite** each mathematical statement into slope-intercept form *y = mx +b;*
- **Second I will plot using** the slope and the y-intercept of each inequality;
- **Third I will use broken line if** the inequality used is < or >
  I will use solid line if the inequality used is ≤ and ≥;
- **Fourth, I will shade above the line if** the inequality is in the form y ≥ mx + b and y > mx + b;
  I will shade below the line if the inequality is in the form y ≤ mx + b and y < mx + b;
- **Finally, I will identify the solution of the system by** finding set of ordered pairs in the double-shaded region.

Lesson 1
What's More: Activity 2

The graph of
$$\begin{cases} 2x + y > 3 \\ y < 5 - 2x \end{cases}$$



What I Know

Pre-Assessment

1. D
2. C
3. A
4. A
5. B
6. B
7. A
8. A
9. A
10. A
11. A
12. C
13. C
14. C
15. C

Answer Key

Assessment

1. D
2. D
3. A
4. A
5. B
6. B
7. C
8. A
9. B
10. A
11. B
12. A
13. A
14. C
15. D

Lesson 2: What's New

1. Let ***x*** be the number of kilograms of White Rice
   Let ***y*** be the number of kilograms of Brown Rice
2.

Statement	Inequality
Number of kilograms of white rice you are planning to buy	$x \geq 1$
Number of kilograms of brown rice you are planning to buy	$y \geq 1$
Total amount of money spent for buying the brown and white rice	$45x + 50y \leq 200$

3.

Graph of the system

$$\begin{cases} 45x + 50y \leq 200 \\ x \geq 1 \\ y \geq 1 \end{cases}$$

Lesson 2:
Additional activities:

$$\begin{cases} 25x + 15y \leq 120 \\ x + y \geq 20 \end{cases}$$

Lesson 2: What's More
Activity 1
A, B, C

Lesson 2: What I Have Learned
Answers may vary

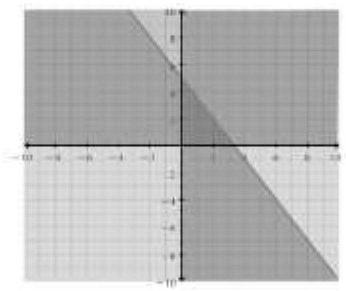
Lesson 2: What's In

2. The difference of 2x and 6y is less than 20.
3. 4x ≤ 16y -2
4. 5x minus 1 is greater than or equal to the product of 2 and a number y.
5. x + 12y ≥ 10

Lesson 2:
What's More: Activity 2

1) $$\begin{cases} 180x + 120y \leq 600 \\ y \leq -\frac{3}{4}x + 5 \\ x > 0 \\ y > 0 \end{cases}$$

2)



3) three ordered pairs: **(1,2), (1,3), and (2,2)**

Note: there are still other ordered pairs that can be found in the overlapping ***regions.***

4) Checking:

(1,2)		
$180x + 120y \leq 600$	$180(1) + 120(2) \leq 600$ $180 + 240 \leq 600$ $420 \leq 600$	**TRUE**
$y \leq -\frac{3}{4}x + 5$	$2 \leq -\frac{3}{4}(1) + 5$ $2 \leq 4.25$	**TRUE**
$x > 0$	$1 > 0$	**TRUE**
$y > 0$	$2 > 0$	**TRUE**
(1,3)		
$180x + 120y \leq 600$	$180(1) + 120(3) \leq 600$ $180 + 360 \leq 600$ $520 \leq 600$	**TRUE**
$y \leq -\frac{3}{4}x + 5$	$3 \leq -\frac{3}{4}(1) + 5$ $2 \leq 4.25$	**TRUE**
$x > 0$	$1 > 0$	**TRUE**
$y > 0$	$3 > 0$	**TRUE**
(2,2)		
$180x + 120y \leq 600$	$180(2) + 120(2) \leq 600$ $360 + 240 \leq 600$ $600 \leq 600$	**TRUE**
$y \leq -\frac{3}{4}x + 5$	$2 \leq -\frac{3}{4}(2) + 5$ $2 \leq 3.5$	**TRUE**
$x > 0$	$2 > 0$	**TRUE**
$y > 0$	$2 > 0$	**TRUE**

References

Abuzo, Emmanuel P., et.al, Mathematics- Grade 8 Learner's Module First Edition, 2013. Published by the Department of Education

Ikeda,Robert,Pham,Priscilla, MathPapa (https://www.mathpapa.com/inequality-calculator/)

Orines, Fernando B., et. al, The New Grade 8 Next Century Mathematics. Phoenex Publishing House

QuiaWeb,© 2020 IXL Learning(https://www.quia.com/jg/2801437list.html)

For inquiries or feedback, please write or call:

Department of Education – Bureau of Learning Resource
Ground Floor, Bonifacio Building, DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Tel. Nos.: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph