Warm-Up

CST/CAHSEE: Grade 7AF 4.1

Solve $-4n-3>-15$

A) $n<-3$

B) $n<3$

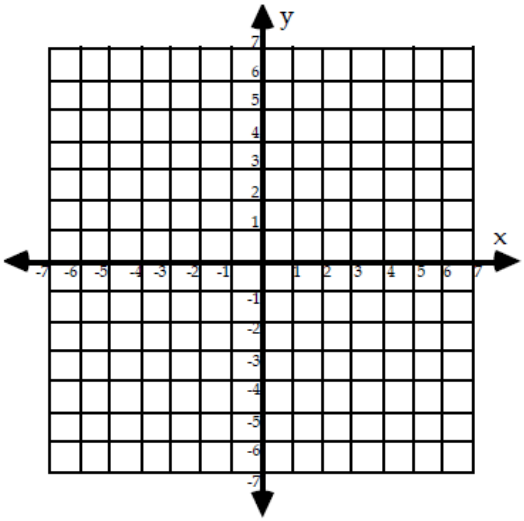
C) $n>3$

D) $n<4\frac{1}{2}$

How would a student come up with the other answers?

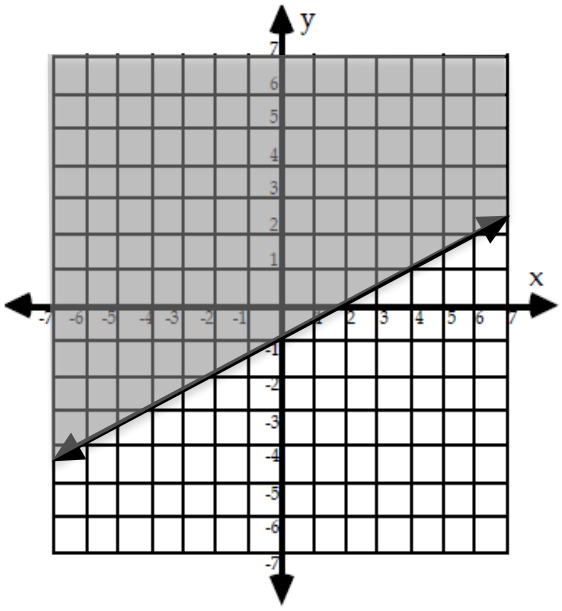
Review: Algebra 6.0

Graph $2x-y=2$ using three different approaches.



Current: Algebra 6.0

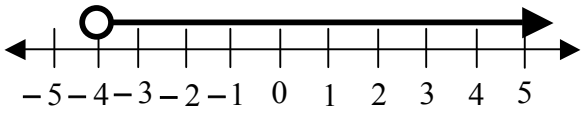
Find the equation for the linear inequality graphed below.



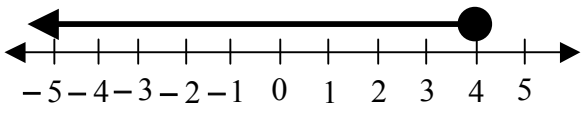
Other: Grade 7AF 1.1

Find the inequality that goes along with the graphs below.

a.



b.



All About Inequality

How does Solving Inequalities apply to solving a System of Inequalities?

When we teach our students about graphing inequalities we are preparing them to solve and graph an inequality on a coordinate plane.

For example, when we teach students about an open versus closed circle, we are preparing them for a solid versus dashed line on a graph. When we teach shading to the left or right of this circle, we are preparing them for shading on either side of a line. In either graph we should be stressing that the circle and the line both act as **boundaries** in our solution. And a large part of the student's solution should be defining whether or not that boundary is part of the solution or not. Finally, in this lesson when we show the student the "Point" test, we are preparing them for the same point test we would use in a linear inequality.

*Note that using the Point Test, you want to pick a point other than your given point, i.e. if $x > 3$ then we will not choose 3 as a point to test. In the examples we use 0, which is always good to use, unless your solution is $n > 0$.

Solving Inequalities:

Let's review the inequality symbols:

$<$	less than
$>$	greater than
$\leq$	less than or equal to
$\geq$	greater than or equal to

Determining the Truth of an Inequality – Students should understand that in an inequality there is not just one solution, but many solutions that will make the inequality true. However, students often struggle understanding the concept of inequality.

Example 1a.

$a + 2 > 6$; $a = -9$

$-9 + 2 > 6$

$-7 > 6$

$-7 \not> 6$

-7 is not greater than 6, therefore this inequality is untrue.

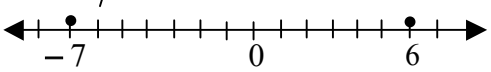
Example 1b.

We can also show this inequality by using a number line.

$a + 2 > 6$; $a = -9$

$-9 + 2 > 6$

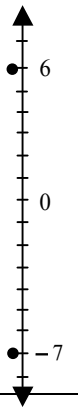
$-7 \not> 6$



Example 1c.

Another way to look at a number line.

By turning the number line vertical, students may be able to better recognize that -7 is less than 6.

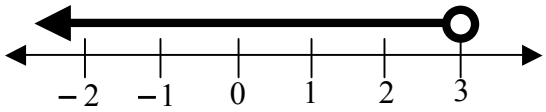


Graphing an Inequality

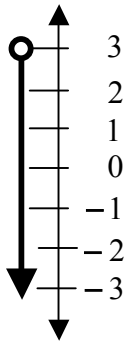
Example 2a.

$x < 3$

$0 < 3$ ← "Point" Test: choosing 0 as the critical point.This is true, so we know that zero is part of the solution.



This will also work if the number line is vertical.



This is a great opportunity to teach students how to use a critical point to find their solutions. Use the "Point Test" and replace ***x*** with any number less than 3. In this case we used "0". If the inequality is true, we shade the graph so that 0 will be included in the solution.

This is a good time to explain the difference between an open and closed circle on the graph - If we replace the variable ***x*** with any number less than 3, then inequality will remain true. If we replace the variable ***x*** with 3 will the inequality still be true? ***[no]***
Therefore we graph this inequality with an open circle, to show that the solution is any numbers less than 3**.**

If we show the number line vertically, we are also preparing students for looking at a ***y***-axis.

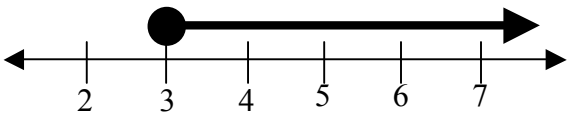
Example 2b.

$x + 3 \geq 6$

$x + 3 - 3 \geq 6 - 3$

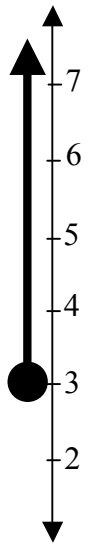
$x \geq 3$

$0 \geq 3$ ← "Point" Test



Graphing Vertically:

Which way do we shade?
Choose a critical point, such as zero (see above).
$0 \geq 3$ is false, therefore 0 is not in the solution.



Use the "Point Test" , and have students choose a critical point (in this case and replace ***x*** with "0". If the inequality is true, we shade the graph so that 0 will be included.

If we replace the variable ***x*** with any number greater than or equal to 3, then inequality will remain true. If we replace the variable ***x*** with 3, will the inequality still be true? [yes]

Therefore we graph this inequality with a closed circle, to show that the solution is any number greater than or equal to 3**.**

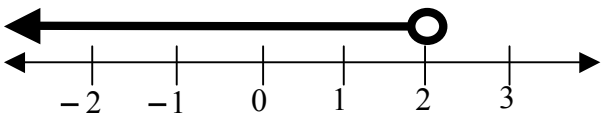
Graphing an Inequality – Two Dimensions

Example 3a. – *One Dimensionally*

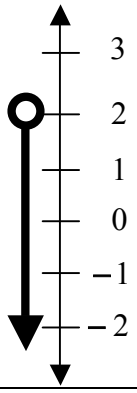
We can graph $y < 2$ on a number line (as shown above).

$y < 2$

$0 < 2$ ← Choose a critical point less than 2 to test in the inequality.

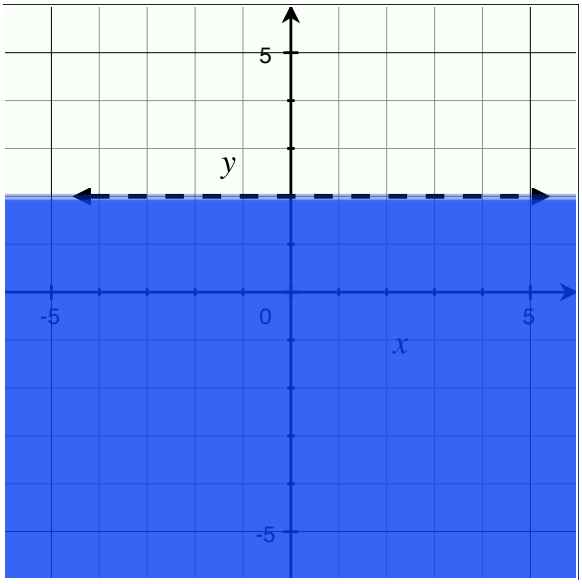


If we graph it vertically:



Example 3b. – *Two Dimensionally*

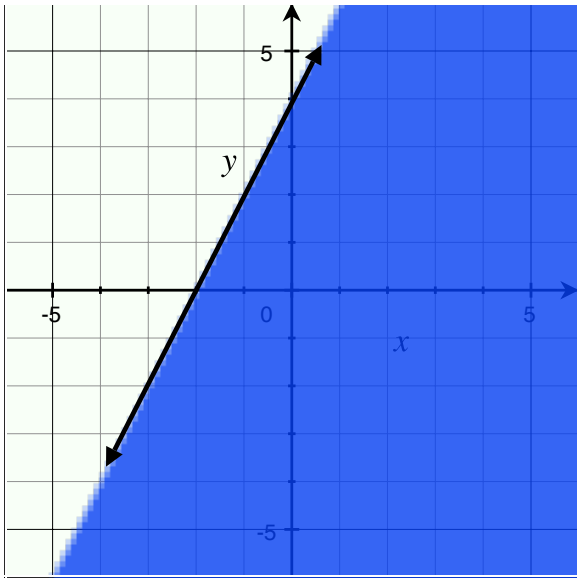
We can also graph $y < 2$ on a graph.



Graphing a Linear Inequality

Example 4a.

Graph $y \leq 2x + 4$



In the Linear Inequality, the student will graph as they would a linear equation.

Students will need to determine if the graph will have a solid or dashed line, similar to determining whether they needed a closed or open circle when they graphed on number line.

Finally students will use the Point Test to determine which side of the line to shade. Again, students can choose any point, however $(0,0)$ is the easiest, unless the line runs through $(0,0)$.

Point Test: Students will choose a critical point such as $(0,0)$.

$y \leq 2x + 4$

$0 \leq 2(0) + 4$

$0 \leq 4$ ← True, $(0,0)$ is in the solution. Students will shade below the line.

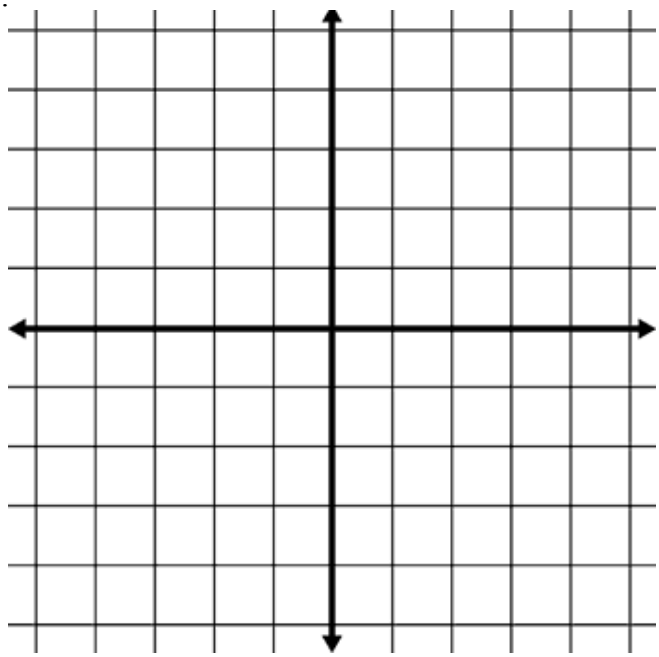
Solving Systems of Inequalities

To solve a system of inequalities we can graph both inequalities on the same coordinate plane.

$y < x + 2$

$y > 3 - 2x$

On the graph to the right, the solutions to both inequalities have been shaded. In the area that has been shaded twice lays the point $(3,2)$. Its coordinates make both inequalities true as shown in the table below.



Your Turn!

Test the other points in the table below to see if they are solutions.

(x,y)	Is (x,y) in the double shaded region?	? $y < x + 2$	? $y > 3 - 2x$	Is (x,y) a solution?
$(3,2)$				
$(6,-1)$				
$(2,-5)$				
$(-5,3)$				
$(3,5)$				

It is really important to note to students that the double-shaded region contains solutions to both inequalities. The double shaded region is the graph of the solution set for this system. It is near impossible to list ALL of the points in this region, therefore we use shading to show the solution.

Solving a System of Inequalities Group Activity

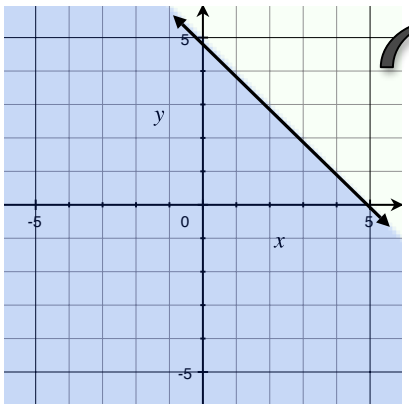
Materials:

- 8-10 sets of the graphed inequalities copied onto transparencies and cut out into groups of 4
- 8-10 envelopes to place the group of four graphed inequalities
- 1 blank page of 4 coordinate planes for each student

Activity Details:

- Students are placed in groups of four
- Each student has a graphed inequality
- Each student will find the equation that goes with his/her graph
- Once the students find the equations then hand out activity sheet and go through example using graph A and graph B.
- Students will create remaining 3 systems in pairs or small groups.
  - They will lay one inequality upon another until the axis match.
  - They will copy the picture it creates onto one of the blank coordinate planes and then write the system that corresponds to the solution they created.
  - They will do this three more times until they have four systems that match four solutions.
- Teacher debriefs activity with class. There are 6 possible solutions so each group will not have the same group of systems
- The four independent practice problems provided can be done in class or for homework.

Example:

<table>
<tr>
<td>Students take one graphed inequality
 
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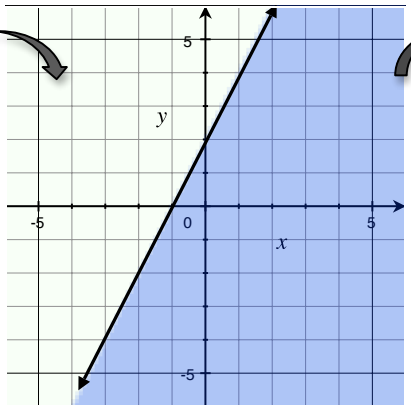
<td>another one,
 
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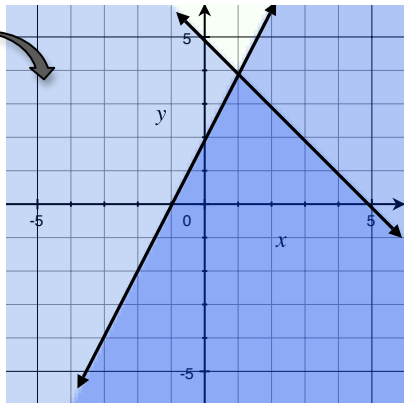
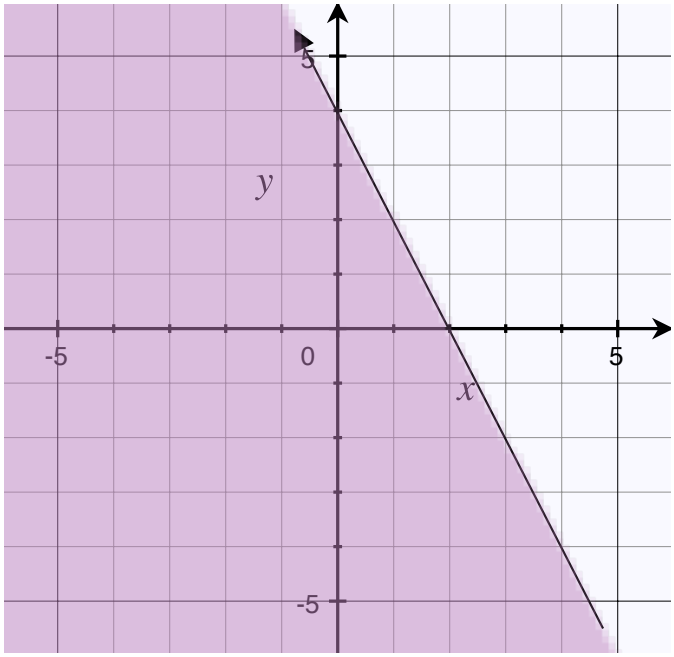
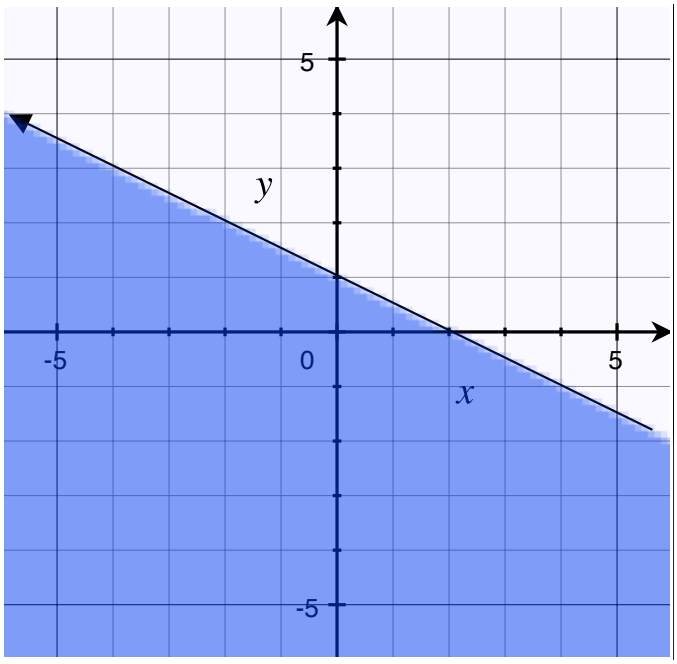
<td>and place them upon each other until the axis match.
 
</td>
</tr>
<tr>
<td colspan="2">They will copy this picuture onto the coordinate plane and write the system of inequalities.</td>
<td>$\begin{cases} y \le 2x+2 \\ y \le -x+5 \end{cases}$</td>
</tr>
</table>

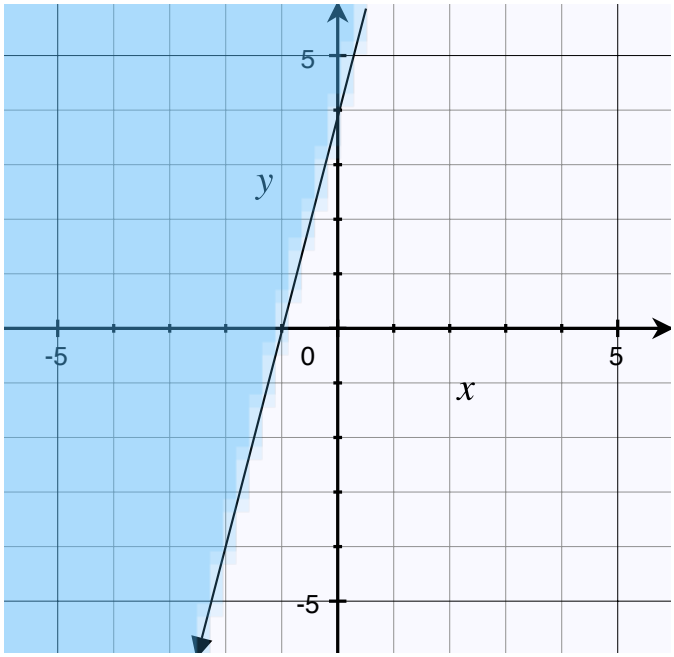
A



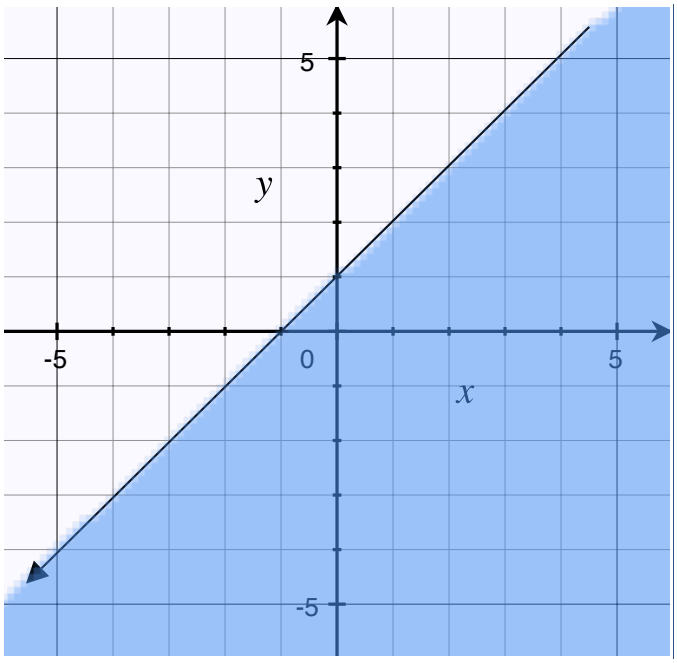
B



C

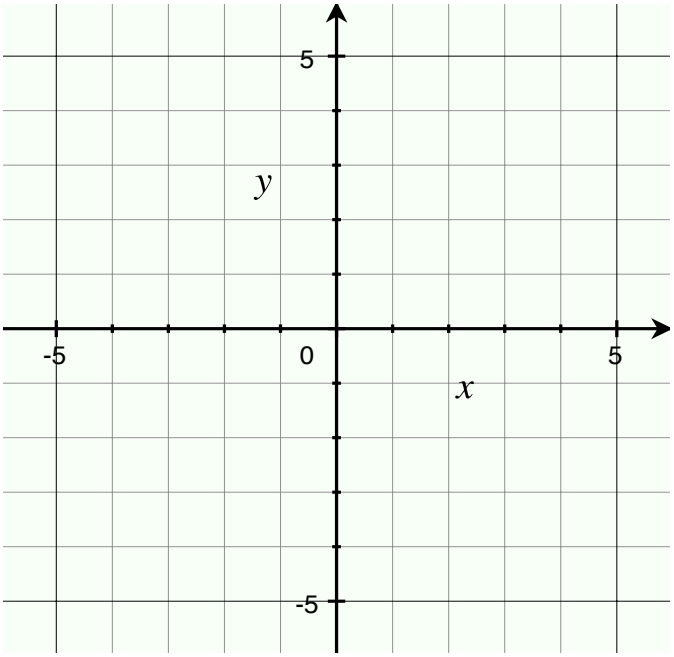


D



Graphing System of Inequalities

Write the system below and then graph the solution



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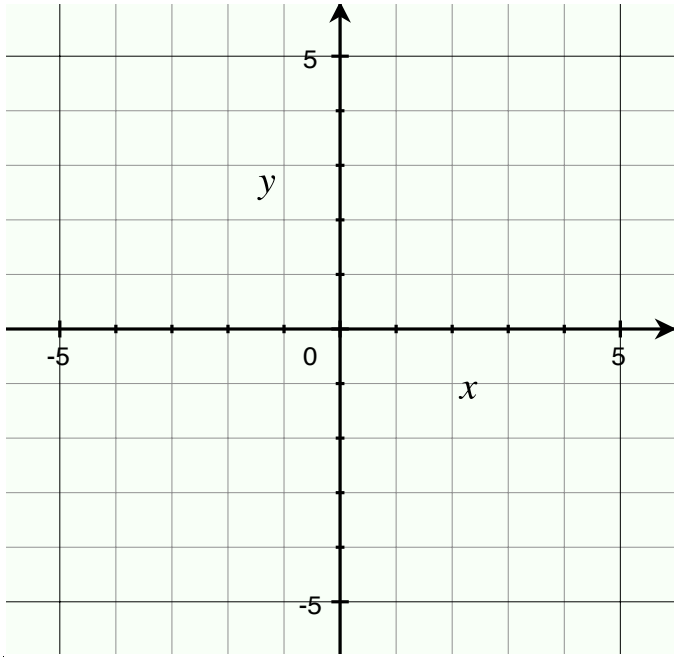

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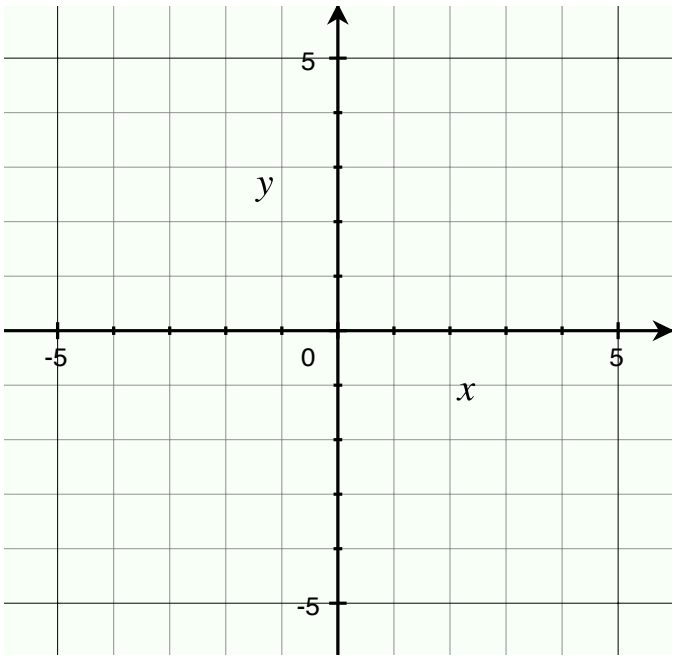

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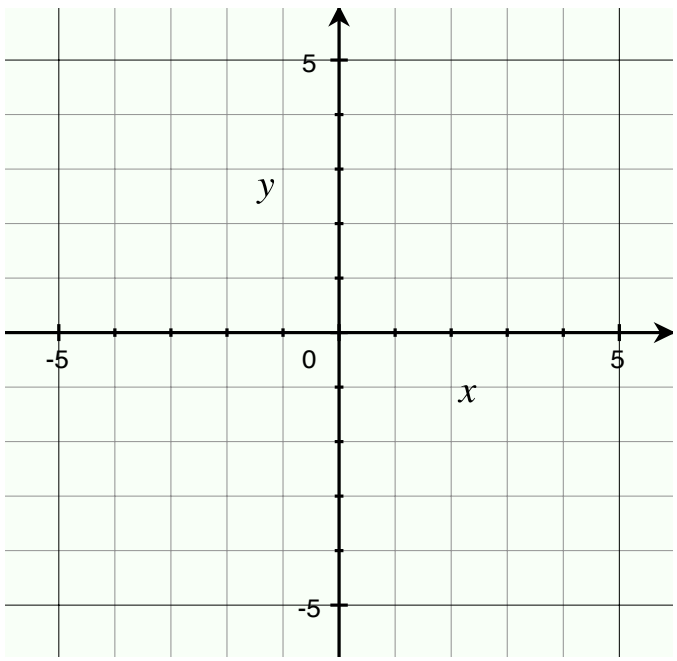
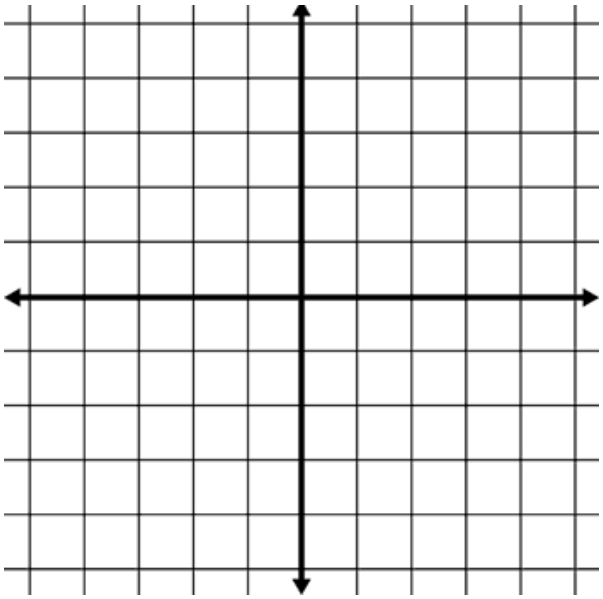


Independent Practice – Show the solution set for each system of inequalities.

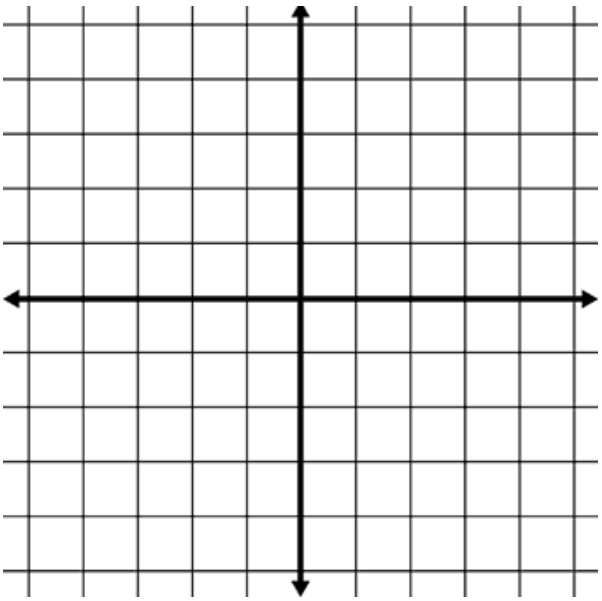
$y > 2x - 5$

$y > -2x + 2$



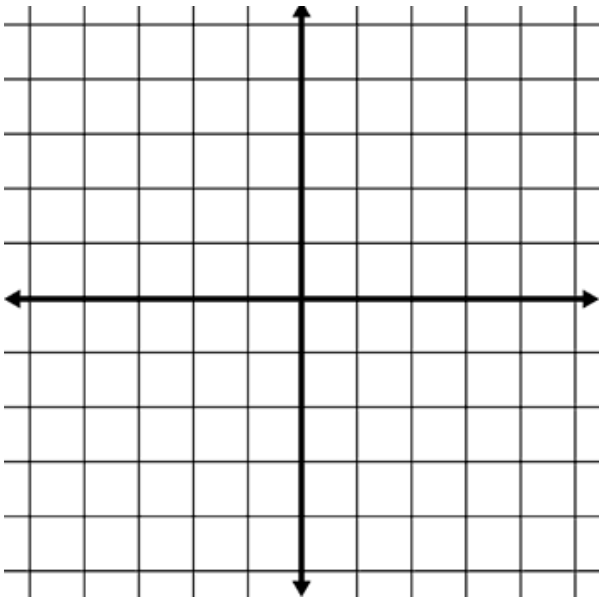
$y > x - 3$

$y < -\frac{1}{2}x + 2$



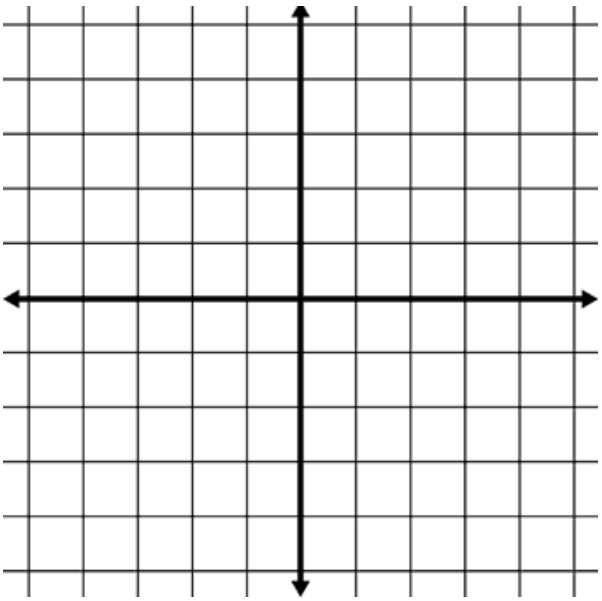
$y \leq \frac{3}{5}x + 1$

$y \geq -x$



$y \geq \frac{2}{5}x + 3$

$y \geq -x + 3$

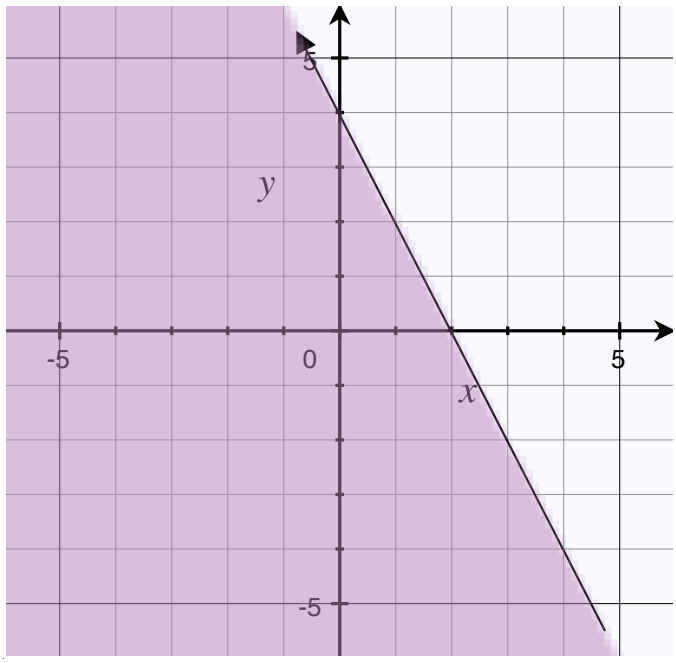


Worked Out Solutions

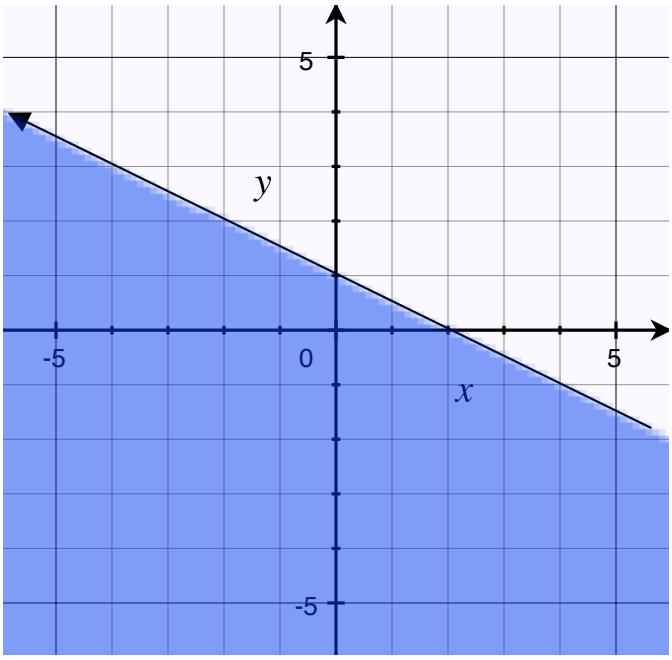
(x,y)	Is (x,y) in the double shaded region?	? $y < x + 2$	? $y > 3 - 2x$	Is (x,y) a solution?
$(3,2)$	Yes	$2 < 3 + 2$ yes $2 < 5$	$2 > 3 - 2(3)$ yes $2 > -3$	Yes
$(6,-1)$	Yes	$-1 < 6 + 2$ yes $-1 < 8$	$-1 > 3 - 2(6)$ yes $-1 > -9$	Yes
$(2,5)$	No	$-5 < 2 + 2$ yes $-5 < 4$	$-5 > 3 - 2(2)$ no $-5 > -1$	No
$(-5,3)$	No	$3 < -5 + 2$ no $3 < -3$	$3 > 3 - 2(-5)$ no $3 > 13$	No
$(3,5)$	No	$5 < 3 + 2$ no $5 < 5$	$5 > 3 - 2(3)$ yes $5 > -3$	No

Key for the inequalities

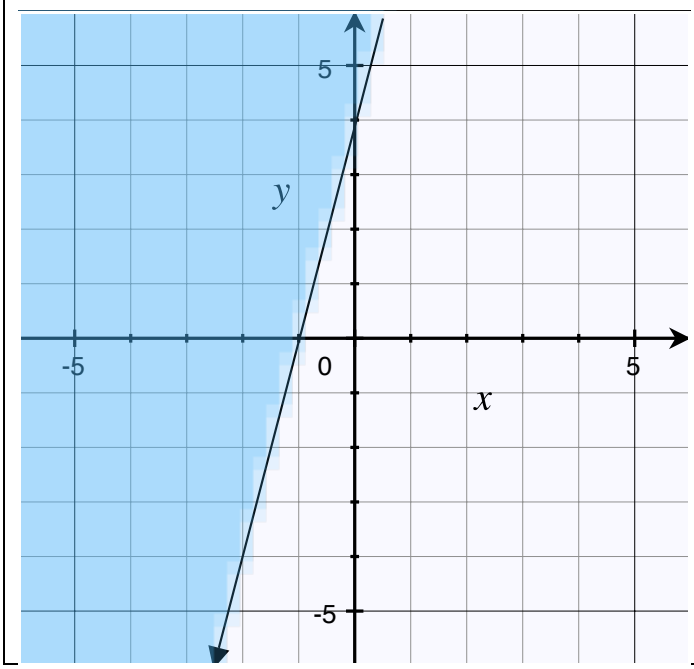
A $y \le -2x + 4$



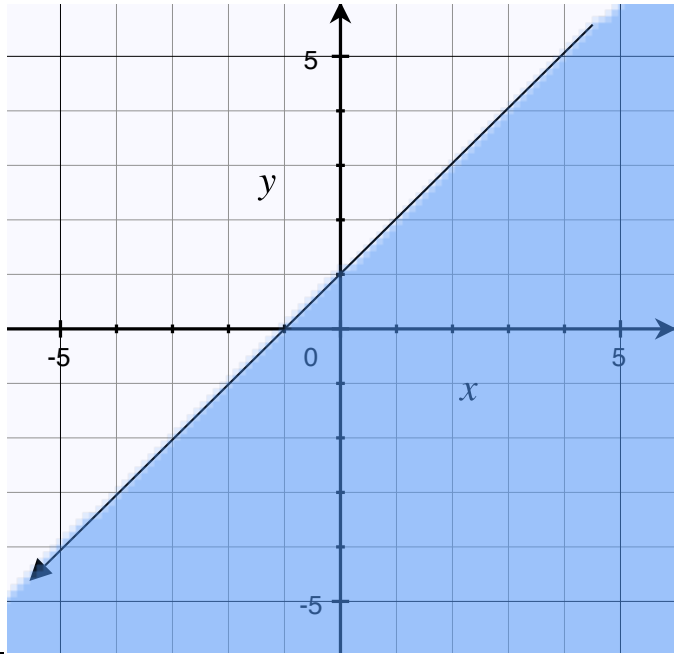
B $y \le -\frac{1}{2}x + 1$



C $y \ge 4x + 4$



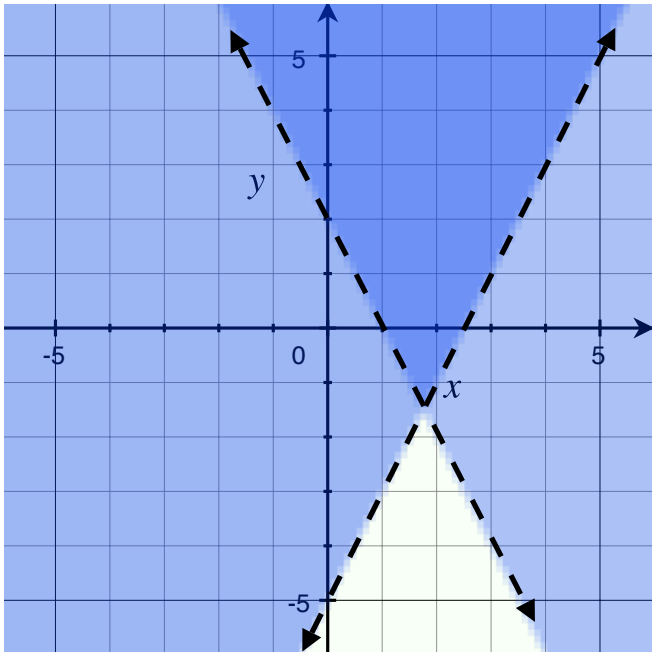
D $y \le x + 1$



Independent Practice Solutions

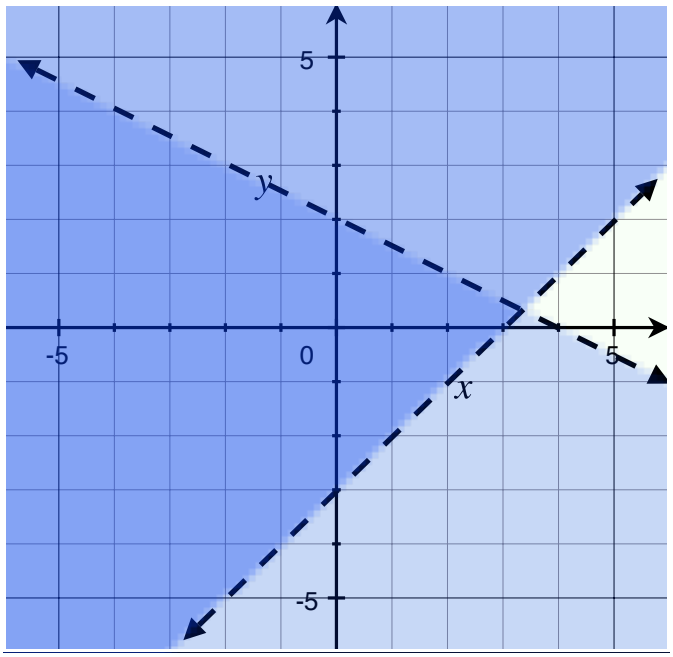
$y > 2x - 5$

$y > -2x + 2$



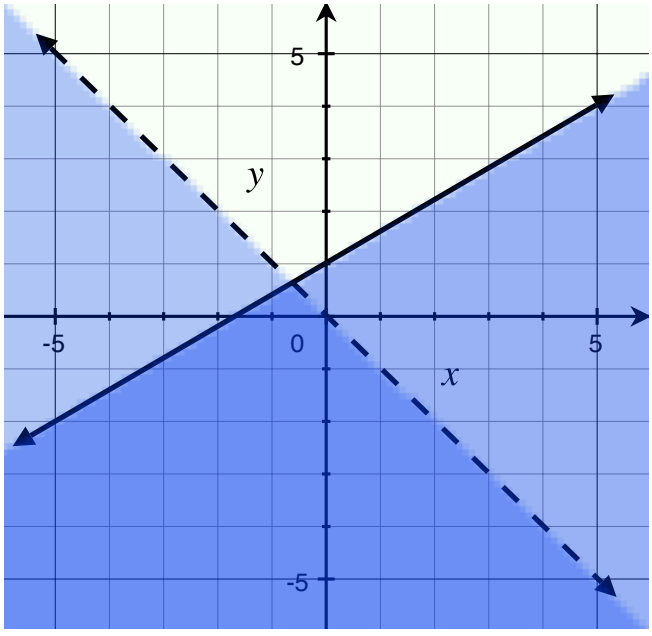
$y > x - 3$

$y < -\frac{1}{2}x + 2$



$y \leq \frac{3}{5}x + 1$

$y \geq -x$



$y \geq \frac{2}{5}x + 3$

$y \geq -x + 3$