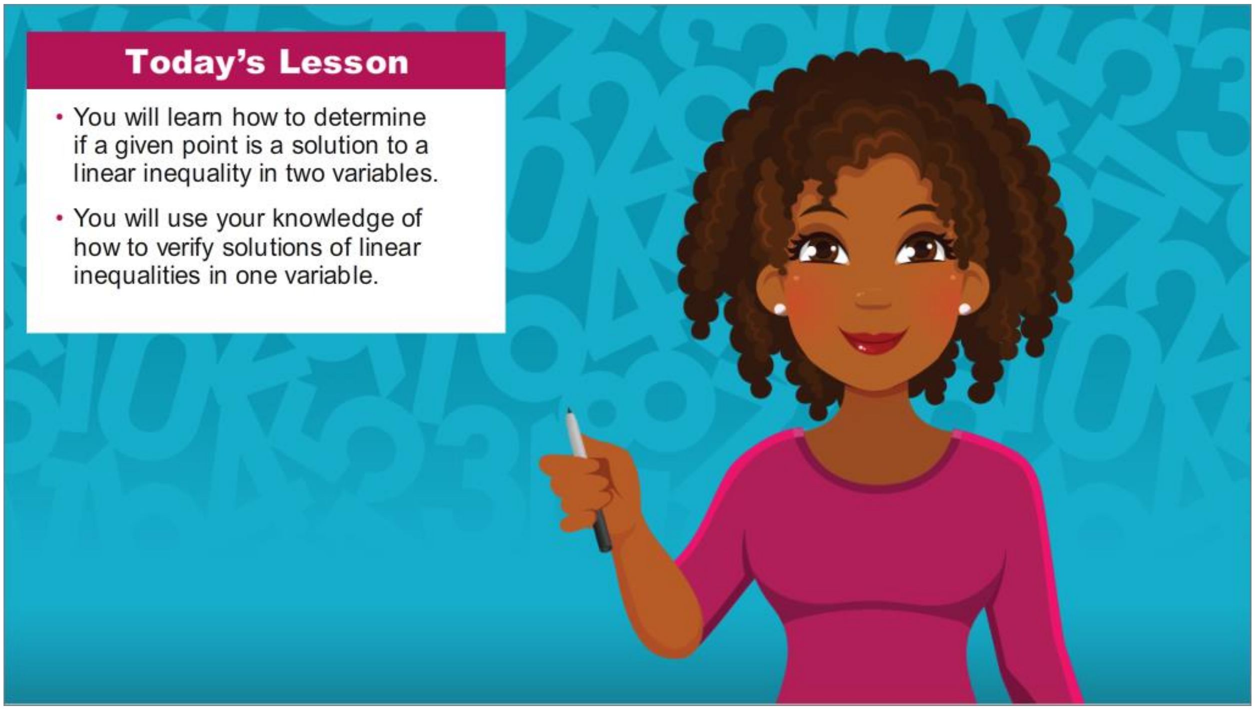
Module 7: Solving Linear Inequalities
Topic 2: Verifying Solutions

Introduction



In this lesson, you will learn how to determine if a given point is a solution to a linear inequality in two variables. Your knowledge of how to verify solutions of linear inequalities in one variable, will be very useful as you move through this lesson. So before we begin our new material, let's jump back a bit and revisit how to verify solutions of inequalities in one variable.

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Anticipatory Set

Is 5 a solution to the inequality, $2x - 3 > 1$?

There are a few different ways you could determine the answer to this question. One method is to substitute five for x in the inequality and determine if the inequality still remains true.

$2x - 3 > 1$ — Is $2 \cdot 5 - 3 > 1$?

$2(5) - 3$

$10 - 3$

$7 > 1$ — 7 is less than 1, so the inequality holds true. Therefore, 5 is a solution to the inequality.

Another strategy you could use to determine if 5 is a solution, is to solve the inequality for x. The inequality does not include any parentheses, and there are no like terms to combine, so you could begin using inverse operations to isolate x.

$2x - 3 > 1$

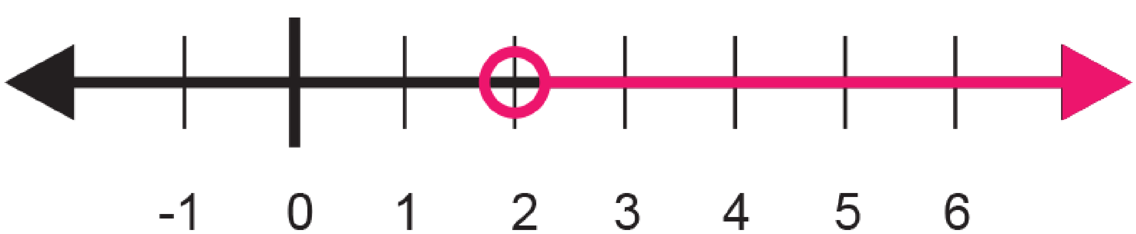
$+3 \quad +3$ — Add 3 to both sides of the inequality.

$2x > 4$

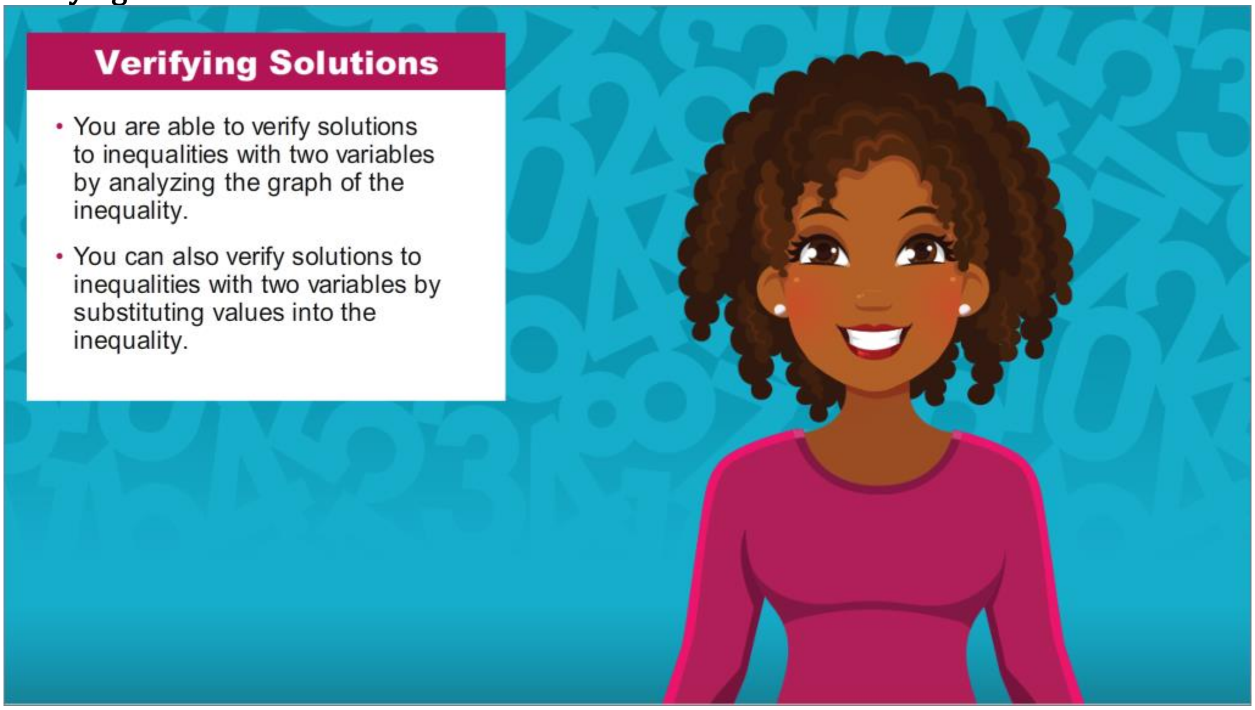
$\frac{2x}{2} > \frac{4}{2}$ — Divide each side by 2.

$x > 2$ — Because 5 is less than 2, it would indeed be included in the solution set.

Graphing the solution set on a number line would also allow you to determine if 5 is a solution. The solution set includes all values greater than two. Graphically, you would represent this by sketching an open circle at two and highlighting all of the values greater than two, the values to the right. Because 5 is included among these values, it is a solution to the inequality.



Verifying Solutions



When working with inequalities in two variables, you can also verify solutions graphically, by analyzing the graph of the inequality, and algebraically, by substituting values into the inequality. In the next example, you will determine if the given points are solutions to the given inequality.

Verifying Solutions to Multi-Step Linear Inequalities

Click the examples below to learn more.

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Example 1

Given: $y + 3 < 2x$

A) Is the point $(5, 1)$ a solution?

When verifying solutions to linear inequalities graphically, solutions can be found in two places:

1. on a solid line
2. in a shaded region

To use the graphing calculator to graph the inequality, $y + 3 < 2x$, you must first solve for y.

$y + 3 < 2x$	There are no parentheses to eliminate and no like terms to combine, so begin using inverse operations to isolate y.
$-3 \qquad -3$	Subtract 3 from each side of the inequality.
$y < 2x - 3$	The final inequality is $y < 2x - 3$.

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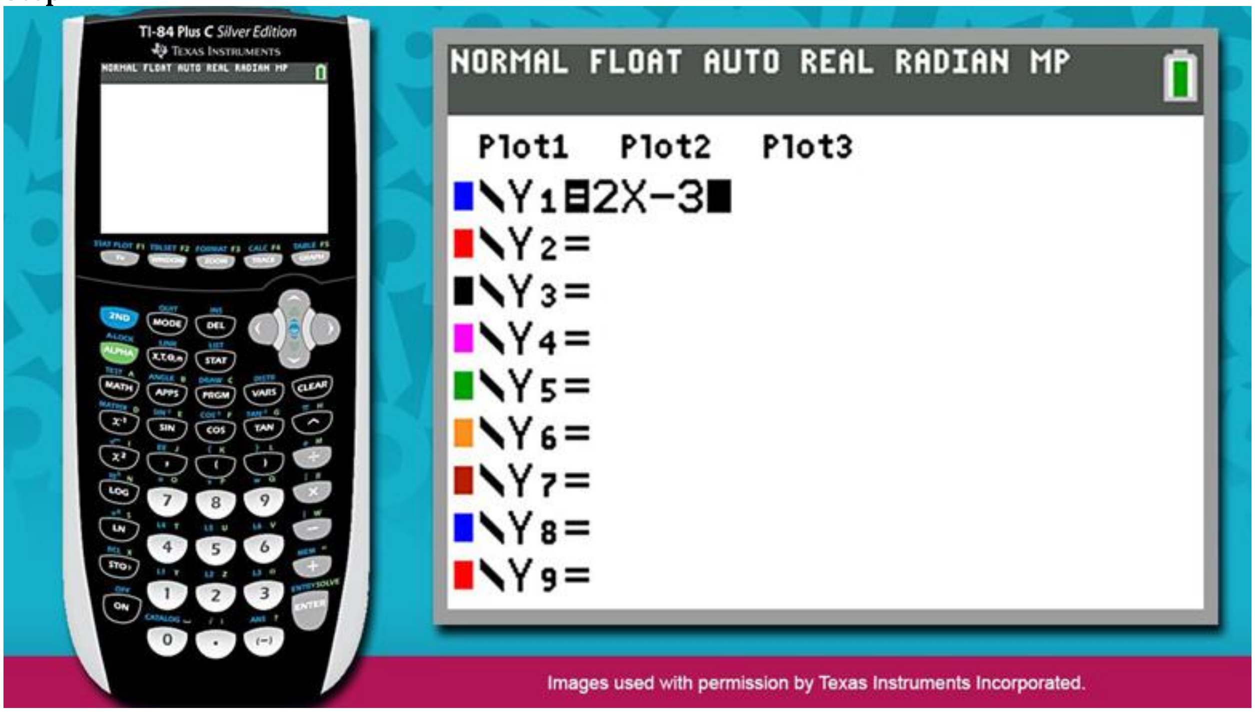
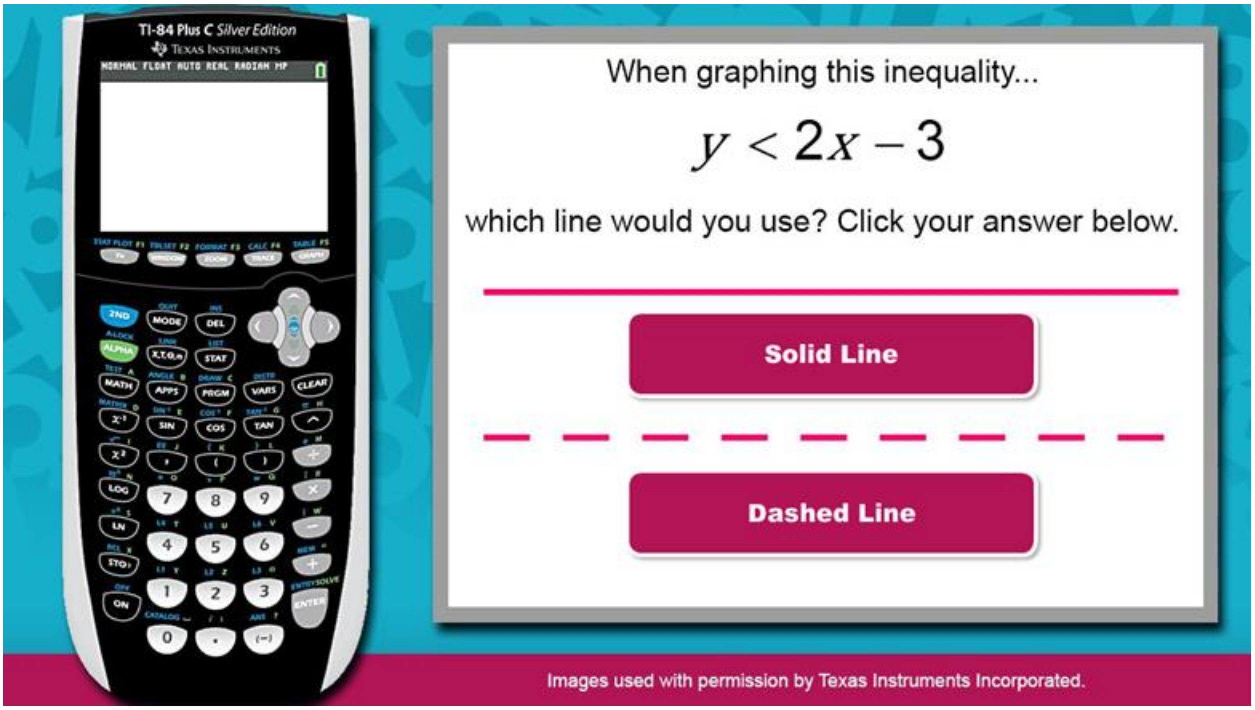
Step 1



Now that the inequality is solved for y, you can use the graphing calculator to graph it on the coordinate plane. Clear the memory in the calculator.

Press the Y= key. Then enter the right side of the inequality to the right of Y1.

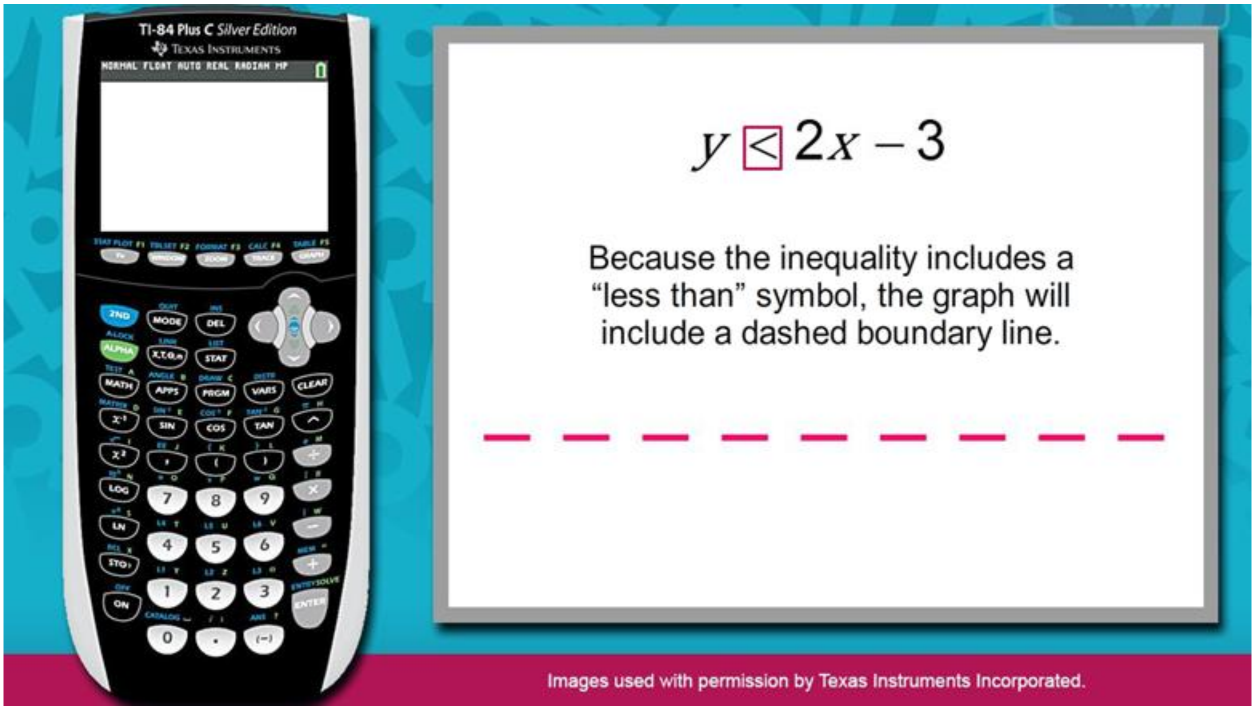
Solid Line or Dashed Line



Recall that the graph of a strict inequality, an inequality that includes $< \ or \ >$, will include a dashed boundary line. The graph of a non-strict inequality, an inequality that includes $\leq$ or $\geq$, will include a solid boundary line.

Will the graph of $y < 2x - 3$ include a dashed boundary line or a solid boundary line?

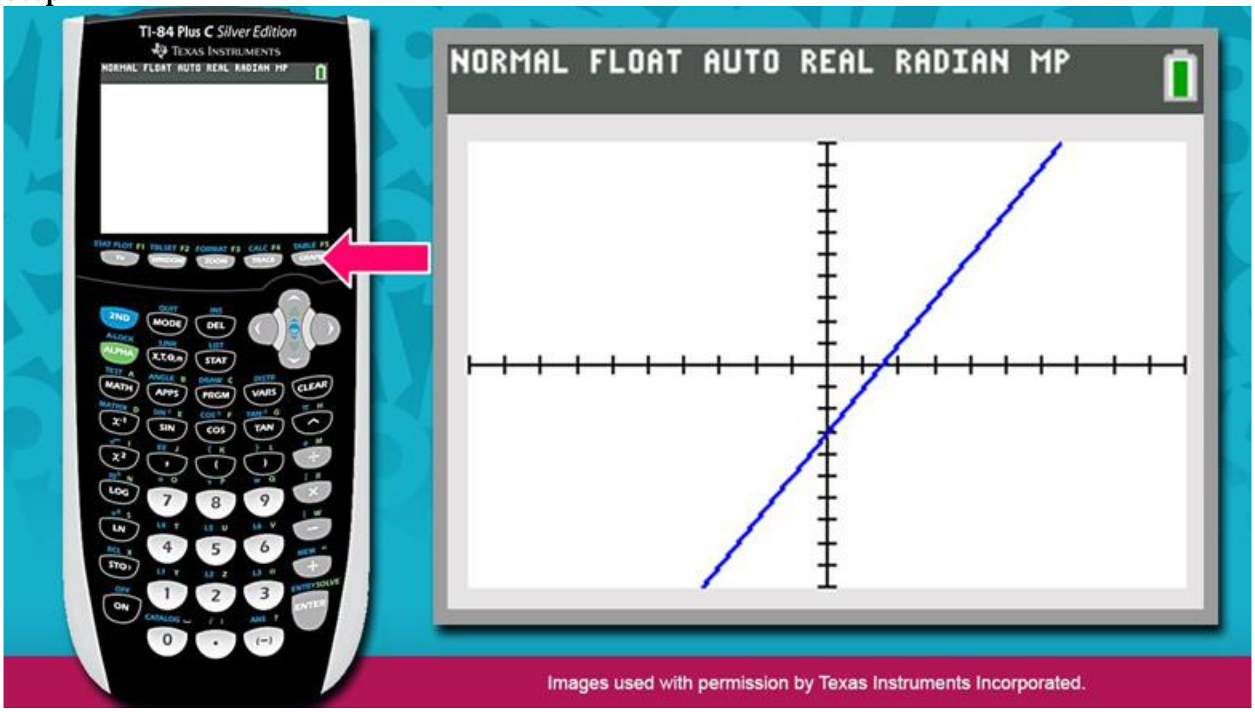
Feedback



The inequality is strict. Therefore, its graph will include a dashed boundary line.

Remember that the calculator will only graph solid boundary lines. Therefore it is helpful to also prepare a rough sketch of the graph, so that you can remain mindful of whether the graph actually includes a dashed line or a solid line.

Step 2



Now that you have determined the graph of $y < 2x - 3$ will include a dashed boundary line, press graph and begin preparing your rough sketch.

Press GRAPH.

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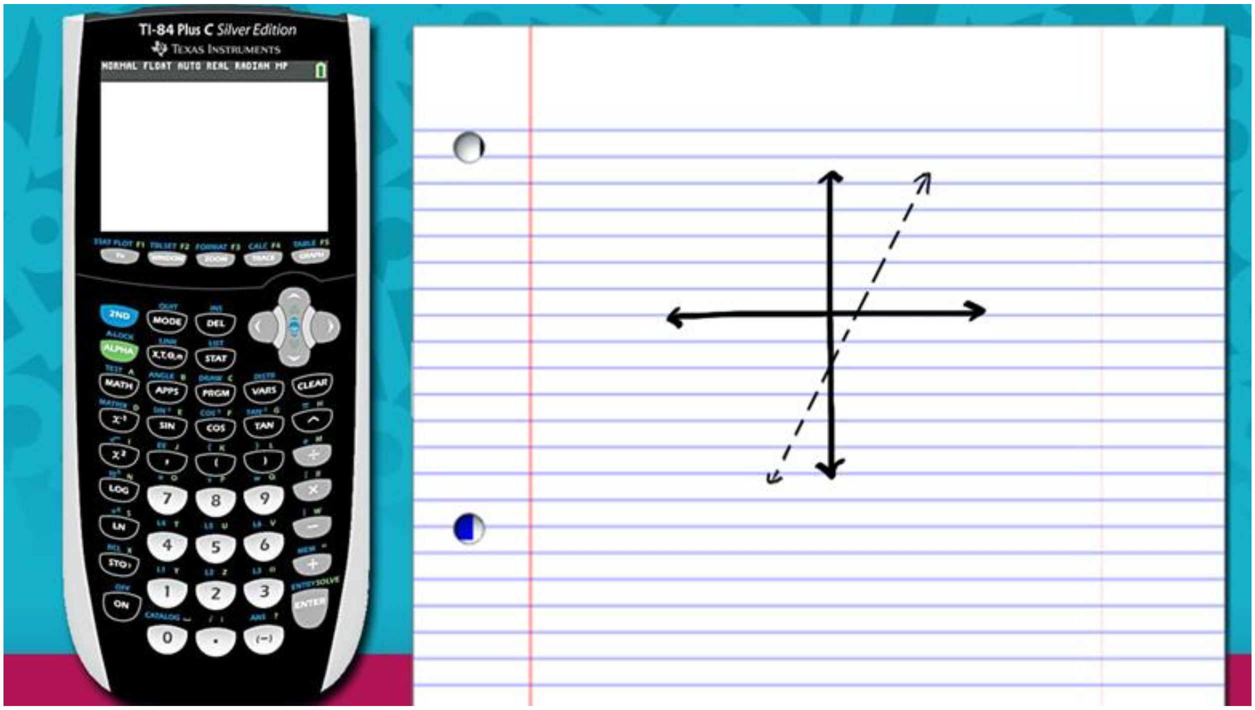
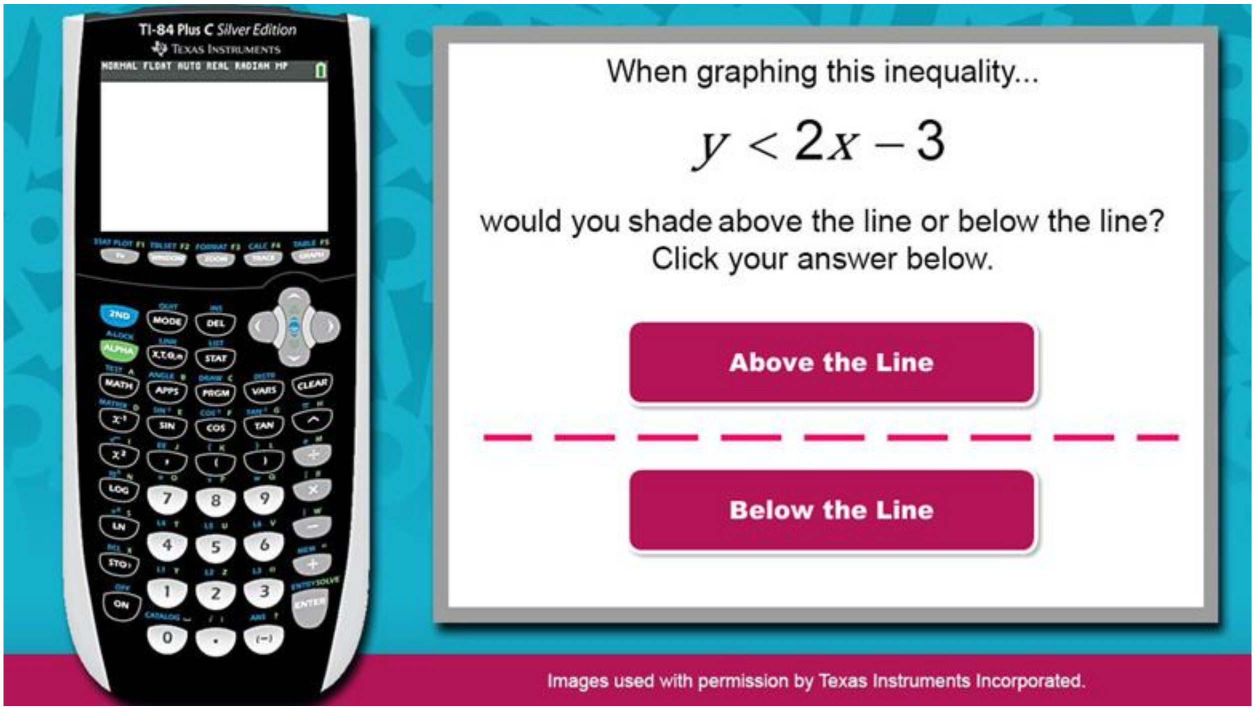
Sketch



Make sure you include a dashed boundary line to represent the solid line shown on your calculator.

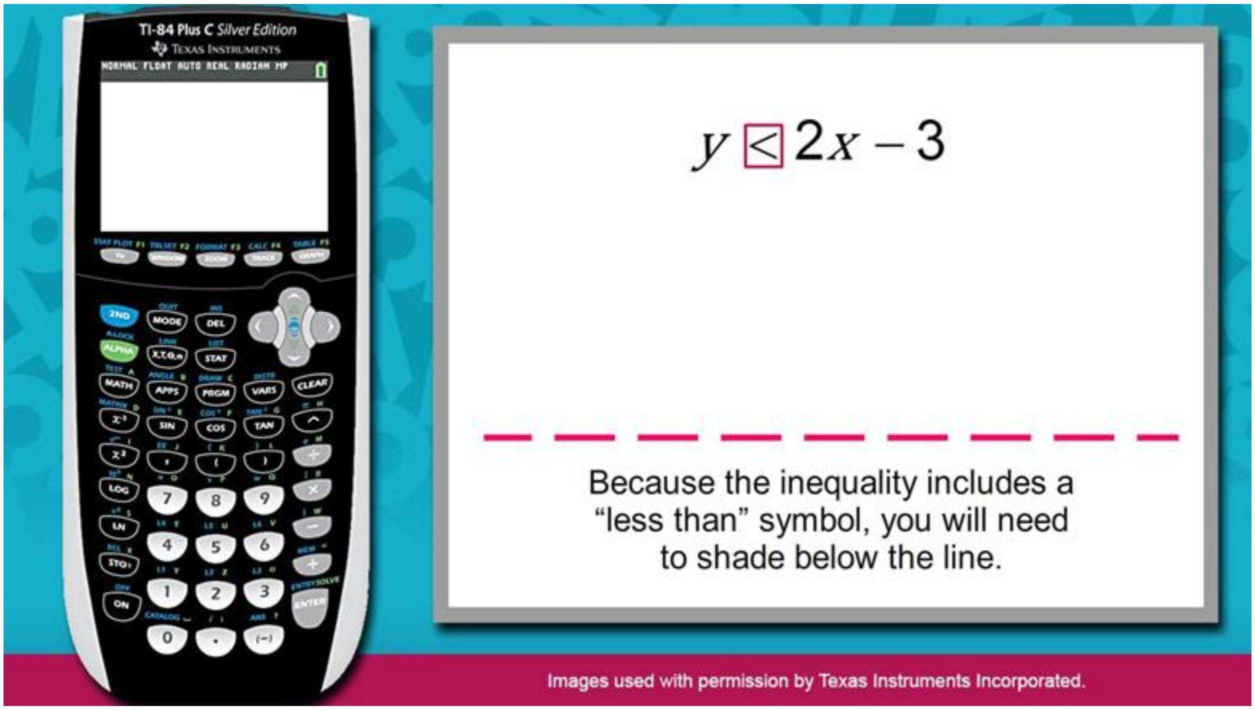
Above the Line or Below the Line



Now it's time to determine which region of the graph should be shaded.

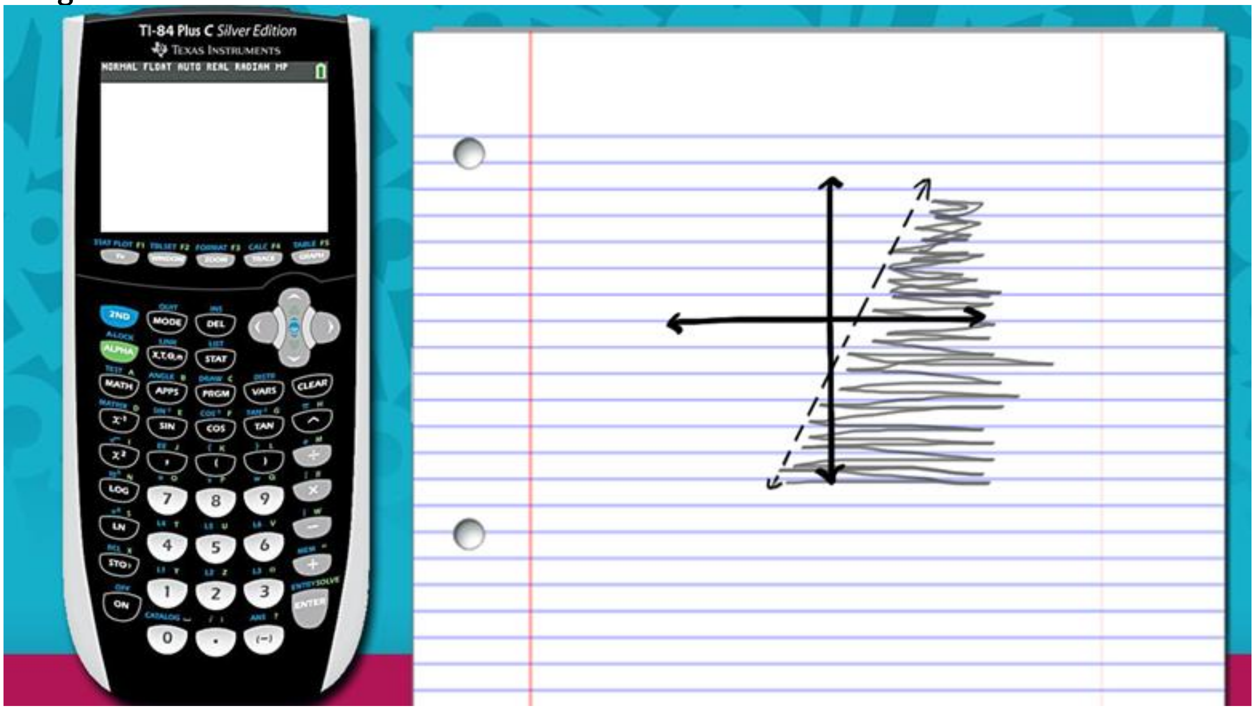
Should the graph of $y < 2x - 3$ include shading above the boundary line or below the boundary line?

Feedback



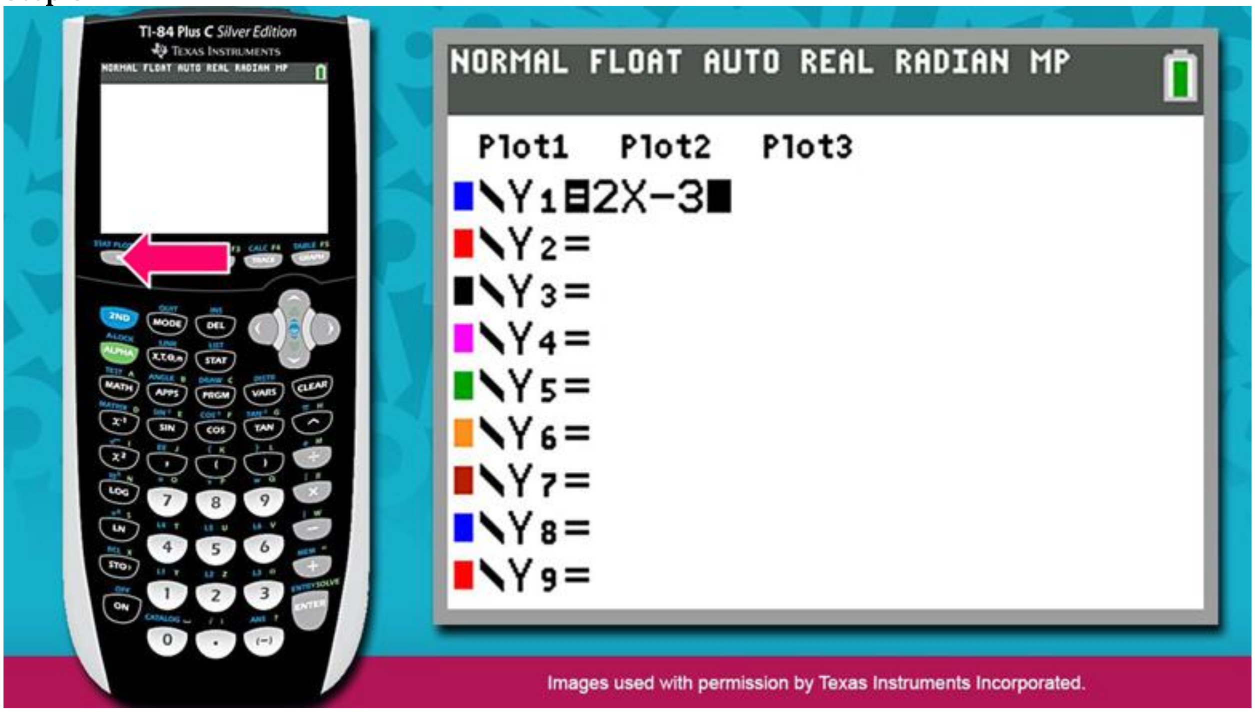
Because the inequality includes "less than," the region below the boundary line should be shaded.

Rough Sketch



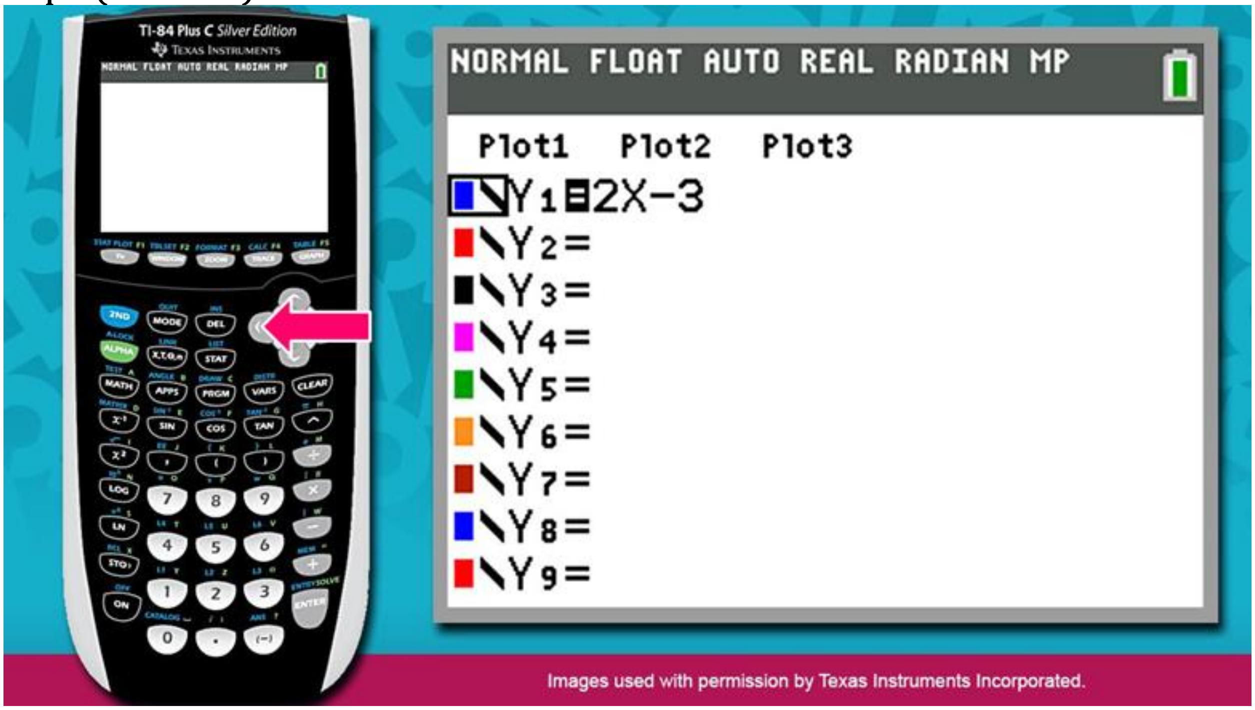
Now that you have determined that the region below the boundary line should be shaded, add the shading to your rough sketch.

Step 3



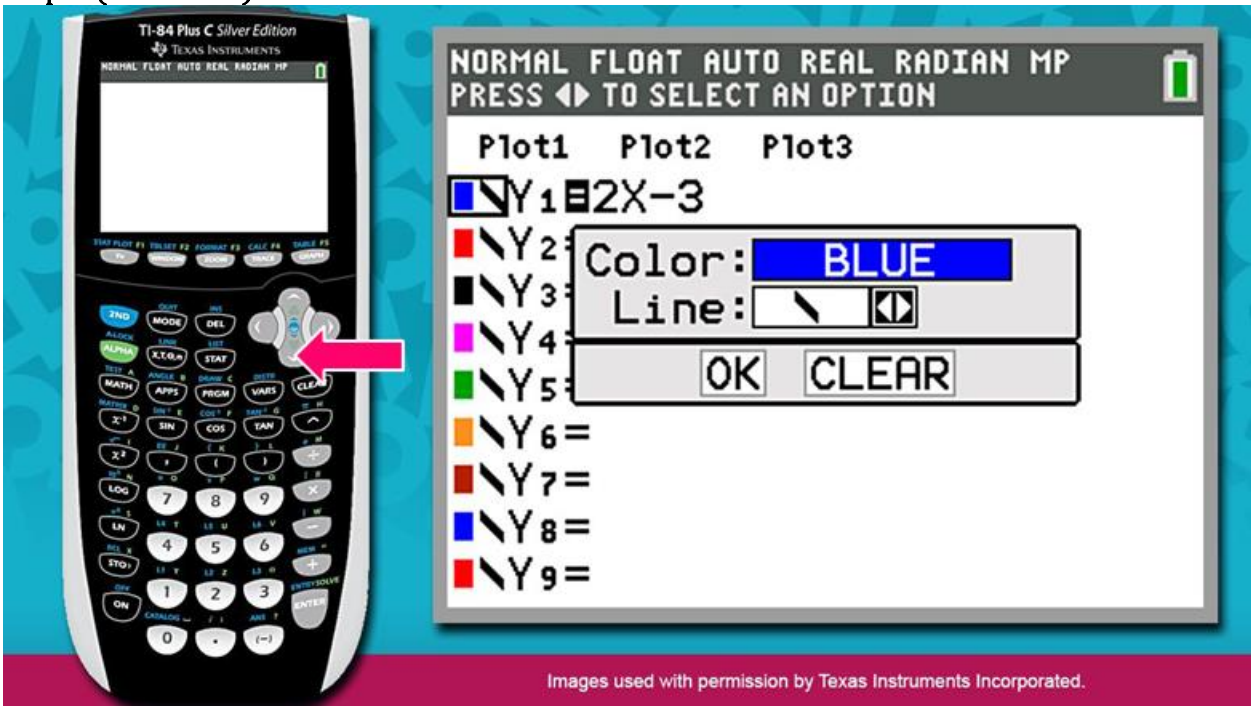
Now instruct the calculator to shade the appropriate region. Press the Y= key. Then press the left arrow until the cursor is blinking to the left of Y1.

Step 3 (continued)



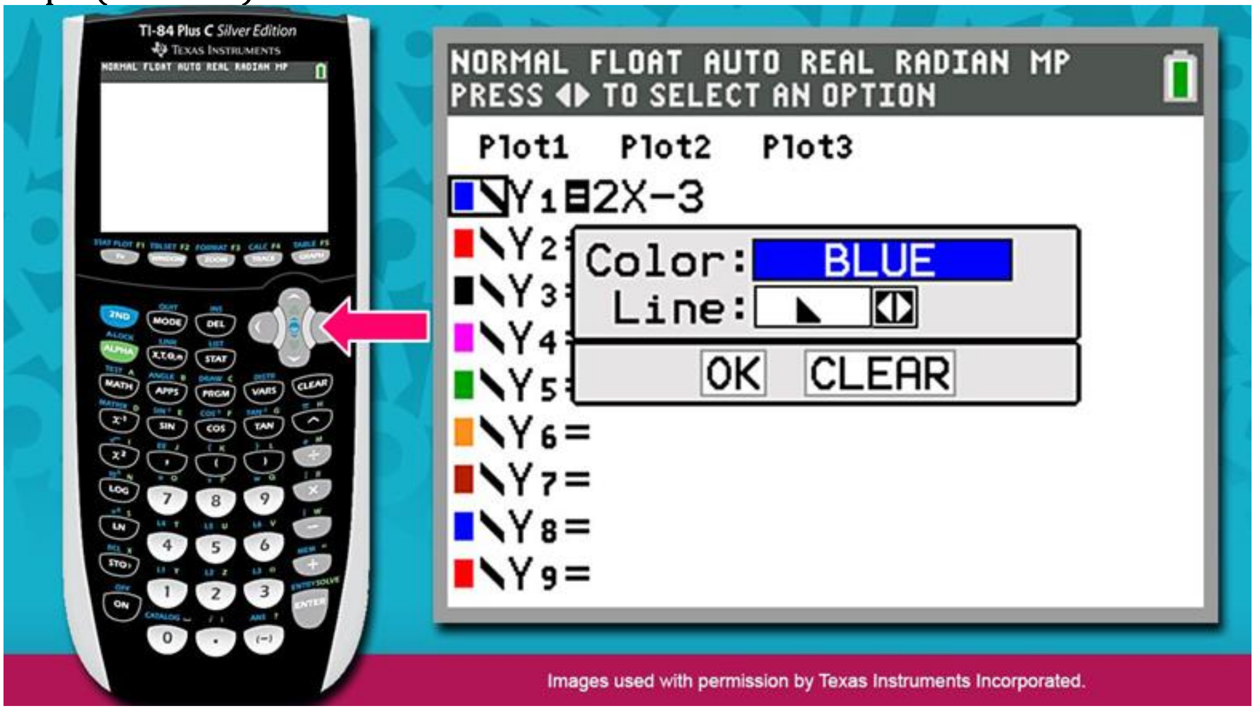
Now press enter. Then press the down arrow key until the cursor is blinking to the right of the “Line” prompt.

Step 3 (continued)



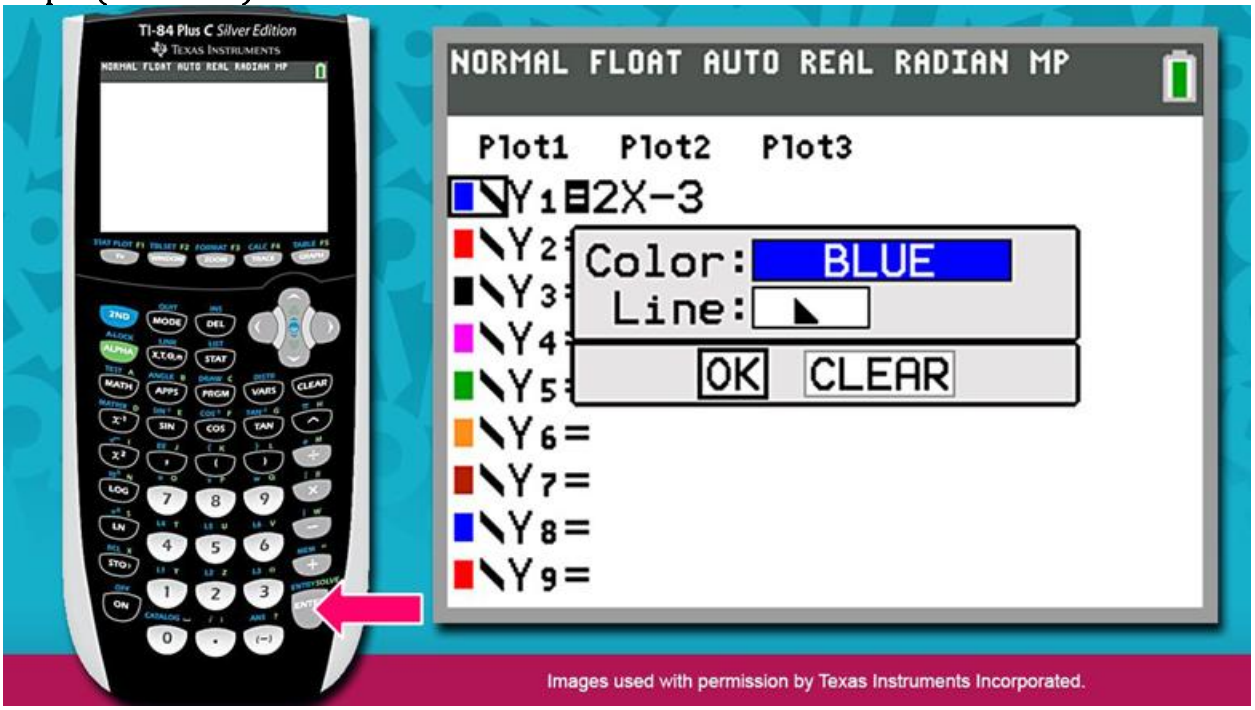
Press the right arrow key until the option for shading below the line appears. Then press enter.

Step 3 (continued)



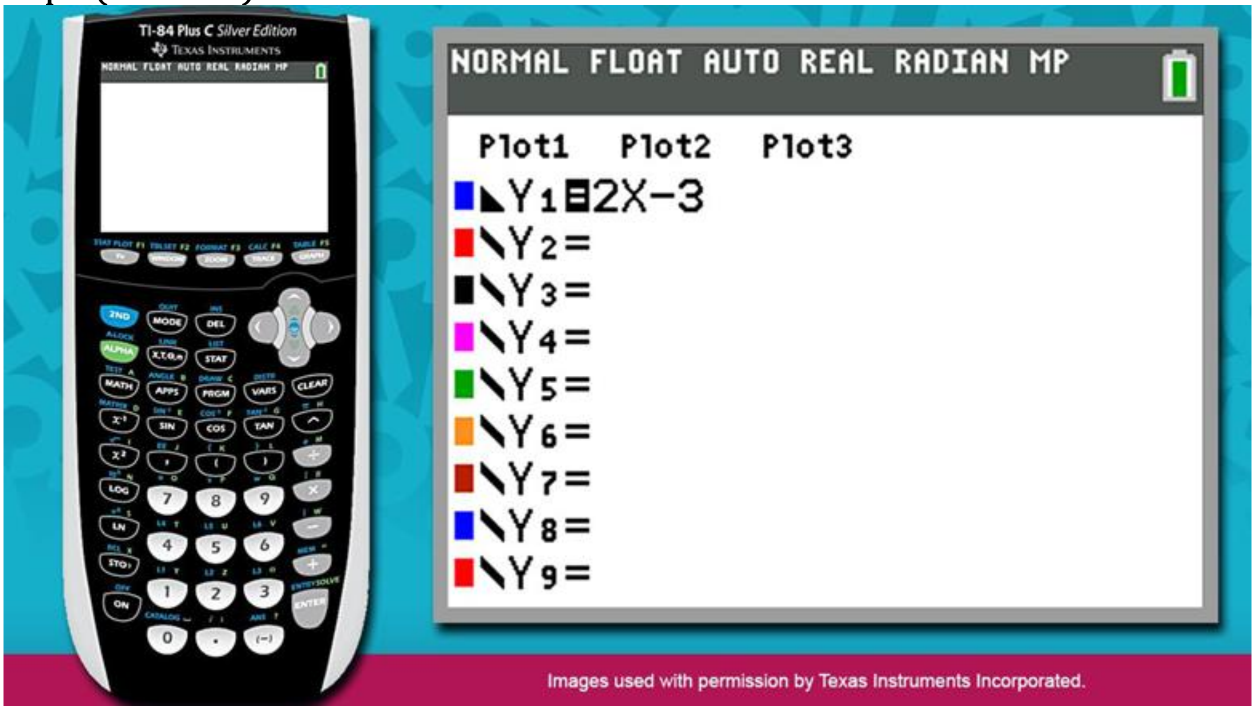
Press enter again once the cursor moves to OK.

Step 3 (continued)



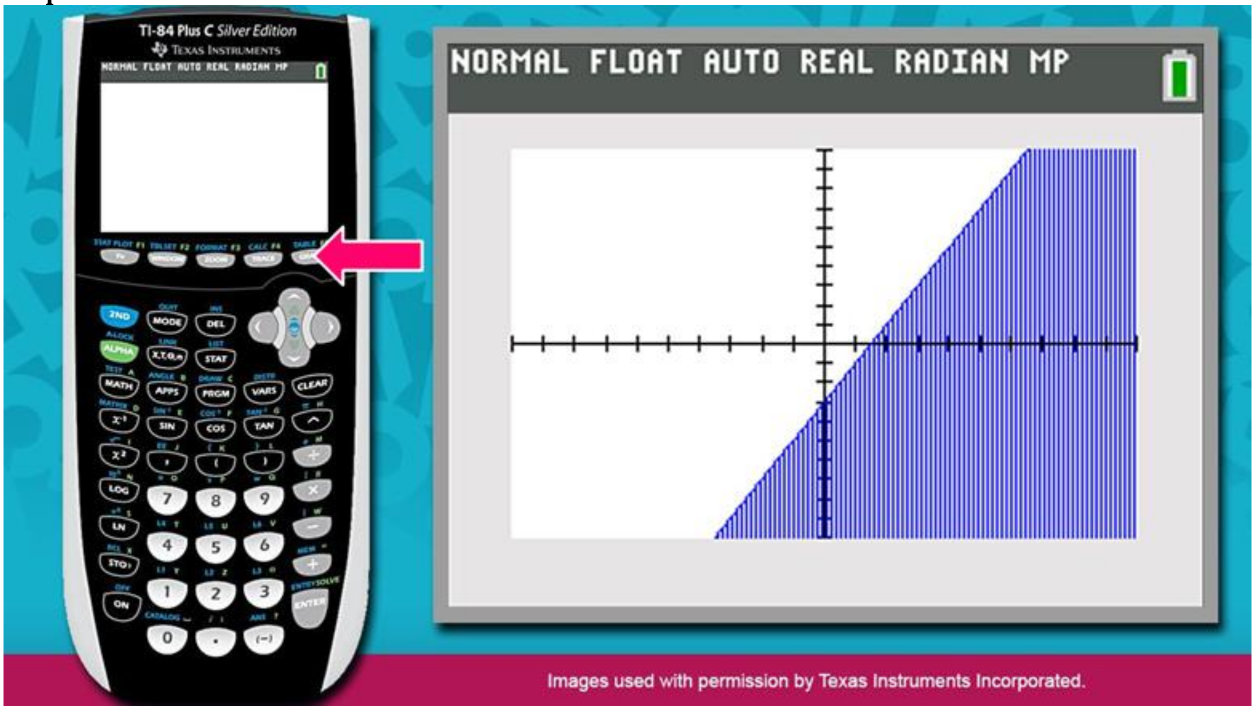
The screen will then display the inequality to the right of Y1, with the appropriate shading option to the left of Y1.

Step 3 (continued)



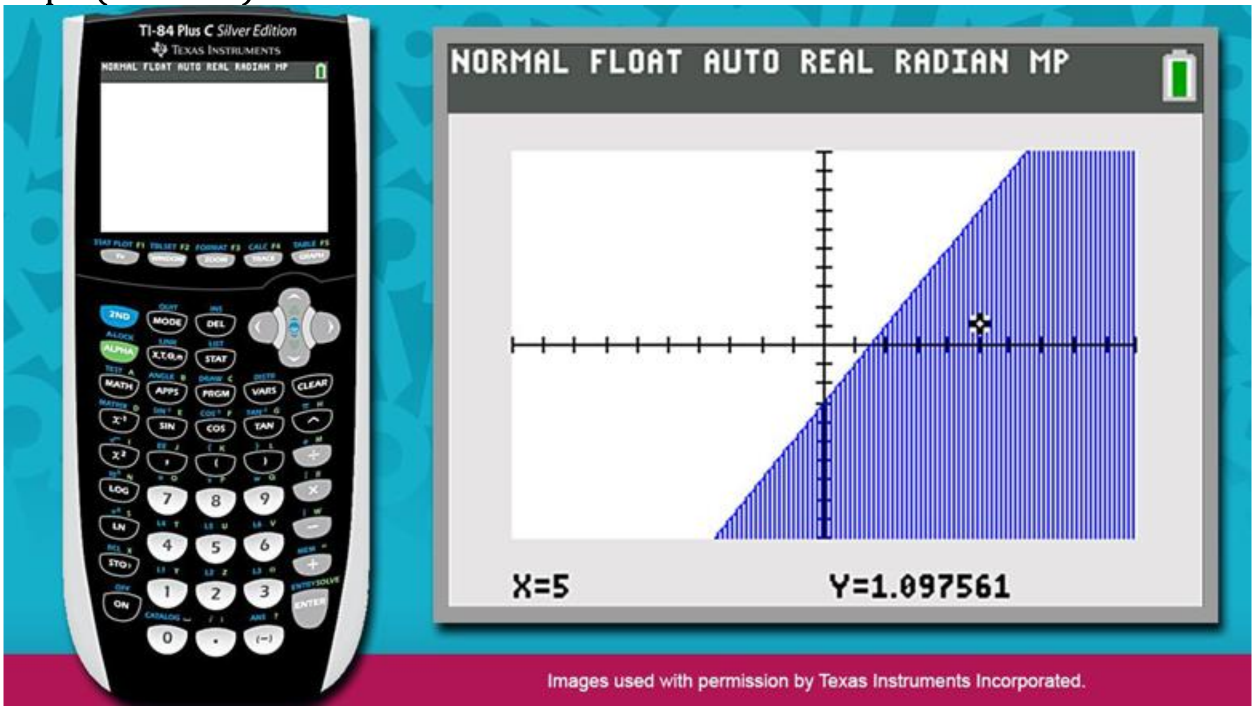
Now press GRAPH.

Step 4



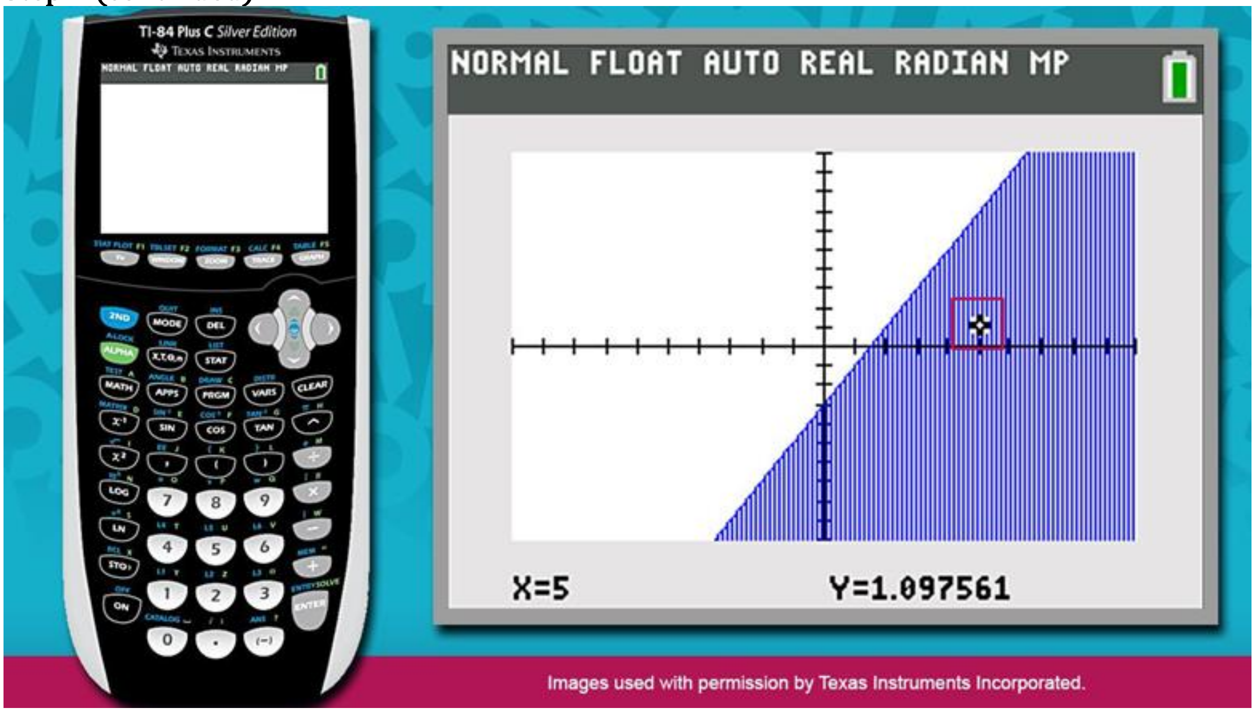
Now that you have graphed the inequality, you can analyze the graph to determine if the point (5, 1) is a solution.

Step 4 (continued)



Press the right arrow key and the key up arrow key to move the cursor around the coordinate plane. You may not be able to land exactly on the point (5, 1), but get as close to it as you can.

Step 4 (continued)



It appears that the point (5, 1) is included in the shaded region of the inequality. Therefore, it is a solution.

You can also verify that the point (5, 1) is a solution, algebraically. The point (5, 1) can also be referred to as an ordered pair. It consists of an x value of 5 and a *y* value of 1. By substituting 5 for *x* and 1 for *y*, into the original inequality, you can verify that it is a solution.

(5, -1)
x y

$y + 3 < 2x$

$(1) + 3 \quad 2(5)$

$4 < 10$

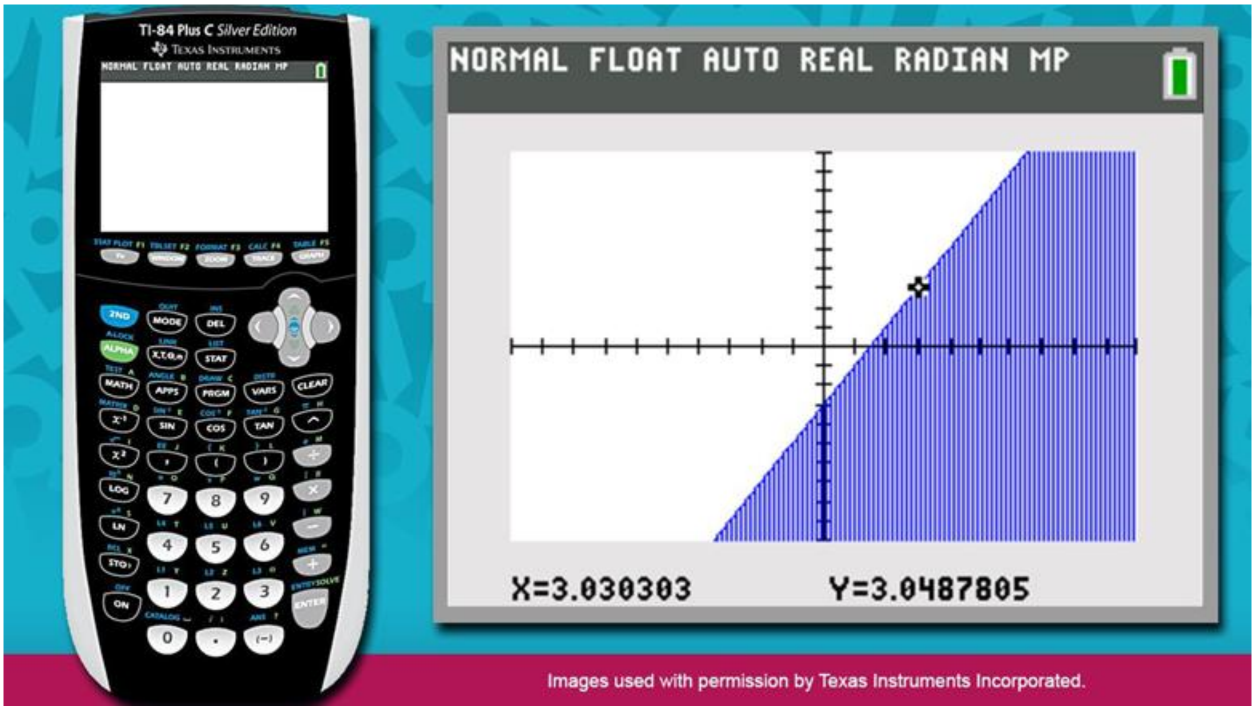
Is $1 + 3 < 2 \cdot 5$?

Is 4 less than 10? Yes it is. Therefore the point (5, 1) is a solution to the inequality.

B) Is $(3, 3)$ a solution?

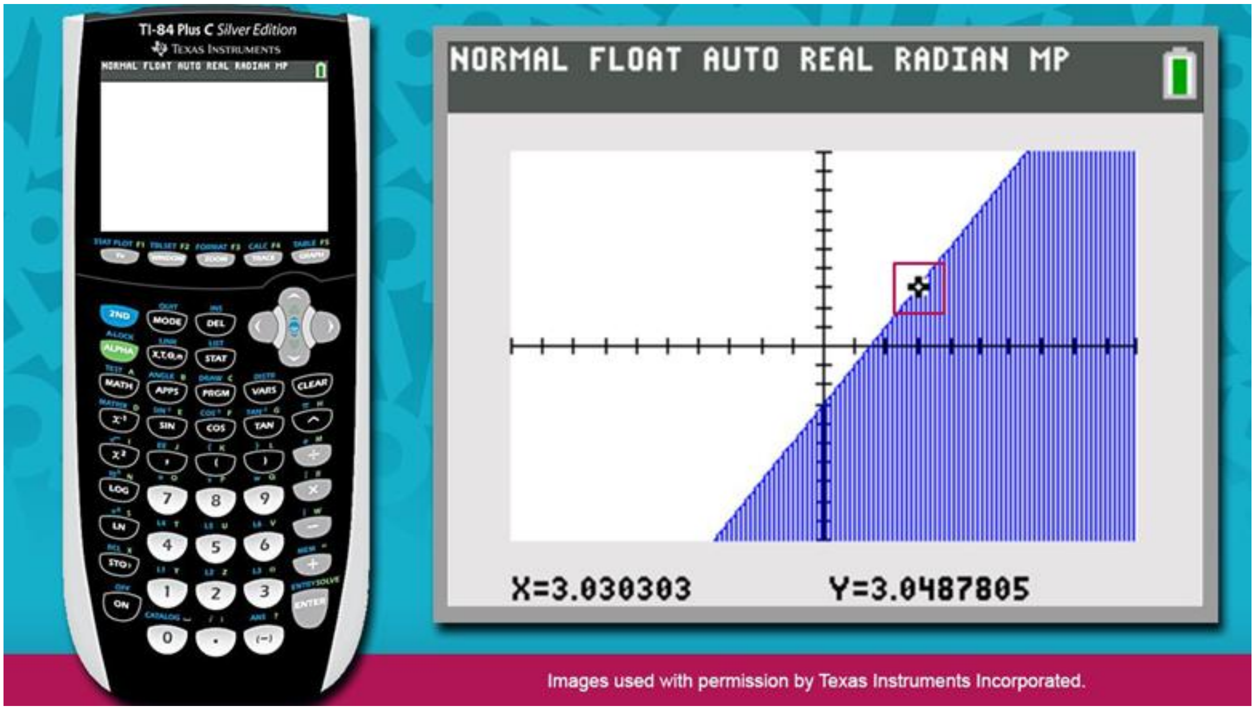
For this example, you will continue working with the inequality, $y + 3 < 2x$. This time you will need to determine if $(3, 3)$ is a solution. Remember, you can verify solutions graphically and algebraically.

You have already determined what the graph of $y + 3 < 2x$ looks like. Press the GRAPH key on the calculator to recall the graph.



Because you want to determine if the point (3, 3) is a solution, you will need to press the left arrow key and the up arrow key until you locate the point (3, 3). If you are not able to locate the point exactly, get as close to it as you can.

Feedback



The point (3, 3) appears to be located on the boundary line. And although the calculator graphed a solid line, you know from your rough draft that the graph is a dashed line. Therefore, (3, 3) is not a solution to the inequality.

Because you were not able to land exactly on the point (3, 3), however, it is a good idea to confirm your answer algebraically, by substituting (3, 3) into the original inequality.

(3, 3)
x y

$$y + 3 < 2x$$

$$(3) + 3 \quad 2(3)$$

$$6 \not< 6$$

Is $3 + 3 < 2 \cdot 3$?

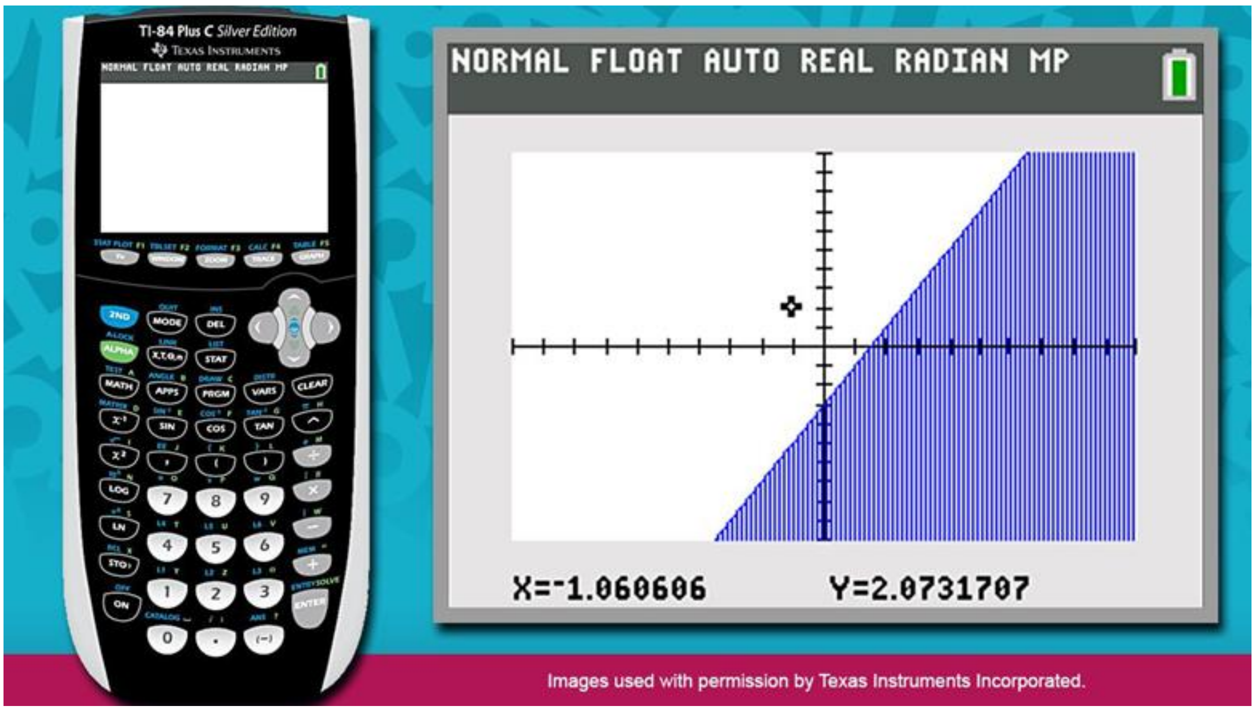
Is 6 less than 6? No, it is not. Therefore the point (3, 3) is not a solution to the inequality.

C) Is $(-1, 2)$ a solution?

For this example, you will continue working with the inequality, $y + 3 < 2x$. This time you will need to determine if $(-1, 2)$ is a solution. Remember, you can verify solutions graphically and algebraically.

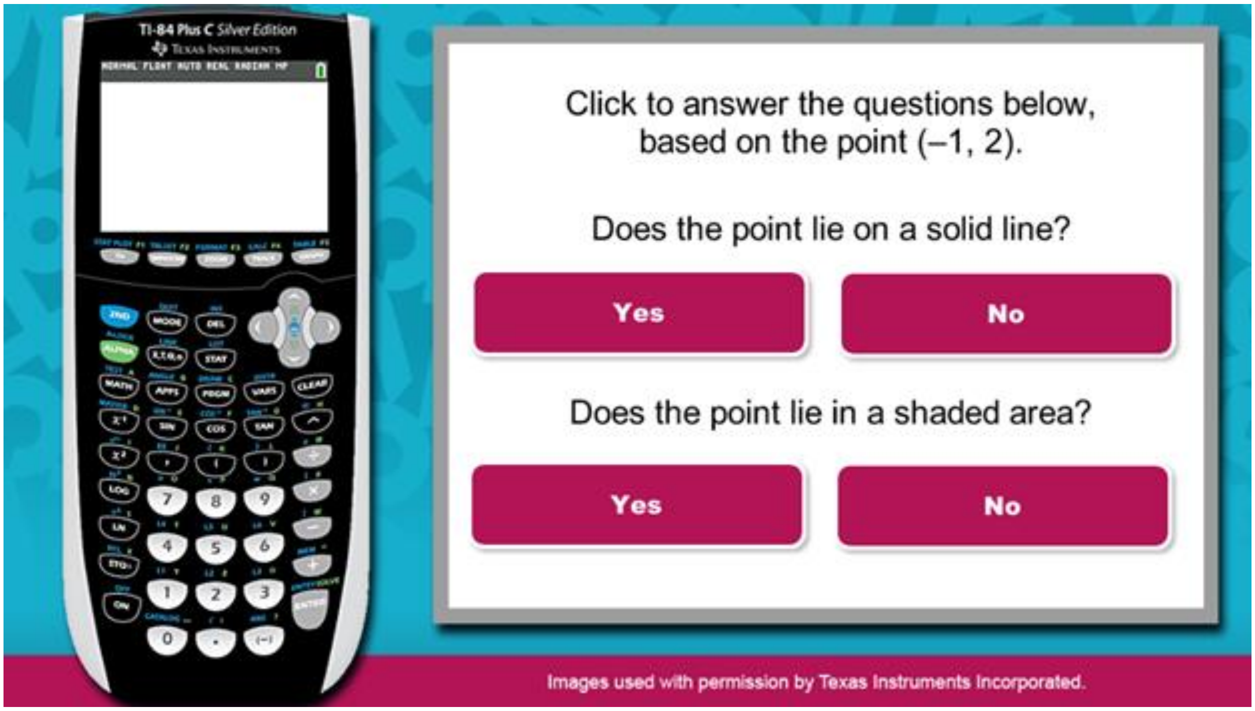
You have already determined what the graph of $y + 3 < 2x$ looks like.

Press the GRAPH key to recall the graph of the inequality.



Because you want to determine if the point (–1, 2) is a solution, you will need to press the left arrow key and the down arrow key until you locate the point (–1, 2). If you are not able to locate the point exactly, get as close to it as you can.

Solid Line or Shaded Area

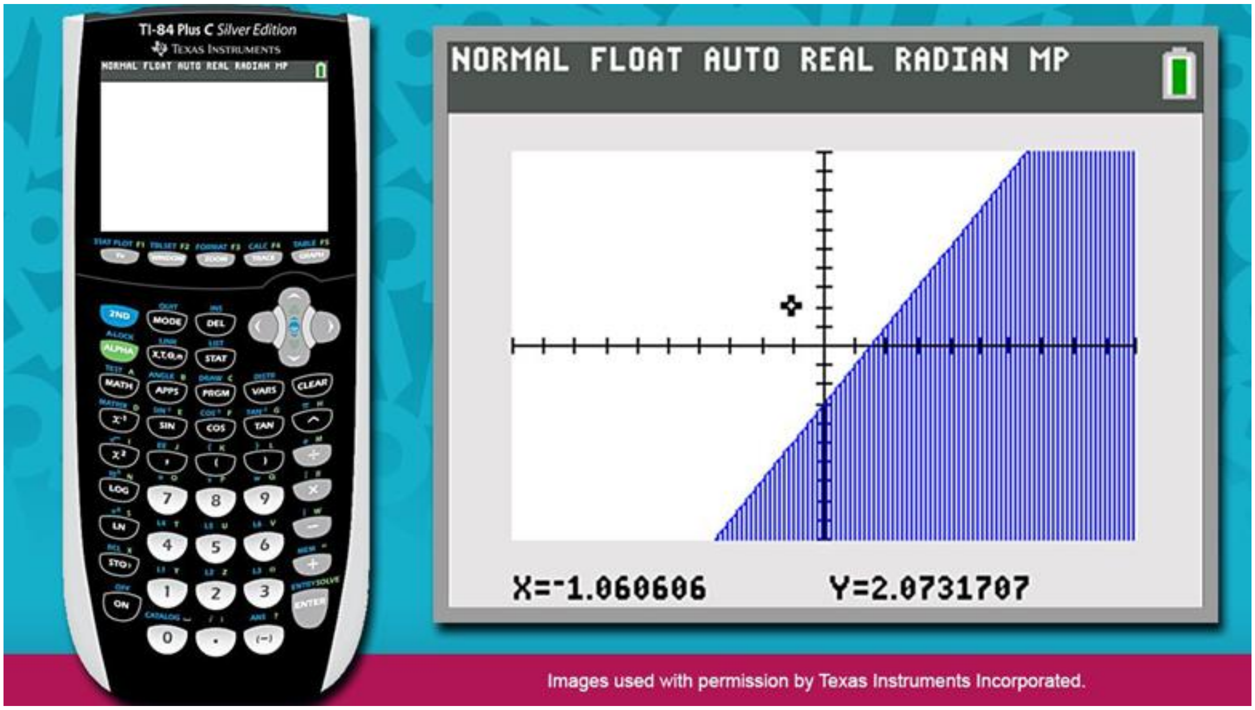


Although you are not able to land on the point exactly, you are still able to answer the following questions with certainty.

Does the point lie on a solid line? No. The point does not lie on a line at all.

Does the point lie in the shaded area? No. The point lies in the unshaded area.

Feedback



It is safe to assume that the point $(-1, 2)$ is located in the unshaded region of the graph. Therefore it is not a solution to the inequality. You can also verify this algebraically, by substituting $(-1, 2)$ into the original inequality.

(-1, 2)
x y

$y + 3 < 2x$

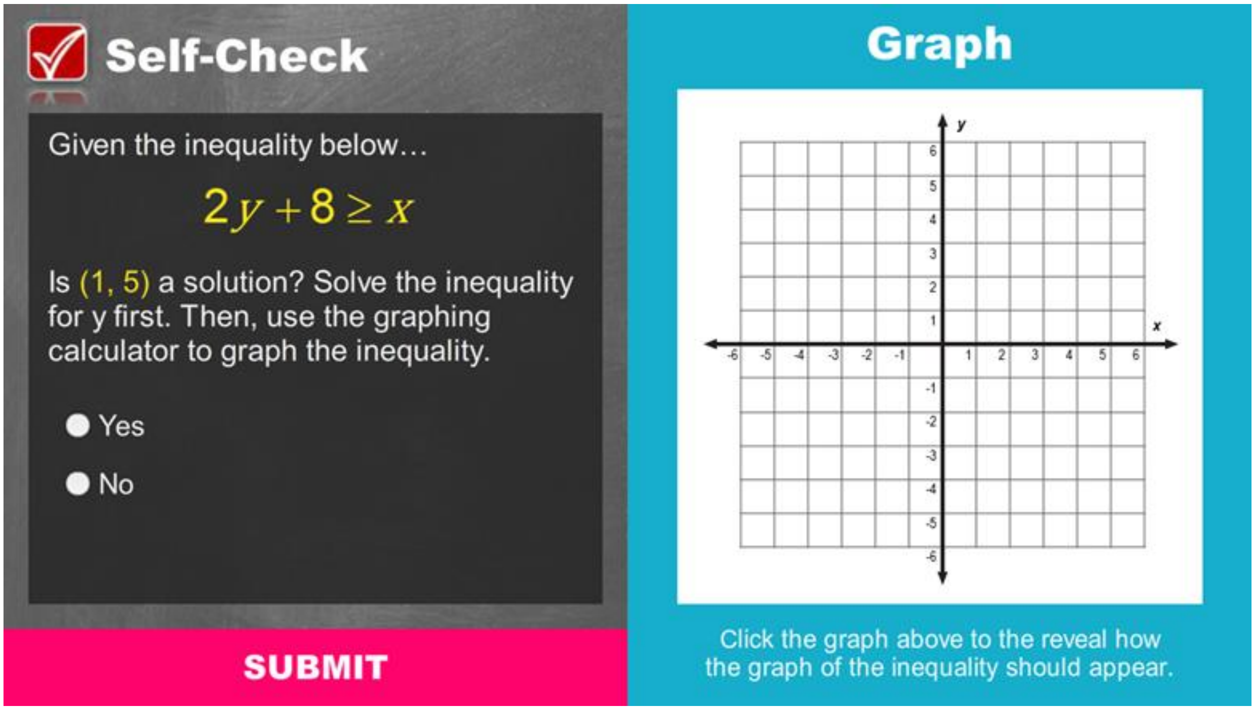
$(2) + 3 \quad 2(-1)$

$5 \nless -2$

Is $2 + 3 < 2 \cdot -1$?

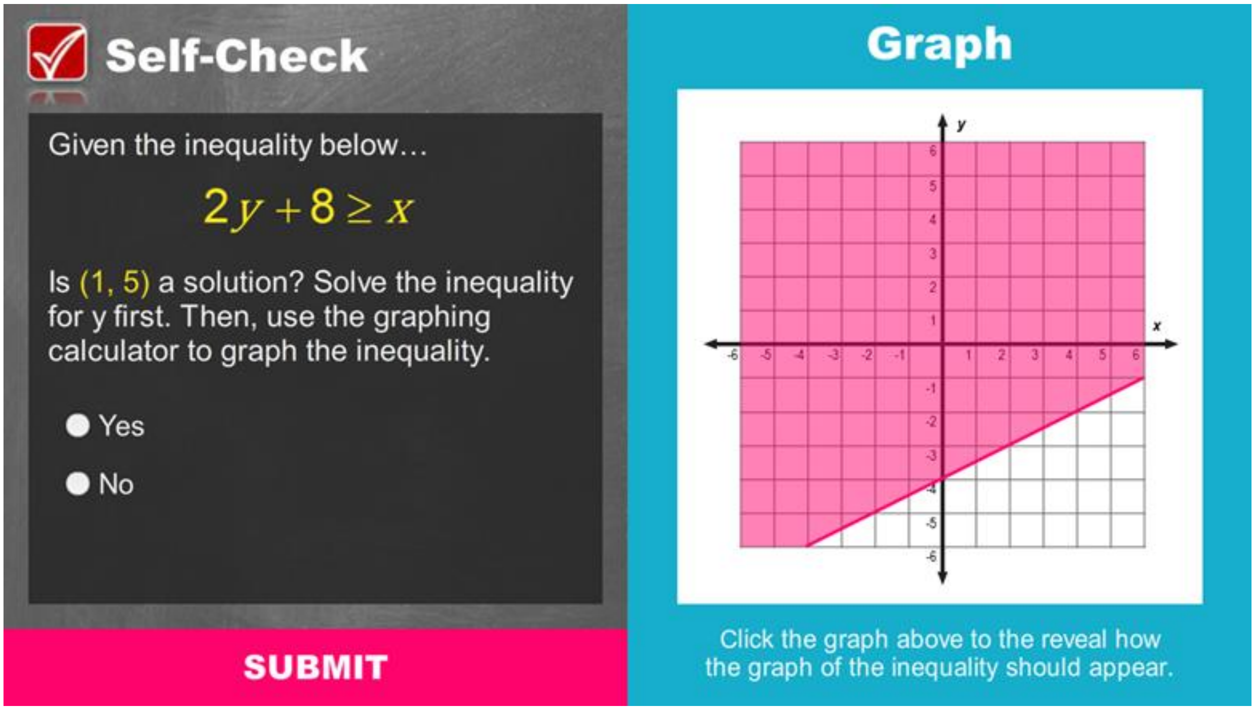
Is 5 less than -2? No, it is not. Therefore the point $(-1, 2)$ is not a solution to the inequality.

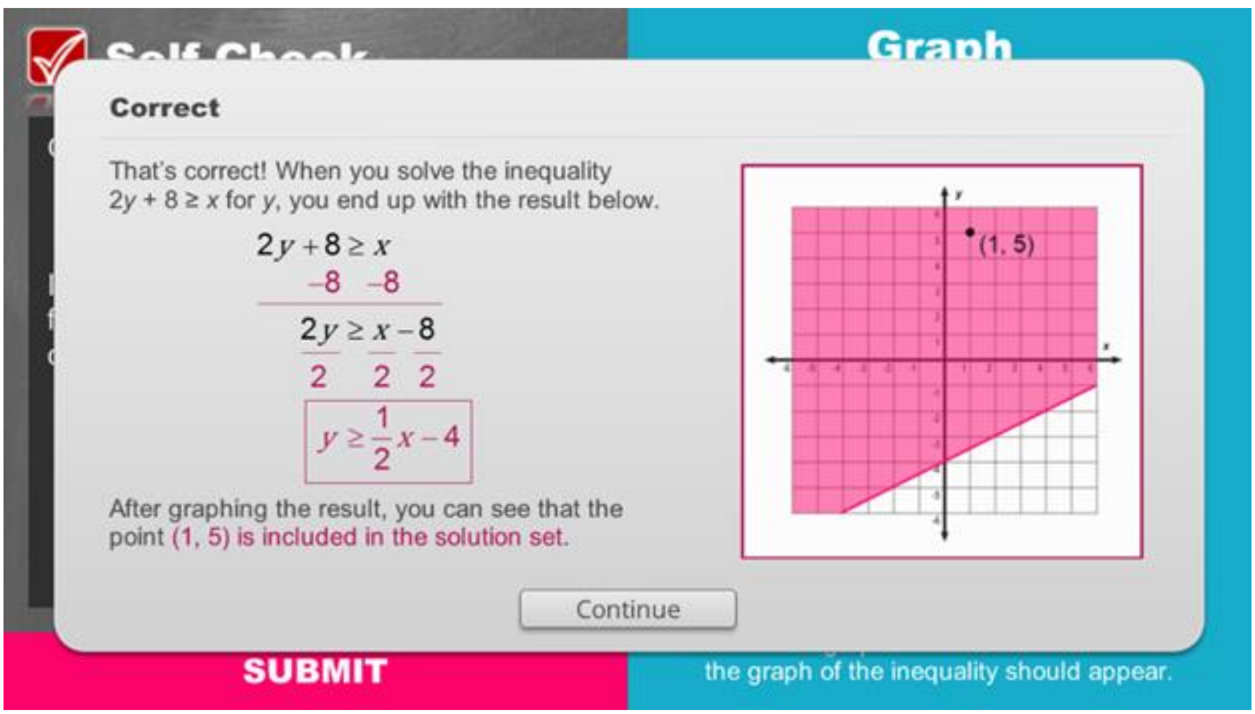
Self-Check 1



Solve the problem in the image above to check your understanding of the content.

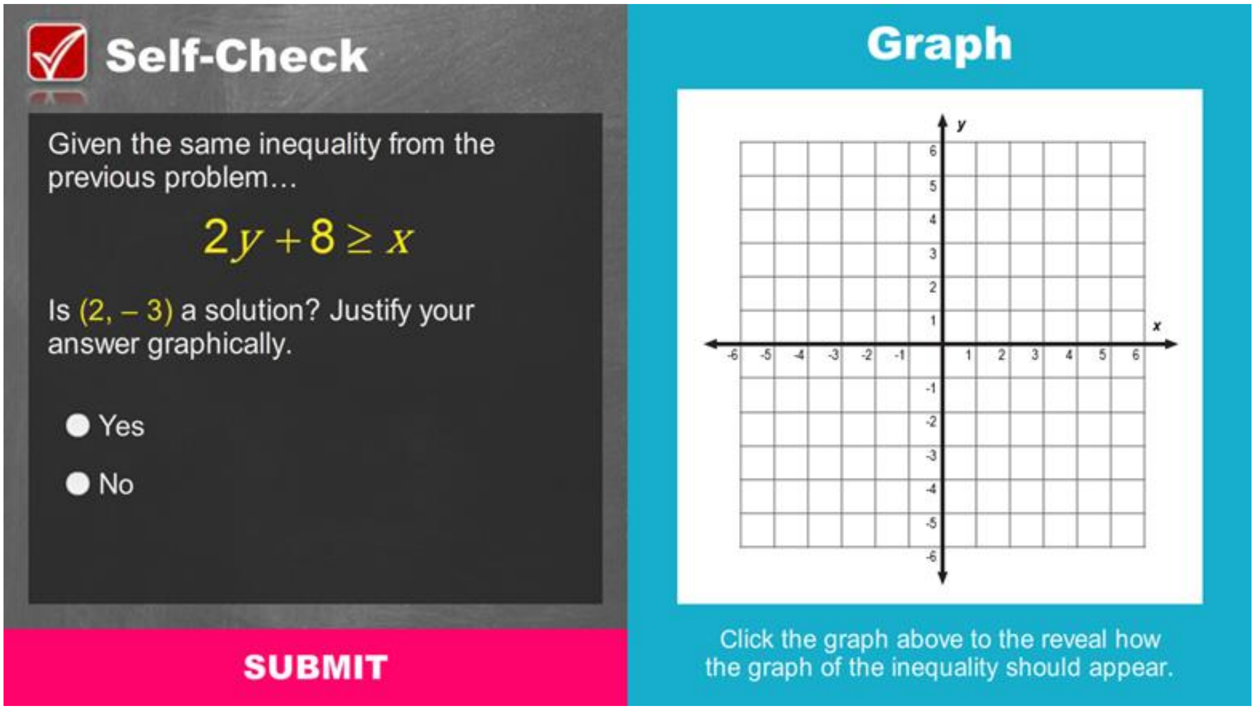
Self-Check 1: Answer





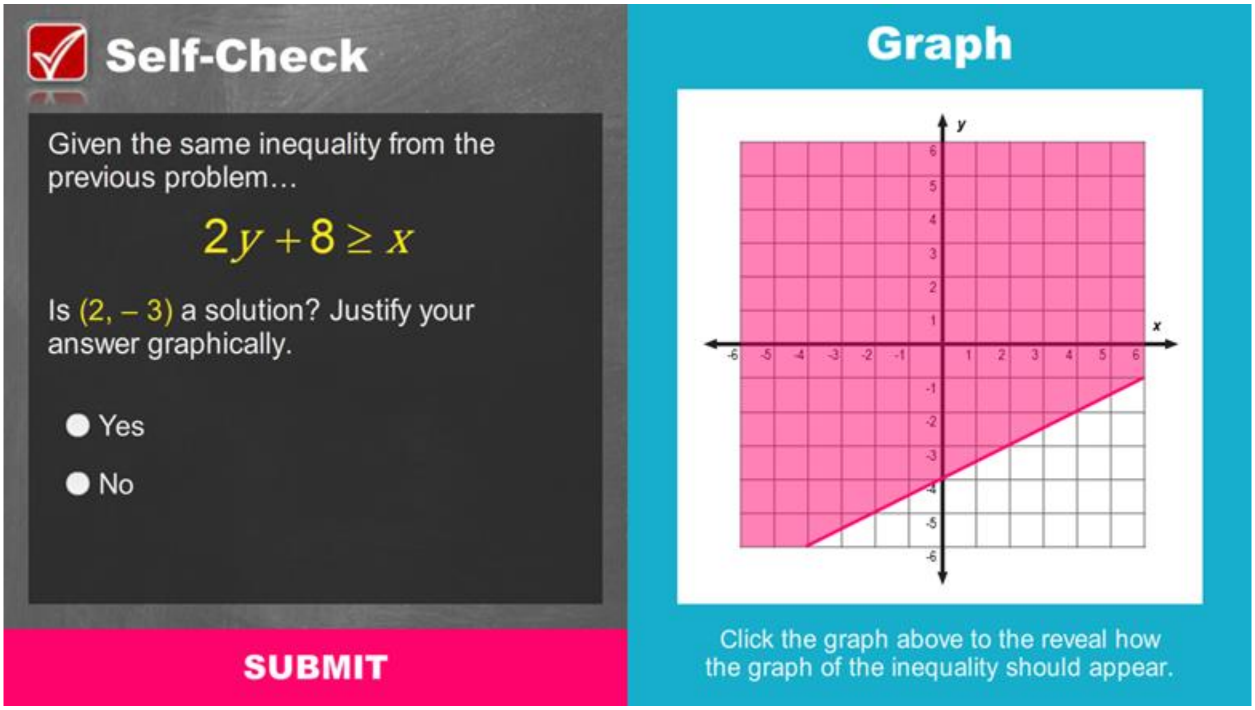
For your reference, the image above shows the correct solution to the self-check problem.

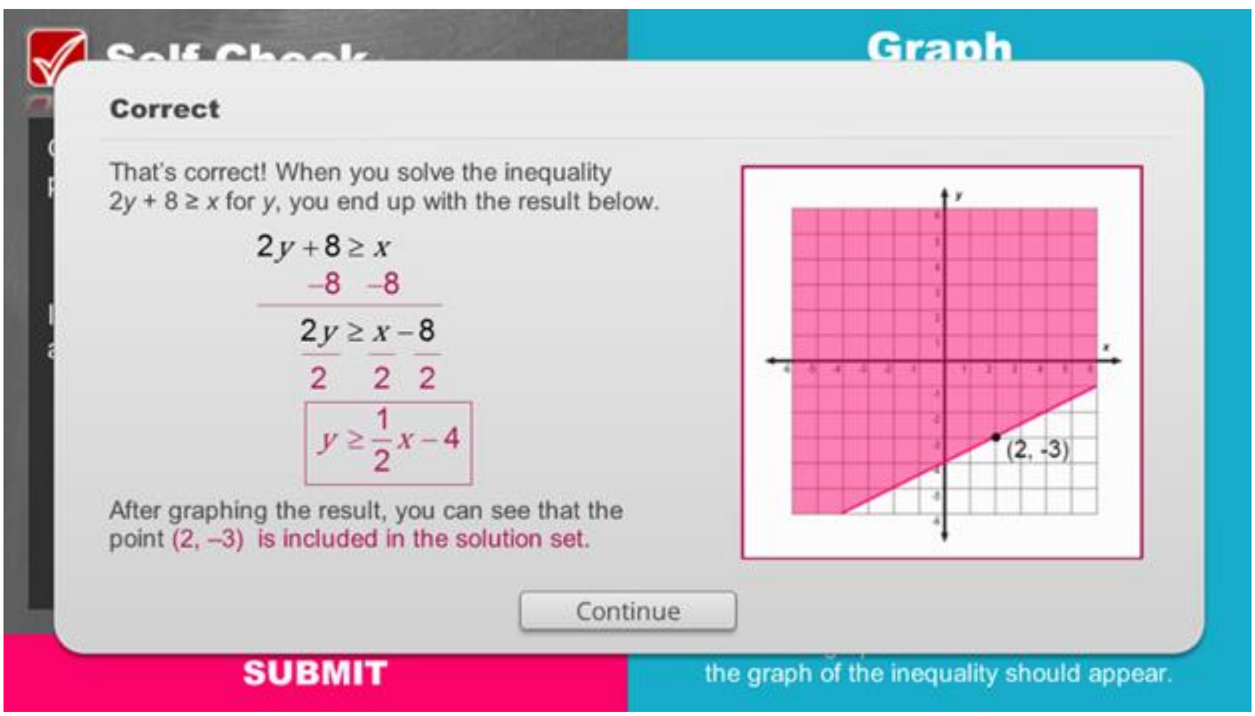
Self-Check 2



Solve the problem in the image above to check your understanding of the content.

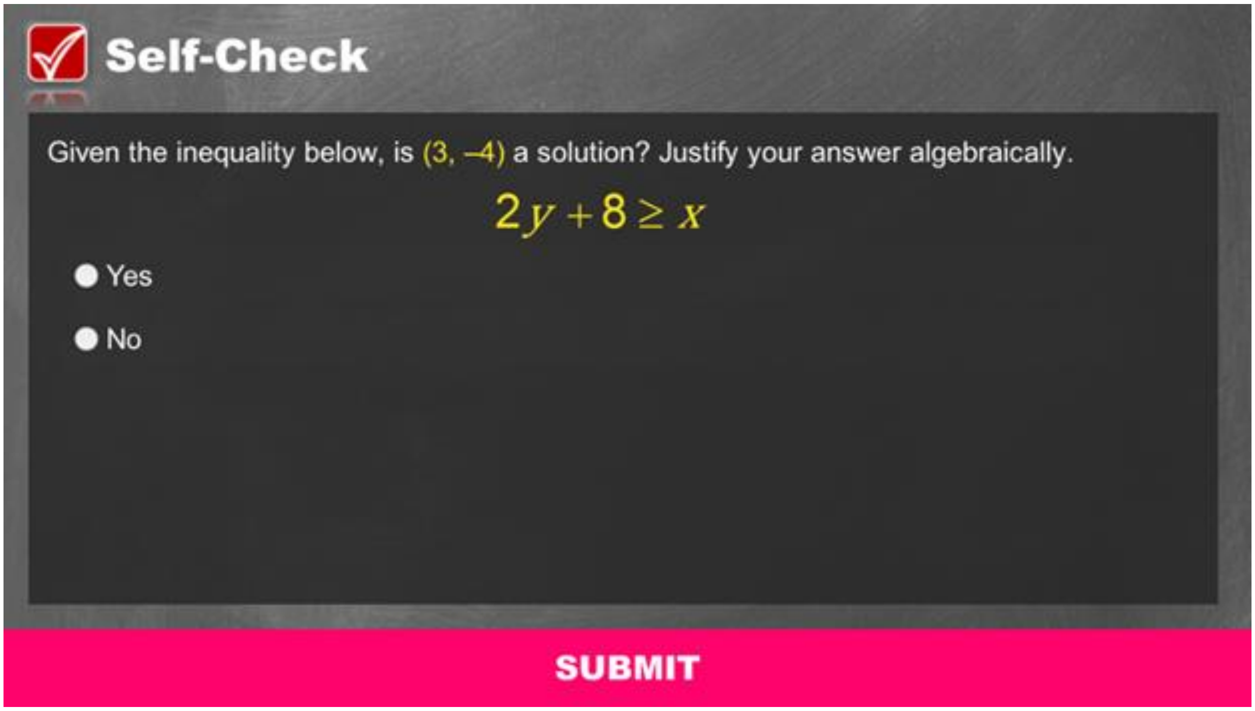
Self-Check 2: Answer





For your reference, the image above shows the correct solution to the self-check problem.

Self-Check 3



Solve the problem in the image above to check your understanding of the content.

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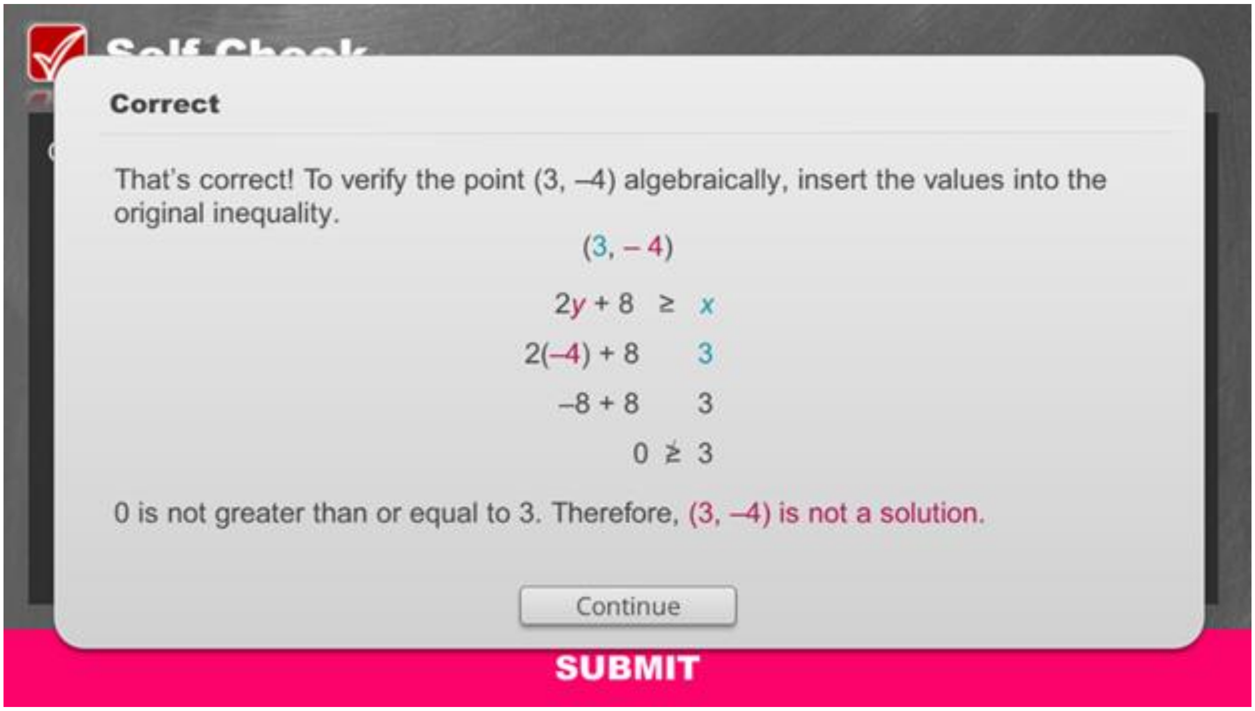
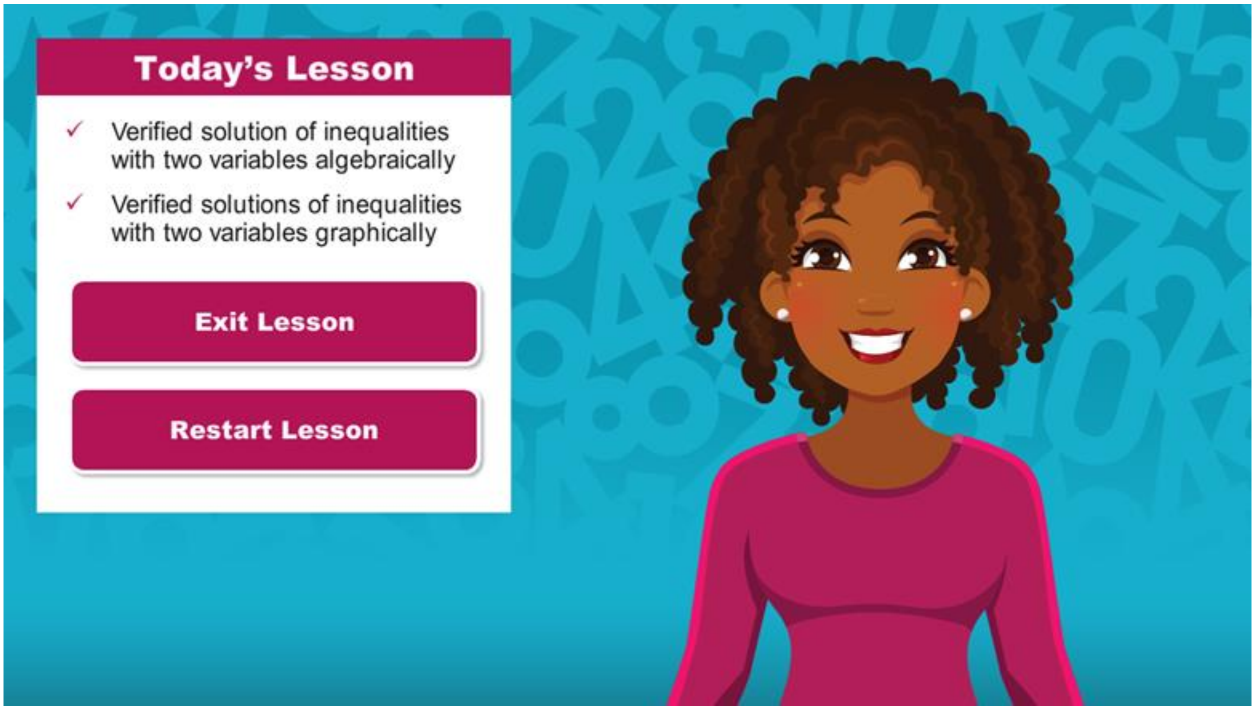
Self-Check 3: Answer



For your reference, the image above shows the correct solution to the self-check problem.

Conclusion



Great job! Your knowledge of how to verify solutions of inequalities in one variable, served as the foundation, for you to build your knowledge on verifying the solutions of inequalities in two variables. You are now well-equipped to use graphic or algebraic techniques in order to verify a solution.