

## Linear Inequalities

ID: 8773

 Time required  
60 minutes

### Activity Overview

*In this activity, students first look at tables of values to see that inequalities (in a single variable) are true for some values of the variable and not for others. They are guided to connect “true” with a value of 1 and “false” with a value of 0, creating a bridge from the table of values to a graph of the linear inequality. In Problem 2, students solve one-step linear inequalities using addition or subtraction and compare the graph of the original inequality with that of the simplified form, finding they are the same. In Problem 3, students perform a similar exploration solving one-step linear inequalities using multiplication or division.*

### Topic: Linear Inequalities

- *Graph a simple linear inequality of the form  $x < a$ ,  $x \leq a$ ,  $x > a$ , or  $x \geq a$  on the real line.*
- *Use addition or subtraction to solve a “one-step” linear inequality in a single variable.*
- *Use multiplication or division to solve a “one-step” linear inequality in a single variable.*

### Teacher Preparation

- *This activity is designed for use in an Algebra 1 or Pre–Algebra classroom.*
- *Prior to beginning the activity, students should download the **LINEQUA** program to their handhelds. They should also have some experience solving simple one-step and multiple-step linear equations.*
- *This activity is intended to be a combination of **teacher-led** and **student-centered** activity. It is recommended that you introduce each problem by guiding students through the step-by-step instruction in a whole-class setting, then allow them to complete the exercises individually or in small groups with your assistance.*
- *If time constraints prevent you from completing the activity in one class period, you may choose to complete Problem 1 one day and Problems 2 and 3 the next day.*
- ***To download the calculator program LINEQUA and student worksheet, go to [education.ti.com/exchange](http://education.ti.com/exchange) and enter “8773” in the keyword search box.***

### Associated Materials

- *LinearInequalities\_Student.doc*
- *LINEQUA.8xp (program)*

An inequality is a mathematical sentence that shows the relationship between two quantities using these signs:  $>$ ,  $\geq$ ,  $<$ ,  $\leq$ , or  $\neq$ .

Solving inequalities in a single variable is similar to solving equations in a single variable, but there are some important differences. One big difference occurs when you multiply or divide by a negative number. In this activity, you will practice solving linear inequalities and explore these differences using algebraic and graphing techniques.

### Problem 1 – Graphing a simple inequality

In this problem, students will explore and graph a simple inequality:  $x \geq 4$ . When they run the **LINEQUA** program, students should enter **X** for the left side and 4 for the right side, when prompted. Then they will choose  $\geq$  for the inequality sign.

```
Left side?X
Right side?4
```

Students will first view the table of values. The calculator displays a table with several columns. The first column **X** shows the values of the variable,  $x$ . The second column, labeled **Y1**, shows the value of the left side for each  $x$ -value. The third column, labeled **Y2**, shows the value of the right side for each  $x$ -value. Direct students to answer Questions 1-2 on the worksheet.

X	Y1	Y2
1	1	4
2	2	4
3	3	4
4	4	4
5	5	4
6	6	4
7	7	4
8	8	4

X=1

Now students will observe the fourth column, labeled **Y3**. Each entry in this column is either a 1 or a 0. They should notice that all  $x$ -values greater than or equal to 4 have a value of 1 and all  $x$ -values less than 4 have a value of 0.

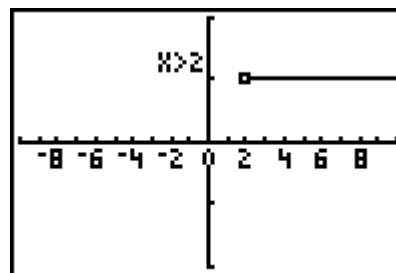
X	Y2	Y3
0	4	0
1	4	0
2	4	0
3	4	0
4	4	1
5	4	1
6	4	1
7	4	1
8	4	1

Y3=0

Students are to repeat these steps with the inequality  $x < -2$ . They should see that all  $x$ -values less than  $-2$  have a value of 1 and all  $x$ -values less than or equal to  $-2$  have a value of 0.

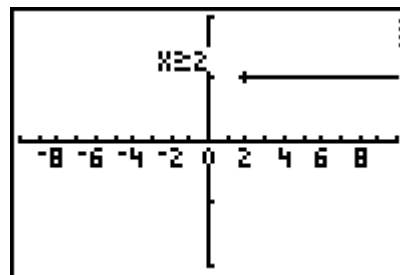
All  $x$ -values that have a value of 1 **do** satisfy the inequality and all  $x$ -values that have a value of 0 **do not** satisfy the inequality.

Now students will observe the graph the simple inequality,  $x > 2$ . They need to press **ENTER** and select **1:Another Ineq.** Then enter the inequality and this time choose **2:View Graph** from the menu.



A line is drawn above the  $x$ -values on the number line where the inequality is true. The inequality is not true when  $x = 2$ , so an open circle is displayed there.

Students will then graph the inequality  $x \geq 2$ . They should see that the line covers the same  $x$ -values but one has an open circle and the other has a cross at  $x = 2$ .

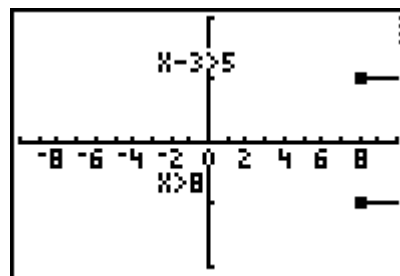


Students are given two examples of how to sketch inequalities on paper. Answer any questions students may have before having them use the calculator to complete the exercises in Question 9.

**Problem 2 – Solving inequalities using addition and subtraction**

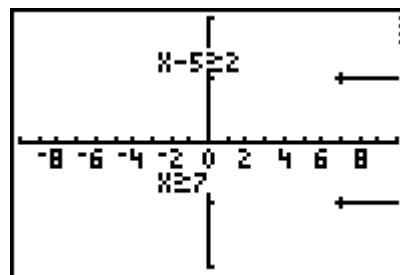
Discuss with students that equivalent inequalities are inequalities with the same solutions. They are given two examples on the worksheet, showing how to add or subtract the same number from both sides of an inequality, which does not affect the solutions. Remind them that this is just as they would do with equations.

Now students will use the Compare Ineq function in the program to compare the inequalities  $x - 3 > 5$  and  $x > 8$ . The calculator displays the graphs of  $x - 3 > 5$  and  $x > 8$  on the same screen. Students should notice that the graphs are the same, so the inequalities are equivalent.



Make sure students are aware that the calculator program shows a “closed circle” as a cross and an “open circle” as a dot.

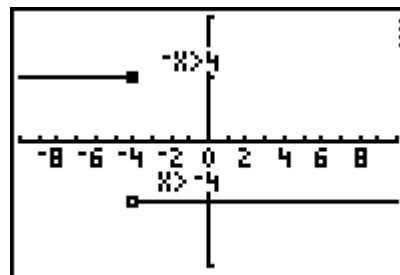
Direct students to work through the exercises in Question 10 using the calculator to compare their solution with the original inequality.



**Problem 3 – Solving inequalities using multiplication and division**

Students will now use the calculator to compare the graphs of  $\frac{x}{5} \leq -1$  and  $x \leq -5$ , which contain

multiplication and division. They should notice that they cannot multiply by a negative number without changing its solutions.



Direct students to work through the problems in Question 15, finding the appropriate inequality symbol. Once they have completed that, discuss with the class reversing or flipping the symbol when dividing or multiplying by a negative number. Have them solve the inequalities in Question 17. Answer any questions they may have.

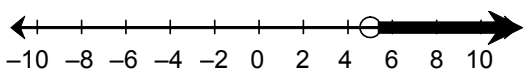
**Solutions**

**Problem 1**

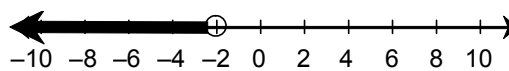
1. The numbers in the **Y1** column are the same as the  $x$ -values because the left side of the inequality is  $x$ .
2. The numbers in the **Y2** column are not affected by the  $x$ -values, because the right side of the inequality is a constant, 4.
3. a. For all of the  $x$ -values greater than or equal to 4.  
b. Sample:  $x = 5 \rightarrow x \geq 4 \rightarrow 5 \geq 4$ ; yes
4. a. For all of the  $x$ -values less than 4.  
b. Sample:  $x = 3 \rightarrow x \geq 4 \rightarrow 3 \geq 4$ ; no
5. a. For all  $x$ -values less than  $-2$ .  
b. Sample:  $x = -4 \rightarrow x < -2 \rightarrow -4 < -2$ ; yes
6. a. For all  $x$ -values greater than or equal to  $-2$ .  
b. Sample:  $x = -1 \rightarrow x < -2 \rightarrow -1 < -2$ ; no
7. a. 1  
b. 0
8. The graphs of  $x > 2$  has an open circle at  $x = 2$ , and the graph of and  $x \geq 2$  has a cross at  $x = 2$ .

**9. Exercises**

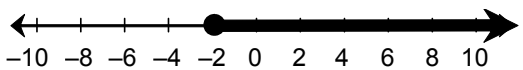
a.  $a > 5$



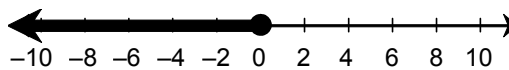
b.  $b < -2$



c.  $z \geq -2$



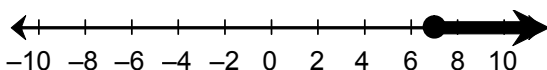
d.  $y \leq 0$



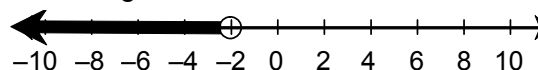
**Problem 2**

**10. Exercises**

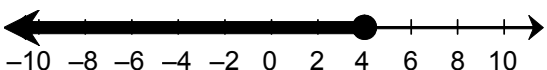
a.  $f \geq 7$



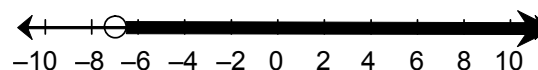
b.  $-2 > g$



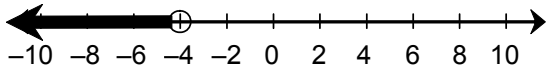
c.  $u \leq 4$



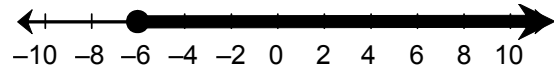
d.  $-7 < v$



e.  $-4 > h$



f.  $-6 \leq t$



**Problem 3**

11. a. yes; they have the same solutions

b. yes

12. a. yes; they have the same solutions

b. yes

13. a. no; they do not have the same solutions

b. no

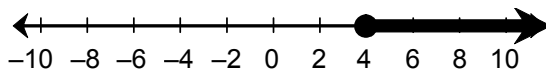
14. yes; they have the same solutions

15. a.  $\leq$     b.  $>$     c.  $<$     d.  $\geq$

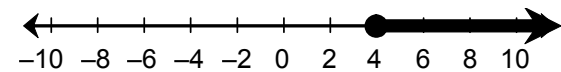
16. flip or reverse

**17. Exercises**

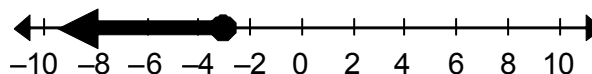
a.  $c \geq 4$



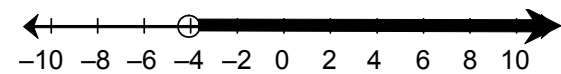
b.  $-8 > d$



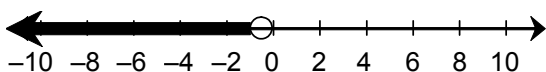
c.  $w \leq -3$



d.  $-4 < x$



e.  $d < -\frac{2}{3}$



f.  $g < 7$

