Linear Inequalities
*LINEQUA.8xp*

Name _____

Class _____

Problem 1 – Graphing a simple inequality

In this problem, you will explore and graph a simple inequality: $x \geq 4$. Press PRGM to access the **Program** menu and choose the **LINEQUA** program.
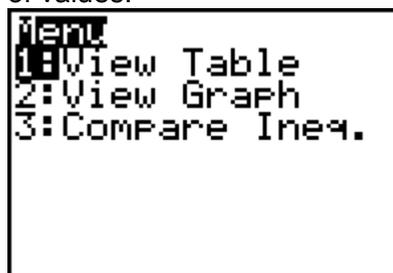
```
Left side?X
Right side?4
```

Enter the left side of the inequality, **X**, and press ENTER.

Then enter the right side of the inequality, **4**, and press ENTER.

Select an inequality symbol. Press 2 to choose ≥.

```
Inequality sign?
1:>
2:≥
3:<
4:≤
```
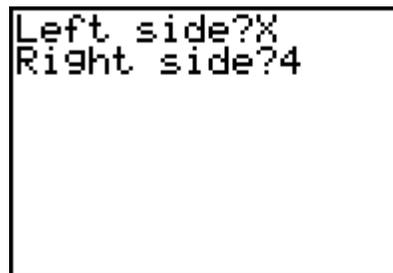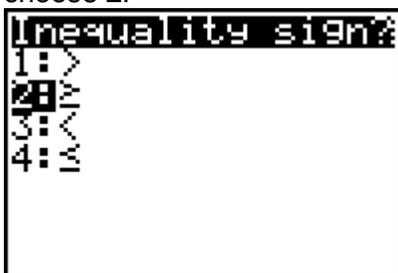
Choose **1:View Table** to see a table of values.

```
Menu
1:View Table
2:View Graph
3:Compare Ineq.
```

In the table, 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.

1. Describe the numbers in the **Y1** column. How do they compare to the *x*-values? Explain.

2. Describe the numbers in the **Y2** column. Are they affected by the *x*-values? Explain.

Now look at the fourth column, labeled **Y3**. Each entry in this column is either a 1 or a 0. Examine this column. (***Note:*** to scroll up or down, you will need to return to the **X** column, scroll, then return to the **Y3** column.)

3. **a.** For what *x*-values is there a 1 in the **Y3** column?

   b. Substitute one of these *x*-values into $x \geq 4$. Is the inequality true for this value of *x*?

4. **a.** For what *x*-values is there a 0 in the **Y3** column?

   b. Substitute one of these *x*-values into $x \geq 4$. Is the inequality true for this value of *x*?

Linear Inequalities

Press ENTER to exit the table, then press ENTER again to select **1:Another Ineq.** This time enter the inequality **x < –2**.
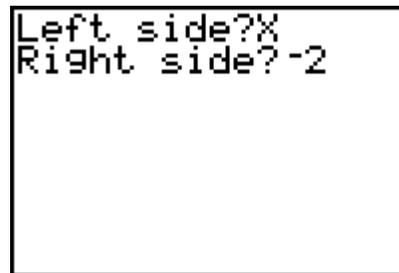
```
Left side?X
Right side?-2
```

Choose **1:View Table** from the menu. Look at each column. Again, each entry in the **Y3** column is either a 1 or a 0.

5. a. For what *x*-values is there a 1 in the **Y3** column?

b. Substitute one of these *x*-values into *x* < –2. Is the inequality true for this value of *x*?

6. a. For what *x*-values is there a 0 in the **Y3** column?

b. Substitute one of these *x*-values into *x* < –2. Is the inequality true for this value of *x*?

7. Complete each statement.

a. If the *x*-value makes the inequality <u>true</u>, the entry in the **Y3** column is _____.

b. If the *x*-value makes the inequality <u>false</u>, the entry in the **Y3** column is _____.

Now you are going to look at the graph of a simple inequality. Press ENTER and select **1:Another Ineq.** Enter the inequality **x > 2**. Choose **2:View Graph** from the menu.
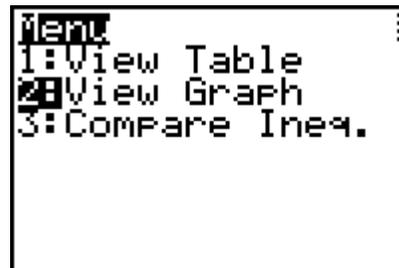
```
Menu
1:View Table
2:View Graph
3:Compare Ineq.
```

The calculator draws a line 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.
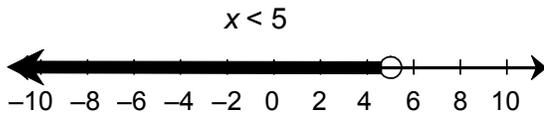
```
X>2
-8 -6 -4 -2  0  2  4  6  8
```
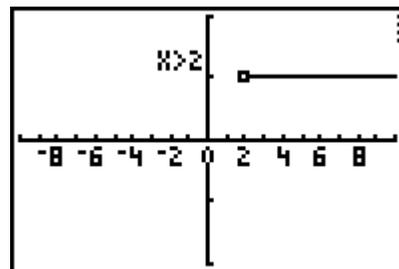
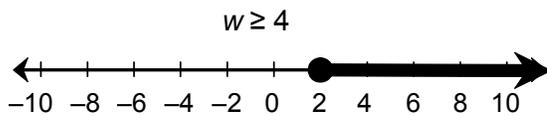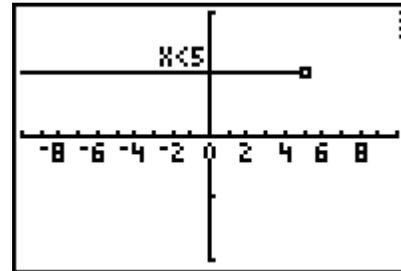Press ENTER and select **1:Another Ineq.** Graph *x* ≥ 2.

8. Describe the difference between the graphs of *x* > 2 and *x* ≥ 2.
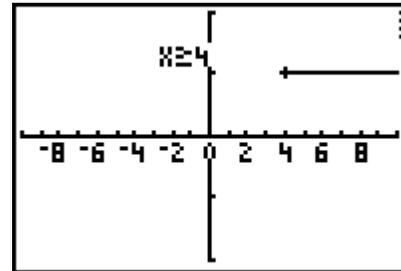
Examples

The following examples show how to sketch the graph of an inequality on paper.

$$x < 5$$

The open circle at 5 means that $x = 5$ is not a solution to the inequality. Since x is less than 5, shade to the left of the circle.
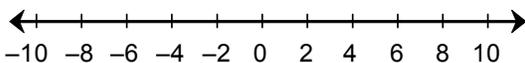

$$w \geq 4$$

The closed circle at 2 means that $x = 2$ is a solution to the inequality. Since w is greater than or equal to 5, shade to the right of the circle.
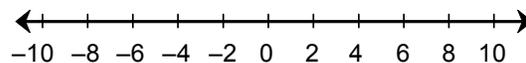

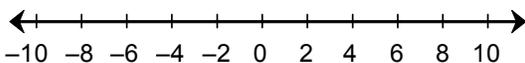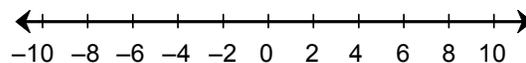**9.** Graph each inequality using your graphing calculator. Sketch the graphs here.

a. $a > 5$

b. $b < -2$

c. $z \geq -2$

d. $y \leq 0$

Problem 2 – Solving inequalities using addition and subtraction

Equivalent inequalities are inequalities with the same solutions. For example, $x - 3 > 5$ and $x > 8$ are equivalent inequalities. You can add or subtract the same number from both sides of an inequality without affecting the solutions, just as you can do with equations.

Examples

$$\begin{aligned} x - 3 &> 5 \\ x - 3 + 3 &> 5 + 3 \\ x &> 8 \end{aligned} \qquad \begin{aligned} x + 6 &\leq 10 \\ x + 6 - 6 &\leq 10 - 6 \\ x &\leq 4 \end{aligned}$$

![Texas Instruments logo] **Linear Inequalities**

You can use your calculator to check that two inequalities are equivalent. To see that $x - 3 > 5$ and $x > 8$ are equivalent, run the **LINEQUA** program. Enter the inequality $x - 3 > 5$.

```
Left side?X-3
Right side?5
Enter a new
inequality.
Left side?X
Right side?8
```

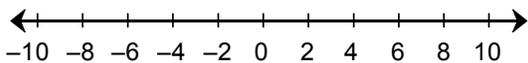Choose **Compare Ineq.** to compare this inequality to another.

Enter $x > 8$. The calculator displays the graphs of $x - 3 > 5$ and $x > 8$ on the same screen. The graphs are the same, so the inequalities are equivalent.
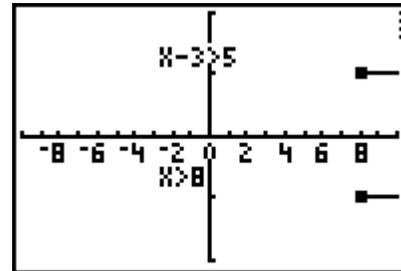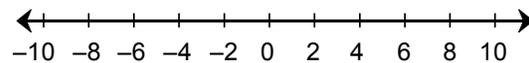
Caution: In some graphs, the open circle will appear to be filled in. This is because of the size of the pixels on the graph screen. For this reason, a "closed circle" is shown as a cross, and an "open circle" as a dot.

10. Solve each inequality. Use your calculator to compare the original inequality with the solution. Then sketch the graph of the solution.
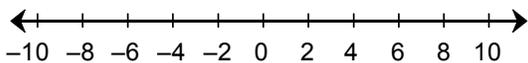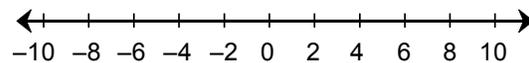
a. $f - 5 \geq 2$

```
←+——+——+——+——+——+——+——+——+——+——+→
 −10 −8 −6 −4 −2  0  2  4  6  8  10
```
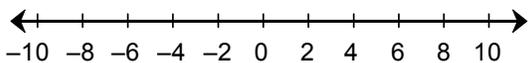
b. $-4 > g - 2$

```
←+——+——+——+——+——+——+——+——+——+——+→
 −10 −8 −6 −4 −2  0  2  4  6  8  10
```

c. $u + 1 \leq 5$

```
←+——+——+——+——+——+——+——+——+——+——+→
 −10 −8 −6 −4 −2  0  2  4  6  8  10
```

d. $1 < 8 + v$

```
←+——+——+——+——+——+——+——+——+——+——+→
 −10 −8 −6 −4 −2  0  2  4  6  8  10
```

e. $-5 > h - 1$

```
←+——+——+——+——+——+——+——+——+——+——+→
 −10 −8 −6 −4 −2  0  2  4  6  8  10
```

f. $-5 \leq 1 + t$

```
←+——+——+——+——+——+——+——+——+——+——+→
 −10 −8 −6 −4 −2  0  2  4  6  8  10
```

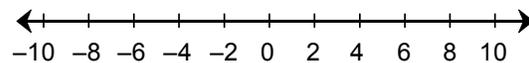**Problem 3 – Solving inequalities using multiplication and division**

Use your calculator to compare the following sets of graphs.

11. a. Are $\dfrac{x}{5} \leq -1$ and $x \leq -5$ equivalent inequalities? Explain.

b. Can you multiply both sides of an inequality by 5 without changing its solutions?

12. a. Are $4x > 8$ and $x > 2$ equivalent inequalities? Explain.

b. Can you divide both sides of an inequality by 4 without changing its solutions?

13. a. Are $-x > 4$ and $x > -4$ equivalent inequalities? Explain.

    b. Can you multiply both sides of an inequality by -1 without changing its solutions?

14. Are $-x > 4$ and $x < -4$ equivalent inequalities? Explain.

15. Compare graphs to find the inequality symbol that makes each pair of inequalities equivalent.

a. $\dfrac{v}{-4} \geq 2$ v _____ -8 **b.** $-\dfrac{d}{3} < -3$ d _____ 9

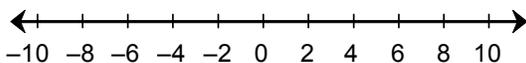**c.** $-2h > -2$ h _____ 1 **d.** $-5r \leq 10$ r _____ -2

16. *Complete the statement:* If you multiply or both sides of an inequality by a negative number, you must _____ the inequality sign to get an equivalent inequality.
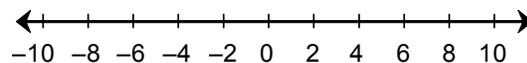
To solve an inequality using multiplication or division, multiply or divide both sides of the inequality by the same number. ***However***, if you multiply or divide both sides by a **negative** number, you must reverse the inequality symbol to obtain an equivalent inequality.

17. Solve each inequality. Use your graphing calculator to compare the original inequality with the solution. Then sketch its graph.
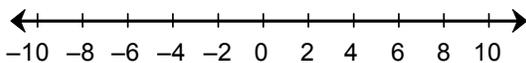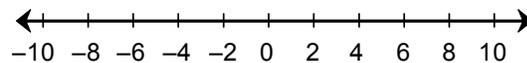
a. $\dfrac{c}{4} \geq 1$

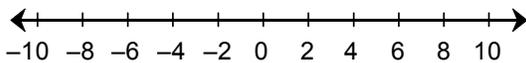**b.** $2 < -\dfrac{d}{4}$

c. $3w \leq -9$

d. $20 > -5x$

e. $18d < -12$

f. $-\dfrac{5}{7}g > -5$