EXPLORATIONS ™

Activity 1

Objectives

- Write and interpret a linear equation and an inequality with two variables
- Use the Inequality Graphing App to graph linear inequalities with two variables in the coordinate plane

Winning Inequalities (Part 1)

Introduction

A day at an amusement park is full of excitement. Roller coasters flip, dip, and twirl you around. Remember when roller coaster thrills were off limits to you because you were not yet tall enough to meet the height requirement? Amusement parks require that a person must be at least 48 inches tall in order to ride roller coasters.

You can represent "at least" or "at most" situations with mathematical inequalities. In this exploration, you will write an inequality using two variables. You will also graph two-variable inequalities in a Cartesian coordinate plane.

Problem

During a basketball game, teams receive one point for free throws scored, two points for field goals, and three points for long-range field goals. In last weekend's game, the Shooting Stars scored a total of 60 points from field goals, both regular and long-range.

How many of each type of field goal did the Shooting Stars possibly make? Write a linear equation that represents this situation.

_____

How would your equation change if the Shooting Stars had scored more or less than 60 points?

_____

_____

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Exploration

1. Let x represent the number of 2-point field goals scored by the Shooting Stars and y represent the number of 3-point field goals scored by the Shooting Stars.

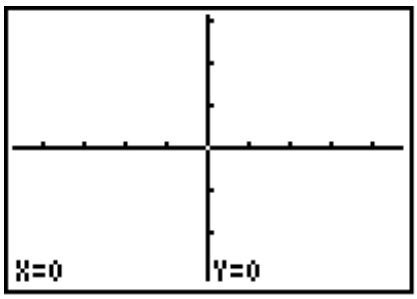
   Write an equation that represents the total points scored from field goals in last weekend's game: _____

2. Rewrite this equation in slope-intercept form ($y = mx + b$): _____

   What is the slope? _____ What is the y-intercept? _____

3. Clear all equations in the **Y=** editor of the graphing handheld. Press ▲ or ▼ to highlight the equation, and then press [CLEAR]. Also, be sure that all plots are turned off. Because x and y refer to the number of baskets scored, you will use integer values for both.

4. Set a viewing window with integer values by pressing [ZOOM] **8** to select **8:ZInteger**. Check that $x = 0$ and $y = 0$. (This indicates that the viewing window will be centered at the origin.) Press [ENTER].

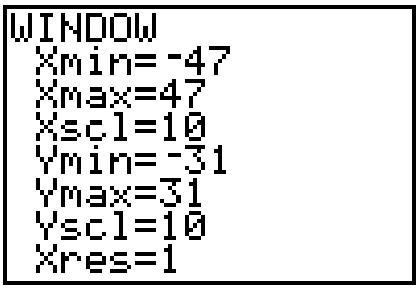


5. Press [WINDOW] and enter the values shown.

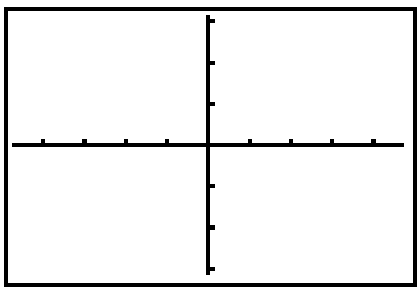
   Do these maximum and minimum x and y values show an appropriate viewing window for the basketball problem? Explain your thinking.

   _____

   _____



6. Enter the slope-intercept form of your equation in the **Y=** editor of your graphing handheld. To do so, press [Y=]. At **Y=** enter your equation. Press [GRAPH]. Sketch the graph that you see on your screen.



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7. You can use the **TRACE** feature on the graphing handheld to complete a table of values that represent possible solutions. Press [2nd] [FORMAT] to access the **FORMAT Menu**. Select **CoordOn**. Press [TRACE].

The coordinates $x = 0$ and $y = 20$ should appear on the screen of your graphing handheld. What do these values represent with respect to the basketball problem?

$x =$ _____ $y =$ _____

These values have been recorded in the table shown.

Next, you will find other values to complete the table.

x	0										
y	20										

8. Press [▶] to trace to $x = 1$. What is the corresponding y-coordinate? _____

Does this ordered pair represent a solution to the problem? Why or why not?

_____

_____

If it does, add this ordered pair to the table of values.

Continue tracing the integer values for x, from $x = 2$ through $x = 30$. Record all the ordered pairs that are possible solutions to the basketball problem in the table of values above.

The set of all x-coordinates in a function is the domain. The set of y-coordinates in a function is the range. Use your completed table of values to list the domain and the range of the function that represent the basketball problem.

Domain: _____

Range: _____

From the table, you can see that as the y-values decrease by 2, the x-values

_____.

Would you describe the relationship between the x-values and the y-values as a constant or variable? What type of function exhibits this characteristic?

_____

_____

_____

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Describe this relationship in terms of the number of 3-point field goals and the number of 2-point field goals.

_____

_____

9. In step **2** you determined that the *y*-intercept for this linear relationship is (0, 20). What is the significance of this point?

_____

_____

_____

10. Press ▶ to trace to $x = 36$. What is the corresponding *y*-value? _____

Verify algebraically that these coordinate points satisfy the equation from step **1** by substituting the *x*- and *y*-values into the equation.

The ordered pair (36, ⁻4) satisfies the equation in step **1**. Can it be a solution to the basketball problem? Explain why or why not.

_____

_____

_____

_____

Identify three ordered pairs that satisfy the equation but are not solutions to the problem.

_____

_____

_____

11. In their next game, the Shooting Stars want to score at least 60 points from field goals. Rewrite the equation from step **1** as an inequality to show this situation.

_____

Write this inequality in slope-intercept form:

_____

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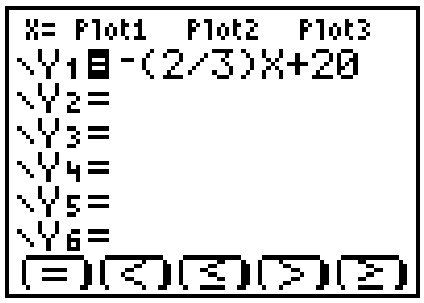
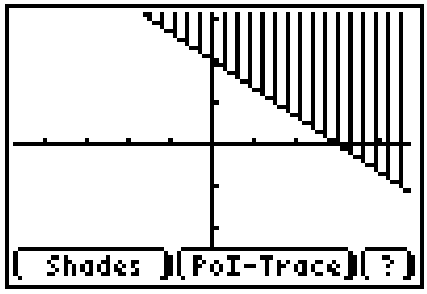
12. Use the Inequality Graphing App to graph your inequality. Press APPS. Select **Inequalz**. Press ENTER and then press any key to continue. The equation you entered in step **2** is displayed. At the bottom of the screen, you should see the equal sign and four inequality signs.



13. Highlight **=** next to your equation. Press ALPHA [F5] to replace the **=** with the "greater than or equal to" symbol (≥).

14. Press GRAPH. (The **Shades** and **PoI-Trace** buttons appear. You will learn about these features in later activities.)



Describe the graph. How does it show that the Shooting Stars scored at least 60 points from field goals?

_____

_____

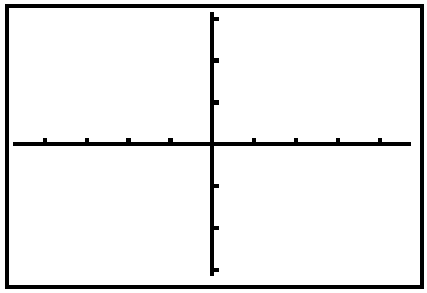
15. Use the cursor keys to navigate about the viewing window. (Press GRAPH to deactivate the **TRACE** feature, if necessary.)

Select a point from the shaded portion of the graph and record the coordinates:

_____

Verify algebraically that the point satisfies the inequality from step **11** by substituting the *x*- and *y*-values into the inequality.

16. Change the inequality in the **Y=** editor to $2x + 3y > 60$. (Be sure to change the inequality to the slope-intercept form.) Sketch the graph on the grid. How does the graph change?



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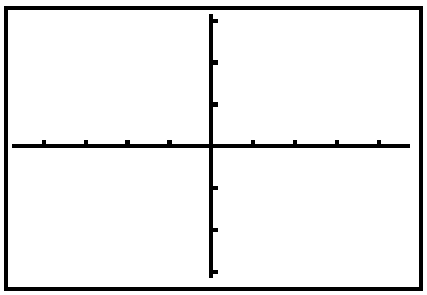
17. Change the inequality to $2x + 3y < 60$. Sketch the graph in the grid. How does the graph change?



18. Verify your graphs using the Inequality Graphing App. Enter each inequality in the **Y=** editor and press GRAPH.

How closely do your sketches match the graphs from the Inequality Graphing App?

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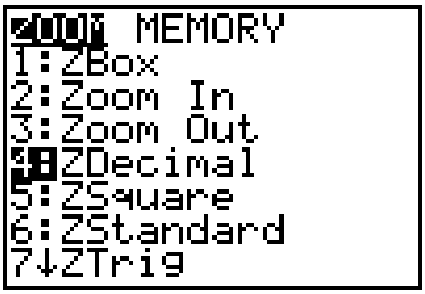
Student Worksheet

Name _____

Date _____

Match each graph with its corresponding inequality. The **ZDecimal** viewing window was used to create all the graphs on this worksheet.

Press [ZOOM] **4** to select **4:ZDecimal** and display the graph.

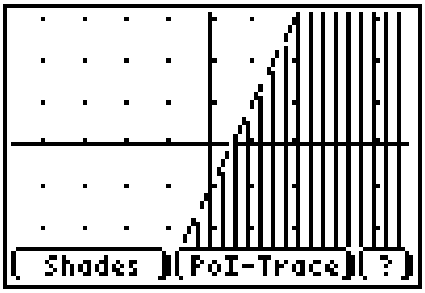


In addition, the grid was turned on to provide a visual guide. Press [2nd] [FORMAT] to access the **FORMAT Menu**.

In Questions **1**, **2**, and **3**, match the graph with its corresponding inequality from choices **A–D**.

A. $y > 2x - 1$
B. $y \geq 2x - 1$
C. $y < 2x - 1$
D. $y \leq 2x - 1$

1. _____



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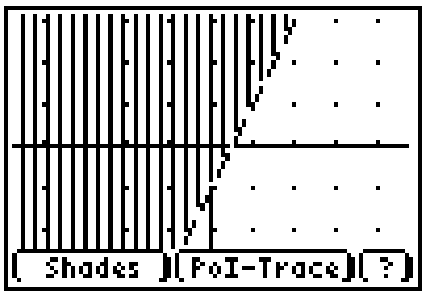
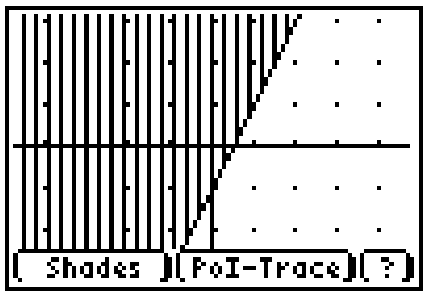
2. _____

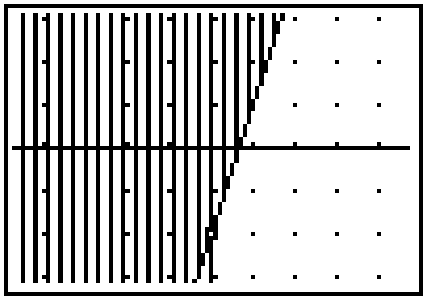


3. _____

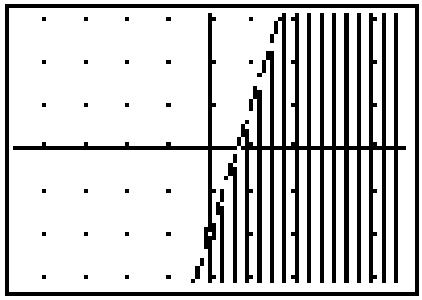


For Questions **4–11**, write the linear inequality that was most likely used to generate each graph. Use the Inequality Graphing App to check your solution.

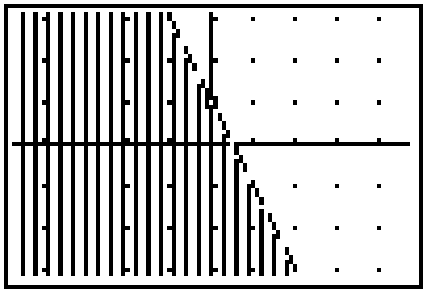
4. _____



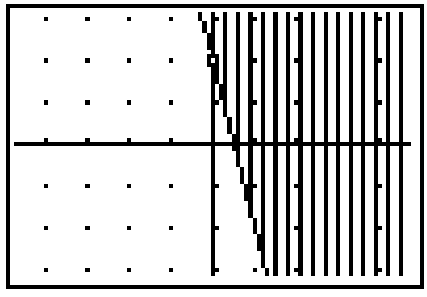
5. _____



6. _____



7. _____



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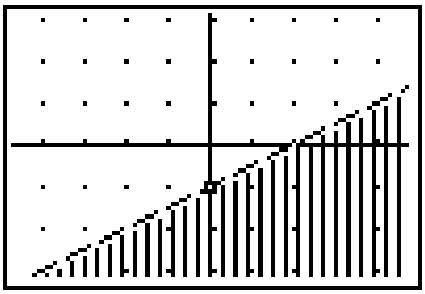
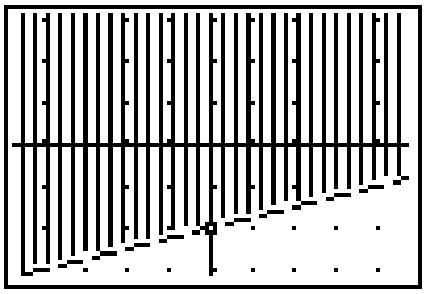
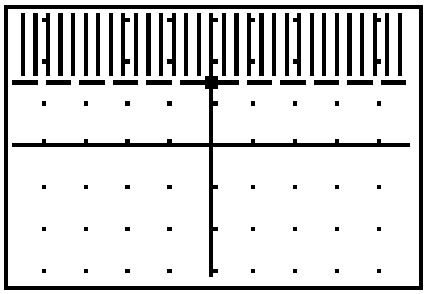
8. _____



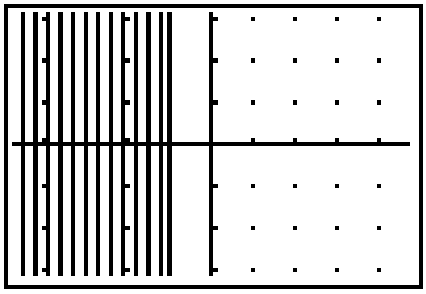
9. _____



10. _____



11. _____

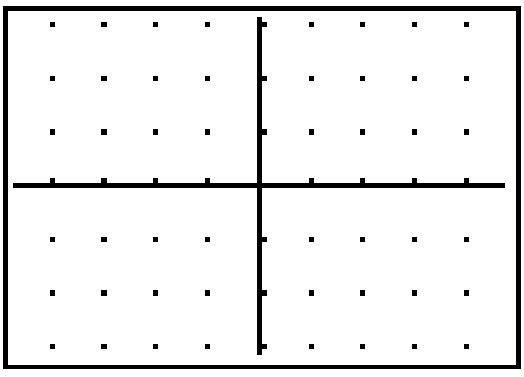


12. Given $y > -x + 2$, state the slope and y-intercept.

slope: _____

y-intercept: _____

Graph $y > -x + 2$ in the grid provided.



13. Explain the process you can use to determine which half-plane of an inequality's graph should be shaded.

_____

_____

_____

_____

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Teacher Notes

Activity 1

Winning Inequalities (Part 1)

Objectives

- Write and interpret a linear equation and an inequality with two variables
- Use the Inequality Graphing App to graph linear inequalities with two variables in the coordinate plane

Materials

- TI-84 Plus/TI-83 Plus
- Inequality Graphing application

Teaching Time

- 60 minutes

Prerequisite Skills

- Writing equivalent forms of linear equations in two variables
- Graphing linear equations in the coordinate plane
- Identifying slope and *y*-intercept of a linear function

Getting Started

Initiate a discussion about inequalities by asking the students to think of other situations that require set minimums or maximums. Have them show their understanding of inequalities by representing different situations using inequalities. For example, students should understand that $h \geq 48$ could be used to represent the minimum height requirement for riding a roller coaster.

Management

Give students time to think about the problem before you distribute the handouts for the activity. A follow-up class discussion will lead to the conclusion that there is more than one ordered pair that represents this situation. The Exploration section of the activity assists students with writing and graphing linear inequalities in two variables that model situations similar to the basketball problem.

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Notes about Exploration

This portion of the lesson has been written to allow for independent student exploration. Depending on student skill level and content familiarity, however, teachers may wish to provide guidance, as needed. (For example, students may experience difficulty with setting the integer viewing window in step **4**.) Teachers may prefer to have students complete only a few items at a time. This would allow for an opportunity to engage in discussions during the activity to assess student understanding.

Steps **7** and **8** provide an opportunity to introduce the concepts of discrete versus continuous sets in an Algebra 1 setting.

Step **10** highlights the difference between solutions to an algebraic representation, such as an equation, and solutions which pertain to a given problem situation.

Step **11** should be a teacher-led class discussion and demonstration. With your monitoring and guidance, students can then reinforce these concepts in steps **16** and **17**.

Lesson closure should emphasize the notation used to indicate exactly 60 points (= 60), 60 or more points (≥ 60), and fewer than 60 points (< 60).

Answers to the Exploration Questions

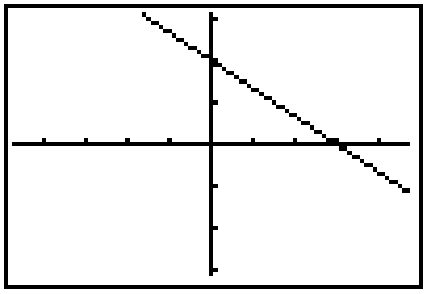
1. $2x + 3y = 60$

2. $y = \frac{-2}{3}x + 20$

slope: $\frac{-2}{3}$ *y*-intercept: 20

3. Possible solution: No, since only positive integer values make sense to represent field goal points.

6.



7. *x* = zero 2-point field goals *y* = twenty 3-point field goals

x	0	3	6	9	12	15	18	21	24	27	30
y	20	18	16	14	12	10	8	6	4	2	0

8. $y = 19.33\overline{3}$

This ordered pair is not a solution to the problem because it is not possible to score a partial field goal.

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Domain: {0, 3, 6, 9, …, 30}; Range: {0, 2, 4, 6, …, 20}

The *x*-values increase by 3.

The relationship is constant. The function is linear.

For every two 3-point field goals that the team misses, they need to score three 2-point field goals in order to reach 60 points.

9. If the Shooting Stars do not score any 2-point field goals, they must make 20 3-point field goals to reach a total of 60 points.

10. $y = -4$

$2(36) + 3(-4) = 60$

$72 + -12 = 60$

$60 = 60$

No, it cannot be a solution because it is not possible to score a negative number of field goals.

Answers will vary. For example, pairs of coordinates with negative integers or fractions would not be solutions to the problem.

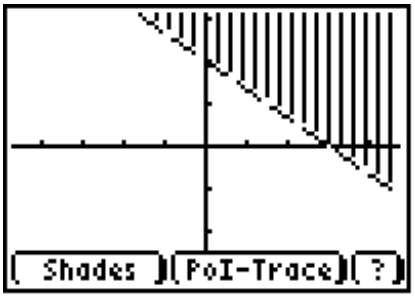
11. $2x + 3y \geq 60$

$y \geq \frac{-2}{3}x + 20$

14. The graph has a solid line and a shaded region. The solid line indicates that the ordered pairs that lie on the line are part of the solution set. The shaded region includes all the integer points that would result in scores greater than 60.

15. Answers will vary.

16.



The line is a dotted line, indicating that those ordered pairs that lie on the line are not part of the solution set.

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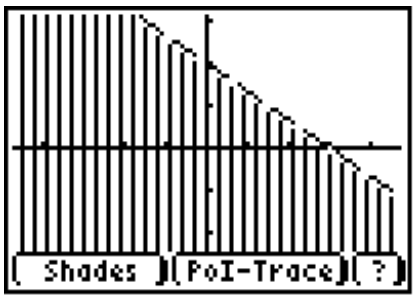
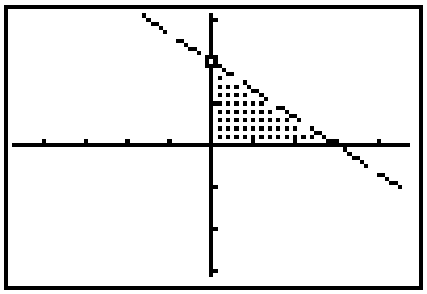
17.



The shaded area is on the opposite side of the dotted line.

In actuality, because the number of field goals made cannot be negative, student-drawn graphs may look like the graph shown.



18. Answers will vary.

Answers to Student Worksheet

1. **C**
2. **A**
3. **B**
4. $y \geq 3x - 2$
5. $y < 3x - 2$
6. $y < -2x + 1$
7. $y \geq -4x + 2$
8. $y < 0.5x - 1$
9. $y > 0.25x - 2$
10. $y > 1.5$
11. $x \leq -1$

Note about Question 11: *Students may be unfamiliar with the* **X=** *screen and may need help finding it. The first step in this process is to clear out any equations or inequalities entered in the* **Y=** *editor. Next, move the cursor up to the* **X=** *icon at the top of the screen. Press* ENTER*. Enter the appropriate equation or inequality.*

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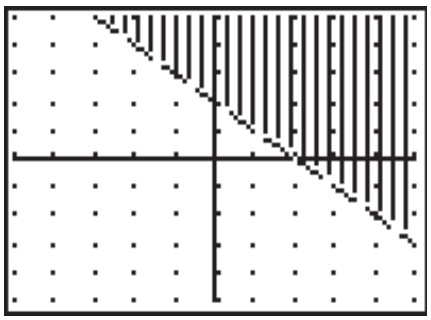
12. slope: -1 *y*-intercept: 2



13. Answers will vary. Encourage students to select a point that does not lie on the boundary line of this graph. The coordinates of the selected point are substituted for the corresponding *x*- and *y*-values in the inequality.

Possible solution: By selecting a point not on the boundary line and substituting it into the inequality, I could tell which half-plane should be shaded. If the resulting statement is true, the half-plane containing this selected point will be shaded. If the resulting statement is false, the other half-plane will be shaded.

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