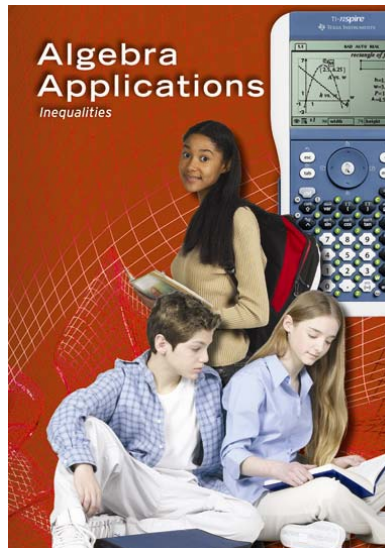




## ALGEBRA APPLICATIONS

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### Inequalities



# Teacher's Guide

## Series Overview

The *Algebra Applications* series brings real-world, relevant applications of algebra to today's classroom. This series also integrates technology through the use of the Texas Instruments TI-Nspire graphing calculator. The key features of this series include:

- Guided applications that are interdisciplinary and can be done as an in-class group activity.
- All keystrokes are clearly shown.
- Dynamic footage and animations bring math to life.
- Math concepts are developed clearly, making this series an ideal supplement to an Algebra 1 or Algebra 2 class.




















## Program Overview

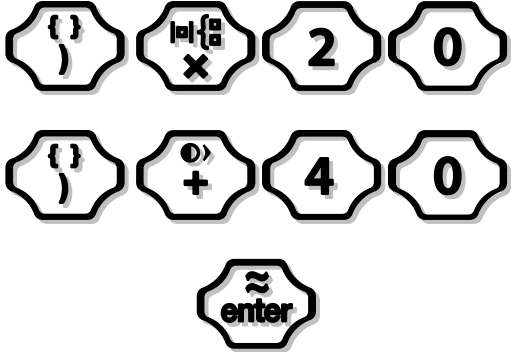
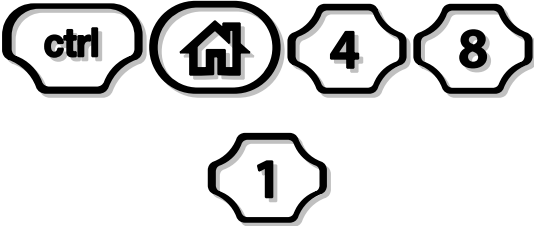
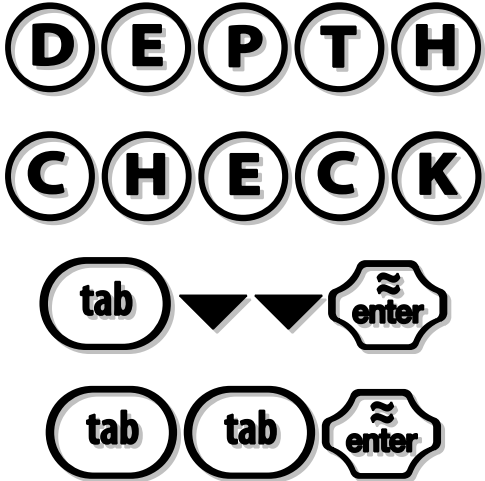

In this episode of Algebra Applications, two real-world explorations are developed:

- **The Floods in Venice.** The city of Venice is slowly sinking into the Adriatic Sea. So what does a city whose streets are full of water do about flooding? Venice experiences a great deal of flooding, and with the expected rise of sea levels over the next century, this ancient city is in peril. Through a series of inequalities, students analyze the impact of flooding, rising sea levels, and sinking have on this grand, ancient city. Students use the Lists and Spreadsheets and the Program Editor features of the TI-Nspire.
- **Hybrid Cars.** With the increasing demand worldwide for cars, the cost of gasoline continues to rise. The need for fuel-efficient cars makes hybrids a current favorite. An examination of the equations and inequalities that involve miles per gallon (mpg) for city and highway traffic reveals important information about hybrid cars and those with gasoline-powered engines. Students use the Graphs and Geometry features of the TI-Nspire.

## Application 1: Flood Control


In this application, students investigate the creation of a flood-control program. The particular example is the city of Venice, which experiences a lot of flooding. The city is building a massive floodgate that is activated if the water level rises above a certain distance. Students use the Program Editor of the TI-Nspire, along with a random number generator in the spreadsheet to test the program.

TI-Nspire Keystrokes	
Turn on the <i>N</i> spire.	
Press the home key followed by 6, or <b>ctrl N</b> to open a new document.	  OR  
A previous document may be open: if so, a prompt will ask if you wish to save the document. Click to choose “yes” or press tab then click to choose “no.”	 OR  
Press 3 to create a spreadsheet window.	
Create a random variable function in cell A1. This randomly generates a number in the range of 40 to 60.	         

	
<p>We now need to create a function that tests different iterations of the random variable to see if it has passed a threshold level.</p> <p>Press Ctrl, Home, 4, 8, and 1 to activate the Program Editor.</p>	
<p>At the dialogue box create a function called depthcheck, as shown.</p> <p>Press Tab, the Down arrow twice, and Enter to select Function</p> <p>Press Tab twice to select the OK button and press Enter.</p>	
<p>The depthcheck function will take an input value and evaluate it. So input the letter A as shown and press down arrow key.</p>	
<p>A Function always returns a value or an expression. So, we define the function so that it evaluates the input value <b>a</b> and returns a message to either</p>	

raise the floodgate or not.

For our floodgate, suppose that when **a** is greater than or equal to 55, the gate needs to go up. Otherwise, the gate stays down.

Input the If statement with the inequality as shown. Be sure to use the space key  between the If and the variable A and elsewhere as shown.

**I F L A >**

**= 5 5 **

**R E T U R**

**N L " G A**

**T E L U P**



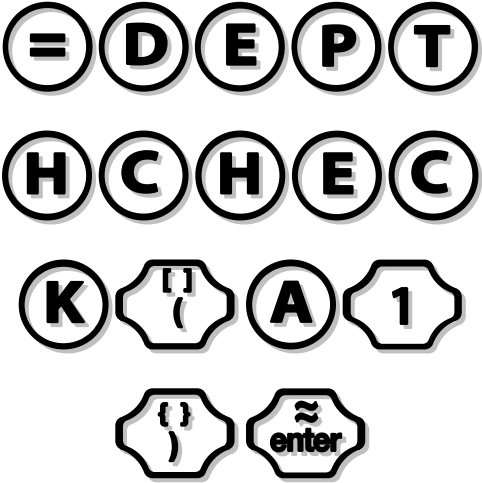

**"  **

**R E T U R**

**N L " G A**

**T E L D O**

**W N "**

<p>Once the function is defined, press Ctrl B to save it. Use this command any time you make changes to the function.</p>	
<p>The function will evaluate the input and will determine if the floodgate comes up or stays down. A function like this can be used in a computer program that controls the floodgate mechanism. Let's test this function with the spreadsheet value.</p> <p>Press Ctrl and the Left Arrow to activate the spreadsheet window. Make sure that cell A2 is the active cell.</p>	
<p>Input the newly defined function <b>depthcheck</b> and have it evaluate the value in cell A1, where the random variable is generated. Press Enter.</p>	
<p>Press Ctrl and R several times to test different values.</p> <p>You'll notice that for the most part the gate stays down, and comes up only on rare occasions. This is an accurate model of how the floodgate system would work, only in the infrequent cases where a severe storm is expected to cause flooding.</p>	

## Assessment

Use the program you created to answer the following questions.

1. Conduct 100 trials using the spreadsheet. Record your data in a frequency table.

Flood	No flood

- a. How many times did it flood?
- b. Use the following formula to calculate the probability of a flood.

$$\frac{\text{Number of floods}}{\text{Number of floods} + \text{Number of non-floods}} \times 100\%$$








- c. Suppose in a given year there were five floods. Is this above or below expectation?

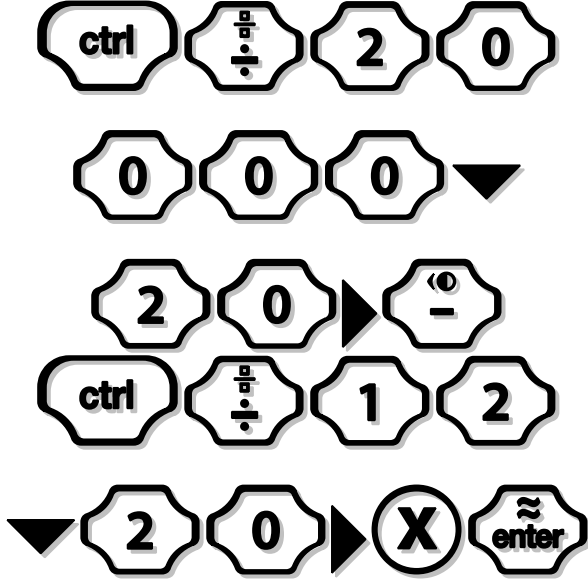
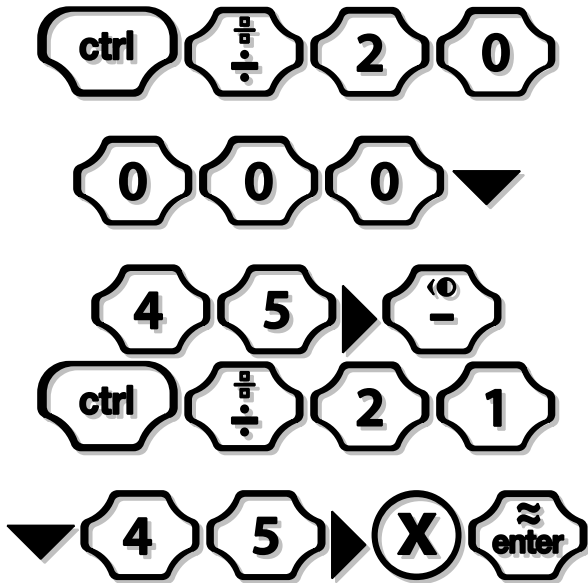


## Application 2: Hybrid Cars

In this application, students investigate equations and inequalities relating the miles per gallon (mpg) for hybrid cars and traditional gas-engine cars. The problem students investigate is the following:

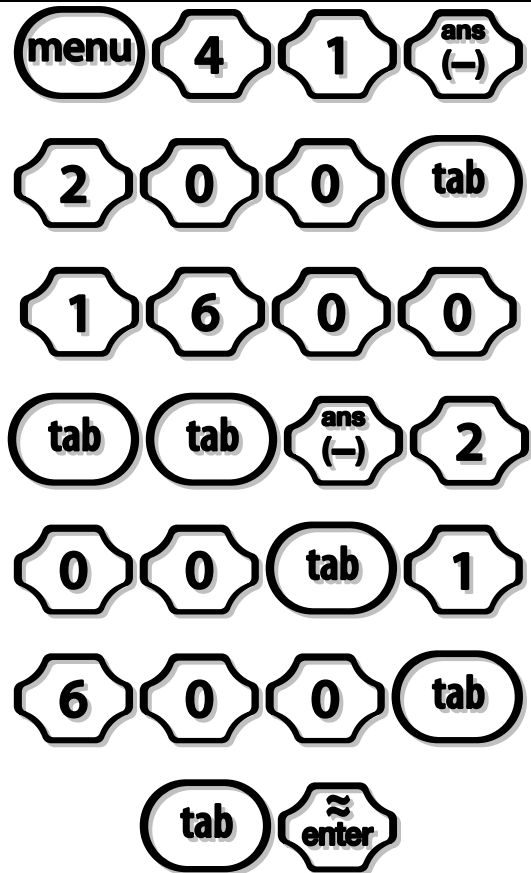
What combination of city and highway driving will allow the owner of a gasoline-powered car to not spend more than the owner of a hybrid car that travels 20,000 miles in one year?

This is an open-ended problem with many solutions. Students use the TI-Nspire to construct a mathematical model for comparing mpgs for each type of car.

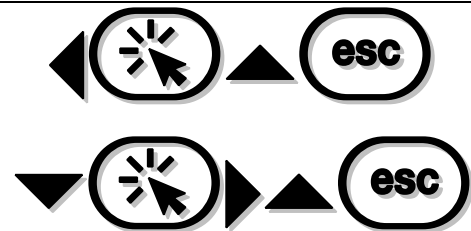
TI-Nspire Keystrokes	
Turn on the Nspire.	
Press the home key followed by 6, or <b>ctrl N</b> to open a new document.	 OR 
A previous document may be open: if so, a prompt will ask if you wish to save the document. Click to choose “yes” or press tab then click to choose “no.”	 OR 
Press the home key and 6 to create a new document. You may need to save a previous document.  Press 2 to create a graph window.	 

<p>The cursor is on function f1. Input the first function:</p> $y = \frac{20,000}{20} - \frac{12}{20}x$ <p>Press Ctrl and the division key to create a fraction placeholder. Use the down arrow to move to the denominator. Press Enter to graph.</p>	
<p>At the f2 entry screen, input the second function.</p> $y = \frac{20,000}{45} - \frac{21}{45}x$ <p>Again, press Ctrl and the division key to create a fraction placeholder. Press Enter to graph.</p>	
<p>Notice that the graph window is empty. The graphs are there but are not visible. Change to window settings by pressing Menu, 4, and A for the Zoom Fit option.</p>	
<p>Press Ctrl G to hide the entry area.</p>	

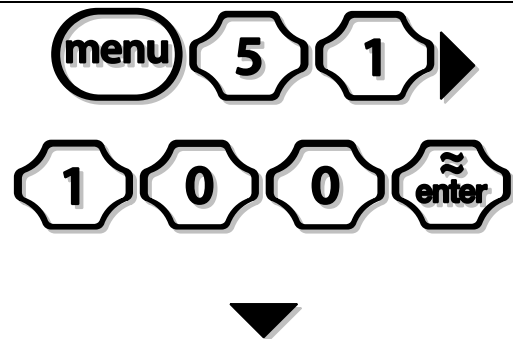
Now that you can see the graph, you can further refine the window settings by pressing Menu, 4, and 1. Change X min and Y min to -200 Xmax and Ymax to 1600. Press tab to move from one field to another. Press Enter after you have tabbed to the OK button.


























Clear up the screen. Use the NavPad to hover over the text of the equations. Press and hold the click key till the open becomes a closed hand. Use the NavPad to drag the label to the upper part of the screen. Repeat with the other equation label.



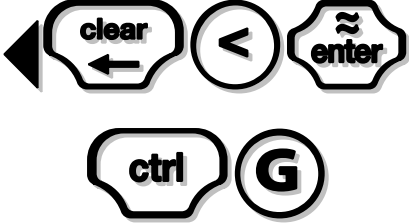






















Now, press Menu, 5, and 1 to activate Trace. Use the NavPad to slide the pointer to the right to see different values for x and y. Input 100 to see what the value is. Press the down arrow to see the corresponding values for the other function, the one representing the hybrid car.























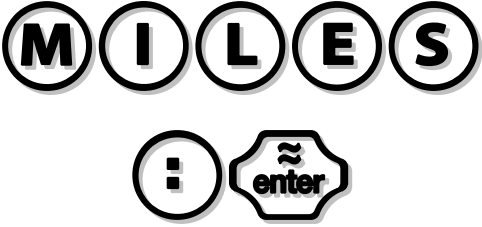
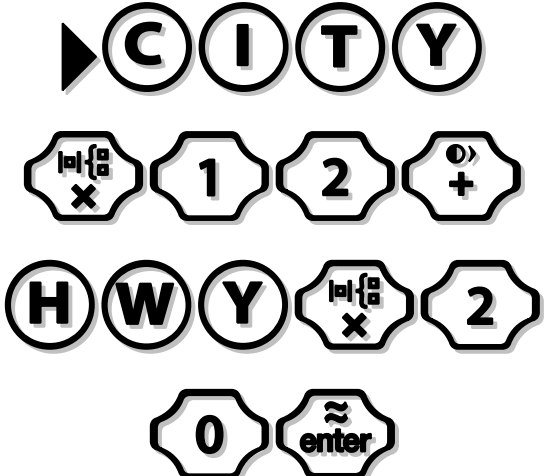






<p>For each graph the sum of the x and y values is the total amount of gasoline needed to get to 20,000 miles. Let's track how these x and y values change.</p> <p>We'll add a point to each line and track its coordinates.</p> <p>Press Menu, 6, and 2. Use the NavPad to move the pointer above the first graph. Press Enter to place the point.</p>	 <p>(Use    to move the pointer over the first graph.)</p> 
<p>Now assign variables to the x and y coordinates. Use the NavPad to hover over the x-coordinate. Press the Var key, and select Store, and assign this value to the variable a. Press Enter.</p> <p>Repeat with the y-coordinate. Assign its values to variable b. Press Enter.</p>	 
<p>Press the Tab key to go to the function entry line. Input the function <math>a + b</math> and press Enter. Then press Esc.</p> <p>This horizontal line tracks the total amount of gas used for all the possible scenarios, where the gasoline-powered engine travels 20,000 miles.</p>	 
<p>Use the NavPad to hover over the point. Hold the Click key to highlight it.</p> <p>Now use the left and right arrows to move the point. Notice how the horizontal line moves up or</p>	<p>(Use    to move the pointer over the point.)</p> <p>(Press and hold  to highlight the point.)</p> 














<p>down. As you move the point to the left, the amount of city driving decreases, which means the amount of highway driving increases. As you move to the right, the amount of city driving increases, and since this has a lower mpg, then you will need more fuel to reach 20,000 miles.</p>	
<p>Now compare the situation with the hybrid car. Press Menu, 6, and 2 to access the point tool. Use the NavPad to move to the second graph. Add the point by pressing Enter.</p>	<p></p> <p>(Use  to move the pointer over the second graph.)</p> <p></p>
<p>Hover over the x coordinate. Store this value into the variable c. Press Enter.</p>	<p></p>
<p>Hover over the y coordinate. Store this value into the variable d. Press Enter.</p>	<p></p>
<p>Press Tab to go the function entry line. Input the function <math>c + d</math> and press Enter.</p> <p>Press Esc and use the NavPad to hover over the second point to highlight it. Slide the point across the line to see the graph of the total amount of gasoline needed change.</p>	<p></p> <p></p> <p>(Use  to move the pointer over the point.)</p> <p>(Press and hold  to highlight the</p>

	<p>point.)</p> 
<p>Suppose this driver has decided to keep his or her gasoline engine car for another two years before switching to a hybrid car. The driver doesn't want to drive more than 20,000 miles. Let's examine some scenarios involving inequalities.</p> <p>Press Ctrl G to bring back the function entry line.</p> <p>Use the up arrow to bring up the f1 function.</p>	
<p>Use the left arrow key and the Clear button to delete the = sign. Replace it with the less than symbol and press Enter.</p> <p>Press Ctrl G when you are done.</p>	
<p>This inequality makes many more scenarios available for the driver of the gasoline engine car. Let's investigate these scenarios by adding a point.</p> <p>Press Menu, 6, 1. Use the NavPad to place a point in the shaded region.</p>	 <p>(Use  to move the pointer over the shaded region.)</p>

<p>Display the coordinates of the point. Press Menu, 1, and 7. Use the NavPad to hover over the point and Press Enter to see the coordinates.</p>	 <p>(Use    to move the pointer over the point.) </p>
<p>Link these coordinates to two new variables. Use the NavPad to hover over the x coordinate. Press the Var key and store the value of the x coordinate in variable e. Press Enter.</p> <p>Do the same for the y-coordinate. Store the value of the y-coordinate in variable f. Press Enter.</p>	<p>(Use    to move the pointer over the x-coordinate.)</p>  <p>(Use  to move the pointer over the y-coordinate.)</p> 
<p>Press Ctrl G to bring back the function entry line.</p>	
<p>Input the function <math>e + f</math> and press enter.</p>	
<p>Clean up the screen by hiding some of the items.</p> <p>Click on the items you want to hide. These items will grey out. After you press Esc, they will be hidden from view.</p>	 <p>(The pointer changes to  Use    to move the pointer over the</p>

	<p>item you wish to hide. Press . The item will grey out. Repeat for all items you wish to hide.)</p> <p></p>
<p>Now you are ready to explore different scenarios.</p> <p>Use the NavPad to hover over the point that represents the amount of gasoline used for less than 20,000 miles. Press and hold the Click key until the open hand turns into a closed hand.</p> <p>Use the NavPad to move the point to different positions. Notice how the graph of f5 changes. There are a number of scenarios that allow this driver to use nearly as much as gasoline as the hybrid.</p>	<p>(Use     to move the pointer over the third point.)</p> <p>(Press and hold  until  changes to  )</p> <p>(Use     to move the point.)</p>
<p>But what is the impact on the amount of mileage traveled?</p> <p>You can create a formula to track the mileage.</p> <p>Press Menu, 1, 6 to activate the Text Tool. Use the NavPad to move to the top of the screen and input the following text label.</p> <p>Miles:</p> <p>Press Enter.</p>	<p>  </p> <p>(Use     to move the pointer to the top of the screen.)</p>

	
<p>Use the right arrow to move the pointer and create this second text window.</p> <p style="text-align: center;"><math>\text{City} \times 12 + \text{Hwy} \times 20</math></p> <p>This is a formula for calculating the total number of miles traveled for the gasoline-powered car. Link this formula to the coordinate of our point in the shaded region.</p>	
<p>Press Menu, 1, and 8 to activate the calculation tool.</p>	
<p>Use the NavPad to hover over the formula. Press Enter.</p>	<p>(Use  to move the pointer over the formula.)</p> 
<p>Use the NavPad to hover over the x coordinate of the point. Press Enter.</p> <p>Repeat for the y coordinate.</p>	<p>(Use  to move the pointer over the x-coordinate of the third point.)</p>  <p>(Use  to move the pointer over the y-coordinate.)</p>

<p>Press Esc.</p>	 
<p>Now start moving the point to different locations in the shaded region.</p> <p>Notice how the total number of gallons changes, as does the total number of miles traveled.</p> <p>Since the point is in the shaded region, the driver will travel less than 20,000 miles, but this model allows you to find scenarios in which the amount of gasoline used is comparable to the of the hybrid car, while the total number of miles traveled is not too low.</p>	<p>(Use     to move the pointer over the point.)</p> <p>(Press and hold  until  changes to  )</p> <p>(Use     to move the point.)</p>

### Assessment

Use the inequality model to answer the following questions. Assume the hybrid car travels 20,000 miles in one year.

1. How much more gasoline will the gasoline-powered car use to travel 20,000 miles? What is the least amount of overage?
2. How many gallons of fuel will the gas-powered car use if it travels 20,000 miles? Provide a range of possible values.
3. Describe a scenario in which the gas-powered car travels close to 20,000 miles while spending less on fuel than the hybrid car.