

Building Big Macs

Student Hand-out

Opening Explanation

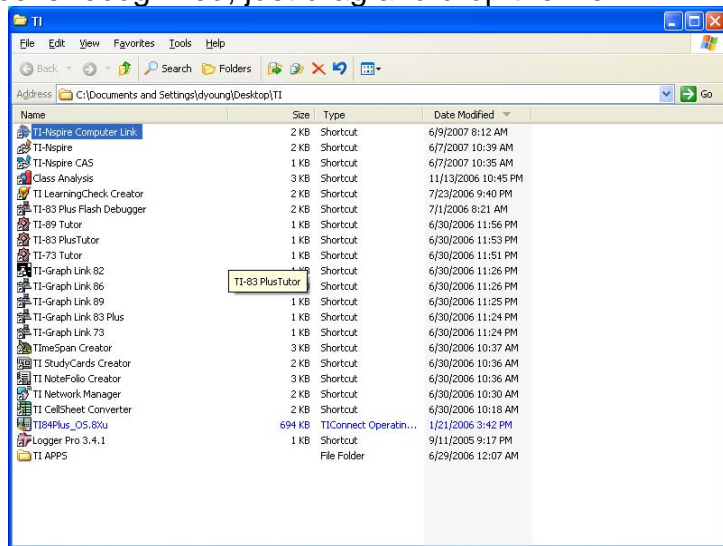
In this investigation we will explore the nature of a reaction from the POV (point of view) of the ingredients. When chemicals mix to form compounds they don't always match in such a way that all ingredients are used. In some cases you use all of one element and leave some of the other, or in some cases you have a little of each left because you don't have enough left to combine to make another molecule of the compound. This part of chemistry is called Stoichiometry and includes some of the mathematics that you have learned in the past.

To set the stage for your experiences with chemicals we will simulate a reaction from the context of a Big Mac. The ingredients (elements) we will be interested in are Bread and Meat.

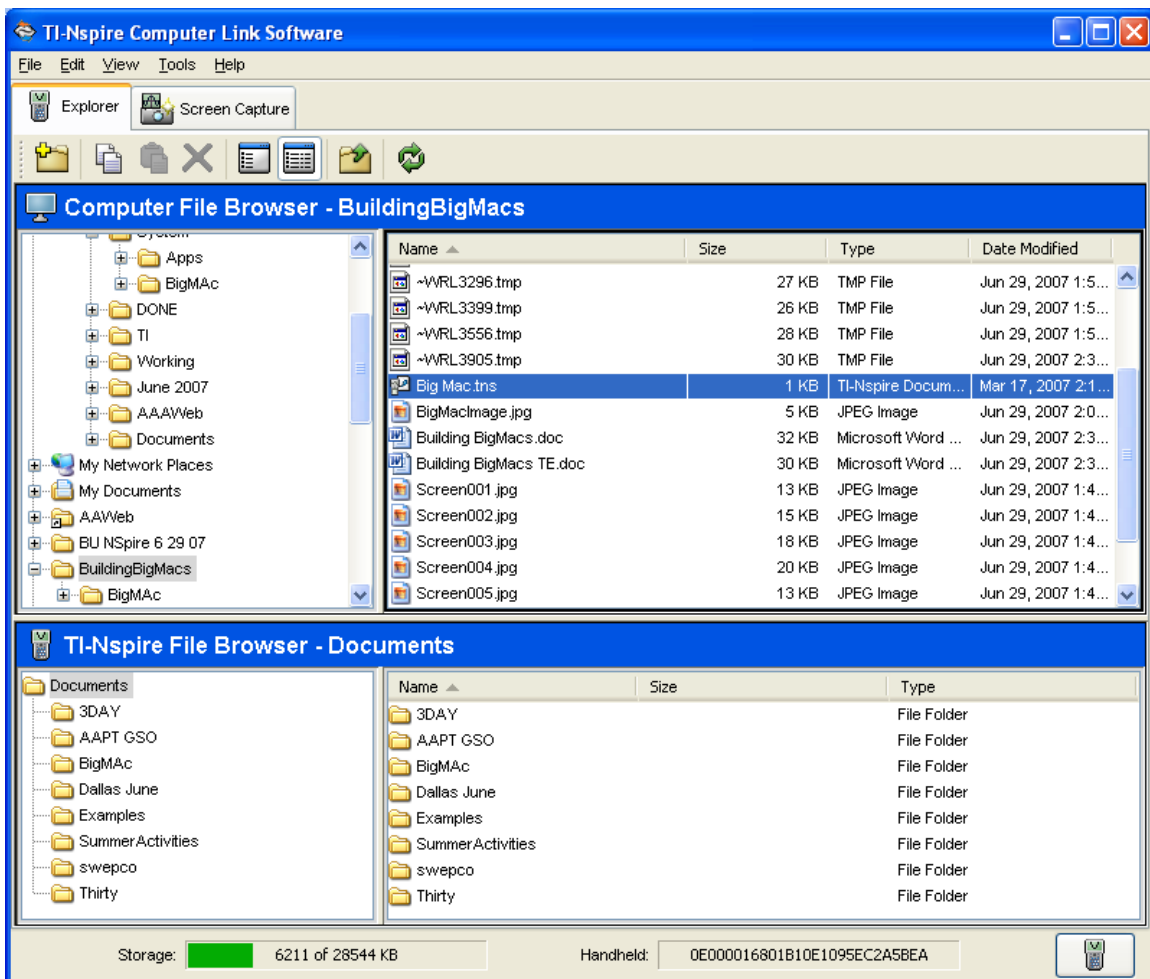
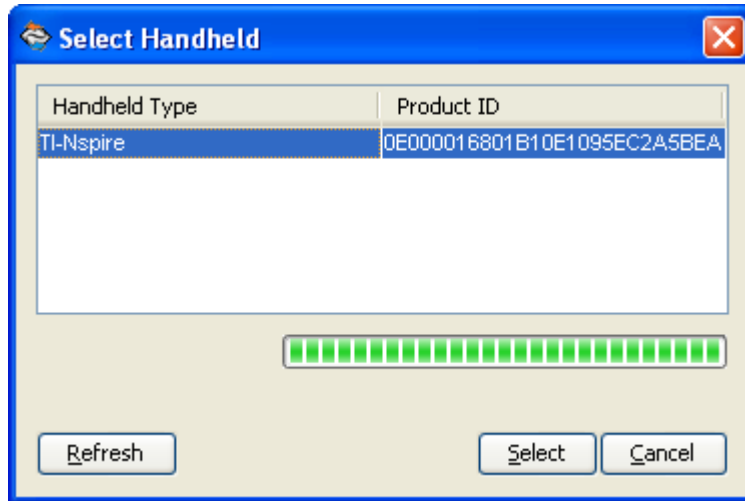


Exploring

1. Get the “Big Mac.tns” file from the instructor or another student. To get the file from the computer plug in the USB Black link and launch the software. Once your device is recognized, just drag and drop the file.

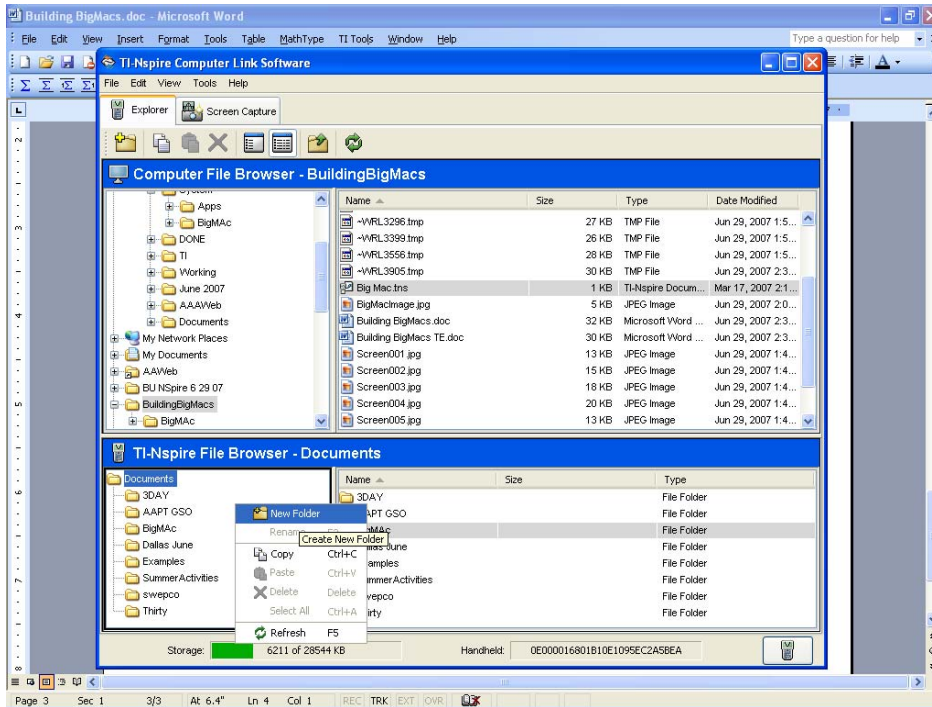


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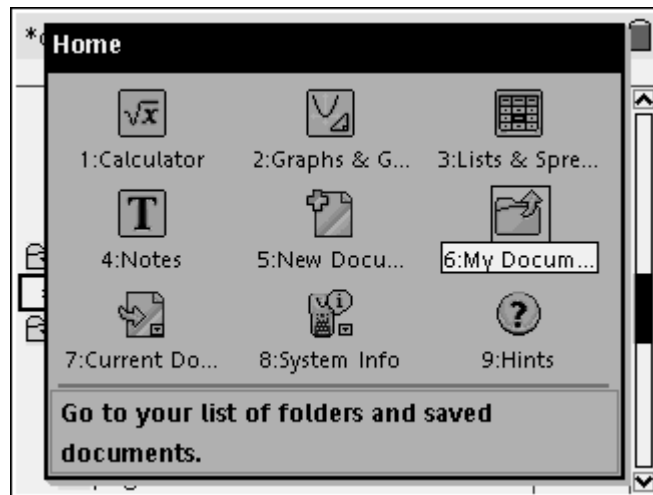


If you don't have a folder created yet, you might want to create one. You may do this with the computer software as shown below.

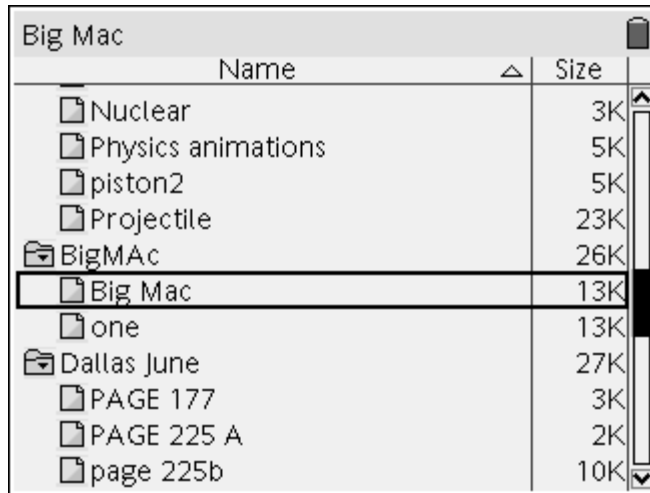
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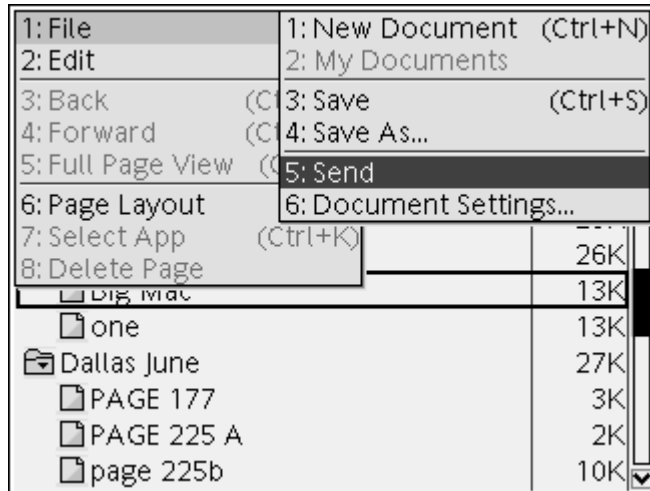
To get the file from another student just plug in the mini-USB handheld to handheld cable and have the sending student press Home and choose 6:My Documents and highlight the file they want to send.



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Then press **ctrl** and select 1:File to get the 5:Send option.



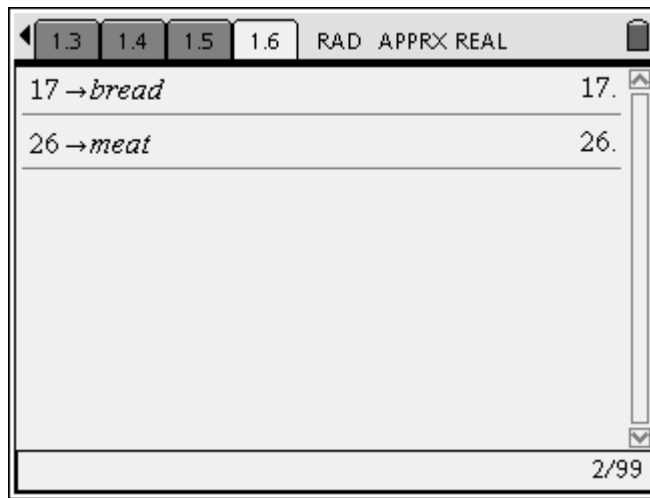
When the file is sent, it may go into the Folder that it was stored in on the handheld that had it or you may copy or move it into another folder.

2. Open the file and follow the instructions starting on Page 1.1. Don't forget to periodically save your work as you add more to the document. To save it press **ctrl** and select 3:Save as shown above. Your team will submit one document.

3. On page 1.3 seed the random number generator using 4 digits.
[RandSeed xxxx]

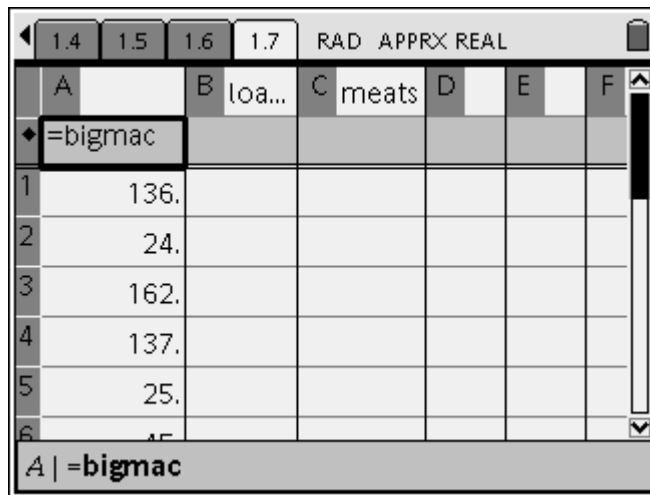
Now determine how many slices of bread are in your loaf and how many slabs of meat are in your meat pack by using the randInt command. Use randInt(11,27). This will give you random integers between 11 and 27 inclusive. If you get the same number for bread and meat, press **enter** again until you get a different number. Store these values into Bread and Meat by keying in the number and then press **ctrl** **stop var** to get **→** and then the name as shown below and report the information on the Student Data Sheet below.

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4. Now, on the same screen we wish to generate a random number of Big Macs to create. To get 7 of these and to store them into BigMac type $\text{randint}(21,177,7)$ $\text{ctrl} \text{stop} \text{var}$ BigMac. Record these values in the Student Data Sheet below.

5. Move to the next page which is a spreadsheet. Place in the first column the list you just made for the number of Big Macs. Do this by moving your cursor to the second row in column labeled BigMacs and key in $=\text{BigMac}$ and then press enter . This should fill your BigMacs column with the 7 sets of Big Macs you want to make.



6. Now move to the loaf column and report the number of loaves of bread you would have to buy to make the indicated number of Big Macs. Fill in the rest for all 7 Big Mac scenarios, both loaves of bread and meat packs using the number for slices per loaf and meat slabs per meat pack you generated before. Report the table in the Student Data Sheet below.

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	A	B	C	D	E	F
1	136.	7.	5.			
2	24.					
3	162.					
4	137.					
5	25.					
6	45.					

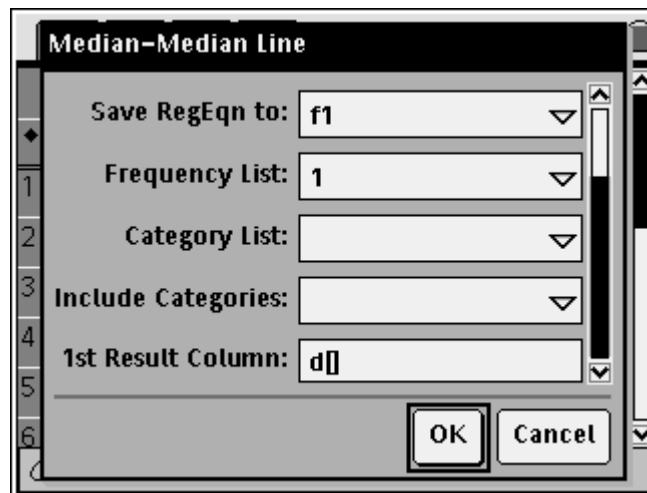
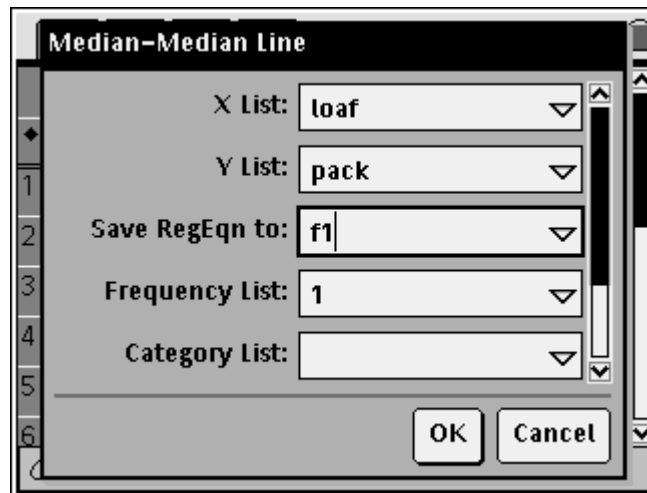
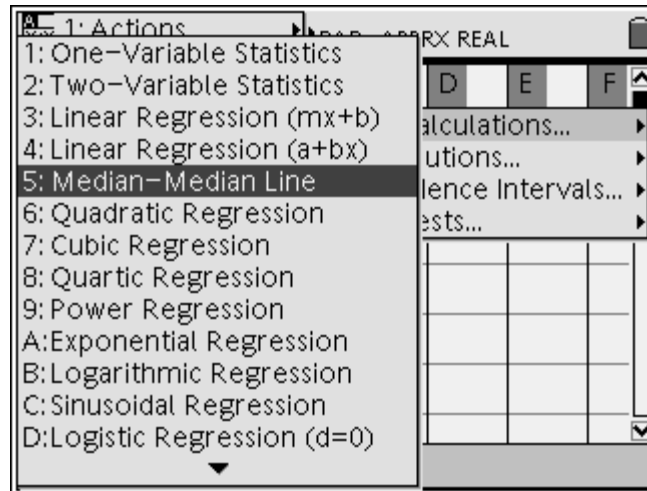
7. Do you see a pattern in the numbers? What was the algorithm you used in the process? Answer on the handheld on the next page.

8. Now let us plot some of the data. On the next page you will set up a scatter plot of Meat Packs vs. Loaves of Bread. This will mean that x = loaves and y = mpack. Adjust the window and see if you get a pattern. Make a sketch of what you see on the Student Data Sheet below.

9. Now return to the spreadsheet. Place your cursor in the third column, the Meat Pack list. Create a Median-Median regression placing the data in columns d and e and the function in f1(x). Report the function that was placed in f1(x) on the Student Data Sheet below.

	C	D	E	F
1	128.	23.	8.	
2	67.	12.	2.	
3	102.	18.	11.	
4	21.	4.	5.	
5	132.	24.		
6	54.	10.		

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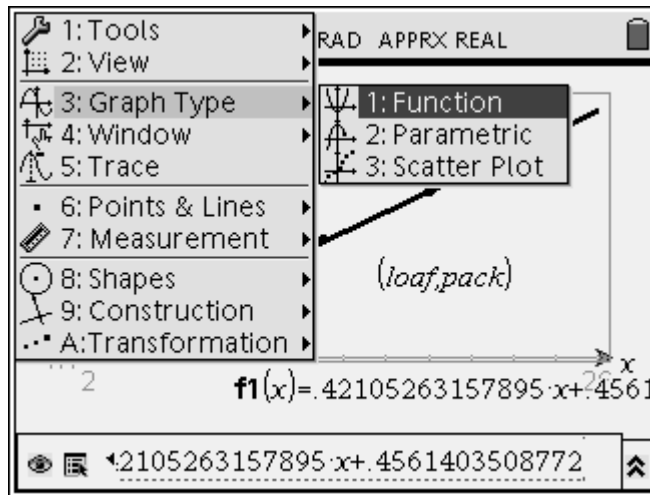


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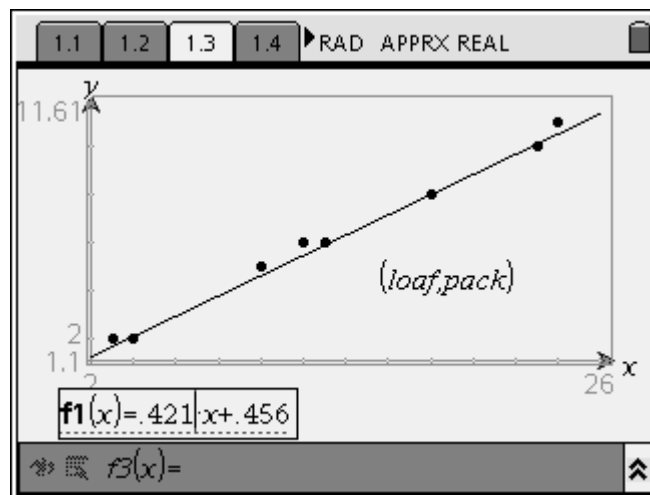
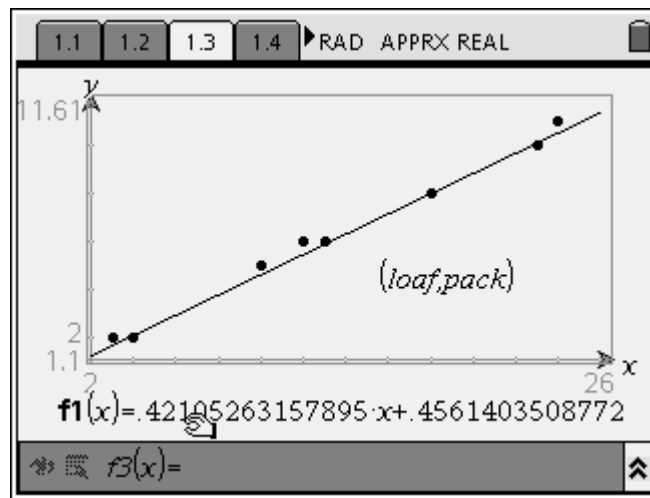
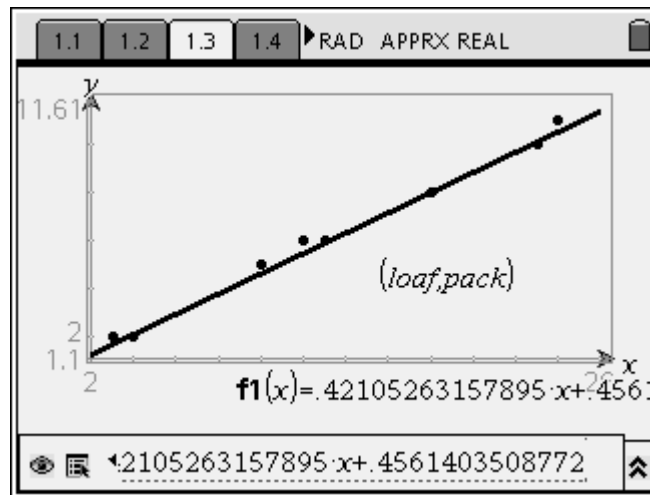
	1.1	1.2	1.3	1.4	RAD APPRX REAL	
	A bigmacs	B loaf	C pack	D	E	F
					=Med	
1	128.	23.	10.	Title	Me...	
2	67.	12.	6.	Reg...	m*x...	
3	102.	18.	8.	m	.421...	
4	21.	4.	2.	b	.456...	
5	132.	24.	11.	Resid	{-.1...	
6	54	10	5			

E7 | ="Median-Median Line"

10. Now return to the page with the scatter plot. Use the Menu button to get the Graph Type of Function on the edit line and then select $f_1(x)$ and press enter so it will show on the graph. Tab around to get off of the edit line and then with the hand grab the function and move it to a strategic place on the screen. Then edit the function by reducing the number of digits in the function. How was the fit? Explain in the Student Data Sheet below.




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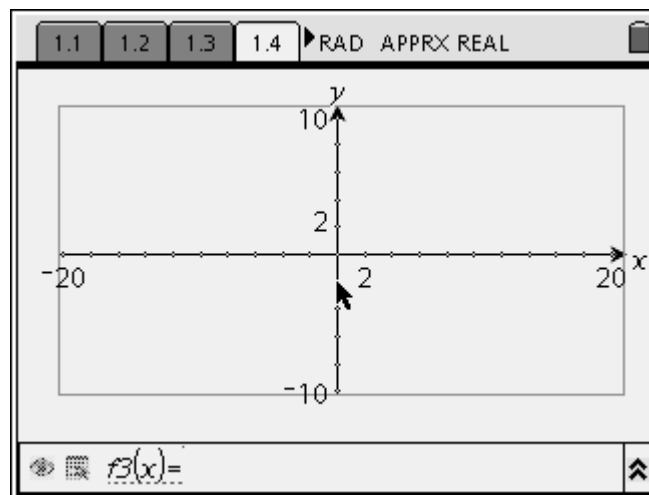
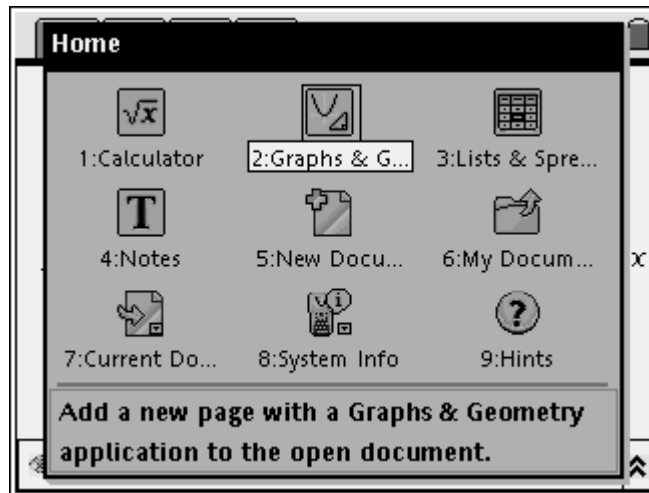


11. To test your understanding of the meaning of this graph, return to the spreadsheet and enter a point that represents an exact match of bread and meat.

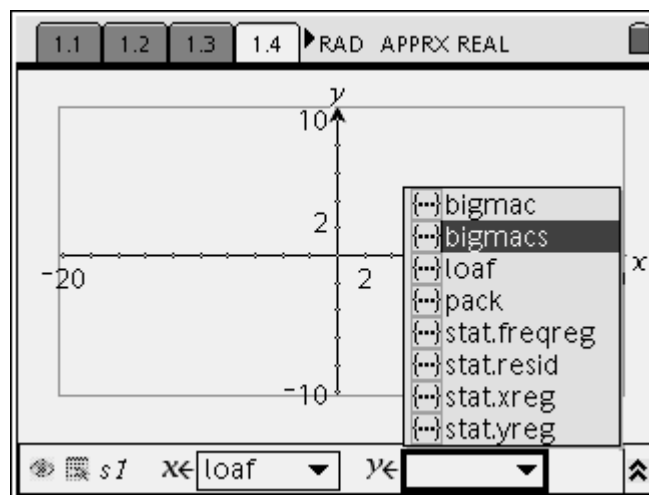
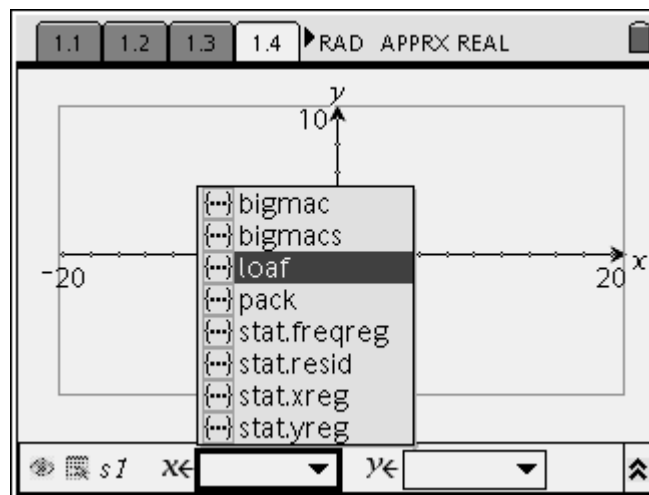
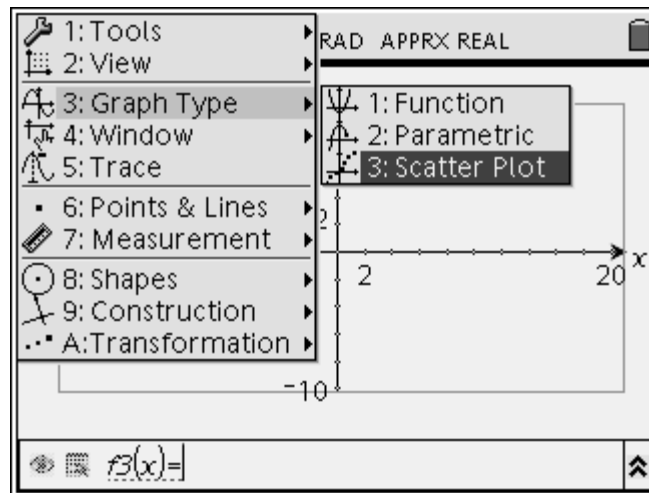
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That is, a number of Big Macs that will use up all the bread in the loaf and all the meat in the meat packs. Pick a number low enough to fit on the graph window, or you will have to adjust the settings to see the new point. Note: You will get an error, but once you have the ordered pair in your errors will go away. If you can't get an exact pair, use a number of Big Macs that will use up all of the bread or the meat and leave a very small amount of the other. Look for this point on the scatter plot. How close to the line did it come? How did your function change? Explain in the Student Data Sheet below.

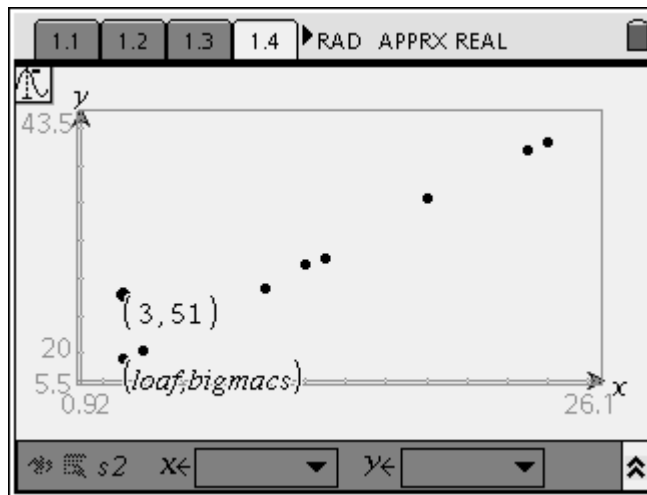
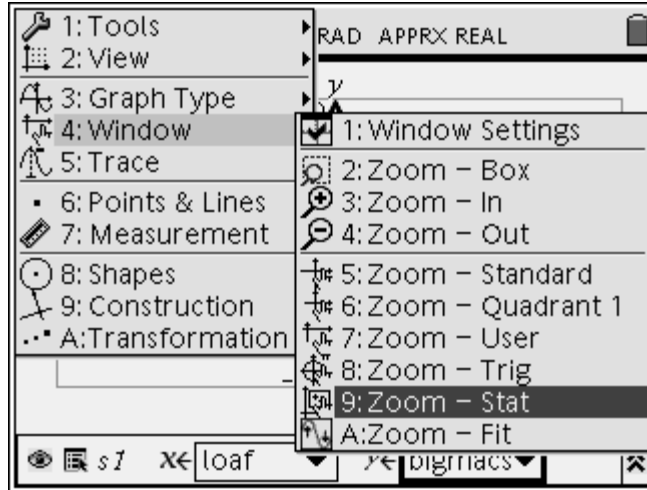
12. You can repeat this process with the number of loaves of bread as a function of the number of meat packs, but it might be more revealing to see the relationship between the loaves and the number of Big Macs. Create a new page by pressing  and selecting 2 for Graphs & Geometry. On this screen set up a plot with x = the number of loaves and y = the number of Big Macs. Adjust the Window so you can see all of the data. You can see a linear relationship and notice any mistakes in your calculations that you did not pick up before.



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13. Given that you calculated the number of loaves needed given the number of Big Macs, you should be able to guess the function. Get the Function Graph Type and key in your guess. Tab around to get back to the graph and then you can either grab the line and rotate it, or just edit the values of the function. Once you get the best line, report it in the Student Data Sheet below.

14. Add another page for a new graph and set up the other plot. In this case we have x = Number of Meat Packs and y = Number of Big Macs. Report the results in the Student Data Sheet below.

15. Using these two equations work out the relationship between the loaves and the packs of meat. Report the results in the Student Data Sheet below.
Hint: You have two equations and three variables. You must eliminate the number of Big Macs as a variable.

16. Test this equation on a known relationship that you have enough of - one that uses all of the meat and all of the bread. Report the results in the Student Data Sheet below.

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17. Go to the page of Notes that reads Balance this. Answer the questions.
18. Now add a page that will hold a spreadsheet. Label the columns BM for Big Macs, B for loaves of bread, and M for packs of meat. Fill the BM column using a sequence with 77 Big Macs. In the second row of the first column key in $=seq(x,x,1,77)$ and press enter.

	A	B	C	D	E	F	G
	bm	b	m				
1	$=seq(x,x,1,77)$						
2							
3							
4							
5							
6							

	A	B	C	D	E	F	G
		b	m				
1	1.						
2	2.						
3	3.						
4	4.						
5	5.						
6	6.						

Now fill in the number of loaves of bread and the number of packs of meat needed for each of the number of Big Macs. Report in the Student Data Sheet below.

19. Add a new page for a graph and set up a scatter plot of B vs. BM (Big Macs = x and Loaves of Bread = y). Adjust the window and describe what you see in the Student Data Sheet below.

20. Now use the int function to get a line that matches the data. Report your equation in the Student Data Sheet below and answer the other questions. Note:

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Recall that the `int` function just returns the integer value of the argument. For example `int(17/2) = 8`.

21. Given what you have learned now; answer the questions in the Student Data Sheet.

22. Answer the questions on the Notes pages in your handheld.

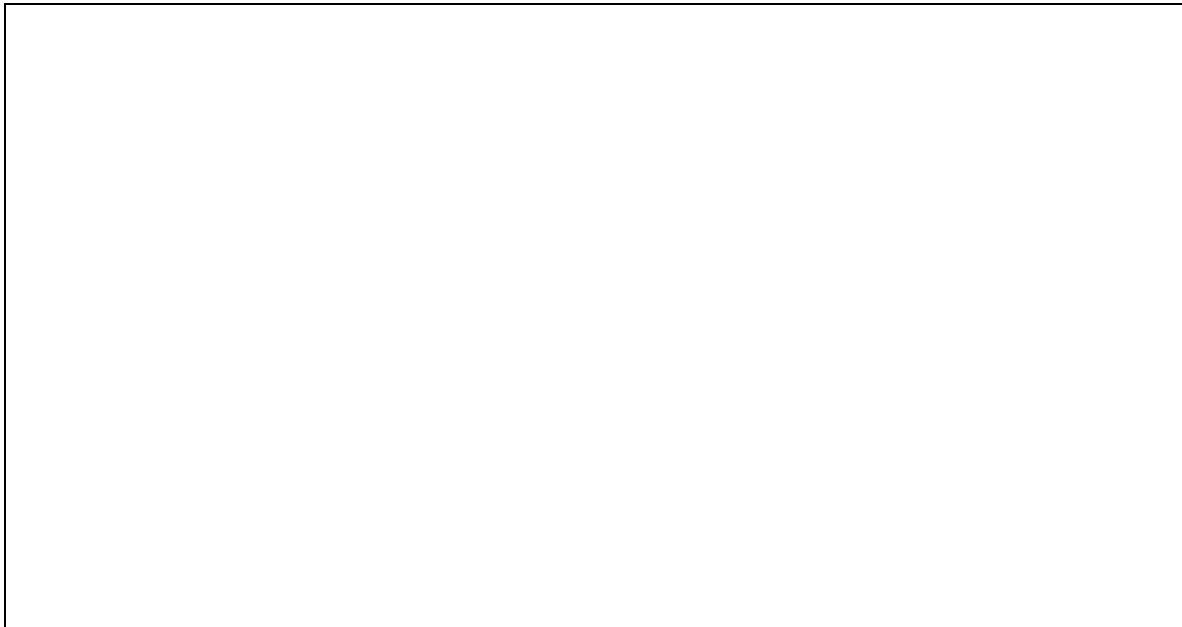
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Student Data Sheet

- A. What seed value did your team use? _____
- B. How many slices of bread in a loaf? _____
- C. How many slabs of meat in a meat pack? _____
- D. How many Big Macs are you going to make?
- E. Complete the table below.

Big Macs	Loaves of Bread	Meat Packs

- F. Sketch and label the scatter plot of Meat Packs vs. Loaves of Bread below. Do you see the number of Big Macs created on the graph?



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G. What was the Median-Median result? _____

H. Sketch the Median-Median line on F above and write the edited equation. Don't use $y = mx + b$, but $\text{MeatPacks} = m * \text{Loaves} + b$. How well did the line fit the data? Why is it not exact? What would it mean to land on this exact line?

I. What point did you add to your list? How did it change the Median-Median line? Where did your point appear on the line? Make a sketch.

Number of Big Macs: _____

Number of Loaves of Bread: _____

Number of Meat Packs: _____

J. What is the relationship between the number of Big Macs and the number of loaves of bread?

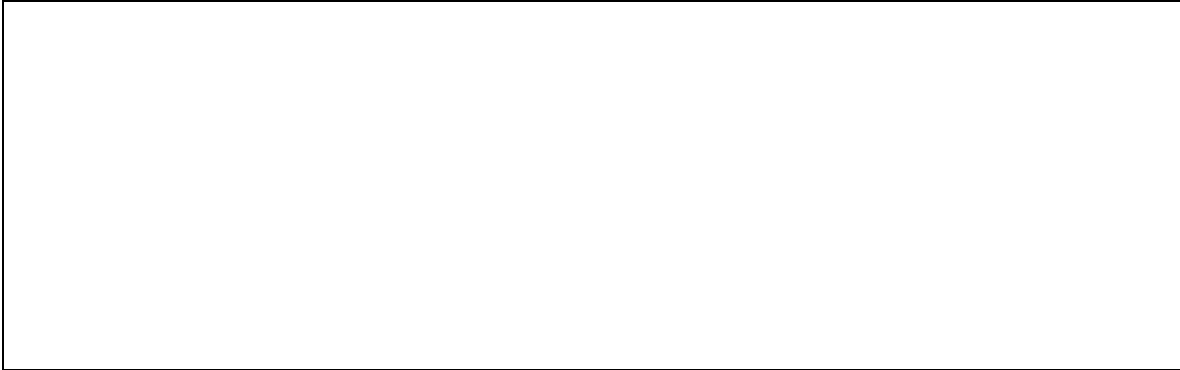
$$\text{BigMacs} = \text{_____} * \text{Loaves}$$

K. What is the relationship between the number of Big Macs and the number of meat packs?

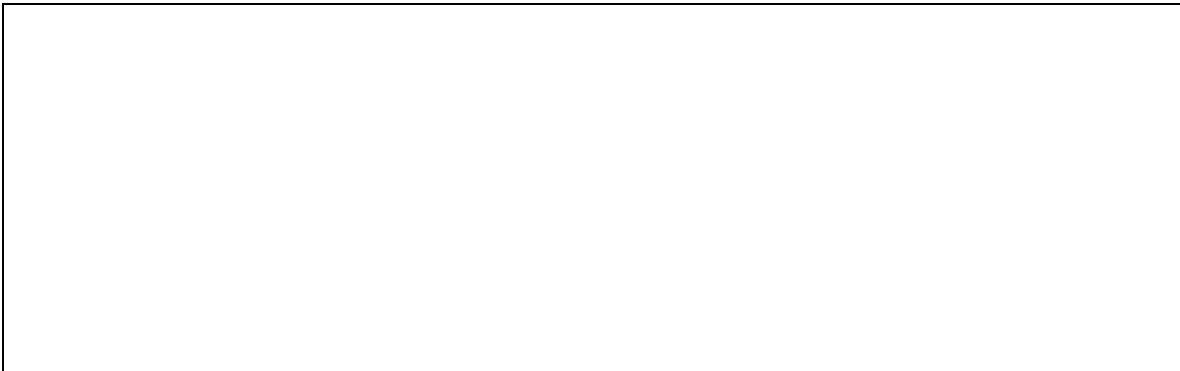
$$\text{BigMacs} = \text{_____} * \text{MeatPacks}$$

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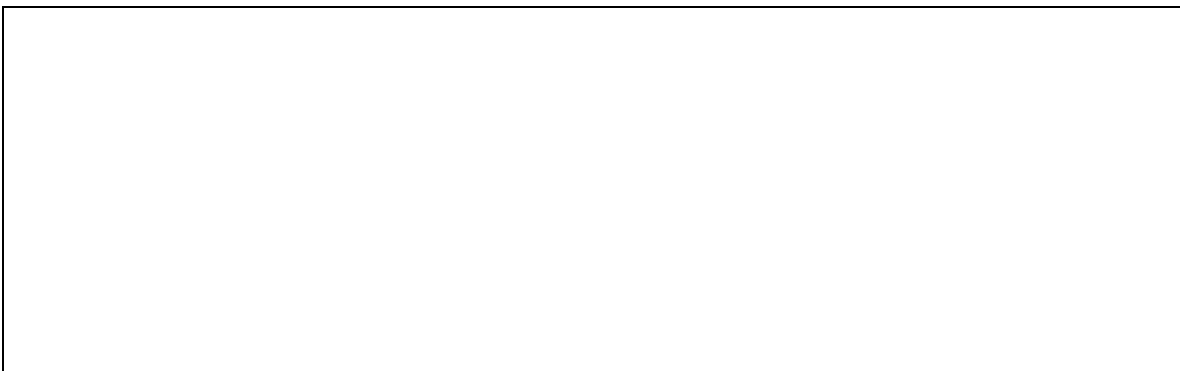
L. Now combine these two equations to get the relationship between loaves and meat packs and then compare it to the answer you got in part G and H.



M. Test the function on a known set of loaves and meat packs. Explain what happened below.

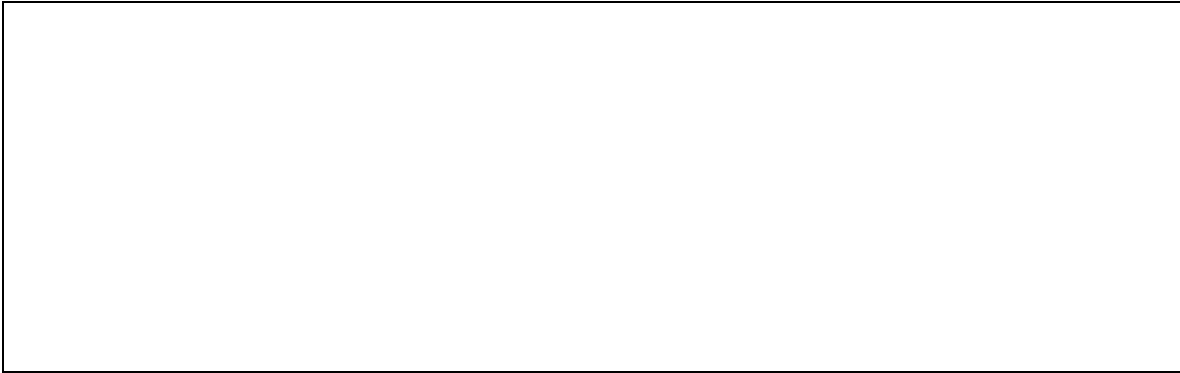


N. What pattern did you see as you filled the columns for loaves of bread and packs of meat?



O. Sketch and label your scatter plot of B vs. BM and explain what pattern you see.

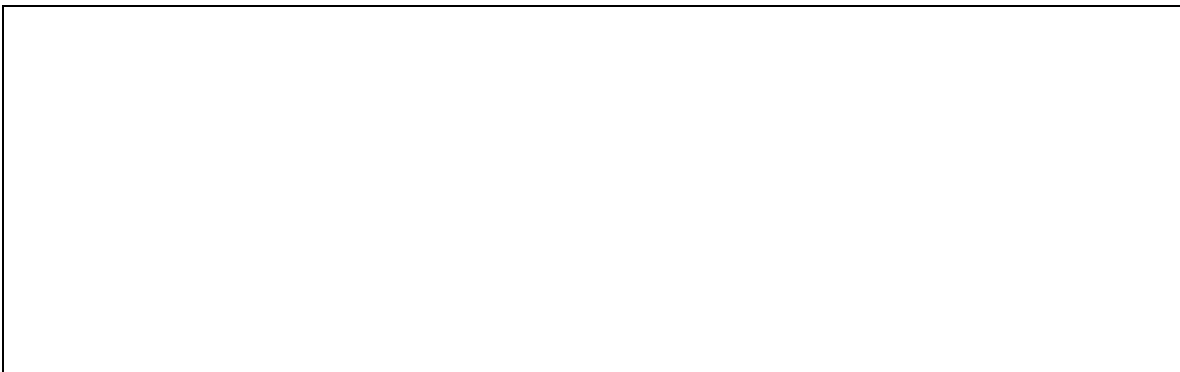
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P. What equation did you use for the step function?

Q. Predict the equation relating BM and M, the number of Big Macs and the number of packs of meat.

R. Use the equation from question P and try it on a know value from your earlier work. Show the results and explain below.



S. Use your equation to predict the number of loaves of breaded needed for 7770 Big Macs.

T. Give an example when you have an excess of meat as you build Big Macs using your loaves of bread and Meat Packs.

Give an example when meat is the limiting agent.

Which is the real limiting agent? Meat or Bread? Explain.