Building Big Macs

Teaching Notes

Activity Overview

In this activity students will explore the nature of the limiting agent in forming a compound. They will determine how much bread and meat will be needed to make a Big Mac. In the process they will see that all the elements are not always used and that there is a ratio of 3 breads to 2 meats to make the compound, a Big Mac. In addition they will write the empirical formula and balance several versions of reactions. The students will develop a mathematical rule that will help them balance reactions equations and to predict how much bread and meat will be needed to make a certain number on Big Macs. This will help them as we study Stoikiometry.

Supplies and Materials

The students will need a TI-Nspire handheld (at least one per team) and a way to send their files in to be graded. This can be a link cable to the teacher's handheld, or a Black USB link cable to the computer to transfer the file with TI-Nspire Computer Link Software so that they may email the file in to be graded. Note: The activity is not written on a CAS device, but some of the mathematics could flow better if you used the CAS as you solve the equations.

Pre-requisite Knowledge

Involved in this investigation will be the use of the random number generator with a seed. In addition students will use the spreadsheet to enter their data and create a sequence. They will set up a scatter plot and do a regression on linear data. They will also need to modify this equation by moving it in the Graph/Geometry app or by just editing the values of the slope and the y-intercept to get a better fit. They also will need to be able to collaborate with their team members and be able to write fully and completely in response to prompts and questions.

Students should have been introduced to balancing equations and the limiting agent idea. The best time for this lesson is just after you have done a few problems to measure excess and after the concept of an empirical formula. After this investigation students will be well prepared to look at molar relationships and percents as you move forward in the study of chemistry.

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Notes on the Investigation

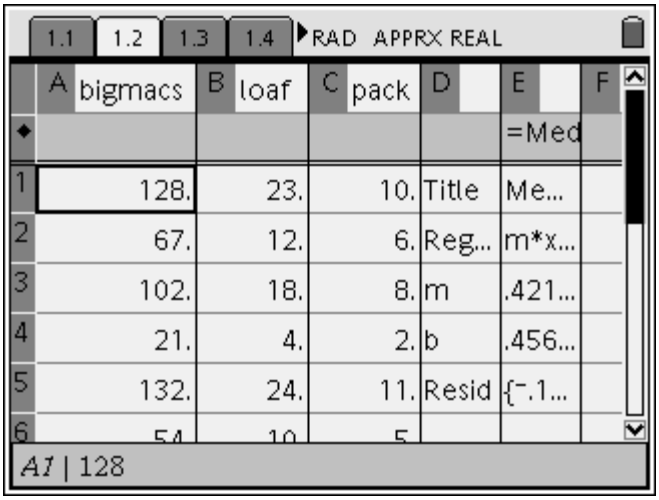
1. The file Big Mac.tns could be emailed to the students, posted on your webpage, or placed in the Student Share drive so that they can load it on their handheld before class or they can get it from your computer or handheld and pass it around at the start of class.

2. The students should work in groups and periodically save their work as they work through the problem.

3. Make sure the students report their seed value so you can reproduce their results. Be sure to check to see that they don't get the same number for both meat and bread. Also, if they get a nice ratio the problem becomes easier (such as 12 and 18). You might set up groups with a seed that will give easy or hard numbers to help differentiate.

4. Students will get 7 numbers of Big Macs to make from the bread loaves and meat packs. They will range from 21 to 177 and the students might get duplicates but probably no more than one pair will show up so don't worry about that.

6. Make sure the students are calculating correctly on the spreadsheet. Have them explain one of their answers to you. In the image below we have 17 slices of bread in a loaf and 26 slabs of meat in a meat pack so to make 128 Big Macs we need 23 loves of bread and 10 meat packs.



7. They should see that the number of loaves and packs of meat form a linear relationship through the number of Big Macs. Since the data is jumbled they may not see the linearity until they plot the data. The algorithm should be clear to them.

8. If the students have never made a scatter plot on the Nspire handheld, you may need a time out to help get their bearings.

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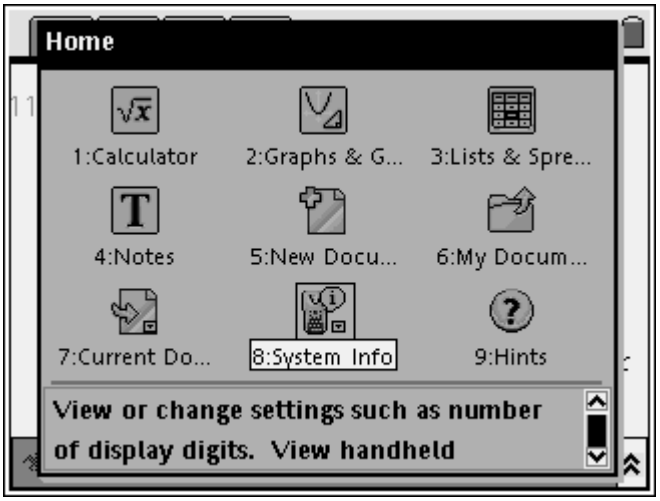
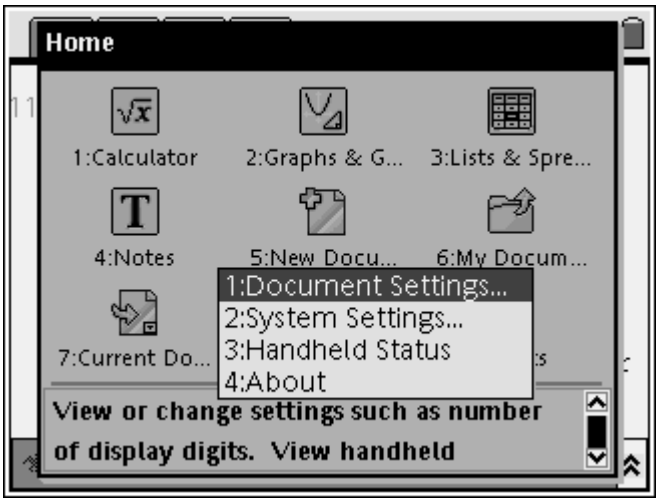
9. If you are not a digit freak, you might want to adjust the Document Settings to Fix 4, or Float 3. If the student does not place the cursor in the third column and she tabs through the option for the location of the regression data, she could loose her data.





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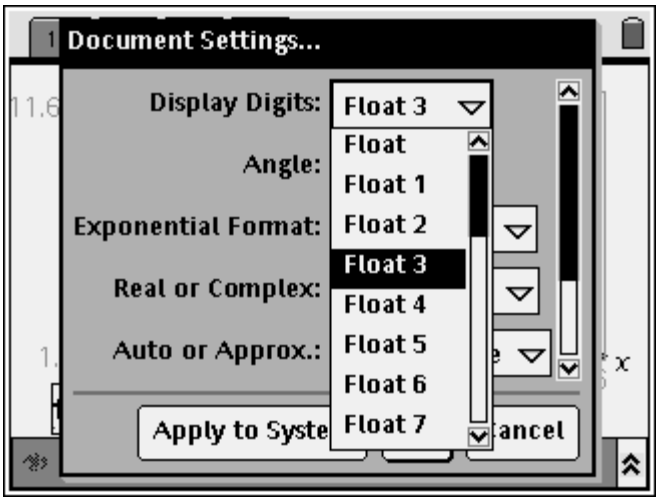

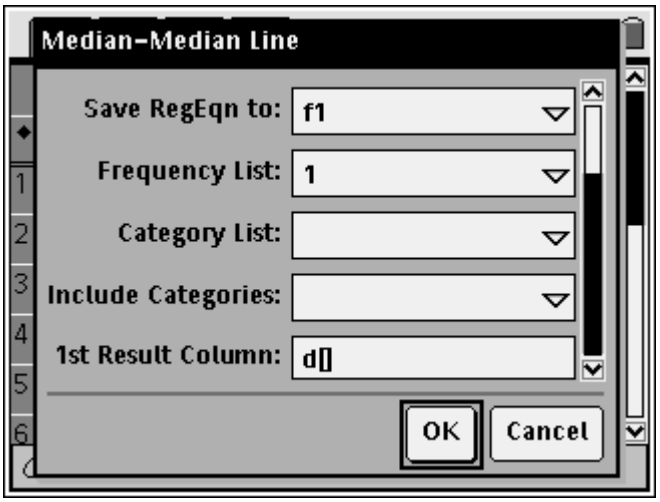

10. You may need to have your better students help with the logistics on this step. Moving the cursor, grabbing the function and getting in and out of the edit line on the Graphs/Geometry page takes a bit of practice. As for the Median-Median, the line should containing points where there are no excesses. That is, the whole loaf and the whole meat pack were used up in making the Big Macs. If you have a point above or below the True line it indicates which is in excess and what the limiting agent is.

11. Some students will find it hard to get an exact number of Big Macs to use up all of the bread and meat, but if they can use all of one element and almost all of the other, that will do. When they get the error, just tell them to select OK and then move on.

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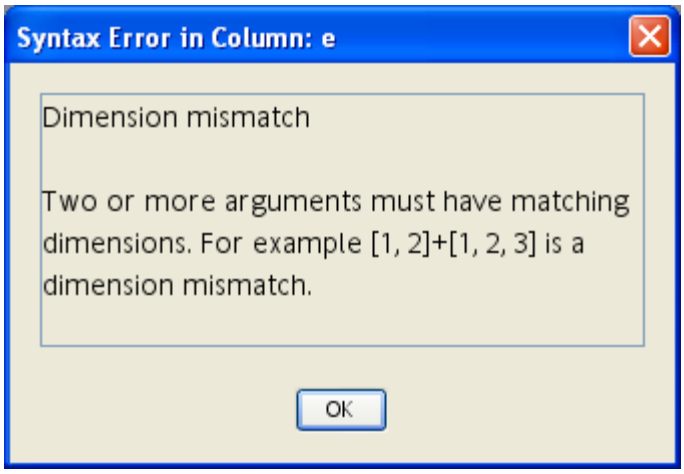
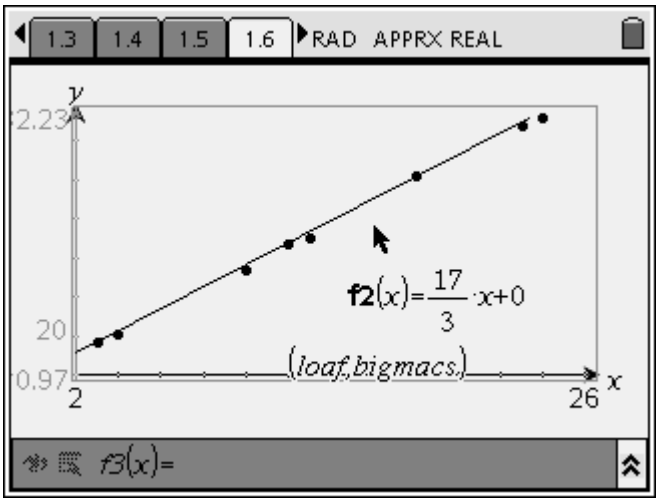


12. You can use the scatter plot of loaves vs. meat packs as an assessment or you can have the class do this one as well.

13. The answer here should be clear. Since it takes 3 pieces of bread to make a Big Mac the equation should be BigMacs = Bread/3 * Loaves. In my example we have:



14. Here we have the other relationship: Big Macs = Meat/2 * MeatPacks. In my example y = 26/2 * x.

15. Since both equations = Number of Big Macs, they just set them equal and then solve for loaves or meat packs.

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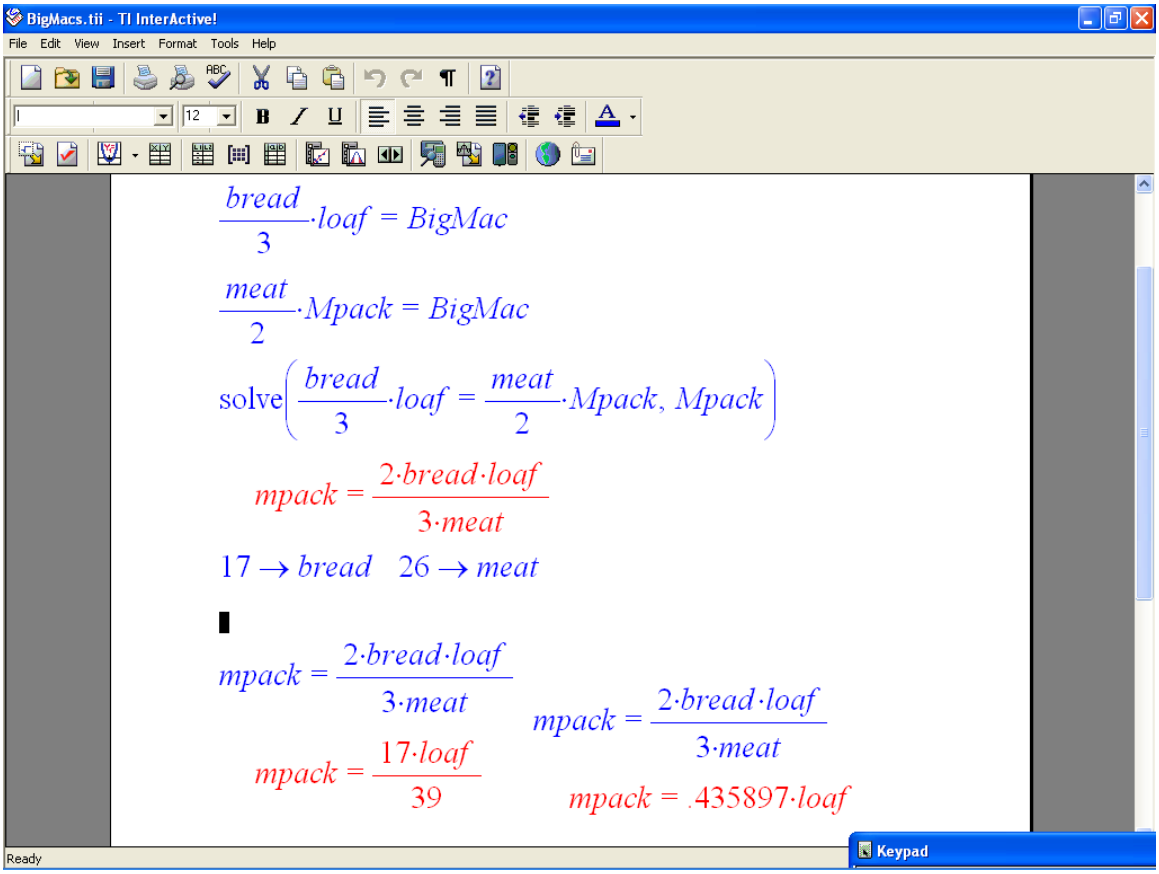

This should agree with the first equation the students got. Solving this for loaf will get the other function (loaf vs. meatpack).

16. They should test their function on a number that will use all the bread and all of the meat.

17. See below:

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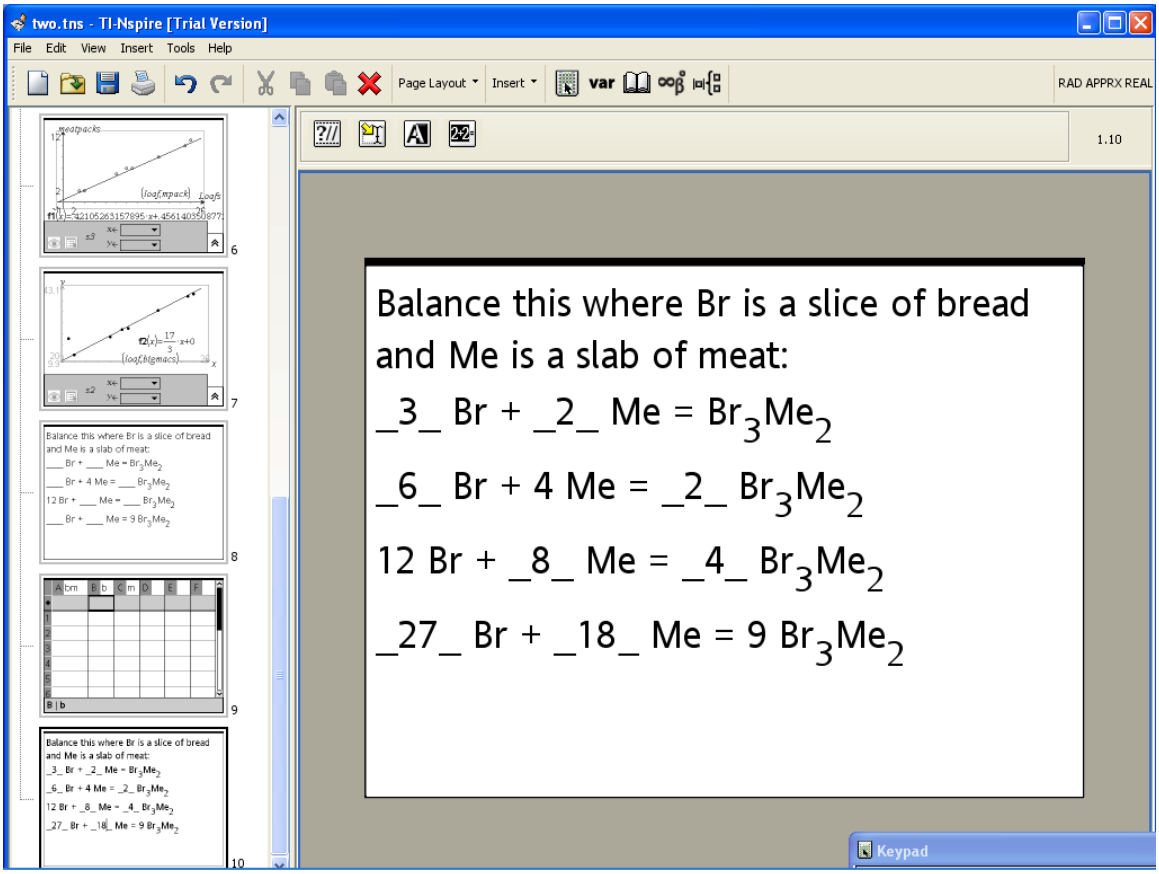

18. The pattern that represents is the bread/3 and meat/2 value.

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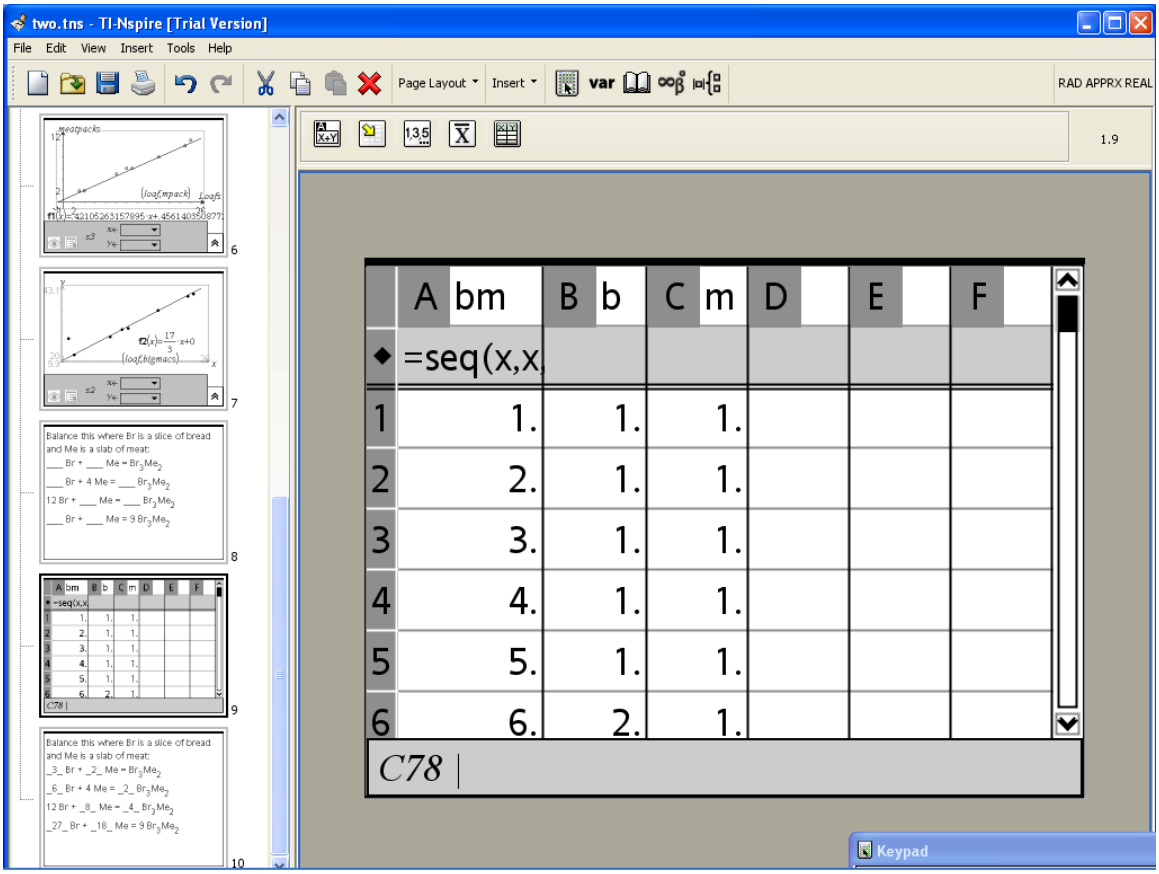

19. They should see a step function in the plot.

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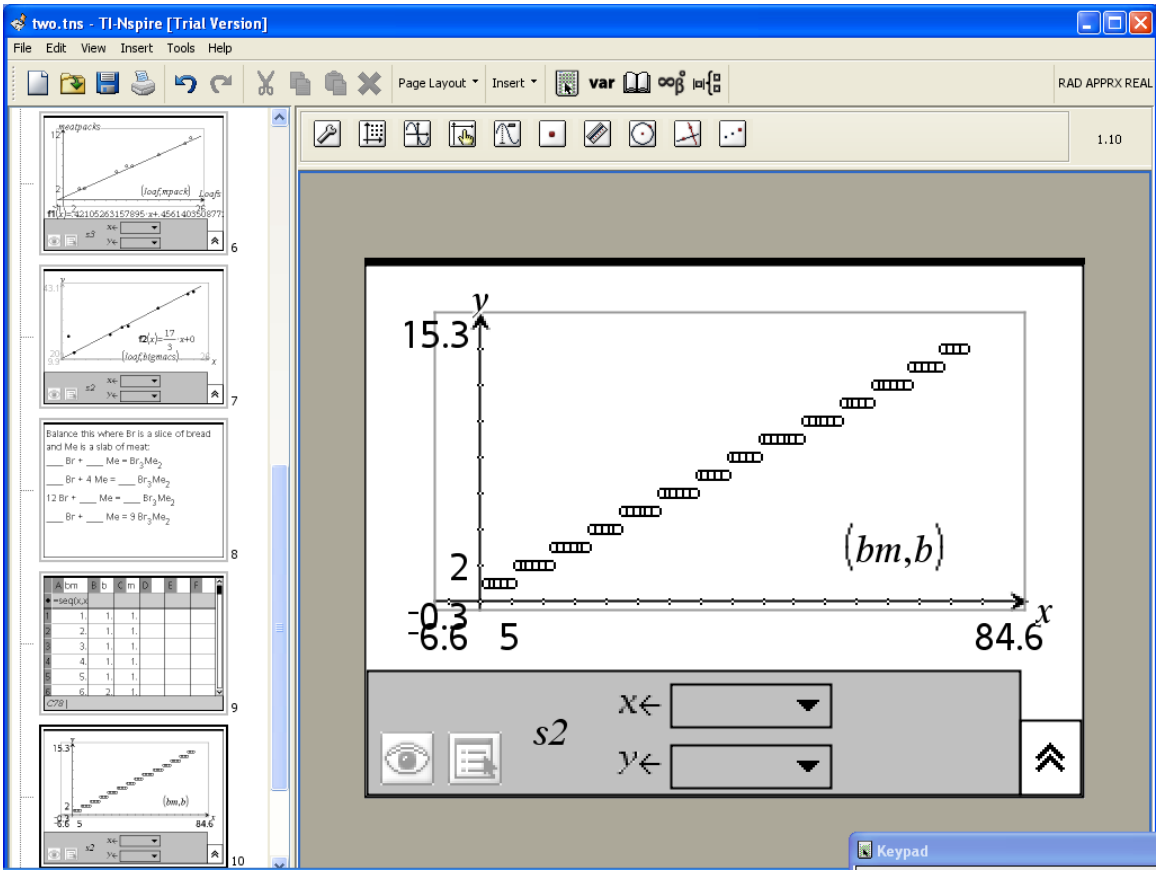
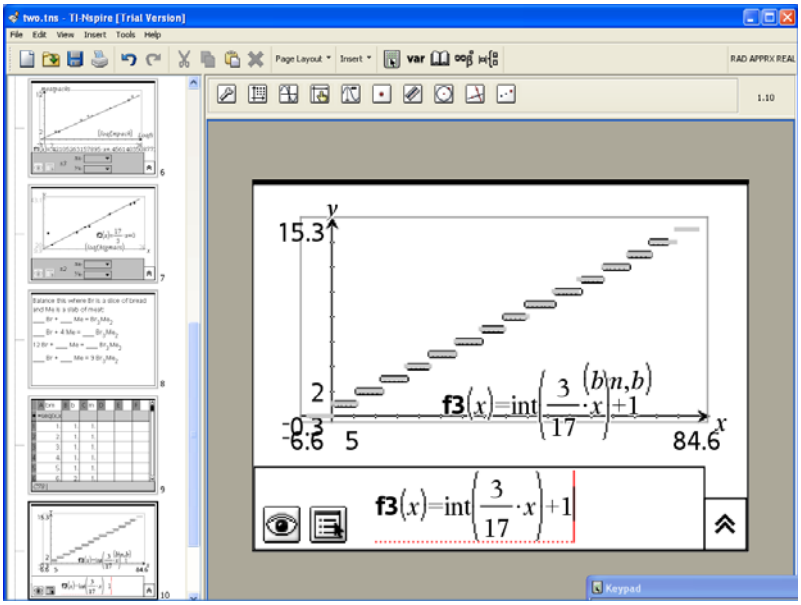


20. Since we need at least 1 loaf of bread, we have B = int(3/bread * BM) + 1 as the equation.



21. Since meat is more expensive, it should be considered the limiting agent.

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22. The Super Big Mac should follow this pattern:

$$5\ Br + 4\ Me = Br_5Me_4$$

The students should submit the 4 samples to balance them.

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