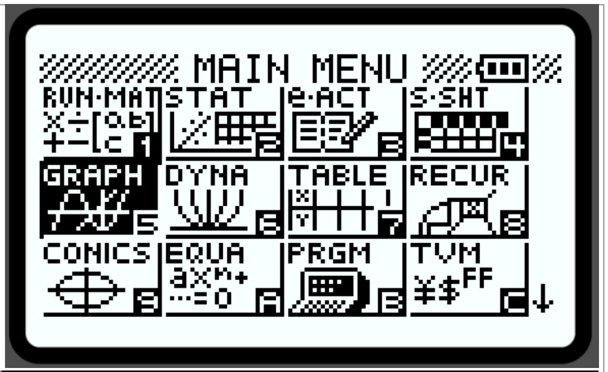
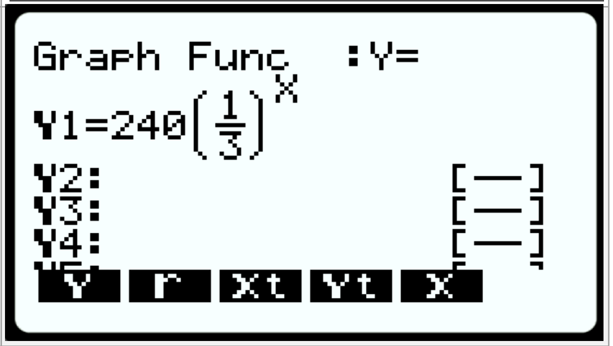
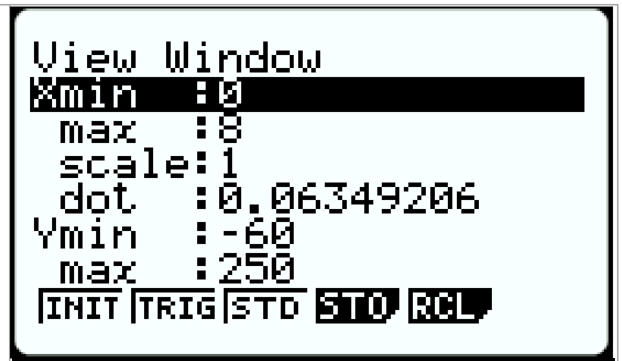
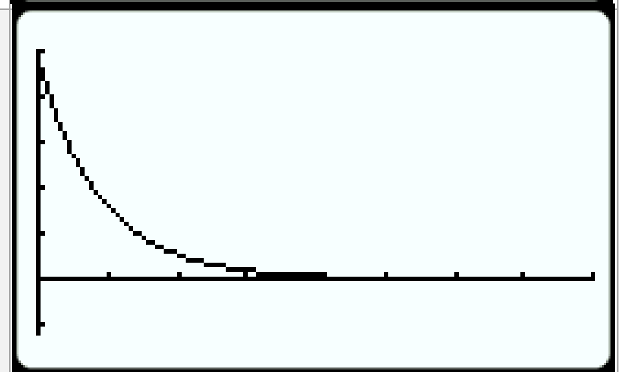
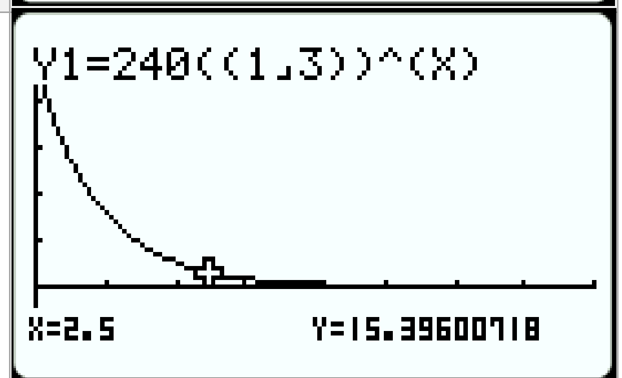
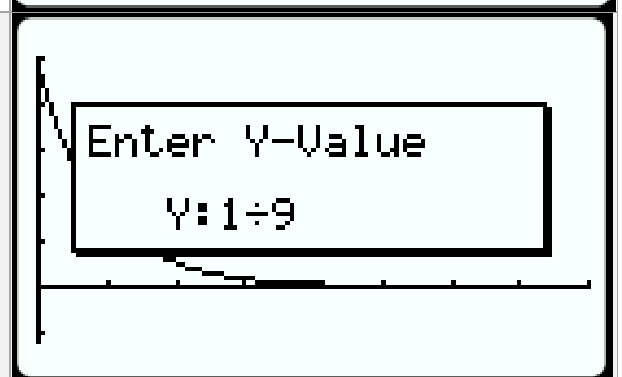
Unit 5: Introduction to Exponential Functions	
Scientific Calculator Required	Lessons 1, 18
Spreadsheet Technology Required	Lessons 1, 2, 7
Graphing Technology Required	Lessons 3, 5, 7, 8, 9, 11, 12, 13, 15, 18, 19, 21
Spreadsheet Technology Recommended	Lessons 11, 19

Lesson 5 – Graphing an Exponential Function

(Example: IM Lesson 5.2:The Algae Bloom)

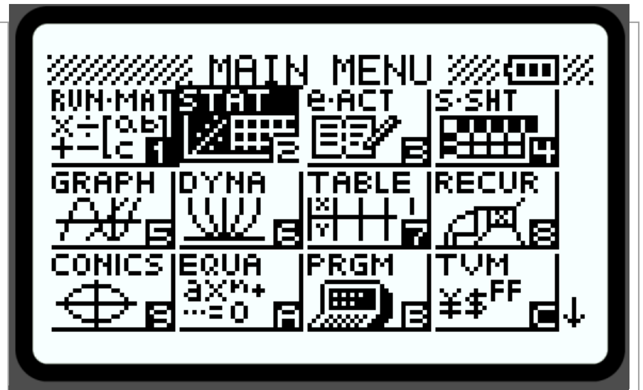
1. To graph an exponential function, press [MENU] then [5] – GRAPH.	
2. Type the function 240 $(\frac{1}{3})^x$ for **Y1**. The equation in the problem uses the independent variable "***t***" but in the calculator always use "***x***". To get the "**x**" in the exponent, after the right parentheses press [^] then press [X,θ,T] for ***x***. Press [EXE] when complete.	

3. Before drawing, press SHIFT , F3 – V-WIN to set the window to the values given in the problem.	
4. To view the graph, press EXE then F6 – DRAW.	
5. To estimate other values for this function, you can edit "**x**" values in the Table App or try the Trace command. Press F1 and then type the desired x-value and press EXE. After **2½** weeks, the algae will cover an area of about **15.4** square yards.	
6. To find the number of weeks when the algae area is under 1 sq. ft., we can use the **X-CAL** command in **G-Solv**. Press F5 for **G-Solv**, then F6 for the **next** menu, and F2 for **X-Cal**. Type in 1/9, as 1 sq. ft is 1/9th of a sq. yd.	
7. Press EXE to see that it will take nearly 7 weeks of treatment to reduce the algae bloom to 1 sq foot of area.	

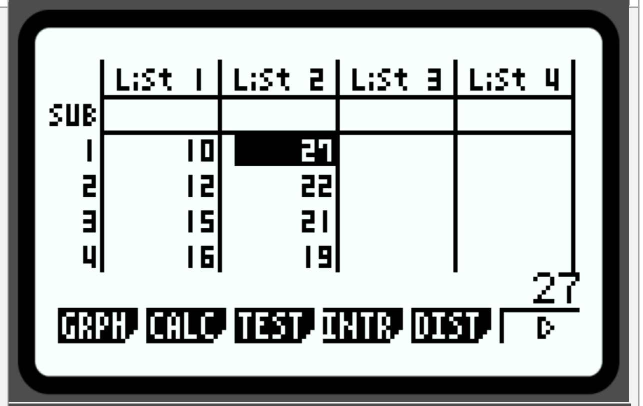
Lesson 6 – Determining the Line of Best Fit

(Example: IM Lesson 6: Practice Problem #6)

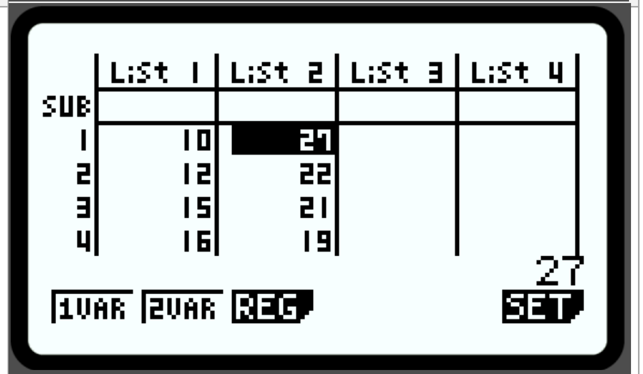
1. Go to MENU then 2 – STAT.



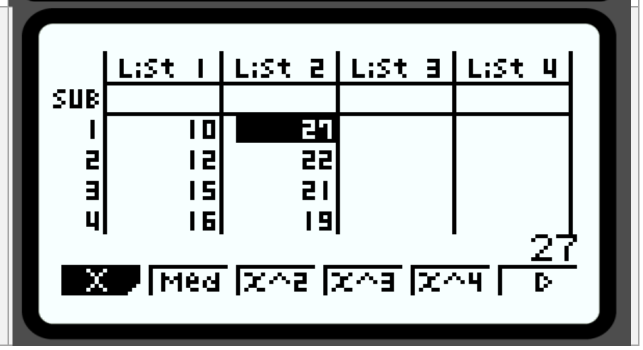
2. From the table provided in the problem, we will use the ***x*-values** in **LIST 1** and the ***y*-values** under **LIST 2**.

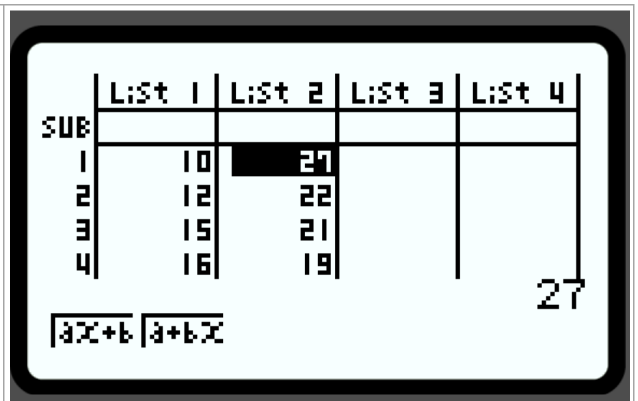
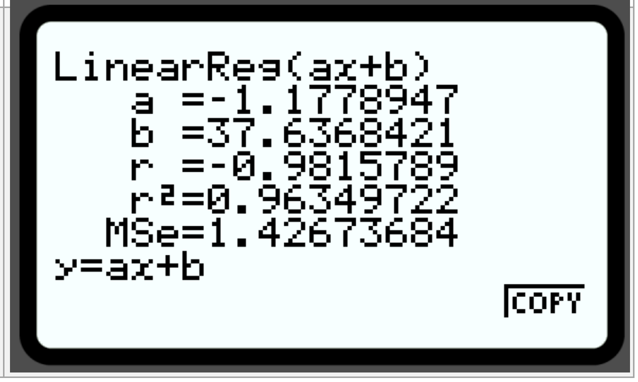


3. To find the equation of the line of best fit of these data points press F2 – CALC.



4. From the previous screen, press F3 – REG.

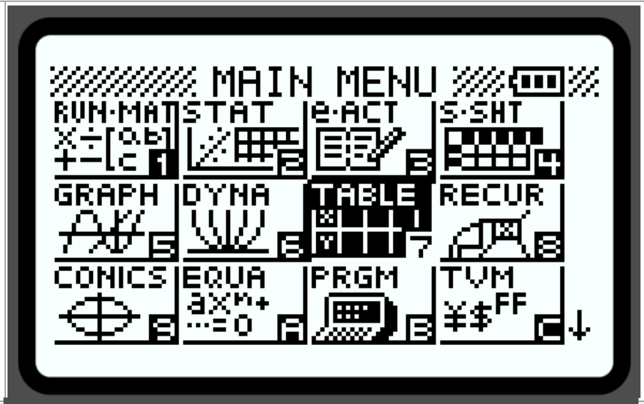


5. Now press [F1] – [X], then [F1] – [ax+b].	
6. From this screen, you can see the "***a***" value which is the **slope** of the line of best fit. The "***b***" value is the **y-intercept** of the line of best fit. The equation for the line of best fit for this data is ***y* = –1.18*x* + 37.64**. (Rounded to the hundredths places)	

Lesson 7 – Using the Table of an Exponential Function

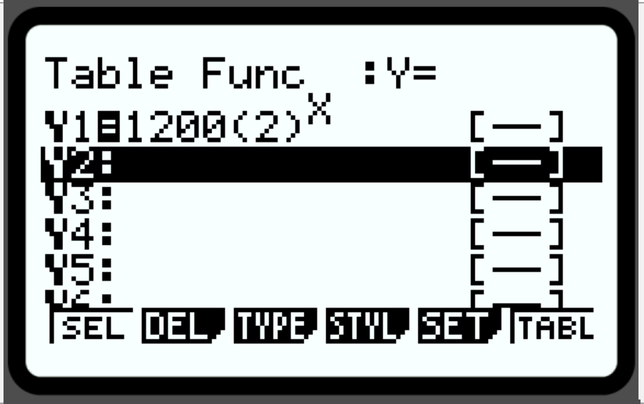
(Example: IM Lesson 7.2: Coral in the Sea)

1. To view the table of an exponential function, press [MENU] then [7] – [TABLE].



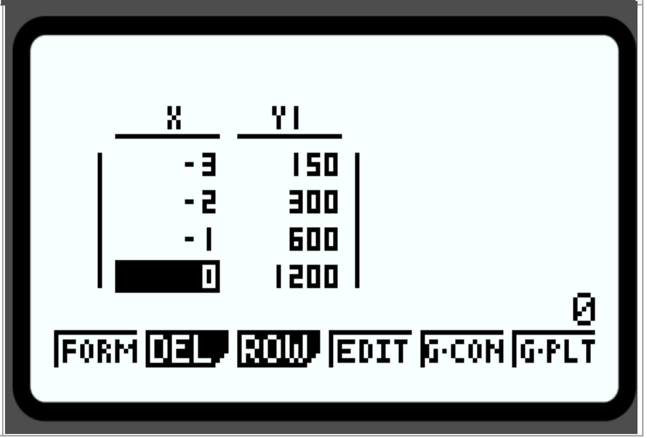
2. The equation that represents the relationship between years since the coral was measured and the volume of the coral in cubic centimeters is $y = 1{,}200(2)^x$.

   Just as before, we use the variable "*x*" when using the calculator but in the real function the input variable "*t*" is used for time.



3. After entering the function into **Y1** and pressing [EXE], press [F6] – [TABL] to view the table. Use the **down arrow key** to view different x-values. Any highlighted **x-value** can be quickly changed by typing the desired value on the number pad and pressing [EXE].

   To find the volume look at the **Y1** values when "*x*" is 5,1,0,-1 and -2. (From the given problem)

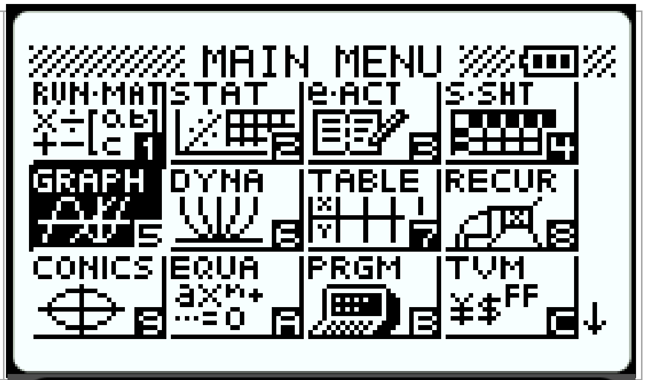


Lesson 10 – Graphing an Exponential Function

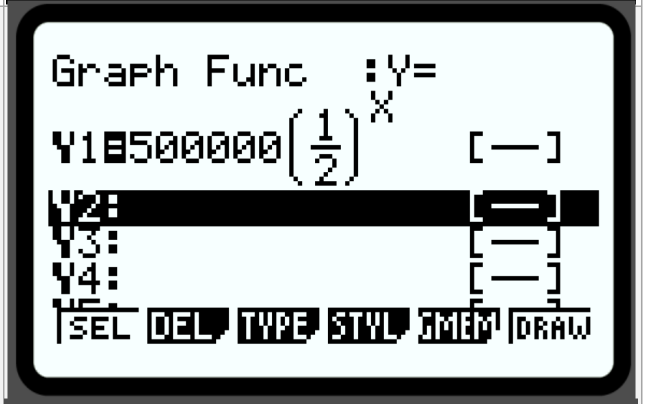
(Example: IM Lesson 10: Practice Problem #6)

1. To graph the function, **$p = 500{,}000(\frac{1}{2})^{w}$** press [MENU] then [5] – GRAPH.

   The equation in the problem uses the input variable "***w***" but in the calculator use the input variable "***x***".



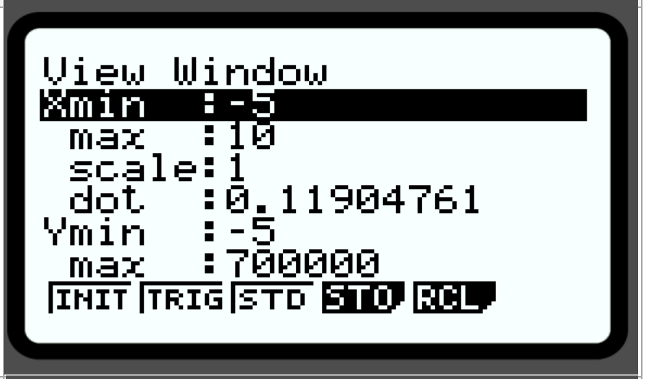
2. After entering the function into **Y1** and pressing [EXE], press [F6] – DRAW to view the graph. If you cannot see the function, then you will need to adjust the viewing window.



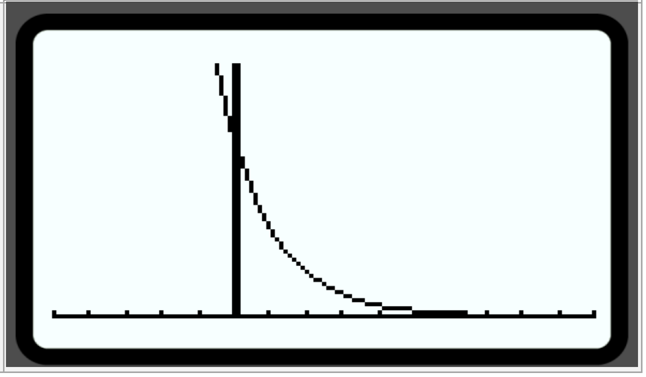
3. From the graph window, press [F3] **– V-Win**.

   Set **Xmin** to -5 and **Xmax** to 10. You do not have to change "**scale**" and "**dot**."

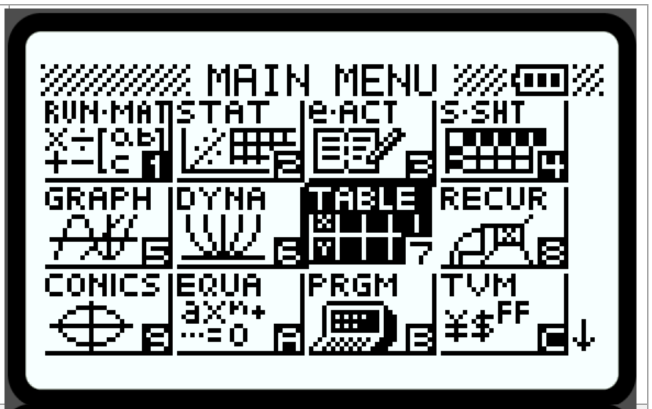
   Press the down arrow to **Ymin** to set it to -5 and **Ymax** to 700,000. (Since the population starts at 500,000 we want a slightly larger number so we can see the entire graph.)



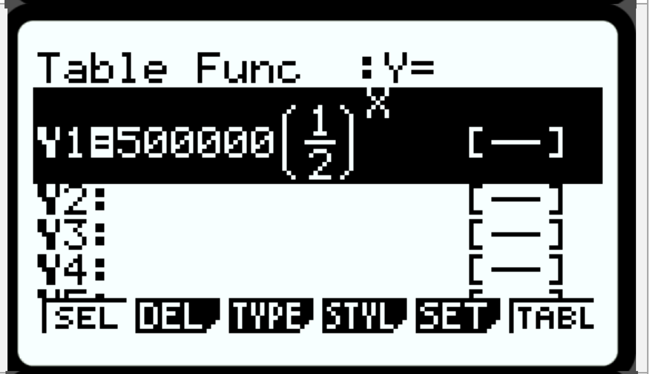
4. Once you set the window, press [EXIT] and you should be able to see the graph now. You can now use [F1] **– Trace** or tools under [F5] **– G-Solv** to further analyze the function as needed. We need the moth population at different weeks for this problem, so we will be switching to the **Table App**.



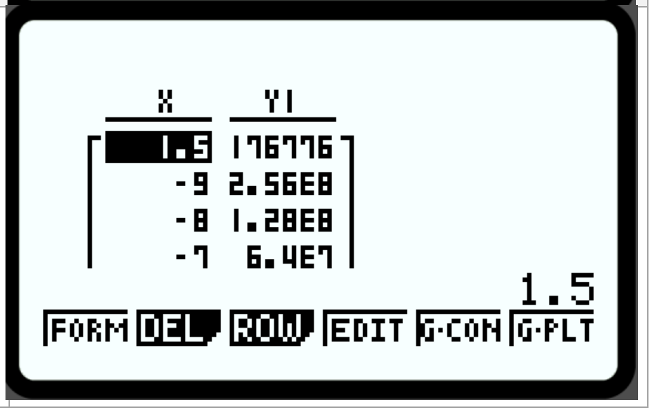
5. From the **Graph App**, press [MENU] then [7] – TABLE.



6. The functions entered under the **Graph App** will be automatically available in the **Table App**, so now press [F6] – TABL to view the table for **Y1**.



7. To see the moth population after 1½ weeks, type 1.5 in a highlighted value in the table and the press [EXE]. The **y-value** to the right will automatically update. In this case the y-value is the population so after **1.5 weeks** the population is **176,776 moths**. Since the problem is in thousands you can round your answer to **177,000 moths**.

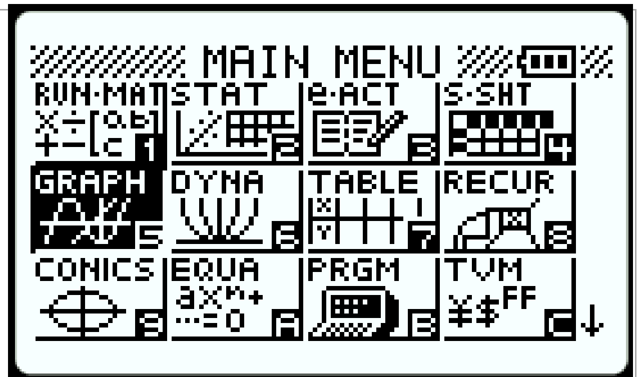


CASIO

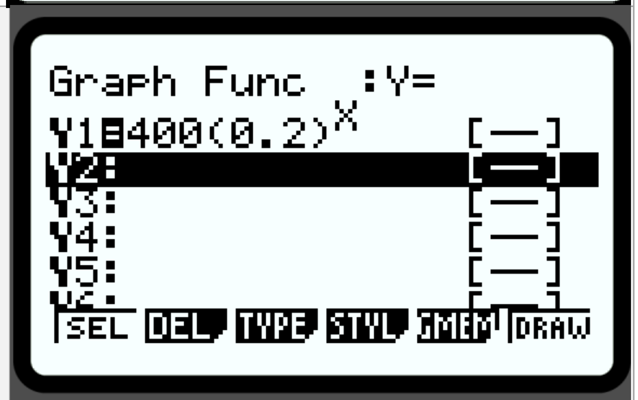
Lesson 11 – Adjusting the Graph Window Prior to Graphing.

(Example: IM Lesson 11.1: Wondering About Windows)

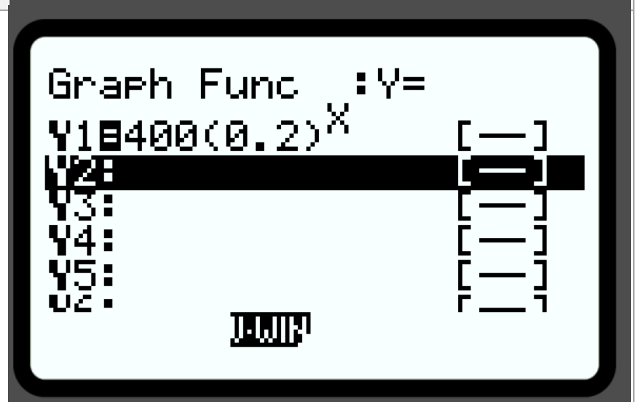
1. To see the window of an exponential function, you must first graph the function. Press [MENU] then [5] – [GRAPH].



2. From the graph function screen type in your function; this case $\mathbf{400(0.2)^{x}}$.



3. Now, press [SHIFT] and then [F3] – [V-WIN].

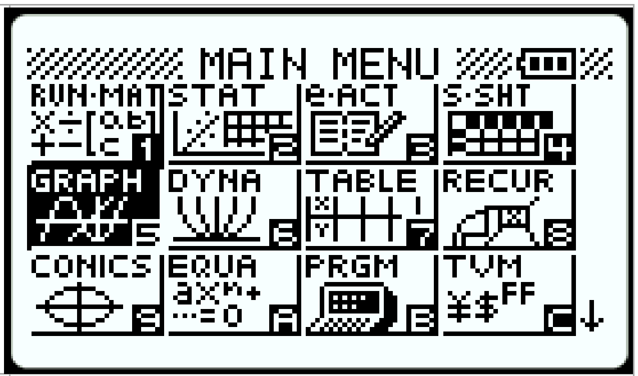


4. You can now view the window settings and change the values to best fit your function.

Lesson 12 – Graphing Multiple Exponential Functions

(Example: IM Lesson 12.2: Equations and Their Graphs)

1. To graph multiple exponential functions, press MENU then 5 – GRAPH.



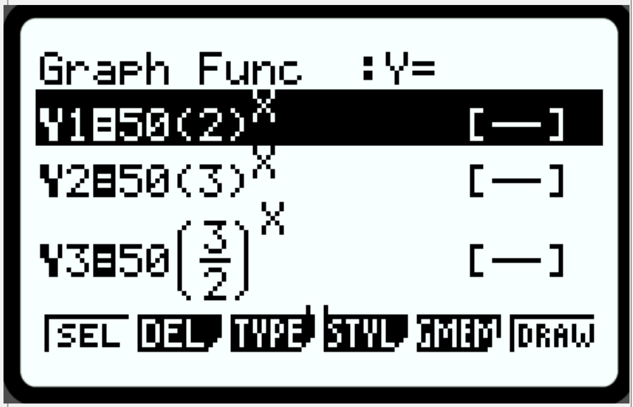
2. In each line, type in one function at a time, then hit EXE. The calculator will automatically move to the next line to enter the next function. Enter the following functions for this task:

$$f(x) = 50(2)^x$$

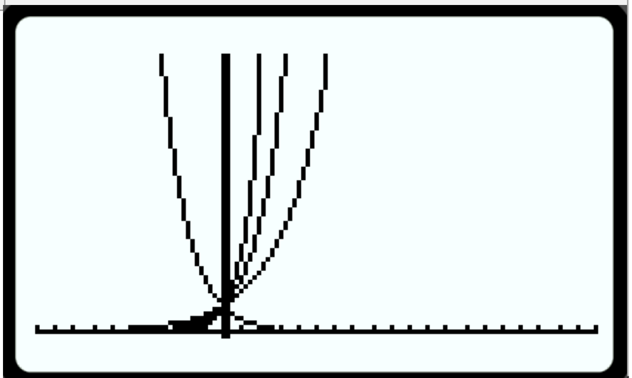
$$f(x) = 50(3)^x$$

$$f(x) = 50(\frac{3}{2})^x$$

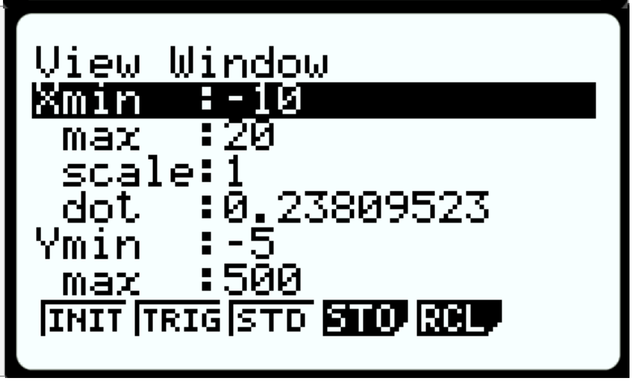
$$f(x) = 50(0.5)^x$$



3. Once each function is typed in the graph entry screen, press F6 – DRAW to view the graphs of all the functions.



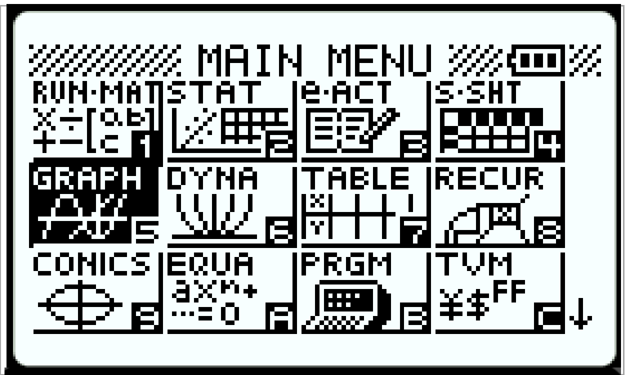
4. If you cannot see all the functions well, you may have to change your window. From the graph screen, press F3 **– V-Window**.



Lesson 12 PP – Graphing a Function and Viewing the Table

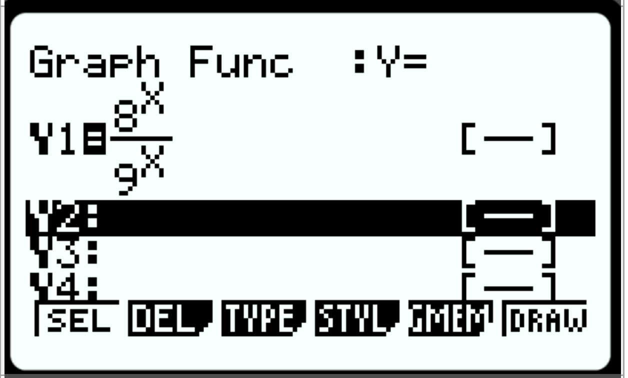
(Example: IM Lesson 12: Practice Problem #6)

1. After creating an equation for the area ***A*** at stage ***n***, you will need to graph next. Go to MENU then 5 – GRAPH.

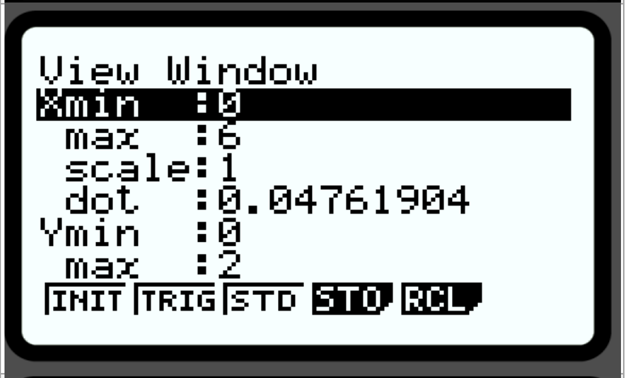


2. The equation we want to graph is $A = \frac{8^n}{9^n}$. In the calculator we will use the input variable "***x***" instead of "***n***".

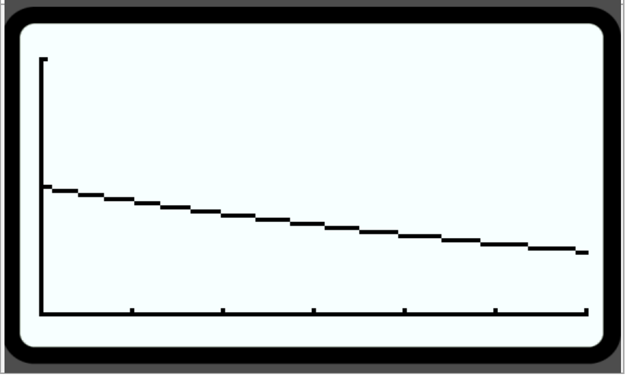
   Press the fraction button, then type 8^x in the numerator, press the down arrow, and type 9^x in the denominator. Press EXE when finished.

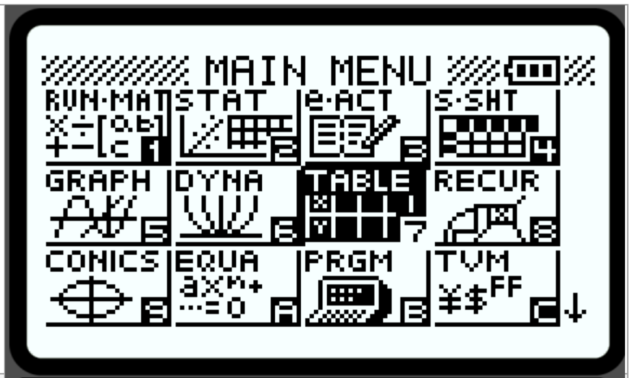
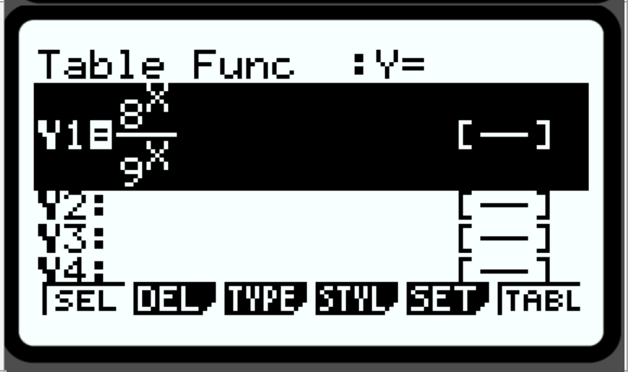


3. Press F6 – DRAW to view the function. If you cannot see the graph, press F3 **– V-Window** from the graph window and adjust the values.



4. When you are finished, press EXE to then see the graph with the new window settings.

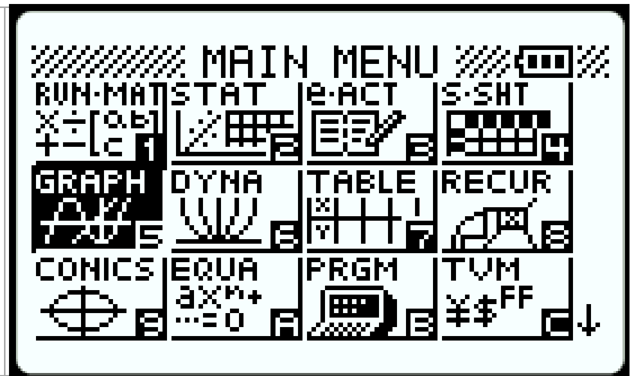


<table>
<tr>
<td>5. To find the first stage when the area is less than ½ square unit, we can look at the table. From within the Graph App, press [MENU] then [7] – TABLE to switch to the Table App.</td>
<td>
</td>
</tr>
<tr>
<td>6. Now press [F6] to view the table. Remember, any functions entered in the Graph App are automatically stored in the Table App and vice versa.</td>
<td>
</td>
</tr>
<tr>
<td>7. We want to find the first x-value where the y-value is just at or below 0.5. At the x-value of 5, the y-value is over 0.5 so we will use the value of 6, since it's y-value is slightly below 0.5 at 0.4932.</td>
<td>
</td>
</tr>
</table>

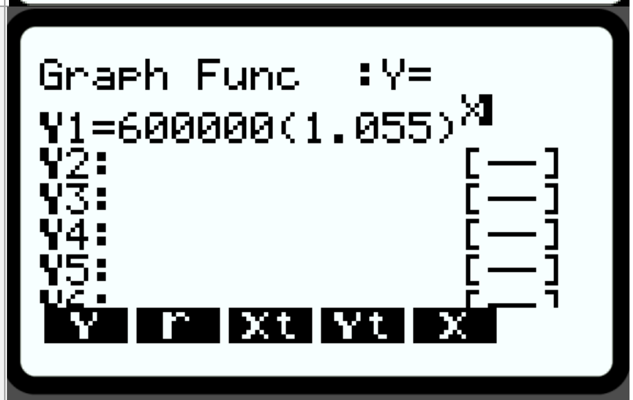
Lesson 13 PP – Choosing a Graphing Window

(Example: IM Lesson 13: Practice Problem #5.)

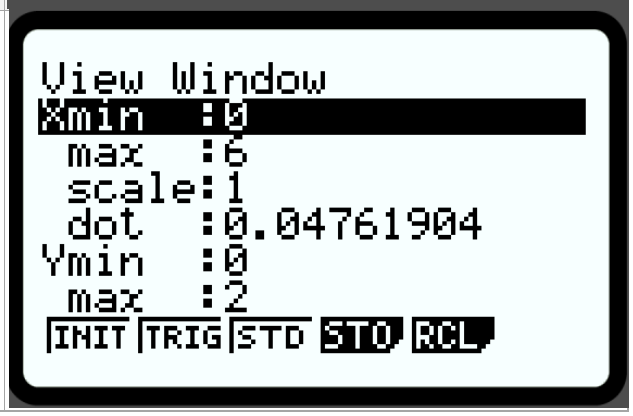
1. Before finding the appropriate graphing window, go to MENU then 5 – GRAPH.



2. Type the function $600,000(1.055)^x$ on the first line. Then press F6 – DRAW to view the graph.



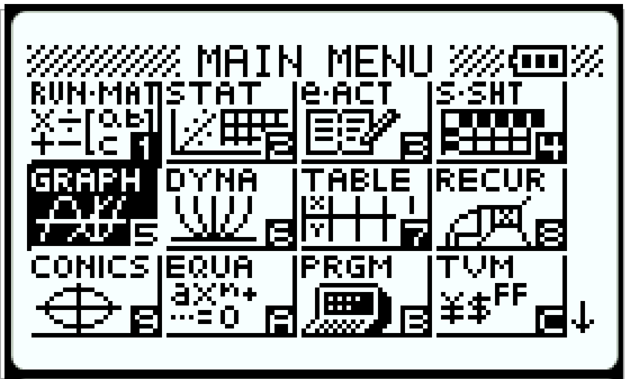
3. From the graph window, you can view/change the graph window by pressing F3 **– V-Window**. Now you can change the values of the **Xmin/max**, etc.



Lesson 19– Graphing to Compare Linear and Exponential Functions

(Example: IM Lesson 19.3: Reaching 2,000 -Activity Synthesis)

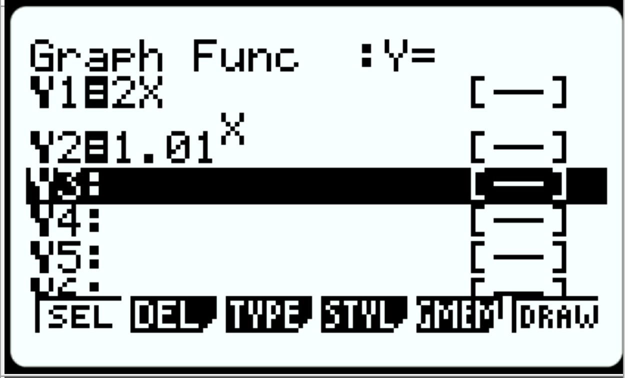
1. In this problem, we will be comparing the graph of a linear function to that of an exponential function. Press MENU followed by 5 – GRAPH to go to the **Graph App**.



2. Type the following functions for **Y1** and **Y2**:

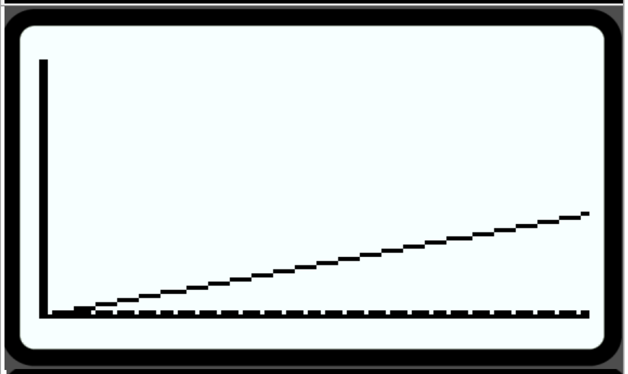
$$f(x) = 2x$$

$$g(x) = 1.01^x$$

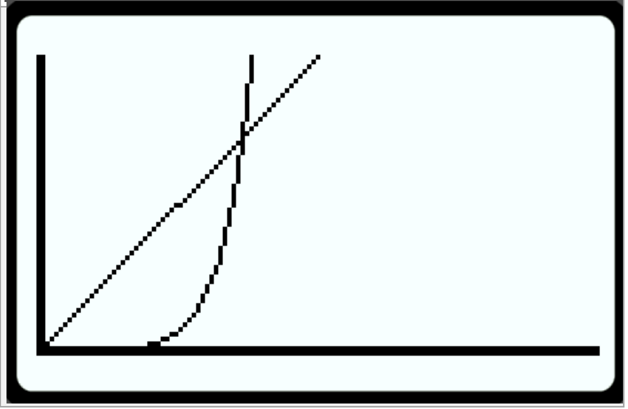


3. When you graph these functions, setting your window is crucial for seeing the big picture. If your window is too small, it might not seem like the exponential function ***g*** is ever greater than the linear function ***f***.

   The picture on the right shows a window too narrow. If you look at the next step there is a better view of these functions.



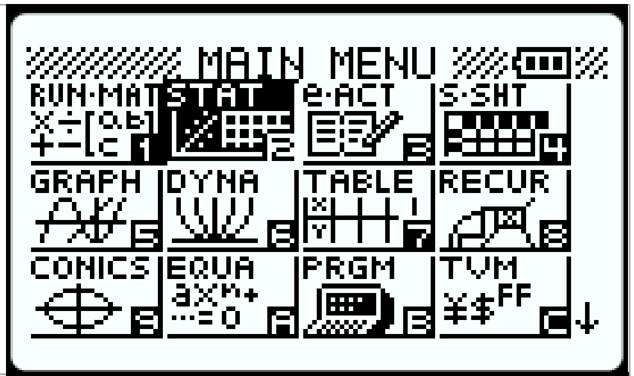
4. Here is the graph when the ***x*-values** have been changed to a **domain** of 0 to 2,000 and the ***y*-values** have been changed to a range of 0 to 2,000. Now it becomes clear, that the exponential growth function will overtake a linear growth function.



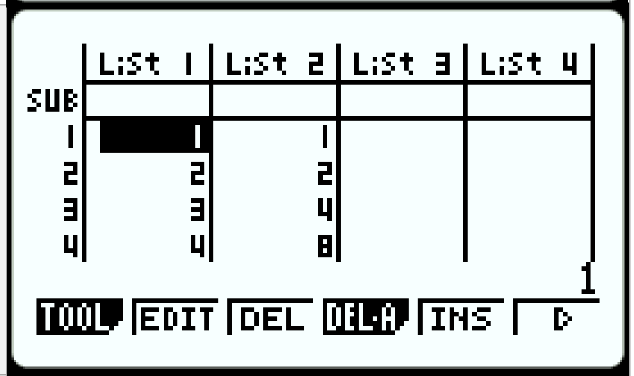
Lesson 21 – Plotting Data to Determine Model Type & Make Predictions

(Example: IM Lesson 21.2: Population Predictions 1)

1. To better visualize the given population data, we will enter it in the **Statistics App** to create data plots. Press [MENU] then [2] – STAT.

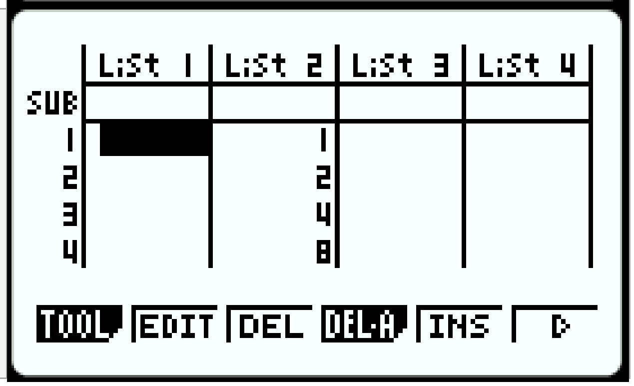


2. To delete prior data, first press [F6] – ▷ for the next menu list; shown to the right. Now press [F4] – DEL·A to delete all values in a List.



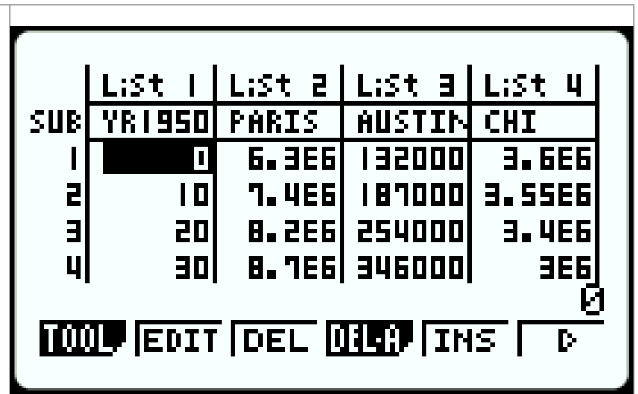
3. A confirmation pop-up window will open. Press [F1] to verify "**Yes**".

4. Repeat as necessary for other data lists.



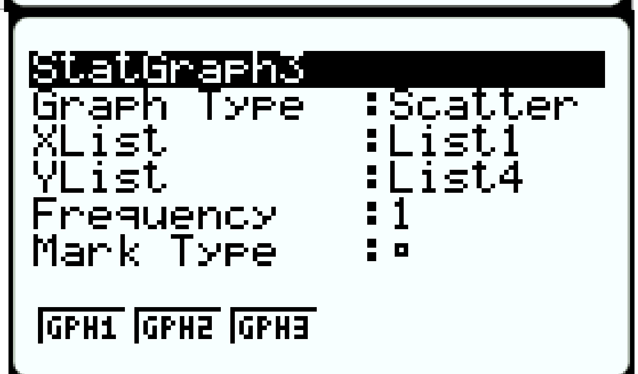
5. Enter the population data given in the task for the 3 cities in each year. This is the same data used in the Warm-Up activity. To model the data and have a meaningful **y-intercept**, enter the years after 1950 in **List 1**. To display large numbers in the lists, the calculator changes **6,300,000** to **6.3E6** to represent **scientific notation** of **6.3 x 10**^{6}.

   It is optional; but you can also use the ALPHA key and enter **names** of your data in the **SUB name** to help organize the lists; as shown.

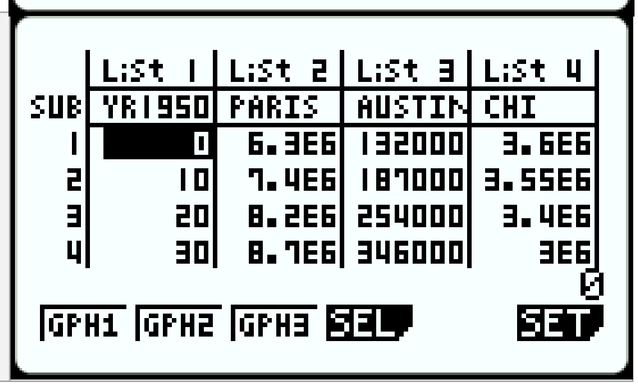


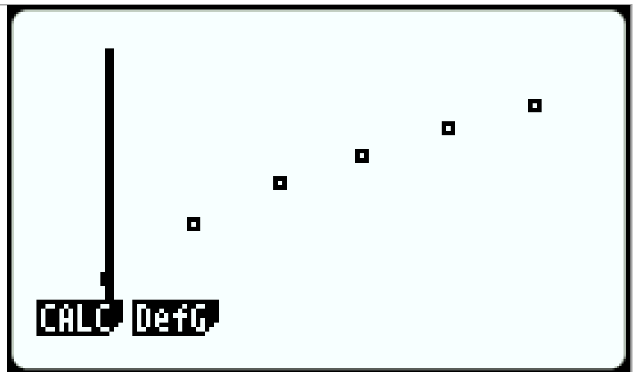
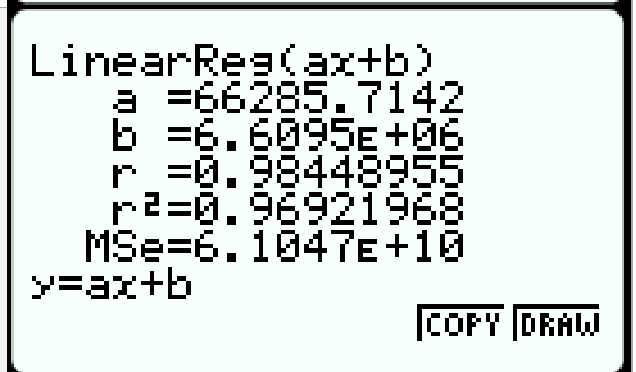
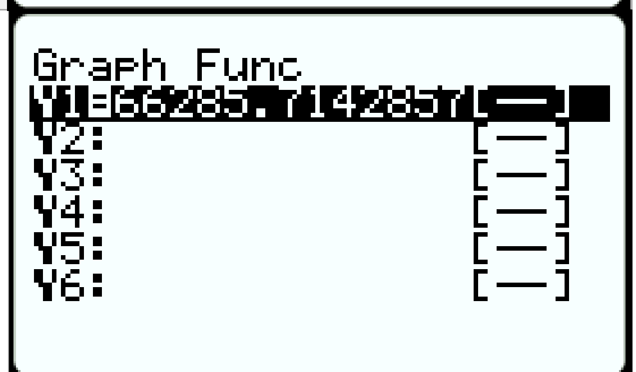
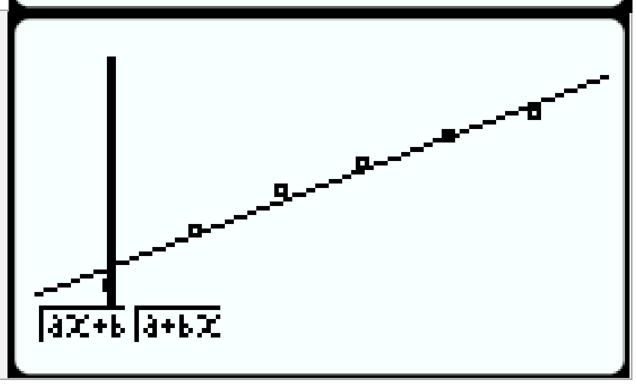
6. Since the data for each city varies greatly, plot each one at a time. Press F6 – ▷ twice to return to the initial menu. Then press F6 – SET to set your **StatGraph** settings. It defaults to **Graph 1**. Select **XList** to **List1** and **YList** to **List2**.

7. Use the F2 and F3 buttons to change the **YLists** for **Graph 2** and **Graph 3**, respectively.

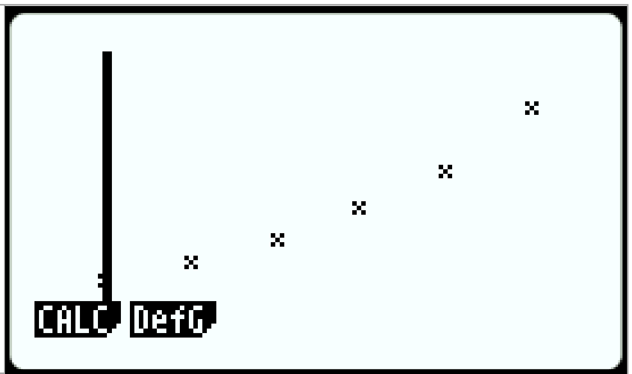


8. Once all 3 graph lists have been set, press either EXIT or EXE to return to the main page.

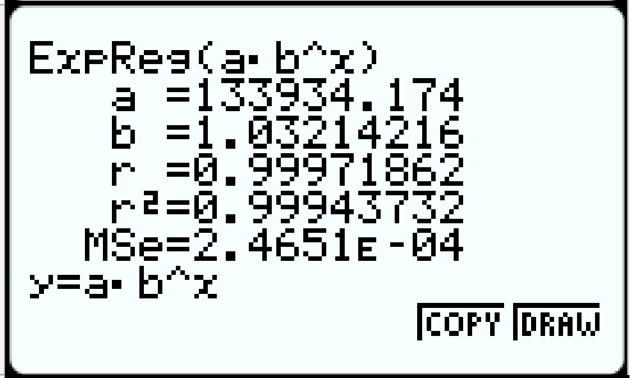


9. From here, pressing [F1], [F2], or [F3] will display **Graphs 1, 2, and 3**, respectively. Press [F1] to view the plot of the population of Paris since 1950. The data looks good modeled by a **linear function**, however the increases do show some slowing from the first couple points and looking at the residual pattern leads us to feel as a better model is available.	
10. Press [F1]–[CALC], [F2]–[X] and then [F1]–[ax+b] to determine the line of best fit for this data; shown to the right.	
11. Press [F5]–[COPY] to copy the regression model to the **Graph App**. Use the arrow down key to highlight where you want the function stored and press [EXE]. We can later use this to predict future populations in Paris.	
12. Press [F6]–[DRAW] to draw the model on the data plot to visually verify the fit.	

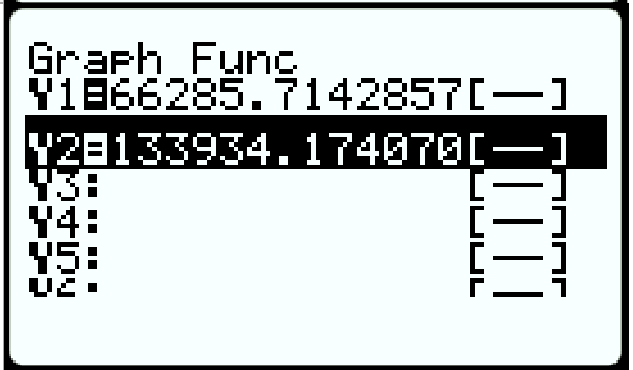
13. Use the EXIT button three times to back out to the original menu. Now, press F2 – GPH2 to repeat the process for **Graph 2**, the population of Austin, TX since 1950. This data appears to fit an **exponential growth** model.



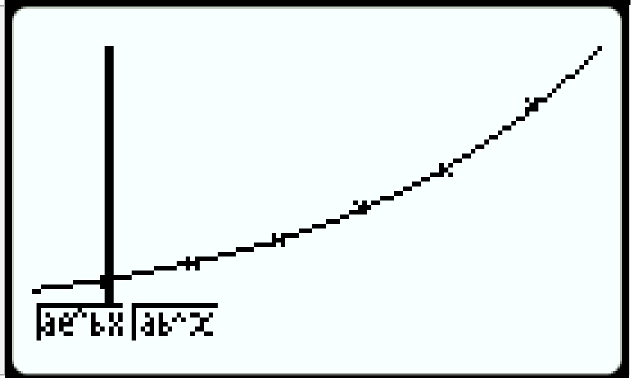
14. Press F1 – CALC, F6 – ▷, F3 – EXP, and then F2 – ab^x to determine the exponential model for this data, shown to the right.



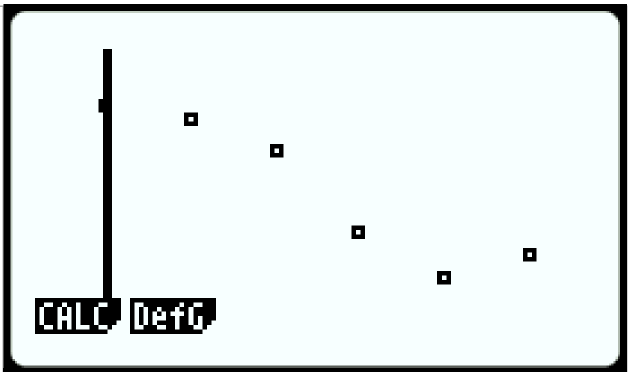
15. As we did for Paris, press F5 – COPY to copy the regression model to the **Graph App**. This time, arrow down to **Y2** to copy the formula there and press EXE. This will return you to the prior screen (in step 14).



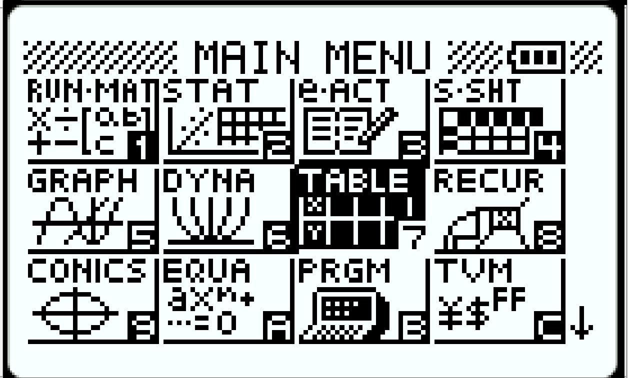
16. Press F6 – DRAW to draw the model on the data plot to visually verify the fit.



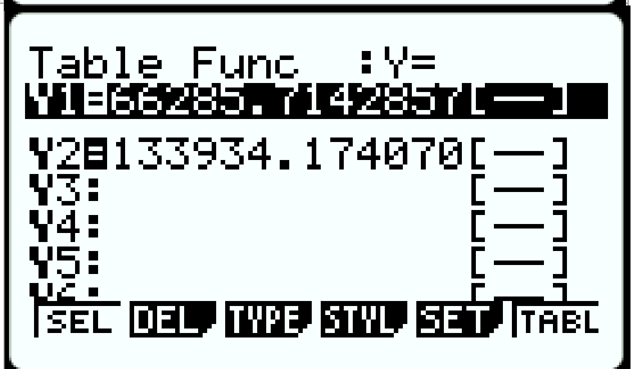
17. Use the [EXIT] button three times to back out to the original menu. Now, press [F3] – GPH3 to repeat the process for **Graph 3**, the population of Chicago since 1950. This data cannot be modeled by either a linear or exponential model. We cannot use either model to predict future population.



18. We are asked to use our models to predict populations in 2010, 2025, and in 2050 in both the cities of Paris and Austin. Let's utilize our models we stored in the Table **App**. Press [MENU] then [7] – TABLE.



19. Our models are also stored in the **Table App**. Both models are based since the year 1950. **2010** would correlate with an input of **60** in our models. **2025** has an input of **75**. Populations in **2050** can be predicted by inputting **100** in our models.



20. Now press [F6] to view the table. Manually enter these values into the table for ***x***. Move the highlighted cell to an output value to see the formula at the top, and the value expanded out at the bottom. The values needed are shown to the right. Remember that extrapolation of data too far away becomes less accurate than interpolated data within the data set.