SPINOFFS

Spinoffs are relatively short learning modules inspired by the LTAs. They can be easily implemented to support student learning in courses ranging from prealgebra through calculus. The Spinoffs typically give students an opportunity to use mathematics in a real world context.

LTA - SPINOFF 7A — Orbits Versus Altitude Regression with TI™ Graphing Calculators

LTA - SPINOFF 7B — Curve Fitting for the Spacelab for Calculus III

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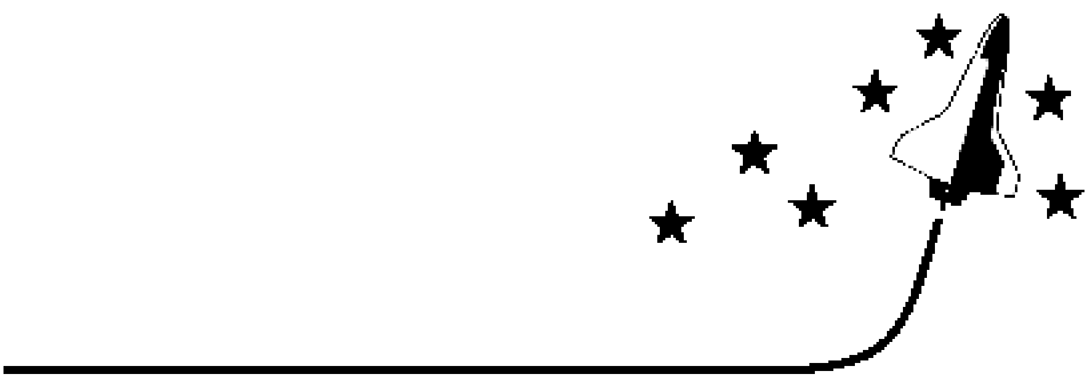

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SPINOFF 7A

Orbits Versus Altitude
Regression with TI™ Graphing Calculators

Section I - Linear Regression with TI™ Graphing Calculators

Part A - Linear Regression with the TI-82™ and TI-83™

If the path the Space Shuttle takes around the earth was nearly circular, then the following data would approximate the orbit length of the trip around the earth at the given altitudes above the earth. The diagram below illustrates two possible orbits at different altitudes. It turns out that if we graph this data, it is approximately linear. It is easy to use your calculator to find the equation of the "best-fit" line for this data. Your calculator does something called linear regression (which minimizes the sum of the squared vertical distances between your points and the line).

Altitude (km)	80	100	150	200	250
Orbit Length (km)	40527	40652	40966	41281	41595

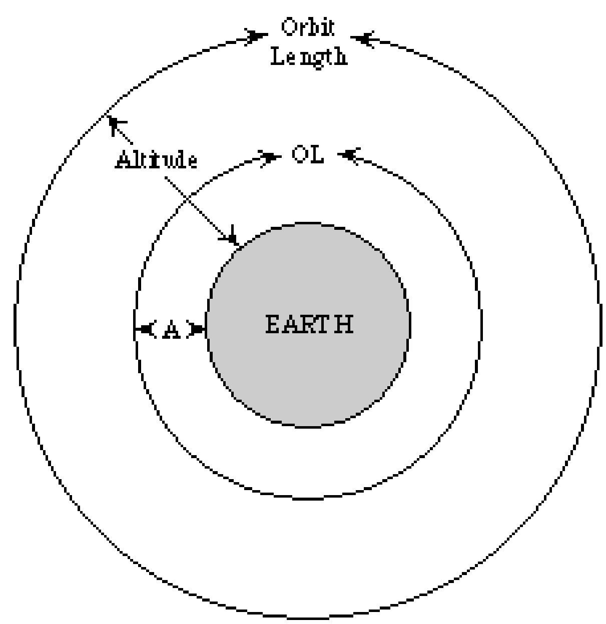

Diagram 1

Keystrokes for Regression: (Note: Keystrokes and menu selections are in **boldface**.)

1) Hit **STAT**, choose **EDIT,** and press **ENTER** to get to the table where you will enter your data.

2) Enter the altitude data into the column labeled L1 and the orbit length data into the column labeled L2. To clear a column that has been used you can move the cursor to the top of the column until it is actually on the list number then hit **CLEAR** and **ENTER**.

3) After entering your data hit **STAT** again, but this time **right arrow** over to **CALC**. Now choose **LinReg(ax+b)** and then **L1 , L2 ENTER**. (L1 and L2 can be found over the 1 and 2 keys, and the comma is on the key above the 7.)

   (Note: You can enter your data into any of the available columns, but when you get to step #3 be sure to indicate which list you use for x and then which list you use for y.)

   You should now see the calculator's results.
   (Round your answers to the nearest thousandth.)

   a) What is the value of "a" and what does it tell you about your line?

   b) What is the physical meaning of the slope for this application?

   c) What is the value of "b" and what does it tell you about your line?

   d) What is the physical meaning of the y-intercept in this scenario?

   e) Write the equation of this line.

   f) The value r that can be seen on the TI-82™ is called the correlation coefficient. To get this information on the TI-83™ you must select **VARS Statistics** right arrow to **EQ** and then choose **r**. (Or you can choose **Catalog** then **Diagnostics On** if you would like r to always show up when doing regression.) Record the value of r for this data.

Graphing your data:

You would also like to see a scatterplot of this data and how well this line fits the scatterplot.

Scatterplot:

1) First go to the **Y=** editor and turn off any equation you have on.

2) Next hit **STAT PLOT** which is above the Y= key and choose: **Plot1**
   On Type: ⋰⋅⋅⋅ Xlist: **L1** Ylist: **L2** Mark: **+**

3) Next choose **ZOOM** and then **ZoomStat** to get the calculator to pick a good window to display this data.

Line:

To get the regression line drawn into your scatterplot go to an empty line in the **Y=** editor, hit **VARS**, select **Statistics**, right arrow to **EQ**, choose **RegEQ**, and hit **ENTER GRAPH**. This will give you a visual check of how well your line fits the data.

Notes:

1) When you are finished with your scatterplot, don't forget to go back into STAT PLOT and turn it off.

2) Next time you want to do regression, start by clearing out your old lists. To do this, you can hit **STAT**, choose **4:ClrList**, and then press **2nd L1 ENTER**. Do the same to clear out list L2.

Part B - Linear Regression with the TI-85™

If the path the Space Shuttle takes around the earth was nearly circular, then the following data would approximate the orbit length of the trip around the earth at the given altitudes above the earth. The diagram below illustrates two possible orbits at different altitudes. It turns out that if we graph this data, it is approximately linear. It is easy to use your calculator to find the equation of the "best-fit" line for this data. Your calculator does something called linear regression (which minimizes the sum of the squared vertical distances between your points and the line).

Altitude (km)	80	100	150	200	250
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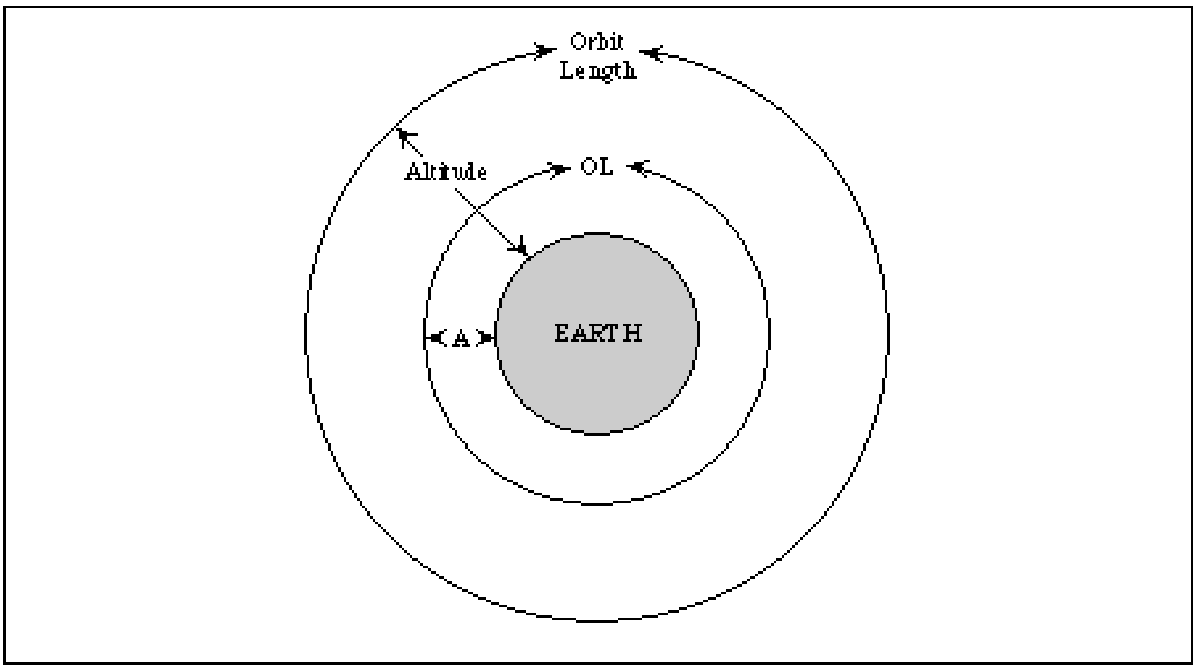

Diagram 2

Keystrokes for Regression: (Note: Keystrokes and menu selections are in **boldface**.)

1) Hit **STAT**, choose **F2** for EDIT, and then hit **ENTER** twice to O.K. the names the calculator will use for your lists or rename them.

2) You will then enter the first data point as x1= 80 and y1= 40527 and continue until all data have been entered. (If your lists already contain data, hit **CLRxy** to clear the lists, then enter your data.)

3) After entering your data hit **EXIT** to back up one menu and then choose **F1** for the CALC menu. Once again you will have to accept the names for the lists which the calculator will use to do the calculations by hitting **ENTER** twice or change the names if they are not the lists you are using. Then choose **LINR**.

   You should now see the calculator's results. On the TI-85™, "a" is your y-intercept and "b" is your slope. (Round your answers to the nearest thousandth.)

   a) Write the equation for the regression line.

   b) What is the physical meaning of the y-intercept for this situation?

   c) What is the physical meaning of the slope in this situation?

   d) Write down the value of the correlation coefficient (corr) for this data. Note: The correlation coefficient is often represented in texts by the letter "r".

<u>Graphing your data</u>:

You would also like to see a scatterplot of this data and how well this line fits the scatterplot.

<u>Scatterplot</u>:

1) Hit **GRAPH**, choose the **y(x)=** , and turn off any equation you have on by pressing **F5** for SELCT. Choose **RANGE** and set up the window so that it is appropriate for this data.

2) After choosing an appropriate window, hit **QUIT** to get back to the home screen and then select **STAT DRAW SCAT**.

<u>Line</u>:

1) If you then choose **DRREG** you will see the regression line drawn in through your scatterplot. This will give you a visual check of how well your line fits the data, however you will not be able to trace on this line.

2) To be able to trace on the line you will need to get the equation into your y(x) = menu. You can do this by either typing it in by hand or hitting **Graph y(x)=** , going to an empty line, and selecting **STAT VARS MORE MORE RegEQ** to paste the regression equation into the y (x)= editor. Now hit **EXIT** and press **2nd F5** to select GRAPH. You will see the line and be able to trace on it.

<u>Note</u>:

When you are finished with your scatterplot, choose **CLRDRW** to clear your graph of the scatterplot. (**CLRDRW** is in the **STAT DRAW** submenu.)

Part C - Linear Regression with the TI-86™

If the path the Space Shuttle takes around the earth was nearly circular, then the following data would approximate the orbit length of the trip around the earth at the given altitudes above the earth. The diagram below illustrates two possible orbits at different altitudes. It turns out that if we graph this data, it is approximately linear. It is easy to use your calculator to find the equation of the "best-fit" line for this data. Your calculator does something called linear regression (which minimizes the sum of the squared vertical distances between your points and the line).

Altitude (km)	80	100	150	200	250
Orbit Length (km)	40527	40652	40966	41281	41595

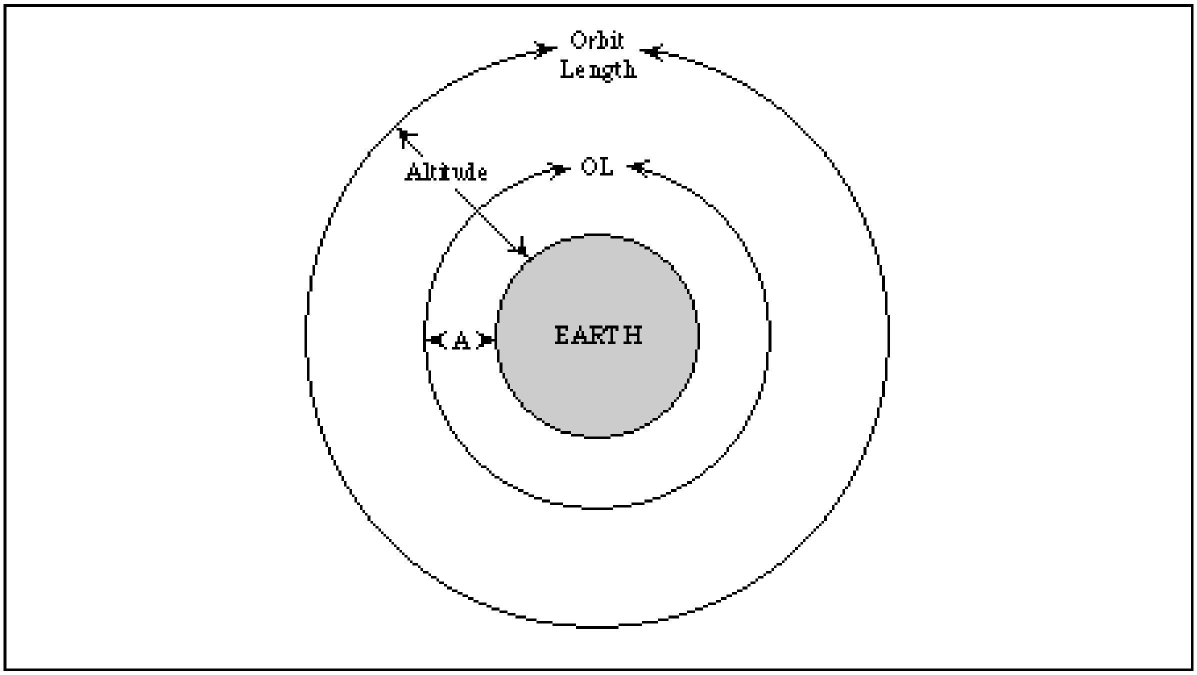

Diagram 3

Keystrokes for Regression: (Note: Keystrokes and menu selections are in **boldface**.)

1) Hit **2nd STAT** and then choose **F2** for edit.

2) You will then enter the altitude data into the column labeled xStat and the orbit length into yStat. If these lists already contain data, **up arrow** until the cursor is on top of the list name, xStat, and then hit **CLEAR ENTER**.

3) After entering your data hit **EXIT** to return to the home screen. Then hit **2nd STAT** again and choose **F1** for the CALC menu. Then choose **LINR** followed by **2nd CATLG-VARS MORE MORE STAT xStat , CATLG-VARS yStat ENTER**. You can also type the xStat and yStat in by hand, but be careful, it's case sensitive.

   (Alternative: You can enter lists similarly through the list editor or you can enter lists by typing : **{0,1,2,3,4} STOR L1** and **{2.5,3.2,3.9,4.3,4.8} STOR L2**. Then in step 3 you would tell the calculator that you are doing linear regression with **L1, L2** or whatever names you stored your lists as.)

   You should now see the calculator's results. (Round your answers to the nearest thousandth.)

   a) What is the value of "a" and what does it tell you about your line?

   b) What is the physical meaning of the slope for this application?

   c) What is the value of "b" and what does it tell you about your line?

   d) What is the physical meaning of the y-intercept in this scenario?

   e) Write the equation of this line.

   f) Write down the value of the correlation coefficient (corr) for this data. Note: The correlation coefficient is often represented in texts by the letter "r".

Graphing your data:

You would also like to see a scatterplot of this data and how well this line fits the scatterplot.

Scatterplot:

1) From the home screen, hit **2nd STAT F3** to choose PLOT.

2) Select **F1** to choose PLOT1 and choose the following options:
   On type= **SCAT** Xlist Name = **xStat** Ylist Name = **yStat** Mark = **+**

3) **EXIT** to the home screen and choose **GRAPH ZOOM MORE ZDATA** to get the calculator to pick a good window to display this data.

Line:

From the home screen, hit **Graph y = 2nd CATLG-VARS MORE STAT RegEQ ENTER** to paste the regression equation into the y = editor. Now choose **GRAPH** to see how close your line comes to the data.

Part D - Linear Regression with the TI-92™

If the path the Space Shuttle takes around the earth was nearly circular, then the following data approximates the orbit length of the trip around the earth at the given altitudes above the earth. The diagram below illustrates two possible orbits at different altitudes. It turns out that if we graph this data it is approximately linear. It is easy to use your calculator to find the equation of the "best-fit" line for this data. Your calculator does something called linear regression (which minimizes the sum of the squared vertical distances between your points and the line).

Altitude (km)	80	100	150	200	250
Orbit Length (km)	40527	40652	40966	41281	41595

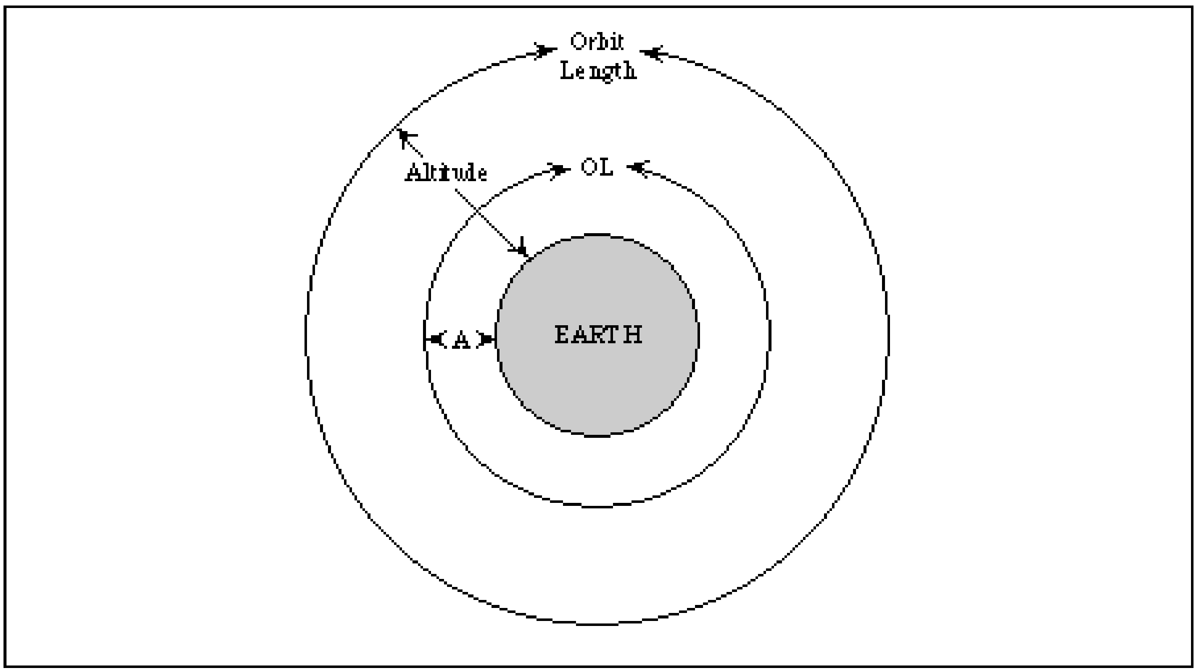

Diagram 4

Keystrokes for Regression: (Note: Keystrokes and menu selections are in **boldface**.)

1) Hit **Apps** and then choose **6:Data/Matrix Editor** and then **3:New**.

2) Choose **Type:Data** (use the right and down arrows to make changes when necessary), **Folder:Main**, and then under variable type in a name, such as: **Variable:orbit**. Hit **ENTER** twice and you should see a table.

3) You should then enter the altitude data from above into the column labeled c1 and the orbit length data into the column labeled c2.

4) After entering your data hit **F5:Calc**, use the right arrow to select **Calculation Type.. 5:LinReg**, the down arrow and fill in **x........ c1** and **y..........c2**. Next choose **Store RegEQ to .. y1(x)**. Leave **Use Freq and Categories? No** and then finally hit **ENTER.**
You should now see the calculator's results.

(Round your answers to the nearest thousandth.)

a) What is the value of "a" and what does it tell you about your line?

b) What is the physical meaning of the slope for this application?

c) What is the value of "b" and what does it tell you about your line?

d) What is the physical meaning of the y-intercept in this scenario?

e) Write the equation of this line.

f) Write down the value of the correlation coefficient (corr) for this data. Note: The correlation coefficient is often represented in texts by the letter "r".

Graphing your data:

You would also like to see a scatterplot of this data and how well this line fits the scatterplot. After finding your equation hit **ENTER** to return to your table and then **2nd QUIT** to return to the home screen.

Scatterplot:

1) From the home screen go to your **Y=** screen. You should see your regression equation in y1 and marked with an x, meaning that it is turned on and will show up on your graph.

2) Next move the cursor up to **Plot 1:** and hit **ENTER**.

3) Choose
Plot Type......... Scatter
Mark....... Box
x......c1
y......c2
Use Freq and Categories? No
and then hit **ENTER**.

4) Now choose **F2:Zoom** and then **ZoomData** to get the calculator to pick a good window to display this data. You should see the scatterplot and your regression line.

Section II - Investigation

For each of the following examples:

a) find the regression equation,
b) sketch a graph of the scatterplot and the regression line, and
c) record the correlation coefficient for the data.

1)

Time (sec)	0	1	2	3	4
Distance (m)	3.5	3.2	3.9	4.3	4.5

2)

Time (sec)	0	1	2	3	4
Distance (m)	5.0	3.2	3.4	4.3	4.8

3)

Time (sec)	0	1	2	3	4
Distance (m)	5.0	4.6	4.2	3.8	3.4

4) Make a hypothesis about what the correlation coefficient is telling you, and then make up some of your own data sets to test your theory.

Section III - Quadratic Regression

NASA's Johnson Space Center operates a KC-135 aircraft which can achieve low-gravity for approximately 15 to 25 seconds. The plane is used for training astronauts and for conducting experiments. This aircraft was also used in the filming of Apollo 13 for the "weightlessness" scenes. Information about these low gravity experiments was obtained from the NASA Educational Brief ,"The Mathematics of Microgravity", EB-1997-02-119-HQ.

The plane climbs very rapidly at a 45 degree angle to a height of approximately 7.3 km and then follows the path of a parabola. During this portion of the flight the passengers experience near weightlessness. Typically during a single flight the crew will fly 40 parabolic trajectories. This plane has been nicknamed the "vomit comet" for obvious reasons.

The following data describes one such parabolic path. Time is measured in seconds after the parabolic flight begins.

Time (sec)	Altitude (km)
0	7.300
5	9.625
10	10.400
15	9.625
20	7.300

Your calculator can find a "best fit" quadratic equation as well as "best-fit" linear equation through regression. If you are using a TI-82™, TI-83™, or TI-92™, use the same steps as for linear regression except use **QuadReg** instead of LinReg. If you are using a TI-85™ or TI-86™, Choose **P2Reg** instead of LinReg. (This means that your equation has a second power leading term).

1) What is the equation of the parabola that fits this data?

2) Determine the altitude of the plane after 4 seconds.

3) At what time(s) is the altitude of the plane 9 km?