MA082: Intermediate Algebra
Quadratic Models for the Path of a Hurricane

Part I: Pick a single hurricane to model.

Step 1: Go to www.nhc.noaa.gov, the home page for
The National Weather Service,
National Hurricane Center (NHC),
Tropical Prediction Center.

Step 2: Scroll down to:

Hurricane Season Summaries and Reports

Atlantic: Monthly Tropical Cyclone Summary | Tropical Cyclone Reports
Eastern Pacific: Monthly Tropical Cyclone Summary | Tropical Cyclone Reports

And click on Tropical Cyclone Reports in the line for the **Atlantic**.

Step 3: Investigate past hurricanes. Pick a year and follow the links to a list (by name) of the hurricanes and tropical storms that occurred.

Once you are on the screen for any particular year, scroll to the bottom to examine the map of *all* the hurricanes for that year. Click directly on this map to enlarge it. Keep browsing until you find a hurricane you like.

Step 4: Choose your hurricane. Be sure to pick one from 1995 to 2013 because the NHC data files are much easier to read. Also, pick one that follows a parabolic path!

Part II: Collect & print the data and maps you will need.

Step 5: Once you find your hurricane, you must access its Tropical Cyclone Report, read it and print the pages you need. The reports are listed at the top of the page for each year. Click out of the map via the back button, scroll up and click on "your" hurricane's name. Depending upon the year, these reports are available in PDF, Word or KMZ format. Once you access the Report, be sure to print your hurricane map (Figure 1) and best track data (Table 1).

For extra copies of the Atlantic Hurricane Tracking Chart, go to:

http://www.nhc.noaa.gov/tracking_charts.shtml

Step 6: Read and verify your understanding of the latitude and longitude data from the best track chart and positions. Be sure to align them properly with your hurricane's map.

Part III: Build your graphs and create your equations.

Step 7: Convert the latitude and longitude readings for your hurricane's path into the Cartesian Coordinate Plane that **we created together in Workshop**.

Step 8: Calculate one or more quadratic models (within the XY Plane) that follow(s) the path of your hurricane. Draw these graphs directly onto your hurricane's chart and verify graphically that your models align with your hurricane's track.

Part IV: Assemble your Report.

Your Report must include:

1. Introduction
    Discuss what a hurricane is and who studies them. State which hurricane you chose and why. Give a *brief* summary of the path and aftermath of your hurricane. (Where did it go; what did it do?)

2. Methods and Materials
    Explain exactly *how* you proceeded with your investigation, what materials you used (maps, calculators, software, etc.) and what methods you employed (quadratic functions, simultaneous equations, etc.)

3. The Maps
    Your hand-drawn map must show the actual path of the hurricane with *all* models superimposed on it. It must be well-labeled and neat. All models must be listed and color coded. **This map must be hand-drawn**.

4. The Calculations
    Your algebraic **calculations**, mathematical observations and a full explanation of same. Verify your calculations with **QuadReg**. Show numeric (a Table) and graphic (a Graph) verification that your model follows the path of the hurricane within the *interval* you specify. You can use the Graph Link software in B109 to print your graphs from your TI calculator.

5. Observations and Conclusion
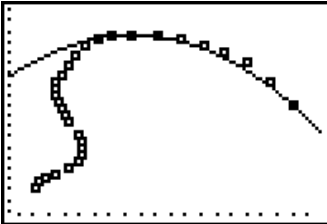   Summarize what you learned about mathematical modeling and about hurricanes. (But mostly, the MATH!)
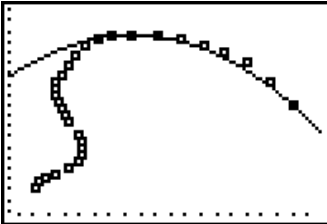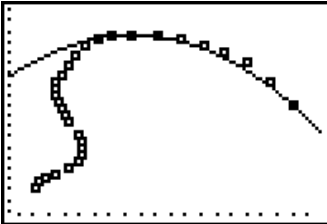
Quadratic Models for the Path of a Hurricane

Here are some sample questions you can consider to write up your conclusion.

- What algebraic processes did you use in creating your mathematical model? What processes worked well and which did not?

- How does the mathematics of quadratic functions relate to the physical realities of your hurricane's path?

- How did you assign x and y coordinate values to the latitude and longitude data from the Best Track Data? What did x represent? What did y represent?

- What pieces of your hurricane's path where the easiest to model? Why?

- Which pieces of your hurricane's path were the hardest to analyze? Why?

- Did your model closely follow the hurricanes path? Why or why not?

- Your model is called a "best-fit." Explain what this means especially to the people living in the path of a hurricane.

- We used only quadratic functions for this analysis. What other mathematical functions could be used? Explain why these other functions are necessary and how they might be used.

- Consider the real-world scenario of a moving hurricane. How would this affect the construction of your model?

MA082: Intermediate Algebra
Quadratic Models for the Path of a Hurricane

How to Compute a Modeling Equation of the Form $y = a(x-h)^2 + k$,
a.k.a. The Vertex Form of a Quadratic Function

Step 1: Look at the tracking data. STAT > EDIT 	2nd STATPLOT >

ZOOM 9 **Step 2:** Choose a likely VERTEX point (*h,k*). 	**Step 3:** Choose one anchor point (*x,y*).

Step 4: Start with $y = a(x-h)^2 + k$, the Vertex Form of a Parabolic Function.

Step 5: Substitute the vertex you chose for *(h,k)* and the *(x,y)* point to form the equation, and solve for *a*:

$For\ the\ Vertex\ (29.5, 89.6) \Rightarrow y = a(x - 29.5)^2 + 89.6$

$For\ the\ annchor\ po\mathit{int}\ (40.1, 82.9) \Rightarrow (82.9) = a(40.1 - 29.5)^2 + 89.6$

$(82.9) = a(40.1 - 29.5)^2 + 89.6$

$82.9 = 112.36a + 89.6$

$a = \dfrac{-6.7}{112.36} = -0.0596$

Step 6: Verify Graphically.

Step 7: Transfer your graph to the appropriate map. Print your screen in B109.

MA082: Intermediate Algebra
Quadratic Models for the Path of a Hurricane

How to Compute a Modeling Equation of the Form $y = ax^2 + bx + c$,
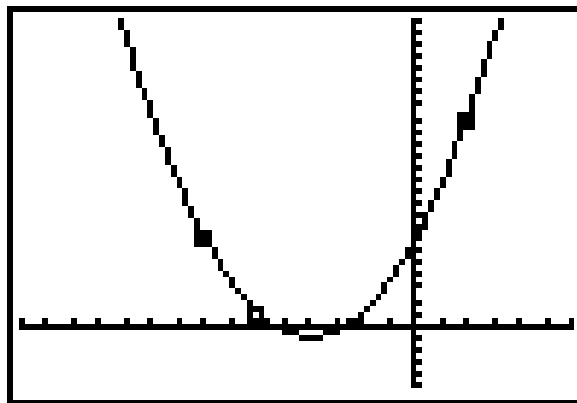a.k.a. The General or Standard Form of a Quadratic Function

STAT > EDIT

L1	L2	L3 3
-8	7	▬▬▬▬
-6	1	
2	17	
------	------	

L3(1)=

2nd STATPLOT > Plot 2

Plot1 **Plot2** Plot3
On Off
Type: ▨ ⬡ ⬛
        ⬡ ⬛ ⬡
Xlist:L₁
Ylist:L₂
Mark: ▫ + ·

ZOOM 9

What's in the Y= screen?

Step 1: Start with $y = ax^2 + bx + c$

Step 2: Substitute the *(x,y)* points to form 3 equations:

$y = ax^2 + bx + c$

For the point $(-8,7) \Rightarrow (7) = a(-8)^2 + b(-8) + c \Rightarrow 64a - 8b + c = 7$

For the point $(-6,1) \Rightarrow (1) = a(-6)^2 + b(-6) + c \Rightarrow 36a - 6b + c = 1$

For the point $(2,17) \Rightarrow (17) = a(2)^2 + b(2) + c \Rightarrow 4a + 2b + c = 17$

Step 3: Solve the System of Equations for *a, b* and *c*.

$64a - 8b + c = 7$

$36a - 6b + c = 1$

$4a + 2b + c = 17$

The work is left to you. Do not forget to verify your answer *graphically*! Print your final screen for your report.

1=Done with 3 or more mistakes	2=Done with 1 or 2 mistakes	3=Done with no mistakes

Your report must include:

1. Introduction   *1   2   3   Missing*
   Discuss what a hurricane is and who studies them. State which hurricane you chose and why. Give a *brief* summary of the path and aftermath of your hurricane. (Where did it go; what did it do?)

2. Methods and Materials   *1   2   3   Missing*
   Explain exactly *how* you proceeded with your investigation, what materials you used (maps, calculators, software, etc.) and what methods you employed (quadratic functions, simultaneous equations, etc.)

3. The Maps
   Your hand-drawn map must show the actual path of the hurricane with *all* models superimposed on it. It must be well-labeled and neat. All models must be listed and color coded. **This map must be hand-drawn**.

   Hand-drawn map is correct: *1   2   3   Missing*

   Models correctly shown: *1   2   3   Missing*

4. The Calculations
   Your algebraic **calculations**, mathematical observations and a full explanation of same. Verify your calculations with **QuadReg**. Show numeric (a Table) and graphic (a Graph) verification that your model follows the path of the hurricane within the *interval* you specify. You can use the Graph Link software in B109 to print your graphs from your TI calculator.

   Calculations for Vertex Form correct: *1   2   3   Missing*

   Graphic Verification: *1   2   3   Missing*

   Calculations for General Form correct: *1   2   3   Missing*

   Graphic Verification: *1   2   3   Missing*

   Quadratic Regression (QuadReg) correct: *1   2   3   Missing*

   Graphic Verification: *1   2   3   Missing*

5. Observations and Conclusion   *1   2   3   Missing*
   Summarize what you learned about mathematical modeling and about hurricanes. (But mostly, the MATH!)

   Mathematics discussed: *1   2   3   Missing*