

10-31-2004

# Baseballs and Quadratic Equations

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## Repository Citation

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CMST SCOLLARCITY “**First tool**” Lesson Plan using your first choice of modeling software, (Due Tuesday, August 3<sup>rd</sup>).

**Submit as hard copy AND electronically through ANGEL**

Name: Mike Peters

Grade level(s)/Subject taught: 9 to 12 Grade Math, Algebra (A) and Geometry (A)

Objectives: (Remember...*How will the modeling tool help the student better learn the objective?*)

The objective of this lesson is for students to see the relationship between the simulation of a real life situation modeled with the Interactive Physics software, the path of a thrown baseball, and the description of the path with a quadratic equation. The student will use the x and y data collected over time in the model and transfer that data into a list in Excel from which a best fit regression program can run on the TI 84 to find the equation of the path of the ball. .

Items to include in your **first tool** lesson plan:

**For the math teacher:**

1. *Write the Mathematical Concept or “key idea” that your first modeling tool will be used to teach: (e.g. Students use mathematical modeling/ multiple representation to provide a means of presenting, interpreting, communicating, and connecting mathematical information and relationships)*

The key idea is to use the modeling of the path taken by a thrown baseball to make a parabola “real” to the student. The mathematical concept is to use multiple presentation methods to show that the path taken by a thrown object acted on by gravity will be a parabola and that the quadratic equations they have been studying have a basis in real life.

## Launch:

Teacher begins the lesson by tossing a tennis ball to a student. (The toss would be underhanded and be up in the air in order to clearly show a parabolic path.) Teacher asks the students whether they knew what kind of path the ball had taken and whether they could write an equation that described that path. (Previous lessons have shown quadratic functions and students have worked with the standard form of the quadratic equation. Students have also explored how changing the coefficients of the standard quadratic equation change the appearance of the graph. Students have also used the graphic calculator to find a best fit line for a set of linear data. )

## Lesson:

In our lesson today we will be using a computer model to show the track or path of a thrown ball. You can change the track of the ball by changing the initial velocity conditions that you give to the ball. Use the slide bars to increase or decrease the starting velocities of the ball. (Teacher demonstrates for the students how to use the computer simulation that has been set up.)

**Interactive Physics - [Quadratic Ball 5]**

File Edit World View Object Define Measure Script Window Help

Run Stop Reset

**Ball Y Velocity**  
13.00

**Ball X Velocity**  
3.00

**Y-Position of Ball**  
y (m)  
t (s)

**X-Position of Ball**  
x (m)  
t (s)

**DIRECTIONS:**  
Find the equation for the path of the baseball.  
1. Set the initial x and y velocity of the baseball using the sliders in the upper left-hand corner.  
2. Click on "Run" in the tool bar above.  
3. Click on "Stop" when the baseball hits the ground.  
4. To rerun the process, click reset and control -e to go back to start.  
5. Try different initial x and y velocities and see what effect they have on the path of the ball. Be able to answer the question about what changing the initial x and y velocities do to the path of the ball.  
6. Set the initial x and y velocities so the ball drops on the field before the wall. Run the program and stop the action when the ball hits the ground. Do not reset.  
7. Click on File, then on Export. In the window that opens click Options and set the number of frames at 3. Click OK. The window should now show the Interactive Physics folder. Name your file "Baseball" and click Export again.  
8. Close the file and open Excel. Open the Baseball file in Excel. A table with four columns will be shown. Use the chart wizard to make a scatter plot of the x and y data. (Highlight the x and y columns.) The resulting graph should look like the path you got in the IP program.  
9. Copy your table values into L1 and L2 in your TI-84. Clear the Y1 value and set Plot 1 to on.  
10. See separate directions on running the quadratic regression line (QuadReg) with the TI-84.

BALL

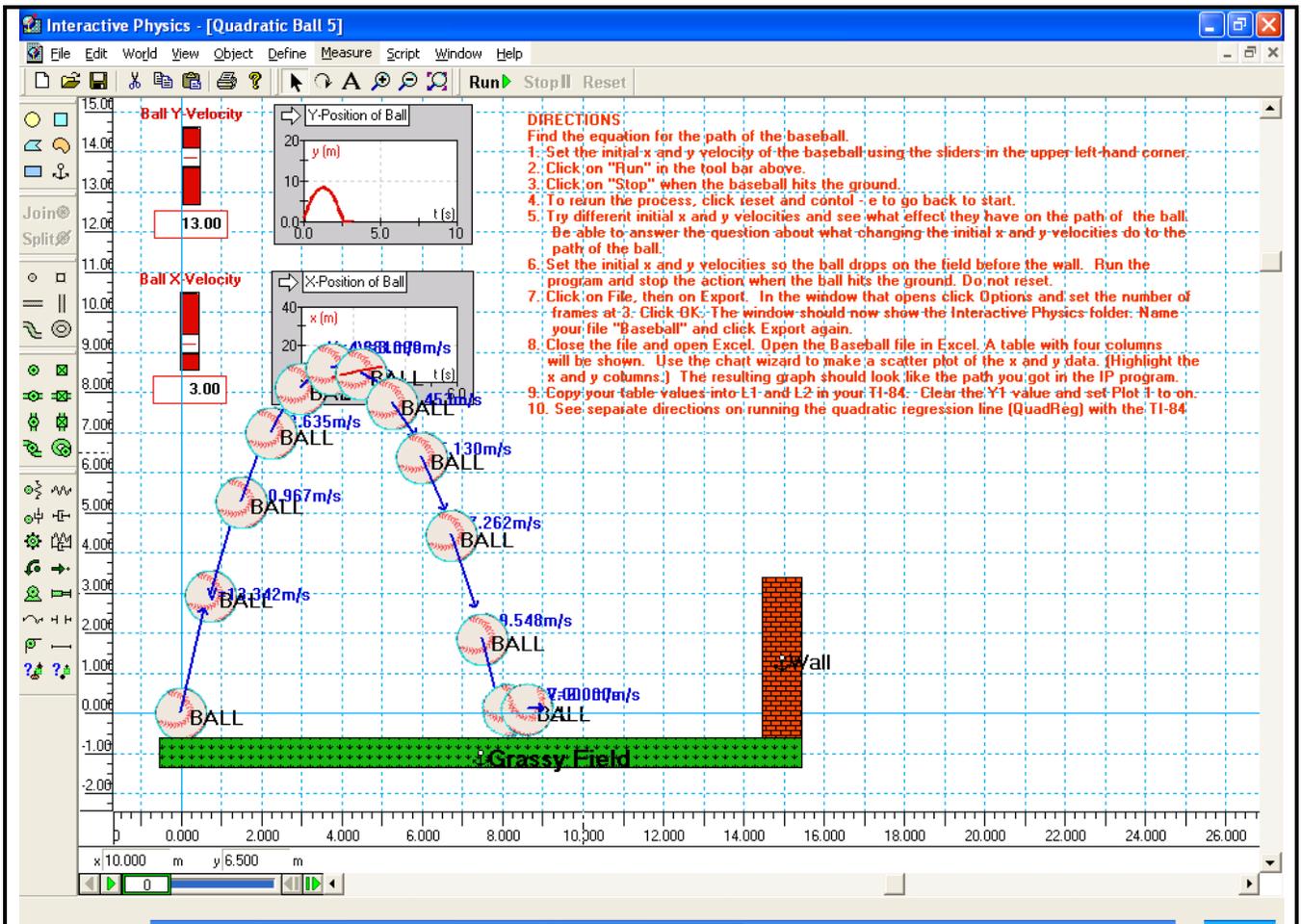
Grassy Field

Wall

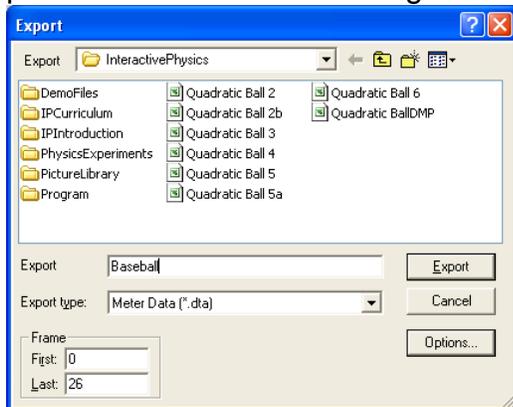
x: 6.750 m y: 2.250 m

0

MPeters\_First\_Tool\_L... Document4 - Microsof... Interactive Physics - ... Microsoft Office Wor... 9:19 AM

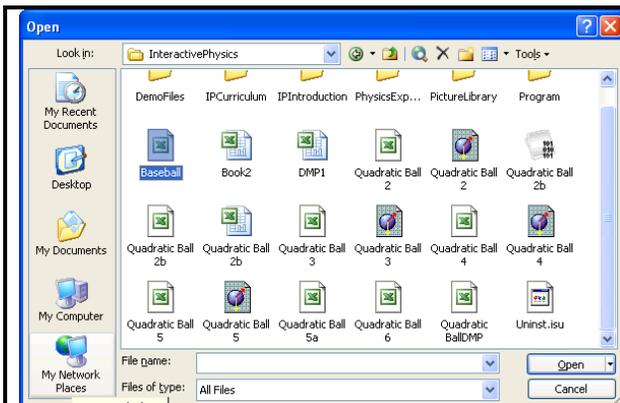


You will use the x and y data for the path captured by the model to make a table. We will use the Export data function of the computer to transfer the x and y values represented by this path in an Excel worksheet. From this set of data points you will use only each 3rd data point so that our lists do not get too big.

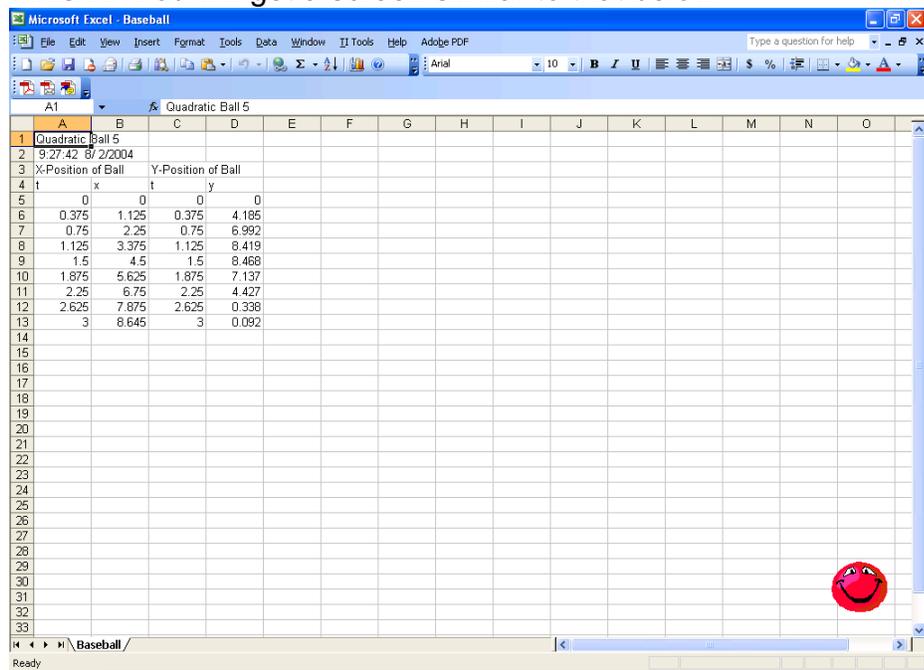


Use the options button to set the number of frames to be collected in the data table.

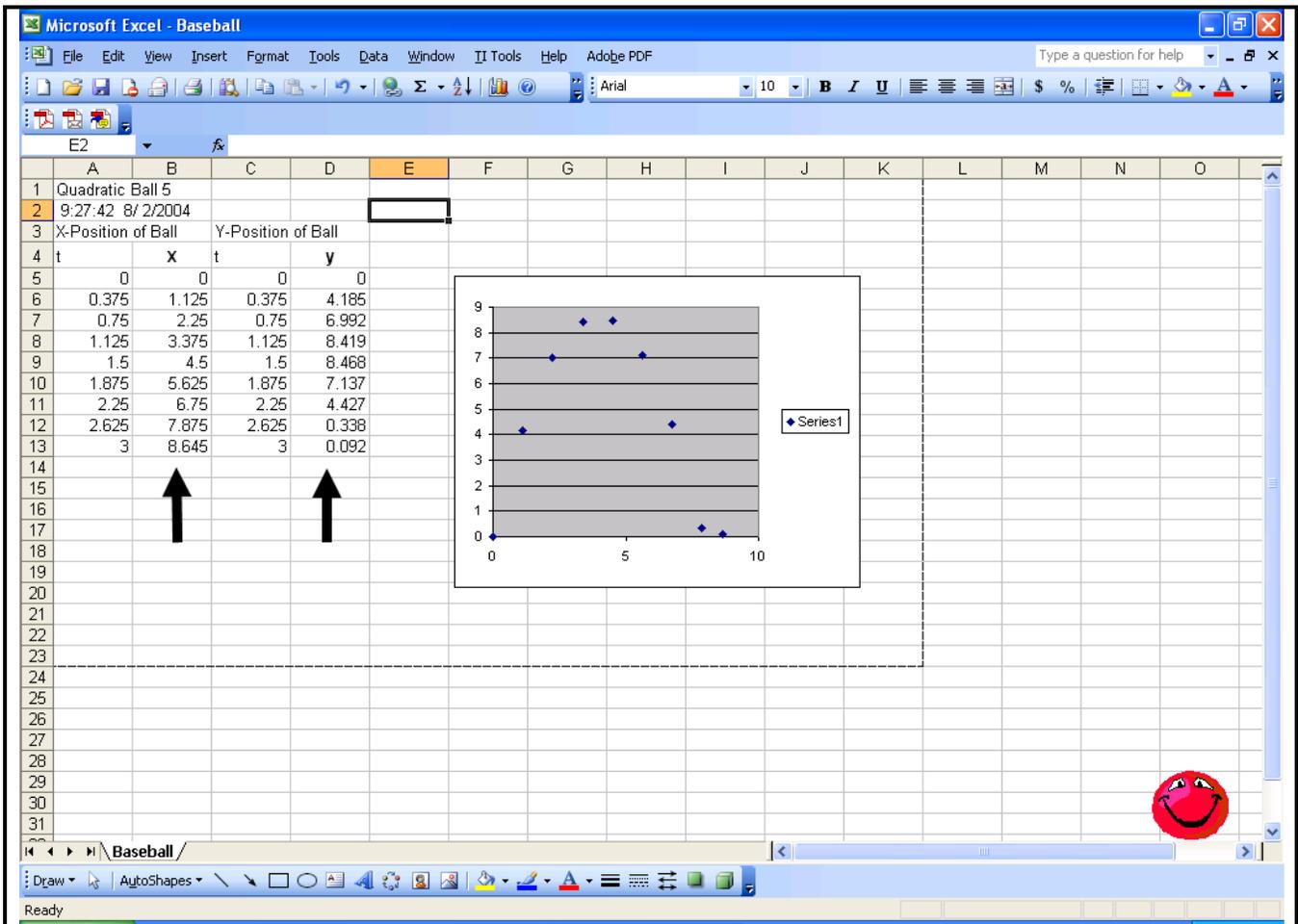
Open Excel and find InteractivePhysics folder. Change the "Files of type" to All Files and then double click on Baseball to open the file in Excel.



The Text Wizard will open and help you format the data. Just keep clicking “next” and then “finish”. You will get a screen similar to that below.



Then use the Chart Wizard function of Excel to make a scatter plot of the x and y data. You will have to highlight the x column of data first and then, holding down “control”, highlight the y column of data. Going through the Chart Wizard you will get a graph like that below.



Now we want to copy the x and y data values into our TI-84 calculators. In your calculator press Stat-Edit-to get the list screen. First clear L1 and L2 or use two empty lists. Copy the x data into L1 and the y data into L2. Then use the Stat Plot key to turn on Plot 1.

<table border="1"> <thead> <tr><th>L1</th><th>L2</th><th>L3</th><th>2</th></tr> </thead> <tbody> <tr><td>0.000</td><td>0.0000</td><td>-----</td><td></td></tr> <tr><td>1.125</td><td>4.185</td><td></td><td></td></tr> <tr><td>2.250</td><td>6.992</td><td></td><td></td></tr> <tr><td>3.375</td><td>8.419</td><td></td><td></td></tr> <tr><td>4.500</td><td>8.468</td><td></td><td></td></tr> <tr><td>5.625</td><td>7.137</td><td></td><td></td></tr> <tr><td>6.750</td><td>4.427</td><td></td><td></td></tr> </tbody> </table>	L1	L2	L3	2	0.000	0.0000	-----		1.125	4.185			2.250	6.992			3.375	8.419			4.500	8.468			5.625	7.137			6.750	4.427			<pre> STAT PLOTS 1:Plot1...Off   [ ] L1  L2  [ ] 2:Plot2...Off   [ ] L3  L4  [ ] 3:Plot3...Off   [ ] L5  L6  [ ] 4↓PlotsOff           </pre>	<pre> Plot1 Plot2 Plot3 [ ] Off Type: [ ] [ ] [ ] Xlist:L1 Ylist:L2 Mark: [ ] + .           </pre>
L1	L2	L3	2																															
0.000	0.0000	-----																																
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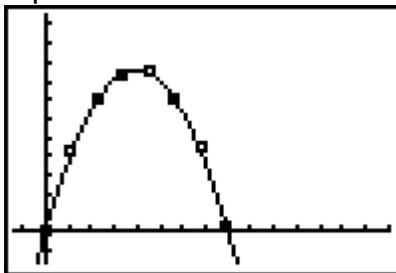
Be sure that y1 in the y= key is empty, then set up the QuadReg function to find the best fit quadratic equation for the data.

We will then put the data from the table into our TI-84 calculators as L1 and L2. Then we will use the QuadReg function to find the quadratic function that best fits that data. Get QuadReg from the catalogue and fill in L1, L2, Y1.

```
QuadReg L1,L2,Y1
█
```

```
QuadReg
y=ax2+bx+c
a=-.545
b=4.333
c=-2.500E-4
R2=1.000
█
```

This gives you the coefficients for the quadratic equation for the path of the ball and the  $R^2$  shows that the line is a perfect fit. You can also press graph and see the graph of the equation.



```
203 Plot2 Plot3
M1 [-.545X^2+4.333+0
M2 =
M3 █
M4 =
M5 =
M6 =
```

We will work in groups of four. Each group will generate a path and set of table values in order to load them into the TI-84 and find the equation of best fit. I will be coming around the room to help you. Each group will need to print out their Simulation, the Excel spreadsheet with their table and graph, and their Quadratic Equation from the calculator and the graph.

For your **first tool** lesson, please describe how you plan on using the desired modeling software package with your students (Stella, AS, GSP, or IP). You might describe what a visitor might see walking into your classroom during this lesson. You might also describe the role of the student during the entire lesson and your role as the teacher. Please try to be specific as possible. Also, construct a tentative rubric that you might use with your students. \*\* see example page 5

“...a rich **one-page, typed, single-spaced**, description or a *vision* of your best thinking...”

Prompts:

1. How will you assess the prior knowledge of the student?
2. How will you begin the lesson?
3. What are the teacher and students doing every 5-10 minutes? (Teacher Actions and Student Actions)
4. How will you assess the learning for the lesson?
5. How will IP, Stella, Agent Sheets, GSP, etc as per rubrics in this packet be integrated into my teaching? (i.e. you may want to discuss a problem or describe how you might use the chosen modeling package in your plan. How does the model/tool help the concept(s) to be taught)?

Using \_\_\_\_\_, *I plan on having my students...*  
(software / modeling package(s))