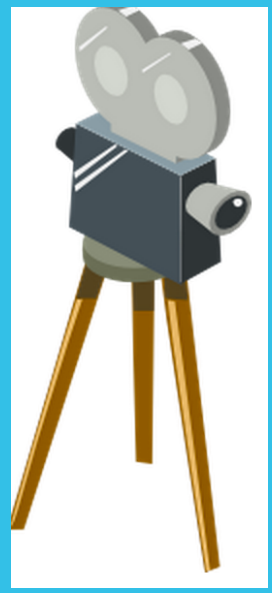
USING VIDEOS AND SENSORS TO CAPTURE REAL WORLD DATA



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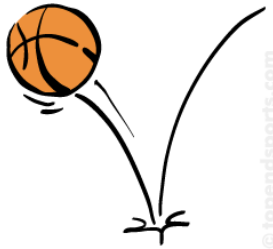
REAL WORLD DATA



- Two Data Collections Activities –

  Create Models and Interpret These Models in Context
- Using LoggerPro, Video Physics App and Sensors

Can help students make sense of functions as models

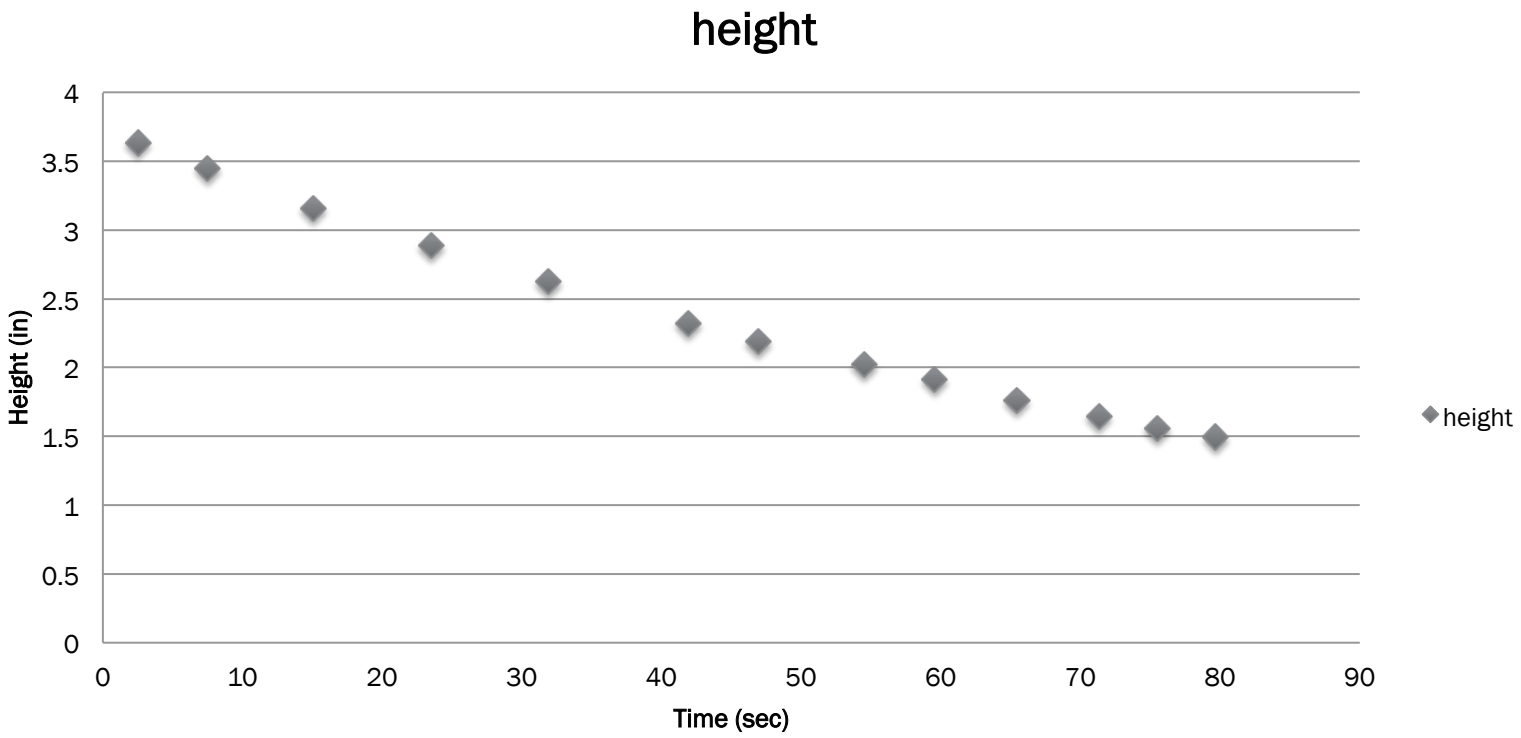
- Explore Domain and Range of Functions in Context
- Apply Transformations of Functions to Real World Problems
- Apply Inverse Functions to Re-Express Data

WATER JUG DATA

- Watch a movie. – Water Jug
  file://localhost/Users/mhernandez/Documents/NCTM/NCTM Regional Baltimore 2013/NCTM WaterJug/Flip+WaterJug.mp4
- Collect data from the movie – DEMO on LoggerPro.

- Create models for the data using transformations of functions or re-expression techniques.

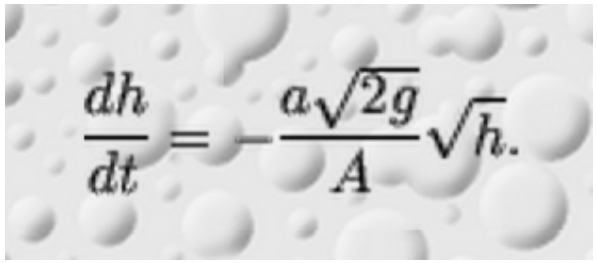
WATER JUG DATA



WHY DO WE BELIEVE THAT WATER JUG DATA IS NOT LINEAR?

- How do we help students see that a linear model is not appropriate?
- Let's Watch the Movie.
- Let's Examine Residuals for Linear Model
- Now that we believe it's not linear, how can we "straighten out" the data?
- Consider Torricelli's Law

  - Nice Extension for Calculus Students



INTERPRET MODEL IN CONTEXT

- Constants have meaning.
- Domain and range are limited.
- Students can use the model to describe the real world phenomenon.

BALL BOUNCE ACTIVITY

- Describe Experiment
- Make Conjecture About Graph

  (time, distance from ball to motion detector)
- Collect Data
- Break Up Data
- Create Models

- Put Them All Together as a Piece-Wise Function –

  -This requires students to think about the domain.

SAMPLE QUESTIONS FROM HANDOUT

We will collect data using a CBL device (Calculator Based Lab), a motion detector and a calculator. We will hold the motion detector above a large ball, bounce the ball and collect data for about 4 seconds.

1. Sketch a graph of what you would expect if you graphed time along the horizontal axes and the distance from the ball to the motion detector. Distance will be measured in meters and time in seconds.
2. Sketch a graph of the general shape of the actual data below.

If your graph in #1 is different from that in #2, explain your reasoning in #1.

Give each group one “hoop” of the data

3. Carefully explain how your group found the function for your section of the data.

QUESTIONS CONTINUED

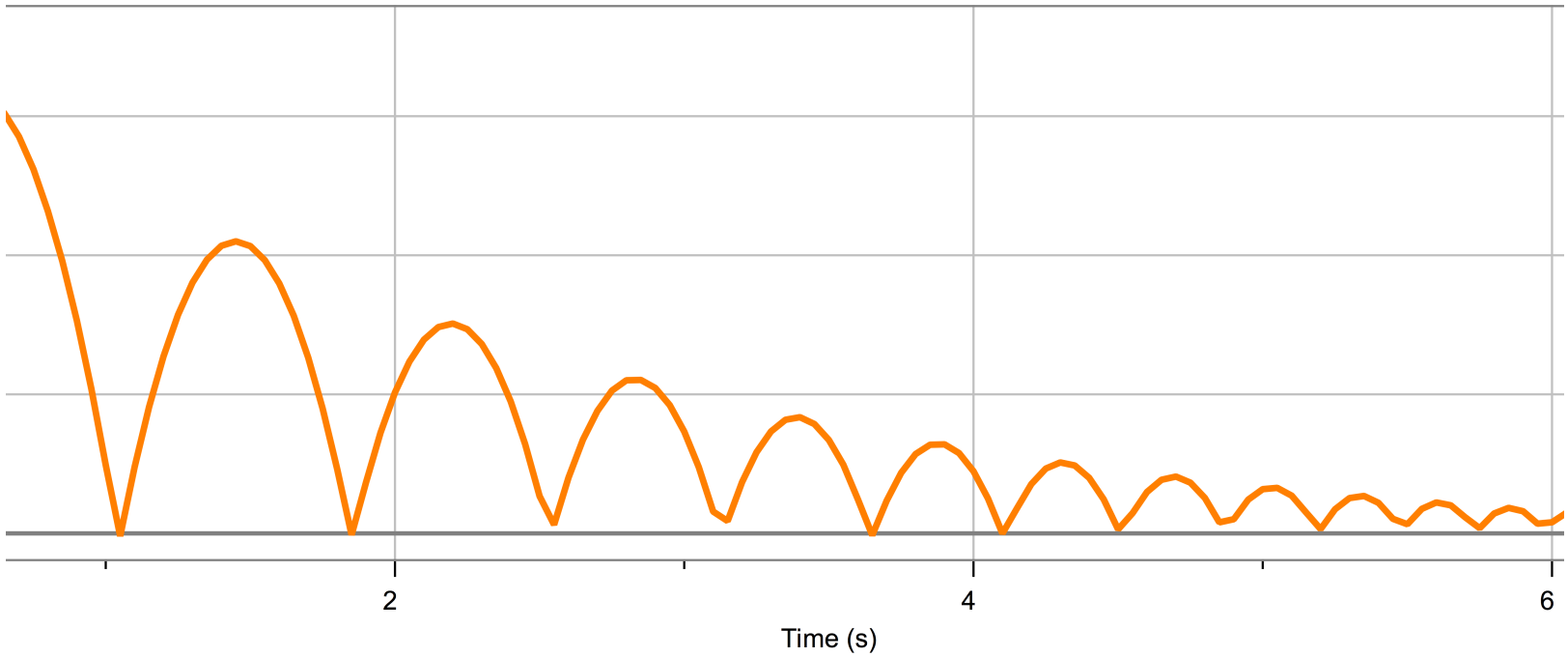
4. Explain what the y-value of the vertex of your parabola represents in terms of the physical problem and the ball.

5. Using the other groups' functions along with your function, write a piecewise function that fits the entire data set.

6. Explain how would you transform the data set so that it represents the actual height of the ball off the ground from the beginning of the data collection cycle to the end of the cycle?

7. Sketch a graph of the transformed data from #6 above. Explain what the *x*-intercepts represent in the physical problem and the ball.

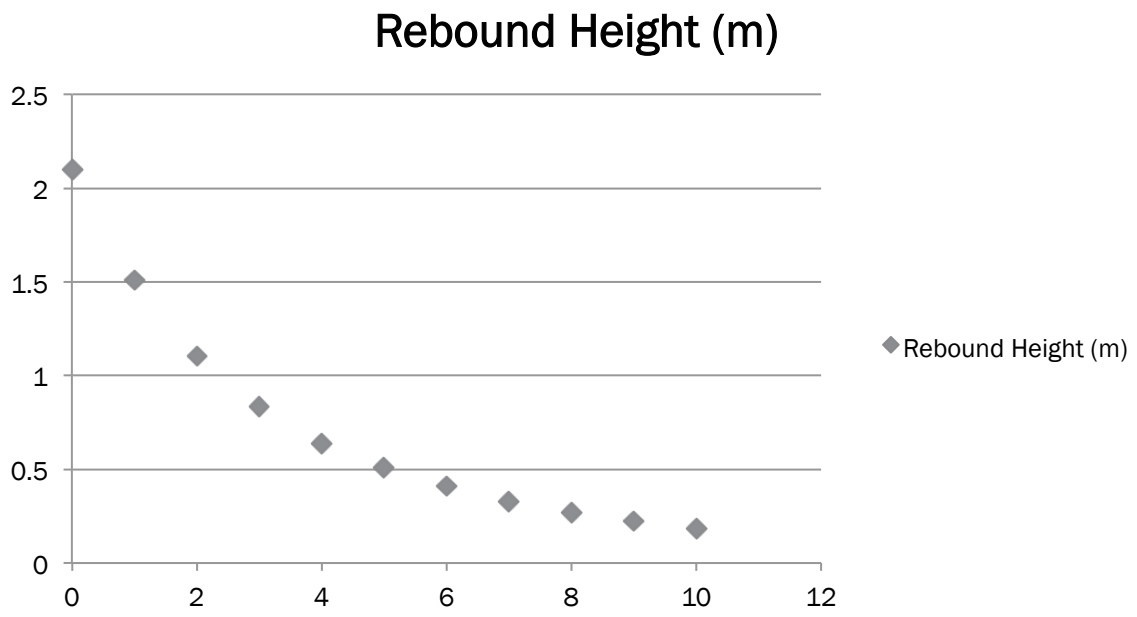
SAMPLE GRAPH OF TRANSFORMED DATA – WHAT DO YOU NOTICE ABOUT THE REBOUND HEIGHTS?



EXTEND FOR EXPONENTIAL FUNCTIONS

Analyze Maximum Height

Bounce	Rebound Height
0	2.1
1	1.509
2	1.103
3	0.8356
4	0.6402
5	0.5102
6	0.4086
7	0.3273
8	0.2691
9	0.2225
10	0.1835



HORIZONTAL ASYMPTOTE?

- If the horizontal asymptote of the exponential function is the horizontal axis, then taking the logarithm of the depended variable should straighten out the data.

Why?

HOW DOES SEMI-LOG RE-EXPRESSION WORK?

If your model is of the form $f(x) = ae^{bx}$

Then taking the natural log of both sides we get,

$$\ln(f(x)) = \ln(ae^{bx})$$

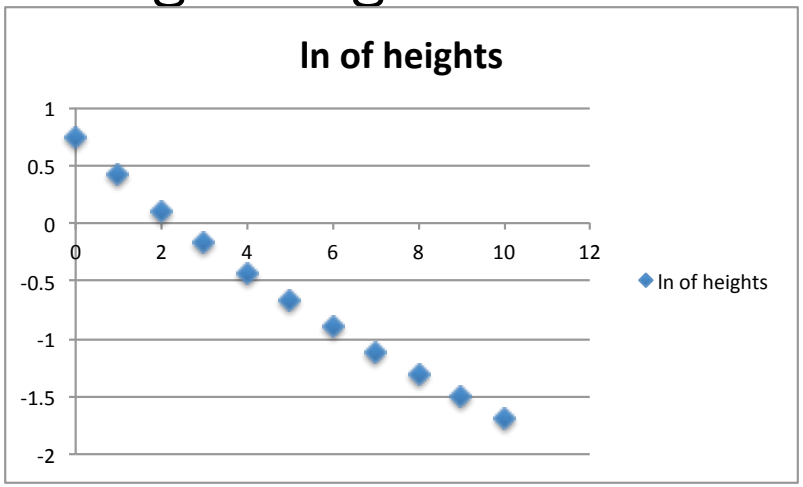
$$= \ln(a) + \ln(e^{bx})$$

$$= \ln(a) + bx$$

And we see that *ln*(*f*(*x*)) is linear in *x*.

HOW CAN WE "STRAIGHTEN" THE DATA?

- If we believe that an exponential functions is is an appropriate model, how do we undo what an exponential functions does?
- Let's try taking the logarithm of the rebound heights.



DIDN'T SEEM TO WORK. WHY NOT?

If your model is of the form $f(x) = ae^{bx} + c$

Then taking the natural log of both sides we get,

$$\ln(f(x)) = \ln(ae^{bx} + c)$$

And we are stuck.

Or are we?

EACH OF THESE ACTIVITIES OR LABS

Gives your students a chance to

- Dive deeper into the mathematics
- Make sense of the math in context
- Ask their own questions about the real-world scenarios

- Engage in the CCSS Mathematical Practices!

RESOURCES FOR TEACHERS:

- **Phillips Exeter Academy Summer Math Workshop**

  June 22 – 27, 2014 Exeter, NH

- **Teaching Contemporary Math Conference – NCSSM**

  January 24 – 25, 2014 in Durham, NC

- **Algebra 2 and Advanced Functions Websites:**

  www.dlt.ncssm.edu/algebra

  www.dlt.ncssm.edu/afm

- **NCSSM Swing Lab**

http://www.dlt.ncssm.edu/stem/content/swing-lab-documents

OTHER RESOURCES

- **LoggerPro Information** http://www.vernier.com/products/software/lp/
- **Vernier Sensors** http://www.vernier.com/
- **Video Physics App**
- **Torricelli's Law Derivation**
  http://www.math.usu.edu/powell/lb-html/node4.html

I hope these will inspire you to make your own movies and try some new data collection activities!

Thank you!

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http://courses.ncssm.edu/math/tcm/TCM2012/talks/hernandez/