Student Names:_____, _____

_____, _____

OBJECTIVE: **Create a bungee line for an object to allow it the most thrilling, yet SAFE, fall from a height of 3 or more meters.**

Each group gets their own object, a meter stick, and 7 *new* same-size rubber bands.

Directions *(Encourage everyone in your group to participate! You will score each other later!)*

1. Measure the objects height. Record this as rubber band length of 0.
2. Connect 2 rubber bands with a slipknot.
3. Wrap one of the two rubber bands tightly around the object.
4. Drop the object, holding the rubber band level with the meter stick.
5. Record the object's fall using the lowest point the object reaches in centimeters. This number is your rubber band length of 1. Do three trials for each length.
6. Add another rubber band, drop Barbie, and record (3 trials). Do this for a total of six rubber band lengths.

Number of Rubber Bands	Distance of Fall *(cm)*		
0			
1			
2			
3			
4			
5			
6			

7. Graph your data on a coordinate plane.
8. Draw a Line of Best Fit.
9. Determine the Long Height you will drop your object from and record below. Then make a prediction of how many rubber bands you will need to get the object close to the floor without smashing into it. Once your prediction is made you may not change it. You only get one chance to drop your object. Good luck!

Long Height:_____ Prediction of Rubber Bands to Use: _____

Actual Distance of Fall:_____ Success or Smash?

Name: _____ Date: _____

Purpose

**You are going to create a bungee line for Barbie that will give her the most thrilling,
yet SAFE, fall from 160".**

Procedures

1. Connect two rubber bands with a slipknot.

2. Then wrap one end repeatedly around Barbie's ankles. Be sure the rubber band is on tight enough not to fall off when she is being dropped.

3. Measure Barbie's height without rubber bands. Record this amount next to the zero rubber bands in the data chart on back side of this paper.
4. Next, drop her with two rubber bands attached to her ankles. Hold the band tight at the top of the yardstick, and simply let Barbie drop from the head-down position. She won't swing; she will just lightly bounce. Record her fall. **You will need to do this several times to ensure accuracy.** Record all attempts in the chart.
5. Complete the data chart as you drop Barbie.
6. Now it's time to start adding more bands. Once again use a slipknot to connect a second band to the bungee line. (Remember the band wrapped around her ankles does not count in the length of the line.)
7. Do this for a total of SIX rubber bands. **Read about the line of best fit (in the assignments section of the MathReuls wiki).**

Do not worry about your problems with mathematics, I assure you mine are far greater.
–Albert Einstein

Name: _____ Date: _____

Number of rubber bands	Lowest point head reaches
0	
2	
4	
6	

8. On graph paper, graph all of the points from the data chart. If you dropped Barbie several times to ensure the highest accuracy, be sure to plot each test (all of the points).
9. Draw in the line of best fit.
10. Now consider the SAFETY issue vs. the THRILL issue:

    If you put too many rubber bands on, her head will reach the floor, she will crack open her skull, and die. You will then be sued for negligence and will lose your business and owe her family millions of dollars that you don't have.

    On the other hand, if you don't put enough rubber bands, therefore you shorten the bungee line TOO MUCH, the ride may not be thrilling enough, and Barbie will pay her big bucks to your competitor. You will lose clients and your business will suffer.

TEST JUMP:

11. Based on your line of best fit, your prediction for the number of rubber bands for the bungee line for the Barbie test jump from a height of 94" is _____.
12. Now, you are ready to test out the jump using the number of rubber bands you wrote for #10. (You may not change this number once it's written down or when you have seen other groups test their jumps!)

Do not worry about your problems with mathematics, I assure you mine are far greater.
–Albert Einstein

Barbie Bungee

Your Name _____

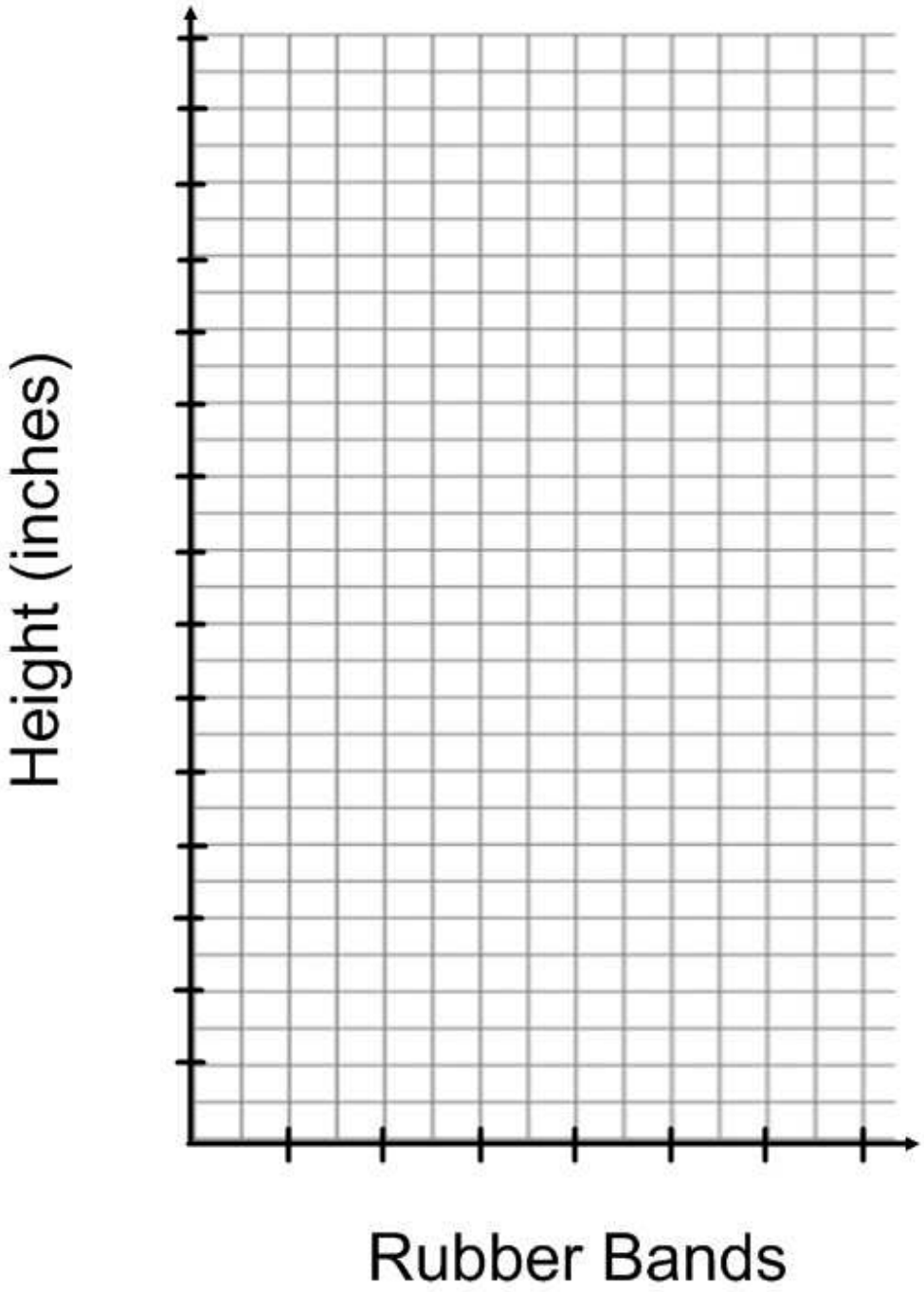
Doll Name _____

Period _____

Station	*r.b.*	*h*
Short		
Tall		
Really Tall		

1

2



3

1. With each additional rubber band, how much does the jump increase?__
2. What if you had 0 rubber bands? _____ (HINT: it's not 0 inches)
3. Number 1 and 2 give the slope and y-intercept. If you can, write an equation below using

   h = height and r = rubber bands

$h=\_\_\_\_\_r+\_\_\_\_\_$

4. How far could your doll jump with 4 rubber bands? _____
5. What if you had 20 rubber bands? _____

4

6. On Thursday, your doll will jump 412 cm.
7. How many bands do you think you'll need? _____
8. What kind of math did you do to find out that big jump?

_____

_____

_____

BUNGEE BARBIE AND KRAZY KEN

SETTING: Your team has been hired to work for the Greenhills Daredevil Entertainment Company. Your company provides rock climbing, sky diving, deep sea adventures, and cliff diving to interested customers. In order to boost sagging sales, the company has decided to add bungee jumping to its list of available adventures. As part of the assignment, the board of directors decided that several teams will undertake the task of working out the details of this newest adventure. Because the bungee jumping will take place at several different locations, it will be necessary to find a way to determine how much bungee rope will be needed for any given height. A successful bungee adventure will maximize thrills but still be safe; therefore the jumper must come as close as possible to the ground without hitting it. This will take some precise planning.

PROBLEM: The task is to determine the maximum length (expressed in terms of the number of rubber bands used) that can be used at any given height without causing any type of injury/fatality, while still giving maximum thrills. Your first clients will show up on Thursday March 17 (they are not leprechauns) and tell you from what height they want to jump. You will then have to decide how many rubber bands to provide for their jump.

MATERIALS: Doll (appropriately dressed), tape measure, calculator w/ regression function, rubber bands.

GOALS: Gather & graph data, determine a function that models data, test the model, make predictions.

SOLUTION REQUIREMENTS:

1. Your doll will start from a standing position, tip over the edge, and freefall head first to thrills or kills.

2. Your team will gather data about the length of fall corresponding to different lengths of bungee cord. You will make certain assumptions about the rubber bands, weight of jumper, etc.

3. Your team will determine a formula/mathematical model to predict the number of rubber bands (excluding the one attached to the feet) needed at any given height. You will consider more than one possible model, and you will be able explain how you decided which of the models considered gives the best fit. Remember that an accurate model is most likely to result when you gather data over a wide set of domain values. Consultants have suggested a *minimum* of 7 data points. Of course, the more data you collect, the more accurate your model will be. Become familiar with the regression feature on your calculator!

4. You should test your model before the final “live jump”. NOTE: Testing your model means using a jump height different than any you used to create your model. If you use one of your original data points, the model will, unsurprisingly, work almost perfectly! The idea is to *test* it, by using a different input and seeing if it gives an appropriate result. Again, consultants suggest that you test your model with a few different values. You may need to “tweak” the model a bit.

5. Your formula will be subjected to a "live testing." You will be given a “jump height” and asked to give your doll an appropriate number of rubber bands. Then we’ll see how good your model is!!

6. Each group will prepare a written report (word processed – yes, including equations) that includes:

    a) An introduction describing the project.
    b) A detailed description of the method used to gather data.
    c) Graphs and data tables, including a scatter plot of your data points with your best fit equation showing on it. (Yes, on a computer.) Make sure your tables and graphs are appropriately labeled.
    d) A description of the method and criteria used to find the final math model (function). (How did you decide among different possible models – linear, quadratic, logarithmic etc?) (What does your model say about the relationship between the variables?) Discuss at least one other possible model and why you rejected it.

e) A discussion of whether your particular model makes sense in the "real world". Why does your graph have the shape it does? Do you know anything about an ideal model for this physics experiment? What is that model like?
f) Any problems encountered by your team.
g) A description and justification of all assumptions made during the project.
h) A description of your team's live demonstration and possible sources of error (if appropriate).
i) A conclusion discussing whether you were successful.

The report should be understandable by someone not familiar with the activity.

Note: This project based on an activity included in *Stepping Stones to Mathematical Modeling.*

TIMELINE:

Monday, March 19 and Tuesday, March 20:
Collect data, develop math model, test math model, revise if necessary.
Remember that you want your equation to predict the necessary number of rubber bands for a given height, so consider carefully which variable is independent and which is dependent.

Thursday, March 22:
The "live jump". Your team will have up to two chances to prove that your model works. Adjustments can be made after the first jump if you so desire, assuming your test subject survives the first jump.

Friday, April 13:
Final report is due at the beginning of your class period. This will count as a test grade, so plan accordingly!

REPORT GRADING RUBRIC:

Introduction and assumptions	_____ / 5
Description of data collection	_____ / 5
Description of model testing	_____ / 5
Data display (tables, graphs)	_____ / 5
Description of model development and choice of best fit equation	_____ / 10
Discussion of why equation does/ does not make "real world" sense	_____ / 5
Live jump results (Extra Credit)	_____ / 5
Discussion of live jump and sources of error	_____ / 5
Conclusion	_____ / 5
TOTAL	_____ / 50