Modeling Project

Name of Assignment: Modeling a Bungee Jumper
Target age group and class: 9th grade Integrated Math 1

1. Objectives:

Students will work in small groups to:

- Analyze experimental data
- Develop a model based on experimental data
- Test their model
- Verify and validate the model
- Write a technical report on their findings
- Present their project to their classmates

2. Project/Problem Statement :

In bungee jumping, a person stands on top of a tower or on a bridge, ties one end of an elastic cord around their feet and the other end around a fixed point (like a rail on the bridge.) Then they jump off the tower or bridge, the elastic cord stretches as they fall, and they come close to the ground or water without touching the ground (ouch) and then bounce up and down over and over until they just hang there.

Your task is to create a mathematical model that simulates some of physics behind bungee jumping.

There are several parts to your task:

1. Collect experimental data
2. Create a model of bungee jumping
    a. You will investigate the effect of the weight of the jumper on the distance they fall.
    b. You will investigate how far they bounce each time and how many times they bounce until they stop.
3. Write a Technical Report that details what you've learned
4. Present your findings to your classmates.

3. Background Materials : None

4. Data Sets: Student Generated

5. Step-by-Step Instructions:

Following are the steps that need to be completed in the project:

A. Initial Data Collection

1. Using 2 meter sticks, rubber bands, and weights, construct a physical model bungee jumping apparatus so that the drop height is 2 meters off the ground.
2.
    a. Attach a weight to one end of the rubber band. Attach the other end to a meter stick. Drop the weight from the 2 meters high, and measure the length of the rubber band at its longest stretch point. Repeat this for ten different weights and three different rubber bands, and record your measurements in Data Table 1:

b. Using the rubber band with the "medium" length, pick a weight, and drop it from the 2 meter height, only this time measure the bounce height for the 1st ten bounces. Record the data in Data Table 2. **Get your teacher to sign off on your data before you proceed!**

Data Table 1

Rubber band Length:		Rubber band Length:		Rubber band Length:	
Weight	1st bounce stretch	Weight	1st bounce stretch	Weight	1st bounce stretch

Data Table 2

Weight:		**Weight:**		**Weight:**	
Bounce #	**Height**	**Bounce #**	**Height**	**Bounce #**	**Height**
0		0		0	
1		1		1	
2		2		2	
3		3		3	
4		4		4	
5		5		5	
6		6		6	
7		7		7	
8		8		8	
9		9		9	
10		10		10	

B. Build a Mathematical Model

1. Using Excel, construct a scatter plot of length vs. weight for the three sets of data in Data Table 1. Use different symbols for each of the rubber bands.
   a. Estimate the nature of the relationship. Is it linear, exponential, something else?
   b. Use the Curve Fitting tool in Excel to find a model for each set of data.

2. Now construct a scatter plot of bounce # vs. height for the three sets of data in Data Table 2. Use different symbols for each of the different weights.
    a. Estimate the nature of the relationship. Is it linear, exponential, something else?
    b. Use the Curve Fitting tool in Excel to find a model for each set of data. Does the model seem to make sense?
3. Compare the different models. How are they alike and different?

C. Test and Verify your Model

1. In bungee jumping, part of the excitement comes from getting close to the ground without touching it. Using each of your three rubber bands and your models, calculate the jumping height for an egg so that it comes within 5 cm of the ground WITHOUT touching. (You'll need to weigh the egg first).
2. Test your model by dropping the egg from the calculated height for each of the three rubber bands. EACH GROUP GETS **THREE** EGGS TO WORK WITH!

D. Write your Technical Report

1. Describe the model objectives and background
2. Signed Data Tables
3. Excel graphs (properly labeled)
4. Describe the parts of your mathematical model and explain why their outputs behave like they do.
5. Your calculations for the egg drop.
6. Answers to the following questions:
    a. What does your model predict is the 1st bounce stretch for extreme weights (1 g and 100kg)?
    b. What does your model predict is the number of bounces that each extreme weight requires before it stops bouncing?
    c. Do you think your model accurately predicts bungee behavior at these extremes? Why or why not?
    d. According to your model, about how many bounces would each egg need before they stopped bouncing? Can you verify this experimentally?

E. Create a PowerPoint presentation of your Technical Report

1. 8-12 minutes in length
2. At least one slide for each of D1 through D5 above

6. Roles for each of the students:

a. Students will be broken up into groups of three. Recommended roles follow
    i. Manager – coordinates project for the group by obtaining materials, communicating with other managers and the teacher, ensures overall requirements of project are met and that the project stays on schedule, acts as supplementary quality assurance member.
    ii. Recorder/Quality Assurance – Observes Experimenter's procedure to assure that high quality data is obtained,agrees with the form of the final mathematical model , observes and agrees with final egg drop calculations and positioning.
    iii. Experimenter – performs experiments with cords and weights and again with the rubber bands. Takes the lead on the creation of the mathematical model, prepares and executes final egg drop.

7. Grading Criteria:

The attached rubric will be used for the project.