Bungee Barbie with Fathom[1]

You have been hired by MathisFun Entertainment Company to design a bungee jump venture that is thrilling but safe. What decisions do we need to make about the bungee jump to make sure it is both thrilling and safe?

Rather than use a real person in our experiments, we will do our testing using Barbie. We will assume that the material that is used for the cord is similar to a rubber band. The challenge is to see who can determine the best length for the cord (i.e., the ideal number of rubber bands) so that when Barbie is dropped from the top of the second floor (or other high place), she comes close to the floor without hitting it. The team that comes closest will win the contract to design all of the bungee ventures for MathisFun Entertainment.

Before we send Barbie on the "Big Jump," it might be a good idea to collect some data when Barbie takes shorter jumps. We can use that data to determine how many rubber bands we should use.

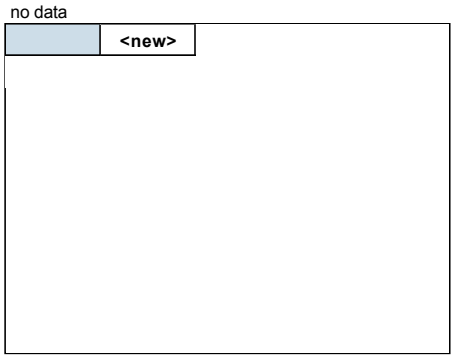
Materials:
Barbie
rubber bands
motion detector
ring stand
Logger Lite
Fathom

Data Collection:

(1) Create a cord of rubber bands by interlocking several rubber bands together. Attach one of the ends of the rubber band cord to Barbie's feet.
(2) It is helpful to place a piece of cardboard around Barbie's neck so that the Motion Detector can collect the data.
(3) Place the Motion Detector on the floor. Someone should hold Barbie upside about 1.5 meters above the ground. A stand may help keep that distance above the ground consistent. (See following picture for set up)

[1] http://www.vernier.com/files/sample_labs/PWV-07-COMP-bungee_jump_accelerations.pdf

(4) Plug the Motion Detector into the USB port of the computer that is running Logger Lite and Fathom.
(5) A graph should appear and a table with columns listed as time, distance, velocity, and acceleration.
(6) Make sure the Motion Detector setting is switched to the Ball/Walker setting.
(7) Hold the rubber band cord so that only one rubber band is between the stand and Barbie's foot.
(8) Click Collect in Logger Lite. About 5 seconds after the Motion Detector begins to click, drop Barbie.
(9) Examine the data and graph. You may repeat steps 7 and 8 until you collect a "good" set of data.
(10) From the graph/table in Logger Lite determine the distance Barbie fell. To determine particular data points in the graph, click Examine in Logger Lite. We will record the distance she fell and the number of rubber bands that were used in a table in Fathom.
(11) In Fathom, bring down a new Case Table.



(12) Enter a new attribute "Number" for number of rubber bands. Enter 1 for one rubber band.
(13) Enter a second attribute "Distance." Enter the Distance Barbie fell when one rubber band was used.
(14) Repeat steps 7-10 and drop Barbie using 2 rubber bands in the cord and enter the data into the table in Fathom. Collect data for 3, 4, 5, 6, and 7 rubber bands.

Questions:

1. Use words to describe the relationship between the number of rubber bands and the distance Barbie fell.

2. Use sliders to develop a function rule so that you can predict how many rubber bands you will need to use if Barbie jumps from a ledge that is about 18 feet above the ground.

3. Describe what the slider values represent in terms of the data the context.

4. Use your function rule to determine how many rubber bands will be needed for Barbie for "The Big Drop." The team whose Barbie comes closest to the floor, without hitting it, will win the contract for MathisFun Entertainment to design all of their bungee ventures.

5. Your teacher will take you to the Drop Zone. Record what happened when you dropped Barbie and what adjustments (if any) you would make if you were to drop her again.

Extension – Examining Barbie's Distance, Velocity and Acceleration

Introduction:

Imagine that you are thinking about going on a bungee jump and you are concerned about what happens throughout the fall. Will you fall at a constant rate? Will you reverse direction quickly when you reach the bottom of the fall?

Before you actually do a bungee jump, you have decided it might be a good idea to test it out on Barbie. While Barbie is jumping, you can collect data on her distance,

velocity and acceleration throughout the jump to gain some insight into what you might experience as a jumper.

Data Collection:

(1) Plug the Motion Detector into the USB port of the computer that is running Logger Lite and Fathom.
(2) A graph should appear and a table with columns listed as time, distance, velocity, and acceleration.
(3) Make sure the Motion Detector setting is switched to the Ball/Walker setting. Secure the motion detector to the ring stand so that the motion detector is pointed toward the floor.
(4) Connect 12-13 rubber bands to each other. Secure one end of the string of rubber bands to Barbie's foot and the other end to the ring stand.
(5) Hang Barbie by her feet from the ring stand.
(6) Click Collect in Logger Lite. When the Motion Detector begins to click, drop Barbie.
(7) Examine the data and graph. You may repeat steps 6 and 7 until you collect a "good" set of data.

Questions:

1) Consider the graph of distance versus time. Move the cursor to four different locations to identify when she was at rest, when she was free falling, when the cord was taut, and during several bounces.

2) In Logger Lite select Graph Options from the Options menu. Click on Axis Options. Choose Velocity versus Time. What do you notice about Barbie's velocity at different locations in the graph?

3) In Logger Lite select Graph Options from the Options menu. Click on Axis Options. Choose Acceleration versus Time. What do you notice about Barbie's acceleration at different locations in the graph?