PH 201 Laboratory Experiment: Bungee Jump
Conservation of Energy

Objectives:

Apply conservation of energy for a real world application. Have fun in the last lab of PH201.

Introduction:

This lab uses a model for a real world bungee. Instead of jumping from a bridge ourselves please bring a model to do the jump and test your physics that way.

When a person attached to a bungee cord jumps, the desired result is that she or he is brought to rest at some predetermined location. (usually before hitting the ground!) When an object is tossed off a high place the gravitational potential energy is converted to kinetic energy. As a result the object is usually moving quickly when it encounters the ground. In the case of a bungee jump, the energy is absorbed and stored in the bungee cord. Ideally enough energy is stored in the bungee so that the object has no kinetic energy (stopped) before it reaches the ground (-:

At professional bungee jumping venues that take place over water it is customary to ask the jumper just how wet they want to get. Your choices often include hair wet, head wet, wet to the waist, and wet to the feet. I met an engineering instructor who was bungee jumping in New Zealand and he requested not to get wet at all. The operator checked his charts and noted that the bungee was set to get her head wet. He offered the thought that if she would jump out instead of just going straight down he thought she would probably stay dry. Does this make sense to you? Jean opted to go straight down and did get wet to the neck as predicted.

On a slightly different note some students in a past class talked about a friend who had purchased a surplus bungee cord. Such cords come with a calibration table that helps you decide how to rig the bungee for different jumping conditions. A group of folks got together and took the bungee cord to one of the bridges up at Billy Chinook reservoir (water below the jump site). After consulting the table and rigging the cord the first person jumped and was severely shocked to discover that he went several meters into the water. This is rumored to be an unpleasant experience since you are going fairly fast when you hit the water and then you get dragged back through it by the bungee. To make a long story short it turned out that they had received the wrong calibration table for the bungee cord. This could have had extreme consequences under other circumstances.

When this lab is over I hope that you would know how to check a calibration table and how to generate one from scratch.

Some of you helped already out to create the attached calibration curve for our surgical tube bungee (in my next life I will become a doctor - doctors have the greatest toys!). Let’s hope we did a good job.

Procedure:

For this lab, you will need the bungee cord, your calculators, some lab weights, and your minds.

1) Spend some time with your group and figure out the answer to the first part of the lab report before proceeding. This will get your thoughts lined up with the physics you need to explore.

2) Examine the cord and the site carefully so you understand the experimental setting. Ask questions! The measured height of the balcony railing is around 5.65 m. Double check before you do your experiment. Determine how far the bungee cord must stretch if the mass will just reach the ground. There are several stages to this bungee jumping process and it is easy to confuse yourself so make sure you go step-by-step through the process.

3) Check the attached F-Δx calibration curves. How does it differ to a physics spring. How is it similar. Can you explain the shape of the curve?

4) The energy absorbed by the bungee cord when it is stretched to a particular length is given by the area under the curve up to that point. (Does this make sense from dimensional analysis?) Generally, finding the area under the curve is a calculus problem but we will take a more direct approach. Begin by determining the energy represented by a little rectangle on the plot. The area under the curve is made up of many of these little rectangles. The question is "When do I stop counting?"

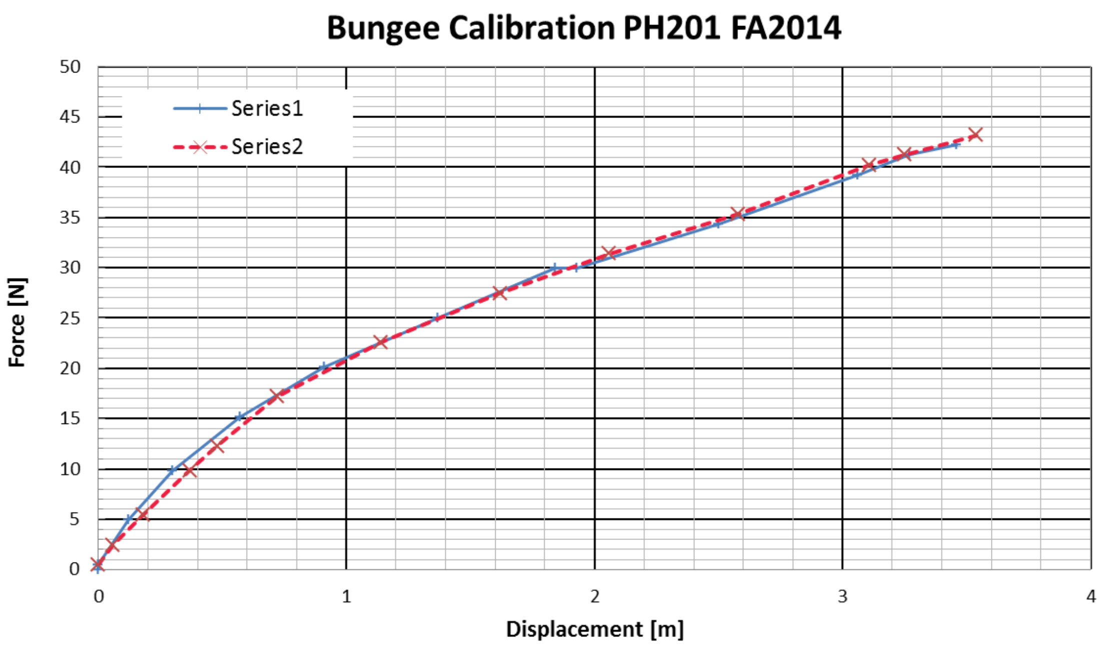
5) When you have determined how far the bungee will stretch you know when to stop counting. Figure out how much energy will be absorbed by the bungee when it has stretched this much. I recommend that at least two people in each group determine this energy independently to try and catch any errors – imagine you are jumping down a 200feet bridge, do you want somebody to double check?

6) Once you understand the energy situation you can then calculate the maximum mass you can put in the bag so that when it is pushed off the railing it will just not hit the ground.

7) When you have completed your calculation show it to me, and assemble the mass in a stack on the front lab table.

8) We will then all together take the bungee cord up to the balcony and test your calculations. Each group will bring their own model jumper, so it will be fun testing our work.

F–Δx Calibration curves taken 11/25.



LAB REPORT – Guidance to be successful with this lab:

I) Describe the movement of energy into and out of the falling mass as it makes it's journey to the ground. This description should make it clear at any point whether the kinetic energy of the mass is increasing or decreasing and where the energy is coming from or going to. Draw a diagram that shows three curves: 1) The potential gravitational energy, 2) the kinetic energy, and 3) the energy stored in the bungee as a function of the position of the dropping mass.

II) Think about the directions of forces acting on the mass relative to it's motion. Draw three free body diagrams

a. Right after dropping the mass
b. In the middle of its journey
c. At the lowest point of the drop

Comment on the acceleration of the body at these three points.

III) Describe and show your calculations that determine the mass you need to add to the bungee cord to make your model jumper dive right into the pool. Calculate the energy absorbed by the bungee cord when the figure reaches water. Make sure you correctly use the calibration curve for the bungee cord.

IV) Analyze the success or failure of your test and suggest possible sources of uncertainty that may have led to the observed results. Any mention of "human error" or some variation of "human error" will result in you getting your paper back for revision. Seek reasons in the data and how the data might reasonably be imprecise.