Bungee Jumper
CONEX Read-ahead

Introduction
Bungee Jumping is an activity in which people jump off of tall objects attached to a flexible bungee cord. After a period of free fall, the bungee cord begins to stretch and the spring-like properties of the cord cause the jumper to bob up and down. Today, we are going to use a simulation to gain insight into how periodic functions can be used to describe the oscillating motion of the bungee jumper. In particular, we will explore, estimate, and interpret *period*, *amplitude*, and *midline* in the context of this activity.

Instructions
After reading through *Bungee Jumper* context and questions below, you should complete the reflection assignment in Canvas. Note: *you will have a chance to talk further with your coach before answering the questions below in detail.* The point of this read-ahead and the reflection is to "prime the pump" for further conversations with your coaches.

Bungee Jumper
We will use the Bungee Jumper simulation to develop some insight about the mathematical model we will use to describe this motion. In order to simplify our model, we assume that there are only two forces governing the periodic motion (i.e., we are ignoring any forces due to friction or air resistance).

The first force is the force due to gravity,

$$F_g = mg,$$

where m is the mass (in slugs) of the object and $g = 32$ ft/sec^2 is the acceleration due to gravity. The second force is the force due to the spring-like properties of the bungee cord. *Hooke's Law* says that this force is proportional to the amount s that the bungee cord is stretched (or compressed) from its natural length, i.e.,

$$F_s = ks.$$

The spring constant k in Hooke's Law is a measure of the stiffness of the spring. A stiff spring has a large k, while a loose spring has a small k. The units of k are lbs/ft.
The four parameters in this simulation that the user can control are

- The spring constant k.
- The weight[1] of the jumper w.
- The length of the rope, l.
- The starting height of the jumper, y_0.

Figure 1: Bungee Jumping in the Ukraine.

[1] Weight and mass are related by the equation $w = mg$, where $g = 32$ ft/sec^2 is the acceleration due to gravity.

Questions

1. Using the simulation tool ”Bungee Jumper” with a spring constant of $k = 150$ lbs/ft, a rope length of $l = 50$ ft a jumper with weight $w = 180$ lbs, and a starting position of $y_0 = 75$ ft, what is the amplitude, period, frequency, and midline of the jumper after free fall? Note you have both a table of data and a graph to assist your decision. In the upper right corner of the simulation, you may input your estimates to see if you can graphically validate your computations.
2. Which of the four quantities (spring constant, rope length, weight, initial position) has the least impact on the *amplitude* after free fall? Consider both the experimental data provided by the simulation and your intuition about the physics of the problem.
3. Which of the four quantities (spring constant, rope length, weight, initial position) has the least impact on the *period* after free fall? Consider both the experimental data provided by the simulation and your intuition about the physics of the problem.
4. Our simplified model ignores the impact of air resistance and friction. In reality, these additional forces dampen the spring-like properties of the bungee cord and the amplitude of the oscillations will decrease until the jumper comes to rest hanging upside down. Suppose again that the jumper has a weight of $w = 180$ lbs, the cord length is $l = 50$ ft, the spring constant is $k = 150$ lbs/ft, and the starting position is $y_0 = 75$ ft. At what final vertical position, y_f, will the jumper be at rest? Hint: Consider the force of gravity, F_g and the force due to the spring properties of the bungee cord, F_s, and how they must related to each other when the jumper comes to a stop. You can ignore the mass of the cord, which is negligible when compared to the mass of the jumper.

Instructions, part deux
After reading and reflecting on these questions, complete the read-ahead reflection assignment on Canvas. This will give your coach some insight on your thinking in order to best help you before you are required to formally answer these questions.