Visualizing Physics with STELLA: Mass-Spring System

Introduction

This lesson uses the "Virtual Bungee Jumping" model to explore the physics of a mass-spring system. In the Simple experiments section, students manipulate mass and spring constant (number of bungee cords). They are provided with graphs of position vs. time, position vs. velocity, and restoring force vs. position. In the Extended experiments section, students can manipulate initial displacement and the force of gravity as well as mass and spring constant.

What you need

To complete this activity you will need the "Virtual Bungee Jumping" sample model and STELLA software. If you don't own a STELLA license, you can use the free isee Player software.

To download the model, visit:
http://www.iseesystems.com/community/downloads/EducationDownloads.aspx

To download the isee Player, visit:
http://www.iseesystems.com/softwares/player/iseeplayer.aspx

Instructions

1.) Open the model in STELLA or the isee Player.

2.) Click on Background and Context to read about the problem you will be investigating. Return to the Home Screen.

3.) Click on Simple experiments and follow the directions. When you have determined the number of bungee cords that will give you the "best ride" (largest displacement without hitting the ground), click on the Review results link.

4.) On this page, three graphs are displayed: position vs. time, position vs. velocity, and restoring force vs. position. Click on each graph to read a description of the graph.

5.) Now press the Run button and watch the graphs plot as the experiment proceeds and answer the following questions: (Note that you may run the simulation multiple times without exiting this page if you need to see a replay of the simulation.)

- When is the velocity of the bungee jumper zero? What is happening to the bungee jumper when the velocity is zero?
- When is the velocity of the bungee jumper at a maximum? Where is the bungee jumper at this point?

- Does the restoring force increase or decrease when the bungee jumper first jumps? When is the restoring force at a maximum and a minimum?

6.) Go back to the Experiment screen and run several different trials with different masses and numbers of bungee cords. After each run, go to the Review Results page and look at the graphs to answer the following questions:

- What effect does changing the mass seem to have on the total displacement (amplitude), velocity, and restoring force?
- What happens to the number of bounces (period) as the mass changes?
- What effect does changing the number of bungee cords seem to have on the total displacement, velocity, and restoring force?
- What happens to the number of bounces (period) as the number of bungee cords changes?
- The bungee jumper represents a mass-spring system, with the jumper acting as the mass and the bungee cords acting as the spring. Do more bungee cords correspond to a stiffer spring or a looser spring? Explain.

7.) Return to the home page and click on Extended Experiments. You will now be able to control the platform height (initial displacement) and force of gravity. Experiment to determine how each of these variables affects the total displacement, velocity, restoring force, and period of the system. Write a paragraph to describe these effects.

About STELLA

Using STELLA modeling and simulation software, students can create models and run simulations of systems over time. The results of simulations are displayed with visual representations to support diverse learning styles.

Thousands of educators and researchers have made STELLA the gold standard; using it to study everything from economics to physics, literature to calculus, chemistry to public policy. K-12, college, and research communities have all recognized STELLA's unique ability to stimulate learning.

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