No Free Lunch

Introduction:

Throughout history people have searched for a free energy source. The perpetual motion machine has been invented countless times and touted over and over by many an inventor as such an energy generator. The idea of the perpetual motion machine is that you can put in a finite amount of energy and the machine will generate an infinite amount of energy in return. Unfortunately, there is a law of physics, man did not write it, that *states energy cannot be created nor destroyed, it can only change objects or forms.* This means if you "generate" energy you are actually converting one form of energy into another. One example of energy changing forms happens when you flip the light switch on in your room; the light bulbs convert electrical energy into light and thermal energy. The U.S. Office of Patents has seen numerous applications for perpetual motion machines, each that claims more energy out than in is put in to the machine. These patent requests can be quickly denied due to the fact that it violates the law of conservation of energy. The moral of this story is that there is no such thing as a "free lunch" with energy…you must have energy to "generate" energy.

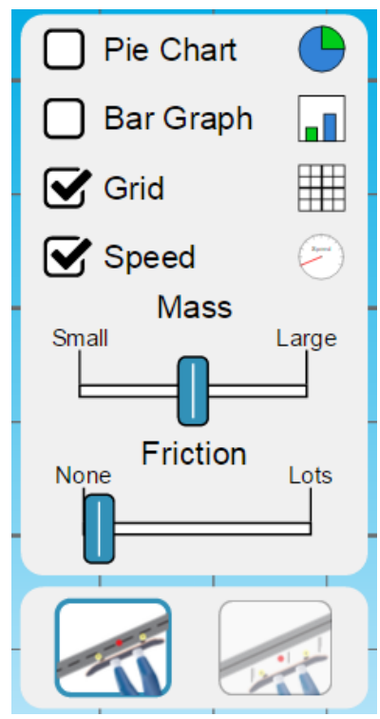
Preliminary Questions: Consider a roller coaster at Six Flags and answer the following questions. You should also give a reason for each of your answers.

1. Where will the coaster have the most ***potential energy?***
2. Where will the coaster have the most ***kinetic energy?***
3. Where will the coaster have the most ***total energy?***

Have your teacher approve now

Procedure:

Figure 1



1. Go to http://phet.colorado.edu/en/simulations/category/html
2. Select the Energy Skate Park Basics simulation.
3. Select the Playground. Adjust the settings to match **Figure 1**. Note that the left edge of the friction slider is even with the line below "None".
4. Here you will build your own roller coaster for a skater. There are four pieces of track available and you must use at least three of them for this activity. To connect the pieces simply drag and place the end track dot on another end track dot.
5. Play around with the track and skater to create your best and most unique roller coaster. You can build your coaster in whatever shape you want within the following conditions:
   a. You must use at least 3 track pieces
   b. All track dots must be centered on a horizontal gridline
   c. Track dots cannot be placed below the one meter gridline
   d. Your track must have at least one hill after the first drop
   e. The last track dot cannot be the lowest dot
   f. The dot below the skater must start in the first track dot, on the track, and on a gridline
   g. The skater must be able to coast all the way from start to finish
6. At this point decide on and sketch your final coaster. Label each dot #1, 2, 3,…on your sketch.

DO NOT CHANGE THE COASTER AFTER THIS POINT
Have your teacher approve now

DO NOT CHANGE THE COASTER AFTER THIS POINT

Now to make some measurements:

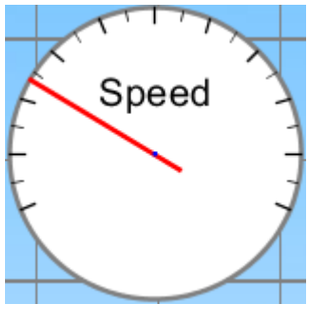
7. In your data table, record the height each dot is above the ground.

8. Always start the skater at the first dot. The easiest way to do this is to click the "return skater" button. Also, you may need to run the skater in slow motion.

9. Let the skater start a run and stop him when the red dot below the skater is on the horizontal gridline in each track dot.

10. For each track dot, record the speed of the skater as shown on the speedometer **Figure 2.** Each mark on the speedometer is 1 m/s. Estimate the speed to the nearest 0.1 m/s. In Figure 2, it reads 4.8 m/s.

Figure 2



<u>Have your teacher approve your data</u>

Analysis:

Go to thetеterszone.net/wp and download the Calculations and Graphing Spreadsheet to your computer/tablet. If you are using a tablet...open the file in a spreadsheet app (Sheets, Numbers…). The spreadsheet will calculate the potential, kinetic, and total energy based on your data for each dot on your track.

1. Enter your height and speed data into the spreadsheet. Ask your teacher for the mass of the skater and enter it as well.

   Potential energy is stored energy. In this activity the stored energy is due to the skater's position relative to the ground. This is specifically the gravitational potential energy. You will need the mass of the skater its height above the ground.

2. Each group member should show K-U-E-S for one different PE. Why? ...because you need to show you know how to solve for the potential energy yourself.

   Kinetic energy is the energy due to motion. In order to determine the kinetic energy you need the mass of the skater and the speed of the skater.

3. Each group member should show K-U-E-S for one different KE. Do not show KU-E-S for dot #1.

<u>Have your teacher approve your K-U-E-S</u>

4. As you entered your data it was graphed. Sketch the graph, be sure to include labels for PE, KE, and TE.

5. Based on the graph, describe what happens to the kinetic, potential, and total energy relative to each other as the skater coasts. Use the data/results from at least three dots to support your description. This should be more than one sentence.

<u>Have your teacher approve</u>

Data Table

Dot	Height (m)	Speed (m/s)
1		0
2		
3		
4		
5		
6		
7		
8		
9		

Energy Conservation Table

Dot	Potential energy (J)	Kinetic Energy (J)	Total Energy (J)
1			
2			
3			
4			
5			
6			
7			
8			
9			