

Alexandria Paley  
Elective 5: Modifying for Levels of Inquiry

I. Content

- The resource I chose to support learning about forces and motion is from the physics cK-12 Exploration Series on Circular Motion and Gravity titled “Loop the Loop” and can be found here:  
<https://interactives.ck12.org/simulations/physics/loop-the-loop/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/physics.html>
- This resource simulates a roller coaster car traveling along a flat path as well as a loop while showing the velocity and acceleration vectors as well as three features that can be manipulated along the bottom of the simulation (mass, hill height, and loop radius) and has a chart showing the various energy components of the cart system as it moves along the track. The energies the graph shows are work, KE, PE, heat and total energy of the system. By manipulating some of the features along the bottom of the simulation the students can observe first if the cart makes it around the intended loop and then how the other features of the simulation respond as the cart moves through the progression of the simulation.
- The physics contents that are related to this simulation are: motion in one direction, motion in a circular loop, total energy within a system, and the velocity and acceleration components of a cart moving in a horizontal and then looped path direction. The NYSSLS (NYS adapted NGSS standards) associated with this simulation are:
  - o HS-PS2-1: Newton's Second Law of Motion: **Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (Cause and Effect)**
  - o HS-PS3-1: Energy Change in Components of a System: **Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. (Systems and System Models)**
  - o HS-PS3-2: Macroscopic Energy Due to Particle Position and Motion: **Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of**

**particles (objects) and energy associated with the relative positions of particles (objects). (Energy and Matter)**

- o **HS-PS3-3: Energy Conversion Device Design: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. (Energy and Matter)**
  - The pros of using this resource are that after students play around with the simulation and get the cart to go around the loop they can easily determine the parameters where the cart falls off the track and then determine the minimum loop height, track length, and cart mass to get around the loop. Also, the energies are graphed off to the side of the simulation so that they can be viewed throughout the entire trial run. Also, the velocity and acceleration vectors are always present off to the side, showing the motions of the cart. At certain points along the motion of the cart the net force and weight of the cart pop onto the screen. Some of the cons of using this simulation are that the cart can never complete one continuous run without stopping at locations along the track to identify the net force and weight of the cart. Also, the acceleration is not always present on the simulation it only shows up when the cart is nearing the loop. Also, there is no way to pause the simulation as it progresses through. It needs to complete one full run before you can see the beginning again. If students have questions at one specific point in the simulation they can't pause it to analyze the data at that position, which can be problematic if you want them to get into further specific detail. The fact that simulation can only be run through and not paused is one limitation that I think can hinder the students. It will be hard for them to analyze the data at the very top of the circle and the very bottom of the circle if they can't collect specific data. Also, they are unable to add multiple loops, which I think would be beneficial if we wanted to talk about constantly increasing the KE and hill heights to make sure that the carts made it around many loops safely.
- II. Modification
- The way that I would utilize this simulation for a low Level of Inquiry for Discovery Learning would be to allow the students to open the simulation and run through the opening introduction without skipping it and then ask them what information we would need to consider when carts are moving around closed loops in circular motion. After having this conversation and generating a list of what we would need to consider I would allow students time to "play" with the simulation to get familiar with what it

measured. After they became familiar with it we would have a class discussion about what we need to change and measure to ensure that our cart makes it around the loop safely. After that I would ask the students to find the lowest mass, hill height, and loop radius so that the cart doesn't fall off the loop and then the same thing for the largest mass, hill height, and loop radius so that the cart stays within the confines of the loop. I would then have each pair of students share their minimum and maximum values in a data table at the front of the room. After each group has input their information we would study the data collected and observe any patterns we notice and/or see if every group got the exact same values. If some groups got different values, we would have a conversation about why the numbers were not exactly the same for every group. As a conclusion to this activity I would have the students individually make a conclusion statement about why they think is the most important aspect to a roller coaster not falling out of a loop as it moves in its path and use evidence from the simulation they tested on their own or data table to support their answer. This modification allows the students freedom to explore the simulation and how objects travel around circular paths while also working within the confines of the simulation and not being able to do as many manipulations to get more specific or exact numerical data on the circular motion of objects.

- I would use this simulation in a different way to have my students complete this with a high Level of Inquiry to be a full inquiry lab. I would have the students investigate the carts motion as well as the maximum and minimum values for mass, hill height, and loop height to keep the cart in its path. Keeping the results of this simulation in mind students will then build their own roller coaster with 3 loops and have a marble move through the path as if it were the cart. The 3 loops need to have varying heights so that their "cart" stays in motion and successfully makes it through the entire track. They will only have 3 tries to complete this activity successfully. Meaning that they can't test each loop and section as they complete it, they can only run the "cart" from the beginning to the end 3 times total. At the end of the 3 trials, even if the track is not successful, students will take a picture of their coaster designs and analyze the components of the track design and determine the forces acting on the "cart" at the bottom and top of each hill, forces at the bottom and top of each loop, and the energies throughout the entire roller coaster cart system. They can write all of this information directly onto their image of the coaster or they can draw a sketch of the coaster. They will need to also include the hill heights and loop heights onto their images. Once they have analyzed their "cart"

and it's motion they will have to summarize the factors/components that are essential to keeping a cart in its tracks and safely moving through loops on a roller coaster.