

# Roller Coaster Design Challenge

## **The Challenge**

The Roller Coaster Challenge explores the physics of Velocity and G-Force through the design, construction and testing of a roller coaster model. The challenge is to design and build a roller coaster out of the defined materials and to be able through your design and model to predict the G-Force and Velocity at three specific points along the path of the coaster.

## **Roller Coaster Criteria**

Use specified coaster parts

Height of Drop: Not to exceed 3 ft. (.9144 meters)

Footprint of Coaster: Not to exceed: 4 ft x 5 ft (1.2192 x 1.524 meters)

Coaster path must include:

- 1 Vertical loop
- 1 Horizontal loop
- 1 bunny hop hill
- Well banked track so that ball does not fall off during test cycle

Maximum G-Force: 5

Statement of Invention: Must accompany model

- Must define 3 points of prediction on track (Bottom of Vertical Loop, Middle of Horizontal Loop, and Top of Bunny Hill)
- Must define predicted G-Force at each point
- Must define predicted Velocity at each point

## **The Process**

The Challenge Process to be documented in Statement of Invention (SOI)

- SOI must include research about the history and modern use of rollercoasters
- SOI should follow Engineering style journal (see template) for design, build and evaluation
- SOI should include sketches, graphed data, and images chronicling process

# Initial Potential Energy

Initial Potential Energy + Initial Kinetic Energy – Work = Final Potential Energy + Final Kinetic Energy

$$m \cdot g \cdot h_1 + \frac{1}{2} \cdot m \cdot v_1^2 - \text{work} = m \cdot g \cdot h_2 + \frac{1}{2} \cdot m \cdot v_2^2$$

Where:

m = mass of the ball

g = acceleration due to gravity 32.2 ft/s<sup>2</sup>

h = height of the where the ball's center of gravity is at that location on the track

v = velocity of the ball

Solve for v<sub>2</sub>

G-Force

At the bottom of the first hill

$$G's = v^2/R + 1$$

(The 1 accounting for the gravity which is already occurring)

Top of the bunny hill

$$G's = -v^2/R + 1$$

Horizontal Loop (Horizontal G Force)

$$G's = v^2/R$$

Where R is radius of the curve

## ROLLER COASTER CHALLENGE PARTS LIST

CPVC 18" Pipe	12	
CPVC 12" Pipe	16	
CPVC 6" Pipe	30	
CPVC 4" Pipe	30	
CPVC 3" Pipe	20	
CPVC 2" Pipe	20	
Tee	50	
Coupling	24	
90* Drop-Ear Elbow	16	
90* Elbow	16	
Snap-Fits	90	
¼" OD Poly Tubing	2	
Nylon Loop Straps	35	
Thumb Screws	35	
Square Nuts	35	
Washers	35	
25.4mm Nylon Ball	1	