Request for Design

Roller Coaster Designs Wanted

The STEM Amusement Park is looking for a new roller coaster to add to their rides!

Criteria:

Your coaster design must include the following:

- initial drop from the top of the hill.
- at least one small hill later in the track.
- a minimum of two turns or twists on the track.
- a loop.

Constraints:

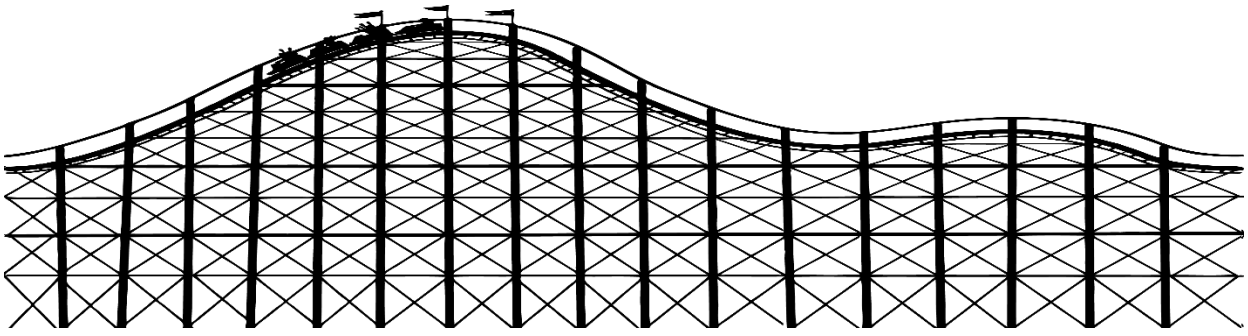
- only materials approved/provided may be used.

Materials:

Foam pipe insulation which has been cut in half lengthwise (lengths of 4, 5, 6, 7, & 8 ft.), masking tape or painters' tape, toothpicks and bamboo skewers, large marbles, soft/flexible tape measure, scissors.

As part of your pitch to the STEM Amusement Park management team, you will also need to:

- be able to answer the following questions:
    - Where and how is energy used in your coaster design? Where is potential energy the greatest? Where is kinetic energy the greatest?
    - Where does the coaster get the initial energy?
    - What different coaster elements help to add energy back into the system?
    - What force helps to pull the car over the top hill?
    - What happens if the coaster is wobbly, or the track does not sit on the track properly?
- sketch/draw an initial design of the coaster that will be constructed and have it approved by the management.
- construct and modify your model, present it to the other teams, and explain the overall design.



R&D

Research and Design

Each team member needs to be able to keep a record of their own notes. Notes should include sketches/drawings, observations, information gathered, and ideas.

Video:
The STEM Amusement Park shared a video with different backyard coasters. What were some of the different coaster elements (parts of the track such as a hill) that you observed?

Design Team Name:
Each team will need to have a company name. What name did your design team select?

Test Stations:
It was great that the management from the park set up some test stations. Safety glasses should be worn by students as they test the different ideas. Make sure you keep track of the information from each of the following:

Station #1: What purpose does the hill have?
Using the materials provided, build a hill that would be at the beginning of the roller coaster. Nothing else, just the initial hill. You will not need to figure out how to "pull" the coaster train to the top of the hill. Do the following and keep notes/sketches:

- Make a hill that has the highest point at least 12 inches from the table by holding the track against the wall so that it looks like the downside of the hill.
- Record the length of the track you have between the top of the hill and where the track hits the table.

- Start the marble at the top and time how long it takes to roll down to the bottom. Test and record your time three times.
- Repeat the above step but make the highest point at least 24 inches from the table.
- What was different between the two heights?
- While you are not measuring speed, you did record the time. What did you notice about the times? Can you draw an inference about the speed?





Height from Table						
Length of track						
Time (three trials)						

Draw an inference about the speed of the coaster train.

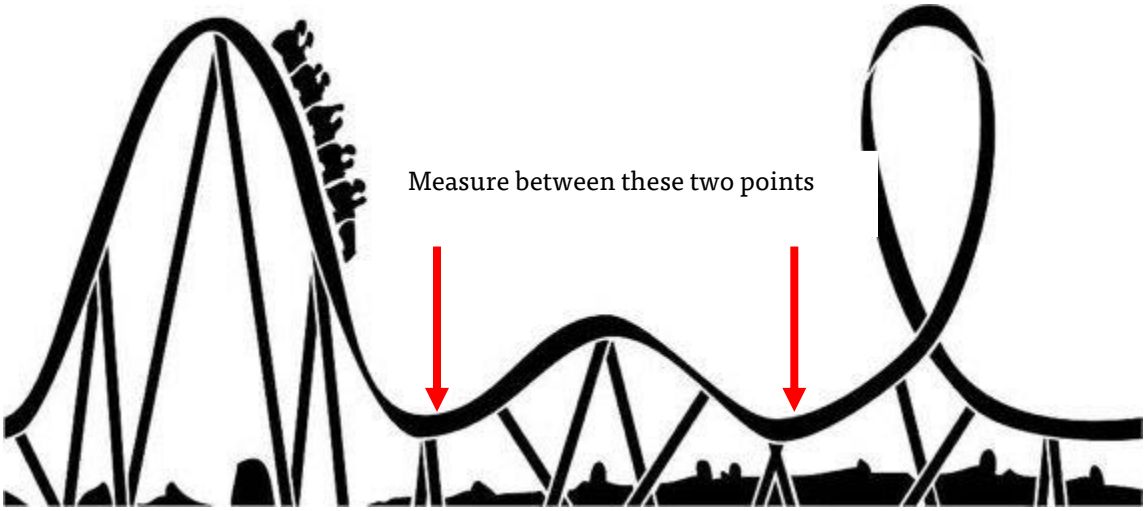
Station #2: How do smaller hills or bumps help the coaster keep going?

- In the videos, there were some smaller hills or bumps later in the track. Using the same set up as above, expand the track forward and include a hill or bump that is not as high as the first hill.
- Measure the height of that hill at the highest point from the table and record it in the table below.
- Measure the length of the track from the point where the coaster hits the lowest point on the track after the initial hill to the lowest point following the second hill.
- Starting at the top of the initial hill, record the time that it takes for the marble to go through the path.

Did your marble get over the second hill? YES NO

If your marble didn't make it over the hill, try a different height for the hill.

Height from Table						
Length of track						
Time (three trials)						

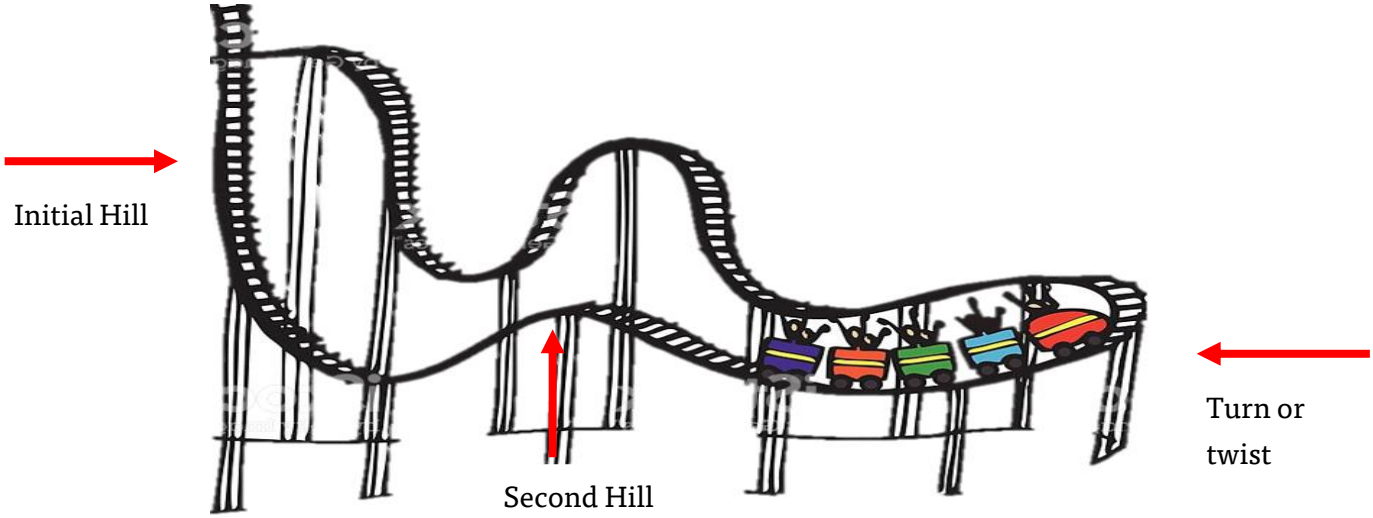


If your marble made it over the hill, what did you notice about the time? Can you draw an inference about the speed?

What do you think the second hill helps do?

Station #3: What is the point of twists and turns?

- The twists and turns are the elements that help to direct the coaster in a different direction but need to be considered when they are added.
- Using the initial set up of the hill only, add a length of track that takes the coaster direction and turns it so that it is going a different way.
- Make observations about what happened to the marble when this was added.

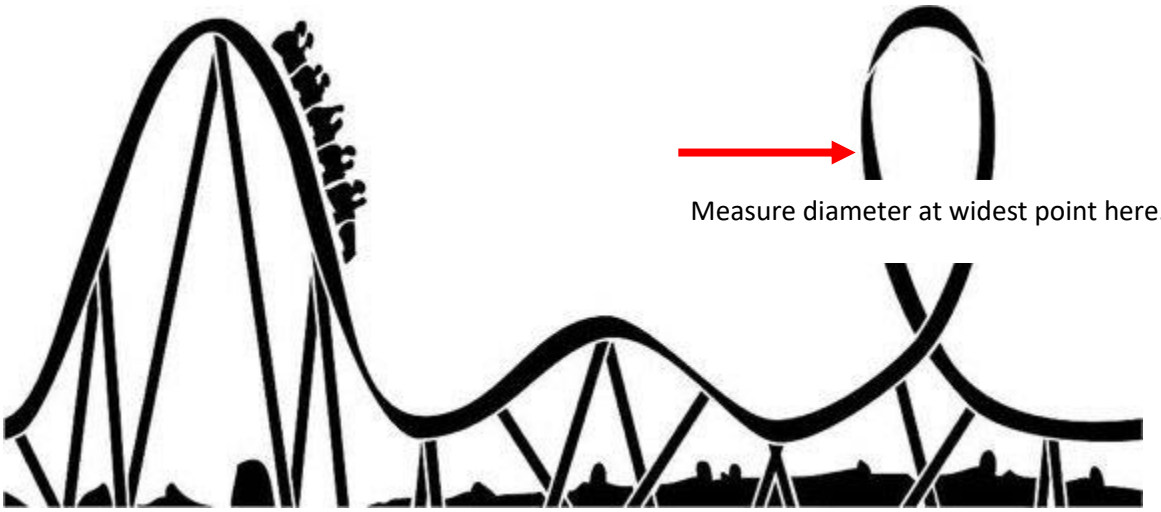


What observations did you make?

Did the marble stay on the track? If yes, what happened to the speed? If not, how did you change the shape so that it did?

Station #4 What do I need to learn about loops?

- After the second hill, change your design so that a loop is next instead of a twist or turn.
- Measure the diameter of the loop.
- Try your marble out and see if the marble goes all the way through the loop.
- Continue to tweak your loop design until the marble goes all the way through.



What observations did you make?

What did you notice about the how fast the marble is moving when it makes it all the way through the loop? What about when the marble didn't make it through the loop?

Connecting Coaster Concepts

Use the book to help think about the concept of energy and how it is used in your coaster design.

Where and how is energy used in your coaster design?
What observations did you make?

Based on what you understand about potential and kinetic energy, label the following image so that you show where potential energy is the greatest. Where kinetic energy is the greatest.



Where does the coaster get the initial energy? (Hint, think about how the coaster train gets to the top of the initial hill.)

What different coaster elements help to add energy back into the system? Explain why.

What force helps to pull the car over the top hill?

What happens if the coaster is wobbly, or the track does not sit on the track properly?

On the next page, sketch/draw an initial design of the coaster that will be constructed and have it approved by the management. Make sure your coaster has the following:

- ☐ initial drop from the top of the hill.
- ☐ at least one small hill later in the track.
- ☐ a minimum of two turns or twists on the track.
- ☐ a loop.

Coaster Design