

Name: _____

Date: _____

Period: _____

Online Simulation Lab → ROLLER COASTER PHYSICS

Purpose: *The purpose of this simulation lab is to strengthen your understanding of energy conservation in real-world applications. You will use a skateboarder and his park to represent the roller coaster and its track. You will observe many other physics concepts at work as well.*

Pre-Lab Inquiry

What Do You Think?

You are asked to design a new roller coaster. It is totally up to you to determine what the riders will experience. The only rule is that the coaster obeys the laws of physics. Take a minute and brainstorm about a design you would like.

1. Name three adjectives that will describe your roller coaster.
2. Describe three features your roller coaster will have that will attract riders.
3. Name three variables that will affect the type of experience a rider will have. EXPLAIN.
4. Name three concepts of physics that the roller coaster must obey in order to be successful. EXPLAIN.
5. Draw a side-view sketch of your roller coaster design below.

Concept Review

Write out an explanation for each question below.

6. Define potential and kinetic energy.

7. Describe when potential and kinetic energy are at their highest on a roller coaster.

8. How does conservation of energy apply to roller coasters?

9. How does friction affect a roller coaster?

10. What is responsible for the apparent change in weight that riders experience on coasters?

Internet Lab Activity

Open up the University of Colorado, PhET Energy Skate Park simulation:

1. Go to <http://phet.colorado.edu/>
2. Click "Play with Sims...>"
3. Click the "Energy Skate Park" icon
4. Click "Run Now!"
5. Spend ONE MINUTE to explore the simulation and familiarize yourself with the controls.
6. Click the "Reset" button in the top-right corner. Begin the exploration below.

Exploration Questions

Use the simulation to answer the questions below.

1. Does the skater hit the same height on the opposite sides of the track? (Checkmark the "Show Grid" button to help you determine this!)
 - a. What must be true about the system for this to be possible?

- b. Click the "Track Friction >>" button to adjust the friction settings. What do you observe about the skater as you adjust the setting?
2. Now, turn on the energy Pie Chart and Bar Graph. (You may need to move things around a little to see everything.)
 - a. On the visual aids, what color represents potential energy and which is kinetic energy?
 - b. When does the skater have the highest amount of kinetic energy? Potential energy?
 - c. When does the skater have the lowest amount of kinetic energy? Potential energy?
 - d. Describe how the bar graph changes as the skater moves along the track.
 - e. Explain which visual aid (pie chart or bar graph) helps *you* understand conservation of energy better, and why.
 - f. Keep your preferred visual aid open for the remainder of the investigation.

Build Your Roller Coaster

Use the simulation to build and test your roller coaster design from the Pre-Lab Inquiry.

1. If you made any changes during the Exploration Questions, click "Reset" again.
2. Right-click the track and select "Roller Coaster Mode". This keeps the skater attached.
3. Notice that you can zoom out to give yourself a wider view. You may want to do this as you build your coaster.
4. Drag in new pieces of track and manipulate the curves until you closely match your pre-lab sketch.
5. Drag and drop the rider to the location of the beginning and observe. DO NOT MAKE CHANGES YET.
 - a. The ride probably was not successful on the first attempt. If not, what physics concept(s) was violated?

- b. Identify several adjustments you need to make.
6. After making the initial adjustments, try the ride again. Continue making adjustments until the ride becomes successful (rider makes it from one end to the other completely - does not have to make it back through).
7. Raise your hand and show the teacher your successful design.
8. Draw a side-view sketch of your successful design below.

9. Click the "Track Friction >>" button and adjust the setting.
10. Run the rider through your track again and observe the changes.
 - a. Did the rider make it to the end?

 - b. What do you notice differently about the pie chart and/or bar graph?
11. Describe the changes you need to make to your design, as a result of the presence of friction.

12. Make the necessary adjustments until you achieve a successful ride with friction.
13. Raise your hand and show the teacher your friction-savvy coaster.
14. Draw a side-view sketch of your friction-savvy coaster below.

Post-Lab Questions:

1. List and explain the differences between each of your sketches.
2. At the top of a hill on the ride, most of the energy is _____ and at the bottom of the hill, most of the energy is converted into _____.
3. What are the equations for potential and kinetic energy?
4. If you were an engineer of an actual roller coaster, what information would you need to know in order to ensure that your coaster would be safe?
5. Would it be possible to predict the speeds that a coaster will reach before it's ever placed on the track? How?
6. The most thrilling roller coasters usually contain vertical loops. What keeps the riders in their seats when they go upside-down?