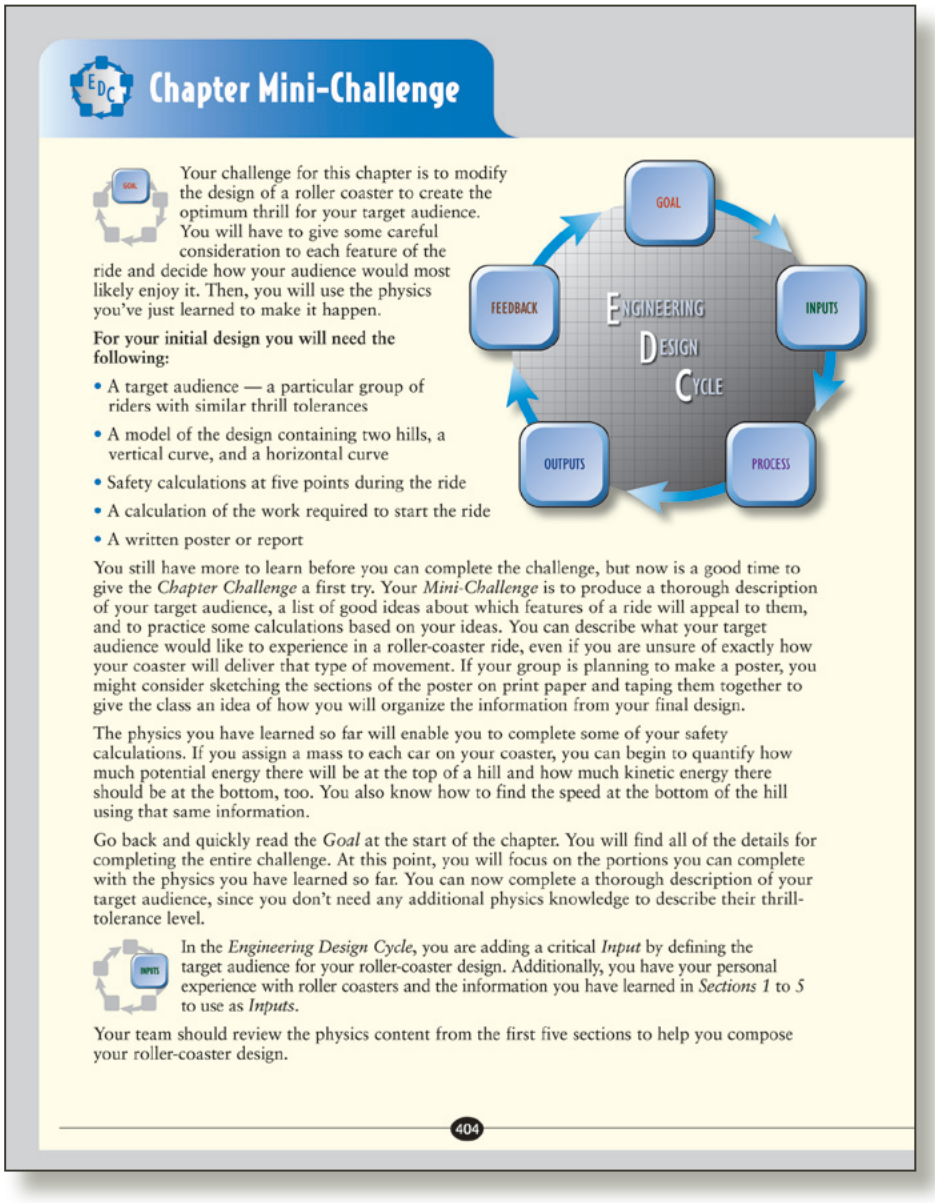
Chapter Mini-Challenge

The *Chapter Mini-Challenge* gives students the opportunity to carefully consider each feature of their roller-coaster ride using the physics they have learned and decide how their audience would enjoy it. As students review a list of what they will need for their initial design of the roller coaster, highlight important aspects of their challenge. Ensure that students are able to describe the features of the ride that their target audience will be able to enjoy. Consider asking students to make a chart that shows a plan of how each movement of the roller coaster will deliver its intended effect on a group of riders.



Chapter Mini-Challenge

Your challenge for this chapter is to modify the design of a roller coaster to create the optimum thrill for your target audience. You will have to give some careful consideration to each feature of the ride and decide how your audience would most likely enjoy it. Then, you will use the physics you've just learned to make it happen.

For your initial design you will need the following:

- A target audience — a particular group of riders with similar thrill tolerances
- A model of the design containing two hills, a vertical curve, and a horizontal curve
- Safety calculations at five points during the ride
- A calculation of the work required to start the ride
- A written poster or report

You still have more to learn before you can complete the challenge, but now is a good time to give the *Chapter Challenge* a first try. Your *Mini-Challenge* is to produce a thorough description of your target audience, a list of good ideas about which features of a ride will appeal to them, and to practice some calculations based on your ideas. You can describe what your target audience would like to experience in a roller-coaster ride, even if you are unsure of exactly how your coaster will deliver that type of movement. If your group is planning to make a poster, you might consider sketching the sections of the poster on print paper and taping them together to give the class an idea of how you will organize the information from your final design.

The physics you have learned so far will enable you to complete some of your safety calculations. If you assign a mass to each car on your coaster, you can begin to quantify how much potential energy there will be at the top of a hill and how much kinetic energy there should be at the bottom, too. You also know how to find the speed at the bottom of the hill using that same information.

Go back and quickly read the *Goal* at the start of the chapter. You will find all of the details for completing the entire challenge. At this point, you will focus on the portions you can complete with the physics you have learned so far. You can now complete a thorough description of your target audience, since you don't need any additional physics knowledge to describe their thrill-tolerance level.

In the *Engineering Design Cycle*, you are adding a critical *Input* by defining the target audience for your roller-coaster design. Additionally, you have your personal experience with roller coasters and the information you have learned in *Sections 1* to *5* to use as *Inputs*.

Your team should review the physics content from the first five sections to help you compose your roller-coaster design.

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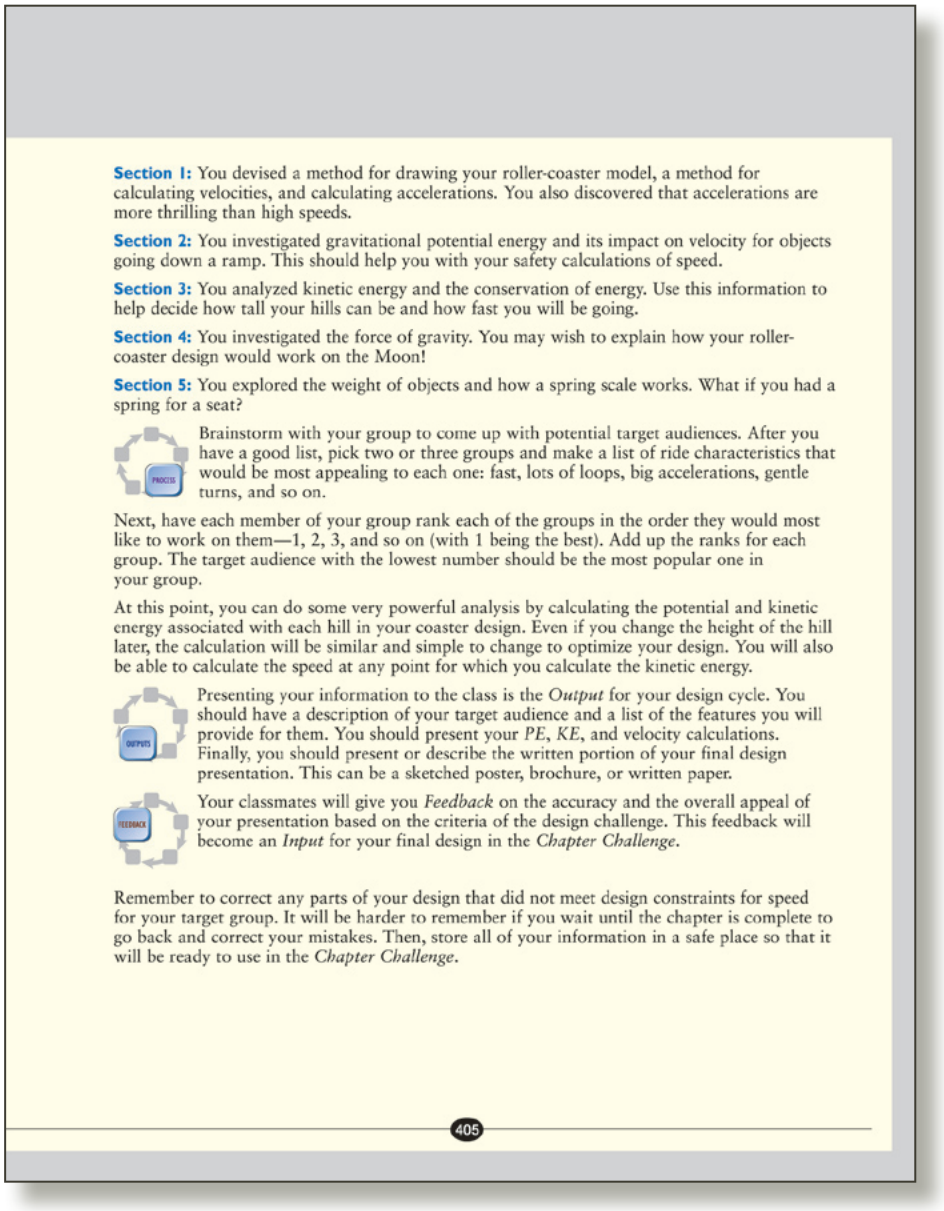
Students should also show their safety calculations using their knowledge of energy equations and Newton's laws. Ask students to assign a mass to each car of the roller coaster that quantifies the amount of potential energy at the top of a hill and the kinetic energy at the bottom. Remind students that speed is independent of mass during the ride.

Direct them to read the *Goal* of the chapter and review the details needed to complete the entire challenge. Emphasize that at this stage they should only focus on the physics they have learned and convey to students that you expect a thorough description of their target audience.

During the *Chapter Mini-Challenge*, review how students are progressing through each step of the *Engineering Design Cycle*.

Discuss the *Inputs* they are using for their roller-coaster design. Ask each group to share their ideas with members of other groups. A review of the physics content of the first five sections will be particularly helpful to students if they list physics concepts they have learned and how those concepts can be applied in their roller-coaster design.

Deciding on the many features of a roller-coaster design to make it safe and thrilling at the same time may appear to be a daunting task in the *Process* phase for some students. Ask them to analyze the list of their ride characteristics and potential target audiences so that they are more confident of their choices while deciding on an effective roller-coaster design. Encourage students to calculate the kinetic energy of the ride at different heights and from that calculate the speed of the roller coaster.



Section 1: You devised a method for drawing your roller-coaster model, a method for calculating velocities, and calculating accelerations. You also discovered that accelerations are more thrilling than high speeds.

Section 2: You investigated gravitational potential energy and its impact on velocity for objects going down a ramp. This should help you with your safety calculations of speed.

Section 3: You analyzed kinetic energy and the conservation of energy. Use this information to help decide how tall your hills can be and how fast you will be going.

Section 4: You investigated the force of gravity. You may wish to explain how your roller-coaster design would work on the Moon!

Section 5: You explored the weight of objects and how a spring scale works. What if you had a spring for a seat?

Brainstorm with your group to come up with potential target audiences. After you have a good list, pick two or three groups and make a list of ride characteristics that would be most appealing to each one: fast, lots of loops, big accelerations, gentle turns, and so on.

Next, have each member of your group rank each of the groups in the order they would most like to work on them—1, 2, 3, and so on (with 1 being the best). Add up the ranks for each group. The target audience with the lowest number should be the most popular one in your group.

At this point, you can do some very powerful analysis by calculating the potential and kinetic energy associated with each hill in your coaster design. Even if you change the height of the hill later, the calculation will be similar and simple to change to optimize your design. You will also be able to calculate the speed at any point for which you calculate the kinetic energy.

Presenting your information to the class is the *Output* for your design cycle. You should have a description of your target audience and a list of the features you will provide for them. You should present your *PE*, *KE*, and velocity calculations. Finally, you should present or describe the written portion of your final design presentation. This can be a sketched poster, brochure, or written paper.

Your classmates will give you *Feedback* on the accuracy and the overall appeal of your presentation based on the criteria of the design challenge. This feedback will become an *Input* for your final design in the *Chapter Challenge*.

Remember to correct any parts of your design that did not meet design constraints for speed for your target group. It will be harder to remember if you wait until the chapter is complete to go back and correct your mistakes. Then, store all of your information in a safe place so that it will be ready to use in the *Chapter Challenge*.

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For the *Outputs* phase of the *Mini-Challenge*, ask students to present their description to the target audience. They should also be asked to present information on a poster, brochure, or written paper that will become their final design of the roller coaster. Remind them that they are also expected to show their calculations of potential energy, kinetic energy, and velocity. While students are making their presentations, you might want to give each student a rubric that will facilitate a more accurate *Feedback*. You must emphasize, once students have finished their presentations, they should carefully read the comments they received during the *Feedback* stage to adjust any part of their roller-coaster design that is deemed inappropriate or dangerous for their chosen audience.