Chapter Challenge

Scenario

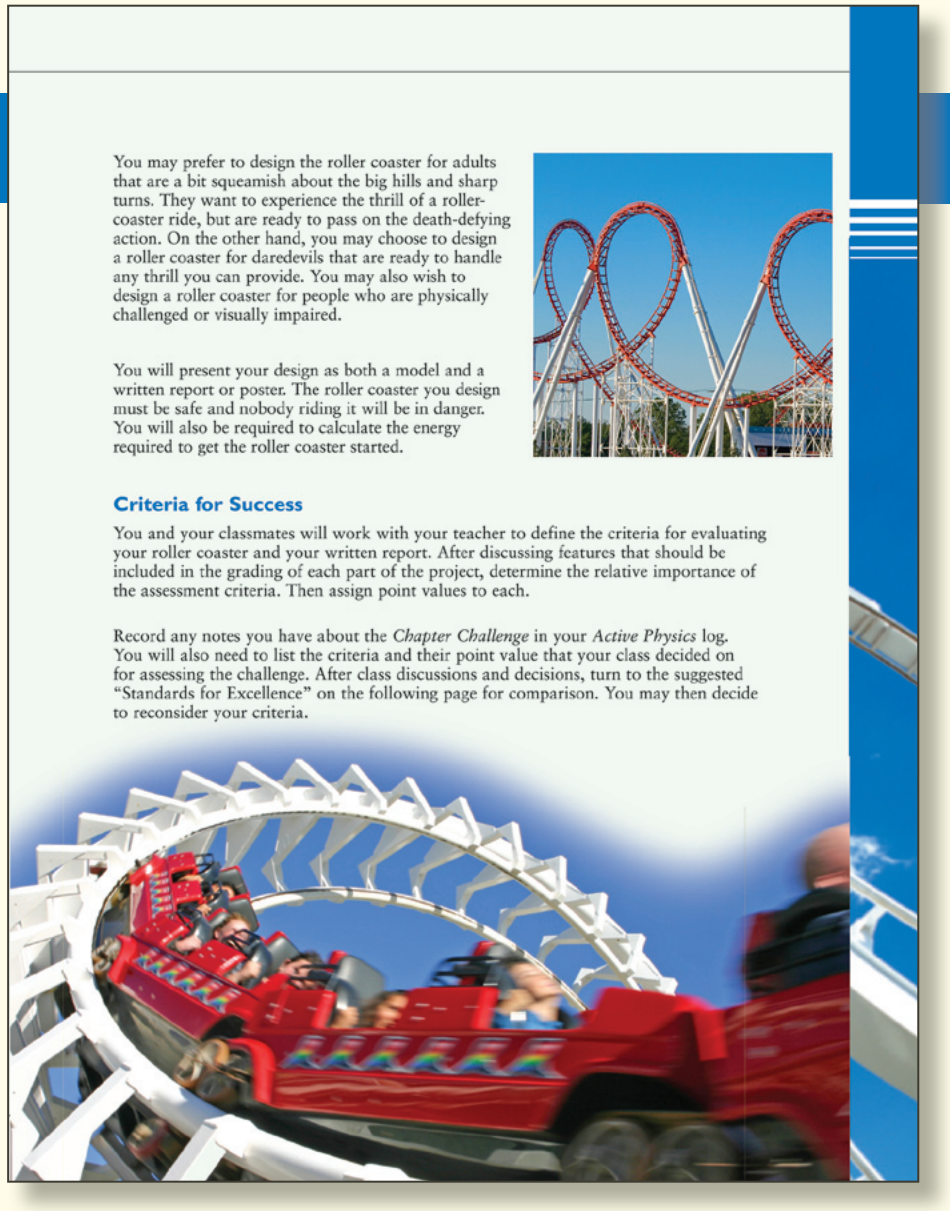
Consider having a student read the *Scenario* aloud. Ask students if they have ever been on a roller-coaster ride and, if so, invite them to share their experience in class. The *Scenario* is meant to engage students' interest from the time they begin reading the chapter. Ask the class if they think they could design a roller coaster for a specific group of people and what features they would include and omit. Make a list of features for various groups such as preschoolers, elementary school students, middle school students, high school students, college students, adults, and senior citizens.

Let students know that they will be altering the design of a roller coaster for a specific group of people. Ask students what physics concepts they think might be involved in the design of a roller coaster. Suggest strategies to keep track of the information presented in each section—such as making a concept map during the chapter, outlining information, or keeping a record of concepts and examples they deem important in their *Active Physics* logs. Avoid providing students with too many examples of what could be done to complete the challenge, as this may limit their creativity and make them less confident in seeking their own solutions.

Your Challenge

Have a class discussion about the challenge and the tasks students are required to complete to successfully meet the challenge. Ask the class to construct a chart listing the criteria and constraints similar to the one shown to the right.

Criteria	Constraints
• Thrilling and non-threatening roller coaster design • Calculations of energy required to get the roller coaster started	• Select group of riders • Safety • Modifications made to a current design



You may prefer to design the roller coaster for adults that are a bit squeamish about the big hills and sharp turns. They want to experience the thrill of a roller-coaster ride, but are ready to pass on the death-defying action. On the other hand, you may choose to design a roller coaster for daredevils that are ready to handle any thrill you can provide. You may also wish to design a roller coaster for people who are physically challenged or visually impaired.

You will present your design as both a model and a written report or poster. The roller coaster you design must be safe and nobody riding it will be in danger. You will also be required to calculate the energy required to get the roller coaster started.

Criteria for Success

You and your classmates will work with your teacher to define the criteria for evaluating your roller coaster and your written report. After discussing features that should be included in the grading of each part of the project, determine the relative importance of the assessment criteria. Then assign point values to each.

Record any notes you have about the *Chapter Challenge* in your *Active Physics* log. You will also need to list the criteria and their point value that your class decided on for assessing the challenge. After class discussions and decisions, turn to the suggested "Standards for Excellence" on the following page for comparison. You may then decide to reconsider your criteria.

Use the information in the student text, emphasizing the criteria and constraints. Let students know that they will need to write a report that explains the physics concepts being used. It is important for the students to complete *Section 10* of this chapter in order to complete the *Chapter Challenge* successfully. Sections of the chapter on forces and acceleration will provide a useful review of these concepts if they have been introduced previously. This chapter has proven to be more effective if the students have completed *Chapter 1* of *Active Physics* before tackling this chapter. There are times when it is preferable to apply knowledge about forces to understanding a problem. There are other times when energy conservation is a more straightforward approach. Encourage students to look at the roller coaster from both an energy perspective and a force perspective, similar to the way in which a physicist would approach the design.

Criteria for Success

Discuss the criteria for evaluating a roller-coaster design by developing ideas your class suggests. The criteria should include more details on the oral and written presentation. These criteria then become a part of the rubric that the class can use to evaluate their work. While developing your rubric, make frequent references to the physics principles that are likely to be considered. The criteria should include accurate and clear explanations with original ideas. Encourage each student to participate during this discussion. This will facilitate student understanding of the assessment. Include the criteria listed in the *Standard of Excellence*. Consider using the Blackline Master of the *Standard of Excellence* while guiding the class discussion.

Read aloud the criteria that you develop with your class. This may bring up other interesting points that could be used to reinforce or modify the criteria. After the class agrees on each criterion, develop a rubric for grading the *Chapter Challenge*. Consider asking your class which criteria are necessary for an "A," and how they should

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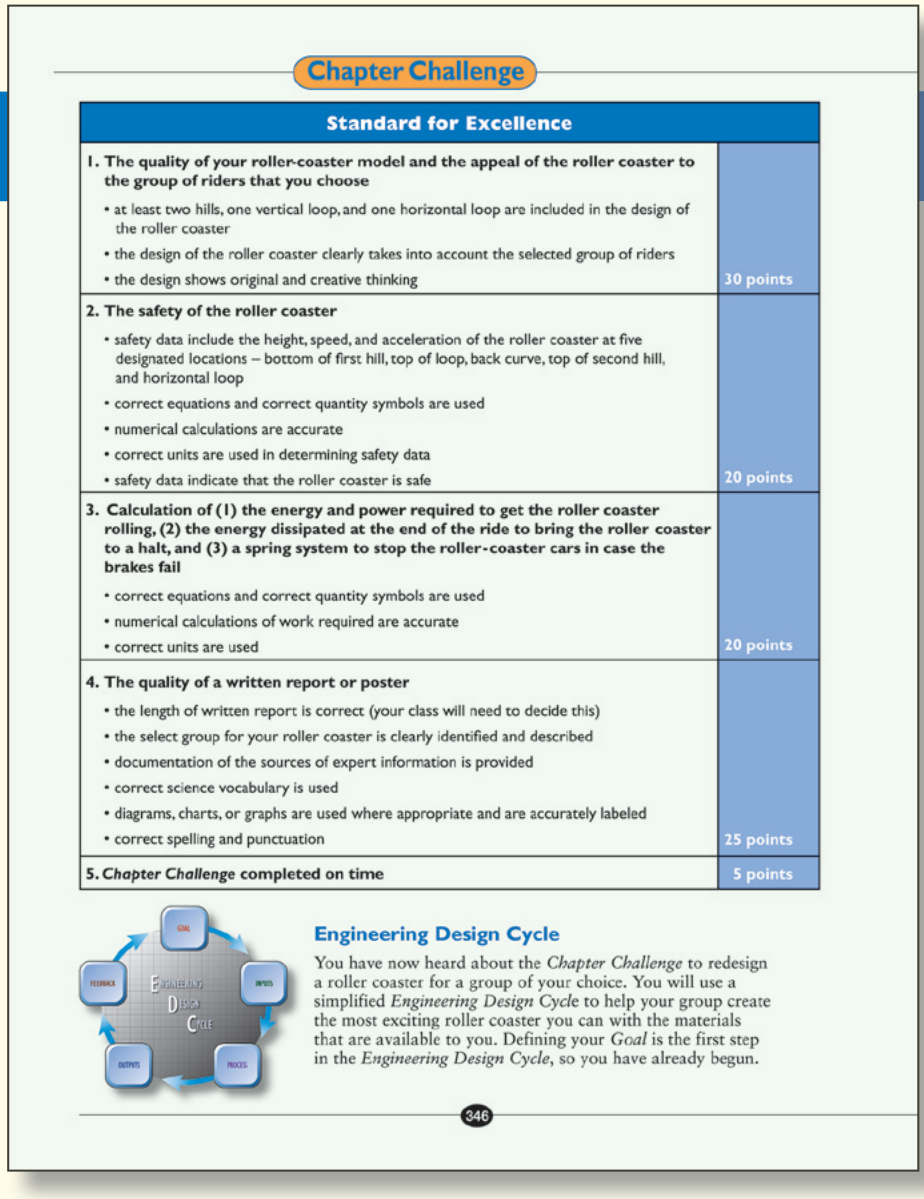
get subsequent grades. Have the students decide how many points each part is worth. For example, you may want to have students assign fewer points to the aesthetic qualities of the report or presentation and more points for explanations using physics principles. The assessment rubric should place the greatest emphasis on showing understanding of physics concepts, and should include the criteria in the student text. Make sure that students understand the criteria and the rubric before they begin their work. After the class decisions have been made on the criteria, compare with the suggested *Standard for Excellence* and reconsider the criteria and grading.

Standard for Excellence

Students should decide the criteria for grading the *Chapter Challenge*. The process of decision making gives them a voice in determining how their projects will be judged. A few criteria are listed in the *Standard for Excellence* table with suggested point values. Help students outline those aspects of the *Chapter Challenge* that should be graded. The primary purpose of each criterion necessary to earn an "A" is to motivate students to succeed and to keep them focused.



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Standard for Excellence	
1. The quality of your roller-coaster model and the appeal of the roller coaster to the group of riders that you choose • at least two hills, one vertical loop, and one horizontal loop are included in the design of the roller coaster • the design of the roller coaster clearly takes into account the selected group of riders • the design shows original and creative thinking	30 points
2. The safety of the roller coaster • safety data include the height, speed, and acceleration of the roller coaster at five designated locations – bottom of first hill, top of loop, back curve, top of second hill, and horizontal loop • correct equations and correct quantity symbols are used • numerical calculations are accurate • correct units are used in determining safety data • safety data indicate that the roller coaster is safe	20 points
3. Calculation of (1) the energy and power required to get the roller coaster rolling, (2) the energy dissipated at the end of the ride to bring the roller coaster to a halt, and (3) a spring system to stop the roller-coaster cars in case the brakes fail • correct equations and correct quantity symbols are used • numerical calculations of work required are accurate • correct units are used	20 points
4. The quality of a written report or poster • the length of written report is correct (your class will need to decide this) • the select group for your roller coaster is clearly identified and described • documentation of the sources of expert information is provided • correct science vocabulary is used • diagrams, charts, or graphs are used where appropriate and are accurately labeled • correct spelling and punctuation	25 points
5. *Chapter Challenge* completed on time	5 points

Engineering Design Cycle

You have now heard about the *Chapter Challenge* to redesign a roller coaster for a group of your choice. You will use a simplified *Engineering Design Cycle* to help your group create the most exciting roller coaster you can with the materials that are available to you. Defining your *Goal* is the first step in the *Engineering Design Cycle*, so you have already begun.

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As the *Chapter Challenge* approaches, revisit the rubric to develop a more comprehensive assessment rubric, which should determine grading and expectations that meet your own evaluation system. As an example, a complete *Sample Assessment Rubric* for *Chapter 4* is provided at the end of the chapter in this *Teacher's Edition* and as a Blackline Master in your *Teacher Resources CD*.

4c Blackline Master

Engineering Design Process

Discuss the *Engineering Design Cycle* with the class. Let the class know that they will be going through the cycle during the first half of the chapter. Then discuss the *Goal* and ask students to

provide a specific example. Tell them that they will be using the *Engineering Design Cycle* when designing their roller coaster.

Students should first set their *Goal* using the criteria and consider the *Inputs* they receive after each section. These inputs will become important physics concepts that they will apply to complete their roller-coaster design and the rest of the challenge. Discuss how the *Mini-Challenge* will require them to complete the *Process* step that involves combining their ideas with the criteria of the challenge, comparing and contrasting potential solutions. Remind students that they will be presenting *Outputs* to the class in the *Mini-Challenge* and eventually the *Challenge*. Emphasize that the entire class will be providing *Feedback* on the *Outputs*. The *Feedback* from the *Mini-Challenge* will be used to refine the design of the roller coaster and the report before the *Chapter Challenge* is completed.

Physics Corner

The *Physics Corner* lists physics concepts presented in the chapter. This section illustrates how students should be involved in scientific inquiry. Ask students if they are familiar with any of the concepts they are about to study. Encourage them to provide definitions for the terms they know, or what they think the terms mean. Record students' ideas and revisit them when they are discussed in the chapter. Ask students where physics concepts are being displayed in the illustration. Remind them that an application of these concepts is needed to complete their *Chapter Challenge*, and that they will need to incorporate important physics concepts in their presentation. Use an overhead of the *Physics Corner* while guiding class discussion.

Students will be motivated when they are actively engaging in the learning process. As the *Chapter Challenge* approaches, review the *Physics Corner* to help them keep track of the physics they have learned.