Chapter Challenge

Scenario

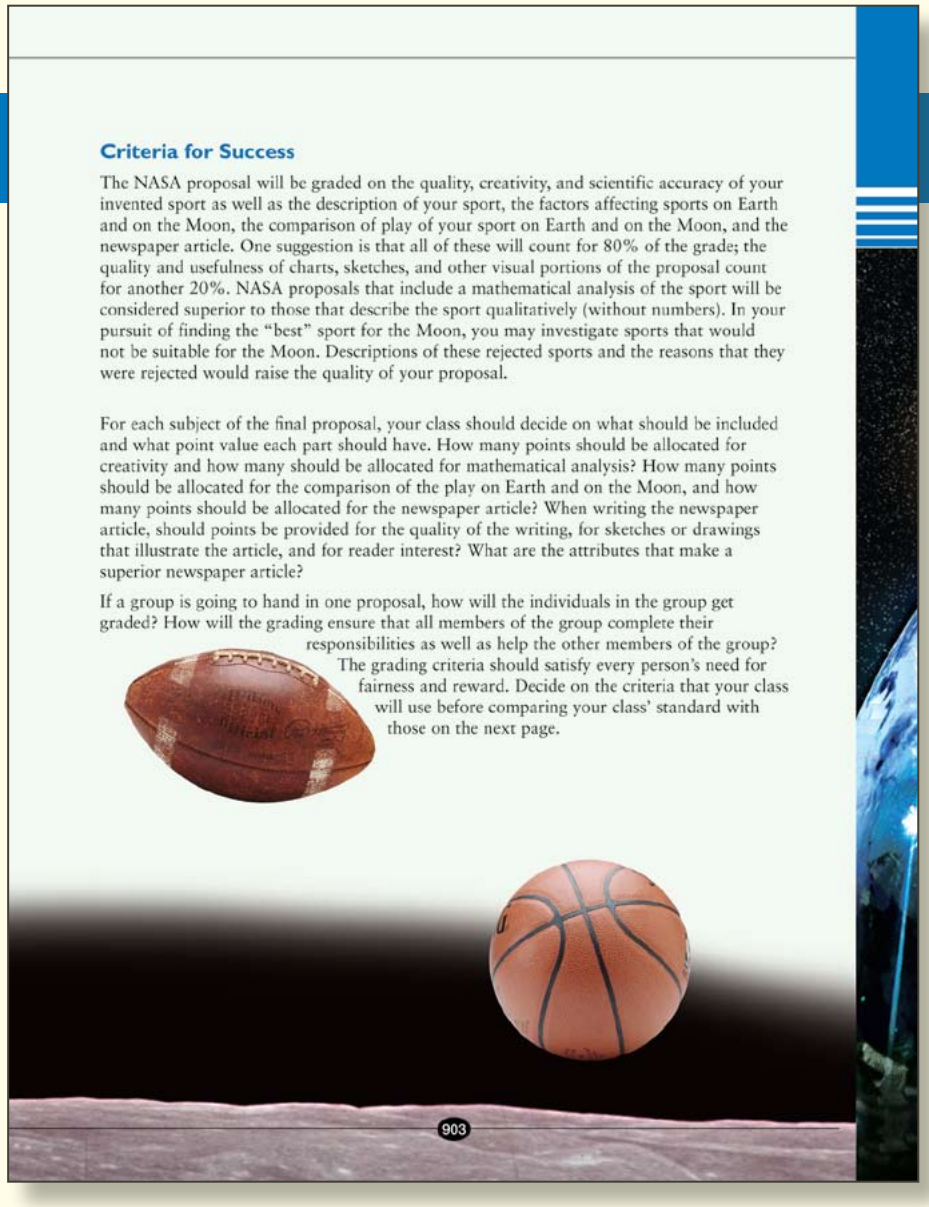
The *Scenario* builds on the exciting proposition that one day humans will thrive on the Moon. Like life on Earth, people will engage in exercise and entertainment. They will participate in sports to satisfy these needs. Possibly, people on Earth will watch these sports that are played on the Moon on their television sets.

Consider reading the *Scenario* aloud or have a student read it to the class. Discuss the *Scenario* with your class. Ask students what sports they might choose for exercise and entertainment on the Moon and how they think these sports might be possible. Consider brainstorming to figure out what your students already about the atmosphere and existence of life on the Moon. Ask students what might happen if they played a sport on the Moon using the same rules as those on Earth. Record their responses and bring them up as you progress through the chapter.

Your Challenge

To invent or adapt a sport on the Moon is a challenging task. Students must understand that they will have to describe the sport that they choose, know how the sport will be affected if it is played on the Moon, and what modifications will have to be introduced to make the sport successful. Lead a class discussion to let students know that they will have to make a general comparison between sports on the Moon and sports on Earth. Assure them that the physics principles they will be learning subsequently will enable them to alter the equipment for a sport and change the rules to accommodate conditions that would affect a player on the Moon.

For the newspaper article, consider discussing the articles in the sports sections that students might have read and ask them to bring clippings of those articles for a range of ideas that describe the matches. Encourage students to share their ideas to give them the opportunity to write an interesting commentary that grabs the reader's attention. Emphasize that the proposal to NASA must demonstrate a strong knowledge of physics concepts that show how a sport can be effectively played on the Moon.



Criteria for Success

The NASA proposal will be graded on the quality, creativity, and scientific accuracy of your invented sport as well as the description of your sport, the factors affecting sports on Earth and on the Moon, the comparison of play of your sport on Earth and on the Moon, and the newspaper article. One suggestion is that all of these will count for 80% of the grade; the quality and usefulness of charts, sketches, and other visual portions of the proposal count for another 20%. NASA proposals that include a mathematical analysis of the sport will be considered superior to those that describe the sport qualitatively (without numbers). In your pursuit of finding the "best" sport for the Moon, you may investigate sports that would not be suitable for the Moon. Descriptions of these rejected sports and the reasons that they were rejected would raise the quality of your proposal.

For each subject of the final proposal, your class should decide on what should be included and what point value each part should have. How many points should be allocated for creativity and how many should be allocated for mathematical analysis? How many points should be allocated for the comparison of the play on Earth and on the Moon, and how many points should be allocated for the newspaper article? When writing the newspaper article, should points be provided for the quality of the writing, for sketches or drawings that illustrate the article, and for reader interest? What are the attributes that make a superior newspaper article?

If a group is going to hand in one proposal, how will the individuals in the group get graded? How will the grading ensure that all members of the group complete their responsibilities as well as help the other members of the group? The grading criteria should satisfy every person's need for fairness and reward. Decide on the criteria that your class will use before comparing your class' standard with those on the next page.

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Criteria for Success

Review the requirements of the *Chapter Challenge* and start developing a set of criteria that accommodate different aspects of the challenge. You could begin by asking students to decide on what points and corresponding grade should be assigned to quality and creativity of the proposal. You could guide their decision on each criterion by asking them how they understand that criterion and ask them to provide an example of what they might suggest. For example, how would they describe a creative sport? Because knowledge of the science discussed is important to the proposal, students should consider what a description of a physics concept should include and how many points should be assigned to the criterion that outlines scientific accuracy.

Mathematical analysis and how students make comparisons between a sport on Earth and the Moon would also require that students know how significant these criteria are to the challenge. While the class as a whole allocates points to each criterion, the requirements of the challenge have to be clearly explained so that the weight of each criterion is decided according to how relevant it is to the final proposal. Whether the proposal will be submitted collectively in groups or individually must be decided by the students. You should make sure that a process is established where each students is given equal responsibilities and is rewarded for the work completed in an equitable manner. The *Criteria for Success* is meant to give students a sense of fairness and reward as they decide which criteria they should choose, how it reflects their understanding of the requirements, and how they must meet those criteria.

Standard for Excellence

Once students have decided on an initial draft of the criteria that will be used to grade the requirements of the challenge, you can compare these criteria with the criteria in the *Standard for Excellence* table. Ask students to see how closely their initial draft matches the criteria provided in the student text. They should now start building a rubric that incorporates details that they have gathered and decided upon as a class and determine how many points each

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Chapter Challenge

criterion should receive. Point out to students that their rubric is a grading tool that is gradually refined as students become more familiar with the physics content that they will be learning as they progress towards their *Chapter Challenge*.

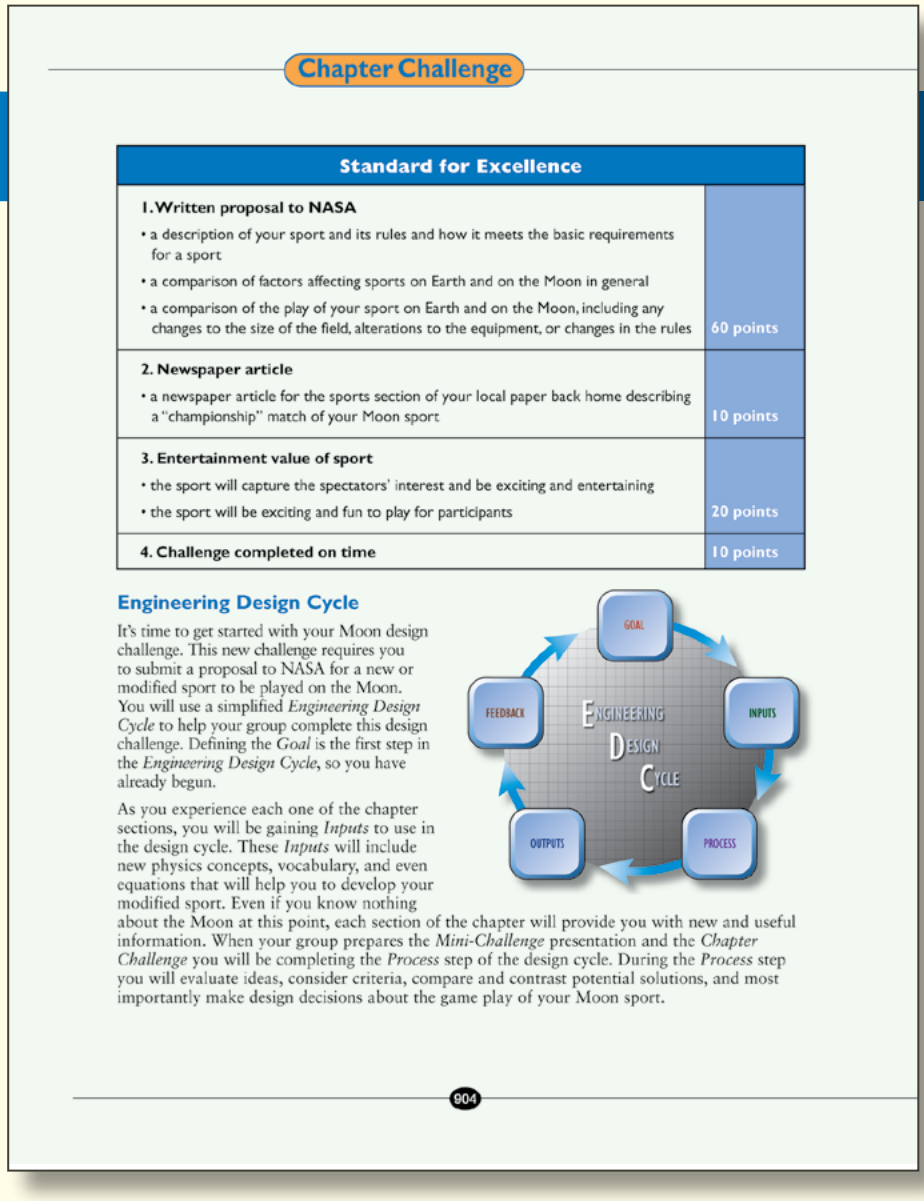
At this stage, it is necessary to highlight the essential parts of the challenge and which criteria should receive greater emphasis. Emphasize that the criteria related to the science content should be assigned a higher grade. Students should be able to describe how playing a sport on the Moon would affect the motion and weight of the players. This description, for instance, should carry more points than the entertainment value of the sport or if the challenge is completed on time. A sample rubric is provided at the end of this chapter in the *Teacher's Edition*. You could incorporate the criteria and other ideas from this rubric into the rubric that you develop with the feedback from your class.

9a Blackline Master

Engineering Design Cycle

As students get started on their design challenge, review the steps of the *Engineering Design Cycle*. Outline the requirements of each step and how it relates to the *Goal*. A significant element of this cycle is that it provides for a continual refinement of the challenge. Emphasize to the students that they have already completed the first step once they have defined the *Goal*. Therefore, the requirement to submit a proposal to NASA for a new or modified sport is the first step of the *Engineering Design Cycle*.

Discuss the *Inputs* that students will be gaining from each section. Ask students what *Inputs* they think they will be gaining from each section. Emphasize that the new physics concepts they will learn will form an essential part of their *Inputs*. The concepts will include new vocabulary and new equations. Stress that each section provides useful information, which students can use to develop their challenge. Point out that during the *Process* phase, they will complete the first half of the process of analyzing and evaluating information.



Chapter Challenge

Standard for Excellence	
1. Written proposal to NASA • a description of your sport and its rules and how it meets the basic requirements for a sport • a comparison of factors affecting sports on Earth and on the Moon in general • a comparison of the play of your sport on Earth and on the Moon, including any changes to the size of the field, alterations to the equipment, or changes in the rules	60 points
2. Newspaper article • a newspaper article for the sports section of your local paper back home describing a "championship" match of your Moon sport	10 points
3. Entertainment value of sport • the sport will capture the spectators' interest and be exciting and entertaining • the sport will be exciting and fun to play for participants	20 points
4. Challenge completed on time	10 points

Engineering Design Cycle

It's time to get started with your Moon design challenge. This new challenge requires you to submit a proposal to NASA for a new or modified sport to be played on the Moon. You will use a simplified *Engineering Design Cycle* to help your group complete this design challenge. Defining the *Goal* is the first step in the *Engineering Design Cycle*, so you have already begun.

As you experience each one of the chapter sections, you will be gaining *Inputs* to use in the design cycle. These *Inputs* will include new physics concepts, vocabulary, and even equations that will help you to develop your modified sport. Even if you know nothing about the Moon at this point, each section of the chapter will provide you with new and useful information. When your group prepares the *Mini-Challenge* presentation and the *Chapter Challenge* you will be completing the *Process* step of the design cycle. During the *Process* step you will evaluate ideas, consider criteria, compare and contrast potential solutions, and most importantly make design decisions about the game play of your Moon sport.

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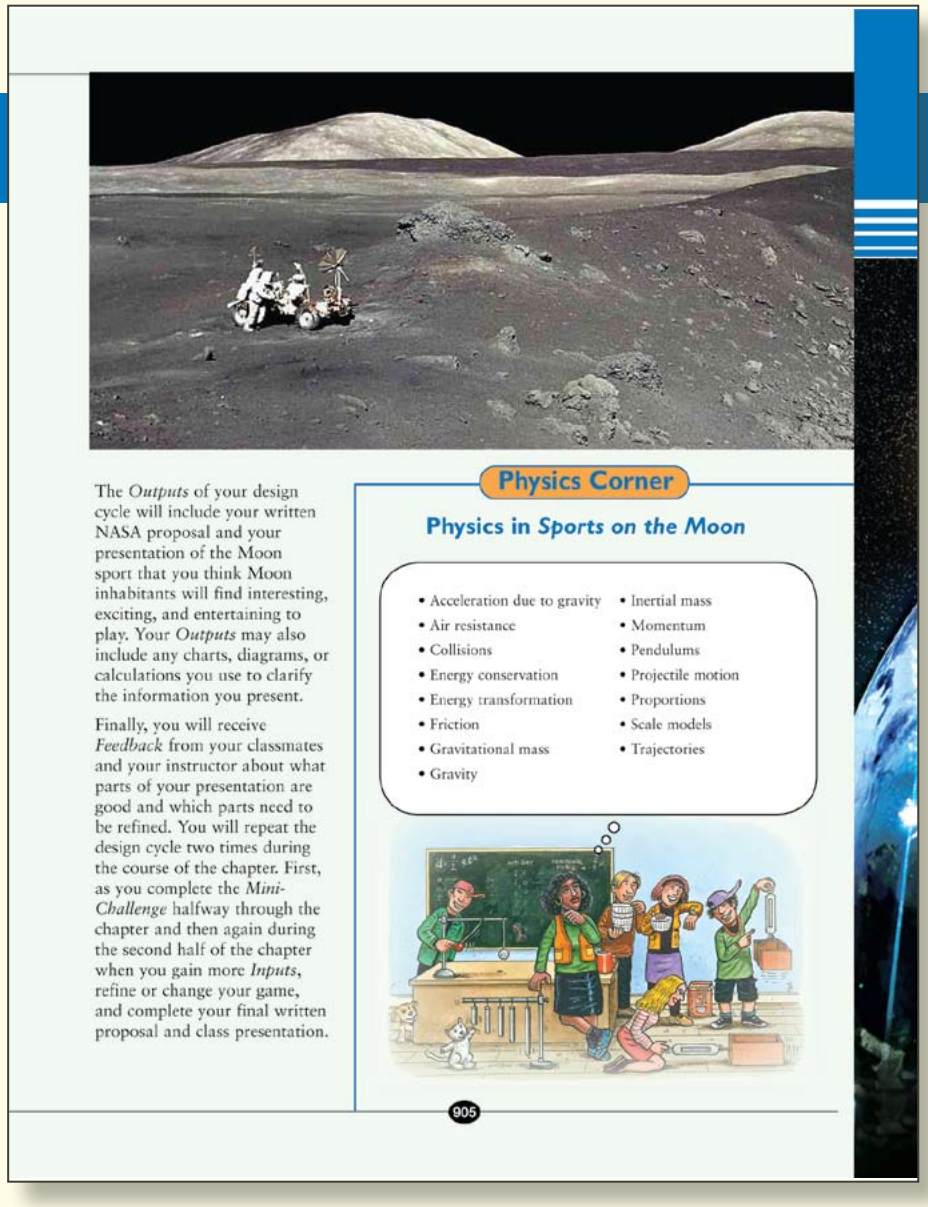

The *Outputs* of your design cycle will include your written NASA proposal and your presentation of the Moon sport that you think Moon inhabitants will find interesting, exciting, and entertaining to play. Your *Outputs* may also include any charts, diagrams, or calculations you use to clarify the information you present.

Finally, you will receive *Feedback* from your classmates and your instructor about what parts of your presentation are good and which parts need to be refined. You will repeat the design cycle two times during the course of the chapter. First, as you complete the *Mini-Challenge* halfway through the chapter and then again during the second half of the chapter when you gain more *Inputs*, refine or change your game, and complete your final written proposal and class presentation.

Physics Corner

Physics in *Sports on the Moon*

- Acceleration due to gravity
- Air resistance
- Collisions
- Energy conservation
- Energy transformation
- Friction
- Gravitational mass
- Gravity
- Inertial mass
- Momentum
- Pendulums
- Projectile motion
- Proportions
- Scale models
- Trajectories

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Physics Corner

The illustration accompanying the list of physics concepts is provided to give students an idea of the physics concepts they will be investigating. Students will most likely be familiar with some of the physics terms and could use their prior knowledge as prompts to provide definitions of the terms they do not know. Do not teach the vocabulary. They will learn the vocabulary as it is introduced and used in each appropriate section. Use an overhead of the *Physics Corner* to bring students' attention to the significance of different images, which demonstrate how different conditions might affect a sport on the Moon. To stimulate interest, you could ask students whether an object would encounter friction on the Moon, whether there is any air resistance, or whether momentum would be conserved. As students respond to your prompts, you could point out how their explanations might be linked together to form an understanding of other concepts. For instance, friction is related to air resistance and momentum to inertial mass and energy conservation to energy transformation. Students should realize that they will be revisiting this section to see how they are incorporating the physics concepts in their *Chapter Challenge*.

For the *Outputs* of the *Engineering Design Cycle*, ask students to list all the requirements of the challenge. Emphasize that the information they choose to present should be entertaining as well as informative. Encourage them to use visual tools, such as diagrams and calculations on charts to produce a user-friendly presentation where information is quickly accessible. For the *Feedback* phase, remind students that they will be completing the *Engineering Design Cycle* twice during the course of the chapter, with the *Mini-Challenge* being their first opportunity. After the *Mini-Challenge,* when students gain more *Inputs,* they apply these through a second *Process* phase to complete their final presentation.

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