

Chapter Mini-Challenge

In this *Chapter Mini-Challenge*, students incorporate what they have learned to design and describe their sport. They are required to make the sport entertaining so that future inhabitants of the Moon are excited to play or watch the game. The rules of the game should accommodate the different environment on the Moon. To explain the sport to NASA in a written proposal, students are expected to make a thorough comparison between how their sport is played on Earth and how it is played on the Moon. In addition, students have to write a newspaper article on a championship event that describes how spectators will view the sport.

As students begin their *Chapter Mini-Challenge*, tell them that they will be using the *Engineering Design Cycle* to prepare for the *Chapter Challenge*. Ask them to review the *Goal* and make sure that they have understood the details required to meet their *Chapter Challenge*. Point out that they will be focusing on the physics concepts they have learned so far. Their sport's design will be constructed from *Inputs* taken from the first five sections. Ask students to read the brief summary provided for each section in the student text and identify physics concepts they have learned. During the *Process* phase, ask students to decide how a sport might be modified to be played upon the Moon, or invent a new sport that would meet the

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GOAL

Your challenge for this chapter is to design or modify a sport that will be interesting, exciting, and entertaining for the future inhabitants of the Moon to play and watch. The design of your game will be fully explained in a written proposal that you will submit to NASA. Your proposal will contain a complete comparison between playing your sport on Earth and the Moon and will also include a newspaper article covering a "championship" game to help describe how spectators will view the sport.

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. You are now halfway through the chapter and you have learned a lot about the different factors that will change the way sports are played on the Moon compared to on Earth.

For the *Mini-Challenge* you will complete three of the four parts of the *Chapter Challenge*. You will incorporate the physics you have learned so far to describe your sport, describe the factors you have learned about that will affect all sports, and describe any changes that need to be made to your sport to make it interesting, exciting, and entertaining on the Moon. You will use the simplified *Engineering Design Cycle* to help you work through this design challenge.

Go back and quickly review your *Goal* you established at the start of the chapter. You will find all of the details for completing the entire *Chapter Challenge*. At this point, you will focus on the portions you can complete with the physics you have learned so far.

INPUTS

This challenge will rely heavily on your knowledge of physics on the Moon as well as on Earth. Since you will be comparing how differences between the two locations will affect a sport of your choice, you will have to make sure you get the physics right. Your physics *Inputs* will come directly from the chapter sections that you have completed. The only constraints you have to consider are making sure that your sport retains its excitement and interesting characteristics when played on the Moon.

Your team should review the physics content from the first five sections to help you compose your NASA proposal.

Section 1: You practiced the creative process of brainstorming in an effort to create your own definition of the word "sport." You should now have a good understanding of all of the types of activities that your team would consider a sport.

Section 2: You examined falling objects and compared how quickly dropped objects will reach the ground on Earth to how fast they will reach the ground on the Moon. The difference is due to a different acceleration due to gravity at each location. You also learned how time, distance, and acceleration are related for falling objects.

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same criteria. Once students have decided on a sport, they should make a list of all the physical actions associated with that sport. Emphasize that students will have to analyze the sport that they have selected to propose changes and modify actions so that the sport can be played on the Moon. Encourage them to use the decision table mentioned in the student text to develop a good analysis of their sport. Point out

that making a modification makes it necessary to check whether their modification produces the desired change and not unintended consequences.

When students reach the *Outputs* phase, they must include a description of their sport, a written analysis of the physics that affects the sport on Earth and how it would affect the same sport on the Moon.

Section 3: You explored the way a force causes a mass to react in order to compare the masses of different objects. You also explored how different gravitational forces are related to changes in weight for the same mass. (Pushing will be the same, but lifting will be different on the Moon.)

Section 4: You developed a model to compare the flight of a projectile on Earth to the flight of that same projectile on the Moon. During the construction of your model, you should have discovered some factors you could modify to make the projectile's path, or trajectory, on the Moon more similar to its typical trajectory on Earth.

Section 5: You used conservation of energy, work, and mass to analyze an athlete's vertical jump on Earth. You then used a similar analysis to estimate potential jumping heights for athletes on the Moon. Jumping is one area you will need to modify for your sport.



With your group, brainstorm to help come up with a list of all the possible sports you could choose. After you have a list of 10 or more sports, have each member of your group rank them in order, assigning a number one to their favorite, a number two to their second favorite, and so on. Add the numbers from each group member to get a total rank value for each sport. Using this method, the sport with the lowest score would be the group's first choice. Remember, some sports might be easier to modify than others.

Once you have selected a sport, make a list of all the physical actions that the sport requires. Activities like running, jumping, swinging a bat, pushing, throwing, and so on should be on your list. Put the list in the first column of a three-column table, labeled ACTIONS. Label the next column CHANGE. For each action on your list, put a mark in the second column if the action will change when played on the Moon based on what you have learned so far. Label the third column GAME PLAY. Look at your list of actions again, think about the changes you know will occur to that action on the Moon and decide if the game will require some type of modification to keep it exciting, interesting, and entertaining. Write MODIFY in the third column for any action that will have to be modified to keep the game interesting, exciting, or entertaining.

The decision table you have just constructed will help your group prepare the analysis you will need to help you design your Moon sport. Analysis is a key part of the engineering decision-making process. You will have to analyze jumps, throws, hits, and falling on the Moon to see how they will change your sport. Each time you analyze an action, you will also have to propose a modification. Then, you will have to analyze that modification to make sure it provides the change in action you were looking for. For example, making a basketball six times more massive might have unintended consequences.



Presenting your information to the class are your design cycle *Outputs*. The *Outputs* should include a description of your sport, a discussion of the physics affecting sports on Earth as well as sports on the Moon, and a description of the changes you would make to your sport to keep it exciting, entertaining, and interesting. You might even try to create the newspaper article for a championship game based on what you know so far.



Your classmates will give you *Feedback* on the accuracy and the overall appeal of the sport you have presented based on the criteria of the design challenge. This *Feedback* will become an *Input* for your final design in the *Chapter Challenge*. You will have enough time to make corrections and improvements, so you will want to pay attention to the valuable information your classmates provide.

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The information presented in class should be lively, entertaining, and exciting. An initial draft of the newspaper article could also be presented for a championship game based on how students have applied their learning. Encourage students to consider the *Feedback* of their presentation carefully and use the suggestions to make corrections and improve their presentation for the final *Chapter Challenge*.