


Physics Chapter Challenge

As students prepare a second round of the *Engineering Design Cycle*, point out that their lists of *Inputs* has grown and their task is to incorporate additional physics content to meet their *Goal*.

Students should review their challenge for this chapter. Point out that they must design or modify their sport so that it can be played on the Moon. They will have to write a proposal that convinces the NASA judges that their sport will accommodate the changes necessary in the Moon's environment and can be adjusted to meet those changes. Students should also make an effort to make the sport interesting and exciting.

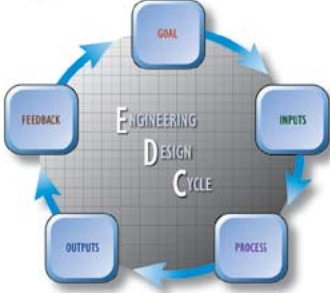
While reviewing the *Inputs* in this chapter, ask students to identify the concepts they have learned and apply them to analyze differences that exist between Earth and the Moon's environments. It is important for students to review the information presented in the student text. Ask them to write a brief summary of concepts they have learned in each section. From their definition of a sport to developing models that analyze potential jumping heights and trajectory of projectiles on Earth and the Moon, students should identify all the *Inputs* they have gained in this chapter.

For the *Process* phase, ask the students to sort and sift through the information and decide within their groups which information to incorporate in their challenge.

 Chapter 9 Sports on the Moon

Physics
Chapter Challenge

You will now be completing a second cycle of the *Engineering Design Cycle* as you prepare for the *Chapter Challenge*. The goals and criteria remain unchanged. However, your list of *Inputs* has grown.



Goal

Your challenge for this chapter is to design or modify a sport so it can be played on the Moon. You must prepare a proposal to present to NASA explaining how the sport could take place on the Moon with clear descriptions of the adjustments and modifications that will need to be made to accommodate the different environment. At the same time, you must convince the NASA judges that your Moon sport will be interesting, exciting, and entertaining for participants and spectators.

Inputs

You have completed all the sections of this chapter and learned the physics content you need to complete this challenge. You now have additional physics information to help you identify and analyze the differences between

actions that take place on Earth and the Moon and the physics concepts that apply to them. You also have the additional input of your own personal experiences in sports activities as well as the feedback you received following your *Mini-Challenge* presentation.

Section 1 You practiced the creative process of brainstorming in an effort to create your own definition of the word "sport." Your team should now have a good understanding of the type of activity that can be considered a sport.

Section 2 You examined falling objects and the effects of gravity. You compared the time it takes for a dropped object on Earth to touch ground with the time required for a similar object dropped on the Moon to hit the surface. You learned that the difference is caused by the acceleration due to gravity on each dropped object. You also learned about the relationship of time, distance, and acceleration for falling objects.

Section 3 In order to compare the masses of different objects, you explored the way a force causes a mass to react. You also learned how different gravitational forces are related to changes in weight for the same mass.

Section 4 You developed a model to compare the flight of a projectile on Earth to the flight of the same projectile on the Moon. While constructing your model, you took note of factors that could be modified to make the projectile's path, or trajectory, on the Moon similar to its typical trajectory on Earth.

Section 5 You applied 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. You recognized that jumping is an action you will need to modify for your sport.

Section 6 You explored two different methods that could be used to change the flight of a golf ball on the Moon. Changing the launch speed of the ball or the mass of the club could affect the total distance a ball will travel. You learned that this analysis also applies to other sports where a ball is hit with some type of stick or racquet.

Active Physics
990

They should confirm that the sport they choose meets the criteria for a sport and satisfies their definition of a sport. Students should enumerate the rules of their sport and make sure that they are correctly modified for playing the sport on the Moon. They must consider the equipment used in their sport and where the sport is to be played. The conditions affecting sports on Earth should be compared with

the conditions affecting the same sports on the Moon, and students should highlight the changes in the sport that have to be modified for the environment on the Moon. Point out that students must also identify aspects of the sport that may not change as well as to show where change would be necessary. The analysis of the championship event that students write for the newspaper should describe the events in such

Section 7 You learned the importance of friction in all sports and how friction on the Moon would be different for the same object on Earth. You recognized the need to perform a careful analysis to make sure athletes can handle the force of friction they will experience on the Moon.

Section 8 You discovered that walking is a more complex process than you may have previously thought. By examining a model of the human leg, a rod-shaped pendulum, you discovered that walking on the Moon would be different from walking on Earth. Would this also be the case for running?

Section 9 You explored the role of air resistance for moving and falling objects on Earth. You realized that whether your sport is an indoor sport with an atmosphere or an outdoor sport with no air resistance, the movement of athletes and other projectiles, such as balls, will be dramatically impacted.



Process

In the *Process* phase, your group must decide what information you will use to meet the *Goal*. You will need to confirm that the sport you have chosen to modify meets the basic requirements of a sport, and agrees with the definition of sport that your group decided upon. Have a brainstorming session to discuss and identify the rules for your sport, both original and modified for playing on the Moon. Remember, not only should the rules be modified for the Moon, they should also be crafted to keep the game exciting to play and watch. Do not forget to consider in your modifications the venue and equipment associated with your sport. It will be important to include the way any changes you have made to the field, equipment, and rules will affect the way the game is played. Be sure to explain how the game play will be different, but still exciting and interesting.

Prepare a list of factors affecting sports on Earth and on the Moon. Your presentation should include a comparison of these factors and how

they affect the play of your sport. You will also need to compare the sport you envision for the Moon with the sport as it exists on Earth and highlight the ways it will be different. Identify the types of sports action that will be different for Earth and the Moon. You may also want to identify the parts that will not change to emphasize where the changes will be important.

The championship description that you will write for the newspaper should prove that your Moon sport is exciting. You might want to include a play-by-play of the home colony's winning score or the final stand of the defense. Do not forget to highlight the actions that are unique to playing your sport on the Moon.



Outputs

Presenting your information to the class are your design cycle *Outputs*. You should have a thorough description of your sport, a comparison of important physics concepts, and a description of changes you would make to the sport to maintain its integrity as a sport when played on the Moon. Your presentation is also part of your design cycle *Outputs*, so take the time to prepare your script and any posters, diagrams, or multimedia pieces you need to make your presentation effective and convincing.



Feedback

Your classmates will give you *Feedback* on the accuracy and the overall appeal of your NASA-sports presentation based on the criteria of the design challenge. This feedback will likely become part of your grade but could also be useful for additional design iterations. The different design solutions may represent *Feedback* in the form of alternative ways you might have solved the problem. From your experience with the *Mini-Challenge*, you should see how you could continuously rotate through the design cycle to refine your Moon sport.

991

Active Physics

a way that make the sport sound exciting, interesting and unique. Information presented to the class marks the *Outputs* phase. Reiterate to students that design of their sport should include a thorough description of their sport, an analysis and comparison of important physics concepts, and changes made to play the sport on the Moon must be well described.

As students get ready for giving *Feedback* on the NASA-sports presentation, hand out a copy of the rubric that the class prepared together and ask them to evaluate each presentation based on established criteria. Once students have finished presenting their challenge, emphasize that rotating through the design cycle will give them the opportunity to further refine their sport.