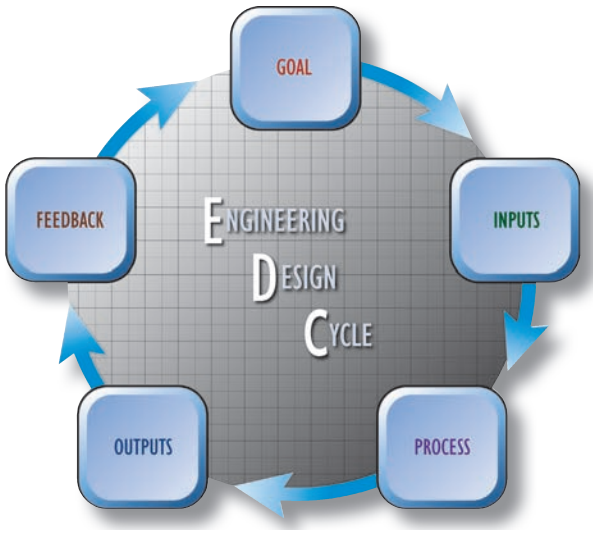
Physics

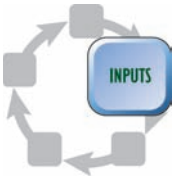
Chapter Challenge

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 create a voice-over for an exciting sports event that will educate an audience on the physics behind the action. Review the *Goal* as a class to make sure you are familiar with all the criteria and constraints.



Inputs

You now have additional physics information to help you identify and analyze the various physics concepts that apply to sports activities. You have completed all the sections of this chapter and learned the physics content you will need to complete your challenge. This is part of the *Input* phase of the *Engineering Design Cycle*. Your group needs to apply these physics concepts to put together your presentation.

You also have the additional *Input* of your own personal experience with sports as well as the feedback you received following your *Mini-Challenge* presentation.

Section 1 You investigated Galileo's law of inertia and learned how it relates to the mass of an object. You read about Newton's first law and learned about reference frames for measuring the speed of an object.

Section 2 You measured speed by making speed vs. time graphs using a ticker timer for objects with constant speeds and changing speeds. You also explored the concept of acceleration, or the rate at which speed increases or decreases.

Section 3 You investigated the relationship between forces on an object and the acceleration and change in velocity that they produce. You also read about Newton's second law, which helps to calculate the unbalanced force, mass, or acceleration of an object.

Section 4 You used models to learn about the horizontal and vertical motion of a projectile. You also explored how the horizontal speed and total height of a projectile affects the horizontal distance that it travels.

Section 5 You measured constant acceleration due to gravity and discovered how it causes all objects to speed up as they fall toward Earth. You also used calculations and models to describe the trajectory, or path, of a projectile.

Section 6 You studied examples of force pairs and considered Newton's third law as an explanation for the forces caused by inanimate objects. You also learned to use force diagrams to clearly represent forces on objects.

Section 7 You measured the force of sliding friction between a sports shoe and various surfaces and calculated the coefficient of sliding friction for the different combinations. You also studied the impact of friction on the movement of objects.

Section 8 You explored the idea of conservation of energy and tracked energy through a system as it changed from potential to kinetic, back to potential, and so on. You also learned that energy could be stored by stretching or bending objects and that restorative forces could transform that stored energy back into motion.

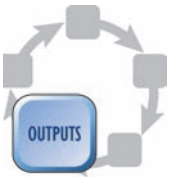
Section 9 You calculated work and gravitational potential energy changes for objects that are lifted and learned that gravity applies a constant force on objects moving near the surface of Earth.

Process

In the *Process* phase, you must decide what information you have that you will use to meet the *Goal*. Deciding what physics topics to include is the first step. Select sports footage that is exciting in terms of game play or competition between rivals. Three minutes of exciting sports action from almost any sport will have examples of most of the physics topics you have studied in this chapter. You may want to watch your film several times and simply list the examples that you see. Once you have a list, try to pick about five that are equally spaced throughout the clip. If you use a computer-based video, you may be able to use slow motion and replay certain features to highlight them.

Gather data that will allow you to calculate the magnitude, or size, of forces, masses, and accelerations that you plan to focus on in your sports action. Make sure you know the SI units for each quantity and include a sample calculation for any estimates you make. For example, if you can find the mass of a baseball and time how long it takes to travel a distance on the field, you can estimate its speed and the size of the force required for the pitcher or the batter to accelerate it to get it to that speed in a limited amount of time.

Once you have selected the five examples, have a person in your group write a short script for each one. Then arrange the scripts into one narrative and see what it sounds like. Refine the script each time you practice. You may consider inserting some humor or dramatic narration for emphasis and entertainment. After all, people are not usually watching sports for its educational content. You will not get the job if you cannot keep the viewers in their seats. Manage your time to make sure your group has an opportunity to rehearse before you present. If you are going to record the narration, you may need extra time to edit the final product. Even the experts make mistakes during live narrations!



Outputs

Presenting your information to the class is your design-cycle *Output*. You will provide an auditory sample for the class either through a live reading of the script or a replay of your recorded narration. Some ad-libbing will be fine for entertainment value, but a purely unscripted narration will score very poorly for this challenge.

Feedback

Your classmates will give you *Feedback* on the overall appeal and the accuracy of your 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. Remember that you will be viewing other design solutions for the same challenge. The different design solutions may represent feedback in the form of alternative ways you might have solved the problem. No design is perfect; there is always room for optimization or improvement. From your experience with the *Mini-Challenge*, you can see how the design cycle is structured to continuously refine almost any idea.