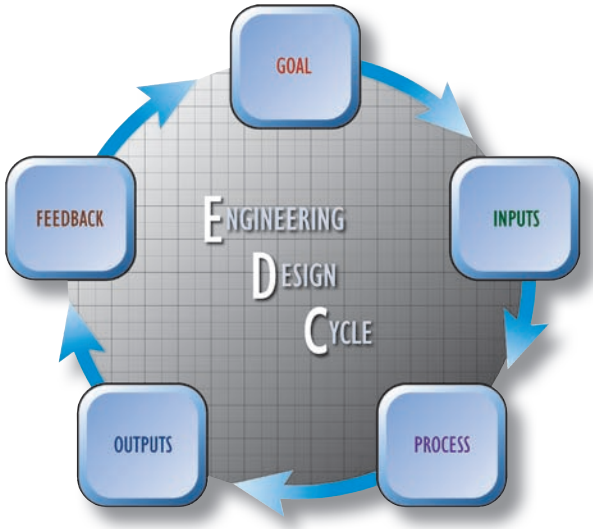
Physics

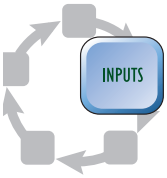
Chapter Challenge

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 safety system to protect passengers in a vehicle of your choice. As part of your design, you will build a model to protect an egg in a collision that you will enact in the classroom during your oral presentation. You will also submit a written or multimedia report of your research and investigation results.



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 optimize the design of your safety system. Remember, you will also be protecting an egg using your new physics knowledge. This is part of the *Inputs* phase of the *Engineering Design Cycle*.

Your group must define the vehicle that your safety device will be used in and apply the appropriate physics concepts to build your presentation. The type of vehicle will determine some key constraints, like the typical speed of the vehicle, the mass and velocity of typical obstructions your vehicle may collide with. The other key *Inputs* for this challenge will be the physics principles you have learned from each section of the chapter.

Section 1 You considered the topic of passenger safety in automobile collisions and explored some of the safety features that are available in modern automobiles. You learned that analyzing safety has led to many safety improvements in vehicle design.

Section 2 You learned about Newton's first law of motion and the role it plays in collisions. You also evaluated different seat belt materials and considered the relationships of force, surface area, and pressure.

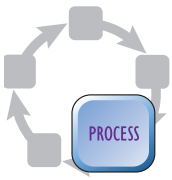
Section 3 You built a model of a vehicle air bag. You used the ideas of energy and work to help explain why an air bag can be helpful to passengers in the event of an collision.

Section 4 You explored what happens in rear-end collisions and learned about Newton's second law, which describes the relationship between the force applied to a mass and the acceleration it will experience. You recognized how this law explains the way objects respond when forces are applied to them.

Section 5 You learned about momentum through investigating staged collisions. The momentum of an object depends on both its mass and its velocity, which is why speed and size are both factors in the outcome of an automobile accident.

Section 6 You learned about the conservation of momentum, which establishes that the total amount of momentum in a system remains the same. This concept can be used to determine the momentum vehicles have after a collision when no external forces are applied.

Section 7 You compared changes in momentum to the forces applied to objects during a collision. Impulse, or change in momentum, can determine the amount of force applied if you know how much time the change took. You can make the force smaller if you make the time of collision longer!



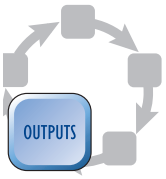
Process

In the *Process* phase, your group must decide what information you will use to meet the *Goal*. Choose the vehicle that will be the model for your safety system. Your group may brainstorm ideas for many different vehicles. Once you have lots of ideas to choose from, select one that your group agrees is workable and that will also allow you to protect an egg in the classroom collision.

Organization and good communication among your group members will be very important for this challenge. One way to stay organized is to assign roles for each person and make a list of the responsibilities. For instance, one person might have the role of "fact checker" and be responsible for making sure the oral report and written report contain accurate information about the physics principles your safety system applies. Other roles might include model builder, scriptwriter, report writer, and so on. Time constraints are also going to make this challenge difficult, so make sure each person knows when his or her portion of the project must be completed.

When you build your model system to protect an egg, be sure to create a safety system that uses the principles you have chosen to protect human passengers. You may have some constraints, such as time, available materials, or even the shape of the cart your egg will ride on. Engineers are constantly working to meet design goals within constraints.

Make sure that your report or presentation explains why your safety system works and contains the information you want your audience to know. You should include all of the key features of your design along with example calculations and results for all of your safety system. You may also describe differences between your human safety system and your egg safety system. If your class prepares a rubric for this challenge, make sure you refer to it often to ensure that you address each category and include all important information.



Outputs

Presenting your information to the class are your design-cycle *Outputs*. It is very important that your egg safety system be effective since it is the model for your design, so make sure your demonstration is well rehearsed. Each piece of the presentation will have similar information, but it is important to make sure each one is complete.

Feedback

Your classmates will give you *Feedback* on the accuracy and the overall appeal of your presentation based on the criteria of the challenge. This feedback will likely become part of your grade but could also be useful for additional design iterations. Remember that there is always room for some improvement and no design is perfect. From your experience with the *Mini-Challenge*, you should recognize how it is possible to continuously refine any idea by constantly rotating through the design cycle.