

CHAPTER 3

Safety

Chapter Overview

Chapter Challenge

The *Chapter Challenge* provides motivation for students to demonstrate their understanding of the physics content presented in this chapter. Students are asked to design and build a prototype safety system that protects an egg in a moving cart during a collision. They are required to provide an oral presentation and a written report in which they describe the physics concepts involved in the safety system that protects automobile, motorcycle, bicycle, or train passengers during a collision. Students present and test their prototypes in class. The class determines the type of collision an egg-carrying cart will undergo after students build their prototypes. For example, they may have the cart crash into another cart or a stationary object.

Students may find the challenge difficult at first, but by the end of the chapter students should have enough understanding of the concepts of force, the work-energy theorem, impulse, momentum, and conservation of momentum to be successful in completing the challenge. Toward the end of each section, students are asked to reflect on the section and consider its meaning for the challenge. At the end of most *Physics to Go* questions is a question designed to guide students in applying the content of that section to the challenge. The *Inquiring Further* is also geared toward helping students meet the challenge.

As you review the assignments, reassure students that while they may feel unprepared now, by the end of the chapter, they should have the necessary knowledge, skills, and vocabulary to respond adequately. To facilitate cooperative work in groups, have each student take individual responsibility for different tasks that make up the challenge.

The criteria for the challenge and a rubric for assessing student performance should be determined with the class based on the *Criteria for Success* in the student text. In your grading criteria, include factors such as the physics principles applied and discussed correctly, the proper use of physics terms, clarity of expression, possible improvements to their design, consumer acceptance and market potential, and credibility.

Chapter Summary

The students investigate and apply ideas involving force, energy, work, momentum, and conservation of momentum as they design and build a prototype of a safety feature to protect an egg in a colliding cart. Students

- identify, describe, and compare features of crash safety designs.
- describe, explain, and apply Newton's laws of motion.
- describe and apply the relationship between force, pressure, and area.
- describe and apply the work-energy theorem to determine force, energy, initial speeds, and stopping distances during collisions.
- describe the collisions that occur during a car crash and how they can affect the human body.
- define momentum, elastic collisions, and impulse.
- analyze collisions in one dimension using the law of conservation of momentum.
- apply Newton's laws, the work-energy theorem, the relationship between impulse and momentum, and conservation of momentum to design and build a "crumple zone" that absorbs some of the energy of a vehicle during a collision.
- apply Newton's laws, the work-energy theorem, the relationship between impulse and momentum, and conservation of momentum to design and build a safety device to directly reduce the net force acting on a person in a vehicle during a collision.