Soft Landing

Goals

Students learn about soft-landing systems used in space exploration.

Video Overview

Students build a soft-landing system and test its ability to safeguard an egg from cracking.

Prerequisite Concepts

Students should have a working knowledge of space exploration technology and forces and motion.

Materials

The following list is a suggestion of materials that could be used in this activity. Feel free to supplement this list of materials as you see fit.

- eggs
- cotton balls
- scissors
- tape
- bubble wrap
- construction paper
- cardboard
- resealable plastic sandwich bags
- empty egg cartons
- boxes, various sizes
- string
- foam packing noodles
- fabric scraps
- newspaper

Teaching Tips

To minimize the amount of materials needed and to encourage cooperation, you may wish to put students into teams to complete this activity.

Ask students if they've ever been in a car that stopped suddenly. The jerk they felt is like what happens to the egg when it hits the ground. To help the egg land gently, the soft-landing system has to keep the egg from falling fast, slow it down gradually when it hits, or both.

CAUTION: Remind students that some of the materials and tools used in this engineering challenge are sharp and may cause injury. Tell the class to wear eye protection during the construction and testing phases. Also, remind students to wash their hands after handling the eggs (whether they are broken or not; *Salmonella* may also reside on the outer shell.)

Activity 1—Researching Forces and Cushioning Land Systems

Video segment: 00 minutes 42 seconds

Preparation Make copies of the worksheet pages and begin gathering materials.

Web Search Keywords soft-landing systems, Mars exploration rover landing system, force and motion, cushioning impact

Discussion Questions

- **Given the design of the lunar excursion model, what type of systems do you think it might have had to ensure a soft landing?**
- **Why is it important that space exploration vehicles have soft-landing systems?**

Completing the Student Page

As students conduct their Internet or library research, encourage them to keep in mind which portions of the soft-landing systems they find could apply to their own designs.

Activity 2—Designing and Building a Soft-Landing System

Video segment: 01 minute 32 seconds

Preparation Give students time to explore the given materials. You may also want to limit the amount of materials that students can use. (For example, limit the number of different materials students can use, or the amounts of each item.) You may also wish to put a limit on the dimensions or the total mass of the system.

Discussion Questions

- **What are some methods used by the Mars exploration rover to soften its landing?**
- **Why is it important to draw a blueprint of your design?**

Completing the Student Page

Remind students that their soft-landing system must take into account that the egg is transported within a plastic sandwich bag. To help prevent possible *Salmonella* contamination, provide each student or group of students with their egg already enclosed in a plastic sandwich bag. To ensure the bag remains closed, you may want to reinforce the seal with duct tape. You may wish to approve students' final designs before allowing them to continue to the construction phase.

Activity 3—Testing the Soft-Landing System and Communicating Results

Video segment: 04 minutes 21 seconds

Preparation Ensure that all students are wearing protective eyewear prior to testing each soft-landing system. At your discretion, allow students to modify their soft-landing designs after testing. You could also opt to allow students to test their soft-landing systems to the point of failure; this is, continue to increase

the height the soft-landing systems are dropped from until only one, or no, eggs survive the drop. Depending on your drop location, you may want to place a drop cloth where the soft-landing systems will hit to catch any of the ensuing mess.

Discussion Questions

- **What were some characteristics of successful soft-landing systems?**
- **What was the easiest part of this challenge? What was the hardest part?**

Completing the Student Page

Remind students to document the success (or failure) of their soft-landing system during the testing phase and also take notes on other students' successes and failures.

Student Page Answers

Activity 1

1. Answers could include drag, air resistance, gravity, and impact.
2. Acceleration refers to both increases and decreases in speed.

Activity 2

1. Answers will vary. Students may mention the rover's parachutes and airbags as potentially useful for their designs; they may mention that the rocket firings would not be useful (or practical) for their designs.
2. Answers will vary. Be sure that students completely understand the available materials.
3. Blueprints will vary. Make sure that students have labeled the materials they plan to use in their soft-landing system's final design.

Activity 3

1. Answers will vary. If you opt to test to failure, students should list each height from which they drop their soft-landing system.
2. Answers will vary. Students should be able to cite evidence from their documentation.
3. Answers will vary. Students should have concrete reasons based on their observations.
4. Answers will vary. Students should have concrete reasons based on their observations.
5. Accept all reasonable answers.