Egg Drop Challenge

Grade Range: Middle School

Lesson Time: 3 - 4 class periods

Key Terms
- Brainstorming
- Collision
- Energy
- Forces
- Impact
- Newton’s Laws
- Specification

Materials and Resources
- Egg Drop Challenge Worksheet
- Tape
- Eggs
- Paper plates
- Sandwich bags
- String
- Cardboard
- Rubber bands
- Paper
- Hot glue
- Cups
- Plastic bags
- Tape
- Straws

Activity Overview
Nothing demonstrates physical sciences concepts better than the classic egg drop! In the zSpace version of this tried-and-true science project, teams of students are immersed in real engineering. This project features real-world brainstorming, rapid prototyping, data collection/analysis, and product optimization. During the activity, special attention is given to setting up safe and well-organized design, construction, and testing spaces similar to those found in major corporations. In short, students who experience the zSpace Egg Drop Challenge learn more than science—they gain first-hand know-how by being part of an engineering team, and they discover how exciting it can be to solve practical problems in a creative and collaborative way. So let’s get cracking!

Essential Questions
1. How might the forces resulting from a collision be reduced or redirected?
2. How can a product be engineered to protect an egg from getting damaged when dropped?

Objectives
- Apply Newton’s Laws to the Egg Drop Challenge
- Use the engineering design process to design, create, and test a solution to the Egg Drop Challenge
- Evaluate and improve upon design solutions

Introduction
Prior to building their egg drop containers, have the students complete the zSpace activities below.

zSpace Activity
Activity 1 - Energy, Momentum, and Impulse
Activity Questions Provided in Newton’s Park
Sample answers are provided below.
1. Here we are on the movie set! In Scene 1, the stunt double will leap off the building with no airbag. The stunt double, represented by the zBlock, is set to 10 kg and will be leaping off of a 7-m building onto a concrete block. Launch the experiment. What happened when the zBlock reached the ground?
   *It bounced a little and then hit the ground hard.*

2. Replay the experiment. What was the velocity of the zBlock right before it hit the ground?
   *The velocity was 11.18 m/s right before it hit the ground.*

3. What was the velocity of the zBlock right after it hit the ground?
   *The velocity was 3.27 m/s right after it hit the ground.*

4. What was the impulse of the zBlock when it hit the ground?
   *The impulse of the zBlock was 144.55 N.s.*

5. In Scene 2, the stunt double will leap off the building again, but this time onto an airbag. The experiment will remain the same with one exception. The zBlock will fall onto a sponge block instead. Launch the experiment. What happened when the zBlock reached the ground?
   *It barely bounced and hit the ground softly.*

6. Replay the experiment. What was the velocity of the zBlock right before it hit the ground?
   *The velocity was 11.18 m/s right before it hit the ground.*

7. What was the velocity of the zBlock right after it hit the ground?
   *The velocity of the zBlock was 1.44 m/s right after it hit the ground.*

8. What was the impulse of the zBlock when it hit the ground?
   *The impulse of the zBlock is 97.58 N.s.*

9. Using your data, what conclusions can you draw about Scene 1 vs. Scene 2?
   *The stunt double would have made it safely to the ground in Scene 2 because there was a greater impulse when falling on the sponge block than on the concrete block.*

**Activity 2 - Collisions for (Crash) Dummies**

Sample answers are provided below.

1. Would you rather be a crash dummy in an elastic collision or an inelastic collision? To answer that question, you might need a little more information. When two objects hit in an elastic collision, they bounce off of each other and do not deform. When two objects hit in an inelastic collision, on the other hand, they stick together and deform. Open your backpack and select models to create a scene that demonstrates an elastic and inelastic collision. take a photo.
   *Photo.*

2. You might be thinking it sounds safer to be a crash dummy inside a steel ball. That is how a lot of cars were designed in the old days. They had heavy bumpers and very rigid bodies. The problem was that, inside the car, passengers were thrown around violently! Look at this car design from 1955. Using the Dissect mode, explore the car to find some of the rigid and heavy elements that drivers thought would make them safer.
   *It is a large-sized car with a metal bumper and heavy steel frame.*

3. Through crash data analysis and extensive testing, engineers discovered that it is actually better to let the car absorb the energy. If most of the energy is absorbed by the car, then the forces on the passengers inside are reduced. If all cars were made out of clay, people might be a lot safer. But that’s not very practical. So engineers have done the next best thing by making them act like clay during a collision. Using the Dissect mode, explore this car to find some safer features.
   *There are bumpers with collapsing columns, crumple zones, and airbags.*
4. Take a look at these crumpled cars. It took a lot of energy to smash it in that much. Look at the crash dummy. He’s not damaged. The car absorbed the energy so he did not have to thanks to a crumple zone. In your own words, how do you think crumple zones might work?

*The crumple zones absorb a lot of energy so it is not transferred to the crash dummy.*

5. What if you are riding a bike motorcycle? Crumple zones and airbags won’t help you avoid hitting your head on the pavement. That’s why riders should always wear a helmet. The first bike helmets were “pith helmets” like the white ones British soldiers wore in India in the late 1800s. It took another 100 years for helmet safety standards to be adopted in the U.S. Smooth, round helmets that slide against the ground offer optimal head protection. Make some observations about the helmet.

*It is made of foam and plastic. It is perfectly shaped to protect the human head.*

6. Look closely at the interior of the helmet and make observations about what you see. Predict why the helmet is made of this material. Bike riders get a lot of concussions—even more than football players. That’s because a lot more people spend time on bikes than on the football field. Concussion is the most common type of traumatic brain injury. Getting a concussion can cause many physical, mental, and emotional problems. A head impact disrupts the brain for days or weeks. Professional football players and athletes in other high-impact sports are now experiencing the negative effects of having many concussions during their careers.

*It is made of foam and plastic. These materials will absorb some of the energy during a collision and protect a person’s head.*

**Part 2 - Build an Egg Drop Device**

The challenge is to use the materials provided to design a container that will protect a raw egg from breaking when dropped from a minimum height of 6 feet. For students to successfully complete this challenge, the egg must not break or leak. Divide students into teams of 4. Students will use the engineering design process to complete this activity.

1. Ask: Using the Egg Drop Challenge worksheet, have students develop questions about the project. These questions may concern the design, the outcome, possible errors…there are no wrong questions!
2. Imagine: Have students brainstorm ideas.
3. Plan: Have students combine their best ideas from the “Imagine” step to create a blueprint and list all materials they will use.
4. Create: Have students assign tasks to each group member and start building!

*Teacher Note: The building time varies depending on grade level, number of students, etc.*
   a. **Hopper** - This person collects the materials and tools needed by the group and also asks the teacher questions or seeks help with use of tools, etc.
   b. **Structural Engineer** - This person works on creating the egg drop device.
   c. **Project Manager** - This person monitors the progress and makes sure the device is being built according to the blueprint. If changes are made, this person creates a new blueprint for the group.
   d. **Quality Control** - This person tries out the device at various points in the construction process to see if it meets the design parameters.
5. Test: Drop each device from the same height, instructing students to record data.
6. Improve: Have students evaluate their devices and create a list of improvements for their device. If time permits, allow the students to rebuild and retest their devices.
Closing

Have students create presentations on what they learned about the physics concepts involved and the engineering design process.

Follow up Activity: *How Do Parachutes Work?* - Studio
Follow up Activity: *Gravity-Defying Parachutes* - Studio

Differentiation

- Group students heterogeneously to allow students with a strong command of the English language to assist in reading or interpreting questions
- Provide paper copies of diagrams for students to use as a reference
- Provide a handout with a list of vocabulary terms and definitions that will appear in the activity
- Allow students to provide answers that are handwritten, typed, or verbal
- Give students a variety of presentation styles to choose from (using charts/graphs, PowerPoint, making 3D presentations, creating videos/movies, making posters)
- Have students work as partners or in small groups (younger children could partner with older buddies)
- Enrichment: Students could change an additional variable in the activity and look for patterns
- Enrichment: Students could find real-world problems involving the concept and design solutions to those problems
- Enrichment: Students could research similar topics and create presentations
- Enrichment: Students could build a model of a key concept
Photos for Inspiration

Resources

Egg Drop done by engineers at MIT

Northeastern University Egg and Pumpkin Drop