Protect Your Eggs

Estimated Time: 90 minutes

SUMMARY

In this activity, students will develop ways to protect hard boiled eggs. Using items found around the kitchen, students will design and build engineered devices to protect their eggs for an “egg drop.” After putting their engineered designs to the test, students learn where their egg cracked by dyeing them.

WHAT YOU’LL LEARN

- Engineering design skills

Materials Used	**Resources Used**
● Eggs ● Cooking equipment for eggs (see Resources section) ● Pencil and paper (ideally graph paper) Egg Drop ● Glue or tape ● Various materials for building an egg protector (straws, paperclips, toothpicks, paper, plastic bags, string, twine, yarn, kabob skewers, popsicle sticks, rubber bands, etc.) Egg Dyeing ● 1 cup or bowl ● 1 cup of hot water ● 1 tsp. white vinegar ● Food coloring	● Steaming Eggs: https://www.seriouseats.com/recipes/2014/04/steamed-hard-boiled-eggs-recipe.html ● Hard Boiled Eggs: https://www.youtube.com/watch?v=xUHKpHek2E8

WHAT TO DO

Hard Cooking Eggs (any method works, but steaming them is the best cooking method and easiest for peeling)

1. Add about half an inch of water in a pot with a steamer basket.
2. Over high heat, bring water to a boil.
3. Add eggs to the steamer basket and cover with a lid.
4. Steam eggs for 12 minutes.
5. Remove eggs. Add them to a bowl of ice water to cool them and to stop the cooking process.

Egg Drop

1. Begin by identifying where you will drop your eggs. It isn’t necessary to drop them from anything higher than someone standing on a chair.

2. Discuss situations where someone may want to land a “payload” (medical supplies, the Mars rover, food, bottled water, etc.) softly. How is that typically accomplished? Answers may include: parachutes, hard structures surrounding the object, inflated cushions, etc.
3. The impact on the egg depends on two factors: the velocity of the egg when it stops falling (hits the ground) and the distance over which it comes to a stop. When you simply drop an egg, it is moving very quickly and comes to an immediate stop when it hits the ground. If you dropped it onto a cushion, the egg would be less likely to break because it would hit at the same velocity, but it would come to a stop more slowly as the cushion compressed. If you were to attach several helium balloons to the egg, the egg would be less likely to break because it would be moving slower when it started to come to a stop.
4. Design the device you will use to protect your egg on a piece of paper with the materials available.
5. Construct the device as designed, or as close to the design as possible. It’s possible that the device may need to be constructed around the egg.
6. Test the prototype by dropping it carefully from the site identified in step 1. To accurately test the prototype, each drop should be done from the exact same height and without lifting or pushing it down while dropping it.

Dyeing Eggs and Evaluating Egg Protection

1. To see cracks in the eggs better, dye the egg. This will help show small cracks in the eggs that may not be visible to the naked eye.
2. Add 1 tsp. of white vinegar to 1 cup of hot water in a cup, mug, or bowl.
3. Add about 20 drops of food coloring of your choice to the mixture.
4. Submerge the egg in the mixture for about a minute. Feel free to vary the time and check the eggs to get the color you are looking for. The vinegar allows the food coloring to stain better and penetrate farther into the egg shell because food coloring needs an acidic environment to work and vinegar is a mild acid. Places on the shell where there are cracks will stand out once dyed because the cracks along the shell provide more surface area for the dye to stain, making the cracks appear darker
5. Analyze the cracks in the eggs to determine how well your design protected the egg. This could be done in several ways:
    a. Count the cracks
    b. Measure the total length of the cracks
    c. Measure the area affected by the cracks
    d. Include “severity” of the crack (Did a whole portion fall off? How dark is the crack?)
    e. Determine your own, or have your kid determine a good measure, to practice experimental design skills

TIPS

- It isn’t necessary to cook the eggs, but it’s more fun to color the eggs to determine where they cracked and to be able to eat them afterward. No reason to waste eggs.
- In reality, the eggs breaking has more to do with the energy of the egg and the force exerted on it to stop, but we can simplify because the mass is constant. Older students may benefit from learning about kinetic energy ($KE=mv^2/2$), force ($F=ma$), and work ($W=Fd$), where m is mass, v is velocity, a is acceleration, and d is distance/displacement. This is beneficial because it shows that reducing the velocity reduces the impact quadratically and reducing the distance reduces it linearly (v^2 and d, respectively).

- Video recording the egg drop, especially the point of impact, can make for valuable piece of evidence for you and your student to review and rethink the design. We have all seen slow motion impact videos.
- Either testing activity can be repeated to optimize the design and test again. This is an important step in the engineering design process, and provides a great extension to the activity. The key is to have your designer compare their designs and explain why things changed. Explaining why is the difference between simply repeating the process and optimization.