

EGG ENGINEERING-SAVE THE EGG

MAKING AN EGG DROP PROTECTIVE DEVICE

Experiment Objective:

The aim of this project is to design a carrier that will prevent an egg from breaking when dropped from a certain height. The project must fit in within the specifications given. Please keep in mind that your egg carrier must be able to withstand numerous drops.

Learning Goals:

Students will work in teams to design and construct an egg protective device. Students will be able to explore the different materials available and learn to apply concepts of momentum, impulse, force and energy to this project.

LESSON IMPLEMENTATION OUTLINE

Introduction:

The egg drop experiment is perfect for learning about gravity and about how materials interact with one another. The end goal of the experiment is for students to create packaging around an uncooked egg to ensure that the egg can be dropped from a height without breaking.

Lesson Background and Concepts:

The egg drop project involves several physics concepts that we have studied in class and other concepts that you will have to research. The main concepts are:

1. Momentum

Momentum is a measure of an object's tendency to move at constant speed along a straight path. Momentum depends on speed and mass. Within a closed system of interacting objects, the total momentum of that system does not change value. This allows one to calculate and predict the outcomes when objects bounce into one another.

When an object is moving, it has a non-zero momentum. If an object is standing still, then its momentum is zero. To calculate the momentum of a moving object multiply the mass of the object times its velocity. Momentum is a vector, which means that momentum is a quantity that has a magnitude, or size, and a direction.



2. Pressure

Pressure is the force per unit area applied to an object in a direction perpendicular to the surface. Pressure is calculated by taking the total force and dividing it by the area over which the force acts. Force and pressure are related but different concepts. A very small pressure, if applied to a large area, can produce a large total force.

3. Air Resistance

A feather and coin will fall with equal accelerations in a vacuum, but unequally in the presence of air. This is because the air molecules cause a frictional force that opposes the motion of the falling objects. This air resistance diminishes the net forces for each. This will be a tiny bit for the coin and very much for the feather. The downward acceleration for the feather is very brief, for the air resistance very quickly builds up to counteract its tiny weight and surface area. The feather does not have to fall very long or very fast for this to happen. When the air resistance of the feather equals the weight of the feather, the net force is zero and no further acceleration occurs.



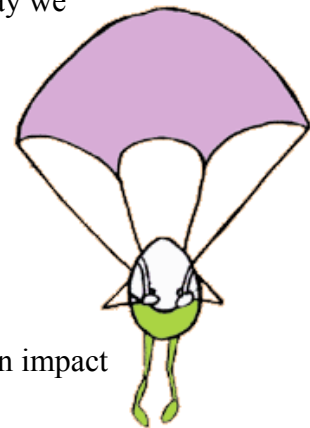
4. Angular Momentum

Angular momentum measures an object's tendency to continue to spin. It can be obtained by multiplying the mass of an orbiting body by its velocity and the radius of its orbit. According to the conservation laws of physics, the angular momentum of any orbiting body must remain constant at all points in the orbit, i.e., it cannot be created or destroyed. If the orbit is elliptical the radius will vary. Since the mass is constant, the velocity changes. A spinning body also possesses spin angular momentum.

5. Gravity

Gravity is a powerful force that has a fundamental impact on the way we live our lives. Even walking, which we take for granted, is not possible without gravity. Gravity provides the necessary downward force on our bodies which creates friction between our feet and the ground, allowing us to walk (push our body weight forward with one leg and then the other).

When other forces are combined with gravity, such as motion (the movement of an object), inertia (the tendency of an object to resist change with regard to movement based on its mass), or power (the ability to exert energy over time), it may be impossible to prevent an impact which will cause damage.



Concepts behind Saving the Egg

For instance, if you roll an egg along the ground downhill at considerable velocity towards a wall, you can reasonably expect the egg to break. Your arm provided the force (power) to accelerate the egg to a certain velocity (motion). That motion is being increased due to the acceleration of the egg down the hill (gravity). The egg will not drastically vary its direction and avoid the wall (inertia tends to keep it moving in a

straight line). The combination of power, gravity, motion and inertia will probably be sufficient to result in an impact between the egg and the wall that breaks the egg. This impact is called the primary impact.

There is a further impact which takes place when the egg hits the wall; this is when the mass inside the egg impacts against the inside of the wall of the egg. The egg white and egg yolk are usually in liquid form, and though liquid has considerable mass, the liquid inside the egg will rarely be the cause of the egg shell breaking. If you put a steel ball bearing into a plastic egg, and then shake the egg, you can hear the impact of the ball bearing hitting the inside of the egg, and it is easy to imagine the egg cracking because of the steel ball bearing.

The impact resulting from the ball bearing striking the inside of the plastic egg due to the motion or change in motion of the egg is called the secondary impact.

Scientists and engineers have been working for many years to reduce the effect of impacts, primarily in the automobile industry. Efforts to reduce the primary impact (energy absorbing bumpers, crumple zones, modified chassis construction) and efforts to reduce the secondary impact (airbags, padded dashboards, collapsing steering wheels, and seatbelts) are commonplace.

Kinetic energy is the energy that a body possesses as a result of its motion. Potential energy is the energy that exists in a body as a result of its position or condition rather than of its motion.

In building the container, you should think about how the energy is converted from potential energy to kinetic energy, and the work done on the container and the work done on the eggs.

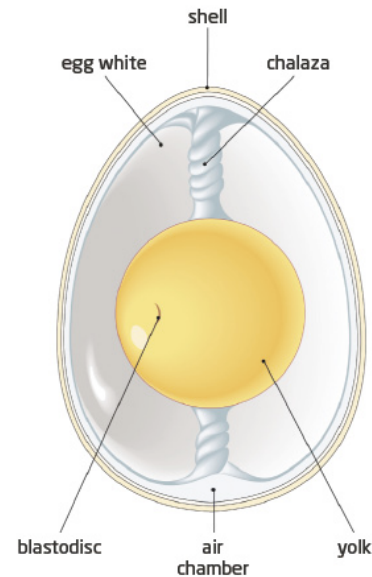
Lab Activity Instructions:

Students will design and construct an egg protective device in their groups. They will be given only one raw egg and limited materials to choose from. Instructors will explain the key concepts before the construction. Students can test their devices in the classroom first and then later at the drop site.

Materials:

You can choose 12 items/materials from the following list:

- Cardboard, 5 elastic bands, 8 popsicle sticks, 1 metre of tape, 2 sheets of construction paper, plastic bag, 10 straws, styrofoam cup, poster board, 6 cotton pads, Q-tips, 1 pair of socks, toilet paper, 30cm string, 10cm wires, spaghetti, 2



balloons, 1 paper plate, 5 pieces of tissue paper, 2 sheets of plastic wrap, 2 sheets of aluminum foil

These materials are provided:

- glue, scissors, rulers, pencil

Procedure:

Phase 1: The Design

When you are designing this apparatus, there are a few things that you need to keep in mind. This device must be protective. The raw egg inside must not even crack at the first drop.



Phase Two: Testing

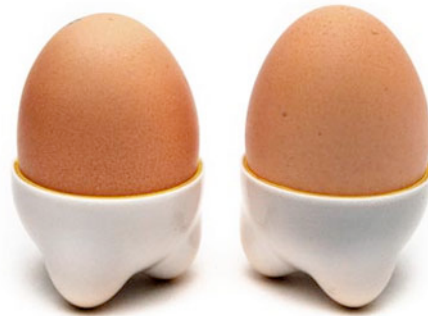
Request practice runs at the drop site to make sure that your apparatus will withstand these tests. The project takes much trial and error and it is highly doubtful that you will succeed in your design on the first trial. You will most likely have to modify your current design or start completely over and design a new apparatus.

Phase Three: Actual Drop

Raw eggs are provided at the drop site. The student should bring a small repair kit for their apparatus, i.e. tape, scissors, and left-over materials provided etc. Be fully prepared and bring all items to the drop site.

Hints:

- Use light and strong materials
- Use simplified apparatuses
- Bring a repair kit to the drop site
- Don't overcomplicate the design
- Don't use heavy materials if at all possible



Specifications:

- No parachutes are allowed
- An area approximately the size of a quarter of the egg must be visible at all times.
- Only the allowed materials may be used (listed above). Items can be negotiated and traded with other designers.
- Only raw, store bought chicken eggs may be used. Your design must not include changing the egg in any way (no tape on the egg, no soaking the egg in vinegar).
- The egg container and all materials must remain intact. For example, no parts – inside or out - can fall or break off during flight or impact.
- Your egg project must fit on a regular size (8 ½ x 11) sheet of paper. (Note that the height of the container is not a factor – it can be “tall” and still fit on the paper)
- The container must be able to be opened once we return to the classroom so that we

may check on the condition of the egg. The inside materials must be designed to allow raw egg to be easily inserted and removed.

Expected Outcome:

The most ideal outcome is that the egg will remain unbroken when dropped from a pre-determined height inside the protective device, or the egg can withstand a height greater than the one specified for the experiment.

Checking for student understanding:

Allow kids to try the experiment on their own. Encourage them to be critical thinkers when constructing the device. Ask them questions during the process and allow them to explain the how they apply the concepts learned in this lesson to their design.

Extensions and connections:

- What are the forces acting on the egg as it falls?
- How can you control the forces that cause the egg to break?
- Was the material, the amount of it, or its compression factor that was the key?
- What are the common characteristics of the material that protected some eggs?
- Did the layering of materials play a role in protection?
- What about your design made the egg break? Not break?
- How would you design your container differently next time?

CURRICULUM CONCEPTS

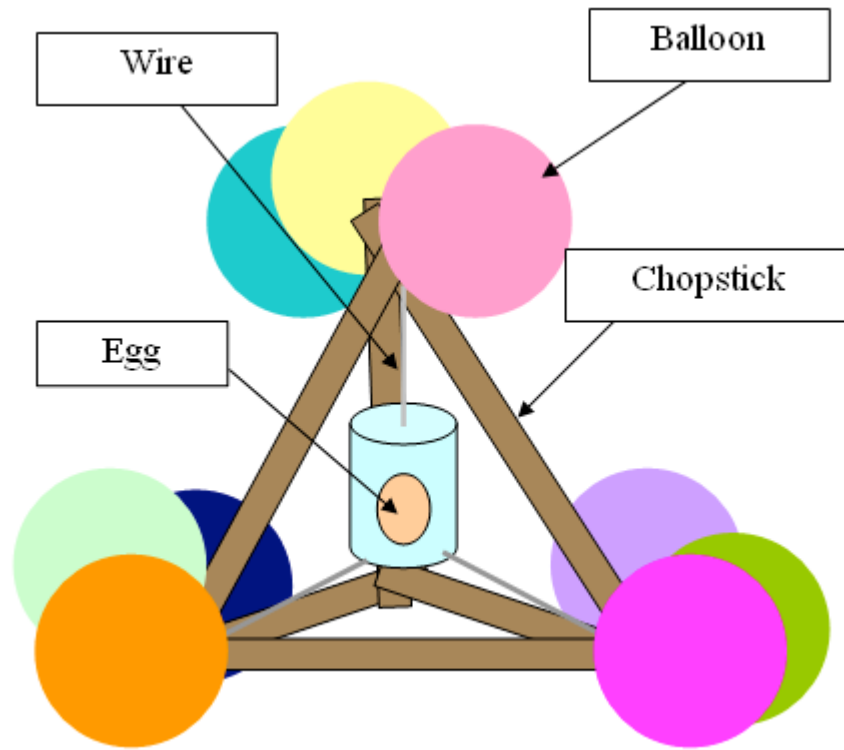
Physics-Gravity, Momentum, Air Resistance, Pressure

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EXAMPLES OF EGG DROP PROTECTIVE DEVICES

EXAMPLE 1:



EXAMPLE 2:

