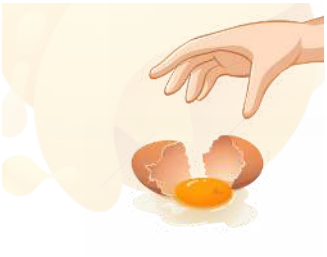
Accelerometer



# Egg Drop

## Overview

Have you ever wondered how to drop a fragile object, like an egg, without breaking it? In this activity, you will explore how forces, motion, and materials interact to protect an object from impact. Using simple materials and tools, you'll design and build a protective device to keep an egg intact during a drop. You'll also analyze the physics behind the experiment by measuring acceleration, examining the forces at play, and learning how to minimize the impact.

**Grades**: Middle School
**Time**: 45 Minutes
**Subject**: Physical Science
**Topics**: Position, Speed, and Acceleration

## What You Will Need/Prep

- Databot
- IOS/Android Smart Device
- Shock-absorbing materials
- Wights for measuring
- Ruler
- Install Vizeey™ on your Smart device.

- Test your databot™ connection.
- You will be prompted to select and connect to databot™ each time you launch an experiment.
- If there are two or more databot™'s listed, the one closest to your device will be highlighted.
- Study the background information and terms and prepare to explore!

## Background

Motion and force are essential concepts in physics, especially when it comes to impacts. When an object falls, gravity pulls it toward the ground, causing it to accelerate. The faster it moves, the greater the force it experiences upon impact. To understand how to protect an object from breaking, it's essential to explore concepts like force, acceleration, and impulse.

Force is what causes an object to accelerate or change its motion. When an egg hits the ground, it experiences a large force over a short time, which often leads to it cracking. By increasing the duration of the impact (the time it takes for the egg to come to a stop), you can reduce the force acting on it.

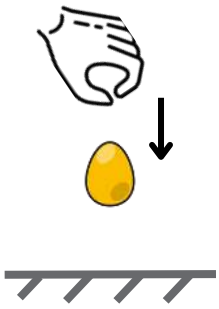
Impulse is the change in momentum of an object, given by the formula:

$$\text{Impulse} = F \cdot \Delta t$$

where "F" is the force and "Δt" is the time over which the force acts. The longer the impact duration, the smaller the force needs to be to stop the egg. This principle is used in designing crumple zones in cars and padding in helmets.

Accelerometer

Protecting the egg during a drop involves redistributing or absorbing the energy of the fall. Materials like foam, cotton, or bubble wrap are excellent at absorbing energy because they compress, increasing the time of impact and reducing the force.



In this experiment, you'll apply these principles to design a device that reduces the impact on the egg. By testing and analyzing your design, you'll gain a deeper understanding of the science behind motion, energy, and materials.

## Learning Objectives

After completing the egg drop experiment, students will be able to:

- Understand the relationship between force, acceleration, and impulse during a fall.
- Explain how increasing the duration of impact reduces the force exerted on an object.
- Measure acceleration and impact forces using databot.
- Apply physical principles to design devices that minimize impact forces.
- Evaluate the effectiveness of their designs and suggest improvements.
- Work effectively in teams to create and test protective devices.

## Important Terms

**Altimeter:** a device that measures **altitude**, the distance of a point above sea level.
**Acceleration:** The rate of change of an object's velocity over time, which can increase or decrease due to forces like gravity and air resistance.

**Force:** A push or pull acting on an object that can change its motion, speed, or direction.

**Gravity:** A natural force that pulls objects toward the center of the Earth, causing them to accelerate downward when dropped. It is constant on Earth (9.8 $m/s^2$).

**Impulse:** The change in momentum of an object, calculated as the product of force and the duration of time it acts. A greater impulse means a greater change in velocity.

**Impact Force:** The force exerted on the egg when it hits the ground. The faster the egg falls, the greater the force when it impacts.

**Energy Absorption:** The process of materials absorbing the energy from the fall, often through compression or deformation, which helps reduce the impact force.

**Cushioning Materials:** Materials used in the design of the protective device that absorb energy and reduce the impact force on the egg. Examples include foam, cotton, bubble wrap, and air-filled cushions.

**Time of Impact:** The duration of the collision between the egg and the ground. Increasing the time of impact reduces the force experienced by the egg, making it less likely to break

**Design Efficiency:** A measure of how well the protective device prevents the egg from breaking, balancing weight, material use, and impact protection.

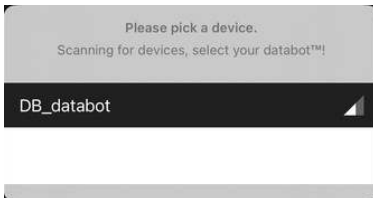
## Using Vizeey

In order to work with the experiment you need to launch the Vizeey application and click on + in the upper right corner.

Then select “Add experiment from QR code” and scan the QR code prepared for this experiment. Your experiment will appear in the list.

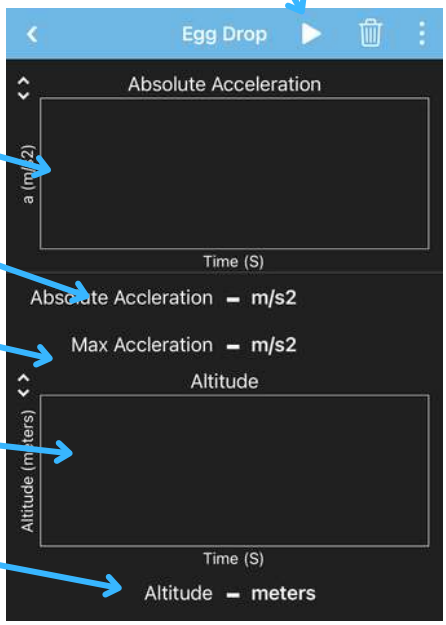
## Once in the Experiment

When you start the experiment active databots show up in your connection list. Select the one with the strongest signal (blue). Make sure you databot is turned on.




In this lab you will explore motion using accelerometer and altimeter (to measure altitude)

Press this button to start the experiment.




- databot acceleration graph
- Current acceleration
- Maximum acceleration, usually the moment of impact.
- databot altitude graph
- Current altitude

- By default you will be in Pan and zoom mode which allows you to move the data side from side to side with your finger or pinch to zoom in or out.
- To see the values at any point of the graph, you first need to press the “Pick data” button.


- Click on any point on the chart to see the values.

## Part 1: Initial Observations and Questions

What do you think are the forces that act on an object when it falls?

What are some real-world scenarios where safe falling of objects is important (e.g., humanitarian aid delivery)?

How does the impact affect the egg?

## Part 2: Hypothesis

Think about how data collected from an accelerometer or databot can be used to measure the impact force and how this information can help determine the most effective design for protecting the egg.

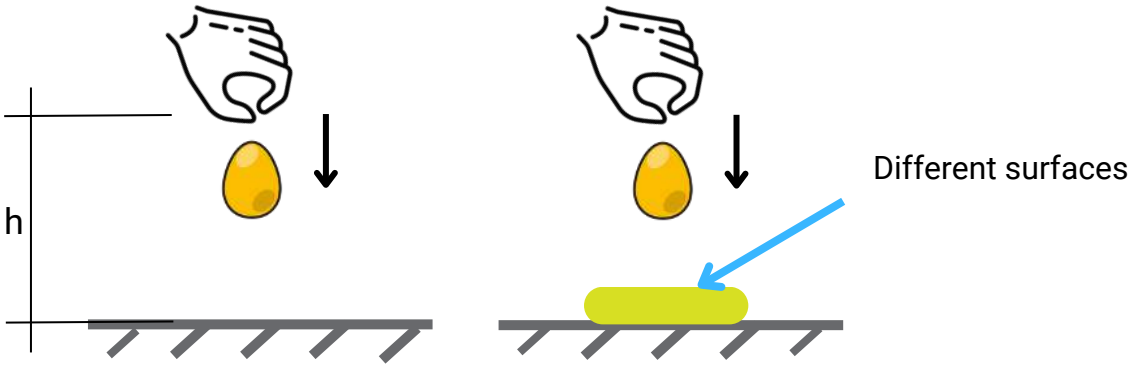
Based on your understanding of forces, acceleration, and impact, propose a hypothesis about how the height from which an egg is dropped affects the likelihood of it surviving.

## Part 3: Experiment Procedure

1. Prepare a solid object in the shape of an egg. This can be a wooden egg or one printed using a 3D printer. The shape should closely resemble a real egg to simulate the experiment accurately.
2. Set up several different surfaces onto which you will drop the egg. Use both hard surfaces (such as tile or concrete) and soft surfaces (like foam, fabric, or a cushion) to observe how different materials affect the egg's behavior when it hits the ground.

Accelerometer

3. Drop the egg from various heights—10 cm, 30 cm, 50 cm, and 1 meter. This will help you understand how the height from which the egg is dropped influences the force of impact.




Write your observations about how a falling egg behaves on different surfaces

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Now, it's time to experiment.

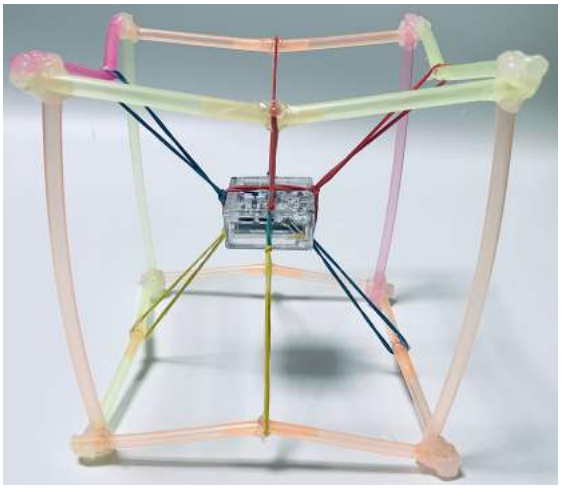
**Goal:** Develop methods to minimize the impact force on the cargo and test their effectiveness.

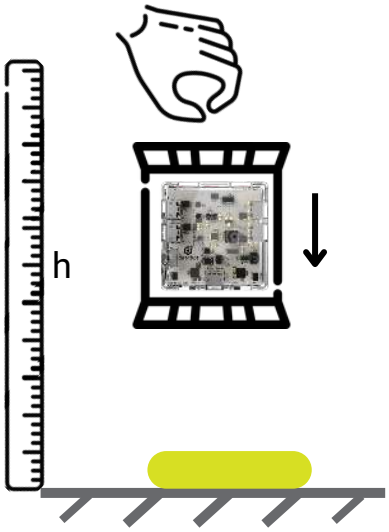
- Open the Vizeey app on your smart device.
- Turn on databot (using the small button on the left side)
- Tap on "**Egg Drop**" in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using:
  - Use these icons at the top of the screen in Vizeey to start and to pause the experiment.
  - Before you start collecting data, you need to secure the databot properly. You can use shock-absorbing materials such as foam or bubble wrap to absorb the shock and protect the device.

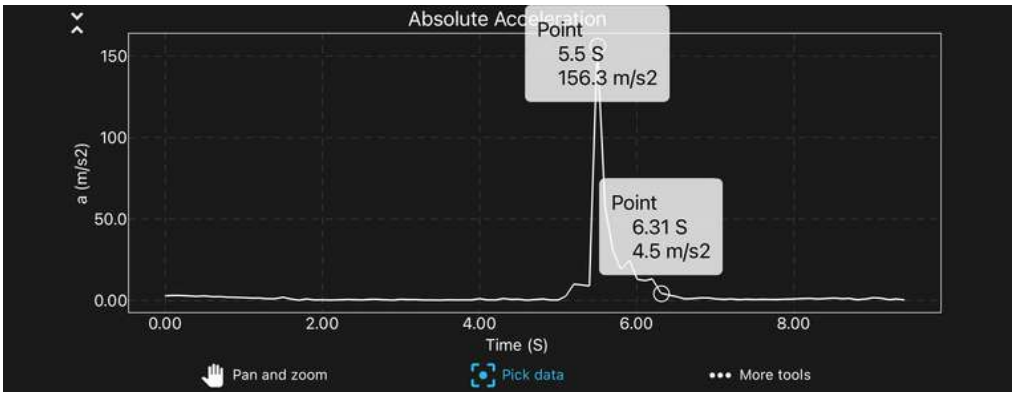
Accelerometer

When conducting the experiment, make sure databot is protected from direct impact. Also avoid sudden falls from a great height to minimize the risk of damage to the device.

- Build a protective structure using drinking straws.
- Place the databot securely inside the structure.
- Use rubber bands to attach the databot to the straw frame, ensuring it is fixed in place but still cushioned.
- Run the experiment in the “Vizeey” program.
- Lift the straw structure with the databot to a height of 30 cm.
- Release the structure and let it fall freely.
- After the fall, stop the databot's data recording.
- Identify the peak acceleration value on the graph — this represents the moment of impact.
- Note the time it takes for the acceleration to return to zero.
- A longer duration indicates a softer impact.





- Modify the straw structure by adding more straws or rubber bands to enhance cushioning.
- Repeat the drop test to observe how these changes affect the impact force.
- Compare the data from different trials.
- Determine which design modifications resulted in a softer landing and explain why.

| Drop № | Maximum acceleration time | Time when acceleration became = 0 | Acceleration(м/s2) |
|---|---|---|---|
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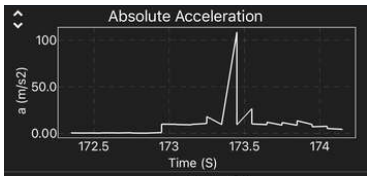
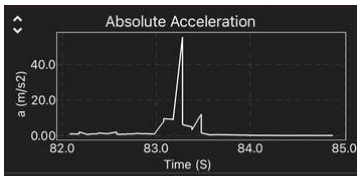
## Part 4: Data Analysis

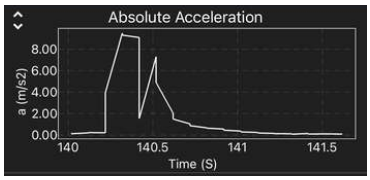
Depending on the methods of protection and the surface you drop on, you can get different graphs. The peak of the chart indicates the maximum impact from the fall.




105 м/s2




59 м/s2




9 м/s2

Databot has a mass of 35 grams, so m=35 g=0.035kg. Knowing the weight and acceleration, you can calculate the force of impact. Use Newton's second law:

$$F = m \cdot a.$$

F = 105 * 0.035 = 3.675 N

F = 59 * 0.035 = 2.065 N

F = 9 * 0.035 = 0.315 N

Do your calculations force of impact here

Think up and create a device that will minimize the force of impact of databot.

Here are some recommendations

- Foam or sponge – soft materials that absorb impact energy.
- Cardboard box with padding (e.g., paper, fabric, straw) – creates cushioning.
- Inflated balloons – used to slow down the fall or as a soft barrier.
- Bubble wrap – effectively softens impacts.
- Plastic bags filled with air – provide additional cushioning.
- Cotton balls or pads – great for absorbing impact energy.
- Plastic bag filled with water – helps distribute the impact force.
- Elastic bands – can slow down the fall when used in a suspension structure.
- Fabric or old clothes – serve as a soft lining.
- Sand or soil – disperses impact energy effectively.

## Part 5: Concept Questions

How could you design a surface or container to minimize the impact force on a fragile object like an egg?

How could you improve your design to better protect the egg from higher drops?

## Part 6: Reflection

What design or material worked best to protect the egg? Why do you think it was effective?

Were there any surprises during the experiment? If so, what were they?