

Why do raindrops sometimes land gently and sometimes land with a splat?

A laboratory experiment from the Little Shop of Physics at Colorado State University



Overview

You've certainly been out during a gentle shower, in which small drops drift like mist, gently landing on your skin. You've also been out in rain showers with big, fat drops that land at high speeds, with a serious splat.

Why the difference?

In this activity, students will observe that raindrops fall at very different rates depending on their size. In this case, size does matter!

Theory

We teach our students that all objects fall at the same speed, but this is only true if you can ignore air resistance. For big things falling at slow speeds, air resistance is a small force. If you jump off a diving board, air resistance has a negligible effect on your fall.



Modeling the fall of raindrops with oil and water.

Necessary materials:

- 1 clear square sided plastic bottle with lid (We've sometimes used empty Fiji water bottles.)
- Mineral oil
- Water
- Food coloring
- Paper towels
- Epoxy or hot glue (optional)
- Tape (optional)

This activity takes patience and a lot of careful observation. If you just have one raindrop bottle for your class, you may want to set this up at a science station and have individual students or small groups rotate through.

This isn't the case for small objects. Air resistance is a big factor. A mouse can fall from any height and land unharmed—it's small enough that air resistance slows its fall.

For raindrops, the situation is even more extreme. Very small drops will fall imperceptibly slowly. Larger drops will fall faster, so small droplets will drift slowly downward. Big, fat drops fall at high speeds, and hit with a splat. In the real world, the speed that things fall at does depend on size. It's not that Galileo was wrong; it's just that he didn't consider air resistance, and for small objects air resistance is quite crucial.

Doing the Experiment

If you have not done so, you will need to prepare your raindrop bottle. Choose your

favorite color of food coloring and add a couple of drops to water in a measuring cup. Pour a small amount of water into a clear square-sided plastic bottle—perhaps 10% of the volume of your bottle, or experiment with how much water to add. If you are using a recycled Fiji bottle, we usually fill water up to the lowest ridge at the bottom of the bottle. Now fill the remainder of the bottle with mineral oil. Fill to the top until it looks like it might spill over. Screw on the cap and have paper towels ready for any oil spills! We recommend coating the lid in epoxy or sealing it with hot glue and then wrapping it with tape, so your classroom stays oil free.

Ask your students the question, “Why do raindrops fall gently sometimes and land with a splat other times?” Jot down their ideas and then have them work with the bottle. They should start by gently tipping the bottle back and forth a few times and then observing. After they done this, have them give the bottle a more vigorous shake and observe again.

Things to look for:

- What shape are the droplets when they are tiny?
- What shape do they take when they are larger?
- Why do you think they change shape?
- Which ones fall slowly?
- Which ones fall faster?
- Why do you think this is so?
- What happens when a big droplet falls?
- What happens if two droplets collide?

Summing Up

Although not a perfect comparison, the raindrop bottle activity lets students observe in slow motion the behavior of falling droplets, and explore concepts such as drag and terminal velocity.

For More Information

CMMAP, the Center for Multi-Scale Modeling of Atmospheric Processes: <http://cmmmap.colostate.edu>

Little Shop of Physics: <http://littleshop.physics.colostate.edu>