

Weighty Issue

Overview: If I drop a ping pong ball and a golf ball from the same height, which one hits the ground first? How about a bowling ball and a marble?

What to Learn: Students will learn that gravity accelerates all things equally. Objects near the Earth fall to the ground unless something holds them up.

Materials (per lab group)

- ping pong ball
- golf ball
- feather
- balloon
- bouncy ball
- eraser
- pencil
- 2 sheets of paper (crumple one up to the size of a golf ball)
- paperclip
- empty water bottle

Lab Time

1. Take a careful look at both objects and make a prediction about which object will hit the ground first if they are dropped from the same height. Record your hypothesis.
2. Test your prediction. Hold both objects at the same height. Make sure the bottom of both objects is the same distance from the floor.
3. Let them go as close to the same time as possible. Sometimes it's helpful to roll them off a book.
4. Watch carefully. Which hits the ground first, the heavier one or the lighter one?
5. Try it three times and watch carefully. It will be a little easier for the person who isn't dropping them to see what happens.

Weighty Issue Data Table 1

[illegible]

Weighty Issue Data Table 2

To determine the mass in kg, use the following conversion: 1 pound = 0.4536 kg.

For calculating area of a 3D object, use the side that the oncoming air sees as it falls to the ground.

For a ball, it's $A_{\text{sphere}} = (\pi r^2) / 4$. For a sheet of paper, it's (length) x (width). Don't forget to write your units!

[illegible]

Reading

For this experiment, you'll need two objects of different weights: a marble and a golf ball, or a tennis ball and a penny for example. You'll also need a sharp eye and a partner.

When dropped from the same distance, you should see that both objects hit the ground at the same time! Gravity accelerates both items equally and they hit the ground at the same time. Any two objects will do this, a brick and a Buick, a flower and a fish, a kumquat and a cow!

"But," I hear you saying, "If I drop a feather and a flounder, the flounder will hit first every time!" OK, you got me there. There is one thing that will change the results and that is air resistance.

The bigger, lighter and fluffier something is, the more air resistance can affect it and so it will fall more slowly. Air resistance is a type of friction which we will be talking about later. In fact, if you removed air resistance, a feather and a flounder would hit the ground at the same time!

Where can you remove air resistance? The moon! One of the Apollo missions actually did this (well, they didn't use a flounder, they used a hammer). An astronaut dropped a feather and a hammer at the same time and indeed, both fell at the same rate of speed and hit the surface of the moon at the same time.

Ask someone this question: Which will hit the ground first, if dropped from the same height, a bowling ball or a tennis ball? Most will say the bowling ball. In fact, if you asked yourself that question 5 minutes ago, would you have gotten it right? It's conventional wisdom to think that the heavier object falls faster. Unfortunately, conventional wisdom isn't always right. Gravity accelerates all things equally. In other words, gravity makes all things speed up or slow down at the same rate.

This is a great example of why the scientific method is such a cool thing. Many, many years ago, there was a man of great knowledge and wisdom named Aristotle. Most people believed whatever he said to be true. The trouble was he didn't test everything that he said. One of his statements was that objects with greater weight fall faster than objects with less weight. Everyone believed that this was true.

Hundreds of years later, Galileo came along and said, "Ya know...that doesn't seem to work that way. I'm going to test it." The story goes that Galileo grabbed a melon and an orange and went to the top of the Leaning Tower of Pisa. He said, "Look out below!" and dropped them! By doing that, he showed that objects fall at the same rate of speed no matter what their size.

It is true that it was Galileo who "proved" that gravity accelerates all things equally no matter what their weight, but there is no real evidence that he actually used the Leaning Tower of Pisa to do it.

Exercises Answer the questions below:

1. What did you notice from your data? Did heavier or lighter objects fall faster? Did more massive objects or smaller objects fall faster? What characteristic seemed to matter the most?
2. Is gravity a two-way force, like the attractive-repulsive forces of a magnet?
3. If I were to drop a bowling ball and a balloon filled with a gas six times heavier than air (sulfur hexafluoride SF_6) and inflated to the exact size of the bowling ball from my roof, which will strike the ground first?

Answers to Exercises: Weighty Issue

1. What did you notice from your data? Did heavier or lighter objects fall faster? Did more massive objects or smaller objects fall faster? What characteristic seemed to matter the most? (see data tables)
2. Is gravity a two-way force, like the attractive-repulsive forces of a magnet? (No, only attractive.)
3. If I were to drop a bowling ball and a balloon filled with a gas six times heavier than air (sulfur hexafluoride SF_6) and inflated to the exact size of the bowling ball from my roof, which will strike the ground first? (Both, unless it's windy!)