

Professor Brainstorm's Investigating Gravity

About this Activity (Information for Parents and Teachers)

This experiment explores the concepts of Gravity and Air Resistance.

It is a very simple experiment - which takes no more than 2 minutes to perform. But it addresses a very important idea about which many people (adults as well as children) have misconceptions. If you are one of these people, prepare to be shocked!

An important aspect of this experiment is to predict what will happen before you do the experiment. (Parents - if your knowledge of science is just a dim memory from your GCSEs, you might like to make the predictions too. It doesn't matter if you get the answer wrong. The main thing, if you do get the answer wrong, is that after doing the experiment you should understand why you got the answer wrong!)

This experiment is designed for children aged from 9 to 11 years (Years 5 & 6).

What you Need

- A book. (A hardback book is best. Make sure it is an old one - which does not matter if it gets slightly damaged!)
- A sheet of paper.
- A large potato.
- A grape.

Which Falls Fastest - Part 1

In this experiment you are going to drop the potato and the grape. (If you don't have a large potato or a grape you can substitute something similar.) You are going to drop them both from the same height and at the same time. Which one will hit the ground first? Make your prediction before you do the experiment.

Now try the experiment. You really need two people for this - one to do the dropping, and one to watch the floor carefully where the items will land.

- The person doing the dropping should hold the both the potato and grape at shoulder height. Hold them both gently in your fingertips - so that as soon as you let them go, they will fall to the floor.
- The other person should watch the floor carefully where they will land. Can you tell which one lands first? (If it is very close, you can try videoing it on your phone - and then play the video back in slow motion.)
- As with all good science experiments, you should repeat this several times. (And it would be a good idea to change roles - so that both people get to be the dropper, and both the observer.)



How does it work? - Part 1

Which one did land first? You probably found it very difficult to decide - because if you let them go at exactly the same time, they should both hit the floor at exactly the same time.

Was your prediction correct? Don't worry if you got it wrong. Many people expect the potato to hit the ground first - because it is much heavier (or we should really say it has more **mass***) than the grape. But what we have discovered in this experiment is that gravity has the same effect on everything. It doesn't matter that the potato is much heavier than the grape - gravity has the same effect on them both.

If you did get the answer wrong, don't worry, you are not alone. In fact, until the late 16th Century even very clever people, such as philosophers, would have given you the same answer. The problem was that until Galileo came along, no one had bothered to try this simple experiment.

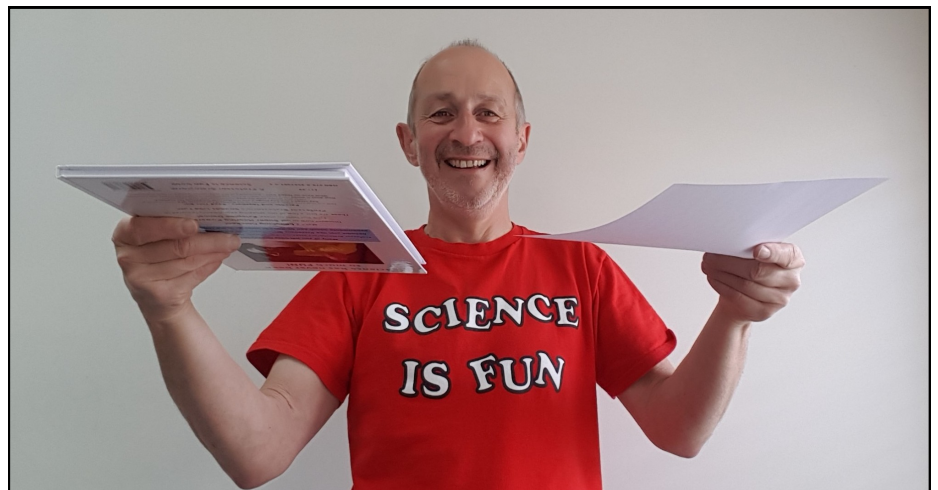
Which Falls Fastest - Part 2

This time we are going to drop the book and the sheet of paper. First of all we want to make the sheet of paper about the same size as the book, i.e. so it has the same surface area. You can cut the paper if it is too large.

Again we will drop both objects from the same height at the same time. Which one do you think will hit the ground first this time?

Now try the experiment.

This time you don't need to have anyone watching the floor carefully. It is obvious that the book hits the floor first. The challenge this time is to explain **why** the book hits the floor first. (Or perhaps we should say why does the paper take so long to hit the floor.)



How does it work? - Part 2

Some people think that the book hits the ground first because it is heavier than the paper. But we have just found out in the previous experiment that the potato and grape hit the ground together - even though the potato is much heavier than the grape.

The real reason why the book hits the ground first is because of **air resistance**. When we drop the book, the air gets in the way and slows it down. But because the book is heavy, the air does not slow it down very much.

However, the sheet of paper is much lighter than the book, but it has the same surface area. So in this case the air slows the paper down dramatically - in fact, rather than falling straight down, the paper almost floats, wafting from side to side as it slowly drifts towards the floor. The same thing did not happen with the grape - because although it is much lighter than the potato (or the book), it does not have a large surface area.

So when we drop an object, gravity pulls it down, but there is another force called air resistance which slows it down. But because gravity is quite a strong force, the air resistance usually only becomes noticeable when the object is both light (i.e. it does not have much mass) and has a large surface area.

Which Falls Fastest - Part 3

We are going to do the experiment one more time. We will again be using the sheet of paper and the book, but this time you are going to lie the sheet of paper **on top** of the book. Before you do this, again make your prediction. What do you think will happen?

Now try it.

Was your prediction correct?

How does it work? - Part 3

Before they do the experiment, most people expect that the book will fall straight down - but that the paper will slowly float down as it did before. However, if you have tried the experiment you will see that the book and the sheet of paper both fall together. How does this happen?

Of course, the only reason why the sheet of paper normally falls slowly is because the air slows it down. When we place the sheet of paper on top of the book, the book pushes the air out of the way as it falls.

So this time the air does not slow the paper down. (And there is no air in between the book and the sheet of paper to slow it down either.) Gravity has the same effect on both the sheet of paper and the book - so they both fall together.

Now try this ...

When the Apollo 15 mission went to the Moon in 1971, one of the astronauts, Commander David Scott, performed an experiment just like the one the you have done here - only he dropped a hammer and a feather. Which one do you think hit the ground first? (Remember there is gravity on the Moon - although it is about 6 times weaker than gravity on Earth - but there is no air.)

So have you made your prediction? Which one hit the Moon's surface first, the hammer or the feather?

Of course it is a trick question: They both landed at the same time. There is no air to slow them down. And gravity has the same effect on both the hammer and the feather - so they both fall at the same rate. (If you are still not convinced, you can find a video of the experiment on YouTube. Search for 'Apollo hammer and feather'.)

(*When we are doing science we should really distinguish the **mass** of an object - which is measured in kilograms - from the **weight** of that object - which is the **force** produced when gravity is pulling the mass downwards. So we should say that the potato has more mass than the grape. But since in this experiment we are talking about the way that the objects are affected by gravity, it doesn't make much difference whether we use the term mass or weight.)