FORCES

GRAVITY AND *AIR RESISTANCE*

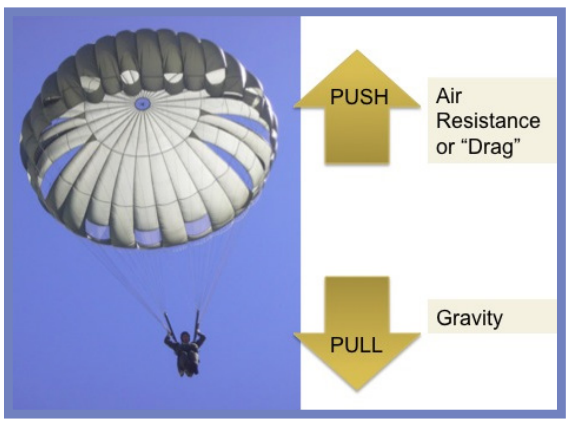
DISCOVERY MUSEUM

Written by: Sarah Tropp-Pacelli

One of the most fundamental truths about life here on Earth is that we all are subject to gravity. ***Gravity*** is a force between all things that pulls between their centers, but we know it best as the thing that keeps us on the surface of the Earth.

There are a few famous stories about gravity. One of the legends commonly shared is that of Sir Isaac Newton, who is said to have discovered gravity when an apple fell on his head as he sat under a tree. This incident sparked many ideas for Newton, leading to his eventual development of the Laws of Motion. But even before Newton made his discovery, another scientist made some other very important discoveries related to gravity that scientists still learn about today.

Galileo Galilei wanted to explore what happens to the speed of falling objects dropped from the same height. In Galileo's famous experiment, he took two balls made of different materials and studied them as they fell. Some versions of the story say he dropped them off the Tower of Pisa, while others say he rolled them down a ramp. In either case, he made an amazing discovery: all objects fall at the same rate, regardless of their materials or their ***mass*** (the amount of matter something contains). His discovery is known today as the ***equivalence principle***.



If you've ever dropped things, you're probably wondering why that doesn't always seem to hold true. Certainly, a bowling ball dropped from a tower will hit the ground before a feather dropped at the same time from the same height. So what else is going on?

Gravity isn't the only force we have here on Earth. One of the other things that makes our planet special is the presence of an atmosphere that gives us air to breathe and protect us from the extreme conditions of space. In 1971, astronauts on the Moon re-enacted Galileo's famous experiment, and they found that he was right: objects dropped on the Moon also hit the ground at the same time--but on the Moon, even a feather drops straight down instead of drifting the way it might here on our home planet.

The reason things might seem like they fall at different rates on Earth is the fact that we have air, which means we also face ***air resistance***. Air takes up space, which means that anything going through that space--such as a falling object--needs to move the air aside to do so.

INVESTIGATION ACTIVITY

ACTIVITY: Investigate how air resistance affects the way that objects fall. Graph your results and come up with an explanation about how the presence of air influences different objects based on their size (volume and mass), their shape, and their materials.

SUGGESTED MATERIALS: feathers, paper, small rocks, pencils, erasers, sports equipment

To set up your investigation, consider how you will time how long it takes for the objects to fall. We recommend that you use slow-motion footage of your drops to calculate the time to get the most accurate result--a cell phone records at 240 frames per second and plays at 30 frames per second, so you can watch your slow motion footage and count the seconds it takes for your item to hit the ground, then divide by 8 to find out how long the drop actually took!

You will also want to consider how you can make sure that the objects really drop from the same height every time. Consider designing a "drop shelf" that items can be placed on that can be pulled out from under them to ensure that they start in the same spot each time.

Once you devise your drop mechanism and your timing system, you're ready to test! Pick some objects to drop. Make sure you use each object at least 3 times so you can get an ***average*** of the result, to make sure you have the best data possible.

Graph your results to demonstrate how long each item takes to drop and use your data to create an explanation about how air resistance influences the way that falling objects move. You might want to graph objects in several ways, such as by density (mass divided by volume) and by material.

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Standards Alignment:

Next Generation Science Standards: 3-PS2-1, 5-PS2-1
Common Core Math Standards: MP.2, MP.5, 3.MD.A.2