Down With Gravity Teacher Guide

OBJECTIVE

Explore gravity as an attraction between objects with mass.

CONCEPTS COVERED

- Gravity is the force that attracts all objects.
- Gravity is dependent on mass.
- Gravity pulls on objects equally, but other forces, such as air resistance, can affect the rate at which objects fall.

SCIENCE PRACTICES

- Making predictions
- Creating a hypothesis and testing for answers
- Engaging in argument from evidence
- Obtaining, evaluating and communicating information

STANDARDS ADDRESSED

- 5-PS2-1
- "Support an argument that the gravitational force exerted by Earth on objects is directed down."

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How to Use This Guide

This video is an introduction to gravity, defining concepts like force, mass and air resistance. Your students will watch the *Down With Gravity* video and will have access to a student guide that accompanies the video. The student guide includes a materials list and a procedure list to help students recreate the experiment and to follow along with the experiment. The materials are simple items they can find in their homes. If your students are not able to gather the materials to follow along with the experiment, they can observe the instructor conducting the experiment and its results. They will still be able to answer the reflection questions which are located at the end of the student guide. We have included those questions, along with the answers, in the teacher guide. There are vocabulary words in the guide that students can refer to when any new concepts have been introduced. At the end of the teacher guide there are links to other related NYSCI resources to extend the learning. We hope this video and guide can add some enrichment to your gravity exploration.

Video Synopsis

In this video, students can follow along to explore the concepts of gravity by doing different experiments. Each experiment allows students to observe how gravity pulls on objects with varying masses, shapes and sizes.

Activity 1 illustrates the concept that objects are attracted to the Earth rather than just being pulled downward. Students will get the opportunity to manipulate objects to explore gravity's attraction.

Activity 2 enables students to experiment with how different objects with varying masses fall from the same height, and observe how the objects land as well as how gravity affects the objects. Students will explore how other forces, such as air resistance, can interfere with gravity by dropping an object with a large surface area versus an object with a smaller surface area (a flat sheet of paper versus a paper ball).

Activity 3 further demonstrates how gravity pulls on objects, including liquids, at the same rate and deepen student's understanding of that concept by allowing them to see how gravity pulls the cup and the water down equally.

To get the most out of any science activity, students should be encouraged to follow their inquiries, further investigate, and create their own experiments. They can try the activities with different materials or a different methodology and compare results, as well as use this video as a launching point to create their own gravity experiments based on the additional questions that arise for them.

Background information

Gravity is a force. A *force* is a push or a pull, but when we're talking about *gravity* you should know that *gravity* always pulls, never pushes. *Gravity* is a *force* that tries to pull

ACTIVITY TIPS

Activity 1: Gravity Pencil Demo

- Students can substitute similar items for the pencil, string and paperclips. (ex. chopstick, pen, ribbon, thread, rings)

Activity 2: Gravity: Water Bottle and Paper Experiments

- Any two objects can work for the water bottle drop, they just need to be a similar size to each other but different weights.

Activity 3: Gravity in a Cup

- Any kind of disposable cup will work.

objects together. *Gravity's* pull is dependent on an object's *mass. Mass* is a measurement of how much matter is in an object. A bigger planet, with a bigger *mass* has a stronger *gravitational* pull than a smaller planet with a smaller *mass. Mass* is different from *weight*, which is a measurement of the force of gravity on an object. If you were to travel to a different planet with a bigger *mass* than Earth, you would actually weigh more because that planet's gravitational pull would be stronger. If you visited a smaller planet, you would weigh less, because the *gravitational* pull would be weaker. However, at no point would your mass change, because the amount of matter that makes you up wouldn't change based on your location. *Weight* is actually relative to the planet it's being measured on, whereas *mass* stays the same no matter where you measure it.

The Earth's *mass* is so much bigger than your own that it overpowers your own *gravitational* pull. If you want to be able to experience your own gravity to the fullest, you would have to journey to the deepest part of space, somewhere where there are no other planets or stars to compete with. There are lots of other forces besides *gravity* that come in to play, such as *air resistance*, the frictional force air exerts against a moving object.

Questions and Answers (Student Guide)

How does gravity pull different masses (heavy and light)?
Gravity has the same pull on different masses; both masses will fall at the same speed, and will land at the same time.

How does air resistance affect the rate objects fall?
Objects that have a greater area or surface will be affected by air resistance. When an object with a lot of surface area falls, the air slows down the fall of the object by pushing up against it. Because of air resistance pushing the opposite direction of gravity's force, this causes the object with greater surface area to slow down its fall compared to an object with less surface area.

What did you notice was different about holding the cup still versus dropping the cup?
When you hold the cup still, your strength is enough to defy gravity and keep the cup up. However, the water will be pulled down through the hole by gravity and will pour out of the cup until it is completely drained. When you release the cup at the same time you release the water, gravity will pull on the cup and the water at the same rate, so the water will not spill out the hole, but rather will fall within the cup.

What would happen if the hole was bigger? If it was smaller? Would that change what happens when you drop it?
If the hole were bigger, the water would spill out faster as it would be easier for the water to escape through the hole. Were the hole smaller, the water would escape more slowly. Theoretically when dropping the cup, the results would be the same (the water would stay in the cup). However, if the hole were bigger it may be more difficult to time releasing the hole and the cup at the same time, so it may be more likely for some

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water to escape out the hole before the cup begins to fall. If the hole were smaller this would be much easier, but the results might be less clear.

Try These Next

Egg Drop Activity
Students can use found materials (tape, paper, craft supplies such as yarn and pipe cleaners, recyclables such as tin cans, cardboard boxes and egg cartons, etc.) to construct a device that will protect a raw egg when dropped from a height. Students can test their device from varied heights and record their results.

Asteroid Experiment
Fill a cookie sheet with a layer of flour, then top with a layer of cocoa powder (either can be subbed out for any other similarly colored/textured material such as play sand, soil, etc.). Students can throw marbles or other small balls into the tray, and then observe what happens to the layers when they're struck by the "asteroids." Students can make comparisons between the sizes of asteroids and the sizes of the indentations they make.

Check out more activities at www.nysci.org.

Chain Reaction II
Students can use different materials (mainly household items) to complete Rube Goldberg-type challenges. Using basic physics concepts (inertia, gravity, force, motion) and common items, learners will build Rube Goldberg-type machines. (Video and Activity included: https://learnxdesign.org/learnxdesign_record/chain-reaction-ii/)

Books

Prasad, K. (2004). *Why Can't I Jump Very High? A Book About Gravity.* A simple question asked on a basketball field sparks a discussion on gravity that carries on into the classroom. The story is coupled with demonstrations, which can be easily duplicated at home or in the classroom.

Chin, J. (2014). *Gravity*. How do we stay put on our planet and not float away into outer space? What makes things fall to the ground from high places? Book introduces readers to the concept of gravity, presenting the information in highly understandable language and captivating paintings.

Floca, B. (2009). *Moonshot: The Flight of Apollo 11*. Describes the adventure and discovery of the Apollo 11 mission. Could be used to jumpstart conversation about the role of gravity.

Walliman, D. (2013). *Professor Astrocat's Frontiers of Space*. Characters such as Professor Astro Cat and his assistant Astro Mouse give a humorous, conversational tone to this nonfiction book's information about space, our solar system, gravity and changing space exploration technology.

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