**"Why Don't We Fall Off the Earth?" - Science and Literacy Connections in Elementary**

**Interdisciplinary Standards**

* Science Standards -

|  |  |
| --- | --- |
| **5-PS2-1.** | **Support an argument that the gravitational force exerted by Earth on objects is directed down.** [Clarification Statement: “Down” is a local description of the direction that points toward the center of the spherical Earth.] [*Assessment Boundary: Assessment does not include mathematical representation of gravitational force.*] |

* NGSS Dimensions-

**Engage:** Students investigate how different objects fall to the Earth’s surface using a variable related to distance/height of the object. Students record observations made in relation to how the object falls to the Earth’s surface.

**Explore:** Students analyze the video and record how the different objects fall to the Earth’s surface.

**Explain:** Students will explain what they see in the Hammer and Feather and compare these observations to what they discovered during their own investigation.

**Elaborate:**  Students will calculate the effect of gravity on the weight of a 65 pound person on the different planets in our solar system distinguishing the relationship of the planets’ size to the person’s weight.

**Evaluate:** Students will create a model supporting their argument that the gravitational force exerted by Earth on objects is directed down (towards the center). Students show understanding of one or both of these variables: height/weight.

* CCSS ELA Standards -

**RI.5.1** - Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-ESS1-1)

**RI.5.7** - Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS1-1)

**RI.5.8** - Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). (5-ESS1-1)

**RI.5.9** - Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ESS1-1)

**SL.5.5** - Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-ESS1-2)

**W.5.1** - Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-ESS1-1)

* CCSS Math Standards -

**5.NBT.A.2** - Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. (5-ESS1-1)

**MP.2** - Reason abstractly and quantitatively. (5-ESS1-1), (5-ESS1-2)

**MP.4** - Model with mathematics. (5-ESS1-1), (5-ESS1-2)

**Background Knowledge**

A Black Hole Is Not a Hole by Carolyn Cinami DeChristofano (pp. 13-15): Explains Newton’s Law

[Gravity Experiment with Supporting Videos](https://wimedialab.pbslearningmedia.org/resource/phy03.sci.phys.mfe.lp_gravity/gravity-and-falling-objects/#.WRSHmBPyu9Y)

**Description of What the Class Does**

* Engage: Inquiry activity

Science Practice and Disciplinary Core Idea Each group will receive a cup of items. (These should range in weight/mass, such as a feather, penny, hex nut, etc.)

-Be prepared to have a videographer in your group shoot what happens in SLOW MOTION (if possible). The videographer should also be able to share the video with each group member.

-If you are unable to video the drops, could you have designated observers who share what they notice?

-Your experiment will answer the following question:

**How does gravity affect matter?**

-Think of what your group could do to experiment with the objects?

-How will you keep variables in mind? (height/distance/drop vs throw, etc.)

-How will you collect data/observations? How will you use them?

-What are some things you noticed as you experimented with gravity?

Essential Question: How can you support the argument that the gravitational force exerted by Earth on objects is directed down?

Essential Question: How does gravity affect matter?

* Science Practice, Disciplinary Core Idea Explorations: View your video/observations. What did you notice?
* Science Practice, Crosscutting Concept Explaining: View video of astronaut dropping objects on the moon. [Hammer and Feather](https://wimedialab.pbslearningmedia.org/resource/phy03.sci.ess.eiu.galmoon/galileo-on-the-moon/#.WRTAmxPyu9Y) What do you notice? How did the results compare to what you discovered? Why?
* Disciplinary Core Idea Elaborate: Essential question: How does planet size affect the gravitational pull on matter? We explored gravitational pull on Earth, as well as observed a video of what happens on the moon, but what about other planets? If the force of gravity is different, how does that affect weight? Small groups will work to determine the weight on a given planet, and then the entire group will compare results to determine patterns and any causality.
  + Science Practice Students will calculate the weight of a 65 pound person on each of the planets.
    - Weight X force of gravity factor = new weight in pounds
      * Mercury - force of gravity factor = 0.38
      * Venus - force of gravity factor = 0.90
      * Earth - force of gravity factor = 1.0
      * Earth’s moon - force of gravity factor = 0.17
      * Mars - force of gravity factor = 0.38
      * Jupiter - force of gravity factor = 2.36
      * Saturn - force of gravity factor = 0.92
      * Uranus - force of gravity factor = 0.89
      * Neptune - force of gravity factor = 1.13
      * If students are not able to do the math at this level, there is a link to Weight Calculator below.
    - Disciplinary Core Idea and Crosscutting Concept Explain how the size of a planet relates to the weight of a 65 pound person. Provide evidence and reasoning to support your claim. Remember to distinguish between mass and weight---it is the amount of mass that affects the gravity.
    - Disciplinary Core Idea and Crosscutting Concept How is the concept of gravity correlated across the solar system? What do our findings show? Are there any patterns? Causality?
    - Disciplinary Core Idea and Crosscutting Concept What about other factors? What if you dropped a flat piece of paper vs a crumpled up one? (does wind resistance/friction affect an item, especially when the objects dropped are the same mass?)
* Science Practice, Disciplinary Core Ideas, Crosscutting Concepts Evaluate: See Assessment Example for Gravity document for ideas
  + Essential question: Is the gravitational pull the same in the northern and southern hemisphere? Remember, “down” means toward the center.
    - Explain what you discovered and how you know by creating a model showing what you learned about gravitational pull in the northern and southern hemispheres.
  + Essential question: What things have been engineered to help people deal with effects of gravity?
    - Create a model that provides evidence of engineered items that defy/use gravity through lifting and defy/use gravity as things are falling.
    - What about sports? How does gravity come into play in a sport? Analyze one and determine how the equipment, motions, facility, etc. use gravity.

CER: Claims, Evidence, Reasoning

**Claim** – a **conclusion** that answers the original question

**Evidence** – scientific **data** that supports the claim

**Reasoning** – a justification that links the claim and evidence

**Additional Resources:**

[**NSTA Resources**](http://ngss.nsta.org/DisplayStandard.aspx?view=topic&id=22)

[Bill Nye-Gravity](http://wimedialab.org/series/episode/gravity)

[Defining Gravity-Crash Course Kids](https://www.youtube.com/watch?v=ljRlB6TuMOU)

[Weight Calculator](http://www.exploratorium.edu/ronh/weight/)

A Black Hole Is Not a Hole by Carolyn Cinami DeChristofano (pp. 13-15): Explains Newton’s Law

[NGSS Interactive Read-Alouds](http://www.kbs.msu.edu/wp-content/uploads/2017/02/NGSS-Interactive-Read-Alouds.pdf)

<http://static.nsta.org/pdfs/2018OSTB.pdf>

<http://tryengineering.org/lesson-plans>

[Weight vs. Mass](http://safeyoutube.net/w/f5Vc)

[The Science of Disney Imagineering Series](https://wimedialab.org/series/episode/gravity-0)

[Sciencing-Gravitational Pull](https://sciencing.com/gravitational-pull-6300673.html)

[MIT-Second Floor Gravity](http://safeyoutube.net/w/c5Vc)