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The Bigger the Heart, the Bigger the Attraction

Relative Gravity and Gravitational Force

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Grade Level	7th Grade	**Time Frame**	2-3 class period(s)
Subject	Science	**Duration**	90 minutes
Course	Earth Science, Physical Science		

Essential Question

How do physical properties influence gravitational interactions?

Summary

Building upon students' understanding of gravity, this lesson helps them to determine that gravity is attractive and is correlated with mass and inversely correlative with distance. Rather than using calculations or formulas, students use data and tables to determine whether the provided information about mass, gravity, and distance is correct, which allows them to explore the qualitative nature of those properties.

Snapshot

Engage

Students respond to a gravity "pick-up line" and are presented with a fact about black holes.

Explore

Students conduct a gravity bucket lab.

Explain

Students evaluate the truthfulness of several statements about gravity.

Extend

Students conduct a comparative analysis of gravity and the planets in our solar system.

Evaluate

Students write a CER statement supporting or refuting a fact about black holes.

Standards

Next Generation Science Standards (Grades 6, 7, 8)

MS-PS2-4: Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Oklahoma Academic Standards (8th Grade)

8.PS2.4.2: There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass(e.g., Earth and the sun).

Attachments

- Always, Sometimes, or Never True Answer Key — The Bigger the Attraction.docx
- Always, Sometimes, or Never True Answer Key — The Bigger the Attraction.pdf
- Always, Sometimes, or Never True—The Bigger the Attraction - Spanish.docx
- Always, Sometimes, or Never True—The Bigger the Attraction - Spanish.pdf
- Always, Sometimes, or Never True—The Bigger the Attraction.docx
- Always, Sometimes, or Never True—The Bigger the Attraction.pdf
- Gravity Bucket Lab Teacher's Guide—The Bigger the Attraction.docx
- Gravity Bucket Lab—The Bigger the Attraction - Spanish.docx
- Gravity Bucket Lab—The Bigger the Attraction - Spanish.pdf
- Gravity Bucket Lab—The Bigger the Attraction.docx
- Gravity Bucket Lab—The Bigger the Attraction.pdf
- Gravity Comparative Analysis—The Bigger the Attraction - Spanish.docx
- Gravity Comparative Analysis—The Bigger the Attraction - Spanish.pdf
- Gravity Comparative Analysis—The Bigger the Attraction.docx
- Gravity Comparative Analysis—The Bigger the Attraction.pdf
- Lesson Slides—The Bigger the Attraction.pptx

Materials

- Lesson Slides (attached)
- Gravity Bucket Lab handout (attached; one per student)
- Gravity Bucket Lab Teacher's Guide (attached)
- Always, Sometimes, or Never True handout (attached; one per group of three students)
- Always, Sometimes, or Never True Answer Key (attached; optional)
- Gravity Comparative Analysis handout (attached; one per student)
- Buckets (3.5 gallon or larger; two per lab group)
- Stretchy fabric
- Bungee cords
- Variety of balls and weights (see Gravity Bucket Lab Teacher's Guide for details)

Engage

Teacher's Note: Every Minute Counts

Students' first task is framed as a Bell Ringer so that the students can get started as soon as possible and use every minute of class. This procedure gets better with time, so the goal with Bell Ringers is to have a task ready every day for students to work on as they arrive.

Use the attached **Lesson Slides** to guide the lesson. As students enter the classroom, have the Bell Ringer on **slide 4** displayed. After reading the phrase, "Even if Earth didn't have gravity, I'd still fall for you," students should take a moment to write down an explanation of why it is funny. After they write down their responses, have a few students share them with the class.

Teacher's Note: Activating Prior Knowledge

This activity is meant to activate students' prior knowledge that gravity exists, and that it is what keeps us on Earth's surface. Fifth grade standard 5PS2-1, which is related to this notion, addresses that students should know that gravity pulls things down (toward the center of Earth).

Display **slide 5.** Show this video that compares the mass of a black hole to the mass of the sun. Let students know that we will answer why this comparison matters at the end of the lesson.

Explore

Teacher's Note: Lab Preparation

The next portion of the lesson is a lab with components that need to be set up ahead of time. Refer to the attached Gravity Bucket Lab Teacher's Guide for complete setup instructions.

Display **slide 6.** Organize students into groups of three and pass out a copy of the Gravity Bucket Lab to each student. Make sure each group has all of the materials needed to complete the lab.

Teacher's Note: Lab Group Size

This lab works best with groups of three students. With larger groups, it is more likely that some students will be left out. If you have a large class where groups of three are not feasible, due to limited supplies or limited space, assigning roles to get everyone involved can help.

Give students time to work through the lab activities and answer the questions on their handouts.

Teacher's Note: Helpless Hand Raisers?

Labs are a tough time for teachers. We want students to work independently, but we also do not want them to get too frustrated or make too many mistakes. Be available, and watch students and their progress. When in doubt, prompt students with a question, and answer student questions with questions to guide their thinking in the right direction.

Teacher's Note: Crosscutting Concepts And Scientific Practices

On the Gravity Bucket Lab student handout, stage 1 question 3d allows students to think about the Crosscutting Concept of Systems and System Modeling. Because we cannot manipulate variables in space, we must use models like the one in the lab to help us understand concepts like gravity. Students should be able to identify that the balls represent planets, the fabric represents space, and the dipping represents gravity.

Bring students back together as a class, and use the questions on **slide 7** to guide a discussion about the lab.

Explain

With their Gravity Bucket Lab handout in hand, have students form new groups of three. These members of these groups should not have worked together on the lab.

Go to **slide 8.** Pass out an Always, Sometimes, or Never True handout to each group.

Teacher's Note: Mixing It Up

Because of the conditional nature of most "rules" we use to make sense of our world, Always, Sometimes, or Never True analysis is actually more challenging than most people predict. Putting students with a group other than their lab group not only gets them out of the comfort of that group, but it also provides more opportunities to identify counterexamples or sort through different results.

Allow students time to use their lab results and their prior knowledge to determine the truthfulness of the statements.

Teacher's Note: Skip Around

If students struggle with determining whether particular statements are Always, Sometimes, or Never True, encourage them to skip difficult questions and go back to them at the end.

Instruct students to hold on to their handouts, but don't reveal the correct answers yet. Students will revisit their answers to the statements later in the lesson.

Extend

Go to **slide 9.** To connect what they have experienced in the Gravity Buckets lab to real-life values, students will continue working with their groups from the Explain activity to do a comparative analysis of gravity, mass, and distance of our solar system's planets and sun. Pass out copies of the Gravity Comparative Analysis handout for students to work through. Have students refer back to the Engage and Explore activities to help them make connections to the data on their handouts.

Teacher's Note: Task Difficulty

This activity will not be easy for students, especially if they are used to direct, simple correlations being given to them explicitly. It is up to us as teachers to help students know that difficult tasks are okay, as-is not being perfect the first time. Effort and perseverance are what we are looking for as we journey to the correct answers.

Teacher's Note: Data Literacy

Adults generally take the skill of data literacy for granted. There are questions in the handout that might seem obvious or barely related to the intended standard. But, use those questions to help students gain the literacy of reading data and tables.

After completing the Gravity Comparative Analysis handout, direct students back to their Always, Sometimes, or Never True statements. Ask if what they learned when comparing data has changed any of their answers or provided new examples or non-examples.

Always, Sometimes, Or Never True Answers

If you want to share correct answers to the Always, Sometimes, or Never True statements, now would be a great time to do so. Don't feel like you have to, though, especially if you think your students have a good understanding of the information. Also, keep in mind that there is not a single example or counterexample that is perfect for each statement, so you cannot give 'correct' answers without taking away some of the ownership of thoughts that students provided. Use **slides 10–17** to reveal the answers.

Evaluate

Go to **slide 18.** Replay the video from the Engage section comparing a black hole to the sun.

Ask students to get out a sheet of paper, and then share the following questions on **slide 19:**

- Based on what you have learned, what **claim** can you make about the gravity of a black hole versus the sun?
- What **evidence** do you have to support your claim?
- What reasoning (supporting details or assurance) do you have to support your evidence and claim?

After they've had time to think about these questions, ask students to write a Claim, Evidence. Reasoning (CER) statement that summarizes their answers to the three questions. If students are struggling, prompt them to look back at the data from the Gravity Bucket Lab, the data tables of the planets in the Gravity Comparative Analysis, and their responses to the Always, Sometimes, or Never True statements.

Once students have written their CER statements, they can turn them in for you to use as a formative assessment to determine their understanding of the content and what concepts need additional clarification in future lessons.

Resources

- K20 Center. (n.d.). Always, Sometimes, or Never True. Strategies. https://learn.k20center.ou.edu/strategy/145
- K20 Center. (n.d.). Bell Ringers and Exit Tickets. Strategies. https://learn.k20center.ou.edu/strategy/125
- K20 Center. (n.d.). Claim, Evidence, Reasoning (CER). Strategies. https://learn.k20center.ou.edu/strategy/156
- Puiu, T. (2017, March 16). The mass of a supermassive black hole relative to the sun explained in one crazy GIF. ZME Science. https://www.zmescience.com/space/supermassive-black-hole-vs-sun/