

5E Integrated STEM Lesson Plan – Template

Lesson Title: Space Bones

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Topic: Distance between two objects, and the mass of two objects affect the gravitational pull between two objects. Mass remains the same on different planets, but weight changes.

Targeted Grade Level: Grade 7

Time Needed: 3-4 days

Subject Integration: Science, Engineering, Math

Justification: Science: The subject of science and the gravitational force is a main focus of this lesson. Students will be learning about the effects on the gravitational force, and how mass and weight are determined on different planets. Engineering is integrated in this activity when students are tasked to create a space treadmill to ensure that astronauts do not float away in outer space. Math is used in this activity when students are asked to calculate their weight, and the weight of different objects on different planets. Also, math is integrated in this activity when students identify relationships between mass, distance, and the gravitational force (direct/indirect relationships).

Standards:

<u>NGSS Performance Expectations</u>		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
<i>Engaging in Argument From Evidence</i>	<i>Types of Interactions: Gravitational forces are always attractive. There is a gravitational</i>	<i>Systems and System Models</i>

	<p>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.</p> <p>Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively).</p>	
<p style="text-align: center;">Common Core State Standards:</p> <p>ELA: RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (<i>MS-PS2-5</i>)</p> <p>WHST.6-8.1 Write arguments focused on <i>discipline-specific content</i>. (<i>MS-PS2-4</i>)</p>		

Measurable Student Learning Objectives: Students will be able to identify the relationship between mass of two objects and the gravitational force between those two objects. Students will be able to identify the relationship between the distance between two objects and the gravitational force between those two objects. Students will be able to compare the weight of an object on Earth to the weight on other planets. Students will be able to design a treadmill for astronauts to use in outer space (or the planet of their choice).

Nature of STEM: This lesson addresses the nature of science tenets: Scientific Knowledge is Based on Empirical Evidence: Science knowledge is based upon logical and conceptual connections between evidence and explanations.

Engaging Context/Phenomena: The hook for this lesson will be the video “ Chris Hadfield Brushes his Teeth in Space” to encourage students to think about gravity and what weight means.

Data Integration: Students will be analyzing data in this activity. Students will be using NASA Data from the Jet Propulsion Laboratory on the different planets, including their mass, radius, and distance from the sun.

Differentiation of Instruction: This lesson can be differentiated in a number of ways. There will be handouts and written instructions for students in order to provide further scaffolding for those who may need it. There will also be different goals that students will be expected to achieve based on their ability. For example, students will not need to determine the weight of more than one object on the different planets, while others may be required to take the lesson one step further and determine the planet the object is on by its weight and their knowledge of calculating weight. Students will also be given an equation sheet to use for the weight calculations.

Real-life Connection: The real-life connection to this lesson will be shown in the beginning with the astronaut video, and when students are asked to find their OWN weight on the different planets. This is connecting their personal characteristics to the content.

Possible Misconceptions: The possible misconception here is that gravity will remain the same because students are very used to gravity on Earth (what goes up, must come down). Students also tend to think that there is zero gravity in outer space in places like the moon, when the moon actually does have gravity, it is just less than Earth’s. Students tend to believe that mass changes when an object is on different planets, when in fact it stays the same. Finally, students tend to believe that gravitational forces only occur between large objects, like the Sun and the Earth, when gravitational forces occur between any two objects.

Lesson Procedure:

5E Model	5E Objectives
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<p>Engage</p> <p>What affects the force of gravity? Weightlessness video</p>	<p>Procedure: Students will watch the video “Chris Hadfield Brushes his Teeth in Space.” They will be asked to write down what they know about gravity. They will also be asked to describe what factors affect the force of gravity on an object. How does this affect weight?</p> <p>Modifications Students will not be required to answer all three jamboard questions. Students may answer at least one (1) jamboard slide.</p> <p>Formative/Summative Assessments There will be a jamboard placed on the board for students to answer the three questions mentioned in the procedure. A class discussion will be conducted where students discuss their answers as a formative assessment.</p> <p>Resources https://www.youtube.com/watch?v=3bCoGC532p8 https://jamboard.google.com/d/1e6-HXmdJHA2rHMGAZW0W49nL-7rdMODZsAHK6Ngcwo0/edit?usp=sharing</p>
<p>Explore</p> <p>Gravitational Force Gizmo</p> <p>Gravitational Force Jamboard</p>	<p>Procedure: Students will complete the Gravitational Force Gizmo - where they will observe how mass and distance between two objects affects the force of gravity. Students will draw conclusions that increasing mass will increase the force of gravity. Increasing the distance between two objects will decrease the force of gravity. In this activity, students will come together and discuss their findings in the Gravitational Force Gizmo Activity. They will once again use the jamboard slides to convey their understanding of the effect of mass and distance between two objects on the force of gravity.</p> <p>Modifications Students will be able to manipulate the mass and distance between two objects to observe its effect on the gravitational force. This is a good visual for students to observe these relationships. Students will be given a vocabulary worksheet to help them identify direct vs. indirect relationships as a guide. Some students will also be given the task of answering only questions 1-4 on Activity A and 1-5 on Activity B, and the summary questions.</p> <p>Standards Addressed 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.</p>

	<p>Formative/Summative Assessments Students will complete a series of questions based on the activity which are linked below in the document below.</p> <p>Resources https://www.explorelarning.com/index.cfm?method=cResource.dspDetail&ResourceID=411</p> <p> Gravitational Force Gizmo Activity :</p> <p>https://docs.google.com/document/d/18AVgwPIhI4E9RaKaA7RXBWpltCaNfY1Y4INpV_ejKp4/edit?usp=sharing</p>
<p><u>Explain</u></p> <p>Mass and Weight Discussion & review of Mass and Weight Gizmo</p>	<p>Procedure: Students will then learn about the vocabulary word weight, and how the weight of an object is equivalent to their force of gravity. Therefore, they will make the connection that increasing mass, and increasing distance between two objects will affect the weight of an object. Teacher will show the students the Mass and Weight Gizmo as a visual aid, and they will observe how the mass stays the same, while the weight changes on different planets. Teacher will have the students look at the JPL data/planetary fact sheets for different planets and discuss which planets have the greatest gravitational force, and which have the smallest gravitational force, based on their mass. Finally, teacher will give students the weight formula so they can calculate their weight on different planets.</p> <p>Modifications Teacher will provide students with a handout of JPL data/planetary fact sheet that has only the specific needed to determine the force of gravity (mass, diameter)</p> <p>Standards Addressed 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.</p> <p>Formative/Summative Assessments: Exit ticket for different weights on planets</p> <p>Resources</p>

	<p>https://www.explorellearning.com/index.cfm?method=cResource.dspView&ResourceID=653</p> <p>Guided notes:</p> <p>https://docs.google.com/presentation/d/17H1vuw56MfimZj-tXuFqMloMAJz0jn1eF6Y2YJG6R2c/edit?usp=sharing</p>
<p><u>Elaborate</u> Treadmill Activity</p>	<p>Procedure: Students will be instructed to design a treadmill for outer space that will ensure the astronaut does not float away (or stay stuck to the treadmill, depending if they choose another planet in outer space). Then, show video of the treadmill on the ISS and have students compare and contrast their designs.</p> <p>Modifications Outlines of treadmills will be available for all students who may need it. Students will be able to create digital versions of the treadmills or can write a descriptive paragraph instead of drawing.</p> <p>Formative/Summative Assessments: Evaluate treadmill designs for completion</p> <p>Slides 15-18</p> <p>https://docs.google.com/presentation/d/17H1vuw56MfimZj-tXuFqMloMAJz0jn1eF6Y2YJG6R2c/edit?usp=sharing</p>
<p><u>Evaluate</u> Mass and Weight Activity</p>	<p>Procedure: Students will then use their JPL data, along with the data provided in the worksheet, to determine the weight of objects on different planets.</p> <p>Modifications Include equation sheet with a practice problem on it that breaks down the steps of calculating weight, print out JPL data for students to have on a separate worksheet</p>

	<p>Standards Addressed 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.</p> <p>Formative/Summative Assessments List of assessment questions are located on the mass and weight activity sheet.</p> <p>Resources 📄 Mass and Weight : https://drive.google.com/file/d/1kPel39xDJbdlu11uguhmBGtIB6pVJL2z/view?usp=sharing</p>
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Teacher Background: In the past, I have completed this lesson using a Nearpod lesson format. That provides students with an interactive learning experience, with embedded videos, questions, and polls. Teachers should have knowledge of Nearpod, OR, they can adapt this lesson to Google Slides and Jamboard. If so, teachers should have knowledge of Jamboard. Teachers should have knowledge of the gravitational force, and how the body is affected when it travels to outer space, with less gravity.