**Lesson Number 3: Phet Expert**

**Problem statement:** Space Junk is a hazard to space travel and satellites in our orbit. Having a firm understanding of gravitational forces and orbits will allow students to better understand the environment in which space junk dwells in.

**Learning objectives:** Students will document their understanding of gravitational forces and orbits by drawing scientific diagrams.

Students will explore the Phet simulation to determine how gravity and orbits function. They will explore the relevance of changing gravitational forces with various orbiting objects in the Phet simulation.

**Lesson standards (NGSS, CCSS, CTE):**

NGSS:

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

CTE:

1.3: Investigate and Think Critically:Research, manage and evaluate information and solve problems using digital tools and resources.

**Soft skills:**

* *Critical Thinking* in investigating the simulation, changing variables and so on

**Locally and/or personally relevant for students:**

Almost everyone utilizes cell phones this day and age or knows someone that does. If students have ever wondered how their cellular devices operate then this lesson plan will peak their interest. Students will be introduced to how satellites function and how they navigate in space. Students may also draw an overall connection to the unit lessons in making the connection to how satellites may become space junk over time.

**Connections to career and educational pathways:**

This unit lesson plan delves into careers surrounding computer simulation that apply concepts pertaining to various fields including math, science and engineering. Some examples of softwares that perform modeling abilities include but are not limited to C++ programming, MatLab, Pro Model and R Simulation Software. Students are typically exposed to a variety of these programs in their undergraduate academic careers pertaining to STEM. Refer to the Career Connections section of the guidebook for real world examples of individuals in these fields.

**Materials:**

[**Phet Gravity Simulations**](https://phet.colorado.edu/en/simulation/legacy/gravity-and-orbits)

Space Junk Summary Table from previous lessons

**Lesson preparation:**

In order to access the free printable materials for this lesson, you will need to sign up for a PhET account: [https://phet.colorado.edu/en/register?dest=%2F\](https://phet.colorado.edu/en/register?dest=%2F%5C)

Then you can print the Gravity and Orbits teacher instructions and students packets from Emily Moore, Kathy Perkins, Christine Denison, and Trish Loeblein.Then you will want to spend time playing with this PhET simulation yourself. You will want to understand the various ways you can manipulate the simulation before having your students show you what they can do as well.

**Time required:**

1-2 hours approximately

**Grouping of students for instruction:**

Students can be seated in small groups, but for this lesson each student will ideally have a laptop, or desktop individually. If needed students could work in pairs. Students will need to consult with a partner, and the whole group.

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

**Understanding the Problem**

|  |  |
| --- | --- |
| **Teacher** | **Student** |
| “Now that you have had a chance to explore how space junk is a problem with the game badge, and you’ve done some research about space junk for your research badge, you now know some interesting details about this problem. Can you name some of the weirder types of space junk? How fast it can move? Etc.”  Allow students report for a bit on what they learned so that any absent students, or students who didn’t finish the research badge can reconnect with the topic.”  (5 mins) | Students will raise hands to share prior knowledge of odd space junk, and various interesting facts they learned in the research badge. Such as some weird space junk: pizza, dead animals, legos, etc.  Space junk moves at ~17,500mph! |
| “Let’s keep track of our reflections on what we’ve learned on our summary table for the research badge.”  Take student responses for observations made, learning notes, and connections made to the space junk problem. Document these for all students to copy or add their own thoughts to.  (5 mins) | Students will enter notes on their own summary tables. |
| “Today it is time for you to venture out to space! Except this time it will be through the computer. We have to make sure you are back in time for lunch (recess etc). There is an online simulation where you will be able to interact with the a variety of elements in space. As part of your training, you will need to record in your logs about how the various parts interact with each other.”  Hand out the training packet.  (1 min) | Students will put their name on their own training packet, the Gravity and Orbits packet. |
| Using google classroom links, or a shortened url such as:  <https://goo.gl/trkacs>  Discuss how there are no specific directions involved with the phet simulation. Model a few of the basic functions, such as turning on the gravity force, velocity, path, and grid lines. Then allow students to discover on their own some of the features of the simulation. Give them about 5 minute to explore independently. Monitor around the room to see what they are discovering.  (5 mins) | Students will get on the phet simulation and begin to explore the tool. Be sure all students are first accessing the “model” version of this simulation. They can go to the “to scale” version as an extension. |
| Ask students to share ways they manipulated gravity, orbits of earth, the moon, and satellites etc. Make sure they have at least covered changing the mass of earth, moon etc. as well as turning gravity on and off, actually moving the orbiting object by grabbing Earth and moving it’s orbit further out for example.  (2 mins) | Students can either share by raising their hands and giving the class instructions on how to use the simulation, or can come up and demonstrate. |
| “Now that you are becoming comfortable with the simulation, make sure you have begun to answer the questions in your training packet.”  (10-20+ mins) | Students will work through this packet at their own pace. As needed, stop to have group conversation and provide support to those student who might be challenged or off task. |
| Monitor the room, taking anecdotal notes on how students are manipulating gravity or orbits. Success criteria: Are student manipulating the variables? Are they writing down the observations based on their experiments? Another skill is to practice drawing scientific diagrams of this understanding.  (5-10+ mins) | Students should be continuing to document their understanding with writing and drawings. |
| “I know it isn’t easy to stop engaging with this simulation, but our time is up for today. Please close your computers. Thankfully, along with other resource suggestions, the PhEt simulations are included in your guidebook. Please turn to the “PhEt badge” page in your guidebook and answer 1 or 2 of the following questions as your exit ticket today:   1. What did you learn about gravity that is new to you? 2. What is an orbit? 3. What is a satellite? 4. What was one creative way you tried altering gravitational force?”   (5-10 mins) | Students will answer the reflective guidebook questions to demonstrate learning for their PhEt badge. |

**Accommodations:** Students can partner up with other students for this lesson as needed. Reducing the number of questions all or some of the class needs to answer in class is reasonable. Or giving more time for written responses outside of the science lesson time would be appropriate.

**Extensions:** Students can explore further with the “to scale” version instead of the “model” version of the PhET simulation.

**Assessment:**

Students will be participating in the PhET simulation, and working to complete the training packet. This document, participation in class conversations, and anecdotal records should guide your formative understanding of what they know.

Completion of their ongoing Summary Table document should continue to guide your formative assessments of this unit.

Completion of their guidebook page will earn them their “PhEt badge” for today, and provide more formative assessment information as well.

**References/Resources:**

**For Class:**

* [**https://phet.colorado.edu/en/simulation/legacy/gravity-and-orbits**](https://phet.colorado.edu/en/simulation/legacy/gravity-and-orbits)
  + ***Requires account set up:*** [https://phet.colorado.edu/en/register?dest=%2F\](https://phet.colorado.edu/en/register?dest=%2F%5C)
* [**https://phet.colorado.edu/en/contributions/view/3401**](https://phet.colorado.edu/en/contributions/view/3401)

**For Guidebook:**

* <https://phet.colorado.edu/>
* <http://www.google.com/sky/>
* <https://space.jpl.nasa.gov/>
* ***Youtube:*** [What the Physics?](https://www.youtube.com/channel/UCj1gfrsi8H8zTrmR0ft1Kjw)