**Mission: Space Junk**

**Grade level(s)**: 5th grade

**Subject(s):** Science, Math, Engineering, Computer Science

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**Problem Statement:**

[Problem statement references clip from movie Gravity, in which the lead character, *Dr. Ryan Stone, is a medical engineer on her first shuttle mission. During a routine spacewalk with her fellow engineer, disaster strikes when the ship is hit by high speed debris!* Link [here](https://www.youtube.com/watch?v=prlIhY3e04k)]

Man-made objects have been entering the space surrounding Earth since the first rockets blasted off in the mid-20th Century. Many countries have contributed to the countless satellites, rockets, and space missions into Earth’s orbit. What tends to be overlooked is the enormous amount of debris left out in space by these scientific endeavors. Each and every rocket and/or shuttle launched into space litters the Earth’s orbit with “space junk”. Currently, NASA is tracking over 500,000 pieces of space junk varying in sizes ranging from big to small. Space junk can be a hazard to space travel and satellites because it can cause major damage if it collide with spacecraft.

If mankind is to continue space exploration or continue utilizing satellite communications, any space junk bringing risk to these endeavors must be removed from Earth’s orbit. Your team’s mission is to help solve this “space junk” problem. First, your team will study the “space junk” phenomena, then design a mechanism for removing it from Earth’s orbit.

Upon completion, your formal proposal should include the following elements:

* An identified solution to the space junk issue
* A physical mock up of the identified solution to the space junk issue
* Rubric score identifying how space junk design scores based off defined criteria (cost, weight, etc)
* Summary of test redesigns
* Summary of test results/data

*We do our best to help Mother Earth, but now we are needed to help Earth’s orbit!*

**Conceptual Storyline:**

The focus of this curriculum will be on the removal of space debris in Earth’s orbit. Students will challenge their imagination in order to consider the realities of a problem that has yet to have a formal solution implemented. Students will be familiarized with concepts pertaining to gravitational force and how satellites orbit. The unit overview below is set to allow students to go through multiple iterations of the Engineering Design Process (Ask, Imagine, Plan, Create, and Improve). The unit will launch with a movie clip from Gravity, in which students will develop a concept of the space junk problem. Once students perform preliminary research into space junk, they will have the knowledge to start identifying a fix for the problem. The unit lessons will entail students working in groups to identify a solution to dealing with space junk, and designing a model that does exactly this. Students will be confined to a budget and size constraints in development of their product. After models are built and tested, students are to then determine improvements in order to produce a final design model that still meets the design criteria, but that can also excel in test performance. Groups will spend the final two unit lessons to present their models and analyze how the design criteria was met.

**Table of Content/Overview of Unit**

Prior to this unit, students should have seen lessons on the following topics:

* Basic knowledge about gravitational force
* Experience working in teams
* Some exposure to technical writing

During the first half of the unit lessons, students will learn about gravitational forces and the space junk phenomena. In the later half of the unit lessons, students will then design, construct, and test a model to solve the ‘space junk’ problem using the steps of the engineering design process. Below is a summary of each unit lesson plan:

1. ***The Game Maker:*** This lesson is about students brainstorming where space junk comes from, and why it is a problem. Students will use basic programming skills in designing and playing their original space junk game as a team.
2. ***The Researcher:*** Students will work together to navigate through various resources providing information about space junk, in which students are to compile their findings.
3. ***PhEt Simulator***: In this lesson, students will review concepts regarding gravitational forces and orbits in being able to connect how space junk maneuvers in space.
4. ***Materials Specialist***: In this unit lesson, students will research the various materials and associated properties that can comprise space crafts; students will also start reviewing what materials they will use to construct a space junk removal product.
5. ***Engineering Designer***: In this unit lesson, students collaborate to come up with ideas for building a space junk removal product; students will be given a budget, various materials and constraints in building their model.

1. ***Master Builder***: In this unit lesson, students take the plans developed from the previous lesson, and construct their space junk removal product.
2. **Optimizer**: In this unit lesson, students will test and identify ways to improve their space junk removal products.
3. **Presenter**: Students compile all findings from previous unit lessons, and present the final designs of the space junk removal product.
4. ***Analyzer***: In this final unit lesson, students will self assess, analyze their product design, and their overall experience in the engineering process.

**Unit Standards (NGSS, CCSS, CTE):**

Science: Engineering and Design:

|  |  |
| --- | --- |
| 3-5-ETS1-1. | Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. |
| 3-5-ETS1-2. | Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. |
| 3-5-ETS1-3. | Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. |

5th Grade Standard:

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

CCSS:

ELA:

SL.5.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 5 topics and texts*, building on others' ideas and expressing their own clearly.

Math:

[4.NBT.B.4](http://www.corestandards.org/Math/Content/4/NBT/B/4/)

Fluently add and subtract multi-digit whole numbers using the standard algorithm.

5.G.A.1

Graph points on the coordinate plane to solve real world and mathematical problems.

Computer Science:

1B-A-3-7 Construct and execute an algorithm (set of step-by-step instructions) that includes sequencing, loops, and conditionals to accomplish a task, both independently and collaboratively, with or without a computing device.

CTE:

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

**Soft Skills:**

Creativity and innovation:

* Think creatively: ie brainstorming
* Work creatively with others
* Implement innovations

Critical thinking and problem solving

* Reason effectively
* Use systems thinking
* Make judgements and decisions
* Solve problems

Communication and Collaboration

* Communicate clearly
* Collaborate with others

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

Not just a movie (Gravity), this is a real life situation!

If there is too much space junk it will interfere with satellites which would potentially deny their access to cable TV, google earth, banking transactions, the ability to fly, use phones,

**Connections to career and educational pathways:**

This unit comes with a “Space Cadet Academy Guidebook” which provides students with a place to answer exit ticket reflection questions, get career connection information, and additional resources on the badge lesson topic.

Additionally teachers may want to make a Careers in STEM poster to go along with these lessons. As they are working on each lesson together teacher and students can create a list of careers associated with each lesson. These could include, but are not limited to:

* Computer programming
* Mechanical, aeronautical, or computer engineer
* Astrophysicist
* Astronaut and support staff
* Satellites division of aerospace engineer
* Meteorologist
* Materials scientist
* Aircraft Builder
* Quality Specialist
* Process Engineering

**Appendix:**

Refer to the Appendix for additional resources utilized in each or many of the lessons:

1. *Space Cadet Academy Guidebook:* This resource is used by students in each lesson to reflect on lesson content, assess teamwork, learn about career connections, and resources connected to the lesson. This document is available in color or black and white. It should be printed double sided, on the short edge for best results. There is also a Guidebook notes page for further explanations on usage of this resource.
2. *Guidebook Reflection Questions:* This document provides reflection questions for each lesson that students will choose from for their exit ticket responses.
3. *Group Consensus Protocol:*the expectations for students in their teamwork.
4. *Space Junk Summary Table:* this document is used to summarize student observations, learning, and connections in each lesson. *Participation Quiz:* these guiding questions can be used to facilitate a formative participation quiz in lessons 5-9 at teacher discretion.
5. *Role Cards and Job Description Cards:* these job cards are used to keep students on task, and focused on their role during a period of time in class, for game play they will rotate jobs, laminating them is a good idea if possible. Role cards are used for game play and job description cards are used for all other group lessons.
6. *Bonus Pages:* this lesson also has “badge” stickers, images, and a binder cover etc. for teachers if they would like to use them.
7. *Photos:* this document provides photo references for lessons.