Space Odyssey Making Challenge: Mission Mars

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Target Grade: 5th Grade, Science

Time Required: 12 Days (eight 60 minute classes and four 90 minute classes)

Standards

Common Core State Standards and Next Generation Science Standards (NGSS):

- RI.5.7: Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question or solve a problem efficiently.
- W.5.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- W.5.2C: Link ideas within and across categories of information using words, phrases, and clauses
- 5-ESS2.1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and atmosphere interact.
- 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.

Lesson Objectives

Students will:

- Compare and contrast geosphere, biosphere, hydrosphere, and atmosphere interactions on Earth and Mars.
- Identify the ways in which the presence or absence of different resources in various subsystems hinder the development of a Mars colony.
- Design and build a prototype to address an environmental concern caused by the subsystems on Mars or subsystem interactions on Mars that prevent the development of a Mars colony.

Central Focus

In this lesson, students will develop an understanding of Earth's four spheres, or subsystems. Students will analyze how these subsystems interact and impact life on Earth. After developing an understanding of Earth's spheres, students will identify how the subsystems and subsystem interactions found on Earth differ from those on Mars and how these differences hinder the development of a Mars colony. Working in teams, students will then develop a prototype that would address a problem created by the subsystems on Mars that hinders the development of a Mars colony.

Key Terms: planets, NASA, Earth, Mars, ecosystem, geosphere, biosphere, hydrosphere, atmosphere, Engineering Design Process

Background Information

Students should have some understanding of Earth's spheres, the lithosphere, biosphere, hydrosphere, and atmosphere. The lithosphere, also known as the geosphere refers to the rock, soil, and sediment that makes up Earth's land. The biosphere refers to where all the living things on Earth are. The atmosphere refers to the gases surrounding the Earth. The hydrosphere refers to the water that is found on Earth. See an example of these different spheres in Figure 1 below. They should have relative knowledge of different climates on Earth and a general understanding on where these climates are and common features of them. Students should also have knowledge about the other planets in our solar system and, more specifically, that Mars comes after Earth in distance from the sun.

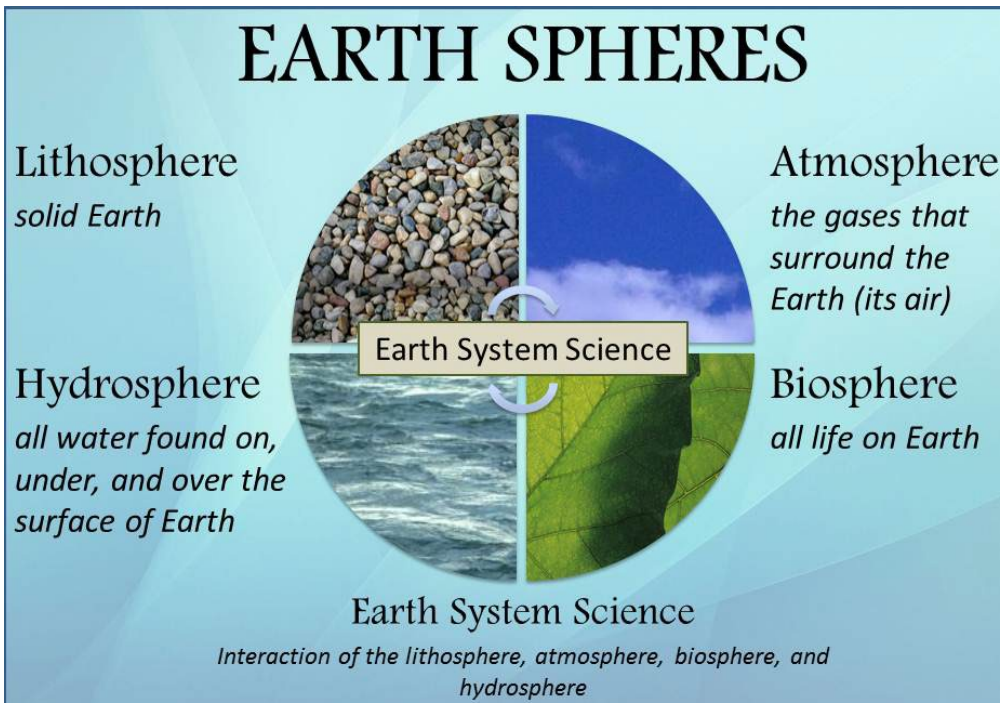


Figure 1: https://fitz6.wordpress.com/2016/11/10/thursday-nov-10th-what-are-the-characteristics-of-the-earths-spheres/

Materials

- Plastic straws
- Cardboard
- Rubber bands
- Paper clips
- Duct tape
- Felt
- String
- Cotton balls
- Pipe cleaners
- Construction paper
- Computers with internet access
- Digital Resources:
    - Mission Mars Video https://youtu.be/DEF3Qj7ntpY
    - Crash Course Kids: Four Spheres Part 1 and 2 Videos https://www.youtube.com/watch?v=VMxjzWHbyFM https://www.youtube.com/watch?v=UXh_7wbnS3A
    - Mars.NASA.gov: Mars Subsystems Website https://mars.nasa.gov/programmissions/science/
    - Mars.NASA.gov: Timeline of Mars Exploration Website https://mars.nasa.gov/mars-exploration/timeline/
- Printable Resources:
    - The Four Spheres of Earth
    - Sphere Interaction
    - Spheres and Systems on Mars
    - Mission Mars Proposal Packet
    - Mission Mars Proposal Cost Calculations
    - Meeting the Mission Mars Objective
    - Engineering Design Process Handout
    - Vocabulary Cards
    - Informal Project Proposal Presentation Rubric
    - Project Reflection Presentation Rubric
- Various tools for testing prototypes (dependent on the prototypes students develop) This could include a
    - Fan
    - Hairdryer
    - Water
    - Watering can
    - Sand

  - Clay
- Makedo tools (optional)
  - These can be found at the following link: https://www.make.do/collections/all-products
- Various Makerspace items for teacher modeling of real world solutions and testing prototypes
  - Makerspace Supply Area in photos below
  - Examples of these items are: cardboard, blocks/Legos, fabric, recycled materials, etc..

Instruction

Day 1: 90 minutes

Introduction:

- Show students the Mission Mars Video.
  - https://youtu.be/DEF3Qj7ntpY
- As a whole class, identify the objective presented in the video.
- Then, in small groups, have students brainstorm the steps they must take to meet the objective.
- As a whole class, discuss the ideas students came up with in their small groups. Create a master list of steps students will follow to meet the objective (see Meeting the Mission Mars Objective for guidance).
- Explain that by completing these steps, students will meet the learning objective and present each learning objective to students.
- Introduce the essential question that will be guiding student learning throughout each part of the project.
  - Essential Question: How does the interaction of different spheres or subsystems impact and sustain life?
- Exploration:
  - Show the Crash Course Kids 6.1 Four Spheres Part 1 and 2 to students.
    - https://www.youtube.com/watch?v=VMxjzWHbyFM
    - https://www.youtube.com/watch?v=UXh_7wbnS3A
  - While watching the videos, students should take notes on their The Four Spheres of Earth note page.

        - Identifying the 4 spheres of Earth
        - Identifying two examples of something belonging to each sphere
    - As a whole class, discuss the 4 spheres and examples of things that belong to each sphere. Have students expand their list of different things belonging to each sphere on their note page throughout the discussion.
    - Then, in partners, have students identify how one sphere might impact another. Provide students with an example modeling through a think aloud. As you conduct a think aloud, model for students how they will complete the Sphere Interactions page and have them take notes along with you in the teacher example square on the page.
        - Tell students that a volcano, which is a part of the geosphere, might impact an ecosystem in the biosphere when it erupts. When volcanoes erupt, they are quite destructive and lava flow can kill plant and animals nearby the eruption. It takes years for the ecosystem to recover.
    - Have students identify how one sphere might impact another with their partner. They should record their example and draw a diagram of their example on the Sphere Interaction page in the Partner Brainstorm Square.

Day 2: 90 minutes

- Review:
    - As a whole class, revisit the ideas discussed in the previous part of the lesson.
        - Have students talk with a partner sharing what they remember from the previous part of the lesson before discussing whole group.
        - Together, identify the 4 spheres and examples of things that are a part of each.
    - Remind students of the example you provided of sphere interactions or subsystem interactions; a volcano; a part of the geosphere, impacting the biosphere.
- Share and Explore:
    - Have students share their sphere interactions partner examples with the class.
    - After students have shared, share a few ways humans have tried to address this negative system interaction.
        - Each student should record a fellow classmate's idea in the Classmate Example square of their Sphere Interaction page as the discussion takes place.
    - Show different solutions that have been attempted to address the sometimes negative impact of subsystem interactions.
        - For example, water filtration for gritty water, dams being built, and barriers to protect against tsunamis, planting trees to block the wind from destroying crops, canals to prevent flooding and channel water.
    - Then conduct a think aloud brainstorming other possible solutions that haven't been tried by using the makerspace to construct a possible solution to the problem.
        - Example: putting a series of trenches around volcanoes

- Research:
    - Have students research with their partner one of the following questions and write a one paragraph explanation using a cause and effect writing structure. Students should also complete their Sphere interaction page by finding one specific example of the sphere interaction they are researching and creating a diagram and description of it.
        - In what way does the hydrosphere impact the biosphere of Earth? How does this impact life on Earth?
            - Possible answer: rainfall or rivers impact forests or farms
        - In what way does the atmosphere impact the geosphere on Earth? How does this impact life on Earth?
            - Possible answer: wind and rain impact mountains or wind impact forests
        - How does the biosphere impact the atmosphere on Earth? How does this impact life on Earth?
            - Examples: plants and air quality
- Explore:
    - Introduce the idea that different planets have spheres that might look very different from ours.
    - Prompt students to think about how Earth would be different if we had no rivers in our hydrosphere.
- Discuss:
    - Facilitate a class discussion around this idea. Discuss what would cause a lack of rivers and the effects of not having rivers as part of our hydrosphere. Guide students to consider the many ways it could impact life on Earth if we had no rivers.

Day 3: 60 minutes

- Review:
    - Remind students of how you ended the previous day's class. Tell them that different planets have different spheres or subsystems that look very different from ours on Earth.
    - Remind students that you discussed what it would be like if we didn't have rivers as a part of our biosphere. Then ask students how life on Earth might be impacted if we didn't have wind as a part of our atmosphere.
    - As a class, discuss possible impacts these changes might have.
- Explore:
    - Have students visit the NASA MARS EXPLORATION science page and gather information about the different systems or subspheres on Mars and how they interact.
        - https://mars.nasa.gov/programmissions/science/

- Discuss:
    - As a class, debrief what students discovered and create a master list of facts about Mars spheres and systems. Students should copy this list down on their Spheres and Systems on Mars page in the left hand column.
    - After the discussion, provide students with private think time to brainstorm the differences between Earth's Spheres and systems and Mars' spheres and systems. Students should record their ideas in the right column of Spheres and Systems on Mars page.

Days 4 and 5: 60 minutes each

- Writing a Proposal:
    - Present students with the Mission Mars Video again and remind them of their Mission Mars Objective.
    - As a group explore the Mars Exploration Program Timeline from NASA and discuss the history of Mars Exploration to connect the project to scientific exploration that has actually been done at NASA.
        - https://mars.nasa.gov/mars-exploration/timeline/
    - Put students into engineering teams of four. Using their notes, have students identify one aspect of Mars' subsystems that would make living on Mars difficult. Have students record this after the problem prompts in their Mission Mars Proposal Packet. Students should identify the cause of the problem and the effect it has or rather the problem it creates.
    - Prompt students to brainstorm with their group possible solutions to the problem and record their ideas in the Mission Mars Proposal Packet after the possible solutions prompt.
    - Ask students to evaluate their ideas and choose what they believe to be there best idea for solving this subsystems problem they have identified.
    - Students should fully explain their solution to the Mission Mars Problem after The Best Solution prompt in the Mission Mars Proposal Packet.
    - Then, students should draw a detailed diagram of their solution, list the materials needed for the project, and the steps they will take to build a prototype to solve the problem on the following pages of the packet.
    - Students should calculate the overall cost of their project using the *Mission Mars Proposal Cost Calculation* page and attach their proposed budget to their *Mission Mars Proposal Packet*.
    - Students should then prepare to present their proposal to the project board or to your class for approval on.

Day 6: 60 minutes

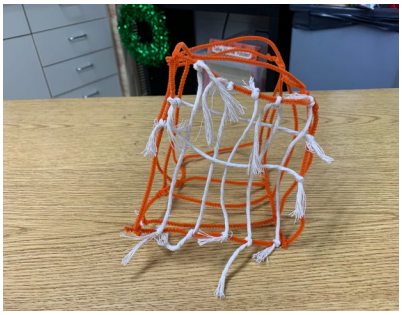
- Proposal Presentations:
    - Have students present their project proposal to the class.
        - Students should describe the following:
            - Problem
            - Possible solutions they considered
            - Solution they chose and why they chose it
            - What the solution will look like
            - How it will be built
            - What it will cost
    - Once approved, have students begin buying and gathering their supplies from the makerspace to build their solution.

Day 7: 90 minutes

- Engineers Design Process:
    - Introduce the engineers design process to students using the handout. Walk them through the steps and identify the steps they have already taken so far during their project. Then, focus on the steps they will need to take over the next few parts of the lesson to complete their project successfully.
    - Provide students with the time and makerspace supplies to build the prototype they designed.

Day 8: 60 minutes

- Invent:
    - Students will spend the day designing and constructing their prototype.
    - Provide students with the makerspace supplies to build the prototype.
    - Be available for questions or guiding comments.



Day 9: 60 minutes

- Test:
    - Once prototypes have been completed, have students design a test that will help them evaluate the success of their design.
    - Students will need to mimic the environmental conditions and actually try to 'use' their prototype in the way that a full scale model might be used to solve the identified problem.
    - Students should document their plan for testing after the testing prompts in their Mission Mars Proposal Packet.

Day 10: 90 minutes

- Have students carry out their test in the makerspace and document prototypes success, challenges they faced, and possible improvements to the overall design after the results and reflection prompts in the Mission Mars Proposal Packet.

Days 11 and 12: 60 minutes each

- Project Presentations:
    - Have students create a slideshow presentation including information about:
        - the Mission Mars Objective
        - the research that influenced their plans
        - the problem they identified
        - possible solutions they discussed
        - the solution they determined would best solve the problem
        - the prototype they designed
        - the budget they proposed
        - the money they actually spent, the test or tests they ran
        - the results of their tests
        - future plans for adjusting or modifying their original design and prototype to better address the problem and support Life on Mars.
        - how they would now answer the essential question.
- As the summative assessment for the lesson, have students present their presentation with their Mission Mars teams.

Extensions After Lesson:

- After students have completed the lesson, they could extend their learning by researching different ideas that have been discussed and tested for sustaining a colony on Mars.
- Students can research the cost of creating a colony on Mars and explore other barriers that have prevented this from happening such as 'land rights' in space.

Differentiation

For students who need ongoing extra support:

- Intentionally partner and group students to provide support for those who struggle with reading, writing, speaking or building.

For students who struggle with writing:

- Provide students with sentence frames for each prompt.
- Allow students to type responses, or use text to speech tools.

For English Language Learners:

- Allow English Language Learners to use bilingual dictionaries.
- Provide students with sentence frames for each prompt.
- Translate key vocabulary into the student's native language.

Assessment

Formative:

- Students will be assessed for understanding throughout the project on the following items based on the rubrics, completion, and participation:
    - Informal Mission Mars Proposal Presentation (for funding)
    - Mission Mars Proposal Packet & Cost Calculations
    - Prototype
    - Four Spheres of Earth, Sphere Interaction, Spheres and Systems on Mars Notes

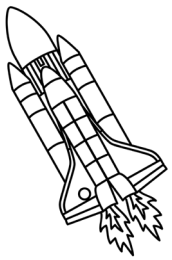
Summative:

- Teacher will check for understanding and accuracy according to the rubric through the Formal Mission Mars Reflection Presentation.

Meeting The Mission Mars Objective

Objective: Solve a problem created by one of the subsystems of an interaction between subsystems on Mars to enable the development of a Mars Colony.

1. Research how life is sustained on Earth.
2. Identify the differences between Earth's resources and systems and the resources and systems on Mars.
3. Identify the environmental factors inhibiting the development of a colony on Mars, and the problems these factors cause.
4. Brainstorm possible solutions to one of the identified problems inhibiting the development of a colony on Mars.
5. Design a prototype to address one of the identified problems and find a solution.
6. Test the prototype.
7. Evaluate the success of the prototype.
8. Present your findings to an audience and reflect on the success of your project.



Name: _____ Date: _____

The Four Spheres of Earth

Define each subsystem, or sphere of Earth and provide examples of elements that fit within each.

Geosphere

Definition:

_____

_____

_____

Things within this sphere:

-
-
-
-

Biosphere

Definition:

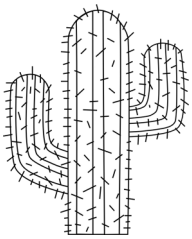
_____

_____

_____

Things within this sphere:

-
-
-
-



Atmosphere

Definition:

_____

_____

_____

Things within this sphere:

-
-
-
-

Hydrosphere

Definition:

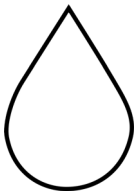
_____

_____

_____

Things within this sphere:

-
-
-
-



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Sphere Interactions

Identify how earth's spheres impact one and other.

Teacher Example

Diagram

Explanation

Partner Brainstorm

Diagram

Explanation

Classmate Example

Diagram

Explanation

Example from Research

Diagram

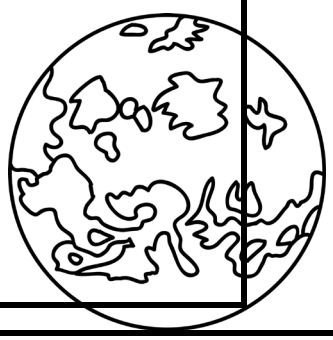
Explanation

Name: _____ Date: _____

Spheres and Systems on Mars

Research Mars and its subsystems. Record your findings, then compare how Mars' systems are similar and different to Earth's.

Subsystems of Mars	Comparing Mars' Subsystems to Earth's
•	•
•	
•	•
•	
•	•
•	
•	•
•	
•	•



Name:_____ Date: _____

Mission Mars Proposal

Earth's top scientists are attempting to create a colony on Mars. The Mission Mars Project aims to sustain life on Mars and open up an entirely new planet of possibilities. Using your research on Mars' spheres and subsystems, identify one part of Mars' environments that hinders the sustainability of a colony on Mars.

Problem: What is the problem?

_____

_____

What causes the problem?

_____

_____

How does the problem hinder the development of a colony on Mars?

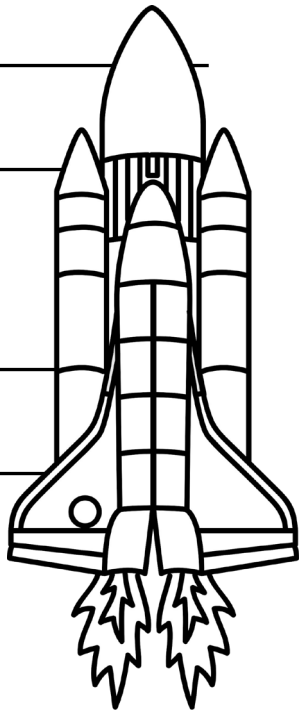
_____

_____

What are the constraints for solving this problem?

_____

_____



Mission Mars Proposal

Possible Solutions: Identify possible solutions to the problem you have identified.

The Best Solution: Identify the solution your team believes is the best for solving the problem.

How will your solution solve the problem?

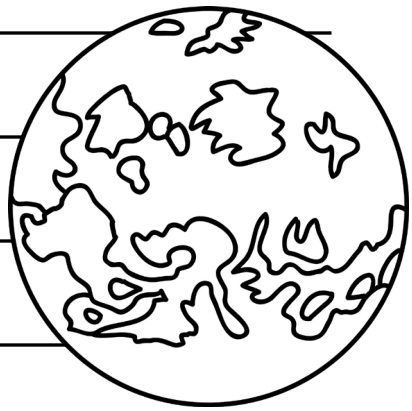
Mission Mars Proposal

Diagram of your solution: Include labels and arrows specifically highlighting the prototype features.

Mission Mars Proposal

Materials: List the materials needed for the project.

Procedure: How will you build your prototype?



Mission Mars Proposal

Test: How will you test your prototype?

What will you test for?

Tools and Materials List: List the tools or materials will you need to conduct your test?

Mission Mars Proposal

Results: What were the results of your test?

Reflection: What did you learn from this experience?

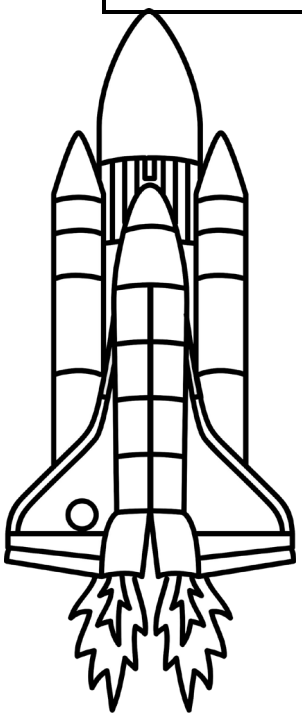
Mission Mars Proposal

What challenges did you face while tackling your Mission Mars project?

How would you improve your prototype for the future?

Mission Mars Proposal: Cost Calculations

Resource	Cost
Plastic Straws (15)	$15
Cardboard (6 in x 6 in)	$15
Duct Tape (1 ft)	$10
Pipe Cleaners (10)	$20
Felt (6 in x 6 in)	$12
Construction Paper (8.5 in x 11 in)	$5
Rubber Bands (5)	$15
Cotton Balls (10)	$20
Paper Clips (5)	$15
String (1 ft)	$10



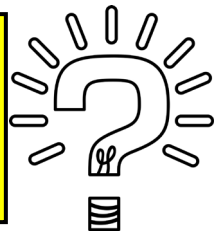
Supply	Cost

Total: _____

Name: _____ Date: _____

Engineering Design Process

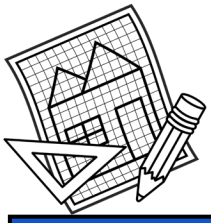
Ask:
Identify the problem
and constraints



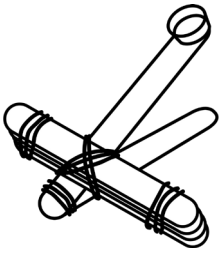
Research:
the problem

Imagine:
possible solutions

Plan:
choose what you
believe is the best
solution

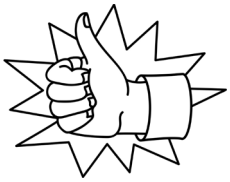


Create:
build a prototype



Test:
and evaluate the
prototype

Improve:
make adjustments or
redesign as needed



Name: _____ Date: _____

Rubric: Informal Project Proposal Presentation

Expectations	1	2	3
Identify the Problem	Student names the problem.	Student names the problem and explains its cause.	Student names the problem and explains its cause and possible effects.
Possible Solutions	Student names one or two possible solutions considered with little detail.	Student names one or two possible solutions considered with detail.	Student names three possible solutions considered with detail.
Chosen Solution	Student names the solution chosen.	Student names the solution chosen and explains why it was chosen	Student names the solution chosen, explains why it was chosen, and why others were not chosen.
Prototype	Student shows the prototype diagram and names it.	Student shows the prototype diagram, discusses a few key features of the prototype and names it.	Student shows the prototype diagram, discusses a all key features of the prototype, materials needed, and the names.
Building Process	Student mentions the building process.	Student gives a general idea of what the building process will look like.	Student gives specific step by step descriptions of what the building process will look like.
Budget	Student names the total projected cost.	Student names the total projected cost and what materials will cost them the most money.	Student names the total projected cost, why they selected the materials they did, and what materials will cost them the most money.

Total: _____

Grade: _____

Name: _____ Date: _____

Rubric: Project Reflection Presentations

Expectations	1	2	3
Objective	Student names the objective.	Student names and explains the objective.	Student names and explains the objective while also elaborating on how the objective is relevant to the project.
Research	Student provides a brief explanation of the research they did.	Student discusses Earth's subsystems and Mars' subsystems.	Student discusses Earth's subsystems Mars' subsystems, their similarities and differences.
Problem	Student names the problem.	Student names the problem and explains its cause.	Student names the problem and explains its cause and possible effects.
Possible solutions	Student names one or two possible solutions considered with little detail.	Student names one or two possible solutions considered with detail.	Student names three possible solutions considered with detail.
Chosen Solution	Student names the solution chosen.	Student names the solution chosen and explains why it was chosen	Student names the solution chosen, explains why it was chosen, and why others were not chosen.
Prototype	Student shows the prototype, the diagram and names it.	Student shows the prototype, the diagram, discusses a few key features of the prototype and names it.	Student shows the prototype, the diagram, discusses a all key features of the prototype, materials needed, and the names.
Budget	Student names the total projected cost.	Student names the total projected cost and what materials will cost them the most money.	Student names the total projected cost, why they selected the materials they did, and what materials will cost them the most money.

Name: _____ Date: _____

Rubric: Project Reflection Presentations

Expectations	1	2	3
Cost	Student names the money spent.	Student names the money spent and if it matched the projected cost.	Student names the money spent, what it was spent on, if it matched the projected cost and why it did or did not.
Test	Student names the test conducted.	Student names the test conducted and provides a short 1 or 2 sentence description.	Student names the test conducted and provides a short 1 or 2 sentence description, other tests that were considered and why the test was chosen.
Results	Student shows the results and gives a brief one sentence summary.	Student shows the results and gives a brief two sentence summary.	Student shows the results and gives a three or four sentence summary identifying trends and possible flaws in the data.
Adjustments & Modifications	Student mentions that things could be adjusted for a more successful prototype in the future.	Student explains two or three ways the prototype could be adjusted in the future.	Student explains two or three ways the prototype could be adjusted in the future and how the adjustments might benefit the design.
Essential Question	Student reflects briefly on the essential question.	Student reflects on the essential question and how it relates to the project.	Student reflects on the essential question how it relates to the project and their life.

Total: _____

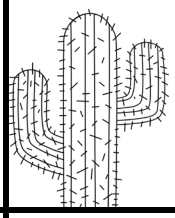
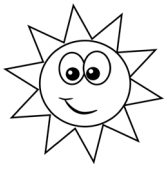
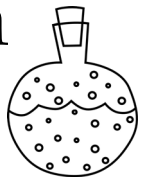
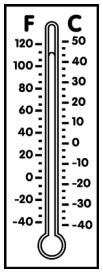
Grade: _____

Comments: _____

_____

_____

_____

 Earth's Spheres	 Hydrosphere
 Geosphere	 Biosphere
 Atmosphere	Systems  
Interaction 	Sustain 
Colony	Resource 

subsystems of earth including land, water, living things, and air	all of water on Earth's surface
the solid portion of Earth	all living things on Earth
the gases surrounding Earth	a set of things working together or that are interconnected
direct contact or involvement between two or more things	to keep or support
a group of people living in a foreign place	a necessary supply or material

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