"Peep Odyssey" Innovation Challenge

Session Time: Twelve, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Understand the importance of professionalism, ethics, and dedication as they relate to all aviation/aerospace operations. (EU4)

Aspire to the highest level of technical proficiency as it relates to flight operations and engineering practices. (EU5)

Gain essential thought processes and life skills, such as good citizenship, critical thinking, informed decision making, which are useful to all learners, whether or not they eventually pursue a career in aviation. (EU8)

ESSENTIAL QUESTIONS

1. Can we ensure human survival in a low-pressure environment, like the one found on Mars?
2. How do engineers consider, design, and test solutions for complex problems?

LEARNING GOALS

Students Will Know

- How to evaluate alternatives in order to select the most promising modification
- Assess the most successful aspects of a prototype and extend these to additional iterations of a product
- How to use engineering practices to solve unique problems

Students Will Be Able To

- *Apply* the practices engineers use to solve a challenge or problem (DOK-L3)
- *Differentiate* and explore alternatives through the creation of prototypes (DOK-L3)
- *Hypothesize* a solution to conduct a successful test (DOK-L3)
- *Synthesize* and share findings in a team presentation (DOK-L4)

ASSESSMENT EVIDENCE

Warm-up
Students write and share their response to a question about what would happen if they were in space outside a protected environment.

Formative Assessment

Teams will defend their SpaceCondo design, present detailed sketches, and seek approval for the materials they plan to use.

Teams summarize the testing of their initial prototype and describe the improvements to be made and solutions they have decided to incorporate.

Summative Assessment
Students will submit their project binders, SpaceCondo prototypes, and make an oral presentation for evaluation.

LESSON PREPARATION

MATERIALS/RESOURCES

Lesson Resources

- "Peep Odyssey" Innovation Challenge Presentation
- "Peep Odyssey" Innovation Challenge Student Activity
- "Peep Odyssey" Innovation Challenge Teacher Notes
- "Peep Odyssey" Innovation Challenge Teaching Aid

Innovation Challenge

- Three-ring binder (per team)
- Several pieces of graph paper (per team)
- 2-3 Peeps (per team)
- One vacuum cylinder and pump (per class)
- Safety glasses
- Suggested materials that a teacher may provide to assist in building prototypes:
    - Pieces of plastic, plexiglass, or other stiff material
    - Scissors
    - Pieces of metal
    - Caulk
    - Duct tape
    - Hot glue gun and glue
    - Foam board pieces
    - Aluminum foil
    - Plastic wrap
    - Wax paper
    - Cardboard or cardstock
    - Any tools required to build the prototypes

SAFETY

- Actively supervise students during the lab or activity. Be ready to offer guidance in situations where safety could be compromised.

- Explain how to safely store sharp objects on an active workspace when they are not in use. Sharp tools should be stored in their protective cases as soon as the students are finished using them.
- When carrying sharp tools, students should keep the sharp end pointed away from themselves and others.
- Guidance for using a vacuum chamber and pump:
    - Use caution when placing objects in the vacuum chamber. Objects can break when exposed to vacuum conditions, sometimes damaging the chamber in the process. Always check to make sure that the chamber is in good condition (no cracks or signs of excessive wear), that seals and gaskets are clean, and that you know how to operate a vacuum chamber.
    - When re-pressurizing the chamber following a test, items in the chamber will not stay where they are when air floods back into the chamber.
    - Take into consideration that the students' SpaceCondo designs may not hold up in a vacuum chamber, so be cautious when removing the contents from the chamber.
    - Be familiar with and practice using the vacuum chamber and pump.
    - Ensure that students use safety glasses when they test their SpaceCondos in the vacuum chamber.
    - Video of how to use a standard vacuum chamber and pump: http://video.link/w/CLJd (Length 3:52)

LESSON SUMMARY

This "Peep Odyssey" Innovation Challenge accounts for the entirety of Unit 9. The innovation challenge scenario is as follows:

- A company called SpaceCondo is working to colonize Mars. Teams of engineers have been assigned the task of designing and building a self-contained dwelling (a SpaceCondo) for Mars's newest residents: a family of Peeps.
- Each student will be part of a team that will design, build, and test a SpaceCondo that will protect an astronaut (i.e., Peep) from the harsh environment that exists on Mars, particularly the extremely low atmospheric pressures.

The vacuum environment that exists in space will be simulated through use of a vacuum chamber and pump.

This innovation challenge will use the engineering practices introduced and used throughout the year. Remind students that similar to practicing engineers, the project will require teamwork as they investigate, evaluate, and develop solutions.

Divide the class into teams of three to five. These teams will work together throughout the entire innovation challenge, which is divided into individual activities. More specific details for the tasks involved to complete the challenge are provided in **"Peep Odyssey" Innovation Challenge Presentation** and **"Peep Odyssey" Innovation Challenge Student Activity.**

The suggested timeline for this innovation challenge is 12 sessions. This is just a guideline. Teachers may choose to adjust this timeline based on class size, work required outside class, presentation schedules, etc. This timeline allows for each team to build/test one prototype SpaceCondo and refine/retest the design one additional time.

Teachers may add additional sessions if time allows.

Session 1	Introduce the Challenge and Define Problems
Session 2-4	Develop and Use Models
Sessions 5-6	Plan and Carry Out Investigations
Session 7	Analyze and Interpret Data, Argue from Evidence, and Design Solutions
Session 8	Modify or Rebuild Models
Session 9	Carry Out Investigation of Modified or New Models

Session 10 Analyze and Interpret Data
Sessions 11-12 Obtain, Evaluate, and Communicate Information

This innovation challenge includes three main project deliverables. Refer to **"Peep Odyssey" Innovation Challenge Teaching Aid** for rubrics to grade each of the deliverables. Teachers should provide copies of these rubrics to students.

1. Project Binder

The student activity packet **"Peep Odyssey" Innovation Challenge Student Activity** will serve as the basis for the project binders. Each team will complete the activity packets and add evidence to their binders as they work through the challenge.

Besides filling out the student activity, students may choose to add additional test summaries, drawings of their models and photos taken at various points throughout the challenge. Students should be reminded that this project binder should provide details, descriptions, data and notes which would allow another team to recreate their prototype and receive systematic and repeatable results.

2. SpaceCondo Prototype

Each team will build and test at least one SpaceCondo prototype. After their initial test, they will use their observations and data and may modify their existing prototype or build a completely new one.

3. Oral Presentation

Teams will prepare an 8- to 10-minute presentation about their SpaceCondo and the solution they created to meet the "Peep Odyssey" Innovation Challenge.

Each team presentation should include the following:

- Description of the problem or need that the model is designed to solve
- Explanation and demonstration of the model(s)
- Explanation and test results from the original design and the inferences that were made to improve the design
- Description of the modifications made between the model iterations and why those changes were made

If possible, invite engineers or STEM professionals from the local community, or other teachers to evaluate the student presentations.

MISCONCEPTIONS

The average atmospheric pressure on Mars is less than one percent of Earth's, and no human could survive there without a pressurized spacesuit or pressurized living space. Mars's atmosphere also lacks a protective ozone layer, which allows much of the sun's dangerous ultraviolet radiation to reach the planet's surface.

Many students have the mistaken impression that there is one distinctive approach common to all engineering design. In reality, engineers employ a broad spectrum of practices.

DIFFERENTIATION

To promote reflective thinking and guided inquiry as they engage in the engineering practices required for this lesson, circulate around the classroom and assist students who might have trouble coming up with probing questions or generating ideas based on evidence. Ask questions that provoke their own ideas for possible answers.

To promote organizational success with long projects, have students set overall goals, as well as smaller goals as steps to reaching them, to encourage consistent, achievable progress, and help students feel confident in their skills and abilities. These can be added to the Project Binder. When learners create their own goals and make a plan to achieve them, they build their capacity to tackle challenges and be successful.

ENGAGE

SESSION 1 - INTRODUCE CHALLENGES AND DEFINE PROBLEMS

Teacher Material: "Peep Odyssey" Innovation Challenge Presentation

Slides 1-3: Introduce the topic and learning objectives for this lesson.

Slide 4: Conduct the **Warm-Up.**

> **Warm-Up**
>
> Show slide four and ask students to individually write their response to the question:
>
> What would happen if you were in space without a suit or anything protective around you?

Answers may include: *Without a suit in space, an astronaut would either freeze or be mummified (from the extreme heat), an astronaut wouldn't be able to breathe and would lose consciousness, or gain severe sunburn from radiation exposure.*

When students are finished writing their response to the warm-up question, ask volunteers to share what they wrote and allow for a brief discussion. Collect student work and grade up to five points based on completeness and participation.

[DOK-L2; *predict*, *summarize*]

Show a short video that explains what happens to the human body in space without a spacesuit.

- "What Happens to you in Space Without a Spacesuit?" (Length 1:53)
  http://video.link/w/wILd

Inform students that as you get higher and higher in altitude above Earth's surface, the more dangerous it becomes for a person to be exposed to the atmosphere. In addition to changes in temperature and air density, the air pressure gets lower with an increase in altitude. This creates a problem for humans if they aren't in a protected environment because of the difference in air pressure between what's inside our bodies and air pressure outside our bodies.

At higher altitudes, air pressure inside our bodies would be much higher than pressure outside. In other words, the outside air pressure would "push" on our bodies less than it would when we were on Earth. Therefore, if not sealed inside a protected environment (a capsule or a suit), our bodies would expand because there would be less pressure being applied on it.

EXPLORE

Teacher Material: "Peep Odyssey" Innovation Challenge Presentation

After the **Warm-Up**, lead a brief discussion about the challenges of living on Mars's surface. The primary focus of the activity revolves around the greatly reduced atmospheric pressure and the devastating effects that such conditions would have on our bodies, but other relevant factors could be raised as well (e.g., lack of food and water, extreme low temperatures, lack of protection from solar radiation, etc.).

Slide 5: Using the vacuum chamber and a Peep, demonstrate what will happen to the Peep when it is exposed vacuum environment.

Using the vacuum chamber in the classroom and a peep, demonstrate for students what will happen to a Peep when it is exposed to an environment that simulates the vacuum in space. Teachers will want to practice this in advance of doing it with students for the first time. A video of this demonstration is also included.

- NASA Implodes Marshmallow Peep for Science (Length 1:01)
  http://video.link/w/FLJd

EXPLAIN

Teacher Materials: "Peep Odyssey" Innovation Challenge Presentation, "Peep Odyssey" Innovation Challenge Teacher Notes, "Peep Odyssey" Innovation Challenge Teaching Aid
Student Material: "Peep Odyssey" Innovation Challenge Student Activity

Explain to students that a vacuum is defined as a space that is entirely devoid of any matter, including air or any gasses. Space is an example of a vacuum environment. In space, a person would swell if not contained in a pressure suit or self-contained environment. Point out that while the surface of Mars is not a total vacuum, the atmospheric pressure on Mars is only a small fraction of that found here on Earth.

Slide 6: Divide the class into teams of three to five. These teams will work together throughout the entire innovation challenge.

Provide each student a copy of **"Peep Odyssey" Innovation Challenge Student Activity** and their team binders. Introduce the scenario for the "Peep Odyssey" Innovation Challenge. Explain to students that they will use engineering practices to complete this challenge.

Slides 7-8: Provide an overview of the engineering practices that will be necessary to complete this challenge.

The diagram on slide eight displays the three spheres of activity for scientists and engineers: Investigating, evaluating and developing solutions. Of utmost importance is sharing with students that they will move back and forth within these three spheres. Their process may be iterative where they are constantly refining their explanations or design.

Teaching Tips

Students often believe there is only one way to design or engineer. Focus on important practices, such as modeling, developing explanations, and engaging in critique and evaluation (argumentation) throughout the "Peep Odyssey" Innovation Challenge. Also, emphasize to students that these practices do not follow any set order and that they often occur in multiple iterations.

Slide 9: Provide an overview of the sessions ahead:

Session 1	Introduce the Challenge and Define Problems
Sessions 2-4	Develop and Use Models
Sessions 5-6	Plan and Carry Out Investigations
Session 7	Analyze and Interpret Data, Argue from Evidence, and Design Solutions
Session 8	Modify or Rebuild Models

Session 9 Carry Out Investigation of Modified or New Models
Session 10 Analyze and Interpret Data
Sessions 11-12 Obtain, Evaluate, and Communicate Information

Teaching Tips

Point out to students that the overview shown here provides some structure to ensure progression until the project is complete, but reiterate that engineering practices do not progress linearly and that they may find themselves repeating certain aspects or engaging in some of the practices in a slightly different order throughout this multi-session lesson.

This lesson may vary in the amount of time it takes to complete it with your students, depending on how engaged they are and what resources they can use to build their "space condo".

Slide 10: Review the design constraints.

Slides 11-14: Provide students with copies of **"Peep Odyssey" Innovation Challenge Teaching Aid,** which includes rubrics for the three main project deliverables. Explain that all three deliverables will be graded.

1. Project Binder

The student activity packet **"Peep Odyssey" Innovation Challenge Student Activity** will serve as the basis for the project binders. Each team will complete the activity packets and add evidence to their binders as they work through the challenge.

Besides completing the student activity, students may choose to add additional test summaries, drawings or sketches of their models, and photos taken at various points throughout the challenge. Students should be reminded that this project binder should provide details, descriptions, data and notes which would allow another team to recreate their prototype and receive systematic and repeatable results.

2. SpaceCondo Prototype

Each team will build and test at least one SpaceCondo prototype. After their initial test, they will use their observations and data and may modify their existing prototype or build a completely new one.

3. Oral Presentation

Teams will prepare an 8- to 10-minute presentation about their SpaceCondo and the solution they created to meet the "Peep Odyssey" Innovation Challenge.

Each team presentation should include the following:

- Description of the problem or need that the model is designed to solve
- Explanation and demonstration of the model(s)
- Explanation and test results from the original design and the inferences that were made to improve the design
- Description of the modifications made between the model iterations and why those changes were made

Each team member should be involved in providing the presentation."

Inform students if there will be engineers from the community or other teachers to evaluate the student presentations. Also encourage the teams to be creative with their presentations.

Slide 15: Direct students to the "Define Problems" section of the **"Peep Odyssey" Innovation Challenge Student Activity** packet.

Each team should make sure they consider each question in this section of the activity packet. Help them complete this section as questions arise. If time allows, ask each team to share their answers with the class. At the end of the session, have students move the relevant information into their binders.

SESSION 2 - DEVELOP AND USE MODELS

Slide 16: At the beginning of the second session, explain to students that each engineering challenge (simulated and real life) involves criteria and constraints. Criteria are the things the object must accomplish to be successful. Constraints are the limitations of the object's design. Show students the SpaceX blooper video linked in this slide, and ask the students to make note of some of the criteria and constraints that SpaceX may have had in designing a recoverable rocket.

- "How Not to Land an Orbital Rocket Booster" (Length 2:08)
  http://video.link/w/DLJd

Possible constraints/criteria include:

1. *The rocket must be recoverable on both land and on an aircraft carrier.*
2. *The rocket must land vertically.*
3. *The rocket must be reusable, with minimum repairs required after each landing.*
4. *The rocket must be heavy and stable enough to not tip off the platform after a water landing.*
5. *There is a maximum budget that the rocket can cost.*

Teaching Tips

After watching the video, help students to understand the importance of creating a plan and testing out designs and gathering reliable data before creating prototypes. Point out the amount of cost, time, and dangers of moving too quickly or relying on incomplete data. Have them revisit their own responses to the criteria and constraints that they face in completing this challenge, and ask them to think about if there are any other criteria or constraints they may not have considered. Remind them that the kinds of failure seen in the video are not uncommon when employing engineering practices to solve challenges like the one they face in this activity, but that the best way to ensure success is to constantly ask questions and seek out additional information. This would be an excellent time to encourage students to conduct any necessary research before (and during) their completion of the next section of the **"Peep Odyssey" Innovation Challenge Student Activity** packet.

After watching the video, direct students to the **"Peep Odyssey" Innovation Challenge Student Activity** and ask them to begin with the "Develop and Use Models" section of the activity packet. Point out to students that they will be working through the items in this section of the activity for the rest of this session, as well as the two subsequent sessions.

Slide 17: Models help engineers explore problems and work toward potential solutions. Through the practice of creating diagrams, models, and prototypes, engineers are able to consider multiple angles, collect data, make observations and predict outcomes.

Before they create their models, students will rank the five attributes according to what their team believes are the most critical for a successful SpaceCondo that will protect their Peep from Mars's harsh environment. Students should include reasoning and justification for their rankings.

Students will create a model by first drawing or creating a diagram that will help them visualize their design. They should consider the attributes they just ranked from most to least important. Students should use graph paper or an electronic design program to make these drawings. They should be very detailed and provide an indication of its scale and the properties of the materials they intend to use. They should also list the tools they will need to construct their model.

When their drawings are complete, they should be prepared to defend their ideas to their teachers and gain approval for their prototype design and the materials their team will use.

Students will then build the physical model, or prototype, of their designs.

Slide 18: Conduct the **Formative Assessment** before students actually begin building their models.

Formative Assessment

Ask each team to present their model concept in a detailed sketch. During the presentation, each team should defend their idea based on open questions from the class and the instructor. Allow up to 10 minutes total for each team to make their presentation.

Once all students have completed the formative assessment, all groups can build their models. All relevant information should be placed in their project binders.

Grade the **Formative Assessment** according to a comprehensive design (up to 4 points), a clear and organized presentation (up to 3 points), and ability to respond to challenging questions (up to 3 points). This assessment is worth 10 points total.

[DOK-L4; *design*, *prove*, DOK-L2; *show*, *summarize*]

EXTEND

Teacher Material: "Peep Odyssey" Innovation Challenge Presentation
Student Material: "Peep Odyssey" Innovation Challenge Student Activity

SESSIONS 5-6 - PLAN AND CARRY OUT INVESTIGATIONS

Slide 19: During the next two sessions, students will plan their investigations and then test how well their models work. Direct students to the "Peep Odyssey" Innovation Challenge Student Activity packet and have them begin the "Plan and Carry Out Investigations" section of the activity packet.

Teaching Tips

Circulate around the room as students begin to formulate their investigation plans. Ask pointed questions to help guide students in their reasoning about the best ways to go about testing their models. They may also need support as they try to decide the kinds of data that should be collected, the specific variables of interest, and how they will record their data.

Once students have developed their investigation plan and it has been approved by the teacher, they may begin conducting their investigations.

Use the vacuum chamber and pump to test each team's prototype. Ensure that several students on each team make notes on the model's performance during the test.

Please take necessary safety precautions. Review the notes and web links in the safety section at the top of this lesson before operating the vacuum chamber and pump.

Teaching Tips

Take advantage of differences in the speeds with which teams work so that while one team tests you can give final approval to another team's investigative plan. Those teams which finish first should begin to brainstorm about what their observations suggest about their models in preparation for the next session. This would be easiest if a teacher's aid or some other adult was available to help monitor the use of the vacuum pump.

At the end of the sixth session, students should make sure to place any relevant information into their project binders.

SESSION 7 - ANALYZE AND INTERPRET DATA, ARGUE FROM EVIDENCE, AND DESIGN SOLUTIONS

Slide 20: Remind students that they will be spending this session analyzing and interpreting their data. Specifically, they will be determining the overall functionality of their models and identifying the aspects of their models that need to be optimized in the next iteration. Have students complete the Analyze and Interpret Data section of the **"Peep Odyssey" Innovation Challenge Student Activity** packet.

Slide 21: Now that students have identified problems with their models, they will create solutions to solve those problems. As the teams derive solutions for their problems, they should take turns presenting their ideas to each other. They should decide as a team which ideas to choose or combine into solutions.

Slide 22: Conduct the **Formative Assessment.**

Formative Assessment

Have each team summarize the testing of their initial prototype by writing their answers to each of the following questions. Have teams write a 3-5 sentence response to each question.

- How did you test your initial prototype?
- Is the prototype functional? What works? What does not work?
- What improvements could be made?

This will provide an opportunity for the students to get another round of feedback and support before moving on to rebuilding and/or modifying their models.

Allow up to 10 minutes for teams to complete the assessment. Collect student work. Score up to 10 points based on thoroughness and answers that reflect having tested their prototype using the principles of engineering design.

[DOK-L3; *apprise*, *assess*, DOK-L2; *summarize*]

SESSION 8 - MODIFY OR REBUILD MODELS

Slide 23: Now that students have decided on how to improve their models, they will redesign and rebuild those models accordingly. Direct their attention to the "Modify or Rebuild Models" section of the **"Peep Odyssey" Innovation Challenge Student Activity**. They should revisit their original drawings (or create new drawings), update their materials list, and decide whether a modification or a complete rebuild is required. Finally, they construct the modified or new model. All relevant materials should be placed in their binders as they complete this section of the activity packet.

SESSION 9 - CARRY OUT INVESTIGATION OF MODIFIED OR NEW MODELS

Slide 24: Have students revisit the investigation plans that they developed. After reviewing their plans, students can begin to conduct the investigations of their modified or new model. They should complete the "Carry Out Investigation of Modified or New Models" section of **"Peep Odyssey" Innovation Challenge Student Activity.**

SESSION 10 - ANALYZE AND INTERPRET DATA

Slide 25: Direct the students to the "Analyze and Interpret Data" section of the **"Peep Odyssey" Innovation Challenge Student Activity.** Once again, they will be determining the functionality of their modified/new models. They will also identify additional improvements that could be made to the model. Once students complete this process, they can spend the rest of the class period beginning to finalize their project binders. It is very likely that they will need to spend time outside of class completing this process.

EVALUATE

Teacher Materials: "Peep Odyssey" Innovation Challenge Presentation, "Peep Odyssey" Innovation Challenge Teaching Aid
Student Material: "Peep Odyssey" Innovation Challenge Student Activity

SESSION 11 - OBTAIN, EVALUATE, AND COMMUNICATE INFORMATION

Slide 26: Each team should prepare an 8- to 10-minute presentation about the way in which they worked through the "Peep Odyssey" Innovation Challenge. Teachers may arrange for several local engineers or other teachers to attend the presentations and evaluate the students. Students will have some time to work on their presentations in class during session 11, but point out to them that they may need to polish the presentations outside of class as well.

The student presentations should include the following:

- Description of the problem or need that the model is designed to solve
- Explanation and demonstration of their models
- Explanations of the test results of their original designs and how they made inferences about how to improve their designs
- Description of the modifications made between model iterations and why those changes were made

Encourage students to be creative in how they design and deliver their presentations. You may suggest the use of video, photos, presentations, and more. Encourage students to add other attention-getters, like a short advertisement, to kick off their presentations. Inform students that they should also be prepared for a brief question and answer session at the end of their presentations.

Once all presentations are complete, have students submit their project binders and SpaceCondo models for the purposes of the Summative Assessment.

For the **Summative Assessment**, use the rubrics found in **"Peep Odyssey" Innovation Challenge Teaching Aid** to grade the three main project deliverables for each team.

Summative Assessment

Once all presentations are complete, have students submit their project binders and SpaceCondo models for the purposes of the **Summative Assessment**.

Use the three rubrics in "**Peep Odyssey" Innovation Challenge Teaching Aid** to grade the three main project deliverables for each team:

1. Project Binder
2. SpaceCondo Prototype
3. Oral Presentation

GOING FURTHER

Teachers may want to add design criteria that will make the challenge even more difficult to solve. One example is that the SpaceCondo must be reusable, meaning that a Peep can be repeatedly inserted and removed through a door. Another idea would be to have students create a budget, give them a certain amount of fake money, and have them buy the parts they would like to use.

Give students an opportunity to display their solutions in school at an engineering "expo." Set up an area in a common space or in the classroom, and invite other students, teachers, and maybe even family members. This will give students the opportunity to gain experience and confidence in explaining their work to others. You may also want to use their prototypes to "recruit" younger students for the class by having the prototypes on display or doing demonstrations.

STANDARDS ALIGNMENT

NGSS STANDARDS

Three-dimensional Learning

- **HS-ETS1-1** - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
    - Science and Engineering Practices
        - Asking Questions and Defining Problems
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.A: Defining and Delimiting Engineering Problems
    - Crosscutting Concepts
        - Systems and System Models
        - Influence of Science, Engineering, and Technology on Society and the Natural World

- **HS-ETS1-2** - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
    - Science and Engineering Practices
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.C: Optimizing the Design Solution
    - Crosscutting Concepts
        - none
- **HS-ETS1-3** - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
    - Science and Engineering Practices
        - Constructing Explanations and Designing Solutions
    - Disciplinary Core Ideas
        - ETS1.B: Developing Possible Solutions
    - Crosscutting Concepts
        - Influence of Science, Engineering, and Technology on Society and the Natural World

COMMON CORE STATE STANDARDS

- **HSG.MG.A.1** – Use geometric shapes, their measures and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
- **RST.9-10.2** - Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- **RST.9-10.4** - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- **RST.9-10.7** - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- **WHST.9-10.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- **WHST.9-10.4** - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- **WHST.9-10.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
- **WHST.9-10.7** - Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- **WHST.9-10.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information

into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

- **WHST.9-10.9** - Draw evidence from informational texts to support analysis, reflection, and research.

REFERENCES

https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-mars-58.html
https://mars.nasa.gov/allaboutmars/facts/#?c=inspace&s=distance https://www.nextgenscience.org/sites/default/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf
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