Maker Mars

Grades: K-12 Prep Time: ~30 Minutes Lesson Time: Varies based on project

WHAT STUDENTS DO: Use the Engineering Design Cycle to develop a prototype to solve a problem.

Students become producers of things in this problem-based engineering design cycle lesson. Students will solve a problem regarding human habitation on Mars using a variety of tools and materials to build a prototype. They will actively engage in creative critical thinking and iterative innovation through collaboration and persistence.

NGSS CORE & COMPONENT QUESTIONS	INSTRUCTIONAL OBJECTIVES
HOW DO ENGINEERS SOLVE PROBLEMS? *NGSS Core Question: ETS1: Engineering Design* **What is a design for? What are the criteria and constraints of a successful solution?** *NGSS ETS1.A: Defining & Delimiting an Engineering Problem* **What is the process for developing potential design solutions?** *NGSS ETS1.B: Developing Possible Solutions* **How can the various proposed design solutions be compared and improved?** *NGSS ETS1.C: Optimizing the Design Solution*	*Students will be able to* **IO1: Create an engineered model limited by criteria and constraints and designed to achieve the task of solving a complex problem**

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1.0 Materials

Required Materials

Please Print:

From Student Guide:

(A)	What is Mars Really Like	– 1 per student
(B)	Credible Sources Evaluation	– 2-3 per group
(C)	Daily Reflection Sheet	– 1 per day/student
(D)	Engineering Design Cycle Defined	– 1 per group
(E)	Engineering Design Cycle Team Summary	– 1 per student
(F)	About your Prototype	– 1 per student
(G)	About the Engineering Cycle	– 1 per student
(H)	About your Thinking	– 1 per student
(I)	Maker Template Rubric	– 1 per student

General Resources:

Maker Education Initiative – Every Child a Maker: http://makered.org/

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2.0 Vocabulary

Criteria	a standard list of "rules" established so judgment or decisions are based on objective and defined ideas rather than subjective ones.
Data	facts, statistics, or information.
Empirical Evidence	knowledge gained through direct or indirect observation.
Engineering	a field in which humans solve problems that arise from a human need or desire by relying on their knowledge of science, technology, engineering design, and mathematics (derived from NRC Framework, 2012).
Engineering Constraints	limits placed on your mission by the hardware you use to accomplish the mission.
Explanations	logical descriptions applying scientific information
Models	a simulation that helps explain natural and human-made systems and shows possible flaws
Observations	specific details recorded to describe an object or phenomenon.
Terrain	a stretch of land, especially with regard to its physical features or geology.

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3.0 Procedures

STEP 1: CHALLENGE EVENT: LIVING AND WORKING ON MARS

Earth supplies humans with everything we need to live. But what about when we leave Earth? NASA is preparing to send people to Mars in the future. NASA scientists and engineers have found ways to support humans away from Earth. A space suit, a space capsule, and the International Space Station are sealed containers protecting humans against the effects of space. These specialized "containers" are designed to provide the protection that humans need to live in space. But what else do humans need to live away from Earth, especially with a three-year round-trip to Mars?

Now, imagine that your classroom has just become sealed with you inside. Nothing comes into the room and nothing leaves the room. Not even air can enter or leave. Imagine that you must remain in the sealed room for two to three years. This sealed room represents a habitat on the surface of Mars.

Your design challenge will be to develop materials to support astronauts living and working on Mars.

STEP 2: WHAT DO WE KNOW ABOUT MARS

Brainstorm what are the requirements you would need to live and work on Mars?

a. What are the temperatures like on Mars?
b. What is the terrain like?
c. What kind of air is there on Mars?
d. Is there water and food on Mars?

Teacher Tip: Have students share what they already know or understand about Mars. Letters (a – d) are provided as additional questions should students struggle coming up with ideas. This is an opportunity to elicit prior knowledge, misconceptions, and unresolved questions. A basic understanding of the Martian atmosphere and raw materials will provide a solid foundation to move the project forward and a stepping-stone for background research to learn more.

STEP 3: BACKGROUND

Provide students with *(A) What is Mars Really Like?* Sheet.

STEP 4: IDENTIFY THE PROBLEM TO SOLVE

- Write a list of as many challenges as you can.

- Share your list with students in your group and listen to the lists they have made.

- Within your group, agree on a list that has the most important challenge as the number one, the next most important challenge as number two, and so on.

- Present your group's list to the class, and explain your reasons.

- Discuss the lists as a class and agree on a list of things necessary for humans to live a healthy life.

- Identify the problem or problems the class/groups will attempt to solve.

Teacher Tip: Keep in mind that the problems can vary. Some can be very large, some more general, and yet others very small and specific. Students could potentially identify a larger problem while individual teams work on smaller problems that are building blocks to solve the larger problem. Identifying the problem to solve will focus the task as students move forward.

STEP 5: MATERIALS AVAILABLE TO SOLVE THE PROBLEM

Provide each group of students a box with a wide variety of materials. Many materials can be purchased at a local store that sells items for a dollar or less. Also consider including items not for purchase, but are recycled or repurposed.

Cutting Tools:
Xacto knife (where age appropriate)
Scissors

Connecting Tools:
Masking or clear tape
Glue

Building Materials:
Pipe cleaners
Soda cans
Used CD's
Fake plants and/or flowers
Styrofoam
Cotton balls
Foil
Plastic containers with lids
Scrubbers
Plastic glassware
(all shapes and sizes)
Fabric
Cardboard
….Use your imagination!!!

Teacher Tip: Students may become frustrated by not being offered the materials they imagined. This is where innovation or even bartering with other groups becomes critical. Some technologies need to be developed in order to move forward or we need to think outside the box using the materials we do have available.

STEP 6: RESOURCES TO LEARN MORE ABOUT MARS

Provide students with *(A) What is Mars Really Like?* Sheet. At the bottom of the sheet is a list of at least three credible sources.

Other possible resources possible for this project:

JPL Mars Maker: http://mars.nasa.gov/mars-makers/
Desert rats: http://www.nasa.gov/exploration/analogs/desertrats/
ISS: http://www.nasa.gov/mission_pages/station/main/index.html#.VMFqksZ4hSs

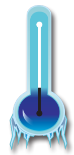
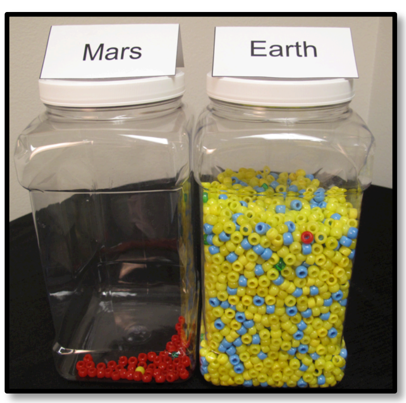
Teacher Tip: Allow the students to do additional research using a *(B) Credible Resource Evaluation* tool to ensure the information is good quality information and doesn't feed into their misconceptions.

4.0 Evaluation/Assessment

Use the *(I) Maker Mars Rubric* as a formative and summative assessment, allowing students to improve their work and learn from mistakes during class.

(A) What is Mars Really Like?

What will people need to survive on the Red Planet?

	Mars is COLD! Temperatures at the equator are between 5 and -85°C (41 to -121°F)
	There is no liquid water on the surface of Mars but lots of water ice at the poles and buried beneath the surface around the other places on Mars.
	There are no gas stations on Mars. How will you get power to run vehicles or provide electricity?
	Gravity on Mars is less than half that of Earth.
	Mars is very dusty! Dust is going to get into everything!
	The air is unbreathable for humans! Martian air is 96% Carbon Dioxide (CO_2) and 0.1% Oxygen (O_2) and there is very little of it compared to Earth. Mars only has 1% the amount of air that Earth does.
Online Resources to Learn More	All About Mars http://mars.jpl.nasa.gov/allaboutmars/ Mars-ePedia http://marsed.asu.edu/marsepedia Red Planet Report http://redplanet.asu.edu/

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(B) Credible Sources Evaluation

NAME:_______________________________

Instructions: Use the following to identify Credible Resources for your research.

What's the difference between a ***primary source*** and a ***secondary source***? For science research, primary sources are original materials not filtered or interpreted by another person or organization. Examples include papers, dissertations, interviews, lab notebooks, study reported in a journal article, and technical reports. A secondary source provides commentary, analysis, discussion, or opinion on the primary source. Examples include review articles, blogs, opinion editorials, newspapers, and news media sources.

URL #1:
URL #2:
URL #3:

Check if Yes ✔			Criteria for a Credible Source
Source #1	Source #2	Source #3	
			1. Is the website an organization [.org], educational institution [.edu], or government [.gov] site? ***If not, see #2, otherwise go to #3.***
			2. Is the website hosted by a ***periodical***, such as a science journal or magazine that publishes science research?
			3. In **Google**, type ***link://*** in front of the home page URL and hit enter. The number in the search result is how many times that page has been linked to as a reference or resource. Is that a big number, such as hundreds of thousands or more? ***If yes, see #4. Otherwise go to #5.***
			4. Investigate the sources (URL's) that have linked to the page. Start at the first link that is not an internal link. Are most of them considered credible sources, such as other .org, .edu, or .gov sites?
			5. Read the "*About us*" section. Is there a list of names for the contributors to the site? ***If yes, see #6, otherwise go to #7.***
			6. Do a search for one of those contributors. Are you able to find information about that person and verify their experience they are advertising on the website? Does their experience match the purpose of the website?
			7. Do links on the page work, meaning they are unbroken?
			8. Is the source a primary source?
			9. Total Score for each resource (total # of checkmarks for each column)

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Check if Yes ✔			Criteria for a ***Non*-Credible Source**
Source #1	**Source #2**	**Source #3**	
			1. Is the website a .com or .net site?
			2. Is the website hosted by a blog, satire site (spoof or parody sites that exaggerate truth using humor), or an opinion editorial page?
			3. Does the site use ***loaded language*** or ***biased language***? (These are words that are chosen to influence the reader to react a certain way that is sympathetic to the author's cause using emotion or stereotypes)
			4. Investigate the sources (URL's) that have linked to the page. Are most of them considered non-credible sources?
			5. Is there a list of sponsors or paid for advertisements for the website? ***If yes, see #6, otherwise go to #7.***
			6. Are the sponsors biased toward one opinion, goal, or cause?
			7. Are links broken and/or has the page not been updated recently?
			8. Is the source a secondary source?
			9. Total Score for each resource (total # of checkmarks for each column)

Now, compare the total checkmarks for each URL. For each URL, put a checkmark in either "*It's Credible, It Might be Credible*, or *It's Not Credible*." You can only choose one.

URL	**# of Credible Marks**	**# of non-Credible Marks**	**It's Credible** (2 or fewer checkmarks in the non-Credible Marks column)	**It might be Credible** (checkmarks are somewhat even in both columns)	**It's Not Credible** (5 or more marks in the non-Credible Marks column)
#1					
#2					
#3					

(C) Daily Reflection Sheet

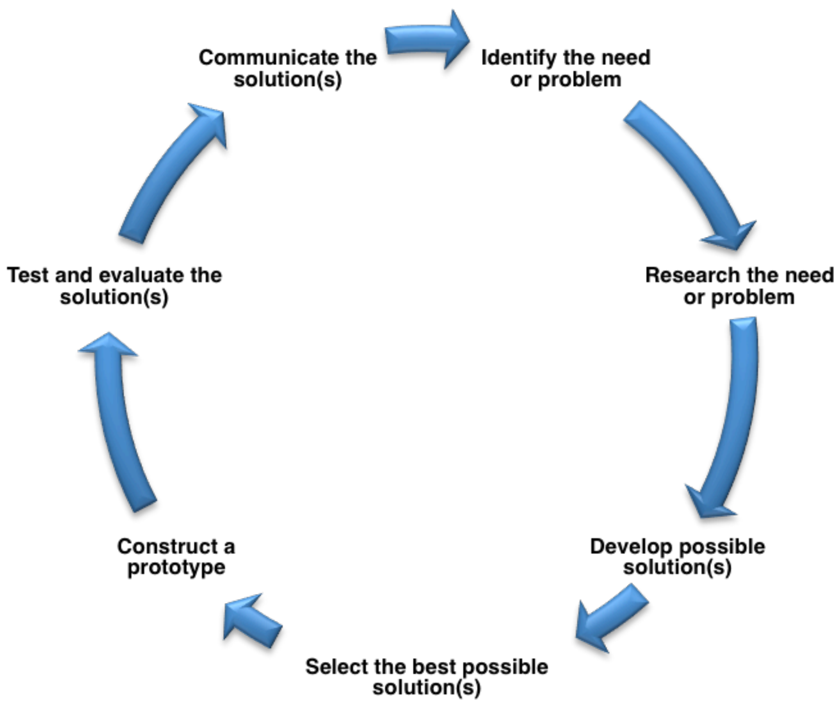
Name: ___________________________________

Challenge Name: __________________________ **Our Problem to Solve**: ________________________________

Meeting #	What obstacle or snag did you solve today?	What new obstacle or snag did you find today?	What is your plan to fix the obstacle/snag tomorrow?

(D) Engineering Design Cycle Defined

This diagram of the engineering cycle is a simplified version of what actually happens in an engineering task. The actual process is much more iterative, often going from later steps in the cycle and circling back to earlier steps as new information is gathered.



Identify the need or problem
- Specify and prioritize requirements and constraints to better define the need or problem

Research the need or problem
- Examine current state of the issue and current solutions
- Explore other options through resources (Ex: Internet, interviews, periodicals, etc.)
- Identify the constraints

Develop possible solution(s)
- Brainstorm possible solutions
- Draw on mathematics and science
- Explain or describe the possible solutions on paper, computer simulation, or 3D model
- Refine the possible solutions

Select the best possible solution(s)
- Determine, using simple analysis, which solution(s) best meet(s) the original requirements

Construct a prototype
- Model the selected solution(s) on paper, computer simulation, or 3D model

Test and evaluate the solution(s)
- Does it work?
- Does it meet the original design constraints?

Communicate the solution(s)
- Make an engineering presentation that includes a discussion of how the solution(s) best meet(s) the needs of the initial problem, opportunity, or need
- Discuss societal impact and tradeoffs of the solution(s)

(E) Engineering Design Cycle Team Summary

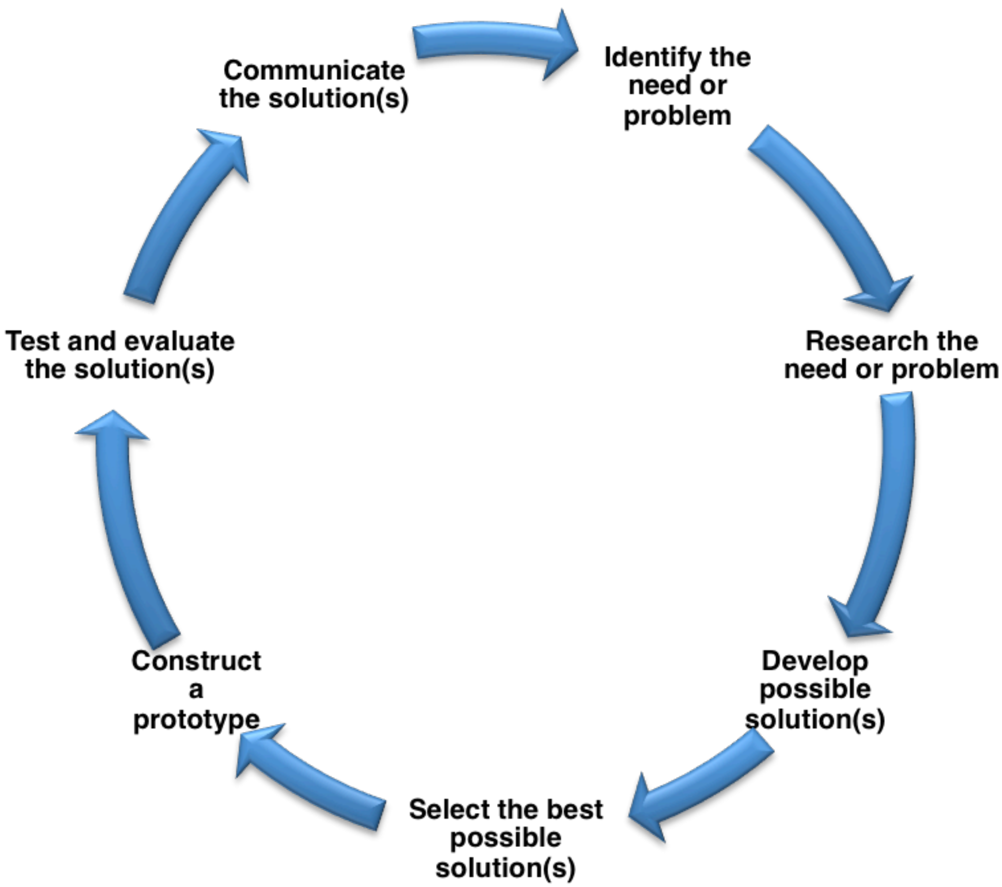
Name: ______________________________

Challenge Name: ________________________________

Our Problem to Solve: ______________________________________

Working with your group, discuss and identify where you participated in each part of the Engineering Design Cycle. Review the *(B) Daily Reflection Sheets* for help with this.

Write the event, problem, need, solution, test, etc. your team participated in next to the appropriate section of the cycle. Include arrows between steps if your team needed to go back (iteration) during the planning to test a new solution. There should be at least one example next to each step in the cycle.



(F) About your Prototype

Name: ____

Challenge Name: __________________________________ **Our Problem to Solve**: ___________________________________

Draw your Prototype as best you can, using labels to point out key features.

Describe your Prototype and how it works

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(G) About the Engineering Cycle

NAME:________________________________

What did you try that didn't work out? How many times did something like this happen?	What did you do when things didn't work out like you expected?
How could you bring technology into your final prototype?	**If given enough time, what would your next step look like?**

(H) About your Thinking

NAME:__________________________________

What were some of the struggles you and your team went through during the project?	What was surprising to you about the engineering cycle?

What do you think you have learned from this process you didn't know before?

(I) Maker Mars Rubric

	Expert	Proficient	Intermediate	Novice
Engineering Design Cycle	Demonstrates multiple iterations (loops) in the cycle using concrete examples from reflection sheet. Each example is appropriately placed and loops back to the correct step of the cycle.	Demonstrates multiple iterations (loops) in the cycle using concrete examples from reflection sheet. Most examples are appropriately placed and loop back to the correct step of the cycle.	Demonstrates a couple of iterations (loops) in the cycle using concrete examples from reflection sheet. Examples are appropriately placed and loop back to the correct step of the cycle.	Demonstrates a one correct iteration (loops) in the cycle, possibly using an example from the reflection sheet.
Prototype Description	Drawing clearly marks key features of the prototype critical to the function and meets the needs of the problem. Description fully discusses all components of the prototypes and how they address the needs of the problem.	Drawing clearly marks many key features of the prototype critical to the function and meets most of the needs of the problem. Description discusses components of the prototypes and how they address the needs of the problem.	Drawing marks a couple of key features of the prototype critical to the function and meets a couple of the needs of the problem. Description discusses components of the prototypes.	Drawing marks a key feature or two. Description and design reflect the personal interests of the group.
Designing Reflection	Reflection fully acknowledges the need to fail and make multiple iterations, yet is still forward thinking to the next steps of the design.	Reflection acknowledges the need to fail and make iterations, yet is still forward thinking to the next steps of the design.	Reflection acknowledges the need to make iterations and there are next steps but these are undefined.	Reflection discusses the success of the first or second prototype and points to this as the final product.
Thinking Reflection	Reflection fully acknowledges the struggles in the process and provides concrete examples of learning as a result of these struggles.	Reflection acknowledges the struggles in the process and provides a concrete example of learning as a result of these struggles.	Reflection acknowledges the struggles in the process and makes an unspecified claim about learning as a result of these struggles.	Reflection discusses the success and complete understanding of the process from day 1.

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