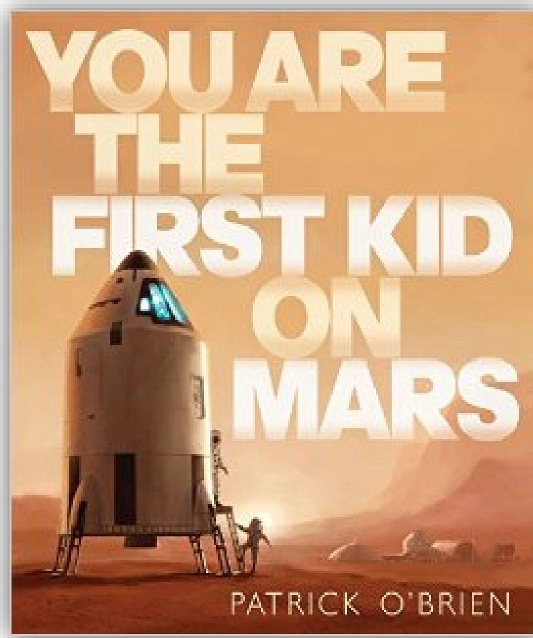
The Mars Launch System

Literacy Connection: *You Are the First Kid on Mars* by Patrick O'Brien



STEM Content:

- Apply scientific ideas to design, test, and refine a device that converts energy from one form to another
- Understand that transportation allows people and goods to be moved from place to place.
- Understand that transportation systems may lose efficiency or fail if one part is missing or malfunctions or if a subsystem is not working.
- Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit. Know relative sizes of measurement units within one system of units

Big Ideas:

- Properties of the Engineering Design Process
- Understanding transfer of energy
- Practicing how to convert measurements
- Being able to create a device that meets certain requirements
- Conservation of fuel (natural resources)
- Solving problems in multiple ways

Content Information:

- How can you create a successful design?
  - By using the design loop. It could help clear your mind and facilitate the thinking process.
- How can energy be transferred from one form to another?
  - Energy: It is neither created nor destroyed, but rather changed from one form of energy to another
  - Potential and Kinetic Energy
- How can you convert centimeters to kilometers?
- Weight: the amount or quantity of heaviness or mass; amount a thing weighs.
- Atmosphere: *Astronomy.* The gaseous envelope surrounding a heavenly body. *Chemistry.* Any gaseous envelope or medium.
- The more fuel that is aboard the spacecraft, the heavier the spacecraft will be. The heavier the spacecraft, the more fuel is needed for lift-off. See the dilemma?
- Earth's atmospheric pressure: 101.325 kPa (kilopascal)

- Mars’ atmospheric pressure: 0.4-0.87 kPa
- That means that Earth’s atmospheric pressure is 126-253 times stronger than Mars’.
- Air Pressure: What is it? https://youtu.be/axbFo-wsp4g
- Lesson on Energy: potential and kinetic.
    - Potential Energy: Energy that is stored within an object (i.e., stretch a rubber band back and hold it).
    - Kinetic Energy: Energy in motion (i.e., release the rubber band and it flies through the air).
- Quick discussion on elasticity and items we know to be elastic.
    - Elasticity: *Physics.* The property of a substance that enables it to change its length, volume, or shape in direct response to a force effecting such a change and to recover its original form upon the removal of the force.
    - Possible items to discuss: Spring, bouncing ball, bowstring, bungee cord, trampoline, etc.
- Short lesson on how to convert from inches to feet to miles

Pre-Lesson Activity:

- Ask the students to read *You Are the First Kid on Mars* as a class.
- Discuss the differences between Mars and Earth, such as the differences in atmospheric pressure and weather.
- Discuss potential and kinetic energy. Use a rubber band as a demonstration device.
- Assign the students to small groups and tell them that they are going to work as a team to creatively solve a problem for NASA.

Scenario:

You are about to become the first girls and boys to set foot on the Red Planet! However, NASA ran into a few problems just before the departure date. NASA needs your help investigating ways to reduce the amount of fuel they need to take on the mission to Mars to decrease the weight of the Orion space launch system. It is your task to develop a launch platform and lift-off device that can be used to launch the Mars Lander Capsule off the surface of Mars with four astronauts after the mission on Mars is complete. The lift-off system must not use convention fuel and must send the Mars Lander Capsule into orbit from the surface of Mars without using fuel.

Essential Question:

How can your team create a device that launches the Mars Lander Capsule high enough out of Mars’ atmosphere to reach Mars orbit and dock with the NASA Crew Vehicle for a return to Earth?

Challenge:

After reviewing potential and kinetic energy, you will need to work as NASA’s most diligent team of scientists and engineers to create a launch system with the greatest amount of thrust. Keep the weight and size of the device in mind.

Remember: The launch (lift-off) device must be able to transfer energy from itself to the Mars Lander Capsule to help it escape the Mars atmosphere.

Parameters or Constraints:

- Each team must complete an engineering journal.
- Use only materials provided or recycled materials approved by the teacher.
- The device must fit inside a .30 x .30 x .30 meter box (size and weight are critical in space).
- Teams must be able to distinguish between an example of potential energy and kinetic energy within the device.
- Teams must be able to convert inches to miles to relate our scale model test (measuring tape and the classroom) of the Mars' launcher to envision the actual distance the Lander would need to be launched.

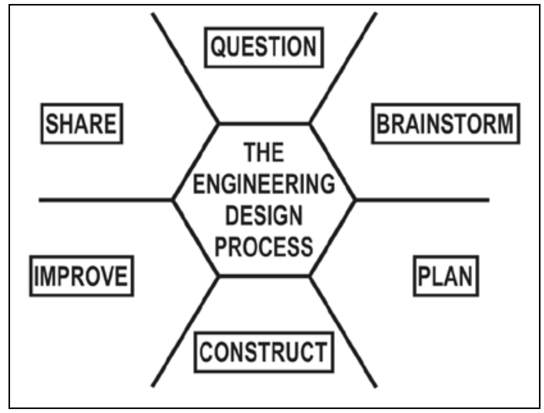
Tools, Materials, and Resources:

- Recycled materials (approved by the teacher)
- 1 - Balloon
- 6 - Rubber bands
- 2 - Wooden pencils
- 3 - Pieces cardboard
- 2 - Plastic Cups
- 24"- String
- 1 - Pair scissors (A tool: Not to be used as a part of the launcher)
- 24" of Duct tape
- The following items will be provided for testing:
    - 1 - Provided "Mars Lander Capsule"
    - 1 - Cloth tape measure to hang from ceiling (I recommend marking the measuring tape with colored tape every 5 cm to more accurately tell how high the capsule was launched)

Deliverables: Each team must submit the following items at the conclusion of this activity:

- Launching device
- Completed Engineering Design Journal
- Completed Worksheet

Engineering Design Journal:



Team Name: ________________________________
Design Team Members: _______________________
____

Design Challenge:
____

QUESTION

Identify the problem that your team has been asked to solve? State the problem in your own words.

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What questions do we need to ask in order to better understand the problem?

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What are the parameters for the design challenge that we must meet?

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BRAINSTORM

Conduct research. What do we know and what do we need to find out?

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What did we find out?

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Imagine what is possible. Generate (draw) as many ideas as possible

PLAN

Make 4 Sketches

Choose the best solution. Sketch what your team will build.

What tools and materials will you use?

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CONSTRUCT

Create your model.

NOTES:

How will you test your model?

____

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____

Collect data from your test.

1. How many feet was your capsule launched? ________________________________
2. How many miles would this be on Mars? ____________________________________
3. Describe the point at which your device was storing potential energy? ____________
   ____
4. Describe the point at which the potential energy was transferred to kinetic energy?
   ____

IMPROVE

Analyze and interpret the data from your test.

How can you improve or modify our design?

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____

Retest your team model. Did your improvements and modification work?

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SHARE

What do you need to prepare before you present your design to others?

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What questions do you think others will ask you about your team design?

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Prepare to defend your team solution. What do you like about your team design?

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____

How could you make further improvements to your team design/solution?

____

____

____

Evaluation Checklist/Scoring Guide

Criteria	Self-Evaluation (Place check mark next to each item completed)	Teacher Evaluation
Completed launch device		______/15
Completed Engineering Design Journal		______/15
Used materials and tools wisely and correctly.		______/ 10
Stayed within the parameters of the challenge.		______/ 20
Launch system lifted the capsule sufficiently		______ / 15
Participated in the presentation of my group's model.		______/ 25
TOTAL:		_____/ 100

Space Launch System Evaluation Rubric

5 Points	10 Points	15 Points	20 Points
Students showed little understanding of concepts from lesson and were unable to launch the capsule at all	Students shows some understanding of concepts from the lesson and were able to launch the capsule	Students applied concepts from the lesson and created a launching device that launched the capsule at least 2 feet	Students effectively applied concepts from the lesson and created a launching device that launched the capsule further than 2 feet
Student completed one or two aspects of the design journal	Student completed some aspects of the design journal	Student completed most aspects of the design journal	Student completed every aspect of the design journal
Student was unable to identify either of the possible energy points on the device	Student was able to identify one of the possible energy points on the device	Student was either able to identify BOTH points of kinetic and potential energy on the device and identify one example	Student was able to identify points of kinetic and potential energy on the device and give real-life examples
Student was unable to convert inches to feet nor feet to miles. Did not show understanding of scale	Student was able to convert either inches to feet or feet to miles. Somewhat showed understanding of scale	Student was able to convert either inches to feet or feet to miles. Showed understanding of scale	Student was able to convert inches to feet to miles. Showed understanding of scale
Students did not collaborate as a team. Communication was lacking and conflicts were not resolved.	Students worked together, but did not share work equally. Conflicts were not resolved.	Students worked equally as a cohesive group, may have shown some signs of conflict without resolution	Students worked equally as a cohesive group and communicated well with each other