Martian Glider
Lander Design Challenge

Objectives

Students will:
- Students will learn aerodynamic principles.
- Students will use teamwork to engineer a physical object.
- Students will utilize aerodynamic principles to create a glider.

Suggested Grade Level

5th -12th grade

Subject Areas

Science, Engineering, Aerodynamics, Math

Timeline

45-60 minutes

Standards

- 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.
- MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
- 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.

21st Century Essential Skills

- Learning Skills
  - Critical Thinking, Creativity, Designing Solutions, Conducting Investigations
- Literacy Skills
  - Organizing Concepts, Constructing Explanations
- Life Skills
  - Flexibility, Initiative, Productivity

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Background

Landing on Mar is a very difficult challenge. This requires slowing down an object moving over 6000 mph and bringing it to a safe and soft landing on the rocky surface. To accomplish this, we use our knowledge of glider aerodynamics to safely land sensitive scientific equipment on the Martian surface. Landers not only need to slow down but make adjustments inflight to maintain a safe approach angle. Too steep of an angle and the lander will burn up due the intense heat. Too shallow of an angle and the lander will “bounce off” Mars's Atmosphere and be sent back into space.

Vocabulary

Aerodynamics, slingshot, glider

Materials

- 30 unused lead pencils
- Ladder (elevated launch area *6ft)
- 30 sheets of cardstock (8.5x11)
- Calculators
- Hot-glue supplies
- Paper towel roll (cardboard inner roll)
- Rubber bands
- Tape Measure

Classroom Setup

A Glider testing station will have a ladder or elevated surface (6ft) to launch the gliders. A tape measure will be used to measure the distance each glider travels from the ladder or elevated surface.

Launch Mechanism (slingshot) See *Figure A*

Create a launch mechanism using a paper towel roll and a rubber band.

1. Designate one end of the roll as the top.
2. Measure and mark one-inch increments along the length of the paper towel roll starting at the top.
3. Cut two slits along the top edge of the roll roughly one inch apart.
4. Center a dot two inches down from the top of the roll between the two slits.
5. Cut towards the dot from the slits to create a triangle cutout in the roll.
6. Cut a rubber band open
7. Secure the ends of the rubber band to the top of the roll where slits were cut. This should form your “sling-shot”

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Figure A

Lesson

1. Use your knowledge of aerodynamics to design and draw glider wings on the cardstock.
2. Cut the wings from the cardstock.
3. Glue the wings to the lead pencil, the eraser will serve as the front of the glider.
4. Push the push pin into the eraser from underneath the glider. The push pin will be used to sling shot the glider from the launch mechanism created earlier.
5. Test glider using the launch mechanism "slingshot".
   a. Cradle the gliders push pin into the rubber band of the launch mechanism
   b. While holding the bottom of the launch mechanism with one hand, pull the tail of the glider back.
   c. Record how far back the glider is pulled using the one-inch increments drawn into the launch mechanism.
   d. Release the glider and record the distance traveled into the Glider-Data Sheet
6. Complete the Glider-Data Sheet
7. Compare test results with other participants after completing all glider testing.
8. Write a brief explanation for the performance of the glider. Would this glider be sufficient to land astronauts safely on Mars?

Extensions

- Use a fan to change the direction and speed of the air in the environment.
- Research real-world gliders and their performance statistics.
- Research the Space Shuttle flight patterns and aerodynamics behind its flight.
- Research the flight paths and aerodynamics of the landers and rovers that have landed on Mars.

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- Go to Discoverspace.org for more space-related lessons and activities.

Resources

Dunbar, B. (2017, August 01). The Aeronautics of the Space Shuttle. Retrieved July 25, 2019, *from* *https://www.nasa.gov/audience/forstudents/912/features/F_Aeronautics_of_Space_Shuttle.html*

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Glider- Data Sheet

Conduct 3-5 practice flights for your glider. With each practice flight, make adjustments as needed to maximize your glider's performance. Once you are done practicing, record the following information for your three test flights. Record the height (in feet) that you released your glider, then record the distance of the flight (in feet). Distance will be measured in a straight line from the starting point to the location of the nose of the glider.

Flight - 1	
Height	Distance
Flight - 2	
Height	Distance
Flight - 3	
Height	Distance

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Calculating Glide Ratio

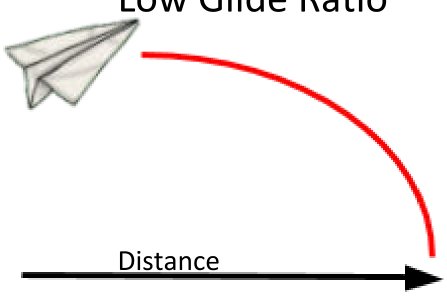
The Glide Ratio represents how well your glider works. An efficient glider can travel a further horizontal distance with little decrease in altitude or height. Calculate the average height and average distance from your final three flights. Divide the average distance by the average height. This will produce your Glide Ratio. You want to accomplish a glide ratio of 2 or higher.

Average	
Height	Distance

Average Distance ÷ Average Height

Glide Ratio = [ ]

Low Glide Ratio

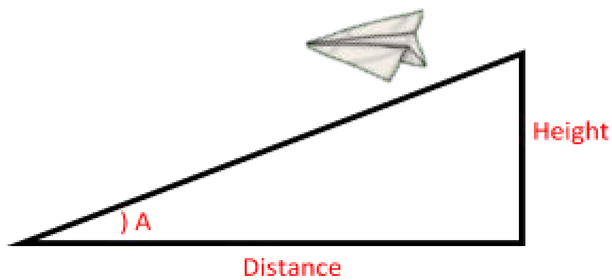


High Glide Ratio

Calculating Glide Angle

The Glide angle is the angle at which your glider approaches the ground. Too steep of an angle and the lander will burn up in Mars' atmosphere. Too shallow of an angle and the lander will skip off the atmosphere and be sent back into space. The average glide angle of the Space Shuttle was 18°- 20°.

**Use your average Height and your average distance to calculate your Glide Angle.



Average Height = ________

Average Distance = ________

Use a calculator to compute the Tangent Inverse of your average height divided by your average distance. This will give you your glide angle.

Tan^{-1} (Avg. Height ÷ Avg. Distance) = A

When using a calculator, be sure that it is in degree mode

Your Glide Angle (A) = _________

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