Engineer: Air Rockets

Time: 45 Minutes **Skill Level:** Elementary (age 6-11), Middle School (age 12-14)

Background

What is Science Inquiry?

Children are natural scientists. From a very early age they explore the world, ask questions and seek answers. This journey of exploration and discovery is Science Inquiry. Science Inquiry helps young people understand their environment, solve problems and gain knowledge about scientific ideas and processes.

Next Generation Science Standards (NGSS)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions and defining problems **3.** Planning and carrying out investigations **4.** Analyzing and interpreting data **5.** Using mathematics and computational thinking **6.** Constructing explanations and designing solutions **8.** Obtaining, evaluating, and communicating information	**PS2:** Motion and stability: Forces and interactions **ETS1:** Engineering design	**1.** Patterns **2.** Cause and effect: Mechanism and explanation **3.** Scale, proportion, and quantity **6.** Structure and function **7.** Stability and change

Objective

Students will investigate air rocket dynamics through engineering design and problem-solving.

Intro to Engineers

Engineering begins with a problem, need or desire that suggests an engineering problem needs to be solved. Engineering makes use of models to test possible solutions to problems. A simple engineering design cycle consists of six steps: (1) State the Problem, (2) Generate Ideas, (3) Select a Solution, (4) Build the Item, (5) Evaluate, (6) Present results.

The Science of Air Rockets

Rockets are a great way to study aerodynamic forces. However, full-scale rockets and even model rockets utilize complex thrusters to provide fuel throughout the flight. An easier introduction to these concepts is with air rockets, where the rocket receives a single, initial thrust at launch. During the entire flight, only the weight and aerodynamic forces (lift and drag) act on the rocket.

The Science of Air Rockets ***(continued)***

The launcher includes a hollow launch tube, which is inserted into the base of the rocket before launch. When the rocket is placed on the launch tube, the body tube becomes a closed-pressure vessel if the clay nose cone is fitted securely. The launch has three stages: (1) the pressurization of the body tube, (2) the initial acceleration along the launch tube, and (3) the expulsion of the compressed air from the rear of the rocket. Fins attached to the base of the body tube provide stability during the flight.

Materials List:

Straws	Clay	Scissors	Goggles
Heavy paper	Tape	Ruler	Pitsco Straw Rocket Launcher (and instructional DVD)

Discuss …What do students know about rockets? Discuss the air rocket and launcher setup. What are the components of the rocket design and what is the purpose of each feature (e.g., body tube length, fins, and nose cone)? Discuss ideas for investigating a particular problem, such as how the fin shape affects the rocket's flight.

Experience "What to Do"- What is the plan for the investigation? Have students follow the engineering design cycle to investigate a problem of their choosing. Students should identify the variable and the controls for their tests. Encourage students to collect and analyze data. Example investigations include:

- How does launch angle affect the range? Measure the range for various angles (e.g., 15˚, 30˚, … 90˚), record data in a table, graph and analyze the results. Variable: launch angle; controls: rocket design and launch rod height.
- How does the launch rod height affect the rocket's range? Keeping the angle constant, measure the range for different launch rod heights (e.g., 10, 12, … 20), record data in a table, graph and analyze the results. Variable: rod height; controls: rocket design and launch angle.
- How does the rocket design affect the range? Choose a *single* design variable to change, such as body tube length, number of fins, fin design, or shape of nose cone. Test five variations on that design variable—measure the range for each variation, analyze the data, and determine how that design variable affects the rocket's range. Variable: the selected design variable; controls: all other design variables and launch variables (launch angle and launch rod height).

Share …Encourage students to troubleshoot their design in detail and solve problems that arise during design. Use observed symptoms (e.g., not launching, wobbly flight path, etc.) to identify cause and effect, and then resolve the problem.

Reflect …**Analyze and interpret the data and results. Discuss among the group.** What causes the rocket to launch? What factor(s) affected the flight and why?

Generalize …**to real world examples. Construct explanations.** Often, rockets are used to perform tasks and go places that are otherwise challenging for humans. For example, rockets may be used to explore space, obtain aerial images, or even collect scientific data. How would you design a rocket that needed to go long distances? How do you launch a rocket that requires a long flight time but short range?

Apply …**outside the classroom or club meeting.** Based on your observations, how is the air rocket design different than that of a full-scale rocket?

Additional resources: For more information on air rockets, see the NASA website,
http://exploration.grc.nasa.gov/education/rocket/rktstomp.html

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