STEM Flights LESSON PLAN

Introduction to Rocketry and Flight		
Grades: 6-12	**Topic: Rocketry and Flight**	**Focus Area: Aerospace STEM Career Pathways**
Lesson Description: Students will explore Aerospace through rocketry and flight; learning how rocketry is possible through the principals of propulsion and aerodynamics.		

Student Objectives: Students will be able to identify the principles of propulsion and the principals of aerodynamics and will be able to describe how these scientific principals allow rockets to take flight and stay airborne.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ● Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.	**P S2.A: Forces and Motion** ● The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. ● All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.	**Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

5E Model of Instruction: NGSS

NEXT GENERATION SCIENCE STANDARDS

ENGAGE:
Post these questions to begin the lesson and explain that students will discover answers to these questions throughout the lesson. Have students hypothesize and discuss possible answers before beginning the lesson:

1. What is propulsion?
2. What are aerodynamics?
3. How do rockets use propulsion and aerodynamics to take flight and stay airborne?

EXPLORE - *Exploring Propulsion*
Have students learn about Newton's 3rd Law of Motion and experience creating propulsion creating their own rockets using this Balloon Experiment. Break students into groups of two to conduct the experiment and record their findings. Have a contest to see which rocket goes the fastest and then discuss Newton's 3rd Law of Motion in relation to propulsion: *"Newton describes this effect in his Third Law of Motion: for every action, there is always an equal and opposite reaction. The gas rushing out of the rocket or balloon is the action and the movement of the object in the opposite direction is the reaction. Propulsion is the act of pushing or driving something forward. When a rocket launches, it is being propelled by gas to create movement in the opposite direction."*

Have students connect this learning to an actual rocket. How does propulsion help rockets to fly?
Tip: Have students create a note catcher that helps to organize what they learn throughout the lesson

To access additional materials, use these resources: Harvard University: How Rockets Work
National Air and Space Museum: Rocket Propulsion

EXPLORE PT. 2 - *Exploring Aerodynamics*
Aerodynamics is the study of how objects move through air and studies the forces that act upon an object as it flies. When a rocket is launched, it is affected by drag (air resistance) and stability (keeping it pointed in the right direction); two factors of aerodynamics and two factors that connect to the Four Forces of Flight that are in effect when an aircraft takes flight. Learn more about Aerodynamics below.

Refer to these resources to expand on Aerodynamics and discover how aerodynamic lift generates the force needed for rockets to fly: **NASA Rocket Aerodynamics**; ***Basics of Rocket Aerodynamics***; ***American Rocketry Challenge: Rocketry***

After learning additional information about Aerodynamics, how would you describe aerodynamics in relation to rocketry?

Take the student exploration one step further. Here are a few additional rocketry and aerodynamic application activities that you and your students can try out! Water Bottle Rockets and More

EXPLAIN After exploring Propulsion and Aerodynamics, create your own rocket model or have each student label their own rocket to describe how these scientific principals work together to allow a rocket to take flight and stay airborne. There are many online resources providing blank rocket templates that can be printed: Blank Rocket Template
ELABORATE - *How do the principals of propulsion and aerodynamics allow a rocket to fly?* **Propulsion:** Discuss the main components and how this connects to Newton's 3rd Law of Motion **Aerodynamics:** Discuss the principals of aerodynamics and how it relates to all aircraft; not just rockets Watch a NASA rocket launch from October 2024 Here: NASA's Europa Clipper Launch; NASA's Europa Clipper Mission
EVALUATE For their final task of the lesson, have students collaborate to develop their own Atmospheric Diagrams using the PDF as a model. Have them label the range of aircraft and include any additional information they learned from the lesson.

Materials Required for This Lesson Plan:

• Balloons, straws, string, wooden clothespins (for balloon rocket experiment)	• Additional Materials if doing Water Bottle Rockets	• Technology to Display Resources to class

Vocabulary Terms:

Propulsion	Aerospace	Aerodynamics	Newton's 3rd Law of Motion	Four Forces of Flight

CONNECT YOUR LEARNING

How does this connect to our world?
Aviation and Aerospace are two industries at the center of STEM expansion. Without these technological advances and the engineering to develop these aircraft or to launch exploration, life would be very different. Rocketry and the science of it, allows Space exploration like never before and allows scientists to continue advancing our knowledge about space and is a dynamic industry that will continue to expand and grow for years to come. Aerospace has advanced our knowledge about space significantly over the last sixty years and will continue to create access to the world of space exploration. Students! This means careers are and will be available for you to explore. Begin that exploration now!

CAREER PATHWAY EXPLORATION

At STEM Flights, we believe that STEM Career Exploration at an early age can help to shape a student's future. We encourage all educators to allow their students to view the links below and explore the different career pathways available in these fields.

What Career Pathways Can You Explore in Aviation and Aerospace? Here are just a few:

Aviation:
- Pilot (Commercial, Agriculture, Helicopter, etc.)
- Military Flight Instructor
- Airport Manager
- Air Traffic Controller
- Aviation Maintenance or Mechanic
- Safety Inspector

Aerospace:
- Aerospace Engineer
- Astronaut
- Rocket Scientist
- Research Scientist
- Systems Engineering

Check out these resources to explore more:
- Aviation Related STEM Careers
- Aviation and Space Careers - FAA
- Careers in Aerospace

Additional FREE Resources and Activities Related to STEM, Aviation, and Aerospace

- Future U Lesson Plans - Discovery Ed & Boeing
- NASA's Educator Guide to Aeronautical Activities for Students (All Hands-On)
- NASA- The Dynamics of Flight
- AeroEducate Teacher's Toolbox
- Teach Engineering Lesson Plans and Experiments
- USA Science & Engineering Festival Lesson Plan Library

Check out additional resources on our STEM Flight Following pages for educators: STEM Flight Following

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