STEM Flights LESSON PLAN

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Drones v. Aircraft: How Do They Fly?		
Grades: 6-12	**Topic: Aerospace and Flight**	**Focus Area: STEM Career Pathways**
Lesson Description: Drones are quickly becoming the accessible option for students' vehicle of flight while on the ground. The science that involves flying a drone is derived from the way an aircraft operates and flies. Dive into aerodynamics, physics, engineering, and technology in this lesson to discover the similarities and differences between the flight of a drone v. the flight of a manned aircraft.		

Student Objectives: Students will be able to identify the similarities and differences between flight when investigating how drones and manned aircrafts fly.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems builds on previous experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** Science knowledge is based upon logical and conceptual connections between evidence and explanations	**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

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. How does an aircraft fly?
2. How does a drone operate?
3. What similarities and differences can you specify between how a drone and an aircraft operates?

EXPLORE - *How do Drones Fly?*

- Drones fly using a combination of physics; aerodynamics and propulsion along with sensors and flight controllers to maintain stability and navigate. Drone Flight Dynamics
- In 1687, English scientist Sir Isaac Newton published his now famous three laws of motion. These laws describe how forces and objects interact to affect motion. Newton's third law of motion states that for every action, there is an equal and opposite reaction. When a drone's propellers spin, they push air downward. Using Newton's third law, this represents the action. For Newton's law to be true, there must be an equal and opposite reaction. This reaction is an upward force pushing on the drone. Once this force exceeds the force of gravity pulling the drone downward, the drone begins to move up.
- For a drone to fly, it must be capable of three different types of movement: vertical movement, lateral movement, and rotational movement. Based on Newton's third law, each of these can be achieved using the drone's four propellers. When the propellers spin, they push air down.
- Similar to a helicopter, pushing the air down is the action in Newton's third law of motion. The reaction is a force, called lift, which pushes the drone up. Each of the propellers will create lift, and the total lift for the drone will be the sum of the four propellers' lifts. The total force of the lift must be stronger than the force of gravity for the drone to take off.
- Once in the air, the drone can hover with no vertical movement by having the forces of lift and gravity equal. When the force of lift acts straight upward, the drone moves vertically. But, when lift acts at an angle, it can also move laterally. This is because part of the force of the lift is upward and part of it is to the side, resulting in lateral movement that can be from side-to-side or forward and backward. Lateral movement occurs by varying the speed of the propellers. Increasing the speed of the two propellers on one side of the drone and/or decreasing the speed of the two propellers on the other side creates uneven amounts of lift on the two sides. The lift created on the side with the faster spinning propellers is greater than the lift created on the opposite side. The result is that the drone moves in the direction of the side where less lift is created. *(NASA: STEM LEARNING: Advanced Air Mobility: The Science Behind Quadcopters Reader Student Guide)*

To learn more about how drones fly, visit the NASA resource and refer to pages **3, 4, & 5:**
NASA: STEM LEARNING: Advanced Air Mobility: The Science Behind Quadcopters Reader Student Guide

Drones, also known as Unmanned Aerial Vehicles (UAV), can be used for tasks large and small and can look very different from one UAV to the next. Explore how a specialized NASA UAV is having an impact on our space investigation. Expand on they physics of flight and learn more about NASA's first Mars Helicopter Ingenuity here:
How NASA's Ingenuity Helicopter was Developed for Mars | How Ingenuity Works | Ingenuity Mars Helicopter

EXPLORE PT. 2 - *How does an Aircraft fly?*

There are four forces that impact an aircraft and its flight; **Thrust, Lift, Gravity, and Drag**. If all four forces are in balance, an aircraft will have a successful flight.

- A plane flies through the air by continually pushing and pulling the surrounding air downward. In response to the force of moving the air down, the air pushes the airplane upward. Newton's 3rd law of motion states that for every action there is an equal and opposite reaction. An airplane wing is shaped so that the air is deflected downward as the wing passes. Because air is a fluid (a gas), both the top and the bottom surface of the wing deflect the air. This is very different from dealing with solid pellets for which only the bottom surface would deflect. The faster an airplane travels the more lift is generated. Inclining the wing to the wind also produces more deflection and more lift. The wings of an airplane have adjustable flaps that can be extended or retracted. When extended, the flaps increase the deflection of the air and provide greater lift for takeoff and landing. (NASA; What makes a plane go up?)
- As it flies, a plane is in the center of four forces. Lift (upward force) and *thrust* (forward push, provided by a propeller) get a plane into the air. *Gravity and drag* (air resistance, which is friction caused by air rubbing against the plane) try to pull the plane down and slow its speed. A plane must be built so that lift and thrust are stronger than the pull of gravity and drag by just the right amount. Lift from the wings is used to overcome the force of gravity. Shape is important in overcoming drag. For example, the nose of a plane is rounded so it can push through the air more easily. The front edge of each wing is rounded too. (NASA; What makes a plane go up?)

These basic flight concepts have been tested for thousands of years; starting with kites, and hot air balloons. For decades, engineers have worked to continue understanding how to get aircraft to fly quicker and have a longer flight time. The different varieties of aircraft provide us with unlimited opportunities such as travel, military travel and protection, consumer products, and medical assistance. To learn more about how aircraft fly visit:

The Basics of Flight: AOPA
How Do Planes Fly? AeroGuard
How Airplanes Fly -Video

The United States military has developed some of the most advanced technology for aircraft in the world. Although different from commercial or private aircraft in many ways, the military jets still use the same basic concepts as all other aircraft. Learn more about the flight advancements our military is making in the world of Aerospace and Aviation here: How a Military Fighter Plane Flies

EXPLAIN and ELABORATE

Let's Investigate! After learning about how drones and aircraft fly, now you can create your own. Investigate by building your own Ingenuity, Airplane launcher, or both! Record your data, compare the two experiments, and explore the relationship between the two types of aircraft. *What makes it possible for your aircraft to fly? What modifications can you include that allows the flight pattern to improve? How does this connect to what you learned previously about flight?*

Create Your Own Ingenuity Helicopter
Build an Airplane Launcher

EVALUATE
What are the similarities and differences between flight of a drone and flight of an aircraft?
Create a Venn Diagram that illustrates the similarities and differences between Unmanned Aerial Vehicles and manned aircraft. Break into groups or create a collective classroom Venn Diagram that uses words, illustrations, diagrams, and photos to compare the two. *What were the major differences between the two? What were the significant similarities?*

Materials Required for This Lesson Plan:

• Materials to create paper airplanes and launcher	• Materials to create Paper Ingenuity	• Computer Access for Students	• Technology to Display Videos for Educator

Vocabulary Terms:

Aerospace	Newton's 3rd Law of Motion	Aerodynamics	Acceleration	Lift	Gravity

CONNECT YOUR LEARNING

How does this connect to our world?
Drones are rapidly advancing and changing our methods of technology. The four forces of flight has impacted everyone's life in one way or another. The Aerospace industry is at the center of the STEM world and continue to advance daily. Without these technological advances and the engineering to develop these aircraft, life would be very different. 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. Drones (UAVs) and large manned aircraft will be at the heart of this advancement.

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?

<u>Aviation:</u>
- 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
- Teach Engineering Lesson Plans and Experiments
- USA Science & Engineering Festival Lesson Plan Library
- Aero Educate | Young Eagles

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