LEADER GUIDE
for
MODULE ONE

INTRODUCTION TO FLIGHT

Chapter One—Flight

Learning Outcomes--Upon completion of this chapter, the cadet should know:

- The relationship between Bernoulli's Principle, Newton's three laws of motion and how they were used to develop a machine that could fly.
- The coefficient of lift and the parameters involved.
- The parts of an airplane and an airfoil.
- The four forces affecting an airplane in flight.
- The three axes, movement around those axes and the control surfaces that create the motion.

Important Terms

Aerospace Education - branch of general education concerned with communicating knowledge, skills and attitudes about aerospace activities and the total impact of air and space vehicles upon society
Aerodynamics - relating to the forces of air in motion
Aeronautics - the science of flight within the atmosphere
Air - a mixture of gases that contain approximately 79% nitrogen, 19% oxygen and 2% other gases
Aircraft - any machine that is capable of flying through the air; ex. ultralights, airplanes, gliders, balloons and helicopters
Airplane - an aircraft that is kept aloft by the aerodynamic forces upon its wings and is thrust forward by a propeller, or other means of propulsion, such as a jet or rocket
Airfoil - a component, such as a wing, that is specifically designed to produce lift, thrust or directional stability
Altitude - height expressed in units above sea level, or ground level
Camber - the curved part of an airfoil that goes from the leading to the trailing edge
Chord - a line drawn through an airfoil from its leading to its trailing edge
Drag - a force which retards the forward movement of an aircraft in flight
Dynamic - forces in motion
Leading edge - the front part of an airfoil
Relative wind - the flow of air which moves opposite the flight path of an airplane
Thrust - the force which moves an aircraft forward in flight
Trailing Edge - the back part of an airfoil
Static - standing still, or without motion
Wind - air in motion

PRESENTATION

Attention: What does it mean to fly? Why did early dreamers fail when they tried to emulate the birds? Make a connection between Bernoulli's principle and actual flight. Make a connection between Newton's three laws of motion and actual flight. Explain the word *force* in terms other than flight. What are the four forces acting upon an airplane in flight? Discuss the forces acting upon vehicles other than an airplane; like a roller coaster, or an automobile, and then compare those to an airplane. Give an example of an axis other than those used in the study of airplanes.

Motivation: Understanding the background and principles involved in flight will help the cadet get more out of and appreciate an orientation flight. Once a cadet understands the vocabulary and principles of flight, he/she will feel much more comfortable around pilots and "airplane people."

Overview: The Wright brothers were successful because they developed an understanding of how a machine can harness the energy of the environment. They used a scientific method of testing their theories and this led to controlling the machine during sustained, gliding flights. By adding power, the brothers then refined their machine so they could repeat their findings again and again. This was putting science to work and that is known as technology.

The AEO should use this example of the Wright brothers, and the explanations within the text to give the students a clear understanding of what a flying machine is and how it works. By weaving in the historical and the technical, the cadet should be able to gain an appreciation for the rich heritage and incredible scientific significance of controlled, sustained and powered flight.

Lesson Outline:

1. Go over the ***Important Terms*** and explain them as a "new language."
2. Develop the history of man's quest to fly.
    a. Introduce Icarus and his fatal effort to fly to freedom.
    b. Introduce man's first powered flight in a balloon
3. Nature's flying machine—Discuss bird flight.
4. Introduce Bernoulli and Newton as great scientists and how their principles and laws laid the groundwork for the science of flight.

Activity One* Demonstrate, and let the cadets follow, how to make a piece of paper lift by blowing over the top.

Activity Two* Use the hair dryer and demonstrate "Is Bernoulli's Principle Worth Two Cents?"

5. Discuss the Coefficient of Lift, not from a mathematical standpoint, rather from what parameters are involved. Point out that the aeronautical engineer has to use several "bits" of information to determine how much lift a wing will produce.
6. Using a "regular" airfoil, have the cadets discuss how (1) making a wing larger; (2) making the camber more curved; (3) making the wing go faster; (4) or how increasing the angle of attack, .will create more lift

7. Using a model airplane, preferably a high wing monoplane similar to a Cessna 172, discuss the parts of an airplane and its wing.

Activity Three* Use the soda straws to demonstrate the three axes.
Activity Four** Make a paper airplane and fly it around.
Activity Five*** Assemble an SR71 and fly it.

Answer to Review Questions: 1 d; 2 d; 3 a; 4 c; 5 b; 6 a

Chapter Two—To Fly By The Lifting Power Of Rising Air

Learning Outcomes—Upon completion of this chapter, the cadet should know:

- How gliders use the environment to obtain altitude.
- Why gliders look differently than powered airplanes.
- How gliders can achieve great distances without power.

IMPORTANT TERMS

Altitude - the height or distance above a reference plane. The most common planes of reference used in aviation are heights above sea level and ground level. If it is above average sea level, it is referred to as "MSL", or Mean Sea Level, and if it is Above Ground Level, it is referred to as "AGL".
Aspect Ratio - the ratio between the span of the wing and the chord length
Glide Ratio - a mathematical relationship between the distance an aircraft will glide forward to the altitude loss. If an aircraft has a glide ratio of 20 to one, and it is one mile above the Earth, it should glide 20 miles before landing.
Lift to Drag Ratio - this ratio is used to measure the gliding efficiency of an aircraft. The angle of attack that results in the least drag will give the maximum lift to drag ratio, the best glide angle and the maximum glide distance.
Stability - the atmosphere's resistance to vertical motion
Thermal - a column of air that moves upward
Tow Plane – usually a single-engine airplane that will pull a glider from the ground to an altitude where it can be released

PRESENTATION

Attention: How does the Sun affect the soaring conditions within the environment. Do gliders often fly at night? Why? How is the atmosphere different at10,000 feet, 25,000 feet; 50,000 feet? Why do gliders have such long wings?

Motivation: There are glider encampments available for Civil Air Patrol cadets. One of the first flight opportunities for Air Force Academy cadets is the glider program. Student pilots can solo a glider as early as age 14. Model gliders are fun to build and if cadets want to take it one step further, it is a very rewarding hobby.

Lesson Outline:

1. Go over the ***Important Terms*** and explain them as a new language.
2. Develop the history of man's attempts to fly and how gliders were the first aircraft built by the Wright Brothers.
3. Go over the components of the glider and then compare those to the actual powered airplane shown in Chapter One.
4. Explain the mathematics of glide ratio. You may also use a paper airplane to deter mine its glider ratio.

Activity One—Build An Air Force Academy Glider* This is an outstanding cadet activity and requires only a few tools and supplies: For 30 cadets, you will need 60 foam meat trays. To bond the foam parts, you will need about 6 hot glue guns and 3 extra glue gun slugs. To cut the foam, it suggested that the squadron buy a set of 30 utility knives that have "snap" blades.

Answer to Review Questions: 1 a; 2 c; 3 d; 4 a; 5 c; 6 c

Chapter Three—Balloons, They Create Their Own Thermals

Learning Outcomes—Upon completion of this chapter, the cadet should know:

- The principle of buoyancy and how this relates to the flight of a balloon.
- The components of a balloon and how each works in the flight profile.
- The history of the balloon and why it's recognized as the first powered manned flight.

Important Terms

Buoyancy - to rise or float on the surface of water or within the atmosphere
Burner - the heat source for filling the envelope with hot air
Envelope - the main body of the balloon usually made of nylon
Montgolfier - the name of the two French brothers who created the first successful manned hot air balloon in 1783
Propane - a lightweight, low carbon fuel used in hot air balloon burners
Wicker - a form of wooden construction used in the baskets (gondolas)

PRESENTATION

Attention: Discuss the statement, " a hot air balloon creates its own thermal. Discuss the shape of a balloon and why it looks so much different from other aircraft. Explain the reason why propane is used as opposed to natural gas, kerosene or even gasoline as a fuel for the burner.
Discuss the various means that a balloon pilot has to control the direction of the flight of a balloon.
Motivation: A balloon, more than any other aircraft, has a very romantic heritage. Tell the cadets about the champagne "brunch" that follows most balloons flights and why one of the most spectacular events in aerospace is the annual **Balloon Festival** in Albuquerque, New Mexico. Consider having the cadets research this event on the Internet or at a library.

There are several outstanding videos about the Balloon Festival that could be shown to the squadron.

Overview: The Wright's weren't the only famous "brothers" in the heritage of aerospace. Two French brothers built the first powered, manned aircraft in the 18th Century. The hot air balloon is a spectacular site and it is not only a marvel to see in flight, it proves that "old" can be as exciting as "new" technology. A balloon is one aircraft where a cloud can come right into the "cockpit" with the pilot and the in flight view is almost a religious experience to many balloonists!

Lesson Outline:

1. Go over the ***Important Terms*** first so cadets will understand how to speak the language of balloons.
2. Develop the history of the Montgolfiers and their contribution to aerospace.
3. Introduce the principle of buoyancy as a science.
4. Study the structure of a balloon and discuss how its technology was developed over two centuries.
5. Develop an understanding of how a balloon is **controlled.**
6. Introduce the mathematics of the lifting power of lighter-than-air gases.

Activity recommendation* It is highly recommended that the squadron aerospace education officer call the Civil Air Patrol Supply Depot and discuss the costs of building and launching a hot air balloon kit. These kits are usually less than $10 and can be built as a squadron project. With a small burner, they can be launched indoors or outdoors, depending upon weather conditions. The CAP Supply Depot's toll-free number is (1-800) 858-4370.

Answer to Review Questions: 1 b; 2 d; 3 d; 4 b; 5 c; 6 b