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How Things Fly: Paper Airplanes

How Things Fly: Paper Airplanes

Building New Ideas for Future Airplanes

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Table of contents

Page

1.- Course Outline/Overview.....3

2.- Goals & Objectives.....4

Florida Standards

3.- Lesson Plans.....9

Lesson Plan #1
How Things Fly: Paper Airplanes 9

Lesson Plan # 2
Foam Glider.....18

Lesson Plan # 3
Lucky Paris Landing.....24

4.- Resources/ Bibliography.....30

5.- Student Work sample.....33

6.- Adapter Application.....35

1.- Course Outline/Overview

Aerospace science and Transportation

As an educator of young children, I let kids apply science, technology, engineering, and math (STEM) skills to design and solve challenges in classroom. Kids have a natural curiosity about their world and how it works. The children constantly wonder, explore, create, describe, manipulate, compare, examine and test technology for the next generation of space transportation. The idea is to build a flying machine by engaging them in related design challenges that defies all of the known concepts of aerodynamics using some simple and inexpensive materials to create their own solutions for space transportation. Use this resource in school and afterschool settings to engage kids and their families in aerospace science and future exploration. Hands-on activities to help prepare for, introduce, run, and wrap up the activity; discussion questions that explore the aerospace, engineering, and space related themes; and ways to make all subjects into the curriculum connections. The process of creating their own art is much more important than any product. The kids will be inspired by seeing other kids tackling the challenge and will understand how the activity relates to aerospace exploration. These are opportunities to unleash an individual's ingenuity and creativity. However, the focus of this lesson is to create controlled flight using a classic paper airplane design and excite the imagination by helping children to better understand aviation and take the initiative for new investigations in aerodynamics.

Aerospace and classroom connection

Many of these methods have an important place in the beginning of the elementary curriculum. The students design challenges and connect by engaging in related design challenges of their own. However, there are additional opportunities for the growth of knowledge, skills, and dispositions when children ask their own questions, conduct their own investigations, and make decisions about their activities. Aerospace science and investigation provide contexts in which children's curiosity can be expressed purposefully, and that enable them to experience the joy of self-motivated learning. Young scientists and engineers can be encouraged to represent what they have learned through brainstorming, sketching, designing, building, testing, evaluating, redesigning and sharing solutions in the classroom with some simple and inexpensive materials, through which projects become communities of learning. Parents can and should be drawn into that community to collaborate and participate in their project process by working at home and in the school community.

2,.-Goals & Objectives

Understand that gravity is a force that pulls objects towards each other.

Understand that all objects will fall to the ground because of the gravitational force between the Earth and the object.

Recognize that all objects will fall to the ground unless another force holds them up.

Observe and recognize that an object will fall when it is dropped.

Infer that a force that is not actually touching an object can make it fall toward the Earth.

Relate that objects in space that are near Earth, like satellites and the moon, remain in place because of the gravitational pull of the Earth.

Observe, describe, record, and compare data.

Keep records, including pictures and writing, of investigations through the use of a Science Journal.

Use the practice of science to question, observe measure, investigate, classify, explain, and communicate the effects of gravitational force.

Construct a flying model. (e.g., paper plane, kite, parachute, paper helicopter) and describe what forces allow it to fly (i.e.' throwing (push), falling (gravity), and floating (air friction)).

Investigate how the gravitational pull is greater for objects with a greater mass.

Explain how the gravitational pull between two objects increases as they get closer (and decreases as they get farther).

Next Generation Sunshine State Standards

*Earth in Space and Time

Humans continue to explore Earth's place in space. Gravity and energy influence the formation of galaxies, including our own Milky Way Galaxy, stars, the Solar System, and Earth. Humankind's need to explore continues to lead to the development of knowledge and understanding of our Solar System.

*Earth Structures

Humans continue to explore the composition and structure of the surface of Earth. External sources of energy have continuously altered the features of Earth by means of both constructive and destructive forces. All life, including human civilization, is dependent on Earth’s water and natural resources.

Sunshine State Standards

Body of Knowledge: E: Earth/Space Science; P: Physical Science – N: Nature of Science

Grade:K

Topic XIII: The Law of Gravity

SC.K.E.5.1: Explore the law of gravity by investigating how objects are pulled toward the ground unless something holds them.

SC.K.N.1.3: Keep records as appropriate such as pictorial of investigations conducted.

SC.K.N.1.4: Observe and create a visual representation of an object which includes its major features.

Grade: 1

Topic V: Law of Gravity

SC.1.E.5.2: Demonstrate that Earth’s gravity pulls any object on or near Earth toward it even though nothing is touching the object.

SC.1.P.13.1: Demonstrate that the way to change the motion of an object is by applying a push or a pull.

SC.1.N.1.3: Keep records as appropriate such as pictorial and written records of investigations conducted.

Grade:2

Topic VIII: Effect of Gravity

SC.2.P.13.3: Recognize that objects are pulled toward the ground unless something holds them up.

SC.2.P.13.4: Demonstrate that the Greater the Applied Force, the Greater the Change in Motion.

Grade:3

Topic XI: Gravity is a Force

SC.3.P.10.3: Demonstrate that light travels in a straight line until it strikes an object or travels from one medium to another.

SC.3.E.5.4: Explore the Law of Gravity by demonstrating that gravity is a force that can be overcome.

SC.3.N.3.2: Recognize that science use models to help understand and explain how things work.

Stand: Mathematics Standards

Grade:K

MAFS.K.MD.1.1: Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

MAFS.K.G.1.1: Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.

Grade:1

MAFS.1MD.1: Measure lengths indirectly and by iterating length units.

MAFS.1.MD.1.1: Order three objects by length; compare the lengths of two objects indirectly by using a third object.

MAFS.1.MD.3.4: Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Grade:2

MAFS.2.NBT.1.2: Count within 1000; skip-count by 5s, 10s, and 100s.

MAFS.2.MD.1.4: Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.

Grade:3

MAFS.3.MD.1.1: Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.

MAFS.3.MD.2.3: Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled bar graphs.

Stand: Reading Standards for Literature

Grade: K

LAFS.K.L.3.4: Determine or clarify the meaning of unknown and multiple meaning words and phrases based on reading and content.

LAFS.K.W.2.5: With guidance and support from adults, respond to questions and suggestions from peers and add details to strengthen writing as needed.

LAFS.K.SL.2.4: Describe familiar people, places, things and events and, with prompting and support, provide additional detail.

Grade:1

LAFS.1.RL.1.2: Retell stories, including key details, and demonstrate understanding of their central message or lesson.

LAFS.1.RI.1.3: Describe the connection between two individuals, events, ideas, or pieces of information in a text.

LAFS.1.SL.2.5: Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.

Grade:2

LAFS.2.RL.1.1: Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.

LAFS.2.W.3.7: Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations).

Grade:3

LAFS.3.RI.1.2: Determine the main idea of a text; recount the key details and explain how they support the main idea.

LAFS.3.RI.1.3: Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

3.- Lesson Plans:

How Things Fly: Paper Airplanes

Lesson Plan #1

Model: Traditional Paper Airplane

1.-Topic

Aerodynamics

2.- Subject

Science

3.-Timeline

15 minutes

4.- Suggested grade levels:

Pre-kindergarten to 12th grade

5.-Objectives

Students will create an airplane that is excellent for long distance flights, fast, stable flier, generate long sweeping turns, and controlled flight using a classic paper airplane design.

6.-Background Information

There are at least three significant historical examples of how Paper Airplanes and Kites were built. The Chinese used these in early experimentations with flight and were early innovators who invented papyrus paper around 2000 years ago. Later, an English inventor Sir George Cayley used paper to construct small gliders that later successfully took a form of paper and wood gliders with a shape of modern aircraft. During the early 1900s Aero magazines published several articles using paper airplane models to demonstrate aerodynamic principles. Wilbur and Orville Wright reportedly used paper planes, wings and airfoils in wind tunnels. During the 1930s Jack Northrop of the Lockheed Corporation used several paper models of planes and wings as test subjects for large aircrafts.

Today, paper airplanes are popular, easy, and affordable to build in schoolyards and parks across the world. National Paper Airplane Day is observed on May 26th every year. The day is an unofficial observance, celebrated in the United States to commemorate the easy way to build aeronautic paper airplanes. These events feature contests in two basic flight categories: distance and time in air.

7.-Vocabulary

Lift
Drag
Thrust
weight
Airplane
Axis
Roll
Pitch
yaw
Fuselage
Rudder
Elevon
Wing
Aerodynamic
Propulsion
Forces of flight

8.- Materials

A sheet of standard print paper

Additional Materials

Bend a wire coat hanger for handle

Tape measure for measuring the distant

Paper clip

Supplies and supplemental materials approximate cost:

A sheet of standard print paper: $3:63 copy paper 500 sheets

9.-Lesson Presentation

The paper airplanes is a flying machine. Because it has wings and a fuselage, it uses the energy of the air to provide lift. By understanding how paper airplanes are built, we have to choose between different designs and variables of paper airplane flights. At this point, we will make a traditional winged paper airplane and Spy paper airplane.

The traditional paper airplane has a long fuselage with wings. This paper airplane is excellent for long distant flights and is extremely fast.

The Spy paper airplane is a glider airplane with wide wings. This paper airplane generates long sweeping turns and is fast.

1.- First, a sheet of standard printer paper is folded in half.

2.- Fold in half, then unfold.

3.- Fold both top corners into the center of the paper.

4.- Fold both sides in again. Both corners meet at the middle of the paper.

5.- Fold top portion in half.

6.- Fold down both wings so the two top corners meet the bottom edge of the plane.

7.- Unfold wings so they lie horizontal when the plane is in flight.

8.- Fly your airplane to create the three directions of flight: nose up/nose down, nose right/nose left, roll right/roll left. How do you accomplish this?

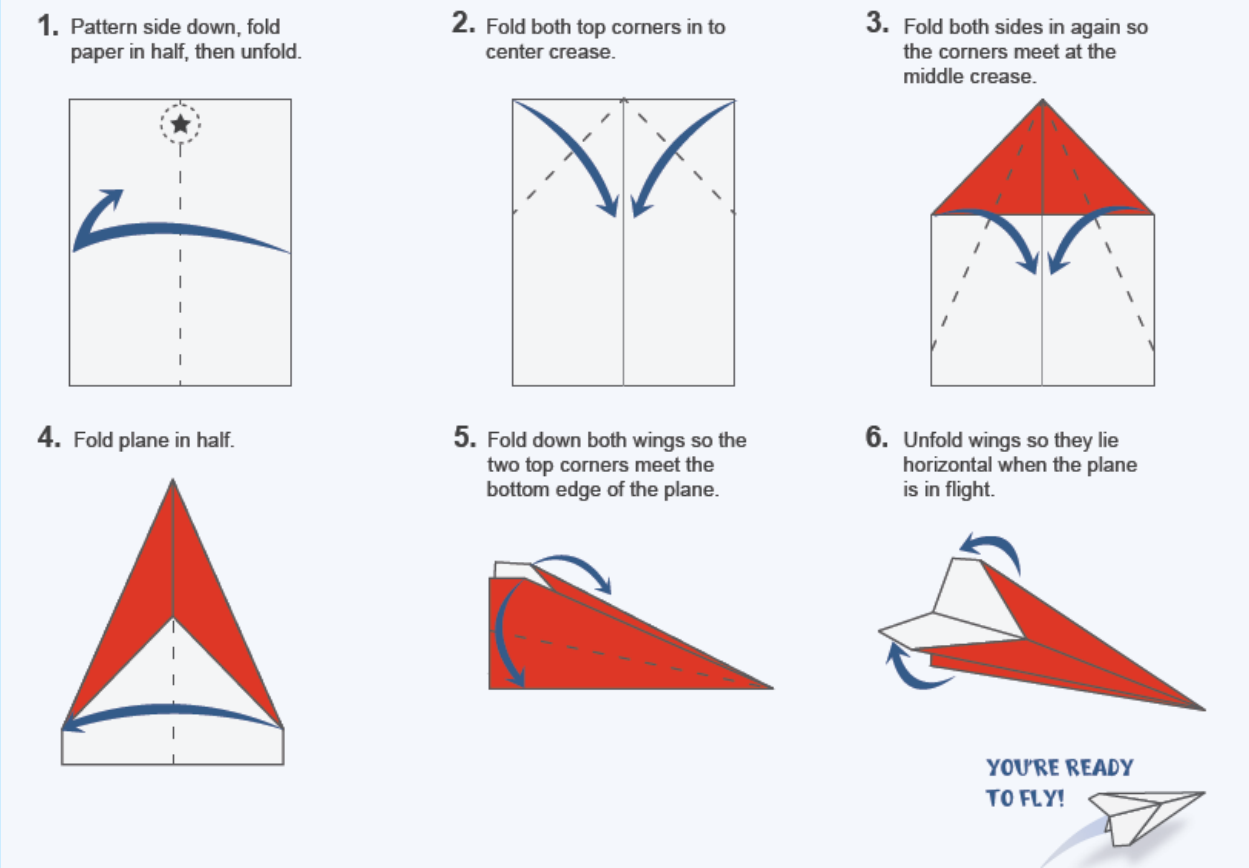
Additional Procedures

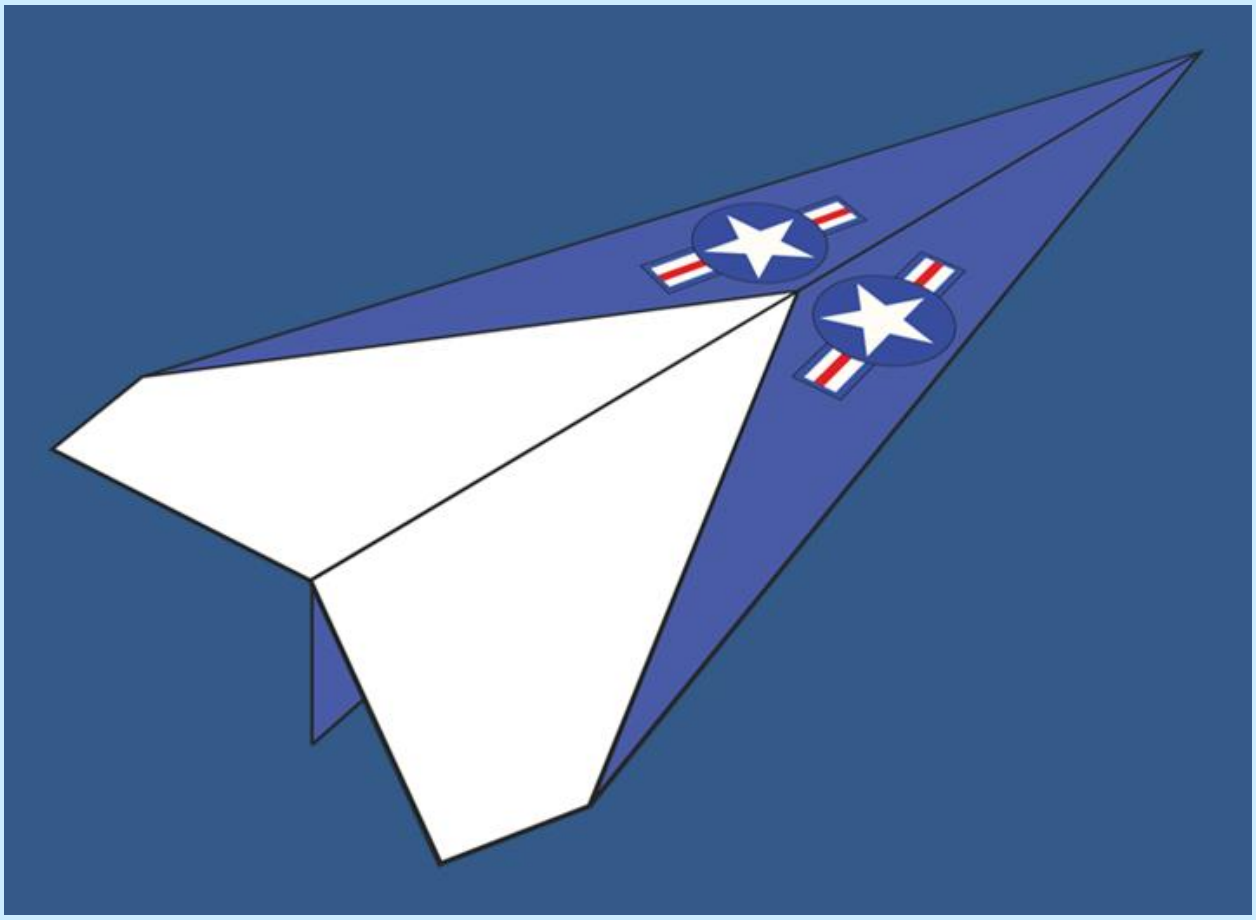
9.- Attach three paper clips to the back of the vertical surface.

10.- Instruct students to place paper clips to the front of the plane for second test.

11.- Glenty bend up the rear corners of the wings.

12 For testing, bend a wire coat hanger into a hoop and hang it.



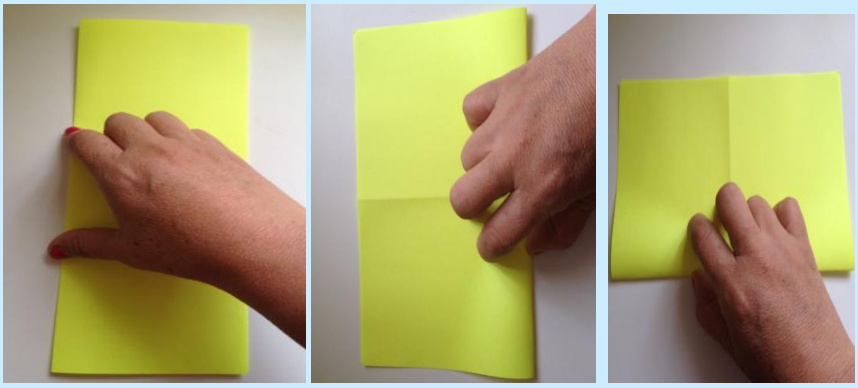


Lesson Plan # 2

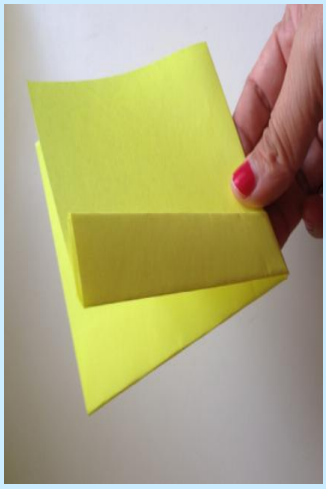
Model: Spy Paper Airplane

1.- First, a sheet of standard printer paper is folded in half.

2.- Fold in half, then unfold and fold the other half and unfold.



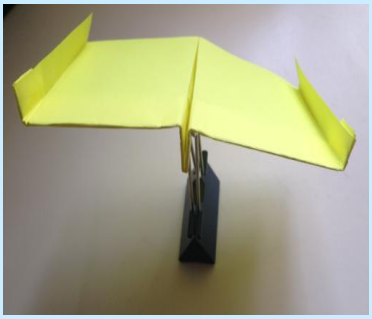
3.- Fold both by one inch 8 times to the center of the paper and fold half of the paper.

4.- Fold left and right wings an inch apart from the center.

5.- Slightly bend the corner of the wings.

6.- Fly your airplane to create the three directions of stability, center of lift, and center of gravity.



Paper Airplane Chart

Test	Distance tested	How long was the flight?
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

You are ready to fly your paper airplanes!

Foam Glider

Lesson Plan # 3

1.-Topic

Aerodynamic aircraft

2.- Subject

Science

3.-Timeline

30 minutes and two weeks, during small group, large group and share reading, math and science activities.

4.- Suggested grade levels:

K to 6th grade

5.-Objectives

The students will learn to create a simple foam glider model FPG-9.

The students will be introduced to concepts about air pressure, drag and how aircrafts use control surfaces to climb, turn, and maintain stable flight.

6.-Background Information

Control surfaces on an airplane help determine the movement of the airplane. The model FPG-9 glider designed by Jack Reynolds will demonstrate how the elevons and the rudder work. Elevons are aircraft control surfaces that combine the functions of the elevator (used for pitch control) and the aileron (used for roll control). The forces generated by the tail surface generates and controls the yawing (left and right wings) motion of the plane.

7.-Vocabulary

Glider
Lift
Drag
Thrust
weight
Airplane
Axis
Roll
Pitch
yaw
Fuselage
Rudder
Elevon
Wing
Aerodynamic
Propulsion
Forces of flight

8.- Materials

FPG-9 pattern
One 9” foam plate
Scissors
Clear tape
Ink pen
One Penny

Additional Materials

Hoola hoop

Supplies and supplemental materials approximately cost:

9” foam plate, 100 count: $3.98
Scissor: $2:60
Clear tape:$4.83

9.-Lesson Presentation

The “Foam Canard Glider” was based on Bill Kuhl’s discovery. The Canard wing glider has control surfaces to climb, turn, and maintain stable flight. This design aircraft model uses elevons as control surfaces for pitch and roll control.

Procedure

1.-Since a paper pattern is hard for students to trace around, the instructor may cut out a foam plate master template for the students to use to trace around.

2.- Cut the FPG-9 glider patter ends along the dotted line. Cut only the bolded lines.

3.- Place the paper pattern in the center of the foam plate and glue it in.

4.- Cut out the foam template by following the lines.

5.- Cut along the dotted line to separate the tail.

6.- Cut out the slots and make them only as wide as the thickness of the foam plate. If it cut too wide, the pieces of the plane will not fit together.

7.- To attach the tail to the wing, slide Slot 1 into Slot 2. Use small pieces of tape to secure both parts.

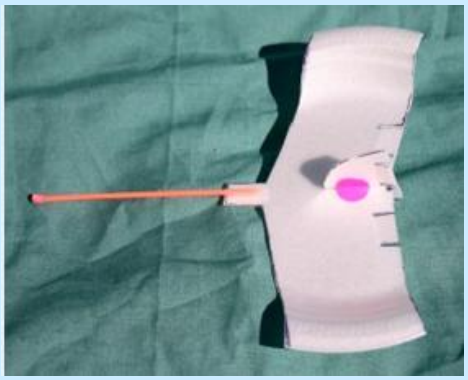
8.- To make the plane fly successfully, the students must attach a penny on top of the wing right behind the square tab. Fold the tab back over the penny and tape it down to secure the coin.

9.- Have a contest to see who can adjust their FPG-9 gliders to hit a target such as a hoola hoop to see which glider goes the farthest.

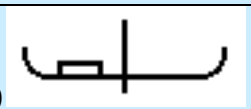
Your foam aircraft is complete and ready to fly. Try throwing it hard with the nose of the glider pointed 30` above the horizon. The speed for a glide is 20 to 25 fee after the loop.

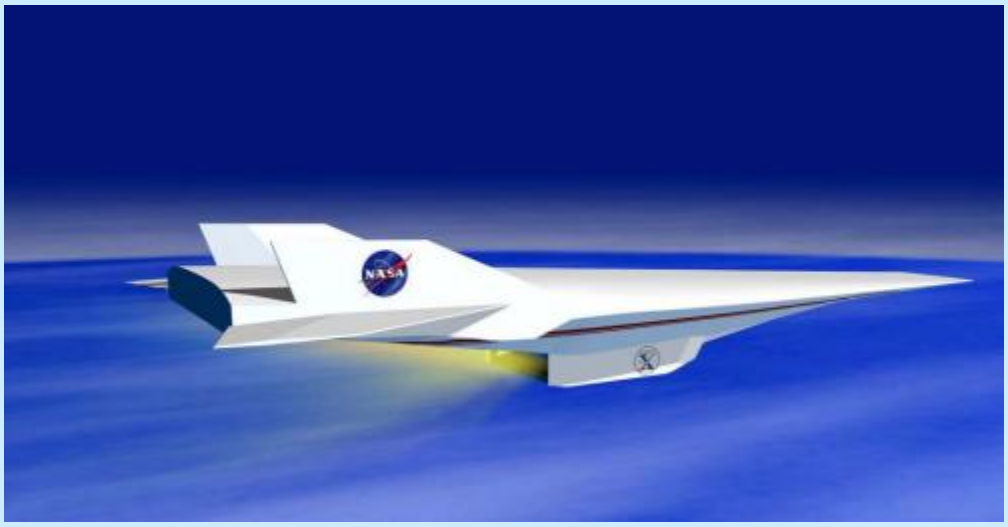






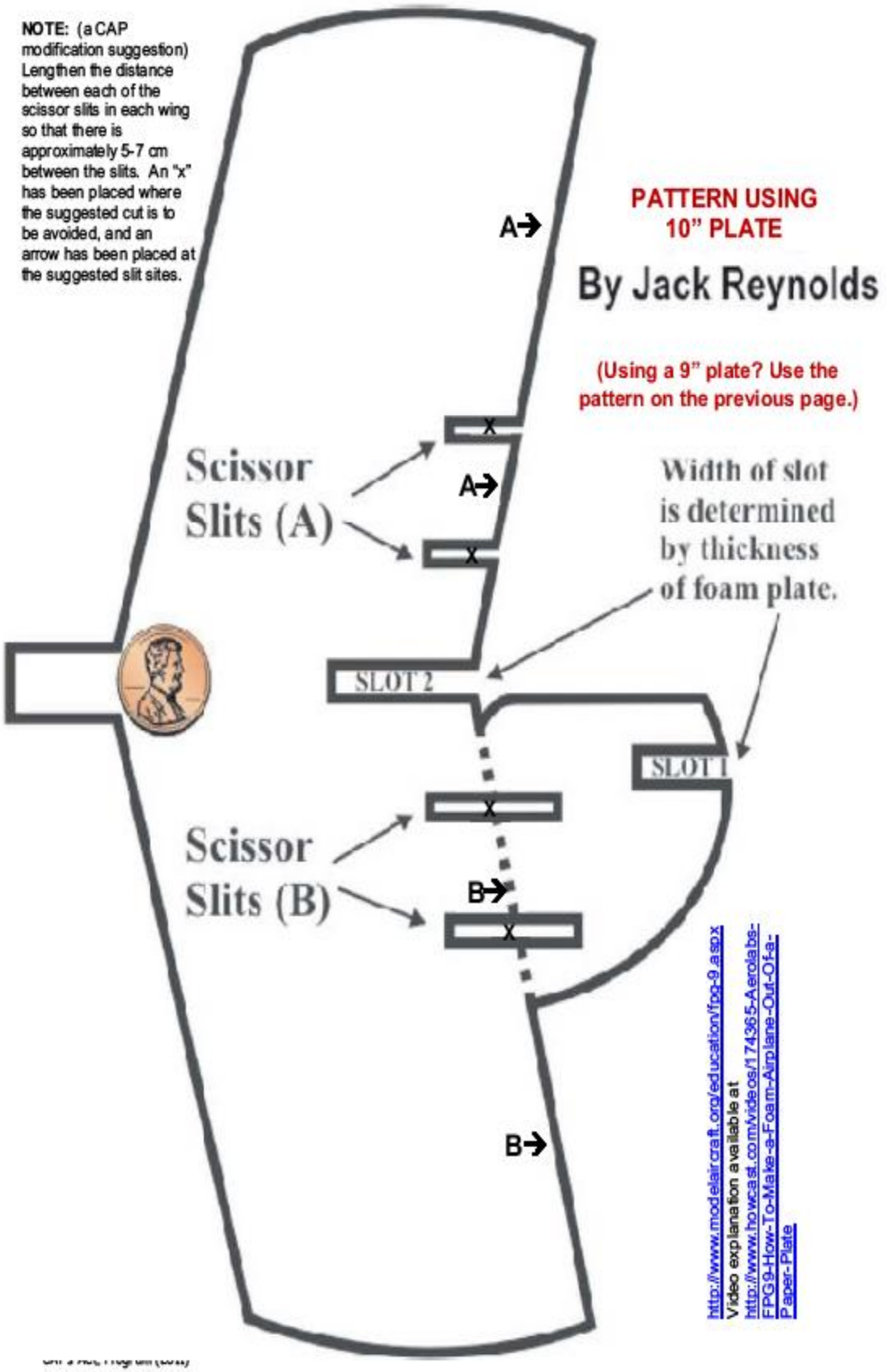
Collect data for these two different elevon configurations:

Elevon Configuration	**Flight Time (Seconds)**				**Average Flight Time (Seconds)**
	Trial 1	Trial 2	Trial 3	Trial 4	
A) 					
B) 					



Template #2

NOTE: (a CAP modification suggestion) Lengthen the distance between each of the scissor slits in each wing so that there is approximately 5-7 cm between the slits. An "x" has been placed where the suggested cut is to be avoided, and an arrow has been placed at the suggested slit sites.



PATTERN USING 10" PLATE

By Jack Reynolds

(Using a 9" plate? Use the pattern on the previous page.)

http://www.modelaircraft.org/education/fpg-9.aspx
Video explanation available at
http://www.howcast.com/videos/174365-Aerolabs-FPG9-How-To-Make-a-Foam-Airplane-Out-Of-a-Paper-Plate

Lucky Paris Landing

Lesson Plan # 4

1.-Topic

Aeronautic

2.- Subject

General science, physics, History and Nature of Science

3.-Timeline

30 minutes and Two weeks, during small group, large group and share reading, math and science activities.

4.- Suggested grade levels:

K -12th grades

5.-Objectives

1.- This is a fun activity designed to create a visual presentation of flight by building and flying an airplane model and learning the basics of flight and parts of an airplane.

2.- Study one of history's aviation pioneers Mr. Charles Lindbergh. He was the first to do it alone from New York to Paris.

6.-Background Information

There are design concepts and basic parts of an aircraft that can be demonstrated using a glider. For example, Cessna airplanes have been used to train pilots. The foam airplane that will be built in this activity include the wing, rudder, aileron, fuselage, stabilizer, winglets, flaps, and elevator. The students will understand the role of weight, balance, control surface deflection, and dihedral on flight characteristics. By using classroom techniques, the students will create a little flying machine.

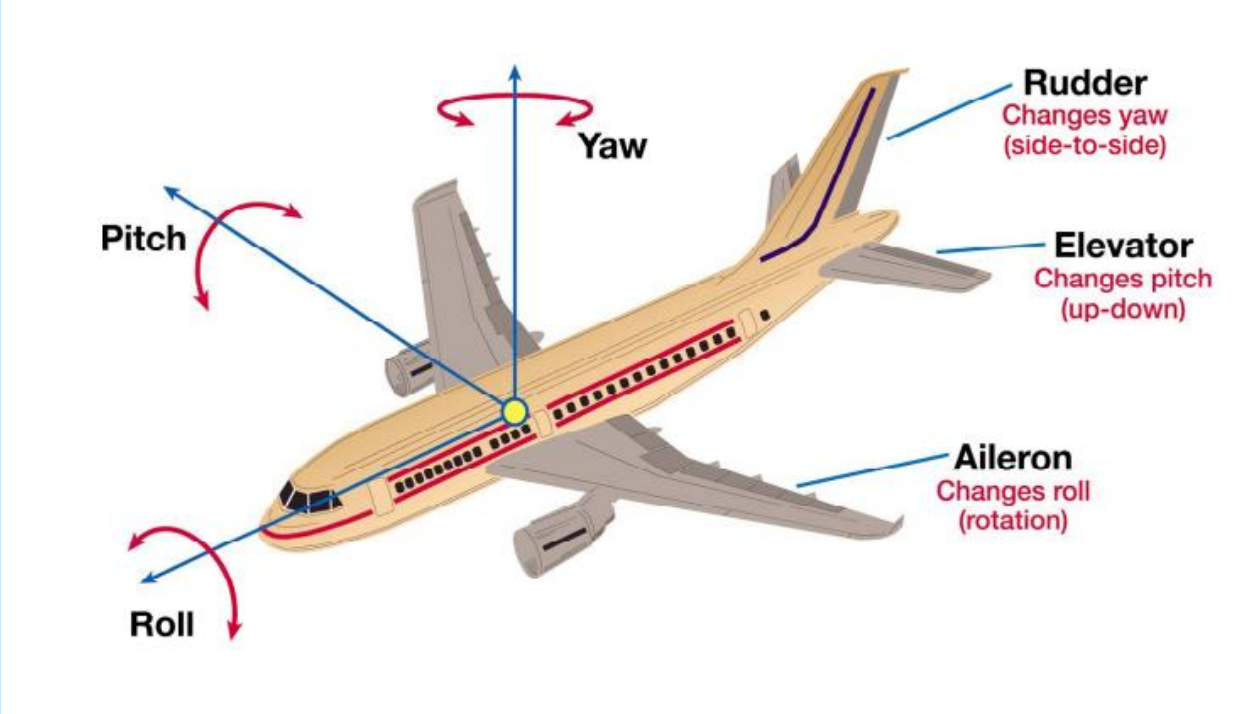
7.-Vocabulary

Propeller
Nose gear
Fuselage
Cockpit
Main gear

Left wing
Left aileron
Left flap
Elevator
Rudder
Vertical fin
Horizontal stabilizer
Right aileron
Right wing
Strut
Cowling

Lift
Drag
Thrust
Weight
gravity
Airplane
Axis
Roll
Pitch
yaw
Fuselage
Rudder
Elevon
Wing
Propulsion

Forces of flight



8.- <u>Materials</u>

Styrofoam meat tray (11 inches by 9 inches)

Template sheet of the airplane

Scissors

Glue stick or a separate area (Table) dedicated to hot glue gun use (teachers or adult supervision)

Tape

Pen

A piece of cardboard (used as a work surface)

Additional Materials

3 soda straws

Nylon fish line (20 pound line)

A wooden dowel or a piece of PVC tubing (24 inches)

Runway area make of tape

Penny

Supplies and supplemental materials approximate cost:

Styrofoam meat tray (11 inches by 9 inches): $3:58
School glue: $4.39
Hot glue gun with glue sticks: $5:22
Scissor: $2.60
Clear tape:$4.83

9.-Lesson Presentation

All that is required is basic aeronautical knowledge and some easily inexpensive materials. This activity design will also introduce history's greatest aviation pioneers by practicing the landing of this foam airplane.

Procedure

1. Let students work in teams of two

2. Teach the four force characteristics of flight.

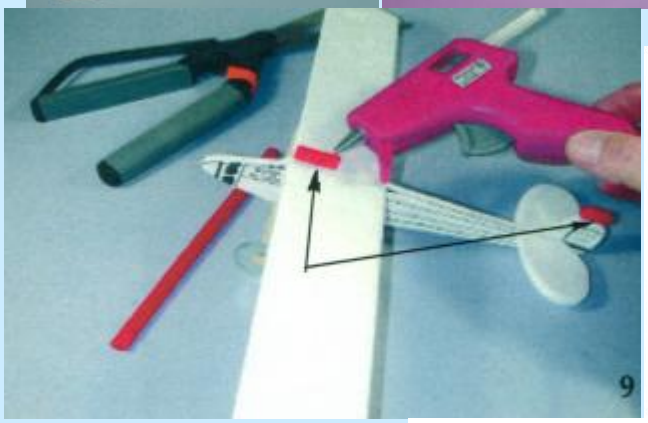
3. Place the paper template in the foam tray and trace the airplane parts

4. Cut out the four pieces of the airplane and glue the part. First glue one wing in plane. Then, once the glue is set, have them glue the other wing in position making sure that it is in perfect alignment with first wing.

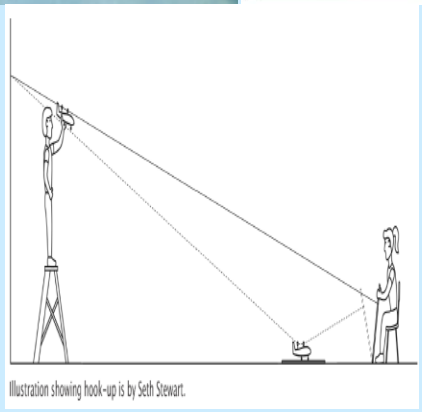
5. Attach a penny to the area of the fuselage using tape or glue.







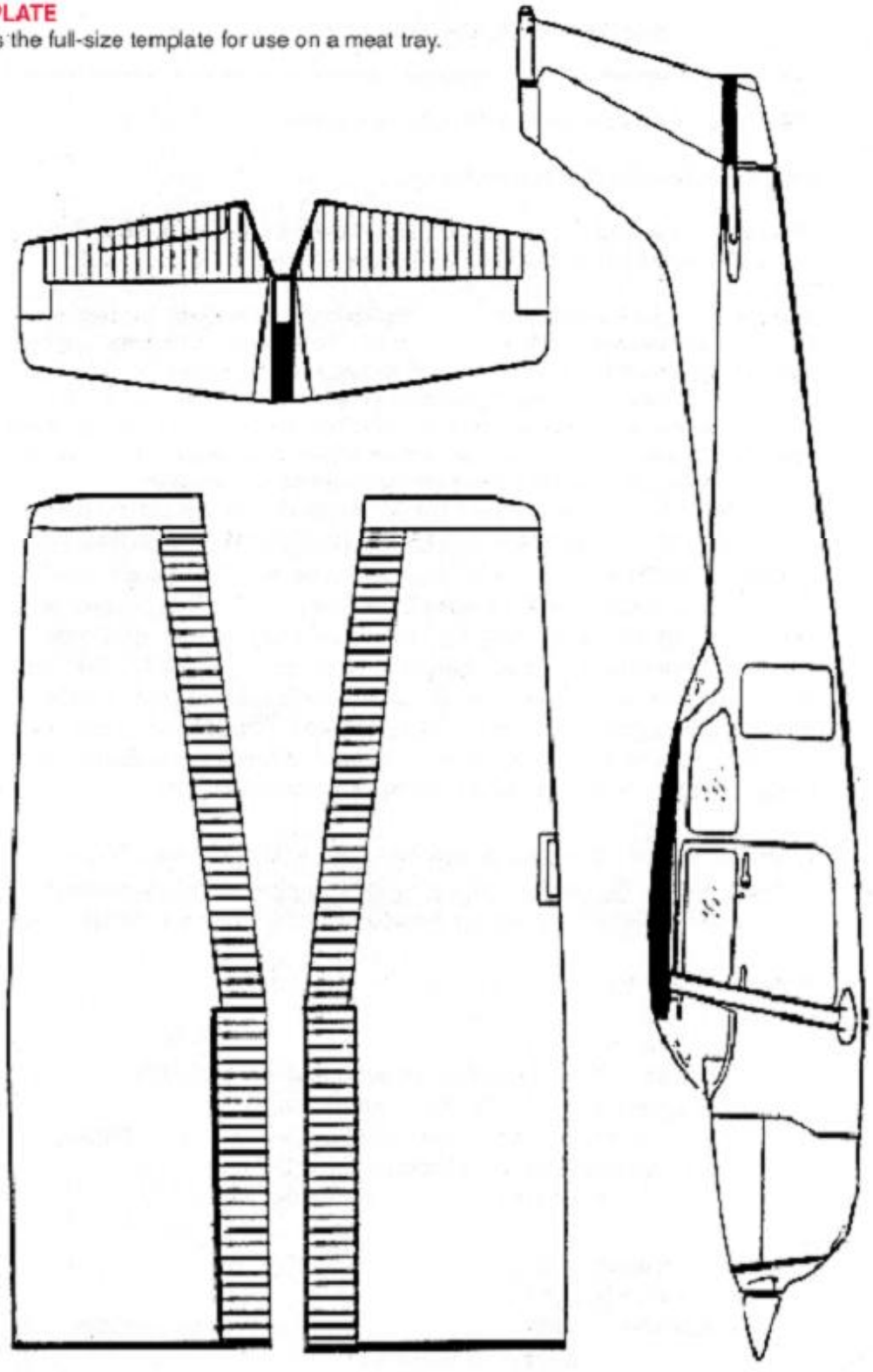




Temple #3

TEMPLATE

This is the full-size template for use on a meat tray.



4.- Resources/ Bibliography

Books:

The Airplane: Alphabet Book by Jerry Pallotta

Kids' Paper Air Plane Book by Ken Blackburn and Jeff Lammers

Cut & Assemble: Paper Airplanes That Fly by Arthur Baker

Growing Up: My First Trip on an Airplane

The Noisy Ride Airplane by Mike Downs

Aerospace: The Journey of Flight by Civil Air Patrol The Official Auxiliary of the United States Air Force, 2nd Edition.

Aerospace Dimensions: Introduction to Flight, Module Published by National Headquarters Civil Air Patrol Aerospace Education Deputy Director Maxwell AFB, Alabama 36112 3rd Edition June 2013 by Dr. Ben Millspaugh

Gllider Event for Distance and Accuracy by Paul LaChance
Simple Gliders in the Science and Mathematics Curriculum by Gary Hinze

Elegance in Flight: A comprehensive History of the F-16XL Experimental Prototype and its Role in NASA Flight Research by Alberto C. Piccirillo
e-book
http://www.nasa.gov/connect/ebooks/elegance_in_flight_detail.html

Teaching Guides: Let's Fly paper Airplanes!
http://edu.jaxa.jp/en/publications/detail/78816

Associated Websites/Videos:

Video from AMA on how to make the FPG-9 glider
http://www.youtube.com/watch?v=pNtew_VzzWg

Simple Bernoulli's principle demonstration
http://www.siue.edu/SIPDC/Library/lesson%20plan/science1.pdf

Animation of Bernoulli's Principle
http://mitchellscience.com/bernoulli_principle_animation

Airfoil Experiment
http://www.allstar.fiu.edu/aero/Experiment1.htm

FPG-9 Control Activity Data Sheet by Jack Reynolds
http://www.modelaircraft.org/education/fpg-9.aspx

Paper Airplanes HQ
http://paperairplaneshq.com/paper-airplanes-designs-for-distance.html

How Things Fly: Smithsonian National Air and Space Museum
http://howthingsfly.si.edu/ask-an-explainer

Paper Airplanes: National Aeronautics and Space Administration
http://www.grc.nasa.gov/WWW/K-12/airplane/glidpaper.html

Activity: Four Forces of Flight
http://www.faa.gov/education/educator_resources/educators_corner/grade_7_8/four_forces_of_flight/

Kids' Corner: Miami International Airport
http://www.miami-airport.com/traveling_with_children.asp

Organizations:

Civil Air Patrol: Aerospace Education
http://ae.capmembers.com

NASA Education
http://www.nasa.gov/offices/education/about/index.html

Space Foundation
http://www.spacefoundation.org/education-programs/teacher-liaison-officers

Patricia and Phillip Frost Museum of Science
http://www.miamisci.org/

Academy of Model Aeronautics
http://www.modelaircraft.org

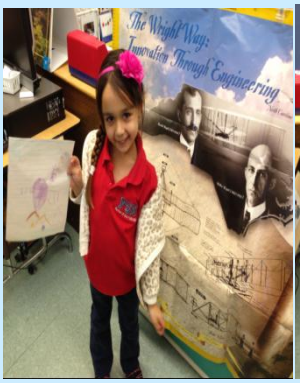
Miami International Airport
http://www.miami-airport.com/tours.asp

Speakers:

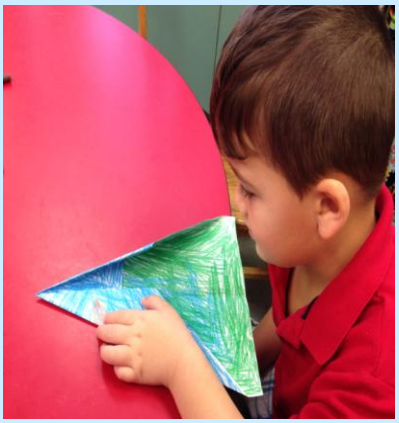
Request a Florida Wing Civil Air Patrol/ United States Air Force Auxiliary's speakers:
Contact: Major Laz Garcia Civil Air Patrol
Opa Locka Cadet Squadron Commander
Serfl464@gmail.com

Request a NASA speaker:
John F. Kennedy Space Center (KSC):
Layla Higgins (321)867-7711
Layala.m.higgins@nasa.gov

5.- Student Work sample




How High Can You Fly?

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