NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE™

# Mathematics with Basic Airplane Motion

*Students will construct simple gliders and conduct a series of test flights to discover how the rudder, elevator and ailerons affect flight. Students will measure distances flown and use a stopwatch to determine time aloft for each glider flight.*

LESSON PLAN

**Grade Level:** 3 – 5

**Ohio Learning Standards/Science (2018)**
*Nature of Science*
Scientific Inquiry, Practice and Application
Science is a Way of Knowing

5.PS.1: Force and Motion

**Ohio Learning Standards/Mathematics (2017)**
*Measurement and Data*
3.MD.4: Generate measurement data
4.MD.2: Solve metric measurement problems
5.MD.1: Convert measurements

**Lesson Objective**

The Students will:
- Construct a glider
- Predict and observe how the rudder, ailerons and elevator affect flight
- Measure distance flown (using metric where appropriate)
- Use a stopwatch to determine time aloft

**Goal**: In this lesson, students will construct paper gliders and conduct a series of test flights to discover how the rudder, elevator and ailerons affect flight. Students will measure distances flown and use a stopwatch to determine time aloft for each glider flight.

**Background:** At the rear of the fuselage on many aircraft is a rudder. The rudder works to control the yaw and adds stability. A yaw motion is a side to side movement of the aircraft nose. Ailerons raise and lower each wing separately. The pilot controls the roll of the plane by raising one aileron or the other with a control wheel. Turning the control wheel clockwise raises the right aileron and lowers the left aileron, which rolls the aircraft to the right. Turning the control wheel counter-clockwise does the opposite. The ailerons are used to make a plane turn. The entire elevator moves up and down which causes the nose of the plane to move up and down. This is called the pitch. In actual flight, the movement of these control surfaces are nominal to produce precise aircraft direction changes. (See page 3.)

**Safety Instructions:** Do not fly paper gliders directly at another person because the pointed tip could cause injury. Use caution when flying the paper airplanes. Create a single direction flight zone. Be sure that students stop flying their airplanes when other students are retrieving airplanes that have already landed.

**Materials Required:**
Each student will need:
- Glider pattern
- Heavyweight paper
- Straw
- Tape
- Scissors
- Paper clip

For the flight you will need:
- Stopwatch
- Tape measure (either standard or metric)

**Resources:**

https://howthingsfly.si.edu/flight-dynamics/control-surfaces
https://www.nasa.gov/sites/default/files/atoms/files/axes_control_surfaces_k-4.pdf
https://www.nasa.gov/sites/default/files/atoms/files/axes_control_surfaces_5-8.pdf

**Procedure:**

***A. Warm-up:***

Explain to the class the function of the rudder, ailerons and elevator.

***B. Activity (Build):***

1. For this lesson, the students should construct a simple glider with traditional wings, a horizontal stabilizer and a vertical stabilizer. Many designs are available online as well as many inexpensive kits are available for purchase – or the students may build a simple straw and paper glider using the following directions.

**2.** Cut out the three shapes from the pattern. Cut the slits in the wings and fin, but **do not fold them back.**

3. Fold the wing in half along the center dotted line. Fold each wing back along the second dotted lines. Tape the straw on top of the wing so that it sits on top of the folds. The folded section underneath the straw will assist in launching the glider.

4. Tape the tail to the end of the straw so that the end of the straw is lined up with the center of the tail.

5. Cut a slit at the top of the straw at the tail end. Insert the fin vertically into the slit and tape it into place.

6. Attach a paper clip to the nose.

***C.* Activity (Fly):**

1. Test the glider in a large, indoor area (such as a gymnasium). At one end of the gym, put a piece of masking tape on the floor to designate where the student will stand to launch the glider. For the first flight, leave the rudder, ailerons and elevator flat.

2. Measure and record the distance it flew, how straight it flew, and the length of time the glider was aloft. Record results on the Recording Sheet. Use metric system where appropriate. Convert between metric and customary where appropriate.

3. Now it is time to discover how the rudder, ailerons and elevator can affect the flight of the glider. First, students will predict what effect each change will have on the glider. Then, changing only one variable at a time, students will test fly the glider and record results.

**Extensions:**

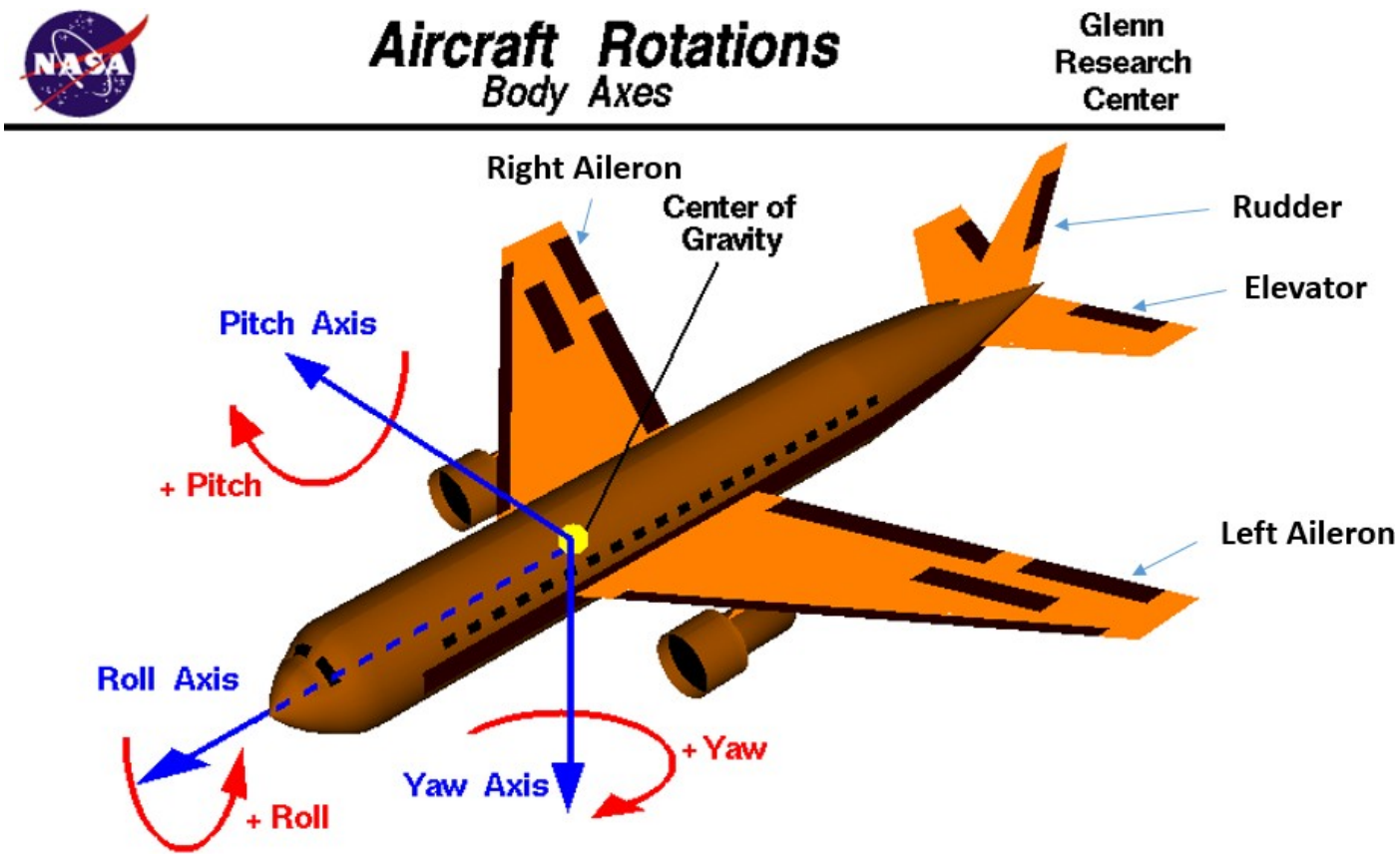
1. Create a graph comparing the results of the glider's time aloft when the elevators are flat as opposed to bent. Calculate a class mean.

2. Write a creative story about a flight where the rudder, ailerons and elevator were frozen. What would happen?

3. Have a contest to determine which glider stays aloft the longest, flies the farthest or is the most accurate.

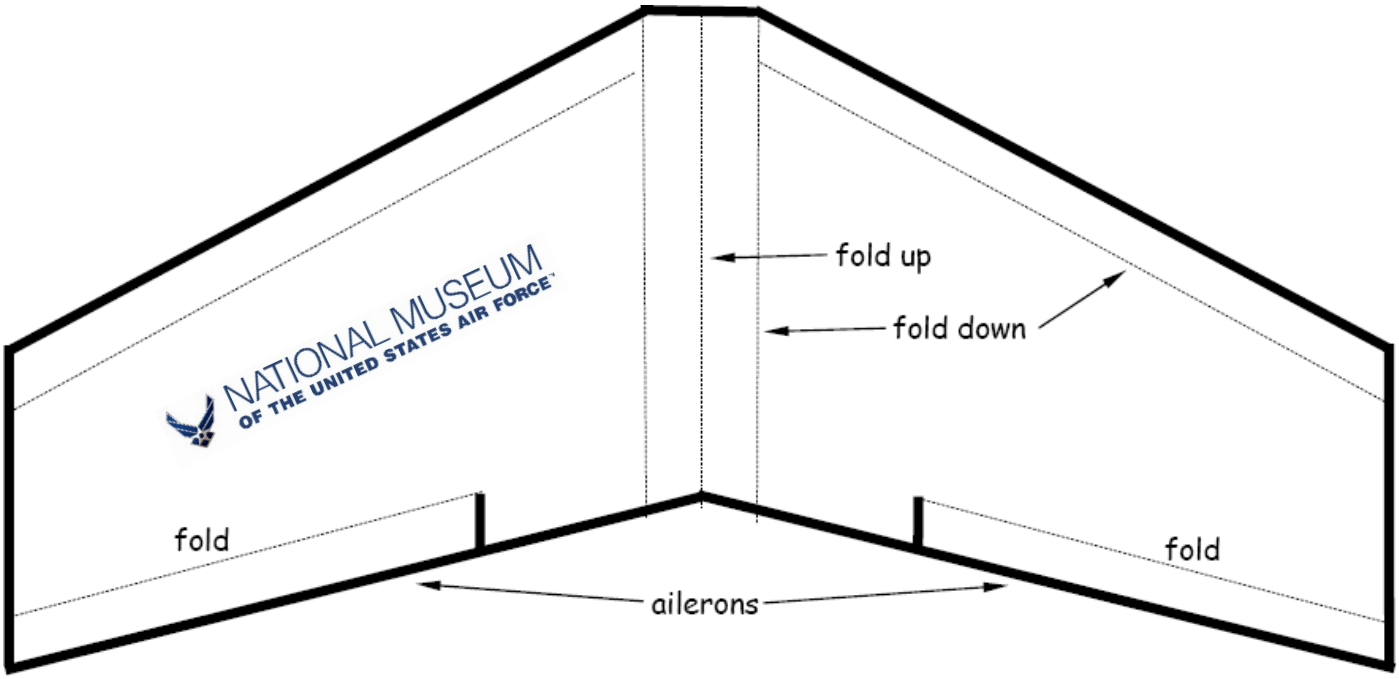
**Assessment/Evaluation:**

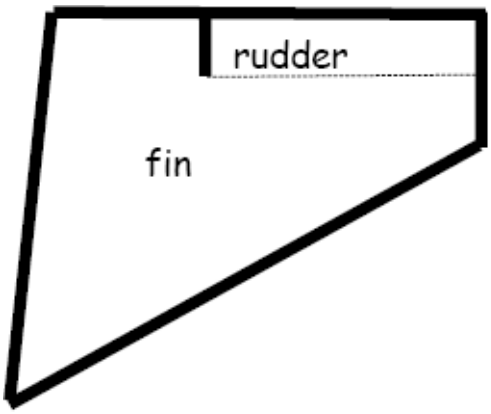
Students will write a paragraph explaining observations made during the various test flights.

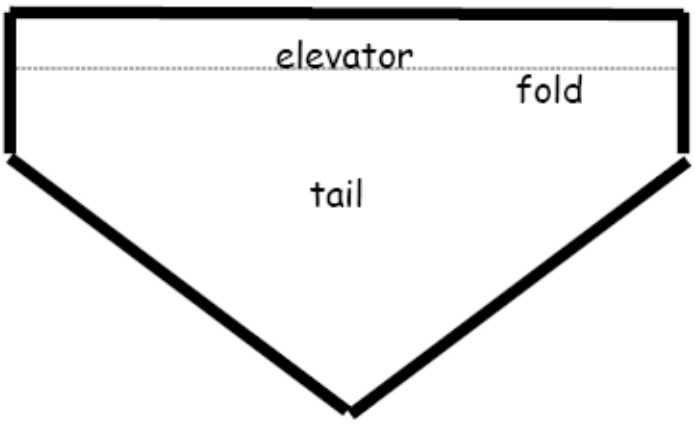



Picture courtesy of NASA downloaded Aug 2020

**Mathematics with**
**Basic Airplane Motion**



## Recording Sheet

| Action | Time Aloft | Distance Flown | Direction of Flight: Straight, roll left or roll right | Observations |
|---|---|---|---|---|
| Initial test flight | | | | |
| Elevator up | | | | |
| Elevator down | | | | |
| Left aileron up, right aileron down | | | | |
| Right aileron up, left aileron down | | | | |

## Answer Key

| Action | Time Aloft | Distance Flown | Direction of Flight: Straight, roll left or roll right | Expected Results |
|---|---|---|---|---|
| Initial test flight | | | | Plane should fly level without turning |
| Elevator up | | | | Plane (nose) should go in a upward motion |
| Elevator down | | | | Plane (nose) should go in a downward motion |
| Left aileron up, right aileron down | | | | Plane rolls left |
| Right aileron up, left aileron down | | | | Plane rolls right |