Civil Air Patrol's

ACE Program

Aerospace Connections in Education

Grades K - 6

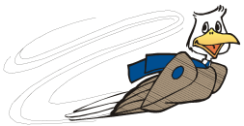
Grade 6

Instructor Guide

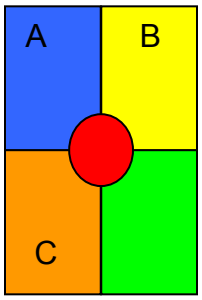
"CAPPY"

www.gocivilairpatrol.com/ace

Program Support



Civil Air Patrol's ACE Program



Target
Grade 6 Academic Lesson #2

Topics: airplane surface controls, motion, design, probability (science, math)

Length of Lesson: 30 - 60 minutes

Reference: Elements of this lesson came from NASA "Why?" Files - The Case of the Challenging Flight.

Objectives:

- Students will define and demonstrate roll, pitch, and yaw.
- Students will experiment with surface controls to adjust flight paths.
- Students will convert fractions to decimals.
- Students will calculate percentages and determine probability from data.

Next Generation Science Standards:

- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

CCSS ELA:

- L 5.6 - Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level.

CCSS Math:

- 6.RP.1 - Understand ratio concepts and use ratio reasoning to solve problems.
- 6.SP.4 - Summarize and describe distributions.

Background Information:

You may wish to watch these videos (or share them with your class):
- Axes of Movement or
- Roll-Pitch-Yaw
(The information and picture below are from Space Day Toolkit: Middle School Teaching Guide.)

Pilots use different terms to describe the particular ways an aircraft moves forward:

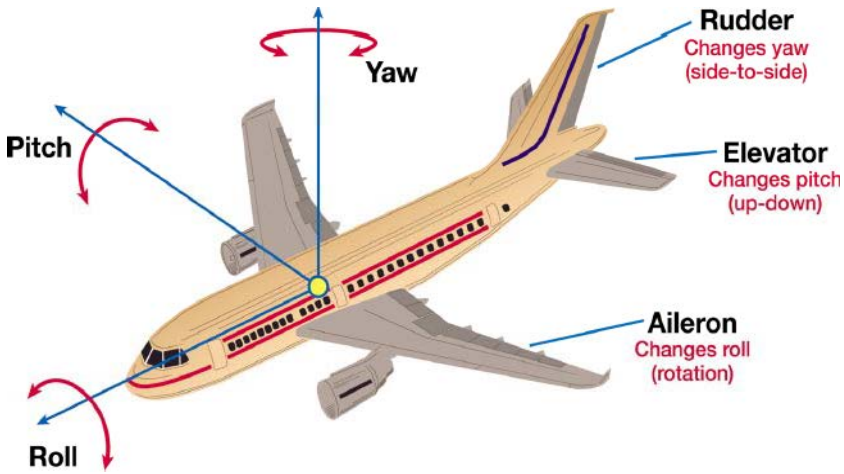
Pitch: Aircraft nose moves up or down
Roll: One wing of aircraft tips up while the other tips down
Yaw: Nose of airplane moves left or right while remaining level with the ground

Pilots use several control surfaces (movable sections on the aircraft's surface) to better direct an aircraft's movement. These include:

Elevator: Section on horizontal part of tail that controls pitch
Aileron: Section at rear edge of wing near tip that controls roll
Rudder: Section attached to vertical part of tail that controls yaw

Materials:

- 5 pieces of green construction paper
- 5 pieces of blue construction paper
- 5 pieces of yellow construction paper
- 5 pieces of orange construction paper
- 1 piece of red construction paper
- tape
- Target Data Sheet (included)



NOTE: For this lesson, students need to have knowledge of converting fractions to decimals and decimals to percents. This motivational lesson provides practical practice and application of these math skills.

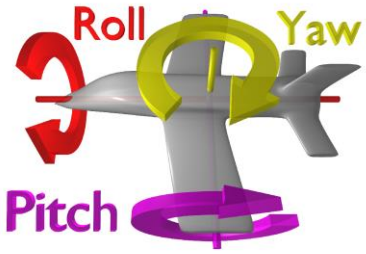
For homework, prior to teaching this lesson, ask students to make their best paper airplane. If they do not know how to make a paper airplane, you may suggest that they research designs, or you may provide the instructions on how to make the "Simple Paper Airplane" included in this lesson. Tell students that they will need their paper airplane during class tomorrow.

Have 5 target areas set up prior to the beginning of class the next day. To assemble the target areas, join 4 different colored pieces of construction paper together using tape. Place a reasonably sized red circle (or square) in the middle of the 4 pieces of construction paper to represent the bulls-eye.
Label the colored squares as A, B, C, and D, as illustrated (on page 31).

Lesson Presentation:

1. Ask students to take out their paper airplane and a pencil. Tell students that they will use math and science to determine how well they can hit a target.

2. Prior to target practice, inform students that they will learn or recall a few things about airplanes. (A fifth-grade ACE lesson provided instruction on pitch, roll, and yaw.) First of all, airplanes can travel forward, but they can also roll, pitch and yaw. Demonstrate roll, pitch, and yaw with a paper airplane.



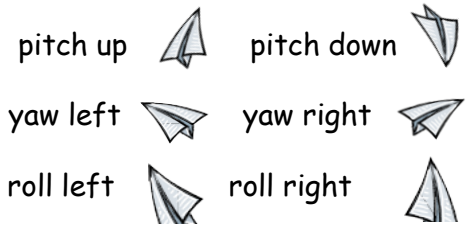
   - Roll: Tell students to imagine an imaginary horizontal line running through the nose of the airplane to the back end of the plane. If the airplane rotates left or right on this imaginary line, it is rolling. Demonstrate roll by tipping one wing down (the other wing automatically goes up), keeping the body of the airplane (the fuselage), in the same place. (You may wish to use a straw to represent the imaginary axis.)

   - Pitch: Tell students to imagine a line running through the plane from wingtip to wingtip. If the airplane rotates up or down on this imaginary line, it is pitching. Holding the wings level, pitch the nose up (move the nose up and the tail goes down). Tell students when the nose goes up, the plane is pitching upward. Tip the nose down, and tell students that when the nose of the plane goes down and the tail is up, the plane is pitching down.

   - Yaw: Tell students to imagine a vertical line stabbing the plane right in its mid-section. If the plane twists left or right along this imaginary axis, it is yawing. Tell students to think of a swivel chair. Turn the nose of the airplane to the left and tell students that this is an example of the plane yawing to the left. Then, demonstrate a yaw to the right.

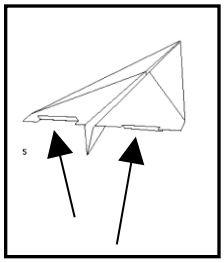
3. (optional) To reinforce or help students better understand roll, pitch, and yaw, have the students kinesthetically demonstrate roll, pitch, and yaw. Tell them to roll by leaning at their waist to their left or right. Tell them pitch by bending forward at their waist and raising their back and head up and down (like bowing to a king or queen). Tell them to yaw by spinning to their left or right on one foot (like being in a swivel chair).

4. Call out roll, pitch, and yaw positions to students and have students orient their paper airplane appropriately.



5. Tell students that an airplane's control surfaces (moveable sections on an airplane's surface), such as a rudder, aileron, and elevator, affect how the plane rolls, pitches, and yaws. (See background information.)

6. Have students make 2 small cuts a few centimeters apart at the back of each wingtip if they have not done so. State that these movable parts are called elevons and that an elevon is a combination of an aileron and elevator. (See background information.) Tell students that they can bend the elevons slightly up or down, and this will change the flight path of their airplane. (Teachers: You may want students to experiment with the elevons to find out on their own how adjusting the elevons affects flight, or if time is an issue you may want to provide instructions. For example, if their plane is flying too low, they can slightly bend both elevons up slightly, and the plane will move up. If their plane is flying too high, they can lower the elevons to bring the plane down. If students have one elevon up and one down, it affects roll to the left or right.) Tell students that their paper airplane does not have a rudder (the movable piece on the vertical tail of the aircraft), so they cannot control yaw.



7. Distribute a "Target Data Sheet" to each student, and divide students into 5 groups. Tell students that they will line up in front of a target area (the colored pieces of construction paper taped to the wall). They will take turns tossing their plane toward the red bull's-eye. After their toss, they will move to the back of the line and make a tally mark on their data sheet in the correct box to indicate where the nose of their airplane hit the target area. For example, if they toss it and it hits the "A" piece of construction paper, they should put a tally mark in the "A" box on their data sheet. Tell students they have 8 times (or other amount determined by the teacher), to toss their plane at the target. Once they have completed all tosses, they should answer the remaining questions on the data sheet. Discuss how to complete the chart by putting an example on the board if necessary.

8. Direct each group to their target area and allow them to begin.

9. As time permits, allow students to share some results from their data sheet. Determine who has the best aim.

10. Ask students to explain how they used math and science to determine how well they can hit a target with a paper airplane. (Possible discussions: Newton's laws of motion help explain why the plane moves: inertia, F=MA, action/reaction. Also, students used the scientific method by asking, "What will happen if I toss it like this?" They hypothesized, analyzed, drew conclusions, and made adjustments. They were able to count and create a percentage to describe their accuracy in hitting a target. It is more specific to say, "I can hit the bull's-eye 70% of the time," rather than saying, "I am good at hitting a bull's-eye with a paper airplane.")

Summarization:

Ask students to summarize what they learned from today's lesson. In sharing lessons learned, ensure that someone explains pitch, roll, and yaw. Remind students that science and math help to explain and provide a better understanding and description of events.

Character Connection: Ask students what would happen if they practiced these skills (tossing airplanes at a target, converting fractions to decimals, and converting decimals to percents), every day. In theory, they should become better and better. Remind students that while practice may not make perfect, it does make one better. Encourage students to practice good character skills daily and work on being the best person they can be.

Assessment:

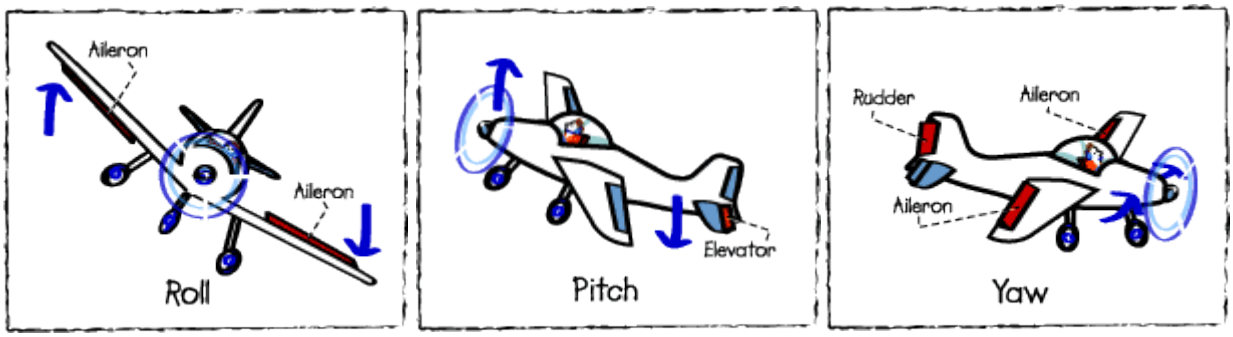
- teacher observation
- "Target Data Sheet"

Additional activity ideas to enrich and extend the primary lesson (optional):

- Have students determine the overall percentage of hitting a target for girls versus boys.
- Complete the "Flight Direction Challenge Point Worksheet." (a NASA worksheet)
- Have students use their own personal data from their "Target Data Sheet" to create a page that provides information like that on the "Flight Direction Challenge Point Worksheet."

Associated Websites:

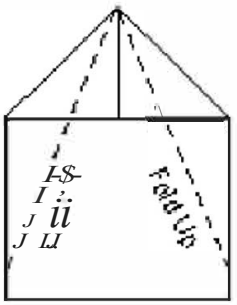
- Diagram of roll, pitch, and yaw from How Things Fly: Roll, Pitch and Yaw



Source: NASA Dynamics of Flight - What is air?

SIMPLE PAPER AIRPLANE

1



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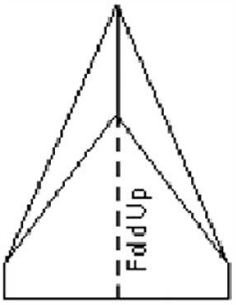

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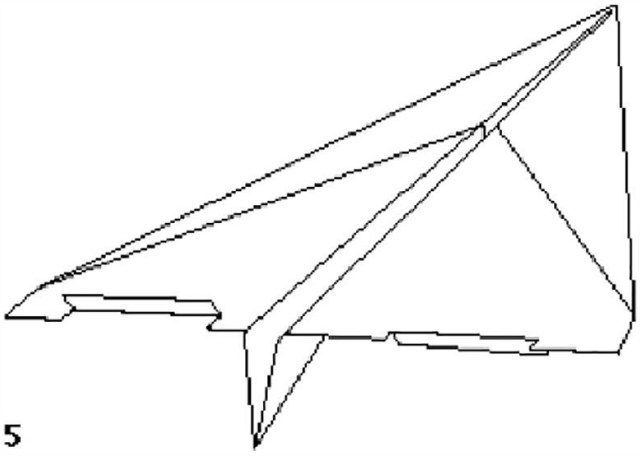
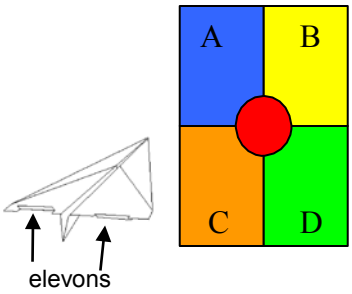


5

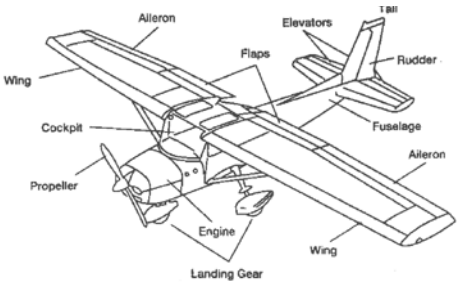
Target Data Sheet

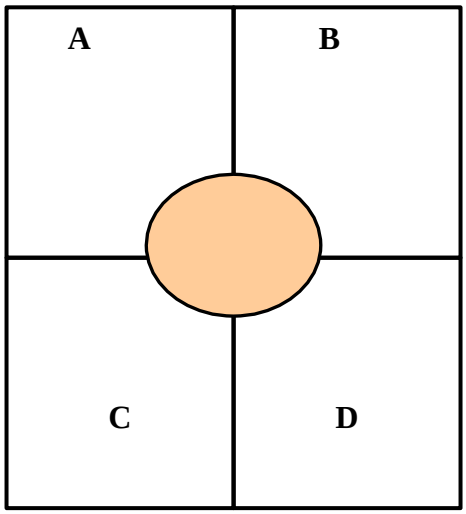


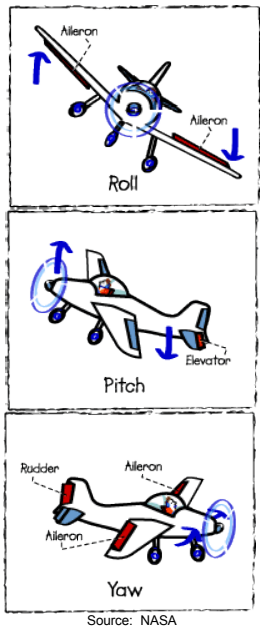
NAME_____

1. How many total times did your teacher say that you are to toss the plane for this activity? _____

2. Each time after you toss your paper airplane, place a tally mark in the target picture below to indicate where your airplane struck the target area.







Source: NASA

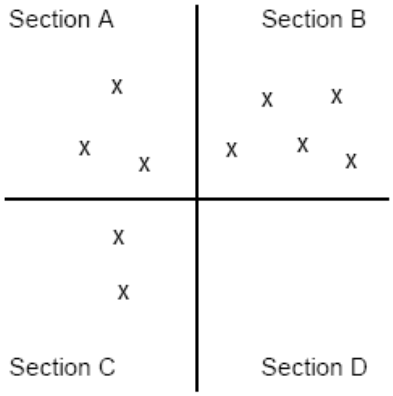
3. Complete the chart below:

	# of times it hit this area	Total # of times you threw the plane	Write a fraction indicating how many times you hit this area.	What % of the time did you hit this area?
A				
B				
C				
D				
Bull's-eye				

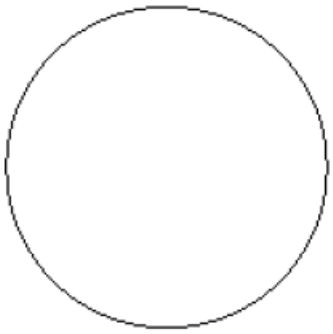
CHALLENGE POINT WORKSHEET
INTERMEDIATE LEVEL (5-8)

McINTOSH STUDENTS' FLIGHT DATA

Flight Results



Create a pie graph to represent the flight results on the left.



Section A—Green Section B—Red
Section C—Yellow Section D—Blue

1. Which section of the target did the McIntosh Team's planes hit the most? The least?
   MOST: Section _____ LEAST: Section _____

2. What patterns do you notice in the data for their airplar s
   _____
   _____
   _____

3. Of the 10 landings, how many were in section A? In section B? In section C? In section D?

   Section A:_____ Section B:_____ Section C:_____ Section D:_____

4. Discuss how the number of landings in a section can be expressed with either a fraction or decimal. Organize the data in the displayed table.

Area	No. of Landings	Total Flights	Fraction	Decimal
Section A		10		
Section B		10		
Section C		10		
Section D		10		

5. Color the circle graph to summarize landing results for each section of the sample data.

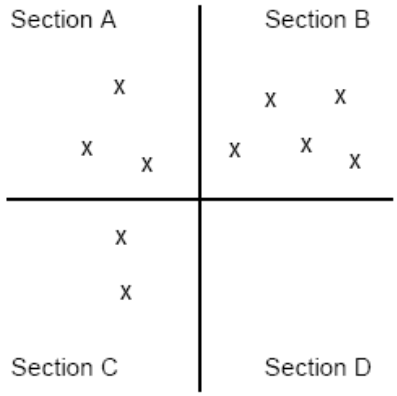
ANSWER KEY

Program 1 Flight Directior

CHALLENGE POINT WORKSHEET ANSWER KEY
INTERMEDIATE LEVEL (5-8)

McINTOSH STUDENTS' FLIGHT DATA

Flight Results:



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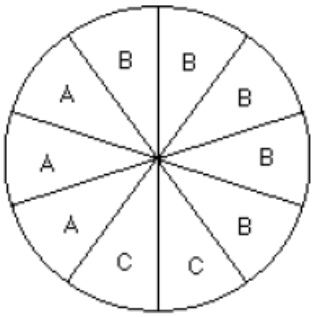


Section A—Green Section B—Red
Section C—Yellow Section D—Blue

1. Which section of the target did the McIntosh Team's planes hit the most? The least?
   MOST: Section B LEAST: Section D

2. What patterns do you notice in the data for their airplar s

   _____

   _____

   _____

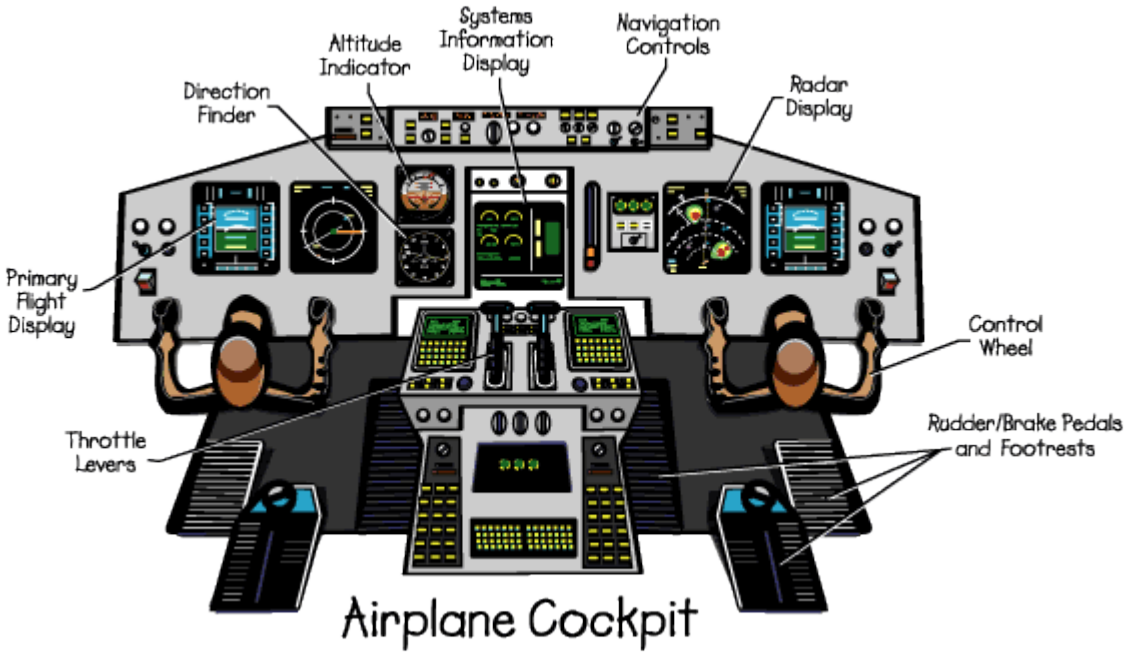
3. Of the 10 landings, how many were in section A? In section B? In section C? In section D?

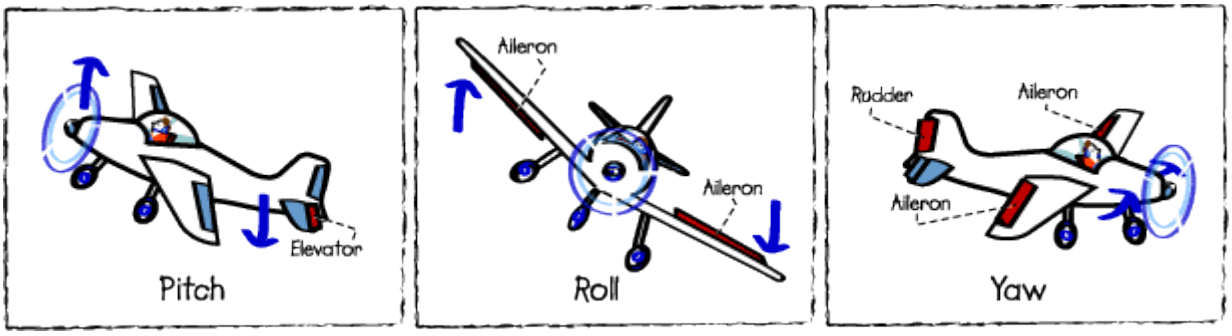
   Section A: 3 Section B: 5 Section C: 2 Section D: 0

4. Discuss how the number of landings in a section can be expressed with either a fraction or decimal. Organize the data in the displayed table.

Area	No. of Landings	Total Flights	Fraction	Decimal
Section A	3	10	3/10	.30
Section B	5	10	5/10	.50
Section C	2	10	2/10	.20
Section D	0	10	0/10	.00

5. Color the circle graph to summarize landing results for each section of the sample data.





Source: [NASA Dynamics of Flight - What is air?]