NATIONAL MUSEUM OF THE PACIFIC WAR
FREDERICKSBURG, TEXAS

STEAM LESSON PLAN: TAKING FLIGHT

INTRODUCTION:

In this lesson, students will explore the five W's and H questions of aviation. Who was involved? What happened? When did it happen? Where did it happen? Why did it happen? How did it happen?

Using this knowledge, students will then design and construct paper airplanes using the process of iterative design to prepare for flight trials.

OBJECTIVES:

- Gain an understanding of the history of aviation, the science behind flight, and the significance of airplane innovations, particularly during World War II.
- Design and build paper airplanes that can successfully fly using their knowledge of airplane parts and their functions.
- Use the process of iterative design to modify their designs to improve its flight.
- Complete flight trials using their final design.

KEY CONCEPTS

- Lift: Understanding the phenomenon of lift and its role in aircraft flight.
- Bernoulli's Principle: Exploring how differences in air pressure contribute to the generation of lift.
- Wing Design: Investigating the significance of wing shape and structure in creating lift.
- Thrust and Drag: Recognizing the importance of propulsion and aerodynamic forces in flight.
- Iterative Process: an approach to continuously improving a concept, design, or product. Creators produce a prototype, test it, tweak it, and repeat the cycle with the goal of getting closer to the solution.

GRADE LEVEL:

5-12

TIME REQUIREMENT:

90 Minutes

TEKS ADDRESSED WITHIN THE LESSON:

Grade 7: 19.1.A, 19.7.E, 19.20.A, 19.20.B, 19.20.C, 19.20.D, 19.20.E, 19.22.A, 19.20.C, 19.23

Grade 8: 20.29.A, 20.29.C, 20.29.A, 20.29.C, 20.31

US History Since 1877: 41.7.D, 41.7.E, 41.28. A, 41.28.C, 41.29.A, 41.29.B, 41.30.B, 41.31

World History: 42.12.C, 42.27.C, 42.28.E, 42.30.A, 42.30.C, 42.31

NATIONAL STANDARDS

Historical Content Era 8, Standard 3B

The student will understand the United States' role in the Pacific theater through the courses of action taken by the Army and the Navy.

Historical Thinking Standard 3

- Students will be able to:
  - Compare and contrast the ideas and behaviors of General Douglas MacArthur and Admiral Chester Nimitz.
  - Understand and explain the cause-and-effect relationships between MacArthur and Nimitz's decisions.
  - Hypothesize the weaknesses and strengths of MacArthur and Nimitz.

World History Era 8, Standard 4B

The student will be able to explain the major turning points of the war in the Pacific theatre.

NGSS-Science Standards

- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- 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.

Common Core-Math

- Represent and interpret data
- Represent and analyze quantitative relationships between dependent and independent variables

MATERIALS

- Blank plane diagram (projected for the class)
- Technology to play videos from YouTube
- Paper
- Writing utensil
- Colored pencils or crayons
- Tape
- Scissors
- Tape measure
- Glue

- Paperclips
- Objects to mark a starting position and landing point
- Parts and Function Worksheet
- Plane design instructions
- Stopwatch

LESSON INSTRUCTION

PART ONE: BEFORE THE ACTIVITY

1. Gather materials and make copies of the flight worksheet, aviation timeline, and trial logs.
2. Create a few paper airplane designs to use as an example.
3. Prepare a testing area by marking a starting position and clearing an unobstructed area to throw paper airplanes.

PART TWO: INTRODUCTION TO AVIATION

1. In a class discussion, ask the students why humans would want to fly. What motivations might they have to take to the skies? How has aviation changed society, war, life, etc?
2. Present the background information to the class. Discuss the history of aviation and the significance of their technological innovations, particularly those during WWII. *Note: Information is at a higher reading level. Adjust and simplify the reading level of the information to meet the needs of your class.*
    a. Now that the students have a brief history, ask them if their answers to the previous prompt have changed?
    b. Additional Resource: The Timeline of Flight from the Library of Congress

HISTORICAL BACKGROUND:

Even though the first sketches of flying machines were made in the 16th century, it wasn't until the flight of the Wright Brothers in 1903 that heavier than air flight became a reality. Quickly, aviation swept the popular consciousness of the world with daring aviators like Charles Lindberg and Amelia Earhart launching careers in the sky.

While civilian aviation grew in popularity, military thinkers began to imagine aircraft as a weapons platform. After a novel but generally ineffective showing in the First World War, leading military air theorists like Arnold, Halsey, and Mitchell envisioned aircraft in increasingly specific roles—Innovation drove the development of dive bombers,

strategic bombers, fighters, interceptors, and special transport planes to fill the needs of the front.

During World War Two, aircraft became more than a novelty on the battlefields of Europe and the Pacific, with over 800,000 being produced worldwide. These planes played decisive roles in the war, sinking Japanese carriers at Midway, bombing Hitler's Fortress Europe into rubble, and even delivering the atomic bombs that ended the war.

By the end of the Second World War, the new, modernized aircraft were unrecognizable from their comparatively spartan predecessors—a mere 42 years had passed since the Wright Brother's flight.

3. After discussing who was involved, "what happened?", "when did it happen", "where did it happen?", and "why did it happen?", ask the students, "how did it happen?" to set up the parts of an airplane and its function.
4. Project the Parts and Function Worksheet to the class. How many parts of the plane can they identify? How many functions can they name?
5. Watch "How do airplanes actually fly?" by TED-Ed on YouTube (5:02)

6. Pass out the Parts and Function Worksheet to the students. As a class, label the airplane parts while discussing the function of each.
7. Wrap up part two by discussing the process of iterative design that helps engineers learn from the mistakes of early designs. This is an approach to continuously improve on a concept, design, or aircraft.
    a. When designing airplanes, engineers often build small-scale models to test how they fly without building large and expensive full-size aircraft. They also experiment with many different designs to find the one that best meets the design objectives.

PART THREE: DESIGN AND BUILD

1. Now that the class has familiarized themselves with the parts of the airplane and their function for flight, they will use the process of iterative design to design and build a paper airplane.
2. Divide students into small groups of four members.
3. Distribute materials to each group and instruct them to design and construct paper planes using their knowledge of airplane parts, their function, and the process of iterative design.

   a. Encourage the students to brainstorm and experiment with different designs, shapes, and sizes and to consider how various adjustments might affect flight performance.
   b. Each group will need to present two different airplanes to test at the flight trials.

PART FOUR: FLIGHT TRIALS

1. Distribute the Flight Trial Logs to each group and relay the instructions:

INSTRUCTIONS:

Fly each airplane three times each and record the distance of each flight to the nearest foot as well as the amount of time it stayed in the air. Take your three measurements, add them together, and divide them by three to get your average flight length.

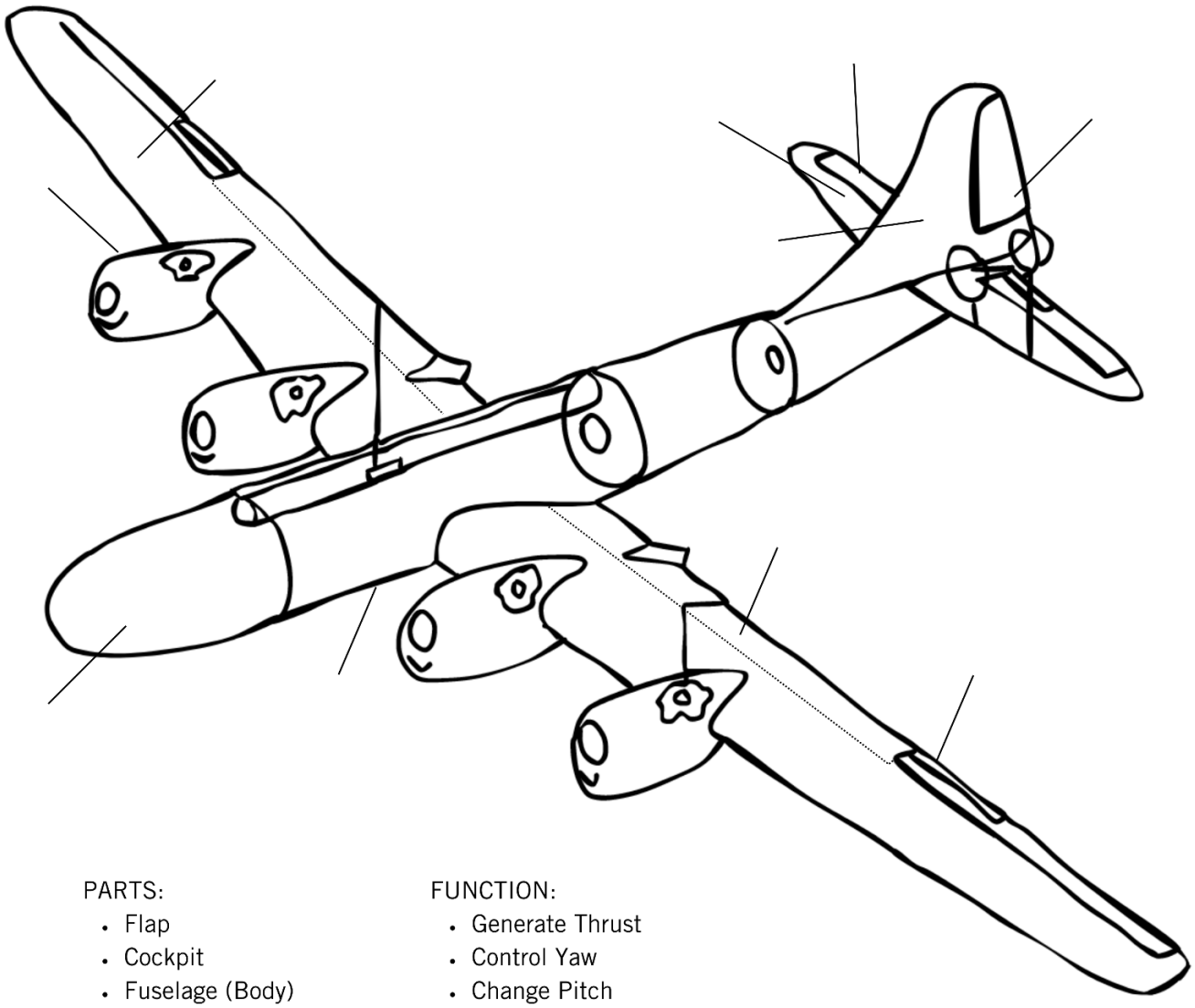
2. Provide measuring tape and stopwatches/timers to each group to measure flight distance and duration.
3. Once all flight trials are complete, ask the students to calculate and record the average distance and flight time for their airplanes.

PART FIVE: CONCLUSION

1. Gather the class together to share the results. Discuss the factors that contributed to successful flights and areas for improvement.
   a. Did any modifications in the design process lead to success? Which designs performed the best? Which performed poorly? Did they notice a relationship between average distance and average time?
      i. Expect a weak relationship between time and distance since it is possible for a plane to fly straight up for a while but only travel a few feet forward.
2. Collectively analyze the class data by compiling flight test results into a Distance/Time Table on a projection or overhead transparency.
   a. Have students individually make two bar graphs
      i. Graph 1: the number of planes on the x-axis and the distance on the y-axis
      ii. Graph 2: the number of planes on the x-axis and the time on the y-axis
   b. Encourage a discussion based on the class's results.
3. For extra math practice, have students create a line or bar graph of their individual plane trials.

NATIONAL MUSEUM OF THE PACIFIC WAR
FREDERICKSBURG, TEXAS

WORKSHEET: PARTS & FUNCTION



PARTS:

- Flap
- Cockpit
- Fuselage (Body)
- Vertical Stabilizer
- Engine
- Rudder
- Elevator
- Aileron
- Horizontal Stabilizer
- Wing

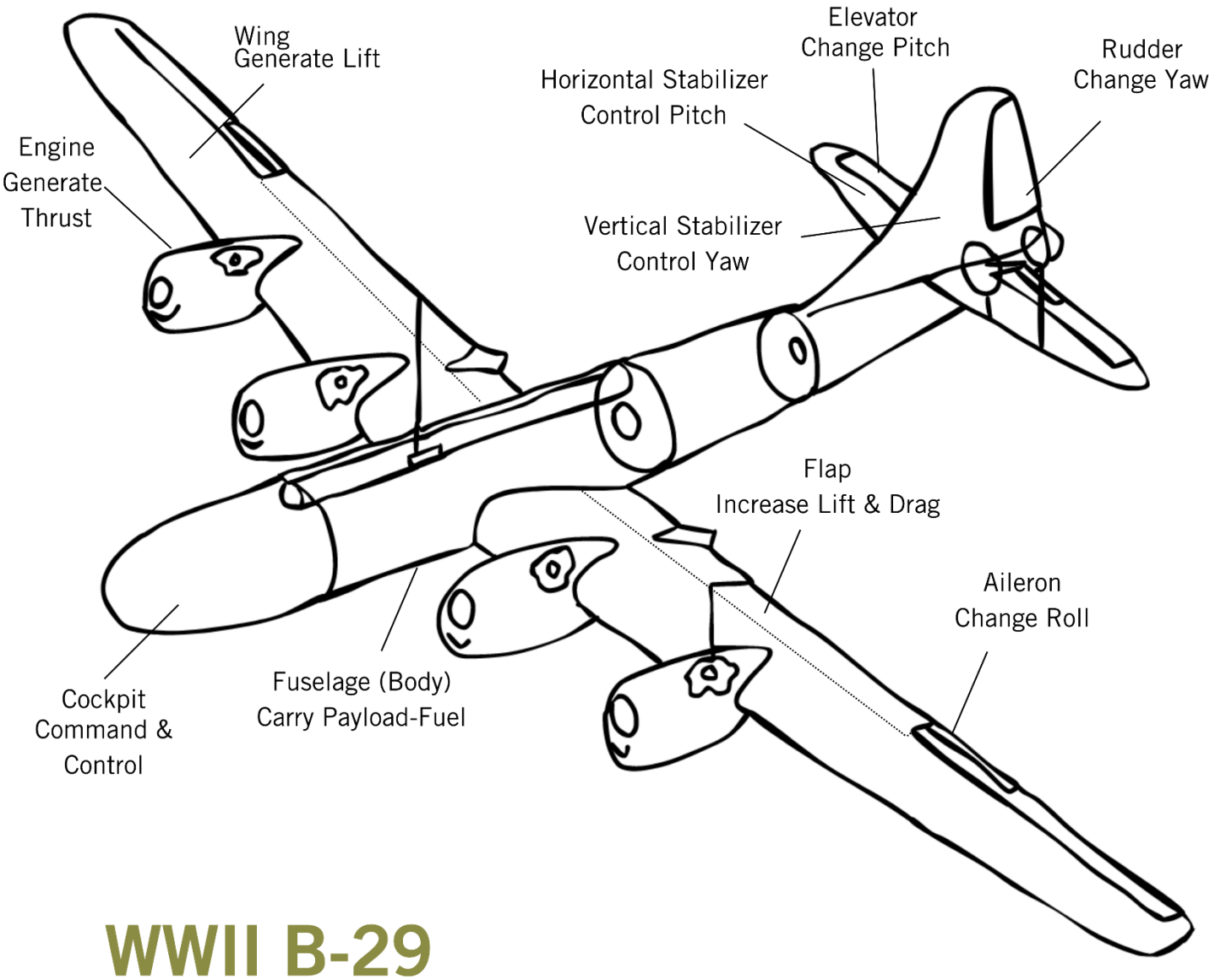
FUNCTION:

- Generate Thrust
- Control Yaw
- Change Pitch
- Change Roll
- Increase Lift & Drag
- Change Yaw
- Generate Lift
- Carry Payload-Fuel
- Control Pitch
- Command & Control

WWII B-29 SUPERFORTRESS

NATIONAL MUSEUM OF THE PACIFIC WAR
FREDERICKSBURG, TEXAS

ANSWER SHEET: PARTS & FUNCTION



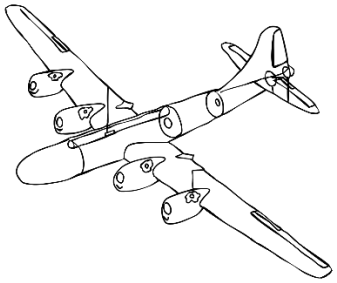
WWII B-29 SUPERFORTRESS

NATIONAL MUSEUM OF THE PACIFIC WAR
FREDERICKSBURG, TEXAS

WORKSHEET: FLIGHT TRIAL LOGS

DIRECTIONS:

Fly your airplanes three times each and record the distance of each flight to the nearest foot as well as the amount of time it stayed in the air. Take your three measurements, add them together, and divide them by three to get your average flight length.



FIRST PLANE DESIGN:

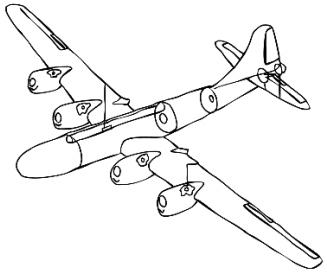
Flight #	Length in Feet	Time in Seconds
1		
2		
3		
Average		

SECOND PLANE DESIGN:

Flight #	Length in Feet	Time in Seconds
1		
2		
3		
Average		

NATIONAL MUSEUM OF THE PACIFIC WAR
FREDERICKSBURG, TEXAS

WORKSHEET: DISTANCE & TIME TABLE



Distance	Number of Planes
<2 feet	
Between 2 and 4 feet	
Between 4 and 6 feet	
Between 6 and 8 feet	
Between 8 and 10 feet	
Between 10 and 12 feet	
Between 12 and 14 feet	
Between 14 and 16 feet	
>16 feet	

Time	Number of Planes
0-3 seconds	
4-7 seconds	
8-12 seconds	
13-16 seconds	
17-20 seconds	
21-24 seconds	
24-27 seconds	
27+ seconds	