National Aeronautics and Space Administration

GRADES K-4

First Flyers

history of flight

Aeronautics Research Mission Directorate

Museum in a BOX Series

www.nasa.gov

First Flyers

Lesson Overview

In this lesson, divided into five activities, students will learn about the abilities of technological design, science as a human endeavor, and the position and motion of objects as they explore the history of American aviation.

More specifically students will learn about famous aviators and important discoveries in flight. In addition, they will experiment with kite design, propulsion and drag as they seek to understand some of the challenges involved in the development of aviation technology.

Each activity is structured around an important discovery in flight and how that discovery affected science and technology as well as society. Hands-on activities and history about a famous aviator who lived at the time of the discovery is also attached to each activity.

Objectives

Students will:

1. Identify five discoveries about flight.
2. Create a series of stories written by the class (called Choral Writing) of one of America's first flyers from a list including Wilbur and Orville Wright, Amelia Earhart, the Tuskegee Airmen, Chuck Yeager, and Neil Armstrong.
3. Experiment with sled kites with different tail lengths, flown in varying amounts of wind to determine optimal design much like the Wright brothers did in 1899 with their famous Wright kite.
4. Experiment with shape and drag using modeling clay dropped in liquid.
5. Experiment with a simple paper helicopter to compare how the lift of rotary wings (in the form of a propeller) in a helicopter differs from the lift of an airplane with fixed wings.
6. Experiment with balloon rockets to learn about propulsion.

Materials:

In the Box

Two straight drinking straws
Tape
Scissors
Two 45cm lengths of string
One 1m length of string
Ruler
Single-hole punch
Paper clip
Markers, crayons, pencils (optional)
Selection of ribbons
Painted canvas to show the material that covered the aircraft
A piece of aluminum from pop can, siding, air duct, etc.
Tall, clear 10-12 oz. plastic cups
Modeling clay
Stopwatch
Clear, syrupy liquid
Ruler/Yardstick
Gallon-sized container(s)
3/8 fasteners (optional)
Maple seed "helicopters" (optional)
Paper Helicopter Template (Worksheet 2)
Paper
Measuring tape
Paper
Balloon rockets kit
Large long balloons
Fishing line
Straight straws
Clothes pins or binder clips

Provided by User

Chart paper

GRADES **K-4** **Time Requirements:** 5 Hours

Background

Discoveries in American Aviation

Airplanes are such an important part of our everyday lives that it is hard to believe that they did not exist until a little over a century ago.

America's progress in aviation has grown out of the belief that better technology improves life for people.

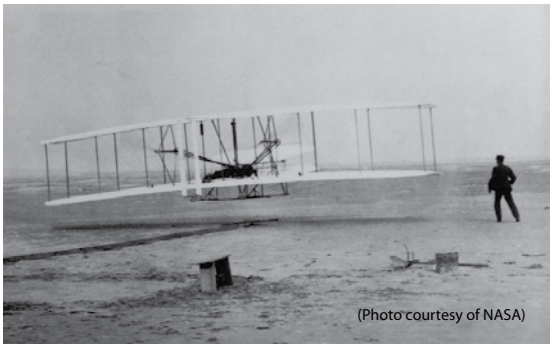
The airplanes included in this timeline represent five significant achievements in the history of flight. These technological advances not only transformed aviation, but society as well by reinventing travel, advancing commerce, changing the way people engage in warfare, creating entirely new industries, and bringing people around the globe together like never before.

Discovery One: The First Successful Powered Airplane

Airplane: 1903 Wright Flyer
Date: First flight on December 17, 1903

SCIENCE AND TECHNOLOGY

The first powered, controlled, heavier than air flight lasted only 12 seconds, covered just 120 feet, and traveled at a mere 30mph, but Wilbur and Orville Wright came up with the basic solutions for powered, controlled flight. Their contributions included an innovative propeller design that provided thrust, and a system for controlling movement in three directions—vertical (pitch), horizontal (yaw), and lateral (roll). These same basic principles have been applied to every airplane that has been built since.



Img. 1 1903 Wright Flyer

SOCIAL IMPACT

The Wright Flyer's first successful flight launched the aerial age and thrilled people around the world about the possibilities of flight. Writers and artists incorporated flight in their work while images of airplanes appeared on clocks, cigarette cases, plates, and other everyday items. Soon airplanes were used to deliver mail and freight, dust crops, map the Earth, and carry passengers.

Discovery Two: The First Airplane to Fly Across the Atlantic Ocean Nonstop With a Single Pilot

Airplane: Spirit of St. Louis (Ryan NYP)
Departed New York, USA on May 20, 1927
Arrived Paris, France 33 1/2 hours later

Img. 2 Charles Lindbergh

SCIENCE AND TECHNOLOGY

At the time Charles Lindbergh made his historic transatlantic flight, the airplane had become a much more dependable machine. Larger and more powerful engines allowed airplanes to travel faster, higher, and farther. The Spirit of St. Louis was built for maximum distance with wings built to carry the 450 gallons of fuel needed to fly from New York to Paris 4,000 miles and 33 ½ hours away.

SOCIAL IMPACT

Lindbergh's flight astonished the world because it demonstrated the safety of airplanes, which led to a rapid advancement in the aviation industry. Within the few years following Lindbergh's flight, airplanes were crossing the United States in 48 hours (compared to 72 hours by train). Soon songs, novels, comic books, and movies made aviation their theme.

Discovery Three: The First Profitable Passenger Airplane

Airplane: Douglas DC-3
Date: First flown in 1935

Img. 3 Douglas DC-3

SCIENCE AND TECHNOLOGY

The DC-3 was built of aluminum, making it stronger and more durable than earlier aircraft, which used modified fabrics like painted canvas. The DC-3 also had a larger fuselage (body) and wings, and it could carry more weight. The DC-3 transported as many as 21 passengers at a time at speeds of up to 212 mph. The design of the DC-3 was streamlined with its bullet-shaped fuselage, two powerful engines enclosed by cowlings (hoods), and its retractable landing gear.

SOCIAL IMPACT

The DC-3 was the first modern airliner. It was the fastest commercial form of transportation in its day, and the first airplane to make a profit carrying passengers. The DC-3 made air travel popular and affordable. Its sleek, streamlined shape influenced the design of everything from automobiles to toasters. Military airplane technology also had advanced by this time, resulting in the remarkable airpower that was demonstrated in World War II. The DC-3 used by Americans to move troops and supplies during the war was nicknamed the Gooney Bird because of its awkward appearance.

Milestone Four: The Invention of the Helicopter

Aircraft: Sikorsky R-4
Date: Made its initial flight on January 13, 1942

SCIENCE AND TECHNOLOGY:
The Sikorsky R-4 as designed by Igor Sikorsky had a single, three-bladed main rotor (engine). The R-4 was the world's first large-scale, mass-produced helicopter and the first helicopter to enter service with the United States Army Air Forces, Navy, and Coast Guard. The R-4 became the model for all modern single-rotor helicopters produced thereafter.

Img. 4 Sikorsky R-4

SOCIAL IMPACT:
Because helicopters have the ability to fly forwards, backwards, up, down and sideways, as well as remaining stationary over a single spot, they are used to complete tasks that are not possible with airplanes. For example, helicopters are often more useful than airplanes in fighting fires, rescuing people stuck in otherwise inaccessible places, transporting the sick and injured, moving and removing large objects, and gathering news and scientific data.

Milestone Five: The First Plane to Fly Faster than the Speed of Sound

Airplane: Bell X-1 "Glamorous Glennis"
Date: First broke the sound barrier on October 14, 1947

SCIENCE AND TECHNOLOGY
The Bell X-1 became the first airplane to fly faster than the speed of sound. Until then, no one knew what would happen to objects in flight at the speed of sound. There was fear of the effects of compressibility or a collection of several aerodynamic effects that "struck airplanes" like a wall keeping them from further acceleration. U.S. Air Force Captain Charles E. "Chuck" Yeager piloted the X-1 as it reached Mach 1.01 at an altitude of 43, 000 feet. Yeager nicknamed the airplane the "Glamorous Glennis" in honor of his wife.

Img. 5 Bell X-1 "Glamorous Glennis"

The X-1 used its rocket engine to climb to its test altitude after launching from the bay of a large Boeing B-29 airplane at an altitude of 23,000 feet. The airplane flew a total of 78 times, and on March 26, 1948, with Yeager as its pilot, the X-1 reached a speed of 957 miles per hour at an altitude of 71,900 feet. It was the highest speed and altitude ever reached by any manned airplane up to that time.

SOCIAL IMPACT

The Bell X-1 laid the foundation for America's space program in the 1960s because the personnel associated with the development of X-1 technology went on to assume key leadership positions in the program. The project also forged the post-war relationship between the U.S. military, private industry, and research facilities. The flight data collected by the X-1 was invaluable for the remainder of the 20th century in furthering U.S. fighter jet design.

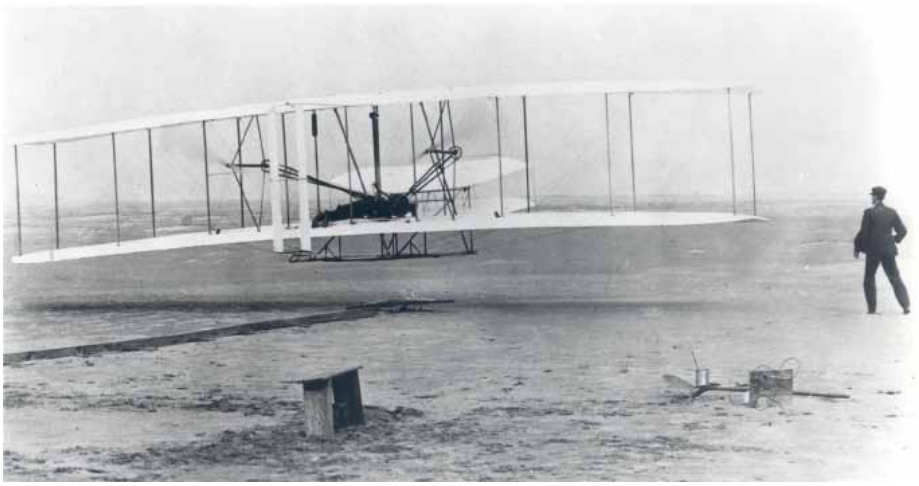
Famous American Aviators

In addition to these great achievements in the science and technology of aviation, the history of aviation would not be complete without the ingenuity and tenacity of many great pilots. The people included in this part of the lesson are only a few of the many Americans who changed aviation history forever.

Wilbur and Orville Wright

Wilbur Wright, the third child of Milton and Susan Wright, was born on April 16, 1867. Wilbur was the oldest child of the brother-partners who would eventually give humankind the capacity for flight.

The other half of that partnership, Orville, was born four years later, on August 19, 1871, in the family's newly built house in Dayton, Ohio.



Img. 1 The Wright brothers

As boys, Wilbur and Orville were inspired by their mother's mechanical abilities and their father's intellectual curiosity. Milton brought his boys various souvenirs and trinkets he found during his travels as a minister for the Church of the United Brethen in Christ. One such trinket, a helicopter-like top, inspired the boys' interest in flight. In school, Wilbur was an excellent student who would have graduated from high school if his family had not moved during his senior year. Then his mother's illness and death kept Wilbur from attending college. Orville, on the other hand, was merely an average student, known for being mischievous. Thus Orville quit school before his senior year to open a printing business. It was common for people to not graduate from high school back then.

The first time Wilbur and Orville called themselves "The Wright Brothers" was when they opened their own printing firm. At the time, Wilbur was 22 and Orville was 18.

In 1892, the brothers began repairing bicycles for friends, and soon started their own repair business. In 1893, the brothers opened a bicycle shop in Dayton, Ohio, and three years later, even made their own bicycle models.

In 1896, while nursing Orville, who was sick with typhoid, Wilbur read about the death of the famous German glider pilot Otto Lilienthal, the first man to make a heavier-than-air flight using a glider. Lilienthal died when his glider lost lift. The news of Lilienthal's work led Wilbur to take a keen interest in flying. On May 30, 1899, he wrote to the Smithsonian Institution for information on aeronautical research.

Within a few months, Wilbur read all that had ever been written about flying. From his reading, he was able to identify the necessary elements for the success of any flying machine: ***wings to provide lift, a power source for propulsion, and a system of control.***

Of all of the early aviators, Wilbur especially recognized the need for controlling a flying machine in all three of its axes: pitch, roll and yaw. Wilbur's solution to the problem of control was 'wing warping.' He came up with this revolutionary system by twisting a long rectangular box which had its ends removed. Twisting the surface of each "wing" changed its position in relation to the oncoming wind. Such changes in position would result in changes in the direction of flight. Wilbur tested his theory using a small kite, and it worked.

In August of 1900, Wilbur and Orville built their first glider and chose a lonely beach on the coast of North Carolina called Kitty Hawk to test their new invention.

The following year, the brothers tested a new, improved glider with a 22-foot wingspan; however, after a disappointing performance they returned to Dayton to construct a wind tunnel in which to test a variety of more effective wing designs. Using the results of the wind tunnel, the brothers constructed their 1902 glider. In October, they returned to Kitty Hawk to test this glider, which succeeded in flying 620 feet, a new record. Following this success Wilbur and Orville returned once again to Dayton to begin working on a propeller and engine for the first ever manned, powered flying machine.

After they designed a propeller based on the same principles used to design their wings, Wilbur and Orville built a 4-cylinder, 12-horsepower engine to power their 1903 Flyer, which was built in sections in the back room of their bicycle shop and shipped to Kitty Hawk where it was to be assembled.

On December 14, 1903, Wilbur won the coin toss and made his first attempt to fly the machine, but the machine stalled on take-off, causing minor damage. Once the plane was repaired three days later, Orville made his second attempt.

At 10:35 a.m., on December 17, 1903, Orville Wright completed the world's first heavier-than-air, machine powered flight. The flight lasted 12 seconds and covered a mere 120 feet, but Orville did what humans had been yearning to do – he flew.

Amelia Earhart

Amelia Mary Earhart was the daughter of Samuel "Edwin" Stanton Earhart and Amelia "Amy" Otis Earhart. Amelia was born in Atchison, Kansas, on July 24, 1897. Amelia's upbringing was unconventional. Her mother, Amy, did not believe in molding her children, Amelia and her sister Muriel (nicknamed Pidge), into "nice little girls."

(Photo courtesy of NASA)

Img. 6 Amelia Earhart

As a child, Amelia spent long hours playing with Pidge, climbing trees, hunting rats with a rifle and "belly-slamming" her sled downhill. In 1904, Amelia and her uncle pieced together a homemade ramp modeled after a roller coaster. They attached the ramp to the family's tool shed and Amelia rode the ramp in a wooden box. Though the wooden box was shattered and Amelia's lip bruised, she exclaimed, "Oh, Pidge, it's just like flying!"

By the time Amelia was in high school, her family had moved to Chicago. There, Amelia searched for a school that had a strong science program. She discovered one in Hyde Park High School. After graduating from Hyde Park, Amelia continued to research her future career, keeping a scrapbook of newspaper clippings about successful women in male-dominated fields including film production, law, advertising, management and engineering.

In 1920, Amelia and her father visited an airfield where Amelia took her first ride in an airplane. That ride would change her life forever. She said, "By the time I had got two or three hundred feet off the ground I knew I had to fly."

Six months after her first flight, Amelia purchased a used bright yellow airplane, which she nicknamed "The Canary." On October 22, 1922, Amelia flew her plane to an altitude of 14,000 feet, setting a world record for female pilots.

A year after Charles Lindbergh's solo flight across the Atlantic in 1927, Amelia got a phone call from Captain Hilton H. Railey, who asked, "Would you like to fly the Atlantic?" Amelia enthusiastically took this opportunity, though she flew only as a passenger, with the added duty of keeping up the flight log. After the flight, Amelia said, "I was just baggage, like a sack of potatoes." She added, "...maybe someday I'll try it alone."

Because of her resemblance to Lindbergh, whom the press nicknamed "Lucky Lindy," some reporters began referring to Amelia as "Lady Lindy" or the "Queen of the Air."

Although Amelia gained some fame from her transatlantic flight, she wanted to set a record of her own. So, Amelia set off on her first extended solo flight, in August of 1928, becoming the first woman to fly solo across North America and back. In 1931, she set a world altitude record of 18,415 feet.

At the age of 34, on the morning of May 20, 1932, Earhart set off from Harbour Grace, Newfoundland with the latest copy of a local newspaper to confirm the date of her flight. She intended to fly to Paris in her single engine plane just like Charles Lindbergh, but after a flight lasting 14 hours, 56 minutes during which she battled strong winds, icy conditions and mechanical problems, Amelia landed in a pasture in Northern Ireland. When a farm hand asked, "Have you flown far?" Amelia replied, "From America." Amelia Earhart had become the first woman to fly solo non-stop across the Atlantic.

In 1935, Amelia became the first person to fly solo from Hawaii to California. In the same year, flying her beloved Vega airplane, which she called "Old Bessie," Amelia soloed from Los Angeles to Mexico City.

Between 1930 and 1935, Amelia Earhart set seven records in aviation for speed and distance, but by 1935, Amelia began to think about a new adventure, a flight she most wanted to attempt – a circumnavigation of the globe at the equator.

In order to prepare for her flight, Amelia contacted Hollywood "stunt" pilot Paul Mantz to help her improve her long distance flying. As well, she joined the faculty of Purdue University in 1935 as a visiting professor in order to counsel women on aviation careers, serve as technical advisor to the Department of Aeronautics and garner support for her around-the-world flight.

Though not the first pilot to circle the globe, Amelia would choose the longest course at 29,000 miles, following a difficult equatorial path. With funding from Purdue, a Lockheed Electra 10E was built to her specifications to include among other things, an especially large fuel tank.

Soon, Amelia contacted Fred Noonan to be her navigator since he had plenty of experience in marine as well as airplane navigation.

On March 17, 1937, Amelia and her crew flew the first leg of the trip from Oakland, California to Honolulu, Hawaii. In addition to Amelia and Fred Noonan, Harry Manning and Paul Mantz were on board; however, the flight could not continue due to technical failures.

While the Electra was being repaired Amelia and her husband, George P. Putnam, a publisher, got additional funds for a second try. This time Amelia would fly from Oakland, California to Miami, Florida. Once she got there would she publicly announce her plans to circumnavigate the globe. The flight's opposite direction, from west to east instead of east to west, was due in part to changes in wind and weather patterns. Fred Noonan would be Amelia's only crewmember on this flight. The two departed Miami on June 1 and after many stops in South America, Africa, India and Southeast Asia, they arrived at Lae, Papua New Guinea on June 29, 1937. At this stage in the journey, Amelia and Fred Noonan had about 22,000 miles behind them. The remaining 7,000 miles would be over the Pacific Ocean.

On July 2, 1937, Amelia and Fred Noonan took off from Lae, Papua New Guinea in a heavily loaded Electra. They were heading for Howland Island, a flat sliver of land 2,556 miles away. Amelia's last known position was taken about 800 miles into her flight by the United States Coast Guard ship Itasca, which had been assigned to communicate with Amelia's airplane and guide them to the island once they got overhead.

Through a series of misunderstandings or errors, Amelia's final approach to Howland Island using radio failed and beginning one hour after Amelia's last recorded message, the Itasca began its search north and west of Howland Island. The United States Navy soon joined in the search, and over a period of about three days all of the area around Howland Island was investigated, but no sign of the flyer was ever found. Airplanes also flew over the area to the north, west and southwest of Howland Island, based on a possibility that the Electra had crashed in the ocean, perhaps leaving the aviators in an emergency raft, but the search yielded nothing.

On July 19, 1937, the official search for Amelia Earhart and Fred Noonan was called off, and no physical evidence of Earhart, Noonan or the Electra 10E has ever been found. Amelia Earhart was declared legally dead on January 5, 1939.

Although Ms. Earhart was not the only female aviator of her time, she was the most famous. She had her own clothing and luggage line, and endorsed multiple products.

Other prominent female aviators included Willa Brown, who was the first African American to earn a commercial flight license in the United States. In addition, she helped train more than 200 students who eventually became Tuskegee Airmen. At age 16, Elinor Smith was the youngest pilot to earn a license which was signed by Orville Wright. Another notable pilot was Jacqueline Cochran, the first woman to exceed Mach 1 (the sound barrier).

Tuskegee Airmen

Although formally they were known as the 332nd Fighter Group of the U.S. Army Air Corps, the Tuskegee Airmen Corps, was the popular name for a group of African American pilots who fought with distinction in World War II. The pilots were nicknamed the Red-tailed Devils because airplane tails were painted red.

The Tuskegee Airmen were the first African American military pilots in the history of the United States armed forces. During World War II, African Americans in many states were still subject to Jim Crow laws, which meant they were required to have separate training schools and facilities and were kept separate from white members of the military. As such, the Tuskegee Airmen experienced racial discrimination, both within and outside of the army. Despite these challenges, the Tuskegee Airmen flew successful missions as bomber escorts throughout Europe.

Before the Tuskegee Airmen, no American military pilots had been African American, but in 1941 when the United States Congress forced the Army Air Corps to form an all-black combat unit, the War Department disagreed. In an effort to eliminate the unit before it could form, the War Department set up a system to accept only those with an uncommonly high level of flight experience or with a higher education, setting up standards they thought would be difficult for African American pilots to achieve. The policy failed dramatically when the Air Corps received an abundance of applications from African American men who qualified, many of whom already participated in the Civilian Pilot Training Program through the historically black Tuskegee Institute.

Strict racial segregation in the U.S. Army required the development of a separate group of African American flight surgeons to support the Tuskegee Airmen. Before the development of this unit, no U.S. Army flight surgeons were Black. The training of African American men as medical examiners was conducted through separate classes until 1943, when two Black doctors were admitted to the U.S. Army School of Aviation Medicine at Randolph Field, Texas. This was one of the earliest racially integrated courses in the U.S. Army. Seventeen flight surgeons served with the Tuskegee Airmen from 1941 through 1949. The chief flight surgeon of the Tuskegee Airmen was Dr. Vance H. Marchbanks, a boyhood friend of Benjamin O. Davis, Jr., who would become the commander of the fighter group.

Img. 7 The Tuskegee Airmen

It was not easy overcoming racism in the military, but by the end of the war, the Tuskegee Airmen shot down 112 German aircraft, sunk a German-operated Italian destroyer, and destroyed numerous enemy trucks and trains. Their squadrons completed more than 15,000 attacks during 1,500 missions. The Tuskegee Airmen were awarded a Distinguished Unit Citation (DUC) for the mission to escort B-17s on their way to bombing the Daimler-Benz tank factory in Berlin, Germany. During this flight, pilots destroyed three enemy jets.

By the end of the war, the Tuskegee Airmen were awarded several Silver Stars, 150 Distinguished Flying Crosses, 8 Purple Hearts, 14 Bronze Stars, 744 Air Medals and earned the distinction of never losing any bombers to enemy fighters.

Chuck Yeager

Charles Elwood "Chuck" Yeager was born on February 13, 1923. Yeager is a famous test pilot and retired major general in the United States Air Force. He was also the first pilot to travel faster than the speed of sound. Yeager's career began in World War II as a private in the United States Army Air Forces. After serving as an aircraft mechanic, Yeager entered a pilot training in September of 1942. Upon graduating, Yeager was promoted to the rank of flight officer, after which he became a North American P-51 Mustang fighter pilot. After the war, Yeager became a test pilot for many kinds of aircraft and rocket planes.

Img. 8 Chuck Yeager

On October 14, 1947, Yeager became the first man to break the sound barrier. Flying the experimental Bell X-1, Yeager reached Mach 1 at an altitude of 45,000 feet. Yeager later commanded fighter squadrons in Southeast Asia during the Vietnam War. In recognition of his outstanding performance ratings for the units he commanded, Yeager was promoted to brigadier general. Yeager's flying career spans more than 60 years and has taken him to every corner of the globe, including the Soviet Union during the height of the Cold War.

Neil Armstrong

Neil Alden Armstrong was born on August 5, 1930. A United States Naval Aviator, astronaut, test pilot, aerospace engineer and university professor, Armstrong is both a distinguished pilot and scientist. Armstrong was the first person to set foot on the Moon. His first spaceflight was aboard Gemini 8 in 1966, on which he was the command pilot, becoming one of the first U.S. civilians to fly in space. On this mission, Armstrong performed the first manned docking of two spacecraft. Armstrong's second and last spaceflight was as mission commander of the Apollo 11 moon-landing mission on July 20, 1969. It was on this mission, that Armstrong and Buzz Aldrin climbed down to the lunar surface for 2½ hours while Michael Collins remained in orbit in the Command Module. For this mission, Armstrong received the Congressional Space Medal of Honor.

Before becoming an astronaut, Armstrong was in the United States Navy, and he fought in the Korean War. After the war, Armstrong served as a test pilot at the National Advisory Committee for Aeronautics (NACA) High-Speed Flight Station, now known as the Dryden Flight Research Center, where he flew over 900 flights in a variety of aircraft.

After flying a number of NASA missions, including the first space docking mission ever, Armstrong was appointed commander for the Apollo 11 mission, which would land him on the Moon. As part of his preparation for lunar module control, Armstrong spent time in a helicopter, though he had previously received helicopter training during his time in the Navy. Armstrong thought the helicopter was good for training the astronauts when it came to determining flight paths for the lunar module, but otherwise, Armstrong thought there were too many differences between the controls of the two vehicles to make it the best training experience.

Armstrong and his crew of Buzz Aldrin and Michael Collins completed a successful mission to walk on the Moon on July 21, 1969. It was upon stepping off the Eagle spacecraft that Armstrong uttered his now famous words, "That's one small step for man, one giant leap for mankind."

Img. 9 Neil Armstrong

After his Apollo mission, Armstrong retired as an astronaut, served as the NASA Deputy Associate Administrator for Aeronautics and went on to teach in the aerospace engineering program at the University of Cincinnati. Later Armstrong became a spokesman and served as a board member for many leading American corporations.

Activity 1 Introducing Discovery One in American Aviation

GRADES **K-4**

Time Requirements: 1 Hour

Materials:

In the Box

None

Provided by User

Chart paper

A map of the United States with Kitty Hawk, North Carolina marked

Stopwatch

Two straight drinking straws

Tape

Scissors

Two 45cm lengths of string

One 1m length of string

Ruler

Single-hole punch

Paper clip

Markers, crayons, pencils (optional)

Selection of ribbons

Worksheets

Sled Kite Template (Worksheet 1)

Reference Materials

Discovery One mini-poster (Figure 1)

Objective:

In this activity, students will learn about position and motion of objects, properties of objects and materials, abilities of technological design, and science as a human endeavor through the first discovery in American aviation, the Wright Flyer. After learning about the Flyer, students will experiment with kite design and lift.Students will learn more about the Wright brothers as they engage in Choral Writing about Wilbur and Orville Wright.

Activity Overview:

Students will first learn about the significance of the Wright Flyer in aviation history. Following this, students will create their own sled kites to experiment, like the Wrights, with design and lift.

Activity:

1. **Introduce students to the idea of a "Discovery in Flight" as an event marking a significant change in what had been previously known about airplanes and flight.** Ask the students to name different discoveries in flight. Ask: "Who invented the airplane?" or "When did humans first fly?"

2. **Tell students that with each of the discoveries in flight, they will be learning about the ways the discovery impacted science and society.** Explain that a scientific impact includes the way newly acquired scientific knowledge is used for practical purposes. Societal impacts involve the way the discovery is used to improve the lives of people living together in various communities.

3. **Tell students: "Listen carefully to these two names – Wilbur Wright and Orville Wright.** Then ask: "Who has heard these names before? "

4. **Go on to introduce December 17, 1903 as the day the Wright Flyer flew successfully for the first time over the sandy shores of Kitty Hawk, North Carolina.** Show students this location on a map.

Key Terms:

Airfoil
Heavier-than-air
Lift
Pitch
Propeller
Propulsion
Roll
Yaw

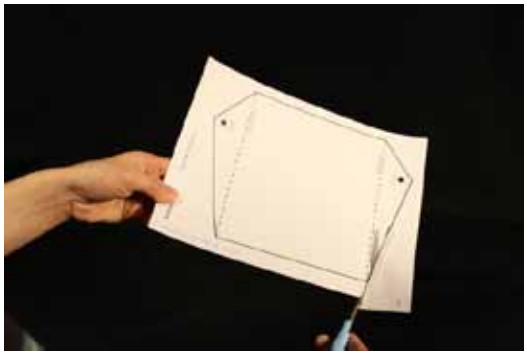
5. **Ask students: "How long do you think Wilbur and Orville's first flight lasted?"** After the students respond, tell them the flight lasted for all of 12 seconds. Tell the students to stand on one foot for 12 seconds while you watch a clock or stopwatch. Afterward, ask students if this seemed like a very long time for an airplane to stay in the air.

6. **Next, ask students: "How far do you think the Wright flyer flew in 12 seconds?"** After some general discussion, tell students that the flyer traveled 120 feet. Have some point of reference to demonstrate this distance for your students (the length of the gym, the playground, the parking lot, etc.).

7. **Now, tell the students that, like the Wrights, who started with kites, the students will make a "sled kite" using a template already made for them.** The teacher will explain the directions and provide a set of written, illustrated instructions for students to follow.
It is recommended that, for younger students, the templates and straws be cut in advance and there are enough adult helpers present to assist the students as they assemble their kites. Alternatively, kite kits could be assembled in advance and sent home for students to make and then bring back to school.

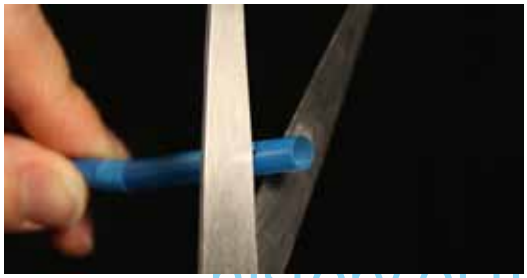
Sled kite directions to follow:

a. Make a copy of the Sled Kite Template.



b. Carefully cut out the kite.

c. Trim the length of the two drinking straws so they will fit in the area marked on the template for the straws.



d. Tape the straws in place.

e. As shown, place two or three pieces of tape over the marked areas, covering the black circles where string holes will be punched.

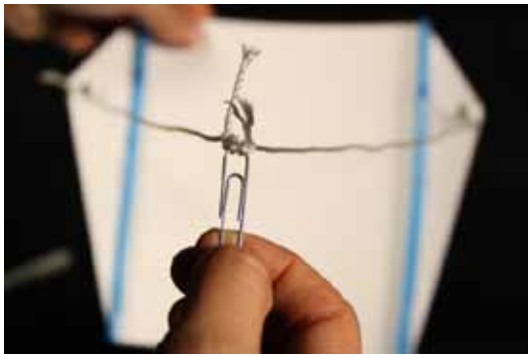
f. Using a single-hole paper puncher, carefully punch the two holes marked by the black circles you just taped.

g. Cut two pieces of kite string each 45 centimeters long and one piece one meter long, which will be used in Step K.

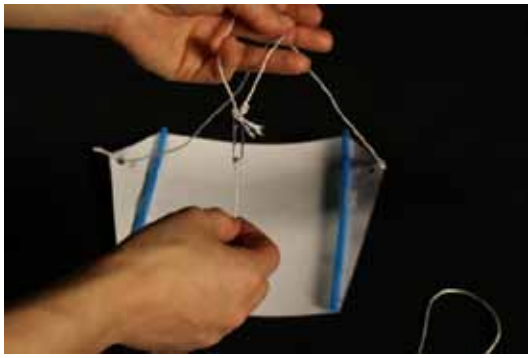
h. Tie one string through each hole.

i. Tie the string tight enough, but do not tear the paper.

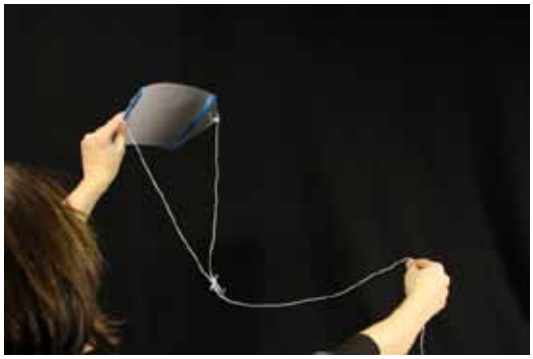
j. Tie the loose end of each string to a paper clip as shown.



k. Pick up the 1m long piece of string and tie the end of this string to the paper clip, opposite the kite.



l. Your sled kite is ready to fly!



8. **To fly the kite, take students outside to a clear area.** If you do not have access to the outside, find a large indoor space. Instruct students to hold the end of the 1 m length of string and run with the kite to make it fly. Ask the students to run fast and then slow to observe how their speed affects the kite's flight.

9. **If there is time, students can add a strip of ribbon or crèpe paper as tails for their kites.** To do this, begin with a long tail, then progressively shorten it to see how the tail design affects flight.

10. **After kite trials, which may last from 10 – 20 minutes, students will return to the classroom and discuss their results, with the teacher recording student observations for all to see.** To guide the discussion, teachers may ask: How did the effect of running compare to walking when you were flying your kite? (Running created the effect of wind; more wind equals more lift). Relate this finding to Wilbur's choice of Kitty Hawk for a test site for the Wright Flyer.

11. **Then, if you had time to add a kite tail, ask the students how the tail affected the kite's motion.** (Tails add stability, keeping the nose pointed upward to provide lift.)

    Show students the photograph of the Wright brothers and the 1903 Wright Flyer (Imgs. 1 and 6, found in the Image section of this lesson). Then read all or some of the lesson's Background Information about the Wright brothers. The students will listen for facts and generate ideas that may be used for the Choral Writing activity to follow. It is a good idea to use chart paper for this activity since all of the students will be able to see the story as it is being written, and it can be easily displayed for others to read as well.

NATIONAL SCIENCE STANDARDS K-4

SCIENCE AS INQUIRY

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

PHYSICAL SCIENCE

- Properties of objects and materials
- Position and motion of objects

SCIENCE AND TECHNOLOGY

- Abilities of technological design
- Understanding about science and technology

HISTORY AND NATURE OF SCIENCE

- Science as a human endeavor

Activity 2 Introducing Discovery Two in American Aviation

GRADES **K-4**

Time Requirements: 1 Hour

Materials:

In the Box

None

Provided by User

Map with flight path from New York to Paris, and from New York to Ireland marked

Chart paper

Painted canvas to show the material that covered the aircraft

A piece of aluminum

Tall clear container

Modeling clay

Stopwatch

Clear, syrupy liquid

Worksheets

None

Reference Materials

Discovery Two mini-poster

Key Terms:

Aerodynamic

Drag

Resistance

Transatlantic

Objective:

In this activity, students will learn about properties of objects and materials, science as a human endeavor, and abilities of technological design through the second discovery of flight in American aviation history, Charles Lindbergh's transatlantic flight in the airplane, the Spirit of St. Louis, on May 20, 1927. After learning about Lindbergh's flight, students will experiment with drag and how drag affects motion. (This activity may be done in small groups, or for younger students, as a demonstration.) Students will learn about Amelia Earhart and respond through Choral Writing.

Activity Overview:

Students will first learn about the significance of Charles' Lindbergh's flight from New York to Paris in the Spirit of St. Louis on May 20, 1927. Following this, students will experiment with drag and aerodynamic design. Finally, students will create a story through Choral Writing about Amelia Earhart.

Activity:

1. **Review what students learned in the previous activity about the Wright Flyer, kite design and lift, and the Wright brothers.**
   You may wish to post the Discovery One mini-poster (Figs. 1 and 6 found in the Reference Materials section of this lesson) before your review in order to help prompt the students to recall what they learned in the previous activity. If not, post the Discovery mini-poster after the students review. Use the mini posters as part of your daily review and to create a timeline of significant, game-changing discoveries in aviation.

2. **Ask students to look at the map you posted. Point to New York and then to Paris.**
   Ask students: "What stands between New York and Paris?" A big ocean of water, they will say. Ask them what that ocean is called. If no one is able to name the ocean, tell students it's the Atlantic.

3. **Ask: Can airplanes cross over the Atlantic?** Follow this question by asking: Who was the first person to cross the Atlantic in an airplane and when? Introduce Charles Lindbergh (Fig. 2) and his airplane, the Spirit of St. Louis, by showing students photos. Mention that shortly after Lindbergh, the first man to fly across the ocean from New York to Paris, Amelia Earhart took to the skies to be the first woman to cross the Atlantic, flying from New York to Ireland.

4. **As an option, search the Internet for and play a song or two about Lindbergh's flight across the Atlantic.**

5. **Ask students what problems pilots might face during such a flight, especially on windy days.** Explain how drag is a key issue in flight. Provide an example of drag by discussing how a parachute or sail is designed to increase drag and use drag as a benefit, but airplanes do not want to increase drag. Drag makes aircraft less manueverable and slows them down.

6. **Introduce the What a Drag activity with the following introduction: "Let's see how shape affects drag."** We are going to use modeling clay to make different shapes. Then we are going to drop each shape into a glass filled with a thick clear liquid. Next, we will time the shape to see how long it takes to get the the bottom of the glass. Once we time each shape, we will determine which shape made it to the bottom of the glass fastest. That shape will win because it will be the most aerodynamically designed shape. In other words, it will be the shape with the least amount of drag."

   A note about safety: Warn students not to taste the liquid or get it in their eyes. If safety goggles are available, you may wish to use them.

   After gathering data about each shape (and you may wish to have 4 -6 different shapes, some bullet-shaped, some cube-shaped, some flat and wide, some round, and so on), generalize about which shapes sunk fastest and what design elements they have in common (rounded, narrow shapes will sink faster). Discuss how these shapes are more aerodynamic (resist fluid less; explain that air is a form of fluid). Relate the aerodynamic designs of clay to other objects in life (cars, airplanes, a football, speed boats, bicycle racing helmets, etc.)

7. **Close by showing the students a photograph of Amelia Earhart (Fig. 7) and reading some or all of the Background Information with your students.** Then complete a story about Amelia Earhart using the Choral Writing Activity.
   If space allows, post this choral writing product next to the choral writing product completed at the end of the previous activity. You may also choose to associate the Discovery mini poster with each related choral writing product by posting them together as a pair.

NATIONAL SCIENCE STANDARDS K-4

SCIENCE AS INQUIRY

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

PHYSICAL SCIENCE

- Properties of objects and materials
- Position and motion of objects

SCIENCE AND TECHNOLOGY

- Abilities of technological design
- Understanding about science and technology

HISTORY AND NATURE OF SCIENCE

- Science as a human endeavor

Activity 3 Introducing Discovery Three in American Aviation

GRADES **K-4**

Time Requirements: 1 Hour

Materials:

In the Box

None

Provided by User

Chart paper
Ruler/Yardstick
Gallon sized container(s)
3/8 fasteners (optional)

Worksheets

None

Reference Materials

Discovery Three mini-poster

Key Terms:

Gas mileage
Square feet
Volume

Objective:

In this activity, students will learn about science as a human endeavor, abilities of technological design, and position and motion of objects through the thirddiscovery in American aviation history, the invention of the DC-3, which made air transportation accessible and affordable, and played a vital role in WWII. After learning about the DC-3, students will explore some math related to the DC-3. Students then will create a story through Choral Writing about the Tuskegee Airmen, an elite corps of African American pilots who gained fame during World War II.

Activity Overview:

Students will learn about the DC-3, the airplane that made air travel accessible and affordable for passengers as well as profitable for airlines. Students will use math to understand the size, construction and fuel limitations of the DC-3. Students will learn about the Tuskegee Airmen and their contributions to military aviation during World War II, the war in which the DC-3 proved to be of exceptional value.

Activity:

1. **Review the information your students have learned thus far, including details about the Wright brothers and Amelia Earhart as well as details related to Discoveries 1 and 2.** Refer to the Discovery mini-posters and choral writings as needed.

2. **Ask students to recall the date on which the Wright brothers flew their flying machine successfully for 12 seconds. (December 17, 1903)**

3. **Tell students that on December 17, 1935, exactly 32 years after the first successful flight of the Wright brothers, a new kind of airplane was introduced to the world.** It was an airplane with a specially designed tail to give the plane better stability and reduce the tendency to fishtail (show how fishtailing looks by moving your hand, palm parallel to the floor, left then right, on a horizontal axis (yaw)). It had longer and stronger wings, a rounder nose and sides for more aerodynamic design, which means less drag, and two newly designed, especially powerful engines.

4. **Tell the students that today's activity will focus on the math of the DC-3 (Fig. 3).** Included in procedure 5 are a number of ways to look at the math of the DC-3. Teachers may choose to explore all or some of this math.

5. **Say to the students: Here are some fun facts about the DC-3 that have some really big numbers in them!**

   - Five hundred thousand rivets (Write this number on board while saying it) were used in the manufacture of the Douglas DC-3 airplane. The average size used in the manufacture was approximately 3/8 of an inch long (Give students an everyday reference for that size such as the length of a thumbnail or show them on a ruler, or show them an actual fastener that is 3/8 of an inch long), and if those rivets were laid end-to-end, they would cover a distance of 15,625 feet or more than three miles (Again, give students a reference point for that such as the distance from the school to the grocery store, etc.).
   - Approximately 13,300 square feet of sheet metal were used in the construction of each DC-3. (Show the students what 1 square foot looks like, or have the students show what 1 square foot looks like. Tell students 13,300 square feet is about 2.5miles of metal when stretched out 1 foot wide.
   - The engines powering the DC-3 weigh 1,275 pounds each or a total of 2,550 pounds. That weight is approximately as heavy as a mid-size car.
   - At a cruising speed of 180 mph and 10,000 feet up in the sky, ninety-one gallons of fuel are used each hour giving the plane an approximate gas mileage of 2 miles per gallon. (Show students a gallon-sized container so they can see what one gallon looks like; compare 2 miles per gallon for the DC-3 to a modern car – hybrid and conventional. Also have them imagine how much space 91 gallons might take up. For older students, ask them to calculate how many gallons would be used for flights of varying lengths. If you are able to collect 9 one-gallon containers of the same shape, show the students how much room those nine containers take up. For example, place 9 one-gallon containers on or under one student's desk and surround that desk with 9 other desks each having 9 gallons on or under them. This illustrates the amount of fuel needed for one hour of flight in the DC-3. Do the same to see how much space the fuel will take up for two hours of flight.

6. **Complete the lesson by reading all or some of the Tuskegee Airmen (Img. 8) Background Information included in the lesson.** Follow the reading with a Choral Writing activity. Note: At this point, your students have written three stories, two about famous individual aviators and one about the famous group of aviators, the Tuskegee Airmen.

NATIONAL SCIENCE STANDARDS K-4

SCIENCE AS INQUIRY

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

PHYSICAL SCIENCE

- Properties of objects and materials

SCIENCE AND TECHNOLOGY

- Abilities of technological design
- Understanding about science and technology

HISTORY AND NATURE OF SCIENCE

- Science as a human endeavor

Activity 4 Introducing Discovery Four in American Aviation

GRADES **K-4**

Time Requirements: 1 Hour

Materials:

In the Box

None

Provided by User

Maple seed "helicopters" (optional)
Paper
Scissors
Measuring tape
3 meters of ribbon (optional)

Worksheets

Helicopter Template (Worksheet 2)

Reference Materials

Discovery Four mini-poster

Key Terms:

Gravity
Lift
Rotary wing aircraft
Seed dispersal
Surface area

Objective:

In this activity, students will learn about position and motion of object, properties of objects and materials, and abilities of technological design as they learn about the evolution of the helicopter from its earliest designs created by Leonardo Da Vinci to the modern helicopter invented by Igor Sikorsky, the father of the helicopter, as we know it today. Students will create a simple paper model of a helicopter and experiment with design and lift. Students will learn about how, as part of Neil Armstrong's training to land the Lunar Module on the moon, he used a helicopter.

Activity Overview:

Students will learn about the history of the helicopter from Da Vinci's drawings of the 1500s to the helicopters of today. Students will also discover how helicopters produce lift by the pressure differences caused by the shape of its rotating blades. To do this, students will make their own paper helicopters to experiment with design and lift. Finally, students will be introduced to Astronaut Neil Armstrong, the first man to walk on the moon, who learned to operate the Lunar module in part by training on a helicopter.

Activity:

1. **Review, as you have done at the beginning of each of the previous activities, the information your students have learned thus far.** Refer to the Discovery mini-posters (Fig. 4) and choral writings as needed.

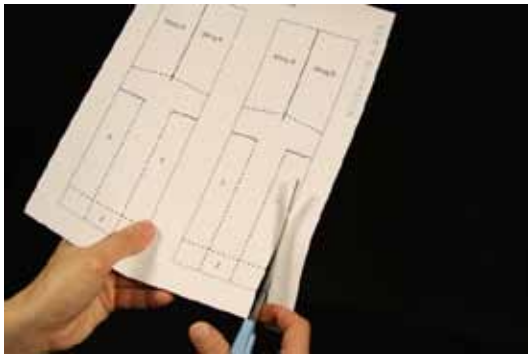
2. **Ask the students if they ever have seen a helicopter before (other than on media device).** Ask those students to describe a helicopter and how they compare to airplanes.

3. **Introduce the helicopter by sharing the following with the students:** *During the mid 1500s, the Italian inventor Leonardo Da Vinci made drawings of a flying machine he called the ornithopter, which some scientist believe was the inspiration for the modern day helicopter. Then, in 1784, French inventors created a toy with a rotary-wing that could lift and fly. This toy proved the principle of helicopter flight. It was another Frenchman who came up with the name, "helicopter," from the two words "helico" for spiral and "pter" for wings. Then in 1910, a Russian born scientist began working on a full-sized helicopter, and by 1940, he designed one that worked!*

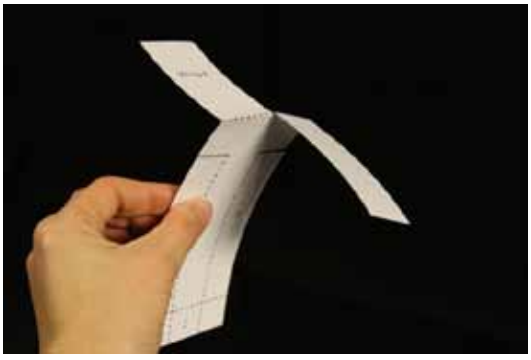
4. **Ask the students if helicopters are more useful than airplanes.** Discuss how helicopters can go up and down while remaining stationary over one spot. This allows them better access to people in need of rescue or operating as an ambulance in the air.

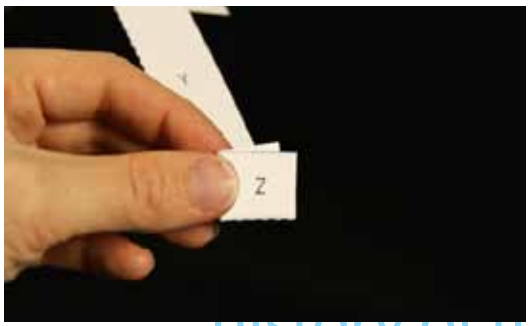
5. **Show students a model of the paper helicopter they will be making in this activity (you will need to make this in advance).** Also, show students the materials they will use to make their own helicopters. For younger students, helicopters may be made in advance or in the interest of time the teacher may simply demonstrate this activity.

6. **The directions for the paper helicopter are as follows:**
   a. Cut along the solid lines of the template.



   b. Fold along the dotted lines. The propeller blades should be folded in opposite directions. X and Y fold toward the center, and Z is folded up to give the body support and a lower center of gravity as shown.





c. Stand up and drop the helicopter.

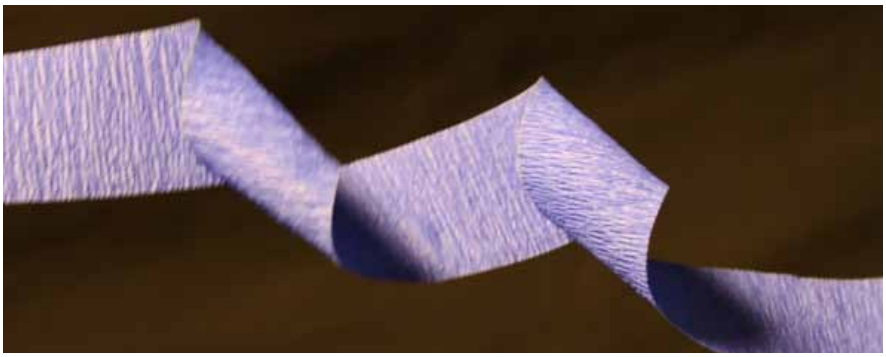
d. Discuss what the students observed after doing this several times.

e. Now, have students drop an unfolded piece of paper and the helicopter. Ask: Which one fell faster? Students will observe that the paper falls faster because it did not generate lift, whereas the spinning helicopter reduced the rate of its fall by producing lift and resisting the pull of gravity.

f. Have the students predict what will happen if they wad up the paper and drop it. (The wadded up paper will drop faster than the sheet of paper and the helicopter. The sheet of paper falls slower mainly because its larger surface area offers greater resistance to the air than the compact, wadded up ball of paper.)

g. Have students add a piece of ribbon to their helicopter as shown in the directions. Tell the students that this ribbon will help them determine the number of rotations because they will be counting ribbon twists instead of trying to count each spin of the paper helicopter.

h. Explain this procedure: Students will stand on the loose end of the ribbon, and pull the helicopter up so there are no twists in the ribbon. Then students will drop the helicopter, counting twists in the ribbon once the helicopter lands. (Caution students to keep their foot on the ribbon as they count.)



i. Experiment with the angle of the "wings" to see if a change in the wing angle affects the helicopters flight.

j. Explain that the quickly moving air over the top of the blade creates low pressure, but the air beneath the blade is moving slower, so it creates higher pressure and high pressure under the rotor blades creates lift, which causes the helicopter to rise.

7. **Close the activity by discussing the person and career of Neil Armstrong (Img. 9).** Once again, students will add to their Choral Writing collection of aviation heroes by using the Choral Writing activity to write about Neil Armstrong after the teacher reads some or all of the Background Information located in this lesson.

8. **If time or the season allows, show the students maple seed "helicopters" or other seeds that disperse by wind and compare how plants spread their seeds by wind using their own kind of rotary blades.**

NATIONAL SCIENCE STANDARDS K-4

SCIENCE AS INQUIRY

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

PHYSICAL SCIENCE

- Properties of objects and materials
- Position and motion of objects

SCIENCE AND TECHNOLOGY

- Abilities to distinguish between natural objects and objects made by humans
- Abilities of technological design
- Understanding about science and technology

HISTORY AND NATURE OF SCIENCE

- Science as a human endeavor

Activity 5 Introducing Discovery Five in American Aviation

GRADES K-4

Time Requirements: 1 Hour

Materials:

In the Box

None

Provided by User

Paper
Balloon rockets kit
Large long balloons
Fishing line
Straight straws
Tape
Clothes pins or binder clips

Worksheets

Paper Airplane Instructions (Worksheet 3)

Reference Materials

Discovery Five mini-poster

Key Terms:

Altitude
Drag
Mach
Newton's Laws
Propulsion
Rocket Engine
Velocity

Objective:

In this activity, sstudents will learn about properties of objects and materials, position of motion and object, abilities of technological design, and science as a human endeavor through the fifth discovery in American aviation history, the first rocket powered airplane to travel faster than the speed of sound, the X-1. After learning about the X-1, students will experiment with propulsion by making a balloon rocket. Students will learn about Chuck Yeager, the first pilot to fly the X-1 and write about what they learned through Choral Writing.

Activity Overview:

Students will first learn about the significance of the flight of the X-1 airplane, the first airplane to fly faster than the speed of sound. While the X-1 used a rocket engine to propel it forward, students will make a balloon rocket to simulate the flight of a rocket-propelled airplane such as the X-1. Finally, students will learn about Chuck Yeager, the first man to fly faster than the speed of sound while piloting the X-1 and write about him as they have the other famous aviators introduced in this lesson.

Activity:

1. **Review, as you have done at the beginning of each of the previous activities, the information your students have learned thus far.** Refer to the Discovery mini-posters and choral writings as needed.

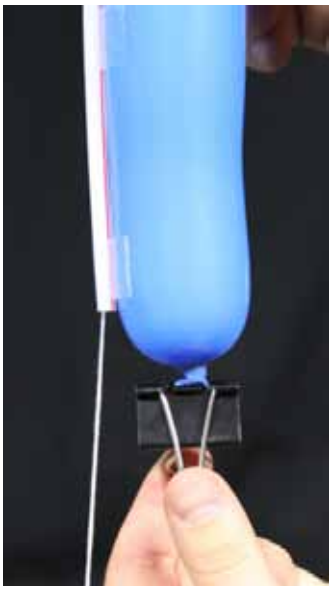
2. **First introduce the X-1 airplane by showing the students a photograph (Fig. 5) and describing the feats of the X-1, the highest and fastest flying airplane of its time.**

3. **Explain that the measurement for the speed of sound is called Mach.** At sea level, the seed of sound is 761.2 mph in the Earth's atmosphere. The speed represented by Mach 1 is not a constant. It is mostly dependent on temperature and altitude. Since the speed of sound increases as the air temperature increases, the actual speed of an object traveling at Mach 1 will depend on the air temperature and pressure of the air around it.

4. **Explain that besides the rocket engine, the bullet-shaped fuselage of the X-1 allowed it to cut through the atmosphere with little air resistance.** To demonstrate this concept, compare the shape of a wad of paper to a standard paper airplane of simple design (See Paper Airplane Template - Worksheet 3). Throw each one in the same direction and see which one goes the farthest. Explain how the shape of the paper airplane decreases air resistance (drag).

5. **Attach a length of fishing line to the ceiling.** Tape the fishing line or attach a paper clip to the fishing line and hook it to the light or ceiling tile braces. The fishing line should hang from the ceiling to the floor or tabletop.
It is a good idea to do this in advance if the space is available.

6. **Blow up one of the balloons and hold it shut with a clothes pin or clip.** You will remove the clothes pin or clip before launch.



7. **Attach the straw to the side of your rocket using the tape.** Be sure the straw runs lengthwise along the balloon.
This will be your guide and method for attaching your balloon rocket to your fishing line.

8. **Thread the fishing line through the straws with the balloon nozzle pointed toward the floor.** Launch is now possible simply by removing the clothes pin or clip.
The fishing line should be taut in order for the rocket to travel successfully up the line, and the clipped balloon nozzle must be untwisted just before release.

9. **Discuss how the exhaust of the balloon rocket and the exhaust of the X-1 rocket engine push against the ground, sending them in the opposite direction of the exhaust because of Newton's law– for every action there is an equal and opposite reaction.**

10. **Read about Chuck Yeager (Img. 10).** Engage in the Choral Writing activity about his life and his career.

11. **Say: "Let's review all of the things we have learned so far by walking past our aviation discoveries time line, which includes important events in aviation history as well as important aviators."**

12. **Allow students time to walk by the display you have made that includes the Discovery mini-posters and the choral writing products.** Allow students time to discuss what they have learned and to ask any questions about what they have learned before completing the "Discussion Points" part of the lesson.

Discussion Points:

Have 4 pieces of chart paper taped to the wall or to the chalk or white board. Write each reflection question on the top of its own paper. List student responses under each question.

1. **Say:** Reflect on the timeline we created. After exploring these five important discoveries in American aviation, how have airplanes evolved, or changed, since 1903 when the Wright brothers first experienced flight?

2. **Ask:** What have we learned about flight since then?

3. **Ask:** Which aircraft impressed you most? Why?

4. **Ask:** In your opinion which aviators did the most to advance the field of aviation? Why?

NATIONAL SCIENCE STANDARDS K-4

SCIENCE AS INQUIRY

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

PHYSICAL SCIENCE

- Properties of objects and materials
- Position and motion of objects

SCIENCE AND TECHNOLOGY

- Abilities of technological design
- Understanding about science and technology

HISTORY AND NATURE OF SCIENCE

- Science as a human endeavor

Reference Materials

Glossary

Aerodynamic:
A design that reduces air resistance

Airfoil:
A structure with curved surfaces designed to give the most favorable ratio of lift to weight; used as the basic form of an aircraft wing

Altitude:
Height above sea level

Drag:
Resistance to motion

Gas mileage:
The ratio of the number of miles traveled to the number of gallons of gasoline burned

Gravity:
The force that attracts a body toward the center of the earth, or toward any other physical body having mass

Heavier-than-air:
The aircraft weighs more than air

Lift:
The force that opposes the weight of an airplane and holds the airplane in the air

Mach:
The speed of sound. Mach 1 is the speed of sound, Mach 2 is twice the speed of sound, etc

Newton's Third Law:
States that for every action there is an equal and opposite reaction

Pitch:
The up and down movement of an aircraft's nose

Propeller:
A revolving shaft on an aircraft that helps create thrust (forward motion)

Propulsion:
A force driving forward

Resistance:
A force opposing another force

Rocket engine:
An engine that produces thrust by the expulsion of high-speed exhaust created by the combustion of solid or liquid propellants

Roll:

The tilt of the wings on an aircraft toward or away from the ground, on the vertical axis

Rotary wing aircraft:

An aircraft that achieves lift through the rotation of its wings' surfaces

Seed dispersal:

The movement or transport of seeds away from the parent plant

Square feet:

A unit of area equal to one foot by one foot square

Surface area:

The total area of the surface of a two- or three-dimensional object

Transatlantic:

Crossing from one side of the Atlantic Ocean to the other

Velocity:

Speed

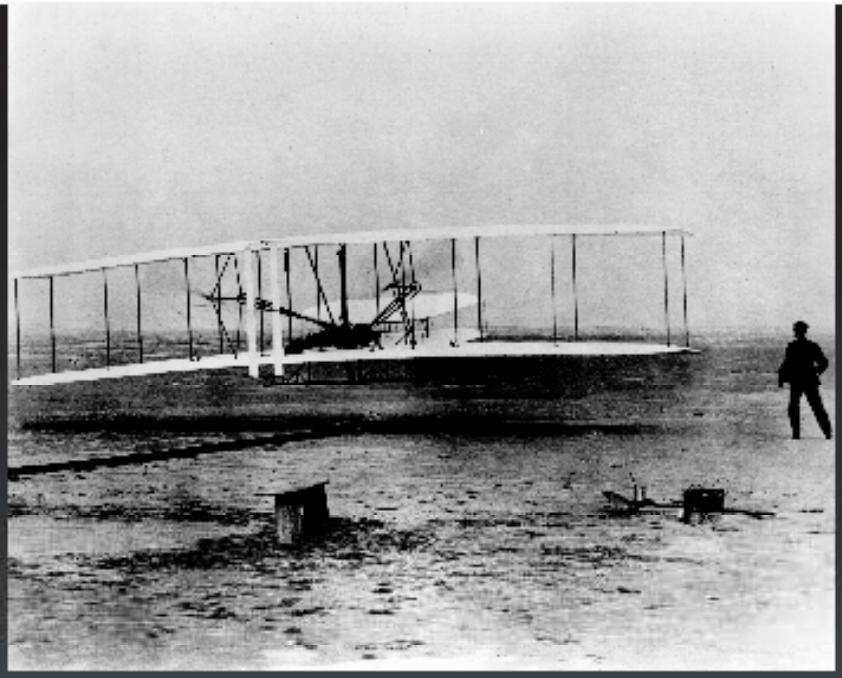
Volume:

A measurement of the space inside an object

Yaw:

The side-to-side motion of the nose of an airplane on the horizontal axis

DISCOVERY ONE:
THE FIRST SUCCESSFUL AIRPLANE



Airplane: 1903 Wright Flyer
Date: First flight on December 17, 1903

SCIENCE AND TECHNOLOGY

The first airplane flight lasted only 12 seconds, covered just 120 feet, and traveled at a mere 30 mph, but Wilbur and Orville Wright came up with the basic solutions for powered, controlled flight. Their contributions included an innovative propeller design that provided thrust, and a system for controlling movement in three directions—vertical (pitch), horizontal (yaw), and lateral (roll). These same basic principles have been applied to nearly every airplane that has been built since.

SOCIAL IMPACT

The Wright Flyer's first successful powered flight brought attention to the aerial age and thrilled people around the world about the possibilities of flight. Writers and artists incorporated flight in their work while images of airplanes appeared on clocks, cigarette cases, plates, and other everyday items. Soon airplanes were used to deliver mail and freight, dust crops, map the Earth, and carry passengers.

DISCOVERY TWO:
THE FIRST AIRPLANE TO FLY ACROSS THE ATLANTIC OCEAN NONSTOP WITH A SINGLE PILOT

Airplane: Spirit of St. Louis (Ryan NYP)
Departed New York, USA on May 20, 1927
Arrived Paris, France 33 1/2 hours later

SCIENCE AND TECHNOLOGY

At the time Charles Lindbergh made his historic transatlantic flight, the airplane had become a much more dependable machine. Larger and more powerful engines allowed airplanes to travel faster, higher, and farther. The The plane he flew, the *Spirit of St. Louis* was built for maximum distance with wings built to carry the 450 gallons of fuel needed to fly from New York to Paris 4,000 miles and 331 ½ hours away.

SOCIAL IMPACT

Lindbergh's flight astonished the world because it demonstrated the safety of airplanes, which led to a rapid advancement in the aviation industry. Within the few years following Lindbergh's flight, airplanes were crossing the United States in 48 hours (compared to 72 hours by train). Soon songs, novels, comic books, and movies made aviation their theme.

DISCOVERY THREE:
THE FIRST PROFITABLE PASSENGER AIRPLANE

Airplane: Douglas DC-3
Date: First flown in 1935

SCIENCE AND TECHNOLOGY

The DC-3 was built of aluminum, making it stronger and more durable than earlier aircraft, which used modified fabrics like painted canvas. The DC-3 also had a larger fuselage (body) and wings, and it could carry more weight. The DC-3 transported as many as 21 passengers at a time at speeds of up to 212 mph. The design of the DC-3 was streamlined with its bullet-shaped fuselage, two powerful engines enclosed by cowlings (hoods), and its retractable landing gear.

SOCIAL IMPACT

The DC-3 was the first modern airliner. It was the fastest commercial form of transportation in its day, and the first airplane to make a profit carrying passengers. The DC-3 made air travel popular and affordable. Its sleek, streamlined shape influenced the design of everything from automobiles to toasters. Military airplane technology also had advanced by this time, resulting in the remarkable airpower that was demonstrated in World War II. The DC-3 used by American troops during the war was nicknamed the Gooney Bird, and it was used to move troops and supplies.

MILESTONE FOUR:
THE INVENTION OF THE HELICOPTER

Airplane: Sikorsky R-4
Date: Made its initial flight on January 13, 1942

SCIENCE AND TECHNOLOGY

The Sikorsky R-4 as designed by Igor Sikorsky had a single, three-bladed main rotor (engine). The R-4 was the world's first large-scale, mass-produced helicopter and the first helicopter to enter service with the United States Army Air Forces, Navy, and Coast Guard. The R-4 became the model for all modern single-rotor helicopters produced thereafter.

SOCIAL IMPACT

Because helicopters have the ability to fly forwards, backwards, up, down and sideways, as well as remaining stationary over a single spot, they are used to complete tasks that are not possible with airplanes. For example, helicopters are often more useful than airplanes in fighting fires, rescuing people stuck in otherwise inaccessible places, transporting the sick and injured, moving and removing large objects, and gathering news and scientific data.

MILESTONE FIVE:
THE FIRST PLANE TO FLY FASTER THAN THE SPEED OF SOUND

Airplane: Bell X-1 "Glamorous Glennis"
Date: First broke the sound barrier on October 14, 1947

SCIENCE AND TECHNOLOGY

The Bell X-1 became the first airplane to fly faster than the speed of sound. U.S. Air Force Captain Charles E. "Chuck" Yeager piloted the X-1 as it reached a speed of Mach 1.01 at an altitude of 43,000 feet. Yeager nicknamed the airplane the "Glamorous Glennis" in honor of his wife.

The X-1 used its rocket engine to climb to its test altitude after launching from the bay of a large Boeing B-29 airplane at an altitude of 23,000 feet. The airplane flew a total of 78 times, and on March 26, 1948, with Yeager as its pilot, the X-1 reached a speed of 957 miles per hour at an altitude of 71,900 feet. It was the highest speed and altitude ever reached by any manned airplane up to that time.

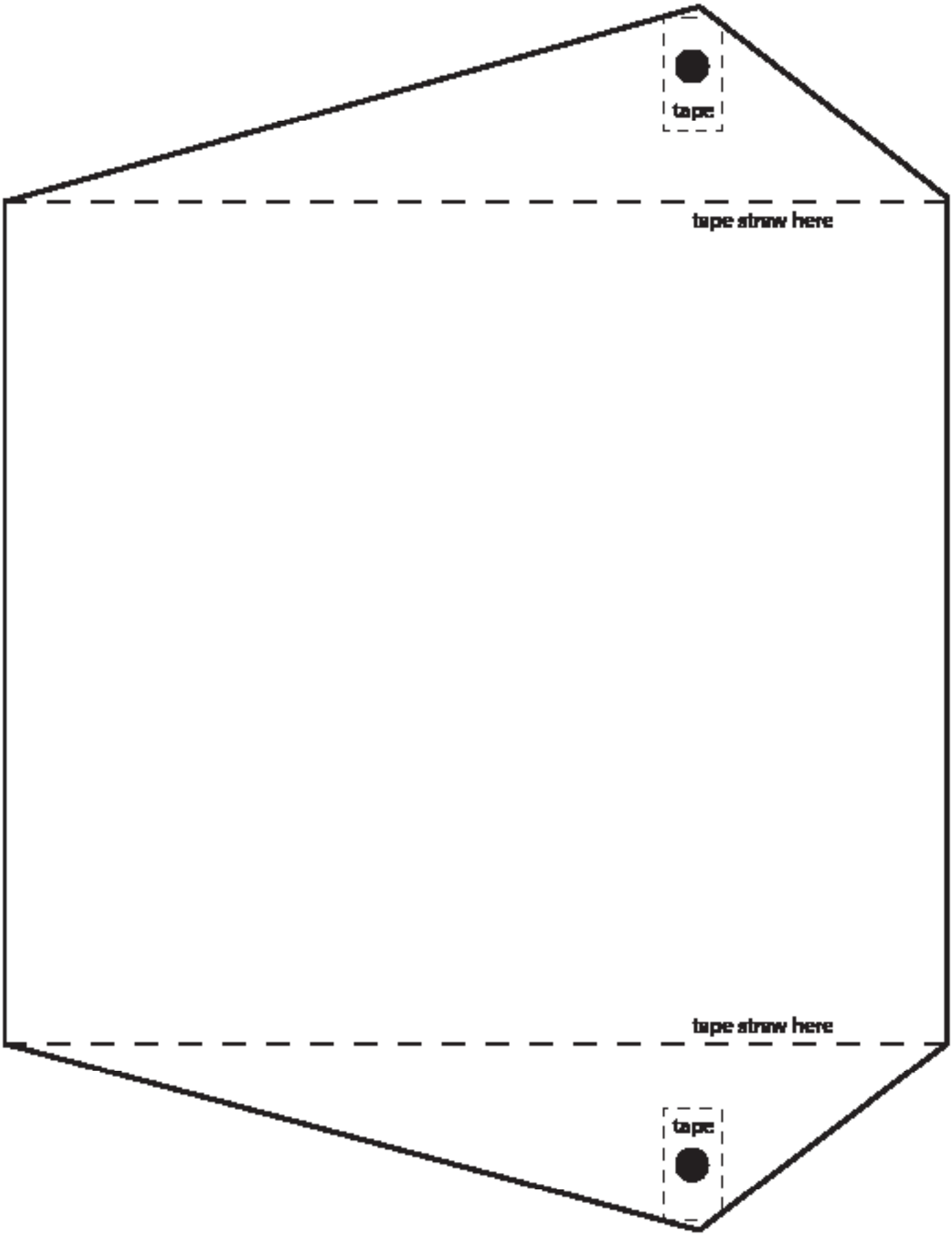
SOCIAL IMPACT

The Bell X-1 laid the foundation for America's space program in the 1960s because the personnel associated with the development of X-1 technology went on to assume key leadership positions in the program. The project also forged the post-war relationship between the U.S. military, private industry, and research facilities. The flight data collected by the X-1 was invaluable for the remainder of the 20th century in furthering U.S. fighter jet design.

Worksheets

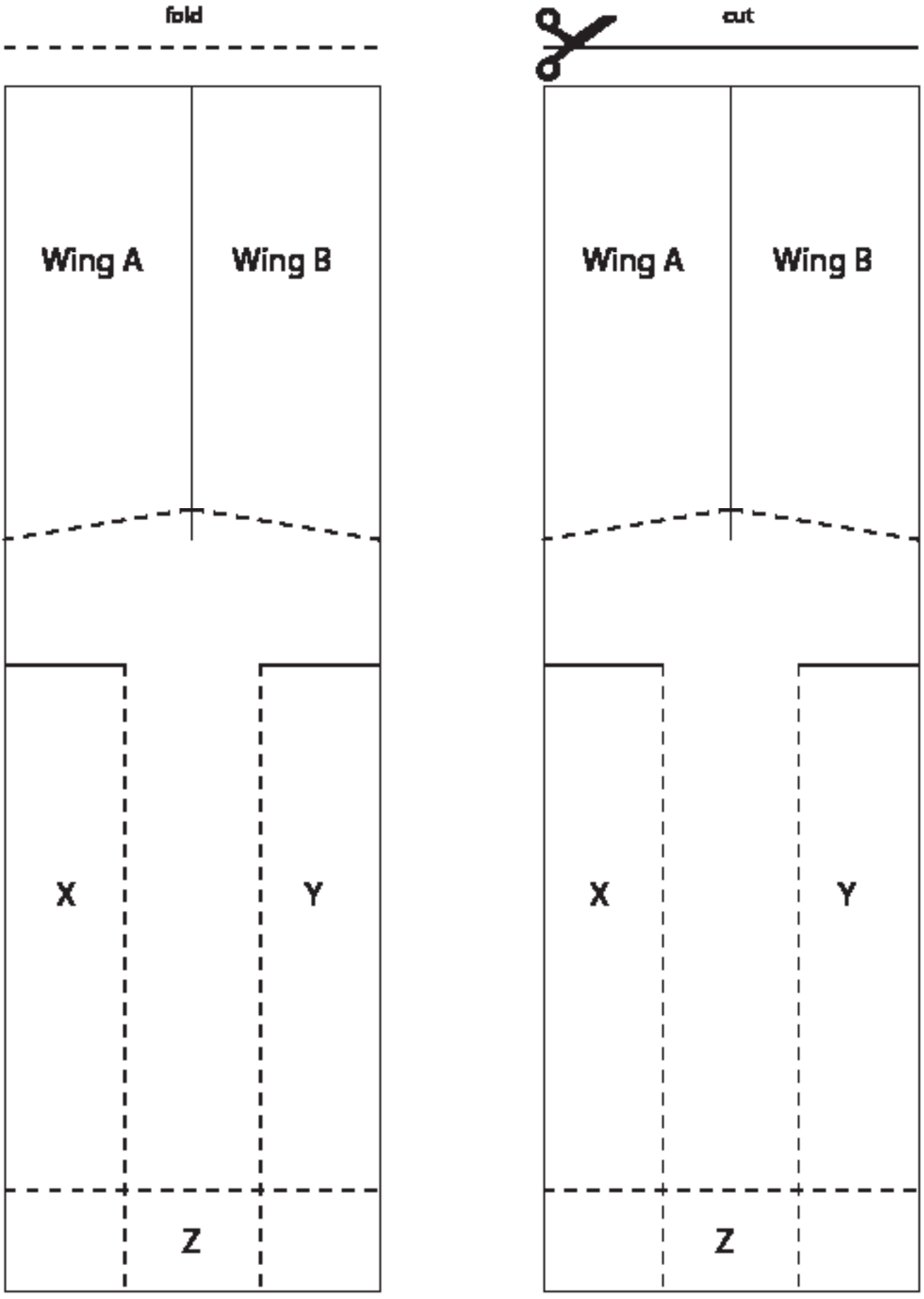
Worksheet 1

Sled Kite Template



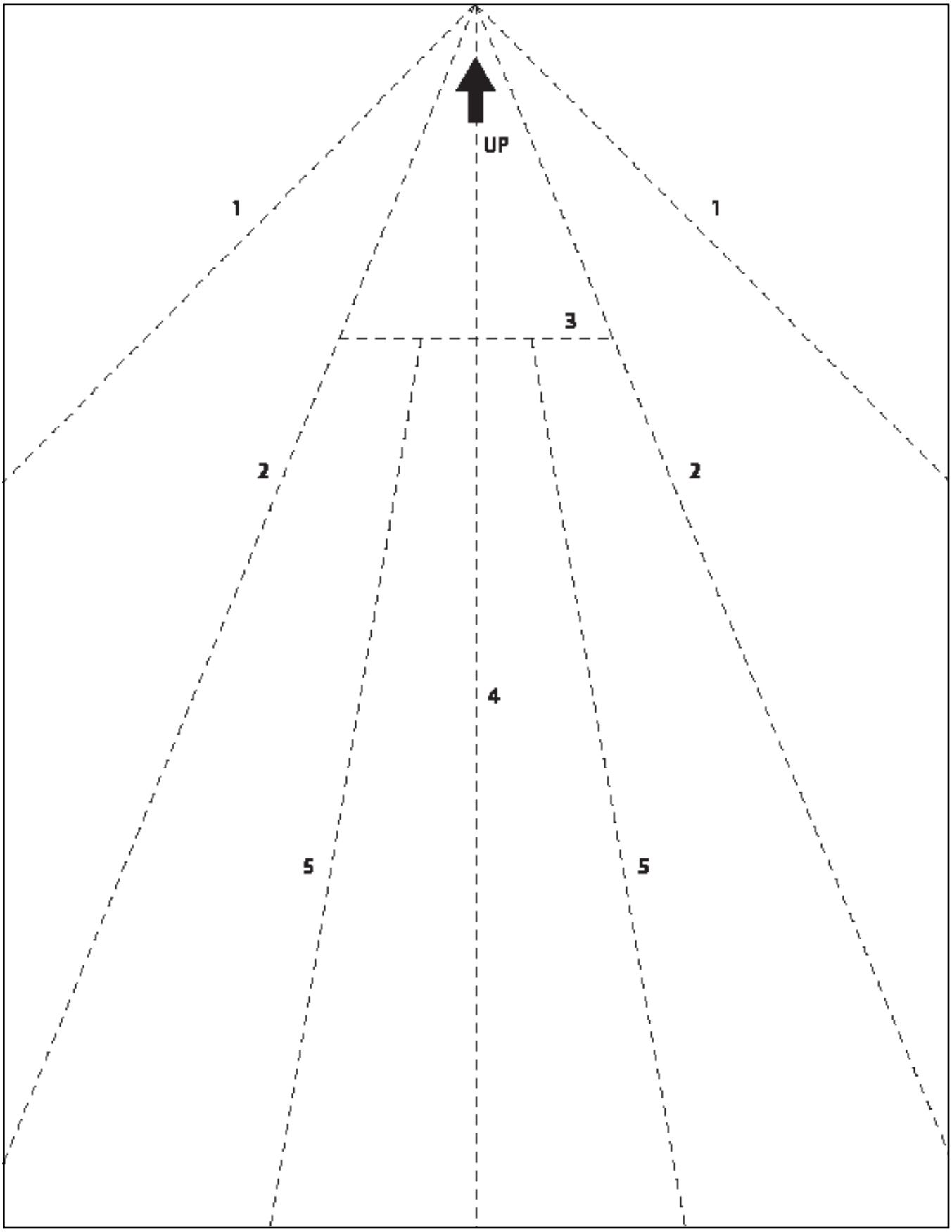
Worksheet 2

Helicopter Template



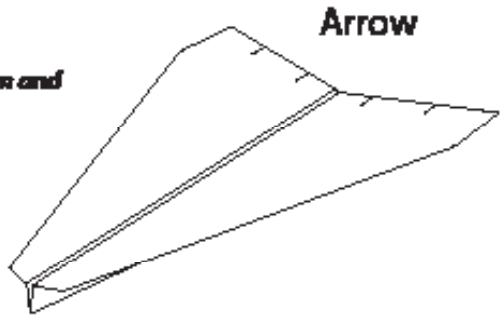
Worksheet 3

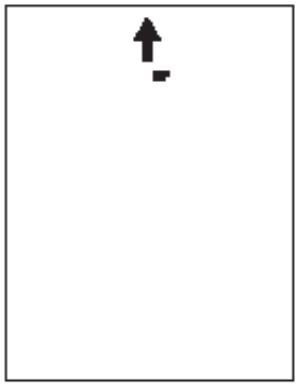
Paper Airplane Template



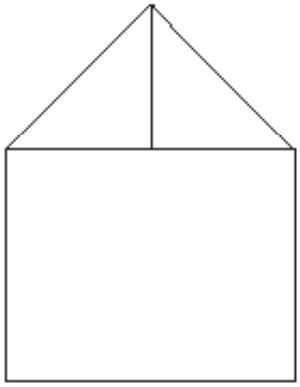
Paper Airplane Instructions

The arrow design paper airplane has an easy to fold design and flies straight and smooth.

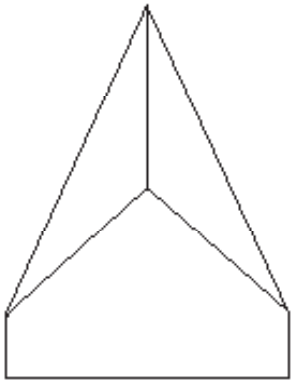




Place the template with the "UP" arrow at the top of the paper. Flip the template over so that none of the fold lines are visible.

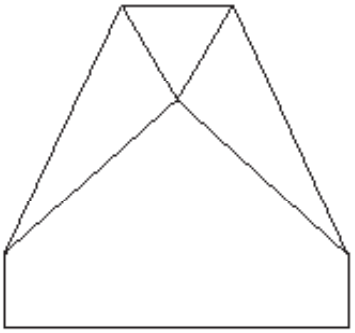


Pull the top right corner towards you until you can see fold line 1. Once visible, crease the paper along the dotted line. Repeat with the top left corner.

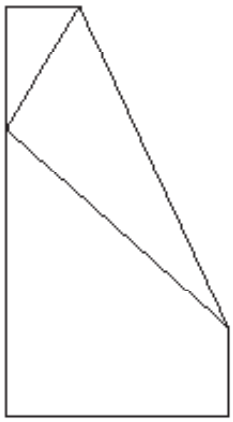


Fold the right side towards you again and crease along fold line 2. Repeat for the left side.

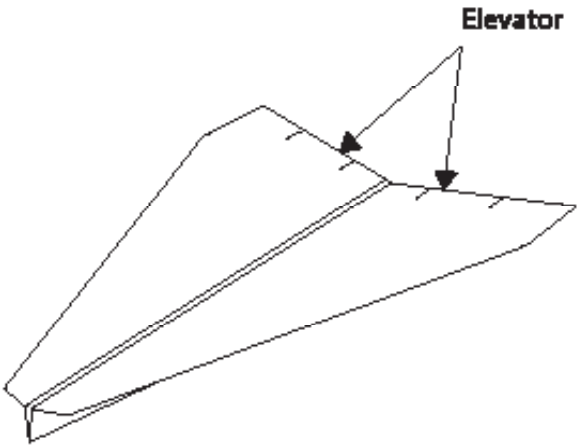
Worksheet 3 (cont.) Paper Airplane Instructions



Fold the tip towards you and crease along fold line 3.



Flip the template over. Fold the left side onto the right side and crease along fold line 4. Make sure that the outsides of the wings line up correctly.

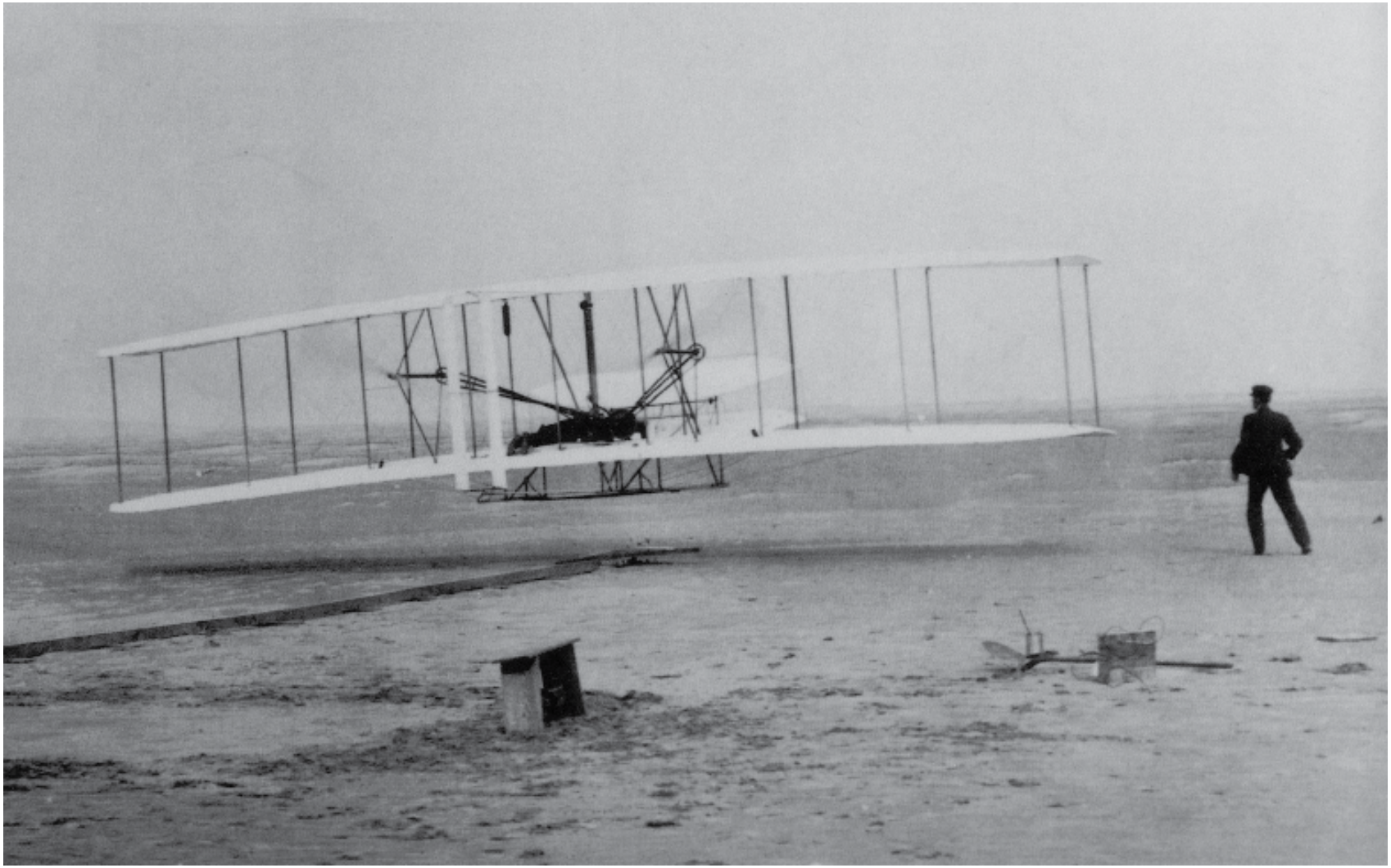


Finally, fold the wings down along fold line 5. Open the fold that you just made so that the wings stick out straight. Cut two one inch slits along the back edge of each of the wings. These are the elevator adjustments. They can be adjusted for flight. You can also adjust the wings by tilting them up slightly away from the fuselage.

Now you are ready to fly!

Images

Img. 1 1903 Wright Flyer



(Photo courtsey of NASA)

Img. 2 Charles Lindbergh

(Photo courtesy of the NASA)

Img. 3 Douglas DC-3

(Public Domain)

Img. 4 Skiorsky R-4

(Photo courtesy of NASA)

Img. 5 Bell X-1 "Glamorous Glennis"

(Photo courtsey of NASA)

Img. 6 Amelia Earhart

(Photo courtesy of NASA)

Img. 7 The Tuskegee Airmen

(Photo courtesy of NASA)

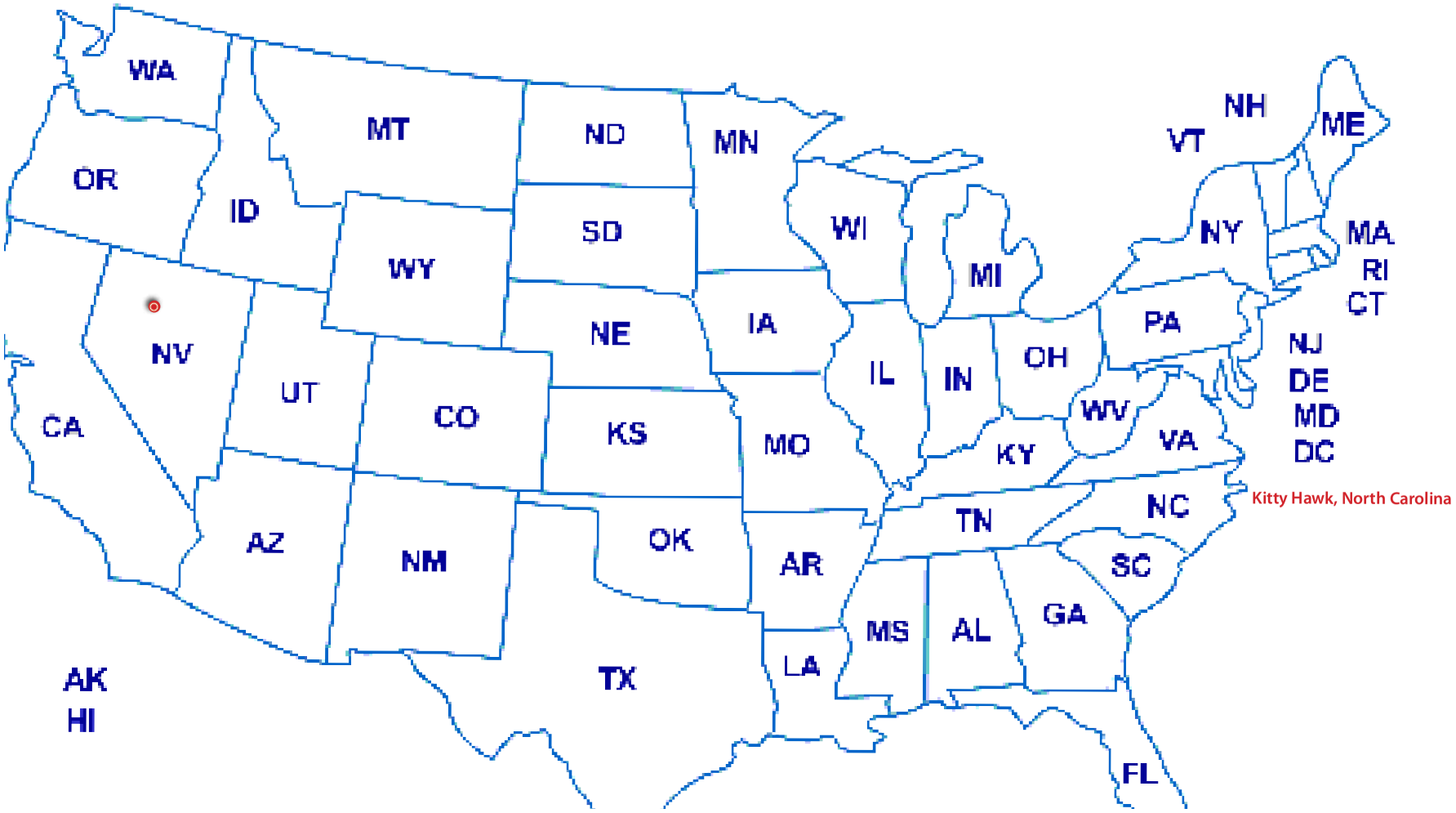
Img. 8 Chuck Yeager

(Photo courtesy of NASA)

Img. 9 Neil Armstrong

(Photo courtesy of NASA)

Img. 11 Kitty Hawk, North Carolina



(Photo courtesy of NASA)

Img. 12 The flight path from New York, USA to Paris, France

(Map courtesy of the Central Intelligence Agency)

Img. 13 The flight path from New York, USA to Dublin, Ireland

(Map courtesy of the Central Intelligence Agency)

Aeronautics
Research
Mission
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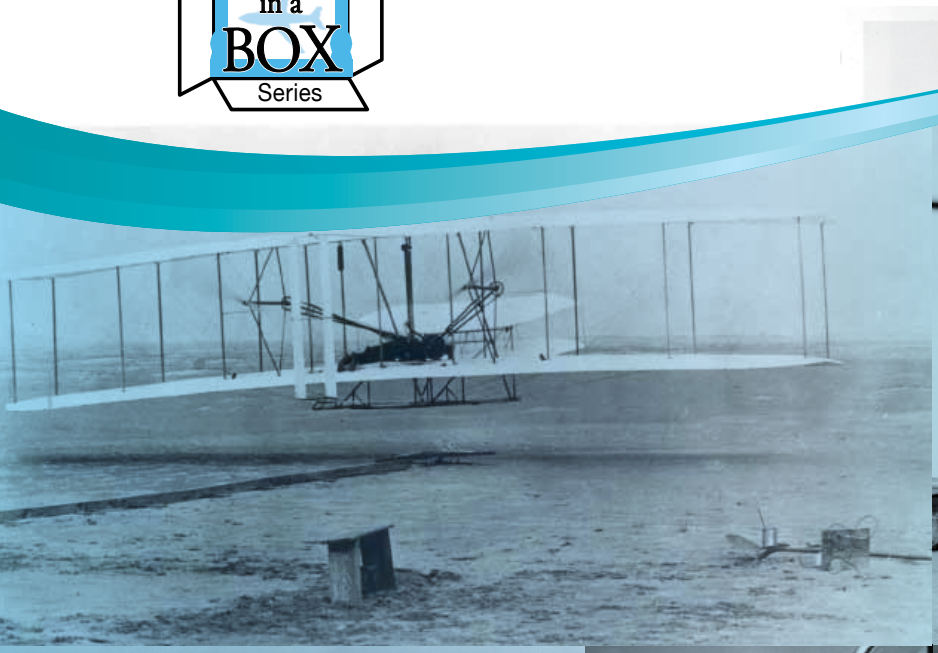
Museum in a BOX Series



history of flight

EP-2010-12-461-HQ