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Tours Available: Monday – Friday 10am to 3pm

*Education tours must be scheduled in advance by calling 301-864-6029.*

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The Department of Parks and Recreation encourages and supports the participation of individuals with disabilities. Register at least two weeks in advance of the program start date to request a disability accommodation. PPC-PR-CPAM-6/10
Dear Educators,

The College Park Aviation Museum will immerse your students in the science and history of flight through an interactive tour and hands-on activities. Our museum educators guide young learners through the links between flight, transportation, and communication. The students will also learn about how planes fly and how new technologies solved pilots’ problems.

An animatronic Wilbur Wright will transport your students to 1909 and share the story of the founding of College Park Airport, now the world’s oldest continuously operating airport. Professional museum educators use historic aircraft and interactive projects to introduce new vocabulary, lead hands-on exploration, and help students understand how life in Maryland has changed over the last century. Your students will also operate the controls of several aircraft, dress like an airmail pilot, and learn how a small airport works (weather permitting).

All activities at the museum and in this packet are linked to Common Core and state curriculum standards. The museum uses inquiry-based tours to encourage students to develop their deductive reasoning skills and form educated responses to museum subject matter, all while in a fun and unique environment.

This teacher’s guide features pre-visit and post-visit educational activities designed to enhance your students’ learning experience at the museum. These activities and demonstrations are tied to museum subject matter and were developed to engage the students in a variety of disciplines. This packet also contains important information about your museum trip and additional resources you can use in your classroom.

The College Park Aviation Museum staff looks forward to hosting your group and exploring this fascinating aspect of American and local history.

Cheers,

Amanda M. Elliott
Education and Interpretation Manager
THE CHANGES IN TRANSPORTATION TOUR

REGISTRATION REQUIREMENTS
- Advanced registration is required for all group tours and programs.
- Group reservations require a minimum of 10 people.
- Groups larger than 100 will be scheduled over multiple time slots or days.
- Tentative dates must be confirmed within 5 business days. Afterwards, unconfirmed dates can be offered to other groups.

To schedule a tour:
By Phone- Contact the Education Department at 301-864-6029
By Fax - fax the registration form to 301-927-6472
By Email- CPAM.Educators@pgparks.com

CANCELLATION AND CHANGE POLICY
48 hours notice is required for cancellations or schedule changes. We will be glad to reschedule your program for a later date. In the case of inclement weather or school closures, we will gladly contact you to reschedule.

ADMISSION FEES
Museum admission is $2.00 per student. School staff are free. We require a student to adult ratio of 10:1, in order to ensure a healthy and safe learning environment for your group. All adults over this requirement will be charged the group rate of $3.00 each.

ARRIVAL & DEPARTURE
Please arrive 15 minutes before your scheduled program to allow time for restroom use and check in. Upon arrival, please check in with the front desk. If you are running late, please contact the museum at 301-864-6029.

PAYMENT
Payment is required on the day of your visit. The museum accepts cash, checks, Mastercard, and Visa.

LUNCH FACILITIES
The museum does not have an indoor eating facility. You are welcome to bring your lunches and eat outside in our designated lunch area overlooking the airport.

Please be mindful that there is NO FOOR OR DRINK ALLOWED INSIDE THE MUSUM.

SPECIAL NEEDS
To better prepare our educators for your students and to best facilitate the learning process, please list any special needs that we should be aware of. For our hearing impaired guests, the museum is able to provide a sign language interpreter with at least 72 hours of notice.

PHOTOGRAPHY
Taking photographs of your experience is greatly encouraged. Feel free to bring a camera with you.
SCHOOL GROUP BEHAVIOR EXPECTATIONS

Teachers: Please review these expectations with your students and chaperones.

Museums are fragile environments and school groups are larger than typical museum groups. Following museum behavior expectations is essential to the success and enjoyment of the learning experience. We reserve the right to ask a school group to leave the Museum due to behavior issues.

- **No food, drink, or gum in museum galleries.** The Museum provides plenty of food for thought as well as a feast for the eyes.
- **Large bags are not allowed in the galleries.** For the safety of the objects, visitors should leave backpacks and other large bags in the museum lobby.
- **Running, pushing, and roughhousing are not allowed in the museum.** Appropriate museum behavior is necessary to avoid bumping into or damaging artifacts.
- **Keep a safe distance between you and the objects.** This helps to avoid accidentally touching or bumping artifacts.
- **Do not touch.** Your touch may not seem like much, but even the slightest contact can damage the surface of objects, rust metal, or leave fingerprints.
- **Only use pencils while writing or sketching.** If an accident should occur, a pencil mark is easier to remove than pen or marker. Please avoid pointing at museum objects while holding a pencil or other items in your hand.
- **No leaning on walls or cases** (either to write or for physical support). This helps keep pictures on the walls and objects secure in their display case. Please feel free to sit on the benches or on the floor as you talk, write, or draw.
- **Use quiet voices in the museum.** We want to respect other groups or visitors.
- **Stay with your group at all times.** This is for teachers, chaperones, and students. We require adult supervision at all times and all we encourage adult participation during field trips.
- **Limit cell phone usage.** Please set a good example by not using your cell phone during programming. Make sure your cell phone is off or silenced during your visit.
- **Chaperone small groups in the Museum Store.** To best serve you and other visitors, we ask that you break into groups of 15 or fewer when visiting the store.
- **We rely on the cooperation of teachers and chaperones** to maintain appropriate behavior and keep students together during your museum experience. Please make sure that all adults accompanying your group are aware of their responsibilities.

Thank you for observing these rules to help keep our museum safe for everyone! Enjoy your visit!
The Changes in Transportation Tour

Students will travel through time, from the early years of the Wright Brothers’ airplanes through today, and experience how and why airplanes have changed. They will enjoy the hands on experience of becoming a pilot, and see how flight clothing changed as airplanes improved. Students will also have a chance to fly our imagination plane and learn how flying controls have changed through the years. Weather allowing, they will also get to venture outside to see up close how the oldest continuously operating airport in the world is still operating today.

Your classroom visit to the museum will include the following components:

1. A tour of the museum’s collections, including the history of the College Park Airport. During this portion of the tour, we will discuss the following topics:
   - The Wright Brothers, their first flight, and how the Wrights came to fly at College Park.
   - The major features of the Wright B airplane, the airplane that the Army purchased from the Wright Brothers for training at College Park.
   - The major features of the Curtiss JN-4D “Jenny”, its differences from the Wright B, and its role during WWI and the first airmail deliveries.
   - Other airplanes in the College Park Aviation Museum collection, their major features, and how and why improvements were made on earlier aircraft.

2. A discussion of pilots in the past and in the present.
   - Students will observe and be questioned about changes in pilots’ clothing from the Wright brothers, to airmail pilots, to modern pilots.
   - Students will gain an understanding of how clothing was directly related to the changes in aircraft through time.
   - This may include a “dress-up” component, with students dressing up like pilots throughout history to learn about these changes.

3. The opportunity to experience the controls of different airplanes, from the Wright brothers’ early airplanes to the small planes that fly at the College Park Airport today, highlighting the differences in how these different types of airplanes fly.
   - Students can climb inside of our imagination plane, a real 1939 Taylorcraft airplane, and experience its controls.
   - We also have simulators that let students learn the controls of the Wright B (dependent on availability) and modern airplanes.

4. A tour of the College Park Airport, the world’s oldest continuously operating airfield (weather allowing)
   - Students will learn about changes to the airfield since its founding in 1909.
   - Students will observe and discuss the current buildings and other features of the airfield.
   - Students will learn about navigational aides, the orientation of airports, and why pilots land in certain directions on runways.
# MATH (Maryland State Curriculum Standards)

<table>
<thead>
<tr>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
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</thead>
<tbody>
<tr>
<td>1.A.2. Identify, describe, extend, and create non-numeric growing or repeating patterns</td>
<td>1.A.2. Identify, describe, extend, and create non-numeric growing or repeating patterns</td>
<td></td>
</tr>
<tr>
<td>6.C.1. Analyze number relations and compute (glider activity)</td>
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# Math (Core Curriculum Standards)

<table>
<thead>
<tr>
<th>Grade 3</th>
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<tbody>
<tr>
<td>3.OA.7. Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division or properties of operations. (glider activity)</td>
<td>4.NBT.6. Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models (glider activity).</td>
<td>5.NBT.6. Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models (glider activity)</td>
</tr>
<tr>
<td>3.NBT.2. Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction. (glider activity)</td>
<td>4.MD.2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.</td>
<td></td>
</tr>
<tr>
<td>3.MD.4. Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot where the horizontal scale is marked off in appropriate units – whole numbers, halves, or quarters.</td>
<td>4.MD.5a. An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. 4.MD.5b. An angle that turns through 1/360 of the circle is called a “one-degree angle,” and can be used to measure angles turns through n one-degree angles is said to have an angle measure of n degrees. (airport compass)</td>
<td></td>
</tr>
<tr>
<td>4.G.3. Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.</td>
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### READING AND LANGUAGE ARTS (Maryland State Curriculum Standards)

<table>
<thead>
<tr>
<th>Grade 3</th>
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<th>Grade 5</th>
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<tbody>
<tr>
<td><strong>1.D.3.</strong> Understand, acquire, and use new vocabulary</td>
<td><strong>1.D.3.</strong> Understand, acquire, and use new vocabulary</td>
<td><strong>1.D.3.</strong> Understand, acquire, and use new vocabulary</td>
</tr>
<tr>
<td><strong>2.A.1b.</strong> Read, use, and identify the characteristics of functional documents such as sets of directions, science investigations, atlases, posters, flyers, forms, instructional manuals, menus, pamphlets, rules, invitations, recipes, advertisements, other functional documents (activities)</td>
<td><strong>2.A.1b.</strong> Read, use, and identify the characteristics of functional documents such as sets of directions, science investigations, atlases, posters, flyers, forms, instructional manuals, menus, pamphlets, rules, invitations, recipes, advertisements, other functional documents (activities)</td>
<td><strong>2.A.1b.</strong> Read, use, and identify the characteristics of functional documents such as sets of directions, science investigations, atlases, posters, flyers, forms, instructional manuals, menus, pamphlets, rules, invitations, recipes, advertisements, other functional documents (activities)</td>
</tr>
<tr>
<td><strong>4.A.2.</strong> Compose oral, written, and visual presentations that express personal ideas, inform, and persuade</td>
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</tr>
<tr>
<td><strong>6.A.1.</strong> Demonstrate active listening strategies</td>
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</tbody>
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### READING AND LANGUAGE ARTS (Core Curriculum Standards)

<table>
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<tr>
<th>Grade 3</th>
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<tbody>
<tr>
<td><strong>L6</strong> Acquire and use accurately grade-appropriate conversational, general academic, and domain-specific words and phrases, including those that signal spatial and temporal relationships (e.g., After dinner that night we went looking for them).</td>
<td><strong>L6</strong> Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal precise actions, emotions, or states of being (e.g., quizzed, whined, stammered) and that are basic to a particular topic (e.g., wildlife, conservation, and endangered when discussing animal preservation).</td>
<td><strong>L6</strong> Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition, and other logical relationships (e.g., however, although, nevertheless, similarly, moreover, in addition).</td>
</tr>
<tr>
<td><strong>SL1</strong> Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.</td>
<td><strong>SL1</strong> Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.</td>
<td><strong>SL1</strong> Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.</td>
</tr>
<tr>
<td><strong>SL2</strong> Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.</td>
<td><strong>SL2</strong> Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.</td>
<td><strong>SL2</strong> Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.</td>
</tr>
<tr>
<td><strong>SL3</strong> Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.</td>
<td><strong>SL3</strong> Identify the reasons and evidence a speaker provides to support particular points</td>
<td><strong>SL3</strong> Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence.</td>
</tr>
<tr>
<td><strong>SL4</strong> Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace</td>
<td><strong>SL4</strong> Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.</td>
<td><strong>SL4</strong> Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.</td>
</tr>
<tr>
<td><strong>W1</strong> Write opinion pieces on topics or texts, supporting a point of view with reasons. (activities)</td>
<td><strong>W1</strong> Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (activities)</td>
<td><strong>W1</strong> Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (activities)</td>
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</table>
Common Core incorporates Social Studies and Science into Reading and Language Arts standards through Grade 6. Below are the Maryland State Curriculum Standards satisfied by the Changes in Transportation tour and activities:

**SOCIAL STUDIES (Maryland State Curriculum Standards)**

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<th>Grade 3</th>
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</thead>
<tbody>
<tr>
<td>3.C.1. Describe how transportation and communication networks link places through the movement of people, goods, and ideas</td>
<td>3.C.1d. Describe the transportation and communication networks for the movement of people, goods, and ideas to, from and within Maryland such as Bay Bridge, National Road, B &amp; O Railroad, the Port of Baltimore, and C &amp; O Canal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.D.1d. Describe how land use and urban growth are influenced by governmental decisions</td>
<td></td>
</tr>
<tr>
<td>4.A.3. Examine how technology affects the way people live, work, and play</td>
<td>4.A.3. Explain how technological changes have affected production and consumption in Maryland</td>
<td></td>
</tr>
<tr>
<td>4.B.2. Identify goods and services provided by the government and paid for by taxes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.A.1. Examine differences between past and present time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.G.1. Describe how the country has changed over time and how people have contributed to its change, drawing from maps, photographs, newspapers, and other sources</td>
<td>6.G.1. Describe how the country has changed over time and how people have contributed to its change, drawing from maps, photographs, newspapers, and other sources</td>
<td>6.G.1. Describe how the country has changed over time and how people have contributed to its change, drawing from maps, photographs, newspapers, and other sources</td>
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**SCIENCE (Maryland State Curriculum Standards)**

<table>
<thead>
<tr>
<th>Grade 3</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1.A.1. Gather and question data from many different forms of scientific investigations which include reviewing appropriate print resources, observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments.</td>
<td>1.A.1. Gather and question data from many different forms of scientific investigations which include reviewing appropriate print resources, observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments.</td>
<td>1.A.1. Gather and question data from many different forms of scientific investigations which include reviewing appropriate print resources, observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments.</td>
</tr>
<tr>
<td>5.A.1b. Using information from multiple trials, compare the speeds (faster or slower) of objects that travel the same distance in different amounts of time.</td>
<td></td>
<td>5.A.1b. Use measurements to describe the distance traveled as the change in position.</td>
</tr>
</tbody>
</table>
The College Park Aviation Museum is located on the grounds of the College Park Airport, the oldest continuously operating airport in the world.

On December 17, 1903, the Wright brothers made their first successful flight in Kitty Hawk, North Carolina. The United States government did not show interest in their airplane until five years later. In 1908, the Wright brothers flew their improved airplane at Fort Myer, Virginia. The Wright Military Flyer had everything that the government wanted in an airplane, and the government asked the Wright brothers to teach two army officers how to fly. Needing a better place to train pilots, the government found College Park, Maryland.

Daily crowds, newspaper writers, and people from the government all came to watch Wilbur Wright teach Lt. Frederic Humphreys, Lt. Frank Lahm, and Lt. Benjamin Foulois how to fly. Their flights were front page news.

The College Park Airport was the first military training field and soon other “firsts” happened here. These included the first woman to fly as a passenger in the United States (Mrs. VanDeman flew with Wilbur), and the first Naval officer to fly in a plane (Lt. Lahm, U.S. Army flew Lt. George Sweet, U.S. Navy).

Between 1910 and 1912, civilian airplane companies also came to the College Park airfield. The airport became home to the Rex Smith Airplane Company, the National Aviation Company, and the Washington Aviation Company.

In 1911, our nation's first military flying school was opened at the College Park Airport. During training, pilots flew two types of airplanes. One type of plane was designed by the Wright brothers, and the other type of plane was designed by Glenn Curtiss, an important airplane maker.

In 1918, the College Park airfield was picked to be part of the first scheduled U.S. Postal Airmail Service route. Planes flew with the mail from College Park, to Philadelphia, to New York City. In 1921, airmail service from College Park ended. The airmail hangar and compass rose used by the airmail pilots are still at the College Park Airport today.

In 1924, a father and son team, Emile and Henry Berliner, were the first people to make a controlled flight in a new type of aircraft, the helicopter. They tested their helicopter at the College Park airfield.

From 1927 until 1933, the Bureau of Standards developed and tested the first radio navigational aids at the College Park airfield, so that pilots could fly at night or in all types of weather.

George Brinckerhoff ran the airfield beginning in 1927. Many pilots learned how to fly at the College Park Airport during this time. There were also airshows, where pilots showed off their flying skills.

The Maryland-National Capital Park and Planning Commission (M-NCP) purchased the Airport in 1973 and it was added to the National Register of Historic Places in 1977. Today it is run as both a historic site and operating airport.
TEACHER INSTRUCTIONS

In this activity students will be introduced to the names for the different parts of an airplane in different languages. They will further learn the ways in which these airplane parts work during flight.

OBJECTIVES
Students will develop the vocabulary necessary to talk about changes in airplane technology, and will gain a deeper understanding of how airplane parts work.

SKILLS AND STANDARDS
Engages reading and language arts and science standards.

INSTRUCTIONS
1. Introduce the different parts of an airplane in English, French and Spanish, using the enclosed labelled diagram, a picture, or a model.
2. Distribute photocopies of the definitions of the airplane parts and the worksheet with the unlabeled airplane parts to the students.
3. Ask the students to work individually or in groups, and correctly match the names to the airplane parts.
4. Come together and discuss their answers, and reinforce the function of each airplane part in flight.
5. Distribute the labelled diagram worksheet (if desired).
PARTS OF AN AIRPLANE

ENGLISH
AILERON
ELEVATOR
RUDDER
FLAP
TAIL
FUSELAGE
COCKPIT
WING
PROPELLER
LANDING GEAR

FRENCH
L’AILERON
L’ASCENSEUR
LE GOUVERNAIL
LE VOLET
LA QUEUE
LE FUSELAGE
L’HABITACLE
LE TRAIN D’ATTERISSAGE
L’HÉLICE

SPANISH
EL AILERÓN
EL TIMÓN
EL FLAP
LA COLA
EL TIMÓN DE PROFUNDIDAD
LA CABINA
LA HÉLICE
EL FUSELAJE
EL TREN DE ATERRIZAJE
LA ALA
AIRPLANE
An airplane is a vehicle heavier than air, powered by an engine, which travels through the air by reaction of air passing over its wings.

FUSELAGE
The fuselage is the central body of an airplane, designed to accommodate the crew, as well as the passengers and/or cargo.

COCKPIT
In “general aviation” airplanes, the cockpit is usually the space in the fuselage for the pilot and passengers; in some aircraft it is just the compartment where the pilot flies the plane. On commercial airliners, this area is called the “flight deck”.

LANDING GEAR
The landing gear includes the wheels underneath the airplane and supports it while on the ground.

PROPELLER
A propeller is a rotating blade on the front or back of the airplane. The engine turns the propeller, which moves the airplane through the air.

WINGS
Wings are the part of the airplane that provide lift, and support the entire weight of the aircraft and its contents while in flight.

FLAPS
Flaps are the moveable sections of an airplane’s wings that are closest to the fuselage. They are moved in the same direction on both wings at the same time and enable the airplane to fly more slowly.

AILERONS
Ailerons are the outward moveable sections of an airplane’s wings. They move in opposite directions (one up, one down). They are used in making turns.

RUDDER
The rudder is the moveable vertical section of the tail, which controls lateral (side-to-side) movements.

ELEVATOR
The elevator is the moveable horizontal section of the tail, which controls vertical (up and down) movements.

TAIL
The rear portion of the fuselage of an aircraft.
DIRECTIONS: Label each airplane part.

Name: __________________________
In this activity students will interpret two photographs (primary sources of information) to learn more about the history of aviation in Prince George’s County Maryland. They will formulate arguments about what is going on in the photographs, supporting their opinions with the photographs and the information that they learned at the museum.

**OBJECTIVES**

Students will practice their critical thinking and writing skills, as they interpret these two photographs. They will also integrate the information that they learn from these primary sources, with the secondary source information that they have already learned about airplane production.

**SKILLS AND STANDARDS**

Engages reading and language arts and social studies standards.

**INSTRUCTIONS**

1. Warm-up: Have a class discussion about some of the changes in airplanes (and airplane technology) and manufacturing that you learned about at the College Park Aviation Museum and from other sources.
2. Distribute the worksheets.
3. Start with asking students to mind map what they see in the included pictures.
4. Come together as a class and discuss the students’ answers.
5. Working individually or in groups, ask students to complete the questions on the second page of the worksheet.
6. Come together as a class and discuss the students’ answers.
Photograph Interpretation

NAME: ____________________________________________

“A picture is worth a thousand words.” Make a mind map by writing down any words that come to mind when you look at these pictures.

Photograph #1

Photograph #2

Photographs are primary sources. By looking at a photo you can gather important information and intelligence.
NAME: ______________________________________

PHOTO #1
Rex Smith airplane factory (in operation between 1910-1916 in College Park)

PHOTO #2
ERCO airplane factory (in operation between 1937-1947 in Riverdale, MD)

Answer the following questions using the two photographs.

1. What is happening in photograph #1?

2. Describe the airplane and the workshop.

3. Who are the people in the photograph? How are they dressed? What do you think their jobs are?

4. What is happening in photograph #2?

5. Describe the airplanes and the factory floor.

6. What is the same about these two photographs?

7. What is different about these two photographs?

8. What can we learn about airplane manufacturing from these two photographs?
PHOTOGRAPH INTERPRETATION

PHOTO #1

PHOTO #2
In this activity students will conduct four short experiments to learn more about the four forces that are essential for airplanes to fly. These concepts, introduced during the students’ tour of the College Park Aviation Museum, will be reinforced through the experiments, which utilize common classroom materials.

OBJECTIVES
Students will conduct experiments about the four forces of flight; thrust, drag, lift and weight. The students will gain a deeper understanding of how these principles work during flight.

SKILLS AND STANDARDS
Engages reading and language arts and science standards.

INSTRUCTIONS
1. Warm-up: Have a class discussion about the four forces of flight, and how you talked about them at the museum. Use the first part of the worksheet as a guide.
2. Distribute the four forces worksheets to students.
3. Ask them to work individually or in groups, and conduct each of the four activities. You will need the following materials; pencils, staple removers, paper, balloons, drinking straws, string or fishing wire, and tape.
4. After each activity discuss the results and why each result occurred. Relate the classroom experiments to how airplanes fly.
At the museum, you learned about how different parts of airplanes help them to lift off the ground, fly, and land. The four forces of flight are gravity, lift, drag, and thrust.

**WEIGHT/ GRAVITY**
The force drawing all objects in the earth’s surface to the center of the earth

**LIFT**
Causes an airplane to rise and is caused by air movement and air pressure

**DRAG**
Resistance that works against motion such as wind

**Thrust**
Movement forward that is greater than drag

Airplane engines or propellers create **thrust**, which makes the airplane move forward. When air flows over the wings, **lift** is created, and helps the airplane go up. The forward movement of an airplane is slowed by **drag**, and airplanes are pulled toward the Earth’s surface (like everything on the Earth’s surface) by **weight** or **gravity**.

**To explore the four forces of flight, you will complete four short experiments.**
ACTIVITY 1: HOW DO WEIGHT AND GRAVITY WORK?

All things have weight (for example your body has a certain weight). The Earth’s gravity pulls down on objects, which gives them weight.

1. Take a pencil and a staple remover (you can also substitute another unbreakable metal object but try to keep your objects of equivalent size).
2. Hold one in each hand and extend your arms out over the floor or desk.
3. Drop the pencil and metal object at the same time.
4. Observe which object falls faster.

Which object fell faster? Why? (hint: which object is lighter/heavier?)

Planes with more weight need more lift to fly. On the tour, we talked about how the Wright brothers and other early airplane builders made their planes out of wood, because it was lighter than the metals of the time period. It was therefore easier to achieve lift than it would have been with metal planes.

ACTIVITY 2: HOW DOES LIFT WORK?

Lift is primarily caused by faster air moving over the top of the wing, creating lower pressure. This makes the wing go up. Lift is also added by wind hitting the bottom of the wing and bouncing down, like a kite.

1. Take a piece of notebook paper.
2. Cut it in half lengthwise (into two symmetrical pieces).
3. Put one end of the paper in a book. Let the other end of the paper hang out and over the top. This paper is the ‘wing’ of your plane.
4. Blow across the top of the paper.
5. Observe what happens to the paper.
What happened to the piece of paper?

Because the air on top of the paper is moving faster than the air below the paper, the air pressure decreases and the ‘wing’ lifts!

**ACTIVITY 3: HOW DOES THRUST WORK?**

The thrust for airplanes is usually provided by engines. Engines can be propeller engines or jet engines. Your arm and hand provide the thrust when you launch a paper airplane. The engine’s thrust keeps a plane flying, by moving the plane through the air. Remember, lift is created when air flows over the wings. We will test the idea of thrust by creating an air engine.

1. For this activity, you will need a balloon, a drinking straw, fishing line or string, and tape.
2. Place the fishing line or string through the straw.
3. Tie one end of the string to the back of a chair and have one student hold the other end of the string.
4. Inflate the balloon with air and hold the end tight.
5. Tape the balloon to the straw.
6. Release the end of the balloon, and observe how the balloon moves.

What happened to the balloon? Did the balloon move toward or away from the end where the air was coming out?

The straw here represents the fuselage of the plane, and the balloon represents the engine. Once the balloon was filled, there was a difference in air pressure between the inside and outside of the balloon, and the inside of the balloon had a higher air pressure than the outside of the balloon. When the balloon was released, the air on the inside of the balloon equalized with the air on the outside of the balloon. Energy was generated as the air moved from high pressure areas to low pressure areas.

The balloon moves in the opposite direction as the flow of released air because every action has an equal and opposite reaction. The air is released from the small opening of the balloon, which means the air is focused in one direction. Therefore, the balloon and straw are forced to move down the string in the opposite direction.
ACTIVITY 4: HOW DOES DRAG WORK?

Drag is caused by the resistance of air or wind against a plane or other object. Drag can slow an airplane down. The speed and shape of a plane determine how much drag an airplane has. A streamlined plane will have less drag than a bulky plane.

1. Take a single sheet of paper.
2. Cut the piece of paper in half widthwise (into two symmetrical pieces of paper).
3. Crumple up one of the papers.
4. Hold the crumpled up paper in one hand, and the flat sheet of paper in the other hand.
5. Extend your arms in front of you at the same height and drop them.
6. Observe what happens to each piece of paper.

What happened to each piece of paper? Why?

The papers were identical in terms of their weight and what they were made of (so a difference in weight was not a factor here, as it was in the first activity). The more surface area that is exposed to the air, the greater the drag will be. The crumpled up piece of paper is more aerodynamic than the flat sheet of paper. In the same way, a streamlined shape helps an airplane to pass through the air more easily.
GLIDER ACTIVITY

TEACHER INSTRUCTIONS

In this activity, students will explore how the four forces of flight affect the distance that paper airplanes can travel. When they throw the paper airplane into the air, they are providing the thrust, or forward motion for the plane. The air moving over and under the wings provides lift. As the plane moves through the air, air pushes against the plane and provides the drag which slows the plane down. Also, the weight of the paper airplane affects its flight and causes it to eventually land. In the extension activities, students will change the weighting of the plane, and its drag, to see how this affects the distance that their airplanes can travel.

During their tour of the museum students will create paper airplanes. With this activity, they will use those airplanes, or other paper gliders, to measure how far they can fly, on average.

OBJECTIVES
Students will measure the distance that their paper airplanes can travel, and calculate the average distance travelled. Students also have the option to further test whether modifications to their airplane (adding a paper clip to the front or the back, or modifying the wings) will cause the plane to fly a greater distance.

This activity utilizes the basics of the scientific method. Based on the question of how far their paper gliders can fly, students will formulate a hypothesis predicting what they think the answer is. Then they will test the hypothesis with an experiment, draw conclusions based on the results of their experiment, and then either accept or reject their hypothesis. During the experiment, they will also use their math skills to calculate the average distance that their glider flew.

SKILLS AND STANDARDS
Engages reading and language arts, math, and science standards.

INSTRUCTIONS

1. Use the paper gliders that students made at the museum, or distribute paper so that students can construct new paper airplanes.
2. Distribute the attached worksheets to students. Have them fill out their hypothesis about how far their airplane will fly.
3. Place lines of masking tape on the floor or otherwise mark your “starting lines.”
4. Having students work in groups or individually, have each person or group launch an airplane (use the same airplane for all three trials). After each trial record the distance traveled.
5. Once all three trials are completed, have each group average the three numbers together.
6. Ask students to evaluate their results. Did their airplanes travel as far as they thought they would?
7. Come together as a class and discuss the range of distances (you could even plot the results on a graph). What is similar about the airplanes that travelled the furthest? What is similar about the airplanes that travelled the shortest distances?
8. If time allows, modify the weight (with paperclips) and wing shape (to affect the drag) of the airplanes and see how this changes the distance that each plane can travel.
Glider Activity

Name: ____________________________________________

College Park Airport is the oldest continually operating airport in the world. You created paper airplanes during your tour of the museum. Now, you will use these airplanes or other paper gliders to measure how far they can fly, on average. Remember that the four forces of flight are needed to keep an airplane aloft.

INSTRUCTIONS
1. Make a glider – Use the glider you made at the museum, follow the directions on this activity for constructing a dart glider, or design your own paper airplane
2. Formulate a hypothesis. Predict how far your glider will fly in meters and/or yards.

HYPOTHESIS
I predict that my glider will fly _____________ meters/ yards.

3. Test fly your glider. From a set starting point, throw your glider and measure the distance your glider flew. Record the distance in the appropriate box. Repeat for the additional tests.

HOW FAR MY GLIDER FLEW

<table>
<thead>
<tr>
<th>Distance in meters/yards</th>
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</thead>
<tbody>
<tr>
<td>Test 1</td>
</tr>
<tr>
<td>Test 2</td>
</tr>
<tr>
<td>Test 3</td>
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</tbody>
</table>

4. Now find the average distance your glider flew in meters/yards. To do this, add the results of all tests and divide the sum by the number of tests.

5. How accurate was your prediction?

Time permitting
Experiment with ballast by attaching a paper clip to the rear of the glider, then to the front of the glider. You may also bend the wings up or down to see how this affects flight.

Does the ballast your glider fly?
Does it fly father without ballast?
What wing shape allows your plane to fly the farthest?
**GLIDER ACTIVITY**

**BASIC DART**

**FOLDING INSTRUCTIONS**

**STEP 1**
Use a sheet of 8½-by-11 inch paper. Fold the paper in half lengthwise and run thumbnail along the fold to crease it sharply. Now, unfold the paper.

**STEP 2**
Fold down the top corners as indicated by the arrows.

**STEP 3**
Fold the two edges toward the center line, as indicated.

**STEP 4**
Make a valley fold in half. Turn the plane 90 degrees as shown in figure of Step 5.

**STEP 5**
Create a wing crease that begins at the nose as shown.

**STEP 6**
Form 3-dimensional shape as shown in figure. The Basic Dart is complete. Bend up the tailing edge of the wings for lift if it has a tendency to nose-dive.
HOW THINGS FLY
Learn about the principles of flight through information and activities created by the Smithsonian’s National Air and Space Museum. 
Find it at: http://howthingsfly.si.edu/.

THE WRIGHT BROTHERS & THE INVENTION OF THE AERIAL AGE
Learn more about the Wright brothers through information and activities created by the Smithsonian’s National Air and Space Museum. 
Find it at: http://airandspace.si.edu/exhibitions/wright-brothers/online/.