National Aeronautics and Space Administration

GRADES **K-4**

Parts of an Airplane

parts of an airplane

Aeronautics
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(Photo courtesy of NASA)

Parts of an Airplane

Lesson Overview

In this lesson, students will learn about characteristics of organisms, properties of objects and materials, abilities to distinguish between natural objects and objects made by humans, and abilities of technological design as they discover how the individual components of aircraft come together to make a fully functioning vehicle. To help in identifying the parts, students will first study the parts of a bird's body, then correlate them to those on an airplane.

Objectives

Students will:

1. Compare pictures of birds and airplanes and learn to identify the individual components of both.

2. Reinforce the concept that it takes many individual parts to build an object.

3. Realize that it takes many unique, individual parts to build an object.

Materials:

In the Box

Crepe rubber puzzles
Peg-A-Plane kit

Provided by User

Tape or thumbtacks

Worksheets

Peg-A-Plane 1 (Worksheet 1)
Peg-A-Plane 2 (Worksheet 2)
Peg-A-Plane 3 (Worksheet 3)

GRADES **K-4** **Time Requirements:** 1 hour 35 minutes

Background

Any vehicle, whether it's a car, truck, boat, airplane, helicopter or rocket, is made up of many individual component parts. Some components are common amongst a variety of vehicles, while others are exclusive to specific ypes. Occasionally, a component is modified and iven a different name, although its basic principle of operation remains intact. This lesson is designed to look at those individual components and allow students to not only identify them, but to understand how they work together to create a functioning aircraft.

Figure 1 shows a typical airplane with its major components listed. Many external airplane components are constructed of metal alloys, although composites made of materials such as carbon fiber and a ariety of fibe glass resins are becoming more popular as technology improves.

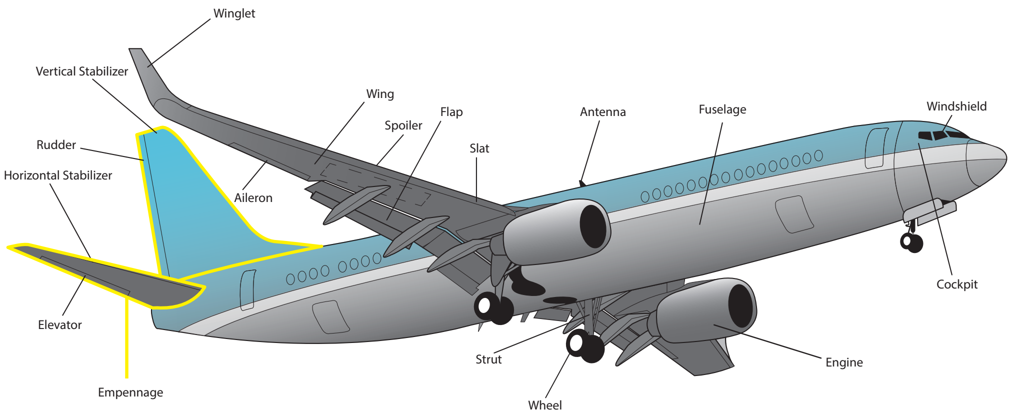


Fig. 1 Airplane Diagram

Aileron

The ailerons are located at the rear of the wing, typically one on each side. They work opposite to each other, meaning that when one is raised, the other is lowered. Their job is to increase the lift on one wing while reducing the lift on the other. By doing this, they roll the aircraft sideways, causing the aircraft to turn. This is the primary method of steering a fi ed-wing aircraft.

Antenna

There are numerous radio antennas located around an aircraft, their size and position corresponding to the type of work each antenna must perform and the frequencies being transmitted or received. The GPS antenna, for example, is always mounted to the top of an airplane. This is because the GPS satellites are in space, and therefore always above the aircraft. As a general rule, longer antennas are used for radio communication and navigation (VHF frequencies), while shorter antennas are reserved for higher frequency data such as the GPS signals and the transponder, which provides air traffic ontrol with information about the aircraft's position and altitude.

Cockpit

The cockpit, sometimes referred to as the Flight Deck, is where the pilots sit. It contains the flig t controls, which move the airplane, as well as all the buttons and switches used to operate the various systems.

Elevator

As the name implies, the elevator helps "elevate" the aircraft. It is located on the tail of the aircraft and directs the nose of the aircraft either upwards or downwards (pitch) in order to make the airplane climb and descend.

Empennage

This name stems from the French word "empenner," meaning "to feather an arrow". The empennage is the name given to the entire tail section of the aircraft, including both the horizontal and vertical stabilizers, the rudder and the elevator. As a combined unit, it works identically to the feather on the arrow, helping guide the aircraft to its destination.

Engine

An airplane has at least one, or as many as eight engines, which provide the thrust needed to fl . There are many different makes and models on aircraft today but all perform the same basic function of taking the air that's in front of the aircraft, accelerating it and pushing out behind the aircraft. Jet powered aircraft perform this function by compressing the air using turbines, while propeller-powered aircraft use a propeller mounted to the engine. In general, the propeller works like a big screw, pulling the aircraft forward while pushing the air behind it (Fig. 2).

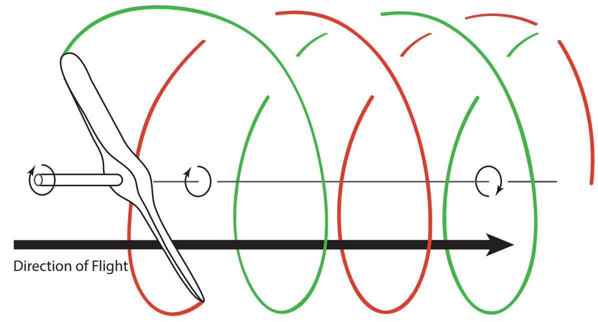


Fig. 2 Propeller path

Flap

Flaps are a "high lift / high drag" device. Not only do they improve the lifting ability of the wing at slower speeds by changing the camber, or curvature of the wing, but when extended fully they also create more drag. This means an aircraft can descend (or lose altitude) faster, without gaining airspeed in the process. Flaps come in 4 main varieties: plain, split, slotted and fowler (Fig. 3).

- The plain flap is the simplest of the our varieties. It works by lowering the aft portion of the wing, increasing its camber, which in turn causes the wing to produce more lift. Plain flaps a e typically used only when the aircraft is required to be as simple to construct as possible.
- The split flap orks by lowering just the bottom section of the wing. Rather than providing additional lift, the split flap is p imarily used to allow an aircraft to descend quickly without gaining forward momentum, or airspeed. As such, it is typically found on aircraft that have to operate in smaller areas, such as those used for crop dusting, or in the Alaskan bush. It was invented by Orville Wright in 1920 and became popular in the 1930's but due to the large quanitity of drag it produces, has been rarely used since then.
- The slotted and fowler flaps a e both designed to physically increase the overall surface area of the wing, literally making the wing bigger. In addition, the slotted fla , as the name implies, creates one or more slots within the wing. These slots provide additional energy to the air on the upper surface of the wing, ensuring that as the airspeed decreases, the air still has suffici t momentum to reach the rear of the wing. In technical terms, it is referred to as preventing the separation of the boundary layer.

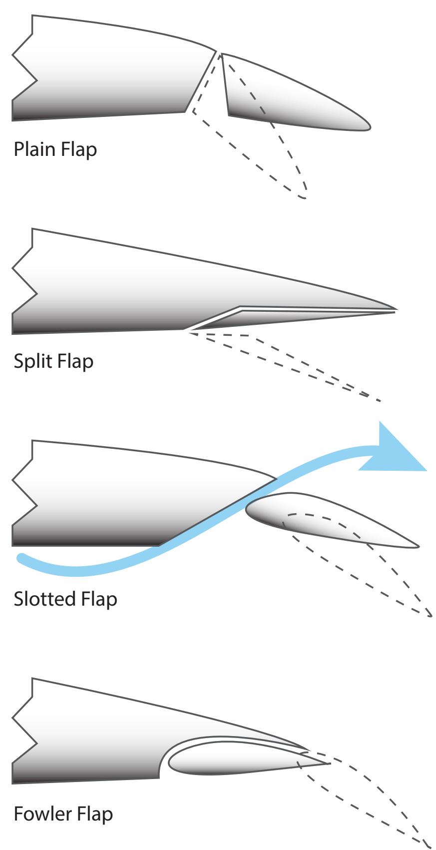


Fig. 3 Flaps

Fuselage

The fuselage, from the French word "fuselé" meaning "spindle shaped", is the portion of the airplane used to literally join, or fuse, the other parts together. It is commonly thought of as the body of the aircraft and holds the passengers and cargo safely inside.

Horizontal Stabilizer

The horizontal stabilizer is quite simply an upside-down wing, designed to provide a downward force (push) on the tail. Airplanes are traditionally nose-heavy and this downward force is required to compensate for that, keeping the nose level with the rest of the aircraft. Some aircraft can control the angle of the stabilizer and therefore the level of downward force while in flig t, while others are fi ed in place.

Rudder

The rudder is attached to the vertical stabilizer, located on the tail of the aircraft. It works identically to a rudder on a boat, helping to steer the nose of the aircraft left and right; this motion is referred to as yaw. Unlike the boat however, it is not the primary method of steering. Its main purpose is to counteract certain types of drag, or friction, ensuring that the aircraft's tail follows the nose, rather than sliding out to the side.

Slat

A slat is a "high lift" device typically found on jet-powered aircraft. Slats are similar to the flaps xcept they are mounted on the leading edge of the wing. They also assist in changing the camber, or curvature of the wing, to improve lifting ability at slower speeds.

Spoiler

The spoiler's function is to disrupt, or spoil, the fl w of air across the upper surface of the wing. They are usually found on larger aircraft, which can have two types installed. The in-flig t spoilers are small and designed to reduce the lifting capability of the wing just enough to allow the aircraft to descend quicker without gaining airspeed. Although the flaps can also perform this function, the spoiler is intended to be used temporarily, while the flaps a e typically used for longer durations such as during the approach and landing. The ground spoilers (Img. 1) typically deploy automatically on landing and are much larger than their in-flig t cousins. They are used to completely destroy the lifting ability of the wing upon landing, ensuring that the entire weight of the airplane rests fi mly on the wheels, making the brakes more effective and shortening the length of runway needed to stop the aircraft.

Img. 1 Ground spoilers on an Airbus 320 aircraft

Struts

The struts are part of the undercarriage, more commonly known as the landing gear. There are two main types - straight leg (Img. 2) and trailing link (Img. 3) - but their function is the same: to absorb the impact of the landing as the aircraft touches the ground. Each strut contains a shock absorber (a collection of springs), hydraulic oil and gasses which work together to reduce the impact felt by the passengers.

Img. 3 Trailing link landing gear

On some aircraft, such as those used by student pilots, the struts are made entirely out of spring steel. This type of steel is treated in such a way that it can absorb the shock of landings repeatedly, bending automatically back into shape (Img. 4).

Vertical Stabilizer

The vertical stabilizer is designed to stabilize the left-right motion of the aircraft. While most aircraft use a single stabilizer, some models, such as the Lockheed C-69 Constellation (Img. 5), use multiple, smaller stabilizers.

Img. 6 A modified oeing 747 carrying the Space Shuttle Enterprise

Img. 2 The straight leg landing gear of the Space Shuttle Atlantis

Img. 4 A NASA modified essna 190

Img. 5 A Lockheed C-69 Constellation

Wheel

The wheels are another part of the undercarriage, or landing gear. While most aircraft have a minimum of three wheels, larger aircraft require many more to support the immense weight (Img. 6). Typically aircraft wheels are filled with nit ogen instead of air. This is because the pressure of nitrogen gas changes very little with changes in altitude or temperature, which is something aircraft constantly experience.

Windshield

The windshield on smaller aircraft is usually made from polycarbonate, a type of plastic, while pressurized airplanes use a sandwich of plastic and glass layers, called a laminate, up to 20mm thick. This is necessary to absorb the impact of birds, insects and other debris that may collide with the windshield as the airplane flies t close to the speed of sound.

Wing

The wing provides the majority of the lift an airplane requires for flig t. Its shape is specifically desi ned for the aircraft to which it is attached. On most aircraft, the interior of the wing is used to store the fuel required to power the engines.

Winglet

Some aircraft wings have an additional component called a winglet, which is located at the end of each wing. Its purpose is to reduce the drag (or air resistance) the wing produces as it pushes through the air. This not only allows the airplane to fly fas er, but also means it burns less fuel, allowing it to fly longer distan es without refuelling.

(Photo courtesy of NASA)

Img. 7 The winglet of a KC-135A cargo plane.

Activity 1 Birds & Planes

GRADES K-4

Time Requirement: 20 minutes

Materials:

In the Box

None

Provided by User

Tape or thumbtacks

Worksheets

None

Reference Materials

Img. 7 - A robin in flig t
Img. 8 - A seagull in flig t
Img. 9 - A hummingbird in flig t
Img. 10 - Boeing 787 Dreamliner

Key Terms:

None

Objective:

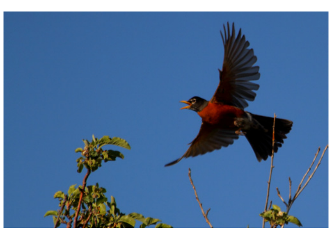
By comparing pictures of birds and airplanes, students will learn to identify the individual parts of both.

Activity Overview:

In this activity, the students will learn about properties of objects and materials, as well as characteristics of organisms, and will develop the ability to distinguish between natural objects and objects made by humans as they identify the similar components and understand their purposes.

Activity:

1. **Begin by discussing the Background information with the students.**
   The topics covered in the Background information are quite detailed in nature. As such, it should be simplified as required to suit the abilities of the students. The priority of this lesson is for students to understand the similarities between birds and airplanes rather than for them to be fluent in naming the individual components.
2. **Next, distribute copies of each of the bird pictures to the students, keeping a copy for yourself which will be used as a demonstration piece.**
3. **Hold up one of the bird pictures and ask the students to name each of the major parts:** Head, Body, Wings, Tail, Legs, Feet.




4. **Repeat the process with another of the bird pictures.** This time, ask the students what each part is for.

   Head: This is what the bird uses to think, hear, eat and see
   Body: Holds the other parts together; digests food
   Wings: Provide the lift needed for the bird to fl
   Tail: Helps the bird both steer and fly in a straight lin
   Legs & Feet: Allow the bird to land and walk on the ground

5. **Repeat the process with the final bird picture.** Ensure that the students now understand that while each of the birds looks different, the names of the body parts are the same.
   If desired, use the tape or thumbtacks to secure the bird pictures to the wall for easier reference during the next step.

6. **Hold up the picture of the airplane.** Ask the students to use what they have just learned about birds to identify the main components.
   At this point, they will likely name each part using bird terms. There is no need to correct them yet.

7. **Finally, point to each of the parts again, but this time tell them the actual name and how it correlates to the bird.**

   Head – Cockpit: *Instead of a bird's brain and eyes, this is where the pilot sits and controls the plane.*
   Body – Fuselage: *While the bird holds food in its belly for fuel, the airplane holds jet fuel or gasoline. The fuselage is also where all the people and bags go.*
   Wings – Wings: *Unlike the bird, the airplane doesn't flap its wings to provide lift. Instead, the plane uses the shape of its wings to provide lift. Also, instead of using its wings to provide thrust like the bird, the airplane uses engines.*
   Tail – Empennage: *The part of an aircraft commonly referred to as the tail is really called the empennage. It works much the same as a bird's tail, guiding the airplane through the air and helping it fly in a straight line.*
   Legs & Feet – Landing Gear or Undercarriage: *The plane uses these wheels to move on the ground like a car, just like the bird walks on the ground.*

Discussion Points:

1. **An airplane is made up of lots of parts. Can you name other manmade objects that are made up of lots of parts?**
   The answer is self-explanatory, but expect responses such as cars, trains, etc. If desired, correlate this to non-mechanical objects such as a pencil, where the lead, eraser and wood shell are considered its parts.

2. **If a part was taken away, or missing, would the bird or plane work properly?**
   In most situations involving living or mechanical objects, the answer would be no. For simpler objects like the pencil, it could still function if the item missing was less critical, such as the eraser. Even though objects or living things might be able to function without some of their parts, they wouldn't be able to do everything. For example, a pencil would still write without an eraser, but what wouldn't it be able to do? If a bird was missing it's feathers, what might it have trouble with?

NATIONAL SCIENCE STANDARDS K-4

SCIENCE AS INQUIRY

• Abilities necessary to do scientific inqui y

• Understanding about scientific inqui y

PHYSICAL SCIENCE

• Property of objects and materials

SCIENCE AND TECHNOLOGY

• Abilities of technological design

• Understanding about science and technology

• Abilities to distinguish between natural objects and objects made by humans

LIFE SCIENCE

• Characteristics of organisms

Activity 2 Plane Puzzles

GRADES K-4

Time Requirement: 30 minutes

Materials:

In the Box

Crepe rubber puzzles

Provided by User

None

Worksheets

None

Reference Materials

None

Key Terms:

None

Objective:

By completing jigsaw puzzles of airplanes, students will reinforce their abilities of technological design as they review the concept that it takes many individual parts to build an object.

Activity Overview:

In this activity, the students will complete crepe rubber jigsaw puzzles of airplanes.

Activity:

1. **If you have not completed Activity 1 – Birds & Planes, discuss the Background information with the students.**
   It is important for this activity to convey the basic concept that many parts can come together to build the whole, rather than attempting to understand how they interact together in flight.
2. **Depending on the number of students and puzzles available, divide the class into even sized groups.** Provide each group with a completed jigsaw puzzle. Ask them to study the puzzle, then remove and jumble all of the pieces. If you are teaching older students, begin with the puzzles in many pieces already.
   When working with younger students, you may wish to pre-stage the puzzle, removing just the larger pieces such as the fuselage and wings, leaving the smaller items, such as the windows, attached to the fuselage. Also, each puzzle contains a paper template to assist the students in reassembly. This can be removed to increase the level of difficulty if desired.
3. **Ask the students to reassemble the puzzle. Repeat this as desired, rotating the different puzzles amongst the groups.**

Discussion Points:

1. **What picture did the puzzle make?**

   An airplane

2. **Where would we find airplanes?**

   At the airport

3. **If a part was missing, could you still tell it was an airplane?**

   Answers will vary by student

4. **Could we take a part from each of the different puzzles and make a completely different airplane?**

   Most likely, no. It is important for the students to understand that each part is specially designed to work with one aircraft and the parts are not interchangeable. Have the students picture a big bird with wings from a really tiny bird; could it fly? No, because the wings were designed for the small bird, not the big one.

NATIONAL SCIENCE STANDARDS K-4

SCIENCE AS INQUIRY

• Abilities necessary to do scientific inqui y

• Understanding about scientific inqui y

PHYSICAL SCIENCE

• Property of objects and materials

SCIENCE AND TECHNOLOGY

• Abilities of technological design

• Understanding about science and technology

Activity 3 Peg-a-plane

GRADES K-4

Time Requirement: 45 minutes

Materials:

In the Box

Peg-A-Plane kit

Provided by User

None

Worksheets

Peg-A-Plane 1 (Worksheet 1)

Peg-A-Plane 2 (Worksheet 2)

Peg-A-Plane 3 (Worksheet 3)

Reference Materials

None

Key Terms:

None

Objective:

By building model airplanes, students will realize that it takes many unique, individual parts to build an object.

Activity Overview:

In this activity, the students will work in groups to complete wood and rubber models of airplanes.

Activity:

1. **If you have not completed Activity 1 – Birds & Planes, discuss the Background information with the students.**
2. **Divide the students into three groups.** Provide each group with one of the worksheets and the corresponding aircraft parts as listed on the worksheet.
3. **Ask the students to build the aircraft per the instructions on the worksheet.** As they build the aircraft, students should refer to each part by its correct name, reinforcing what was studied in the Background information earlier. After completing the build, have the students dismantle the aircraft again.
4. **Rotate the worksheets and parts around the three groups ensuring that each group has an opportunity to build all three aircraft.**
5. **Finally, have the students trade just the fuselage pieces and attempt to rebuild their aircraft, using the new pieces.**
   It should be discovered that rebuilding the aircraft with the incorrect fuselage piece is impossible.

Discussion Points:

1. **What happened when we tried to build an aircraft using a fuselage designed for a different model?**
   As with real aircraft, each part is designed specifically for a particular aircraft. As such, attempting to build a bi-plane with the fuselage for a monoplane aircraft, for example, is virtually impossible.

2. **Name some other items or machines that require many components to be assembled in order to construct the object.**
   Answers will vary but may include: car, blender, clock, cake, computer, pencils, etc.

Reference Materials

Fig. 1 Airplane Diagram

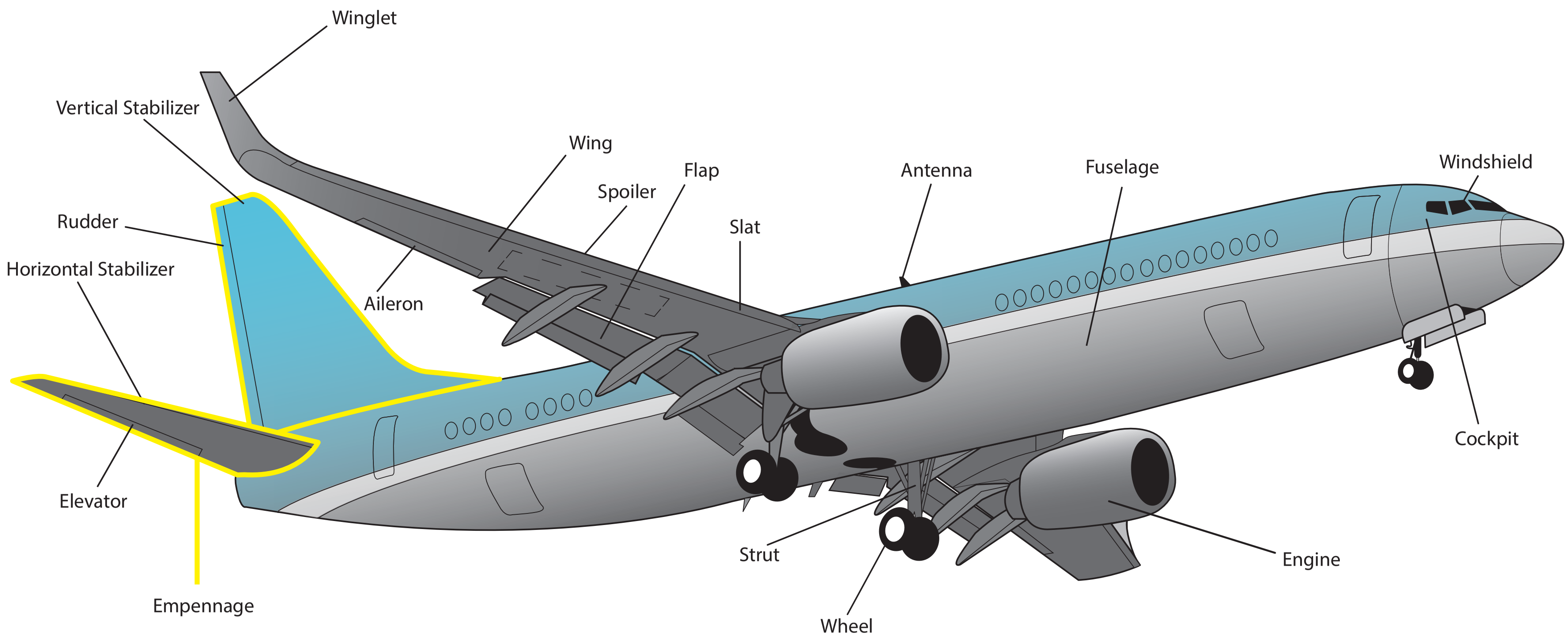


Fig. 2 Propeller Path

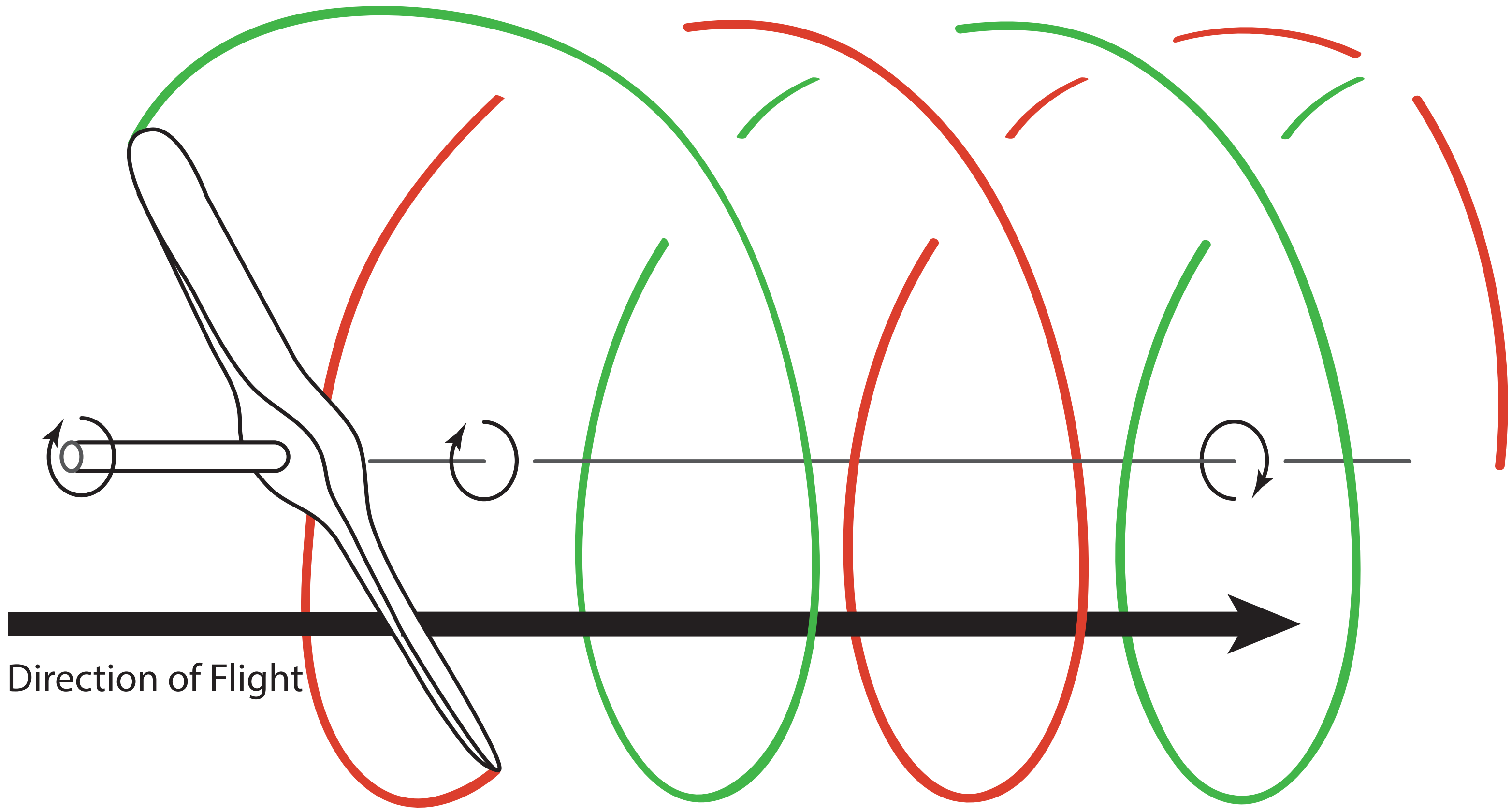
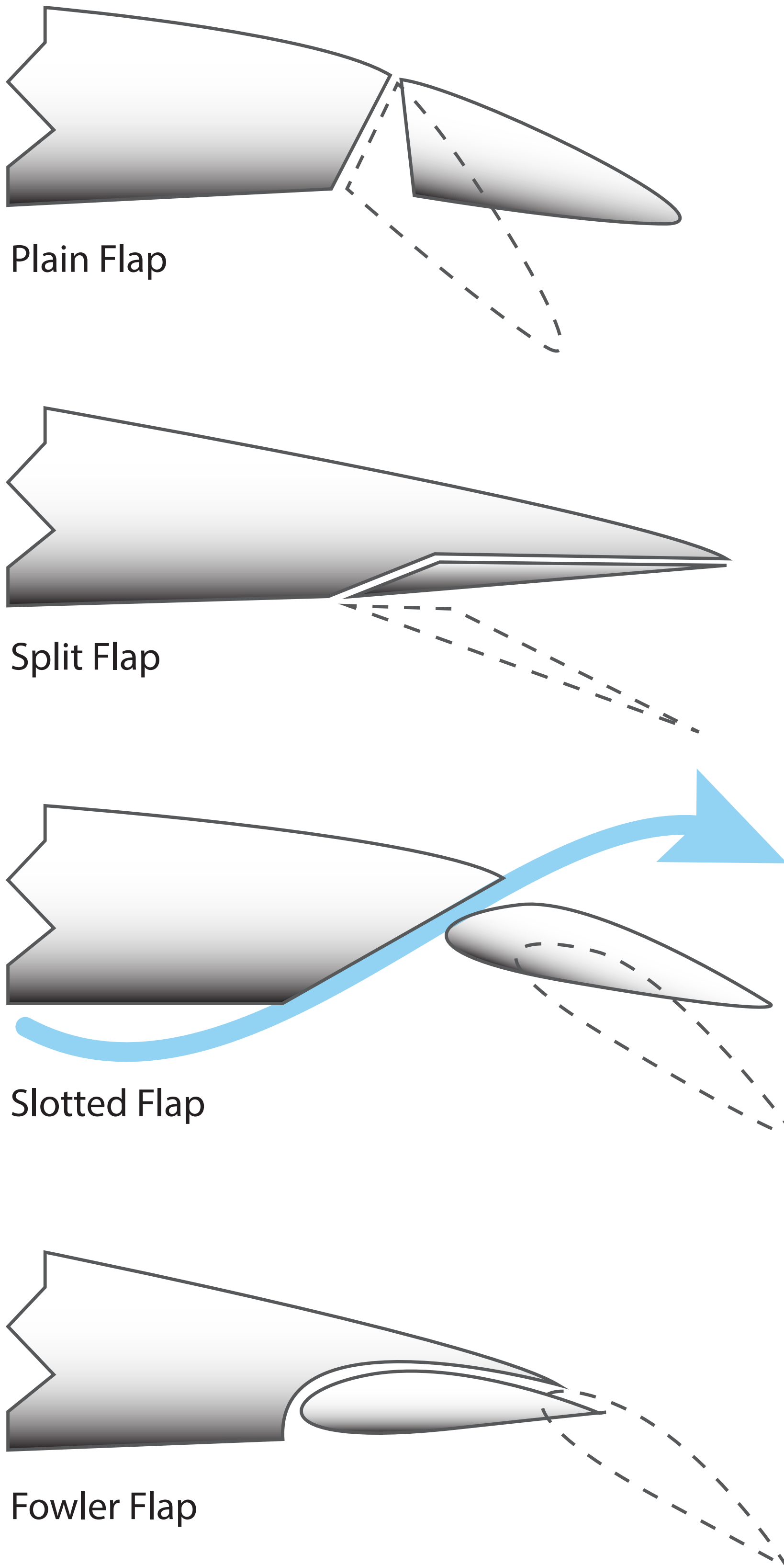
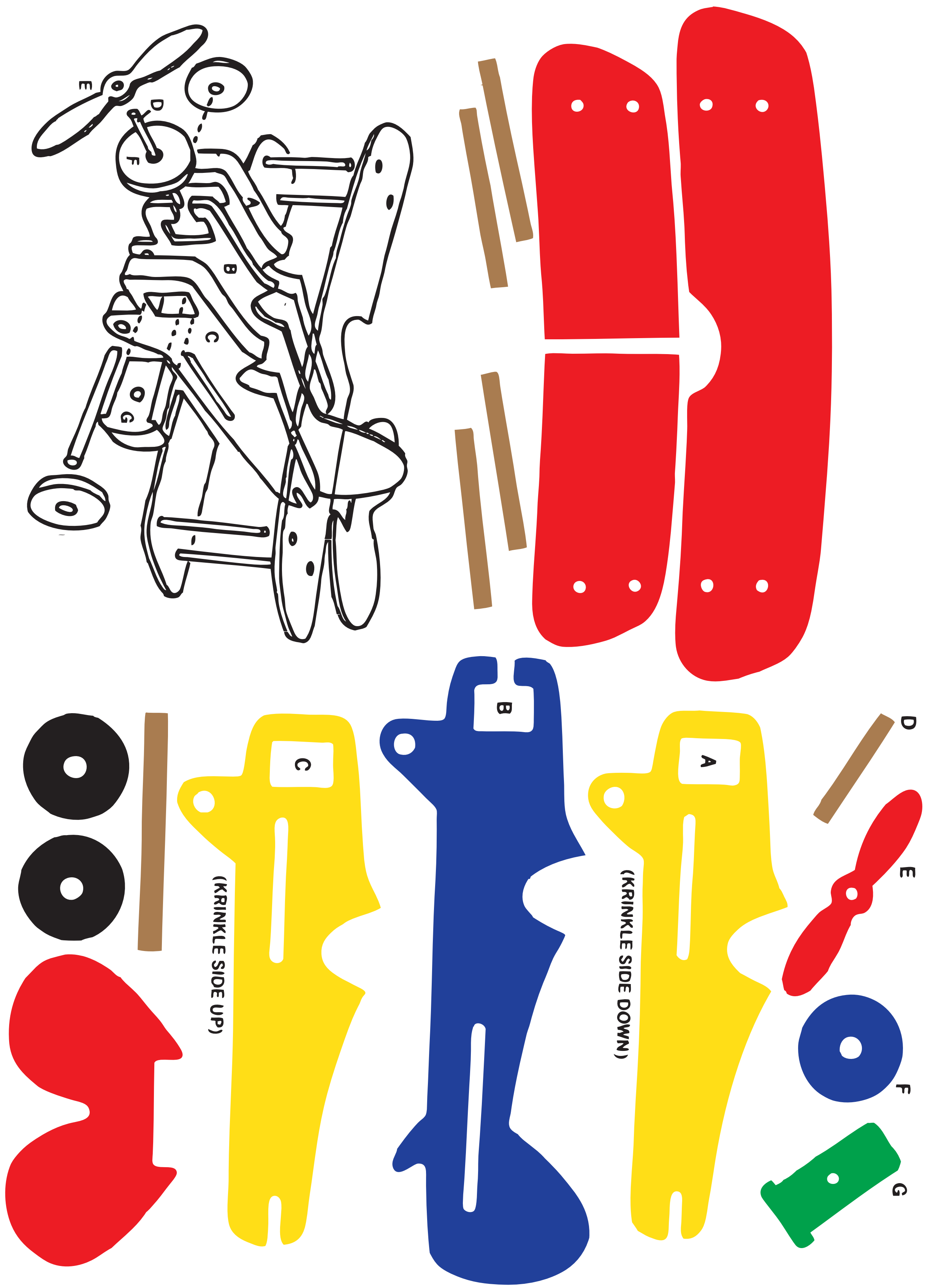


Fig. 3 Flaps

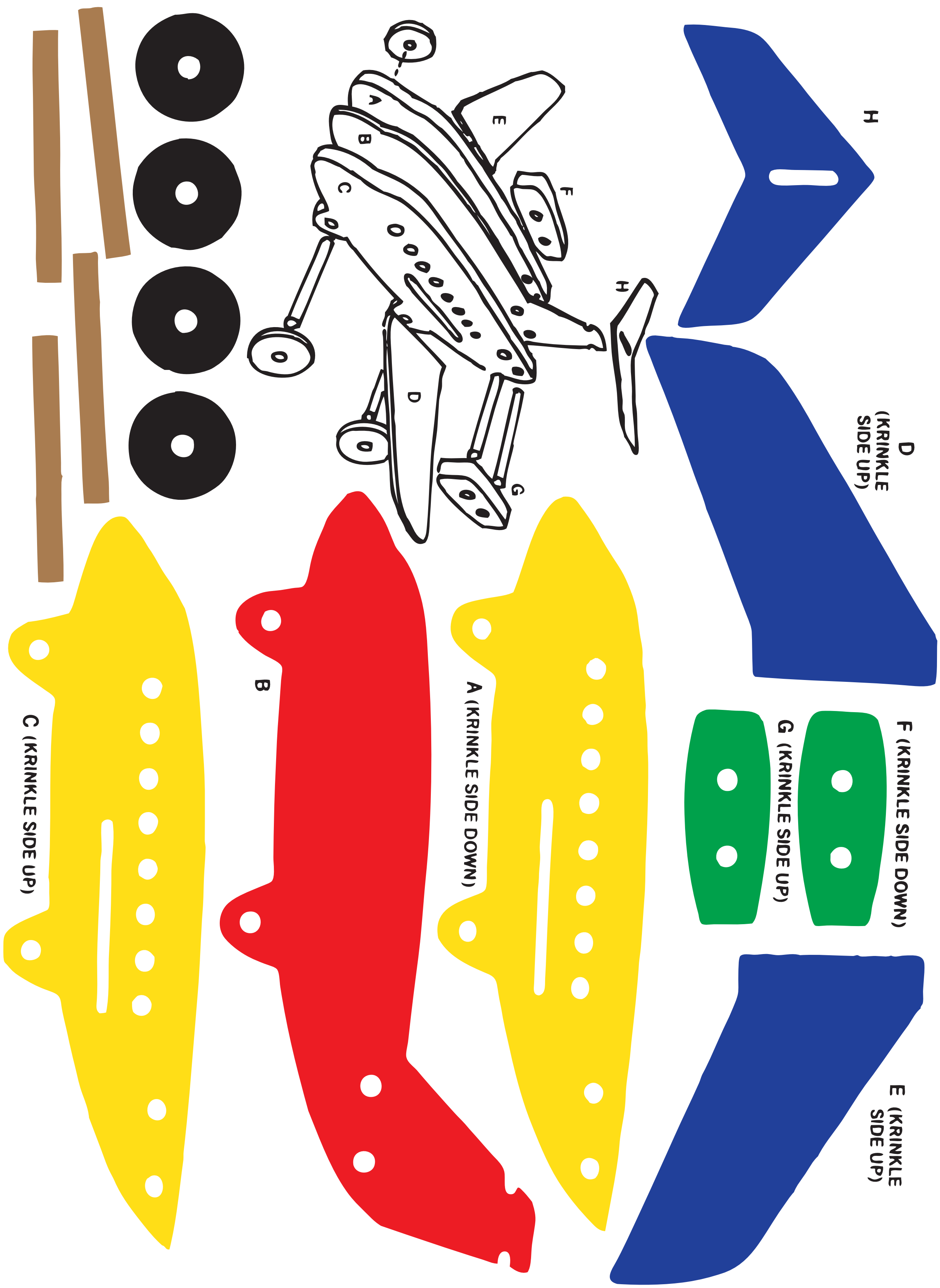


Student Worksheets

Worksheet 1 Peg-A-Plane 1



Worksheet 2 Peg-A-Plane 2



Worksheet 3

Peg-A-Plane 3

Images

Img. 1 Ground spoilers on an Airbus 320 aircraft

(Public Domain)

Img. 2 The straight leg landing gear of the Space Shuttle Atlantis

(Photo courtesy of NASA)

Img. 3 Trailing link landing gear

(Photo courtesy of Lost Trbe Media, Inc.)

Img. 4 A NASA modified essna 190

(Photo courtesy of NASA)

Img. 5 A Lockheed C-69 Constellation

(Photo courtesy of The United States Air Force)

Img. 6 A Boeing 747 carrying the Space Shuttle Enterprise

(Photo courtesy of www.NASAimages.org)

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Img. 10 A Boeing 787 Dreamliner

(Photo courtesy of Boeing)

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