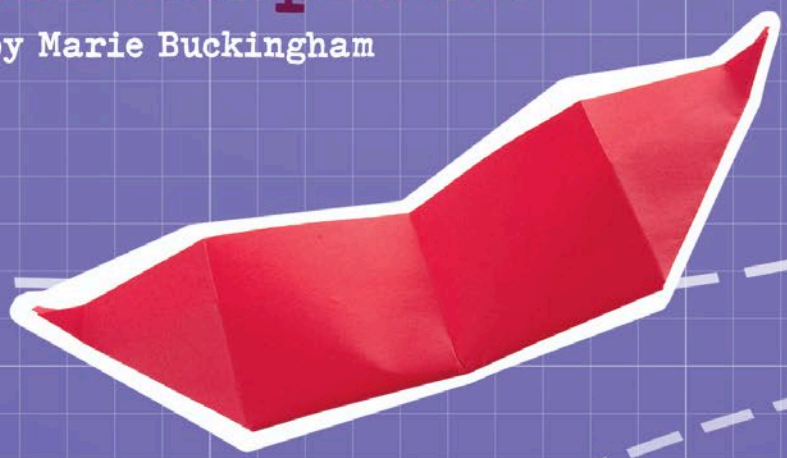
AIR SHARK!

NOVICE-LEVEL
Paper Airplanes

by Marie Buckingham



4D™
An Augmented Reading Paper-Folding Experience

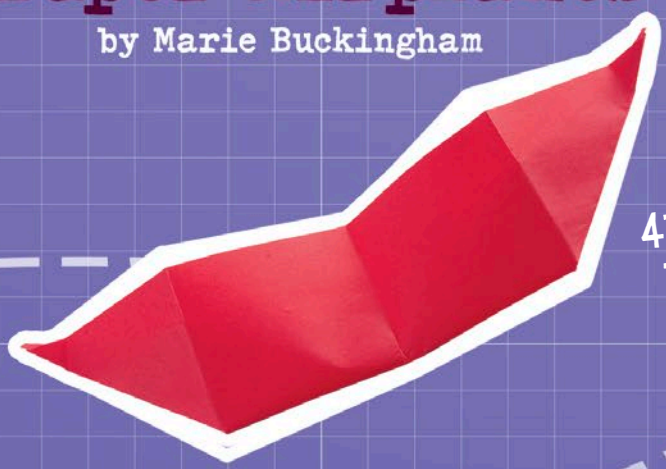
dabblelab

PAPER AIRPLANES with a SIDE of SCIENCE

AIR SHARK!

NOVICE-LEVEL Paper Airplanes

by Marie Buckingham



4D An Augmented Reading Paper-Folding Experience

CAPSTONE PRESS
a capstone imprint

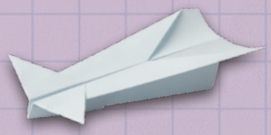
TABLE OF

Time to Fly 4

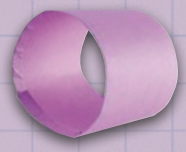
Materials 5

Techniques and Terms 6

Folding Symbols 7



Air Shark 8

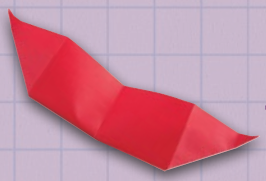


Wind Tunnel 10

Streaking Eagle 13

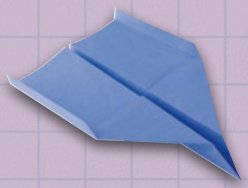
Whisper Dart 16

CONTENTS



Vampire Bat. 18

Arrowhead 21



Nighthawk 24

Vapor. 27

Inside the Hangar. 30

Read More 31

Internet Sites. 31

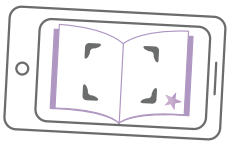
Download the Capstone 4D app!

Step 1 Ask an adult to search in the Apple App Store or Google Play for "Capstone 4D."

Step 2 Click Install (Android) or Get, then Install (Apple).

Step 3 Open the app.

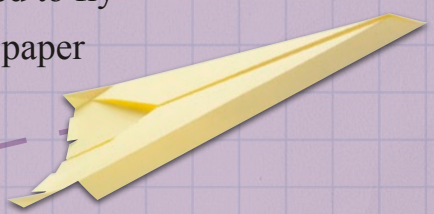
Step 4 Scan any of the following spreads with this icon.



When you scan a spread, you'll find fun extra stuff to go with this book! You can also find these things on the web at *www.capstone4D.com* using the password: planes.shark

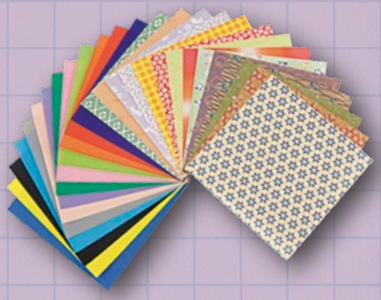
TIME TO FLY

Welcome to the cockpit! You've passed flight school and earned your seat next to the pilot. Now it's time to get a feel for those flight controls. While you're folding your airplanes, be sure to check the lightbulb boxes tucked alongside the instructions for bite-size explanations of flight-science concepts related to your models. Check the photo boxes for tips on how to best launch your finished planes. Remember, there are four main forces that airplanes need to fly successfully: lift, weight, thrust, and drag. But the eight paper airplanes in this book need one more thing: YOU!



MATERIALS

Every paper airplane builder needs a well-stocked toolbox. The models in this book use the materials listed below. Take a minute before you begin folding to gather what you need:



Paper

Any paper you can fold will work. Notebook paper is always popular. But paper with cool colors and designs gives your planes style.

Scissors

Keep a scissors handy. Some models need a snip here or there to fly well.

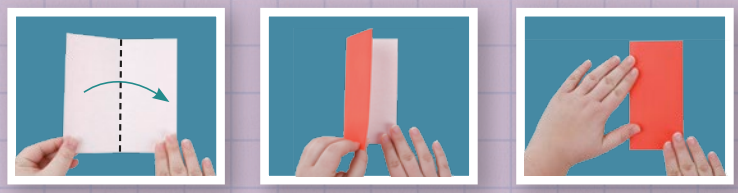
Clear Tape

Most paper airplanes don't need tape. But when they do, you'll be glad you have it ready to go.

TECHNIQUES AND TERMS

Folding paper airplanes isn't difficult when you understand common folding techniques and terms. Review this list before folding the models in this book. Remember to refer back to this list if you get stuck on a tricky step.

Valley Folds



Valley folds are represented by a dashed line. The paper is creased along the line. The top surface of the paper is folded against itself like a book.

Mountain Folds

Mountain folds are represented by a pink or white dashed and dotted line. The paper is creased along the line and folded behind.

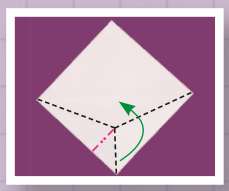
Reverse Folds

Reverse folds are made by opening a pocket slightly and folding the model inside itself along existing creases.

Mark Folds

Mark folds are light folds used to make reference creases for a later step. Ideally, a mark fold will not be seen in the finished model.

Rabbit Ear Folds

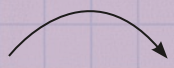


Rabbit ear folds are formed by bringing two edges of a point together using existing creases. The new point is folded to one side.

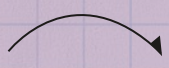
Squash Folds

Squash folds are formed by lifting one edge of a pocket and reforming it so the spine gets flattened. The existing creases become new edges.

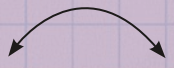
FOLDING SYMBOLS



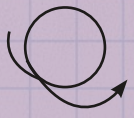
Fold the paper in the direction of the arrow.



Fold the paper behind.



Fold the paper and then unfold it.



Turn the paper over or rotate it to a new position.

A fold or edge hidden under another layer of paper; also used to mark where to cut with a scissors

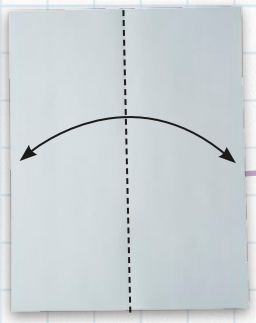
AIR SHARK

Traditional Model

Prowl the skies with your very own Air Shark.
This sturdy plane has a smooth, steady glide.
It's a paper predator that's always ready to hunt.

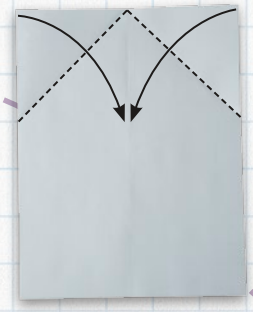
Materials

* 8.5- by 11-inch (22- by 28-centimeter) paper



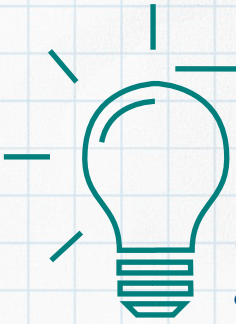
START HERE

1 Valley fold edge to edge and unfold.



2 Valley fold the corners to the center.

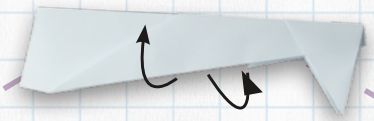
3 Turn the paper over.



On Earth, gravity is a powerful, invisible force that pulls objects toward the ground. Earth's gravitational pull is what causes **weight**. The weight of an object is the total downward force of gravity pulling on each tiny molecule that makes up that object.

FLYING TIP

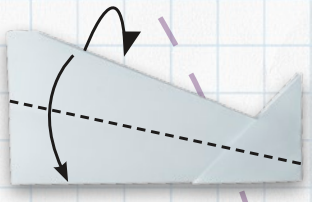
Use a medium, level throw.



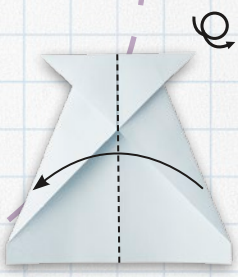
8 Lift the wings.

9 Finished Air Shark

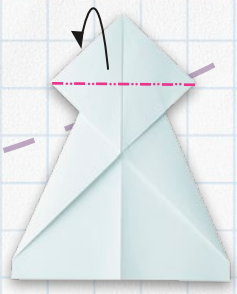
END HERE



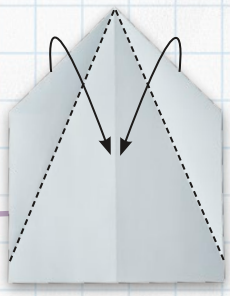
7 Valley fold the top layer even with the bottom edge. Repeat behind.



6 Valley fold the model in half and rotate.



5 Mountain fold the point.



4 Valley fold the edges to the center. Allow the flaps behind to release to the top.

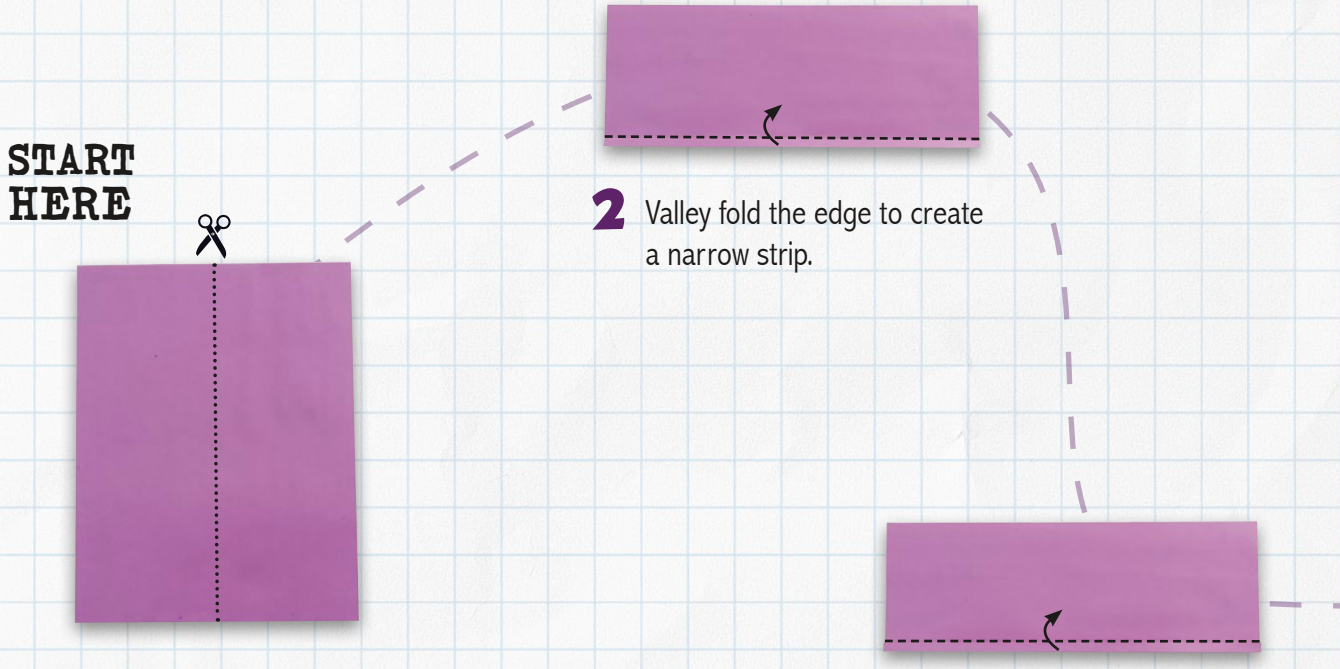
WIND TUNNEL

Traditional Model

The Wind Tunnel takes paper airplanes in a very different direction. This circular wing is thrown like a football. Get your arm warmed up. You'll be amazed by how far this tube will glide through the air.

Materials

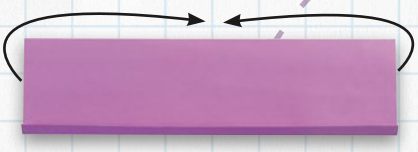
* 8.5- by 11-inch (22- by 28-cm) paper
* scissors
* tape



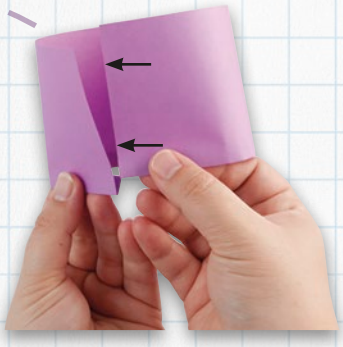
1 Cut the paper in half the long way. Use one half for step 2.

2 Valley fold the edge to create a narrow strip.

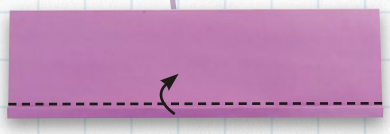
3 Valley fold.



6 Bend the paper to bring the ends of the model together.

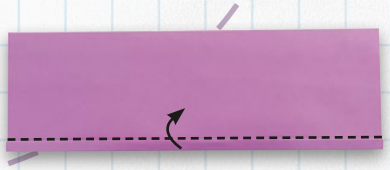


7 Tuck one end of the folded strip into the other.



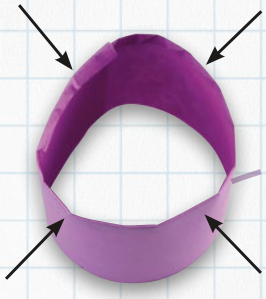
5 Valley fold.

Continue ▶

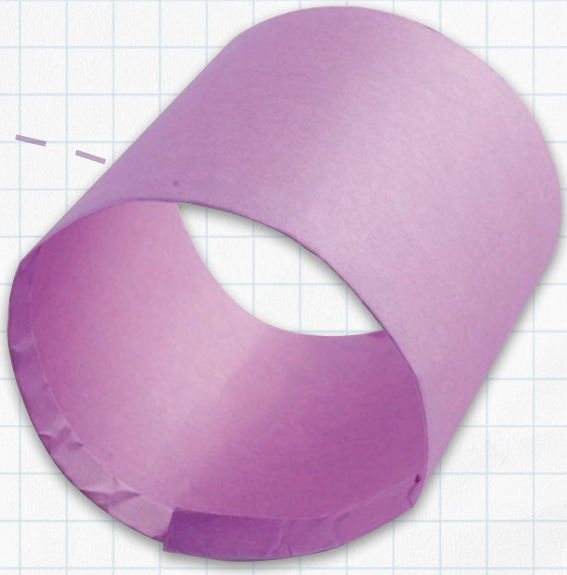


4 Valley fold.

The force a hand provides when it pushes a paper airplane is called **thrust**. All planes — real and paper — need thrust to fly. Thrust is the force that propels a plane forward and helps keep it flying through the sky.

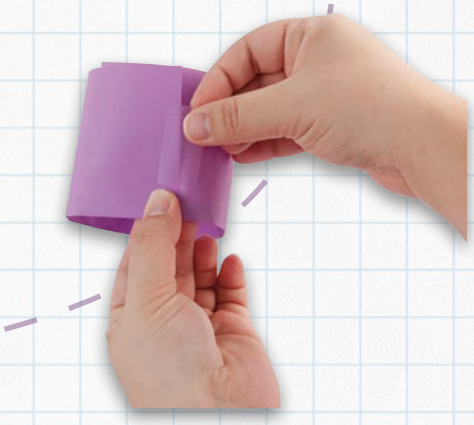


9 Shape the tube into a smooth circle.



10 Finished Wind Tunnel

END HERE



8 Tape the seam to hold the model together.

FLYING TIP

Cup the model in your hand with the folded strip facing forward. Use a hard spiral throw as if you were throwing a football.

STREAKING EAGLE

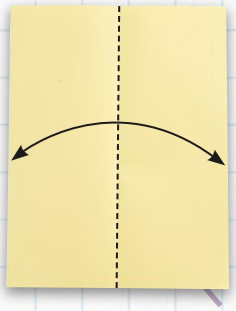
Traditional Model

The Streaking Eagle combines style and mechanics. Sleek wing flaps help the plane fly straight. Elevators let you control how the plane rises or dives.

Continue ▶

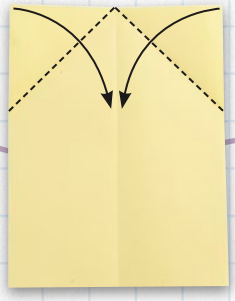
Materials

* 8.5- by 11-inch (22- by 28-cm) paper
* scissors

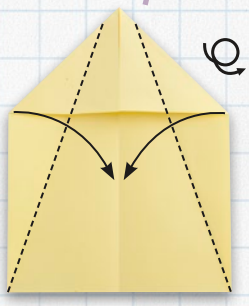


START HERE

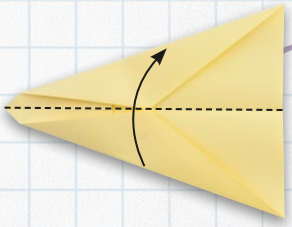
1 Valley fold edge to edge and unfold.



2 Valley fold the corners to the center.

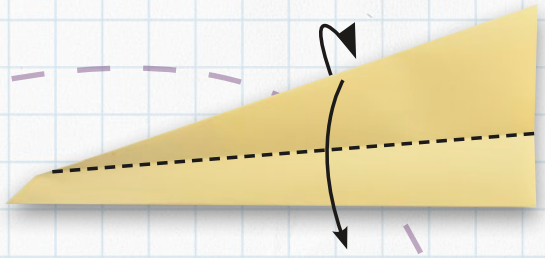


3 Valley fold the corners to the center and rotate.

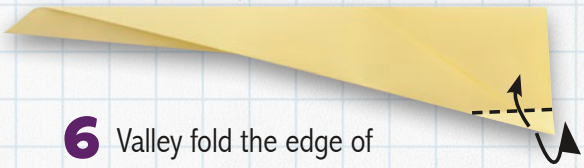


4 Valley fold in half.

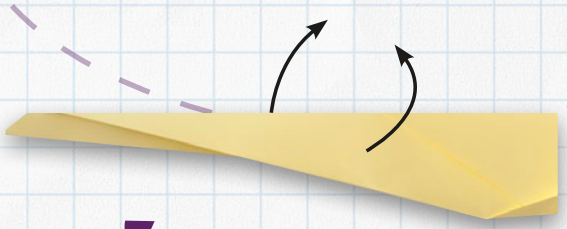
During flight, a pilot controls the movable surface on an airplane's tail called an **elevator**. The elevator moves an airplane's nose up or down. When the elevator is pushed down, the airplane's nose will move down. When the elevator is pulled up, the aircraft's nose will move up.



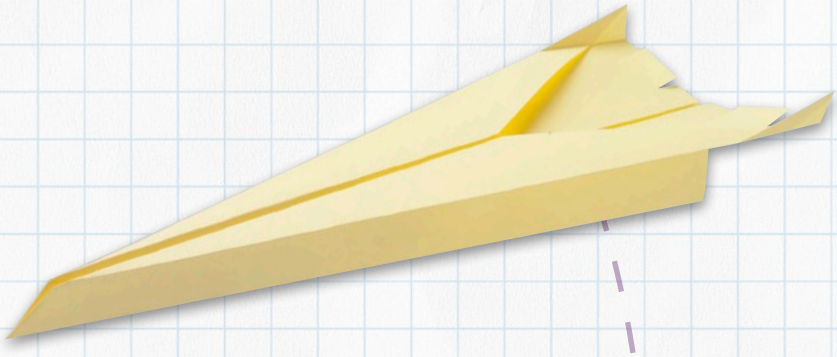
5 Valley fold the top layer. Repeat behind.



6 Valley fold the edge of the wing. Repeat behind.



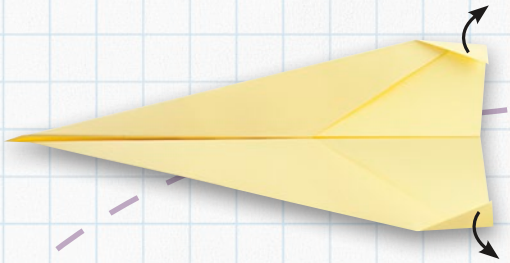
7 Lift the wings.



10 Finished Streaking Eagle

END HERE

9 Cut a flap in the back of each wing. Angle the flaps (elevators) upward slightly.



8 Lift the wing flaps so they stand up at 90-degree angles.

FLYING TIP

Use a medium, level throw. Adjust the flaps to control the flight path.

WHISPER DART

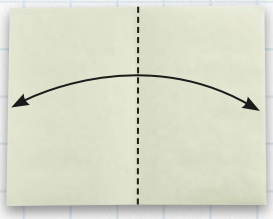
Designed by Christopher L. Harbo

The Whisper Dart looks like a simple paper airplane. But extra folds give it added weight in the nose. Got your eye on a target across the room? This design will deliver!

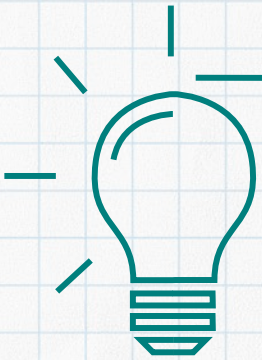
Materials

* 8.5- by 11-inch (22- by 28-cm) paper

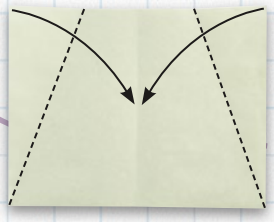
START HERE



1 Valley fold edge to edge and unfold.



Drag is a force that works against objects moving through the air, such as airplanes. Drag is created when air molecules rub against the surface of the plane as it flies. The Whisper Dart model's wide front edge creates more drag than a paper airplane with a sleek, pointy nose does.



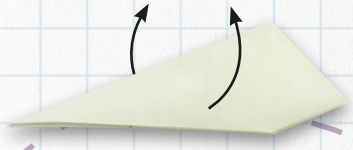
2 Valley fold the corners to the center. Note how the creases end at the bottom corners of the paper.

3 Valley fold to point A.

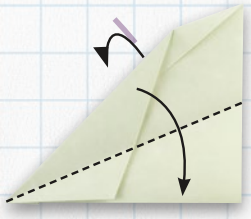
4 Valley fold.

FLYING TIP

Use a medium toss with a smooth, level release.



9 Lift the wings.

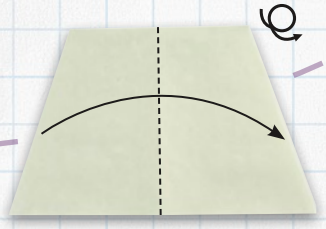


8 Valley fold the top layer even with the bottom edge. Repeat behind.

10 Finished Whisper Dart

END HERE

7 Valley fold the left edge even with the bottom edge. Repeat behind.



6 Valley fold the model in half and rotate.

5 Turn the model over.

VAMPIRE BAT

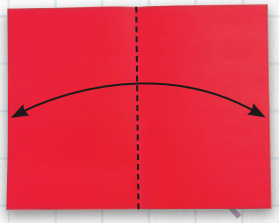
Traditional Model

The Vampire Bat's flight path is a jaw-dropper. This amazing wing soars and swoops when thrown correctly. Folding it is easy. Finding a room large enough to fly it in may be a challenge.

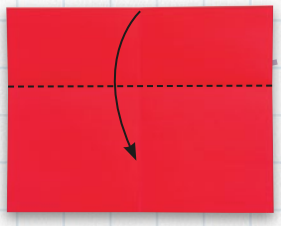
Materials

* 8.5- by 11-inch (22- by 28-cm) paper

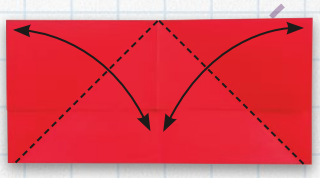
START HERE



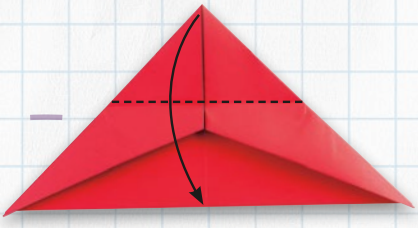
1 Valley fold edge to edge and unfold.



2 Valley fold the top edge so it rests about 2 inches (5 cm) from the bottom edge.



3 Valley fold the corners to the center and unfold.



6 Valley fold the point.

5 Valley fold on the creases formed in step 3.

7 Mountain fold the point and tuck it into the pocket.

4 Valley fold the edges to the creases formed in step 3.

8 Turn the model over.

Continue ▶

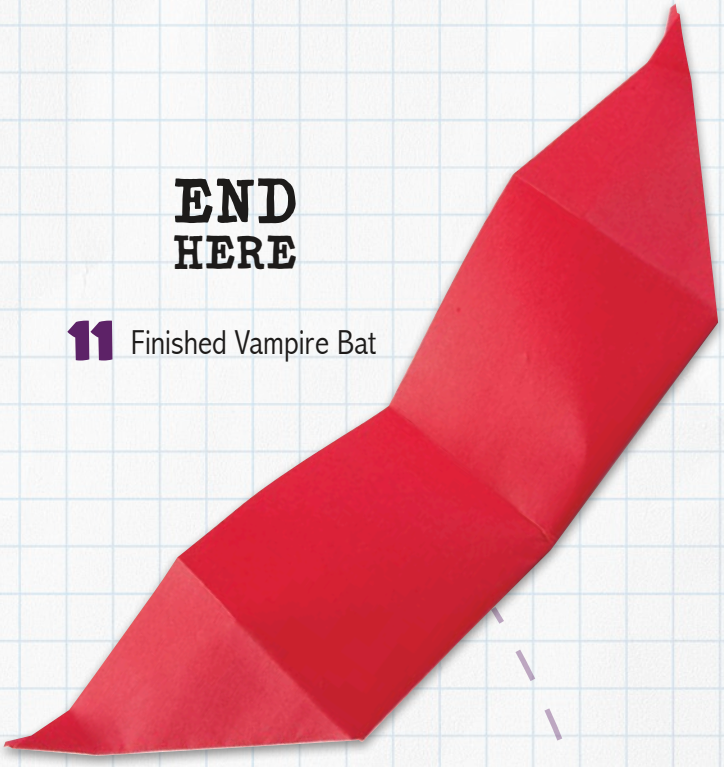
An airplane with one main wing, like the Vampire Bat model, is called a **monoplane**. A biplane has two wings — one on top of the other — while a triplane has three stacked wings. The monoplane has the lowest drag of any wing pattern.

FLYING TIP

Pinch the back of the wing with two fingers and your thumb so the model forms a "V." Raise the model above your head and release with a strong forward flick of the wrist.

END HERE

11 Finished Vampire Bat



9 Mountain fold the wings and unfold slightly.

10 Valley fold the wing tips and unfold slightly.

ARROWHEAD

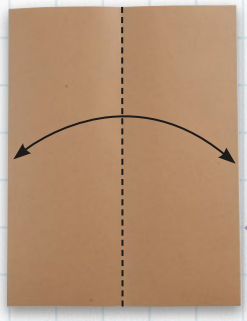
Traditional Model

Get ready to soar! The Arrowhead is a flying champion. This plane can cover amazing distances with very little effort. You'll get your exercise chasing this model from one end of the room to the other.

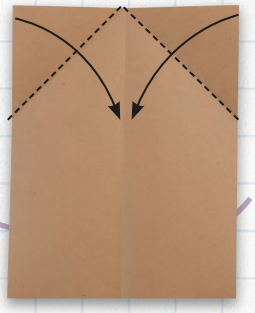
Materials

* 8.5- by 11-inch (22- by 28-cm) paper

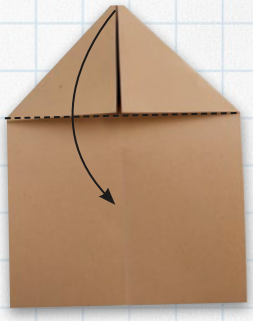
START HERE



1 Valley fold edge to edge and unfold.

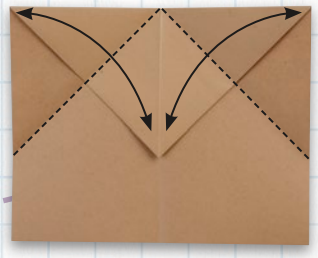


2 Valley fold the corners to the center.

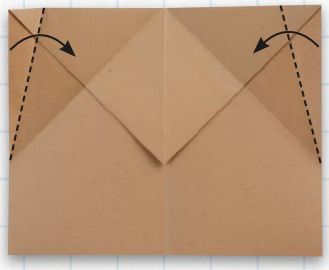


3 Valley fold the point.

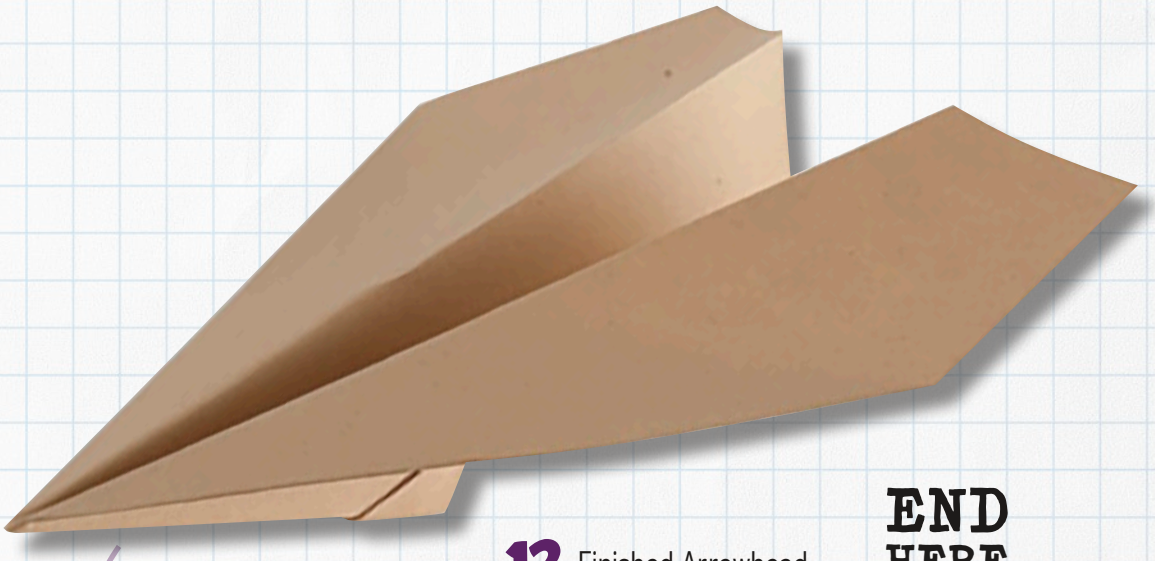
Continue ▶



4 Valley fold the corners to the center and unfold.

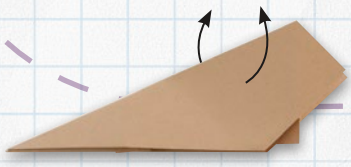


5 Valley fold the corners. Note that the creases end at the creases made in step 4.

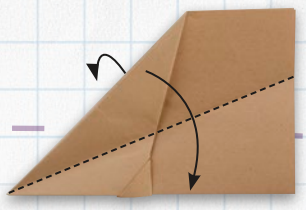


12 Finished Arrowhead

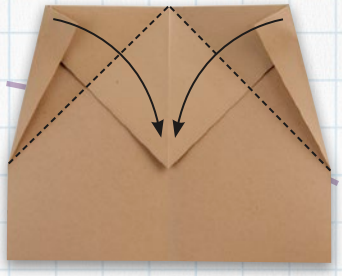
END HERE



11 Lift the wings.



10 Valley fold the top flap even with the bottom edge. Repeat behind.



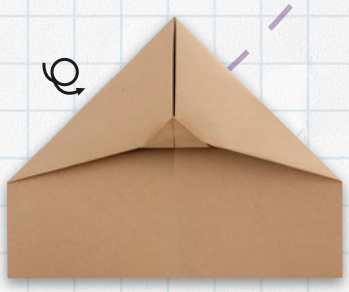
6 Valley fold on the creases made in step 4.

FLYING TIP

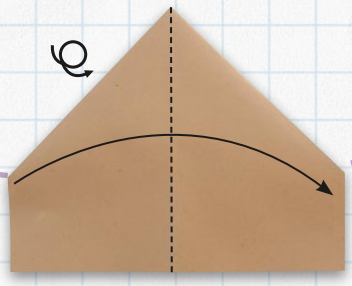
Use a medium throw with a slight upward angle.

An airplane needs an upward force called **lift** to fly. Wings create lift as air flows over them during flight. Airplane wings are usually curved. Air molecules moving over the wing's top, curved surface travel faster than molecules moving along the wing's flat bottom. The slower-moving air molecules beneath the wing create a high amount of pressure and create lift.

7 Valley fold the point.



8 Turn the model over.



9 Valley fold the model in half and rotate.

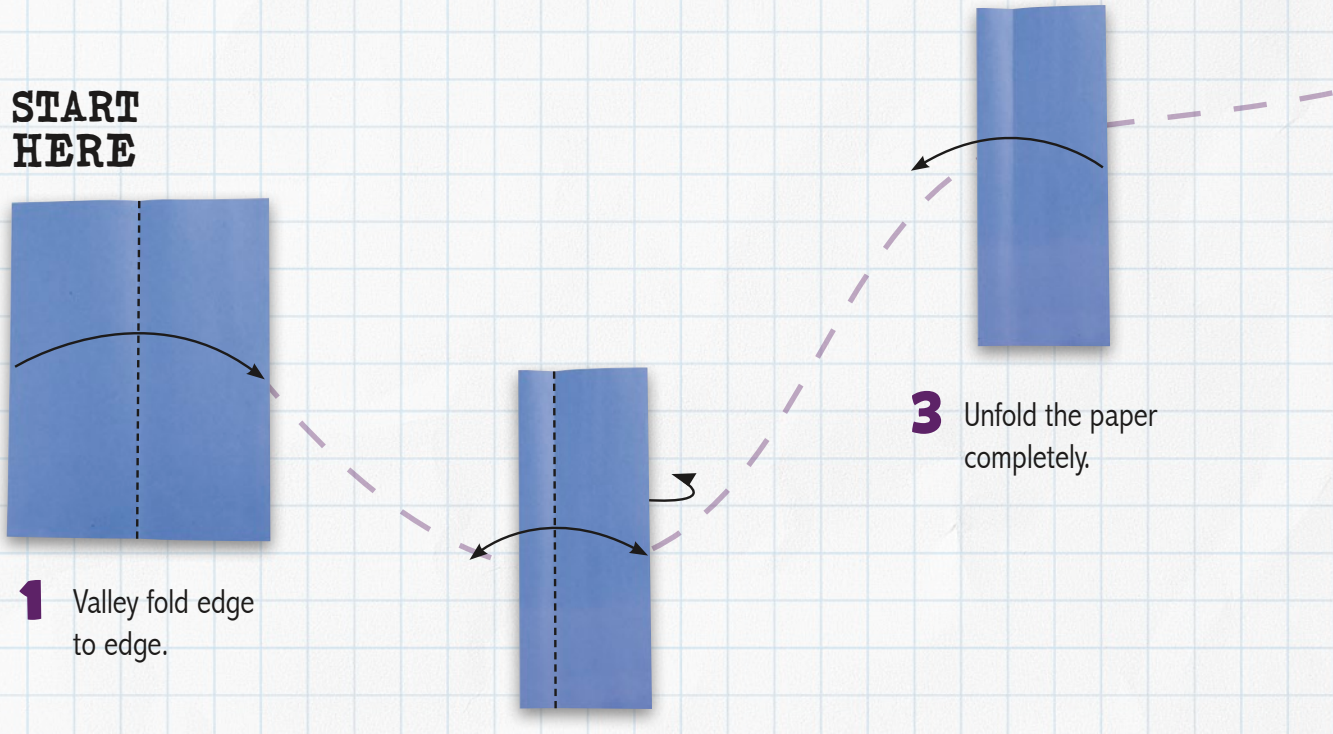
NIGHTHAWK

Traditional Model

The Nighthawk is a great flier with a simple design. This classic glider isn't fancy, but its graceful flight is sure to impress. Make two planes and challenge a friend to a flight contest.

Materials

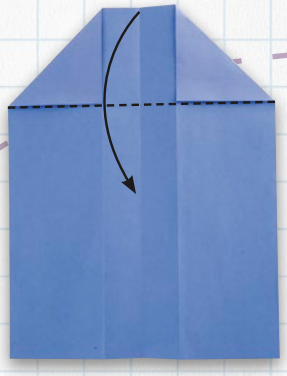
* 8.5- by 11-inch (22- by 28-cm) paper



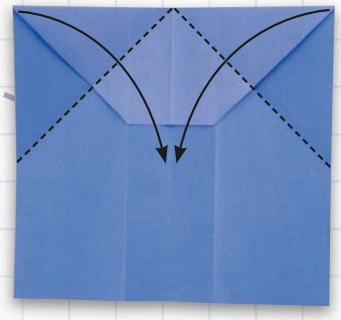
1 Valley fold edge to edge.

2 Valley fold the top layer about 1 inch (2.5 cm) from the left edge and unfold. Repeat behind.

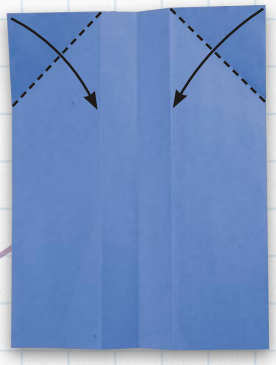
3 Unfold the paper completely.



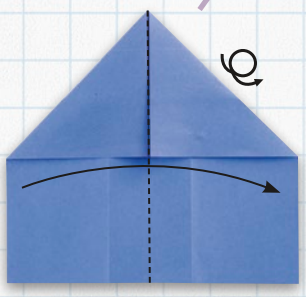
5 Valley fold the point.



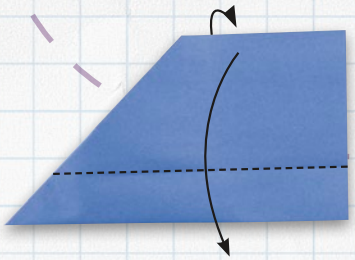
6 Valley fold the corners to the center crease.



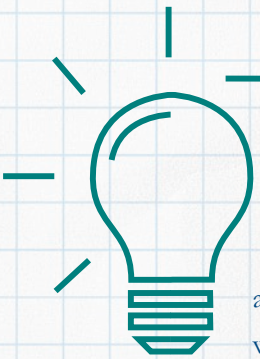
4 Valley fold the corners to the creases made in step 2.



7 Valley fold the model in half and rotate.



8 Valley fold the top layer. Repeat behind.



A **glider** is a small plane without an engine. It's often towed into the air by a rope connected to a motorized plane, then released into the sky. A glider uses air currents called thermals to stay aloft for hours. Thermals are special columns of warm, rising air, created by the sun's rays heating Earth's surface. Thermals push up on a glider's wings and keep it in flight.

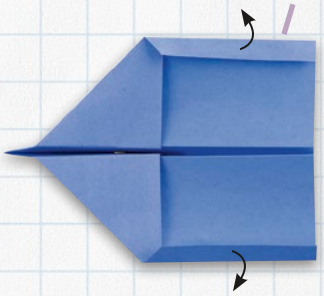
Continue ▶

FLYING TIP

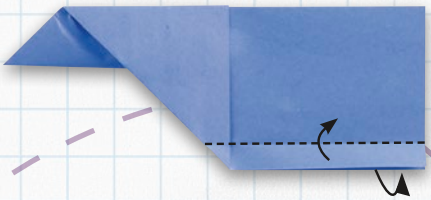
Use a medium, level throw.

END HERE

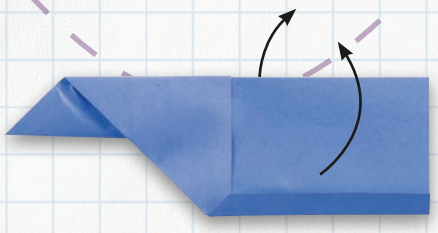
12 Finished Nighthawk



11 Lift the wing flaps so they stand up at 90-degree angles.



9 Valley fold the edge of the wing. Repeat behind.



10 Lift the wings.

VAPOR

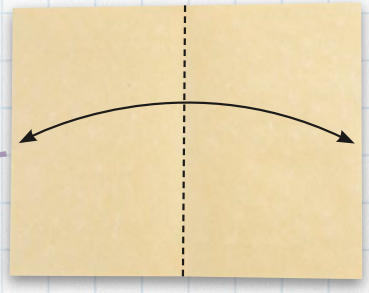
Designed by Christopher L. Harbo

The Vapor has extra folds in the nose for strength and balance. The wing flaps guide the plane on an even flight. With very little effort, this model will slip silently from your hand and arc across the room.

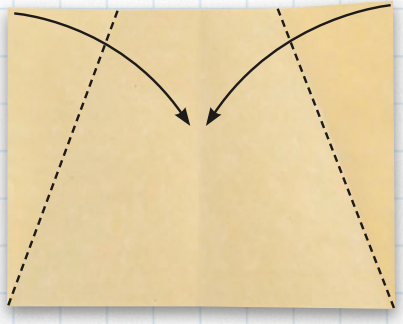
Materials

* 8.5- by 11-inch (22- by 28-cm) paper

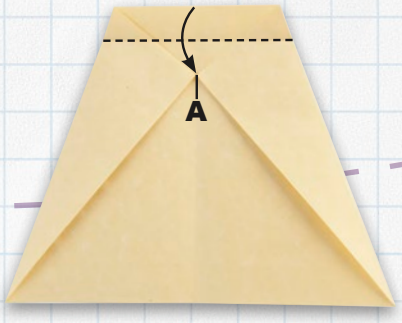
START HERE



1 Valley fold edge to edge and unfold.

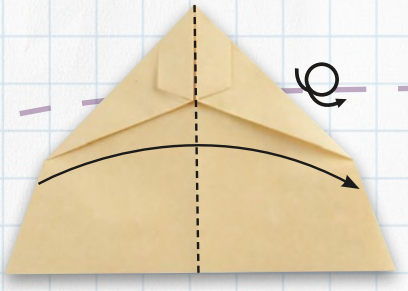


2 Valley fold the corners to the center. Note how the creases end at the bottom corners of the paper.

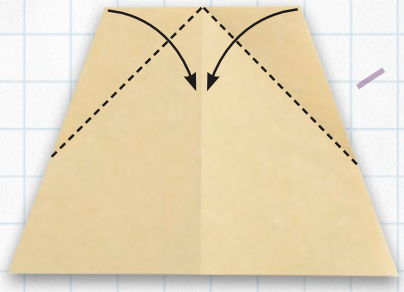


3 Valley fold to point A.

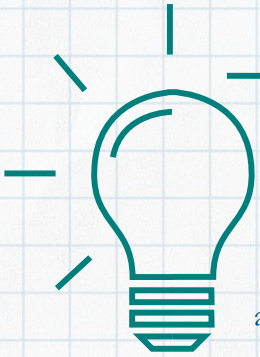
Continue ▶



6 Valley fold the model in half and rotate.



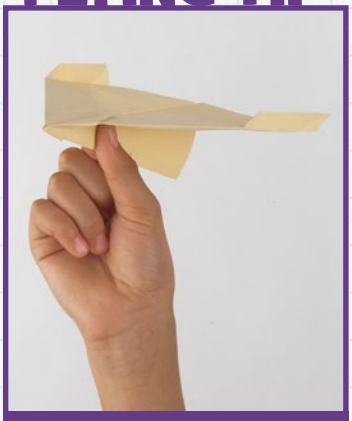
5 Valley fold the corners to the center.



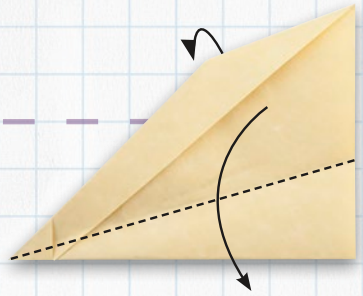
An airplane in flight rotates along three lines, or axes: lateral, vertical, and longitudinal. Movement along the lateral axis (which runs from wing to wing) is called **pitch**. The nose moves up or down. Movement along the vertical axis (which runs through the center of the plane) is called **yaw.** The nose moves side to side. When a plane moves around the longitudinal axis (which runs from nose to tail), the plane **rolls**.

4 Turn the model over.

FLYING TIP

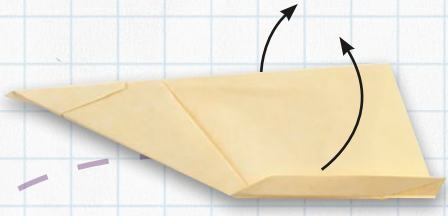


Use a medium, smooth throw with a slight upward angle.



7 Valley fold the top layer. Repeat behind.

8 Valley fold the edge of the wing. Repeat behind.



9 Lift the wings.

10 Lift the wing flaps so they stand up at 90-degree angles.

11 Finished Vapor

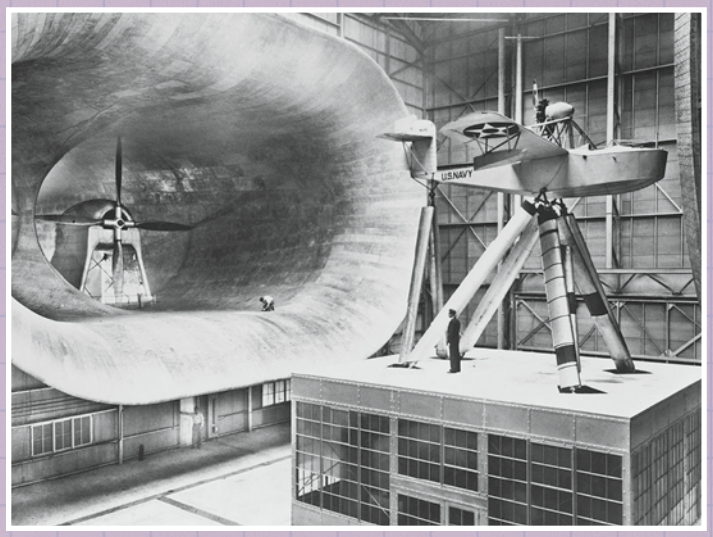
END HERE

INSIDE THE HANGAR:
WIND TUNNELS

Engineers are people who use science and math to plan, design, or build. When creating new aircraft (or spacecraft), engineers often rely on wind tunnels to test their designs. A wind tunnel is a large tube-shaped piece of equipment. A mount in the center of the tube holds a test plane in place. When the wind tunnel is turned on, air flows around the plane like it would if the plane were flying.

Most wind tunnels have powerful fans to create high-speed winds. Air speeds in some tunnels reach 4,000 miles (6,437 kilometers) per hour — five times the speed of sound! During testing, smoke or dye may be injected into the wind so engineers can study how air flows around an airplane. Photographs of this moving air allow engineers to see how they can improve a plane's design to lower drag and increase lift.

To save money, engineers may test a smaller-scale model of a new plane design inside a smaller wind tunnel. Based on the engineers' findings, the design may be changed and tested again.



This seven-story wind tunnel was used to test airplane design in 1932.

READ MORE

Collins, John M. *The New World Champion Paper Airplane Book: Featuring the Guinness World Record-Breaking Design, with Tear-Out Planes to Fold and Fly.* New York: Ten Speed Press, 2013.

LaFosse, Michael G. *Michael LaFosse's Origami Airplanes.* North Clarendon, Vt.: Tuttle Publishing, 2016.

Lee, Kyong Hwa. *Amazing Paper Airplanes: The Craft and Science of Flight.* Albuquerque, N.Mex.: University of New Mexico Press, 2016.

INTERNET SITES

Use FactHound to find Internet sites related to this book.

Visit *www.facthound.com*

Just type in 9781543507966 and go.

Special thanks to our adviser, Polly Kadolph, Associate Professor,
University of Dubuque (Iowa) Aviation Department, for her expertise.

Dabble Lab Books are published by Capstone Press,
1710 Roe Crest Drive, North Mankato, Minnesota 56003
www.mycapstone.com

Copyright © 2018 by Capstone Press, a Capstone imprint.
All rights reserved. No part of this publication may be reproduced in whole or in part,
or stored in a retrieval system, or transmitted in any form or by any means, electronic,
mechanical, photocopying, recording, or otherwise, without written permission of the publisher.

Library of Congress Cataloging-in-Publication data is available on the Library of Congress website.
ISBN: 978-1-5435-0796-6 (library binding)
ISBN: 978-1-5435-0800-0 (eBook PDF)

Summary: Coach your readers into the sky with a few basic paper folds and a side of science.
Photo-illustrated instructions and special 4D components show young flight-school students
how to build the Air Shark and other novice-level paper airplanes step-by-step. Fact-filled sidebars
and an "Inside the Hangar" feature work in tandem with the projects to explain flight concepts.

Editorial Credits
Jill Kalz, editor; Heidi Thompson, designer; Eric Gohl, media researcher; Laura Manthe, production specialist

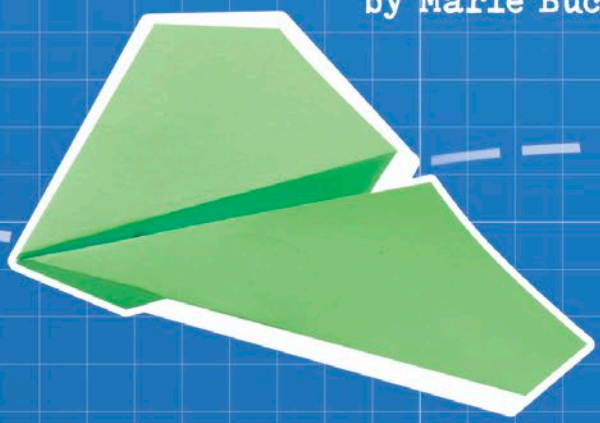
Photo Credits
Capstone Studio: Karon Dubke, all steps
Shutterstock: design elements, Everett Historical, 30

Printed in the United States of America.
010761S18

SPINNING BLIMP!

BEGINNING-LEVEL Paper Airplanes

by Marie Buckingham



4D™
An Augmented Reading Paper-Folding Experience

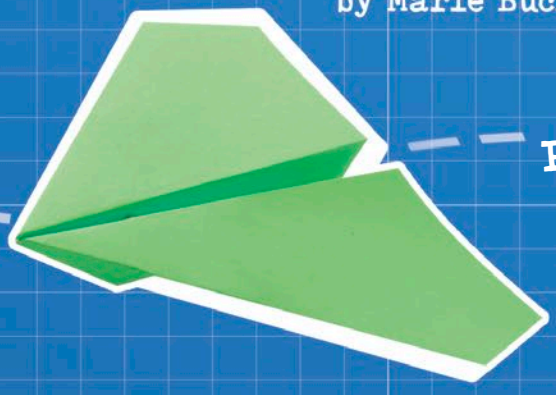
dabblelab

PAPER AIRPLANES
with a SIDE of SCIENCE

SPINNING BLIMP!

BEGINNING-LEVEL Paper Airplanes

by Marie Buckingham

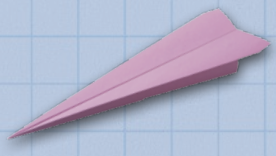


4D An Augmented Reading Paper-Folding Experience

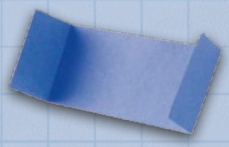
CAPSTONE PRESS
a capstone imprint

TABLE OF

Flight Training 4
Materials 5
Techniques and Terms 6
Folding Symbols 7


Dynamic Dart 8

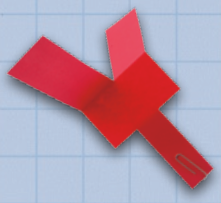

Spinning Blimp 10


Whirly 12

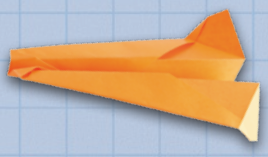

Ring Wing 14

CONTENTS

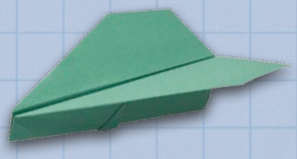
Flying Squirrel 16



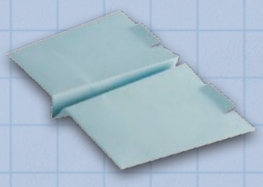
Helicopter. 19



Tailspin 21



Long Ranger 24



Elevator Glider 27

Inside the Hangar. 30
Read More 31
Internet Sites. 31

Download the Capstone 4D app!

Step 1 Ask an adult to search in the Apple App Store or Google Play for "Capstone 4D."

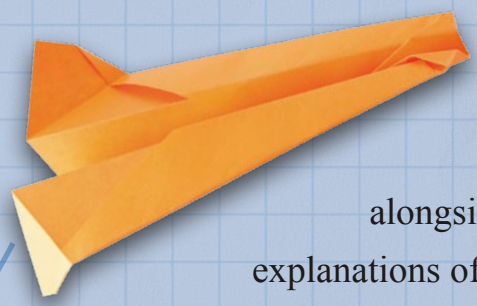
Step 2 Click Install (Android) or Get, then Install (Apple).

Step 3 Open the app.

Step 4 Scan any of the following spreads with this icon.

When you scan a spread, you'll find fun extra stuff to go with this book! You can also find these things on the web at *www.capstone4D.com* using the password: planes.blimp

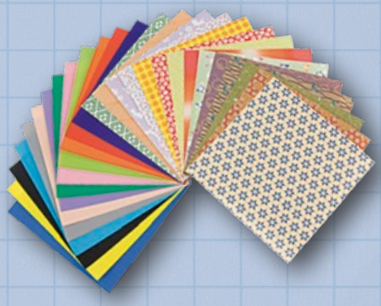
FLIGHT TRAINING



Welcome to flight school! Here are a few basics you should know before diving in: Check the lightbulb boxes tucked alongside the project instructions for bite-size explanations of flight-science concepts related to your models. Check the photo boxes for tips on how to best launch your finished planes. Remember, there are four main forces that airplanes need to fly successfully: lift, weight, thrust, and drag. But the nine paper airplanes in this book need one more thing: YOU!

MATERIALS

Every paper airplane builder needs a well-stocked toolbox. The models in this book use the materials listed below. Take a minute before you begin folding to gather what you need:



Paper

Any paper you can fold will work. Notebook paper is always popular. But paper with cool colors and designs gives your planes style.

Scissors

Keep a scissors handy. Some models need a snip here or there to fly well.

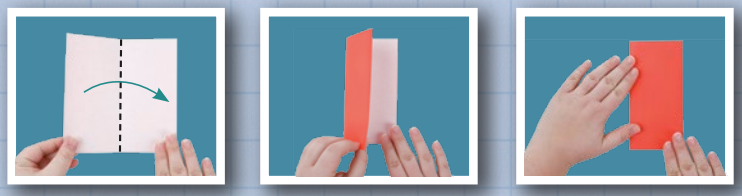
Paper Clips

Paper clips are perfect for adding weight to a plane's nose. Keep a supply of small and large paper clips on hand.

TECHNIQUES AND TERMS

Folding paper airplanes isn't difficult when you understand common folding techniques and terms. Review this list before folding the models in this book. Remember to refer back to this list if you get stuck on a tricky step.

Valley Folds



Valley folds are represented by a dashed line. The paper is creased along the line. The top surface of the paper is folded against itself like a book.

Mountain Folds

Mountain folds are represented by a pink or white dashed and dotted line. The paper is creased along the line and folded behind.

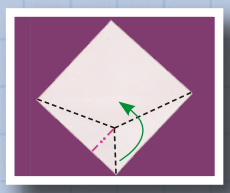
Reverse Folds

Reverse folds are made by opening a pocket slightly and folding the model inside itself along existing creases.

Mark Folds

Mark folds are light folds used to make reference creases for a later step. Ideally, a mark fold will not be seen in the finished model.

Rabbit Ear Folds



Rabbit ear folds are formed by bringing two edges of a point together using existing creases. The new point is folded to one side.

Squash Folds

Squash folds are formed by lifting one edge of a pocket and reforming it so the spine gets flattened. The existing creases become new edges.

FOLDING SYMBOLS

Fold the paper in the direction of the arrow.

Fold the paper behind.

Fold the paper and then unfold it.

Turn the paper over or rotate it to a new position.

A fold or edge hidden under another layer of paper; also used to mark where to cut with a scissors

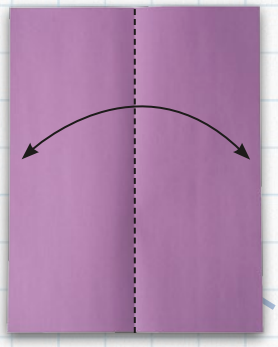
DYNAMIC DART

Traditional Model

The Dynamic Dart is one of the most popular paper planes on the planet. It's the type of model that never lets you down. Best of all, its steps are super simple. You'll be folding it from memory in no time flat.

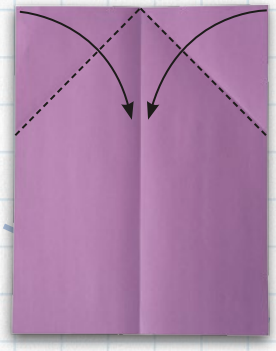
Materials

* 8.5- by 11-inch (22- by 28-centimeter) paper

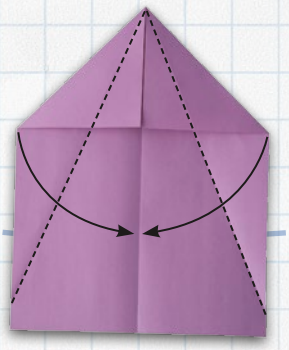


START HERE

1 Valley fold edge to edge and unfold.

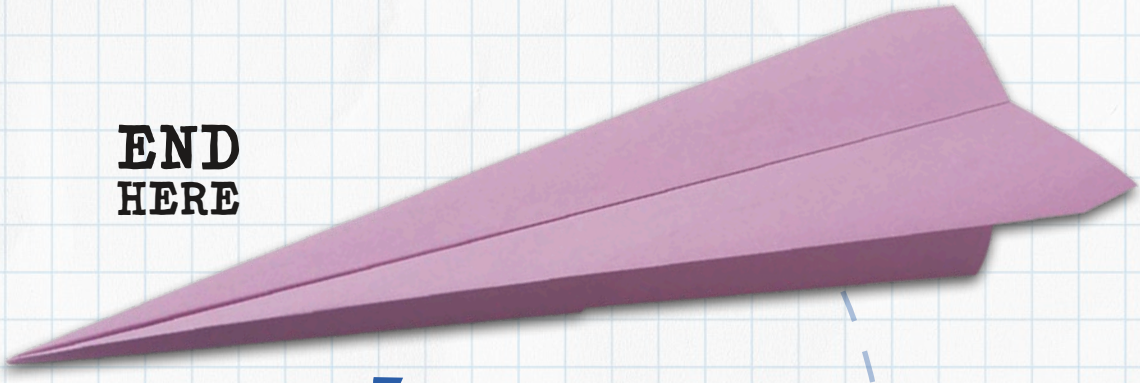


2 Valley fold the corners to the center.



3 Valley fold the edges to the center.

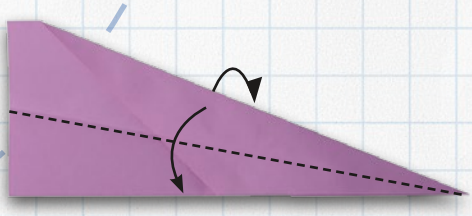
END HERE



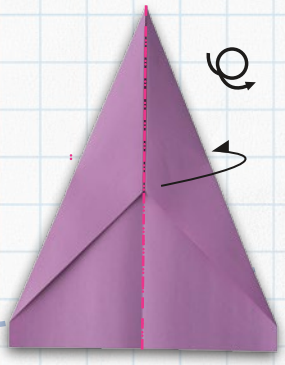
7 Finished Dynamic Dart

Airplanes move forward in flight because of a force called **thrust**. The push of a hand provides the thrust needed for most paper airplanes to fly. Some models use a launcher with a large rubber band that is pulled back and snapped to provide a quick burst of thrust. Real airplanes get their thrust from gas- or electric-powered engines.

6 Lift the wings.



5 Valley fold the top layer even with the bottom edge. Repeat behind.



4 Mountain fold the model in half and rotate.

FLYING TIP

Use a medium throw with a slight upward angle.

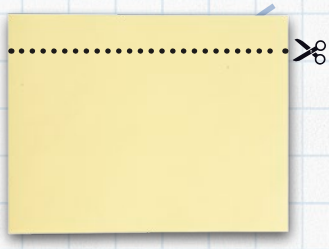
SPINNING BLIMP

Traditional Model

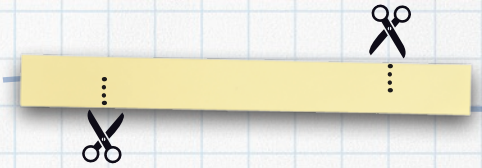
The Spinning Blimp is a clever paper toy. In your hand it looks like a ribbon. But in the air it spins so fast that it looks like a tiny blimp. Release it as high as you can and watch it twirl.

Materials

* 8.5- by 11-inch (22- by 28-cm) paper
* scissors



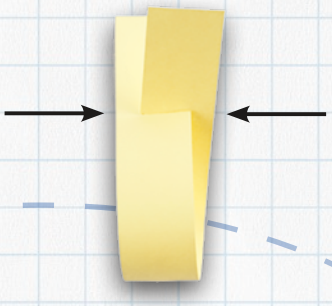
1 Cut a 1.25-inch (3-cm) strip off the paper's long side.



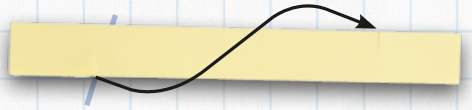
2 Cut slits about 2 inches (5 cm) from the ends of the strip. The slits should be on opposite sides of the strip.

FLYING TIP

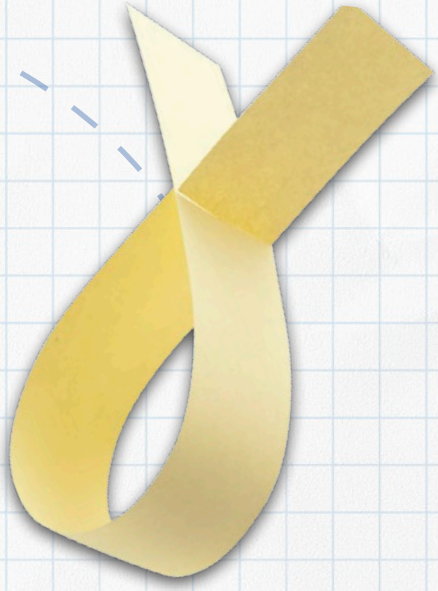
Pinch one side of the model's loop with your index finger and thumb. Release with a gentle forward push.



4 Slide the slits together to form a loop.

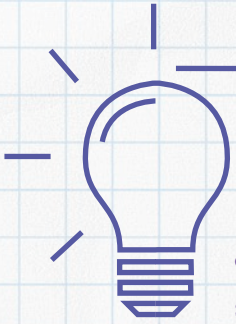


3 Bend the strip to bring the two slits together.



5 Finished Spinning Blimp

END HERE



Weight is a force that pulls a paper airplane (and everything else) down toward Earth. The force of weight is caused by Earth's gravity — or the pull of our planet. When thrust sends a paper airplane soaring through the air, the plane's weight will always bring it back down for a landing.

WHIRLY

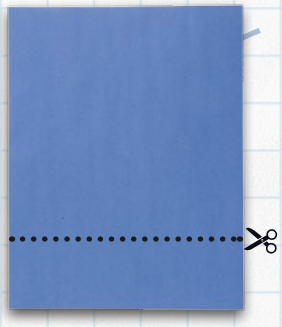
Traditional Model

How can a simple paper strip be so much fun? With two small folds, the Whirly looks like a useless scrap of paper. But launch it once and you'll want to watch it flutter to the floor over and over again.

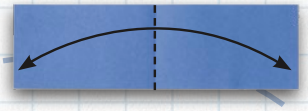
Materials

* 8.5- by 11-inch (22- by 28-cm) paper
* scissors

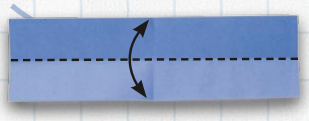
START HERE



1 Cut a 2.5-inch (6-cm) strip off the end of the paper.



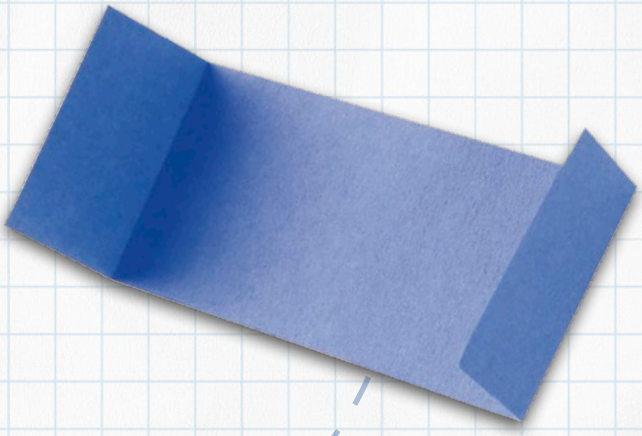
2 Valley fold the strip end to end and unfold.



3 Valley fold the strip edge to edge and unfold.

FLYING TIP

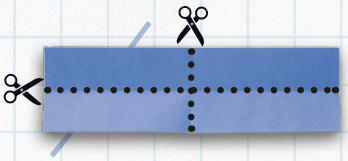
Pinch the middle of the model with your index finger and thumb. Release with a gentle forward push. The higher you hold it, the longer it will flutter.



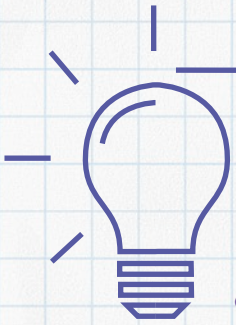
6 Finished Whirly

END HERE

5 Valley fold the ends of one small rectangle. Allow these flaps to stand up at 90-degree angles.



4 Cut the strip on the creases made in steps 2 and 3.



As an airplane moves forward through the sky, a force called **drag** pushes against it. Tiny air molecules rub against the plane and cause drag. Drag always works in the opposite direction of a moving object.

RING WING

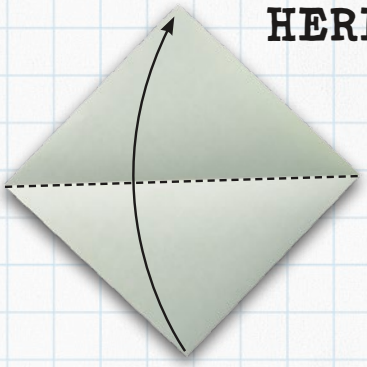
Traditional Model

The Ring Wing looks more like a napkin ring than a paper airplane. But this circular glider really sails.

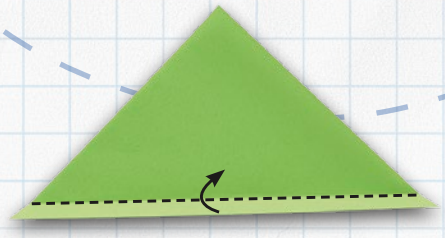
Materials

* 6-inch (15-cm) square of paper

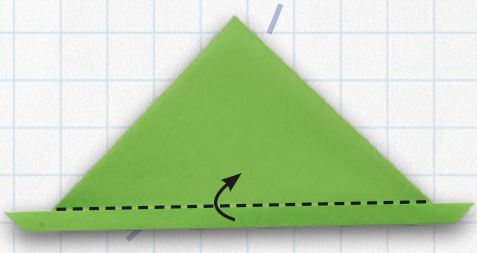
START HERE



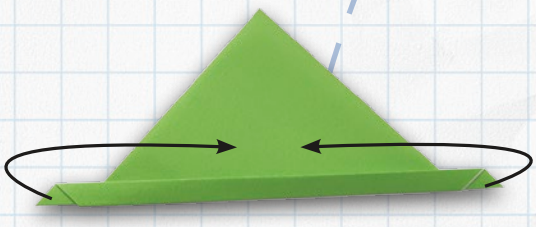
1 Valley fold point to point.



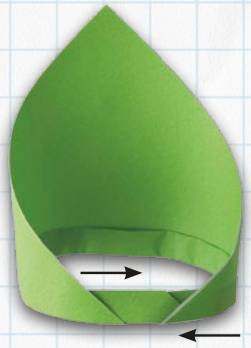
2 Valley fold the edge to create a narrow strip.



3 Valley fold again.



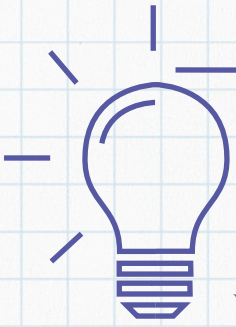
4 Bend the model to bring the ends of the strip together.



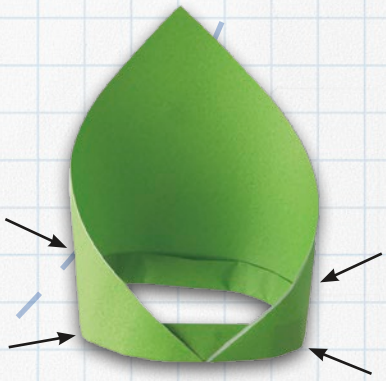
5 Tuck one end of the strip inside the other as far as it will go.

FLYING TIP

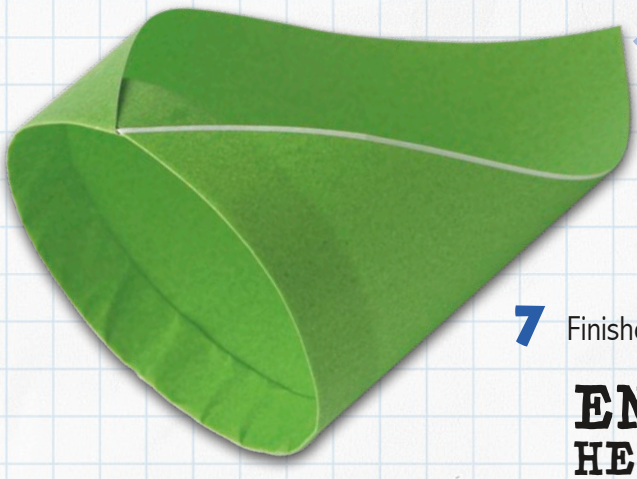
Hold the pointed end of the wing with your index finger and thumb. Release the Ring Wing with a gentle, forward push. Hold it high when you launch it to make it glide farther.



If something is **streamlined**, it has smooth edges, with few parts sticking out. Airplanes are streamlined. They have round, smooth noses and wheels that tuck inside the plane when in flight to reduce the amount of drag.



6 Shape the ring into a smooth circle.



7 Finished Ring Wing

END HERE

FLYING SQUIRREL

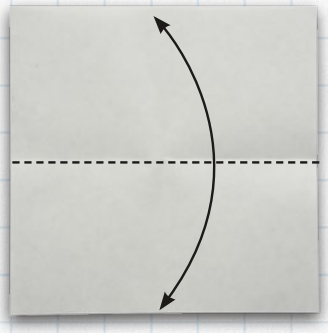
Traditional Model

This glider is nothing more than a single wing. But gravity and air currents give it amazing flights. With the right push, the model will glide like a graceful flying squirrel.

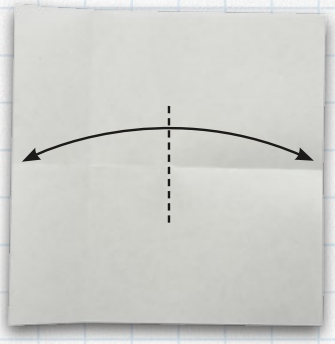
Materials

* 6-inch (15-cm) square of paper

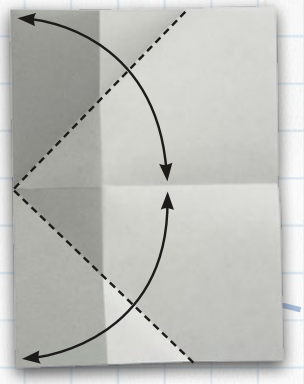
START HERE



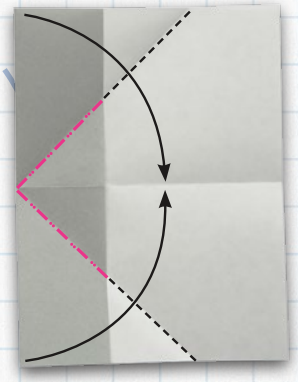
1 Valley fold edge to edge and unfold.



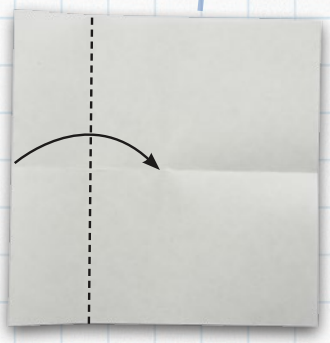
2 Mark fold edge to edge and unfold.



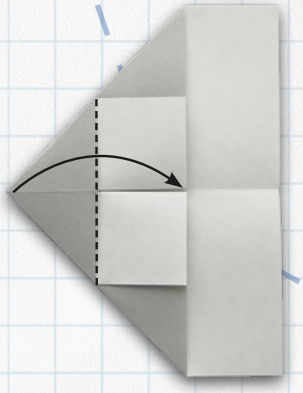
4 Valley fold the corners to the center and unfold.



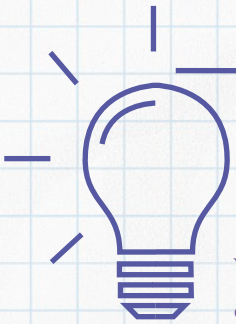
5 Reverse fold on the crease formed in step 4.



3 Valley fold the edge to the mark fold made in step 2.

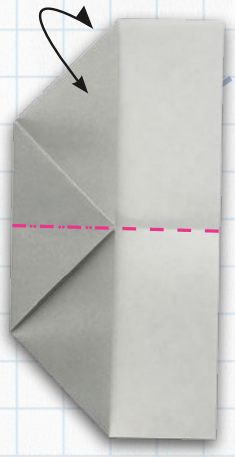


6 Valley fold the point.

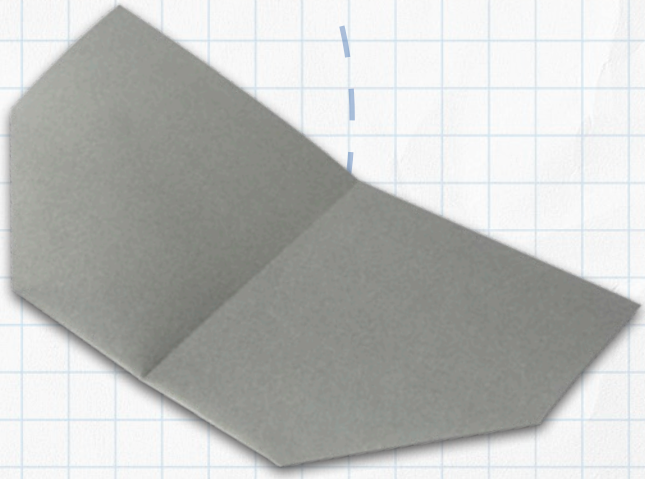


Airplanes need **lift** to fly. As a plane soars into the air, its wings are angled slightly up. Air flowing underneath the bottom of the wing creates pressure. Air moving over the top of the wing speeds up and causes pressure to decrease. Since the pressure below the wing is greater than the pressure above, the pressure difference pushes up against the wings and creates lift.

Continue ▶



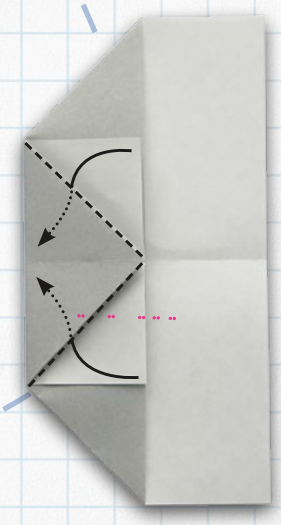
8 Mountain fold the model in half and unfold.



9 Finished Flying Squirrel

END HERE

7 Valley fold the flaps and tuck them into the pockets of the point.



FLYING TIP

Pinch the back end of the wing with your index finger and thumb. Release with a gentle, forward push. The higher you hold it at launch, the farther it will glide.

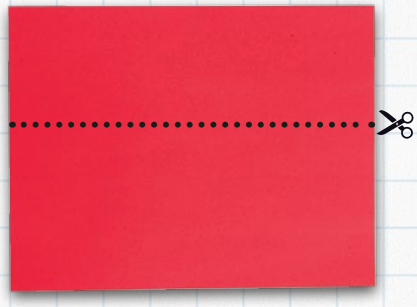
HELICOPTER

Traditional Model

With a snip here and a fold there, you'll make the paper Helicopter in less than three minutes. This classic toy never ceases to amaze. Go ahead, give it a whirl!

Materials

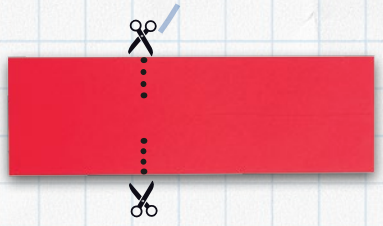
* 8.5- by 11-inch (22- by 28-cm) paper
* scissors
* large paper clip



START HERE

1 Cut a 3.5-inch (9-cm) strip off the paper's long side.

2 Cut a 5-inch (13-cm) slit down the center of the strip.



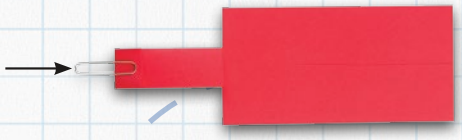
3 Cut two 1.25-inch (3-cm) slits in the sides of the strip. These slits should be about 4 inches (10 cm) from the bottom of the strip.

4 Valley fold the flaps.

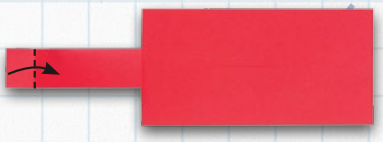
Continue ▶

FLYING TIP

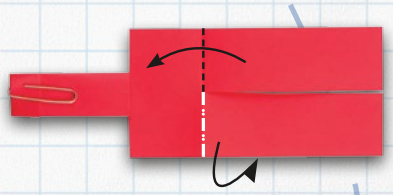
Pinch the paper clip with your index finger and thumb. Throw the model straight up into the air as high as you can. Watch it spin gracefully to the ground.



6 Add a paper clip to the folded edge.

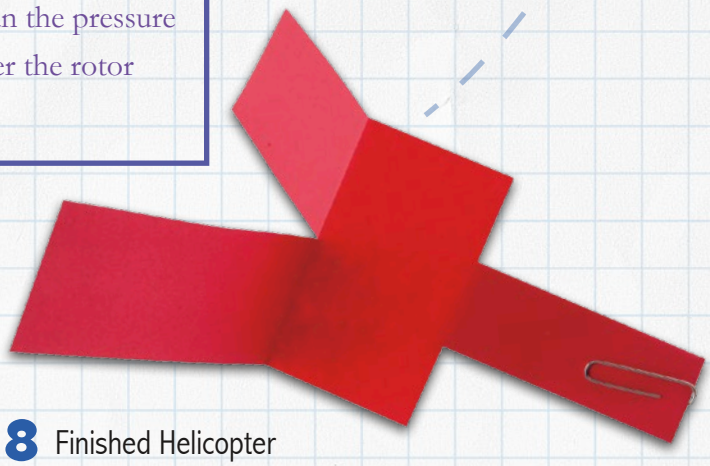


5 Valley fold the bottom edge.



7 Valley fold one propeller. Mountain fold the other propeller.

The main **rotor** on top of a helicopter works like a wing of an airplane. The difference is that the main rotor turns to create airflow, whereas airplane wings rely on the entire plane to move through the air. As air flows over and under the rotor, the pressure created on the bottom of the rotor is higher than the pressure on top. The higher pressure under the rotor pushes up and creates lift.



8 Finished Helicopter

END HERE

TAILSPIN

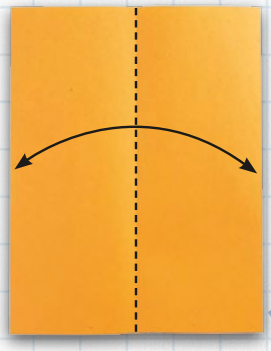
Traditional Model

Some paper airplanes land smoothly. But the Tailspin prefers crash landings. With a hard throw, this model spins wildly through the air and crashes in a blaze of glory.

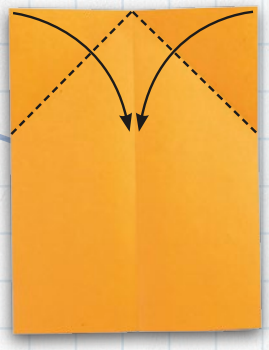
Materials

* 8.5- by 11-inch (22- by 28-cm) paper

START HERE

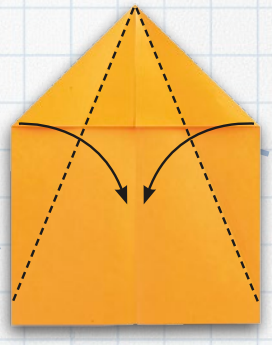


1 Valley fold edge to edge and unfold.

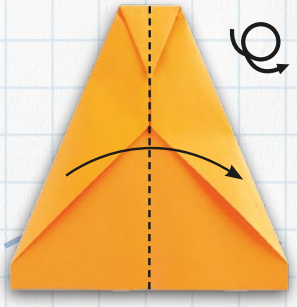


2 Valley fold the corners to the center.

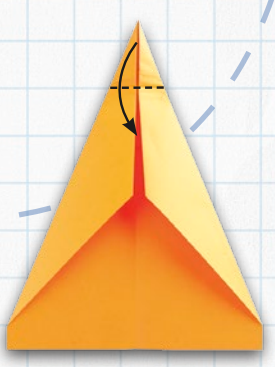
Continue ▶



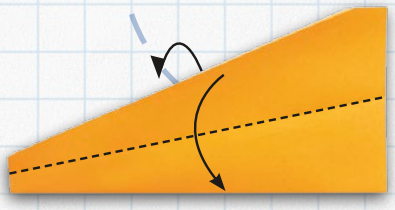
3 Valley fold the edges to the center.



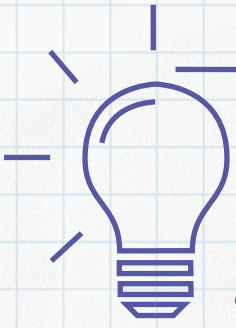
5 Valley fold the model in half and rotate.



4 Valley fold the point.



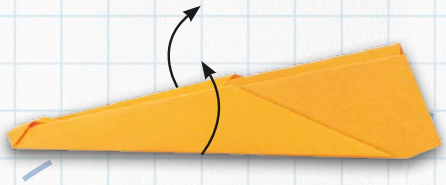
6 Valley fold the top layer even with the bottom edge. Repeat behind.



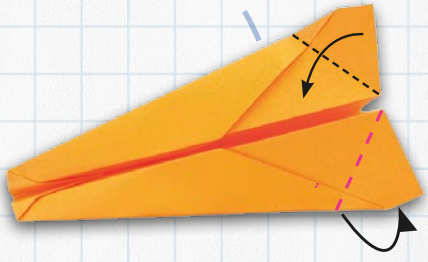
An airplane is usually as close to **symmetric** as possible. If it were cut down the center, length-wise, both sides would be almost exactly the same. Being symmetric helps to create a smooth, straight flight. The Tailspin model has one flap folded up and the other folded down. This asymmetric design sends the plane into a spin.

FLYING TIP

Use a strong throw with a slight upward angle.

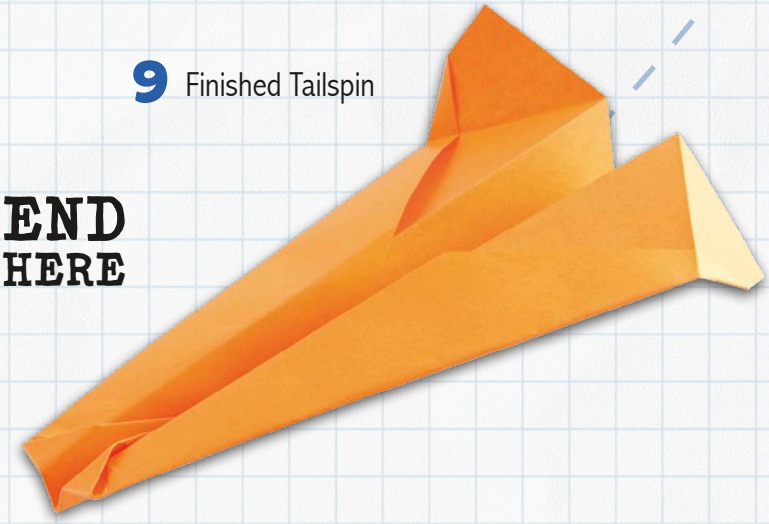


7 Lift the wings.



8 Valley fold one corner up slightly. Mountain fold the other corner down slightly.

9 Finished Tailspin



END HERE

LONG RANGER

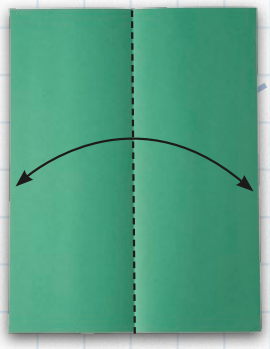
Traditional Model

The Long Ranger has no equal. It flies farther and straighter than any other model in this book. With the right throw, it can cover distances of 45 feet (14 meters). That's something to remember when your school has a paper airplane contest!

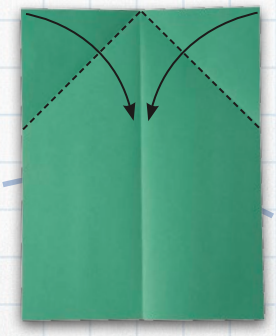
Materials

* 8.5- by 11-inch (22- by 28-cm) paper

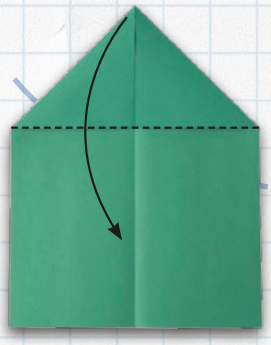
START HERE



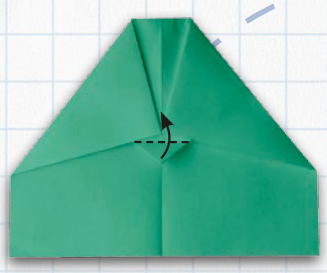
1 Valley fold edge to edge and unfold.



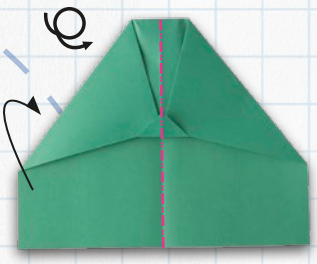
2 Valley fold the corners to the center.



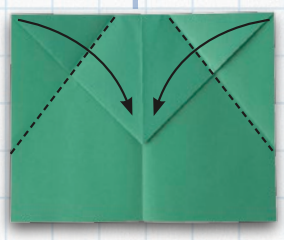
3 Valley fold the point.



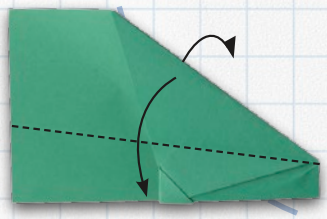
5 Valley fold the point.



6 Mountain fold the model in half and rotate.



4 Valley fold the corners to the center.



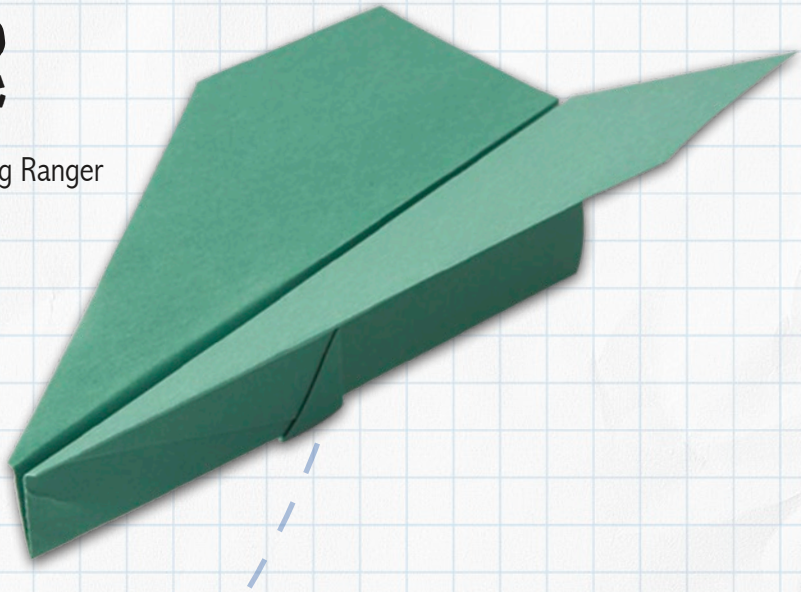
7 Valley fold the top layer even with the bottom edge. Repeat behind.

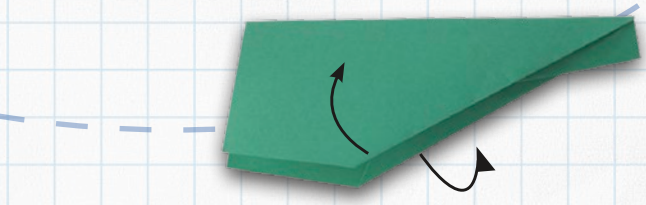
Continue ▶

Wind affects how an airplane flies. When a plane flies in the same direction as the wind (a tailwind), it will fly a longer distance. Pilots use tailwinds to help their planes fly farther with less energy. Taking off into the wind (a headwind) can give a plane lift and help it climb better because of the faster air speed flowing over the wings.

END HERE

9 Finished Long Ranger





8 Lift the wings.

FLYING TIP

Use a medium throw with a slight upward angle.

ELEVATOR GLIDER

Traditional Model

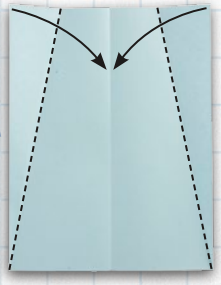
If you like to tinker with flight patterns, the Elevator Glider is just for you. Adjust the angles of the flaps to find the flight that fits you right.

Materials

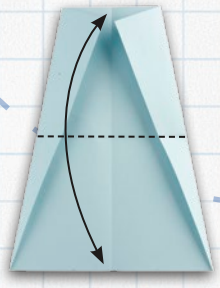
* 8.5- by 11-inch (22- by 28-cm) paper
* scissors

START HERE

1 Valley fold edge to edge and unfold.

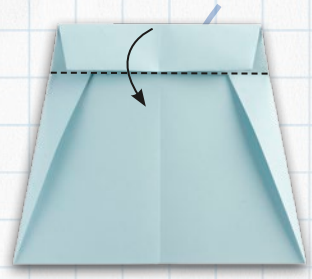


2 Valley fold the corners to the center. Note how the creases end at the bottom corners of the paper.



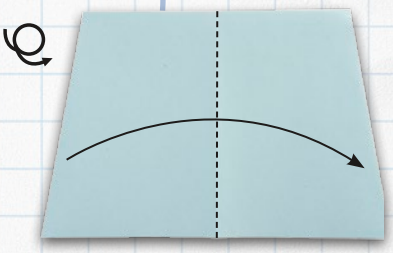
3 Valley fold in half and unfold.

Continue ▶

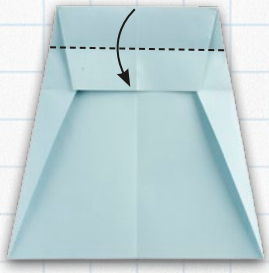


6 Valley fold on the crease formed in step 3.

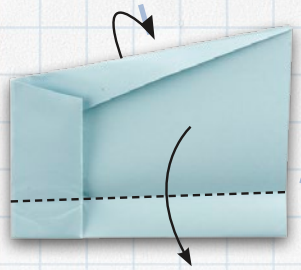
7 Turn the model over.



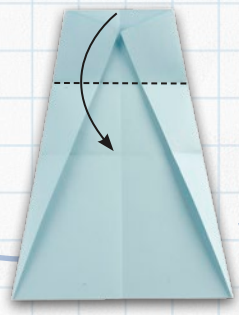
8 Valley fold in half and rotate.



5 Valley fold to the crease formed in step 3 again.



9 Valley fold the top layer. Repeat behind.

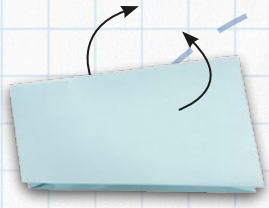


4 Valley fold to the crease formed in step 3.

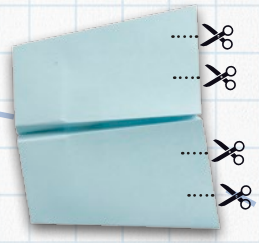
Flaps change the flow of air around an airplane and the direction of air forces pushing on it. A plane with flaps folded up on the back creates a force pushing down on the tail, which lifts the front. That's why the movable surface on the tail is called an elevator — it can cause up or down movement, just like an elevator!

FLYING TIP

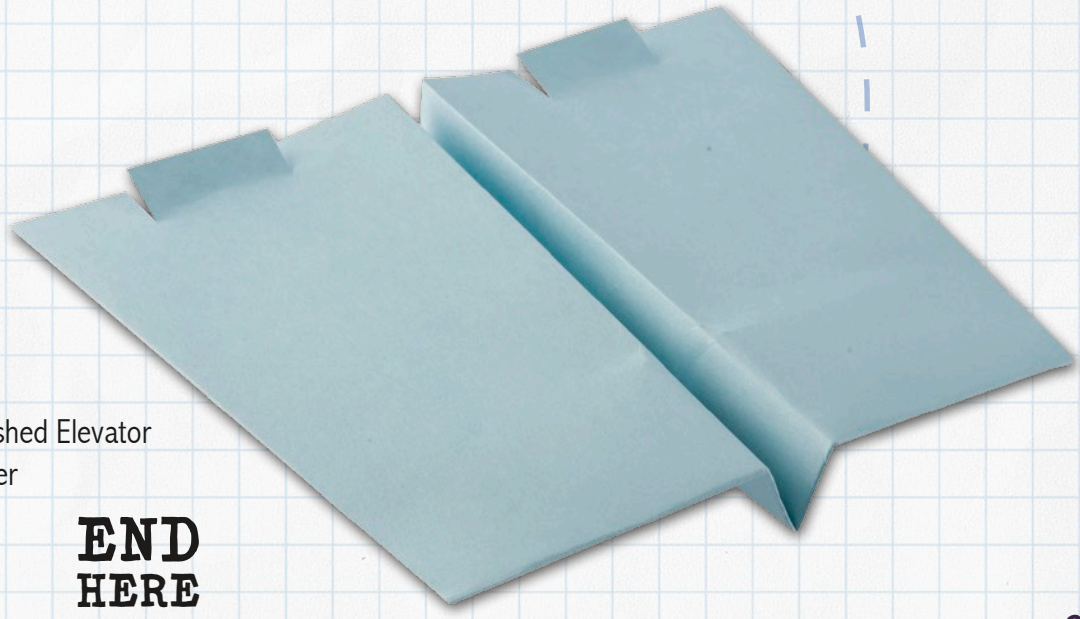
Use a medium, level throw. Adjust the flaps to control how the plane rises or dives.



10 Lift the wings.



11 Cut a flap in the back of each wing. Angle the flaps upward slightly.



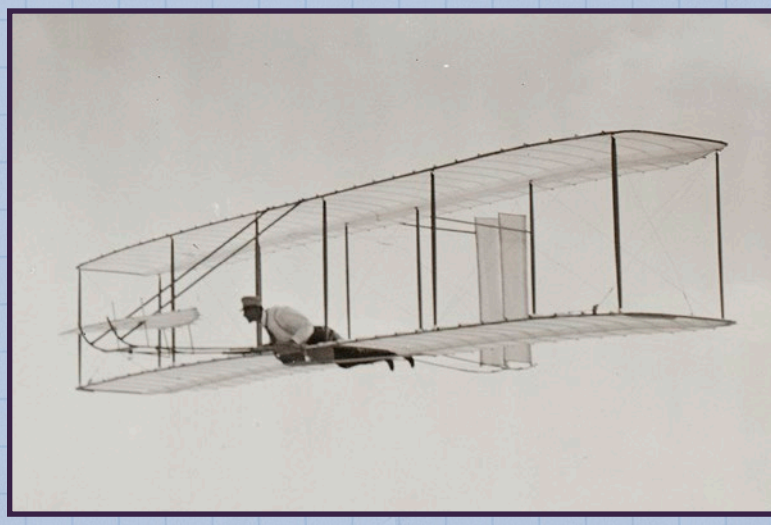
12 Finished Elevator Glider

END HERE

INSIDE THE HANGAR:

The Wright Brothers' 1902 Glider

Two American brothers, Wilbur and Orville Wright, invented the first fully controllable aircraft in the world — the 1902 glider. But their journey to create this incredible flying craft was filled with unexpected problems and lots of crash landings! One of the biggest challenges the Wright brothers faced was finding a reliable way to control the craft's steering. After many test flights, they decided to try a rear rudder. (A plane rudder acts much like the rudder on a ship — it controls the direction of the craft.) Fortunately, their clever rudder idea worked. Finally the pilot could control his craft in three directions: roll (up and down movement of the wing tips), pitch (up and down movement of the plane's nose), and yaw (side to side movement of the plane's nose).



The 1902 glider was the first of the Wright brothers' gliders to include a rudder.

The Wright brothers' glider had two 32-feet (9.8-m) wings. It didn't have any seats. Instead, the pilot lay down on the bottom wing and held on tight to the controls. Built out of wood and strong fabric, the Wright brothers' glider weighed only 117 pounds (53 kilograms).

READ MORE

Collins, John M. *The New World Champion Paper Airplane Book: Featuring the Guinness World Record-Breaking Design, with Tear-Out Planes to Fold and Fly.* New York: Ten Speed Press, 2013.

LaFosse, Michael G. *Michael LaFosse's Origami Airplanes.* North Clarendon, Vt.: Tuttle Publishing, 2016.

Lee, Kyong Hwa. *Amazing Paper Airplanes: The Craft and Science of Flight.* Albuquerque, N.Mex.: University of New Mexico Press, 2016.

INTERNET SITES

Use FactHound to find Internet sites related to this book.

Visit *www.facthound.com*

Just type in 9781543507973 and go.

Special thanks to our adviser, Polly Kadolph, Associate Professor,
University of Dubuque (Iowa) Aviation Department, for her expertise.

Dabble Lab Books are published by Capstone Press,
1710 Roe Crest Drive, North Mankato, Minnesota 56003
www.mycapstone.com

Copyright © 2018 by Capstone Press, a Capstone imprint.
All rights reserved. No part of this publication may be reproduced in whole or in part,
or stored in a retrieval system, or transmitted in any form or by any means, electronic,
mechanical, photocopying, recording, or otherwise, without written permission of the publisher.

Library of Congress Cataloging-in-Publication data is available on the Library of Congress website.
ISBN: 978-1-5435-0797-3 (library binding)
ISBN: 978-1-5435-0801-7 (eBook PDF)

Summary: Send your readers flying down the runway with a simple fold, fold, fold, and a side of science. Step-by-step instructions show budding flight-school students how to build the Spinning Blimp and other beginning-level paper airplanes, while hearty, fact-filled sidebars and an "Inside the Hangar" feature explain basic flight concepts. Engaging 4D components really give this title wings!

Editorial Credits
Jill Kalz, editor; Heidi Thompson, designer; Eric Gohl, media researcher; Laura Manthe, production specialist

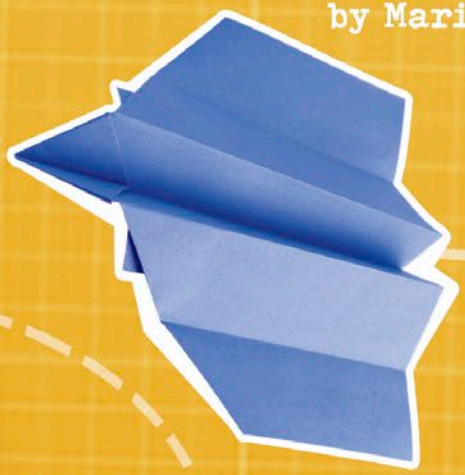
Photo Credits
Capstone Studio: Karon Dubke, all steps
Library of Congress: 30
Shutterstock: design elements

Printed in the United States of America.
010761S18

NEEDLE NOSE!

ADVANCED-LEVEL Paper Airplanes

by Marie Buckingham



4D™
An Augmented Reading Paper-Folding Experience

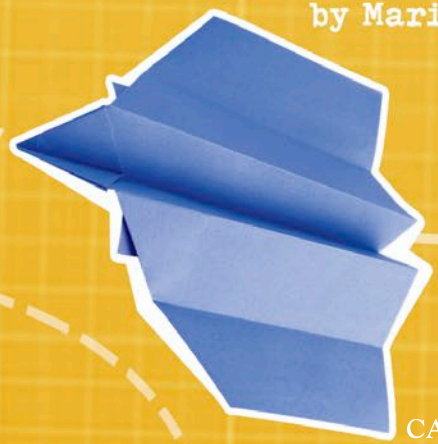
dabblelab

PAPER AIRPLANES
with a SIDE of SCIENCE

NEEDLE NOSE!

ADVANCED-LEVEL Paper Airplanes

by Marie Buckingham



4D An Augmented Reading Paper-Folding Experience

CAPSTONE PRESS
a capstone imprint

TABLE OF

Prepare for Takeoff 4

Materials 5

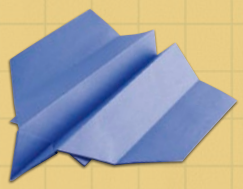
Techniques and Terms 6

Folding Symbols 7

Liftoff 8

Needle Nose 10

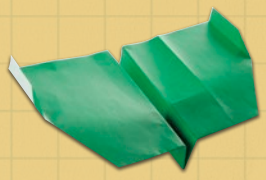
Aviator 12



Fang 14

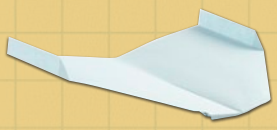
CONTENTS

Lazy Lander 17



Hang Glider 20

Steady Eddie 23



D-Wing.....26

Inside the Hangar 30

Read More 31

Internet Sites.....31

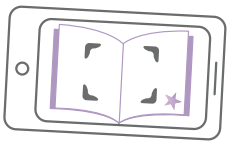
Download the Capstone 4D app!

Step 1 Ask an adult to search in the Apple App Store or Google Play for "Capstone 4D."

Step 2 Click Install (Android) or Get, then Install (Apple).

Step 3 Open the app.

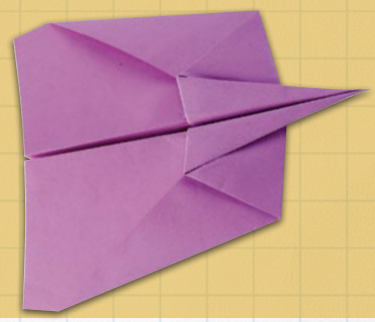
Step 4 Scan any of the following spreads with this icon.



When you scan a spread, you'll find fun extra stuff to go with this book! You can also find these things on the web at *www.capstone4D.com* using the password: planes.nose

PREPARE FOR TAKEOFF

Welcome aboard! You've earned the rank of pilot, and you're ready to fly. Just a reminder: Check the lightbulb boxes tucked alongside the paper airplane instructions for bite-size explanations of flight-science concepts related to your models. Check the photo boxes for tips on how to best launch your finished planes. And remember, there are four main forces that airplanes need to fly successfully: lift, weight, thrust, and drag. But the eight paper airplanes in this book need one more thing: YOU!



MATERIALS

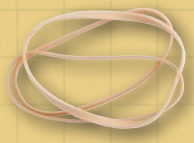
Every paper airplane builder needs a well-stocked toolbox. The models in this book use the materials listed below. Take a minute before you begin folding to gather what you need:

Paper

Any paper you can fold will work. Notebook paper is always popular. But paper with cool colors and designs gives your planes style.

Scissors

Keep a scissors handy. Some models need a snip here or there to fly well.



Rubber Bands

Rubber bands can send some airplane models sailing. Long, thin rubber bands work well.

Paper Clips

Paper clips are perfect for adding weight to a plane's nose. Keep a supply of small and large paper clips on hand.

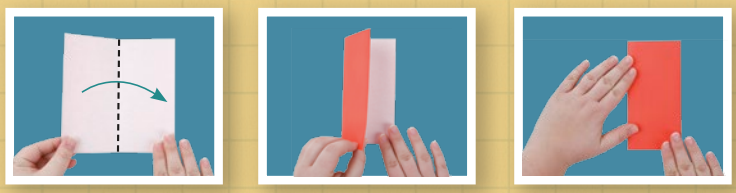
Small Binder Clips

Small binder clips also give weight to a glider's nose.

TECHNIQUES AND TERMS

Folding paper airplanes isn't difficult when you understand common folding techniques and terms. Review this list before folding the models in this book. Remember to refer back to this list if you get stuck on a tricky step.

Valley Folds

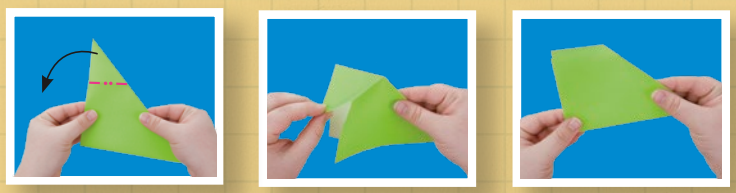


Valley folds are represented by a dashed line. The paper is creased along the line. The top surface of the paper is folded against itself like a book.

Mountain Folds

Mountain folds are represented by a pink or white dashed and dotted line. The paper is creased along the line and folded behind.

Reverse Folds

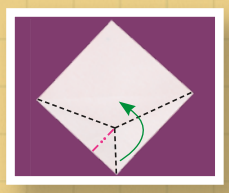


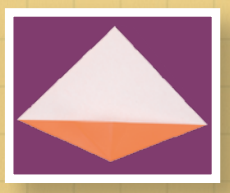
Reverse folds are made by opening a pocket slightly and folding the model inside itself along existing creases.

Mark Folds

Mark folds are light folds used to make reference creases for a later step. Ideally, a mark fold will not be seen in the finished model.

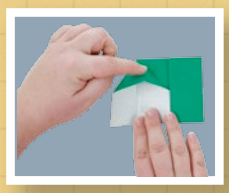
Rabbit Ear Folds





Rabbit ear folds are formed by bringing two edges of a point together using existing creases. The new point is folded to one side.

Squash Folds



Squash folds are formed by lifting one edge of a pocket and reforming it so the spine gets flattened. The existing creases become new edges.

FOLDING SYMBOLS

Fold the paper in the direction of the arrow.

Fold the paper behind.

Fold the paper and then unfold it.

Turn the paper over or rotate it to a new position.

A fold or edge hidden under another layer of paper; also used to mark where to cut with a scissors

LIFTOFF

Designed by Christopher L. Harbo

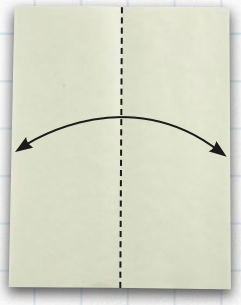
Ever wish you could put more power behind your launch? Your wish is granted with this plane. The notch in Liftoff's nose is strong enough to withstand the pull of a rubber band. Get ready. Aim. Fire away!

Materials

* 8.5- by 11-inch (22- by 28-centimeter) paper
* scissors
* rubber band

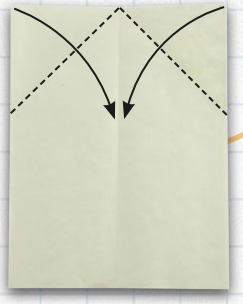
FLYING TIP

Hook the plane's notch onto one side of the rubber band. Hold the other side of the rubber band with one hand. Pull back on the tail of the plane with the other hand. Stretch the rubber band as far as it will go and release.



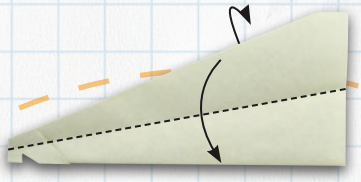
START HERE

1 Valley fold edge to edge and unfold.

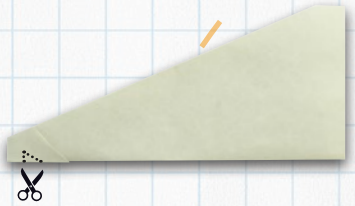


2 Valley fold the corners to the center.

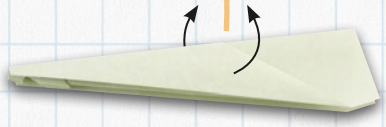
3 Mountain fold the point.



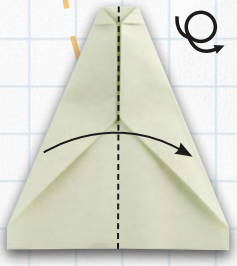
7 Valley fold the top layer even with the bottom edge. Repeat behind.



6 Cut a notch in the bottom edge of the nose.



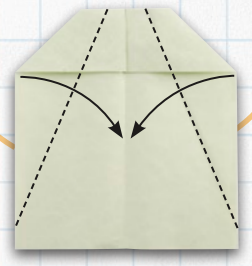
8 Lift the wings.



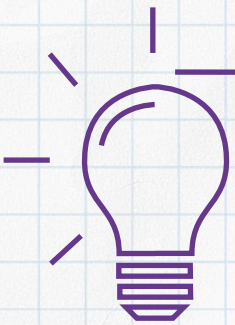
5 Valley fold the model in half and rotate.

9 Finished Liftoff

END HERE



4 Valley fold the edges to the center.



Thrust is the force that pushes an airplane forward. Some paper airplane models get the thrust they need for flight from a rubber band. A stretched rubber band contains stored energy called potential energy. But as soon as the rubber band is released, its potential energy changes into kinetic energy — energy in motion!

NEEDLE NOSE

Traditional Model

It's not hard to figure out how the Needle Nose got its name. This model's pointy beak gets damaged easily. But the plane's awesome flights will make up for the time you spend straightening the nose.

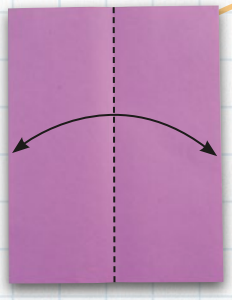
Materials

* 8.5- by 11-inch (22- by 28-cm) paper

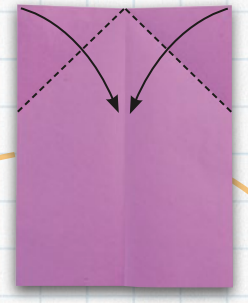
FLYING TIP

Use a medium throw with a slight upward angle.

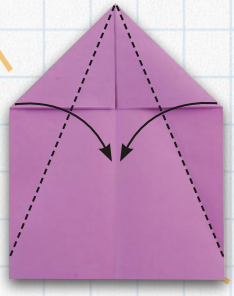
START HERE



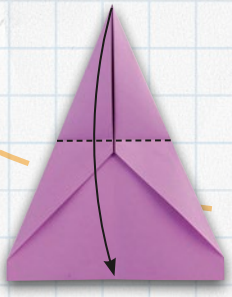
1 Valley fold edge to edge and unfold.



2 Valley fold the corners to the center.



3 Valley fold the edges to the center.

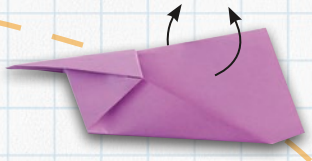


4 Valley fold the point.

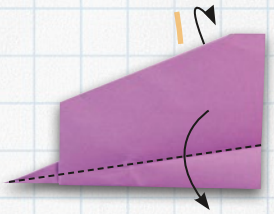
As an airplane soars through the sky, a force called **drag** pushes against its forward movement. Drag is caused by air rubbing against a plane's surface. Airplanes with thin, sleek noses experience less drag upfront, which means a faster flight!

9 Finished Needle Nose

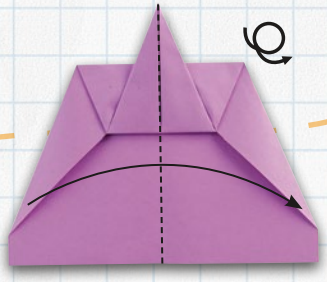
END HERE



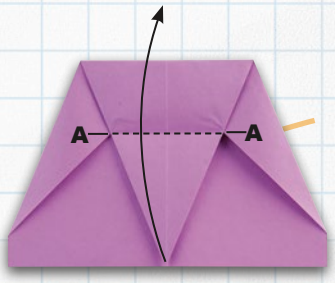
8 Lift the wings.



7 Valley fold the top layer. Repeat behind.



6 Valley fold the model in half and rotate.



5 Valley fold the point. Note how the crease is even with point A.

AVIATOR

Traditional Model

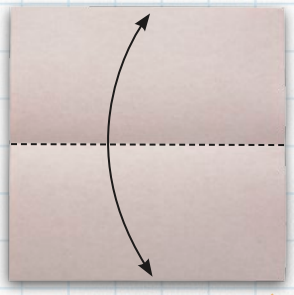
The Aviator is one cool mini jet. This model looks like a dart and has a built-in cockpit. With a strong throw, you might think a tiny pilot is guiding it across the room.

Materials

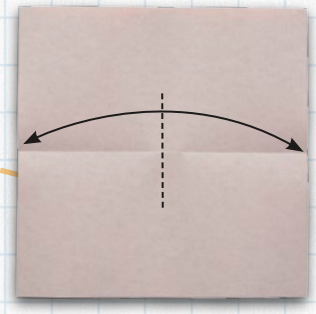
* 6-inch (15-cm) square of paper

Most fighter jets have joysticks in the cockpit. A joystick is used to operate an airplane's **ailerons** and **elevator**. Ailerons are small, hinged fins on the end of wings that help a plane turn by rolling. An elevator is a moveable surface on a plane's tail. It causes up and down movement of the nose, called pitch.

START HERE

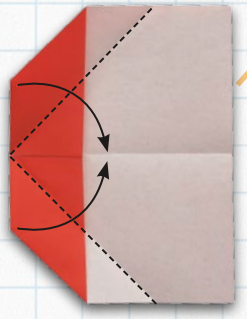


1 Valley fold edge to edge and unfold.

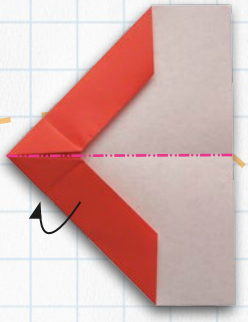


2 Mark fold edge to edge and unfold.

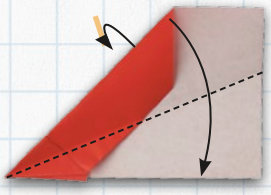
3 Valley fold the corners to the center.



5 Valley fold the edges to the center.



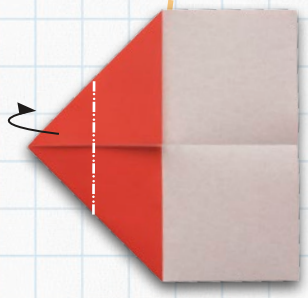
6 Mountain fold the model in half.



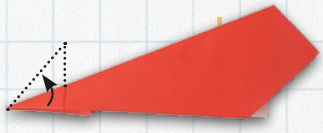
7 Valley fold the top layer even with the bottom edge. Repeat behind.

FLYING TIP

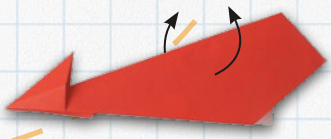
Use a strong throw with a slight upward angle.



4 Mountain fold the point to the mark made in step 2.



8 Pull up the triangle in the nose to form a cockpit.



9 Lift the wings.

END HERE

10 Finished Aviator

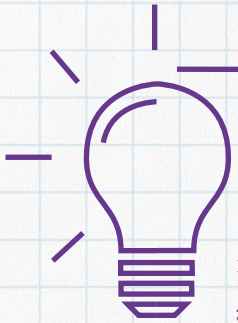
FANG

Designed by Christopher L. Harbo

Tiny teeth give the Fang a dangerous look, but this gentle glider won't bite. The plane's light wings are at the mercy of air currents. In flight, it sways from side to side as it crosses a room.

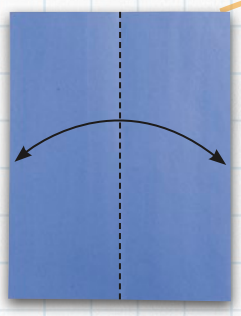
Materials

* 8.5- by 11-inch (22- by 28-cm) paper

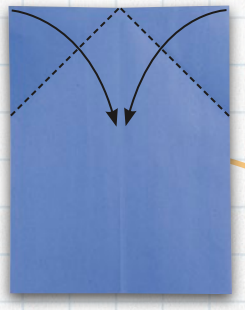


The **weight** of an airplane is the downward force that pulls it toward the ground. **Lift** is the upward force created by air moving around a plane's wings. Lift must be greater than weight for an airplane to take off and fly.

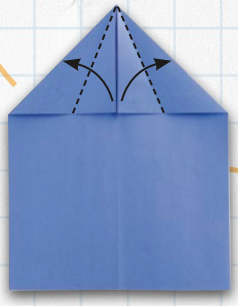
START HERE



1 Valley fold edge to edge and unfold.



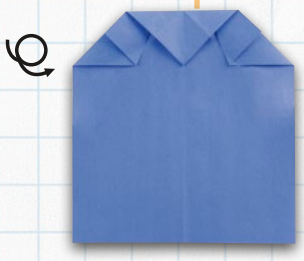
2 Valley fold the corners to the center.



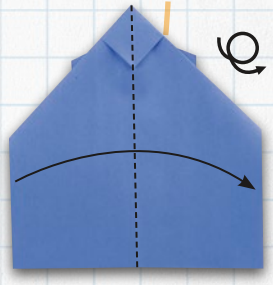
3 Valley fold the flaps even with the outer edges.

6 Valley fold the top corners to the center. Allow the tiny flaps behind the corners to release to the top.

7 Turn the model over.

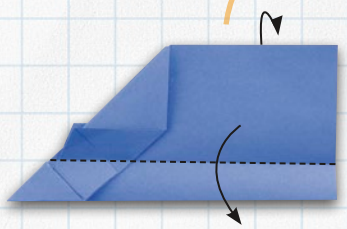


5 Turn the model over.



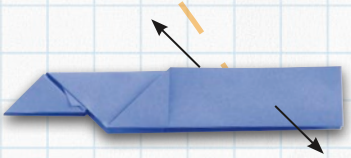
8 Valley fold the model in half and rotate.

4 Valley fold the point.



9 Valley fold the top layer. Repeat behind.

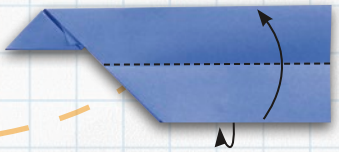
Continue ▶



11 Pull the wings outward to unfold.

12 Finished Fang

END HERE



10 Valley fold the wing even with the top edge. Repeat behind.

FLYING TIP

Use a medium, level throw.

LAZY LANDER

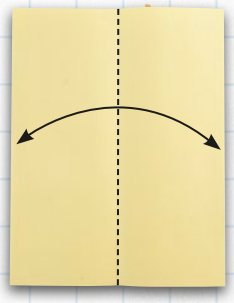
Designed by Christopher L. Harbo

Make way for the Lazy Lander! This plane gets its magic from the binder clip. Placed under the nose, the clip gives the glider the weight it needs to fly. Better yet, the clip's legs can serve as landing gear.

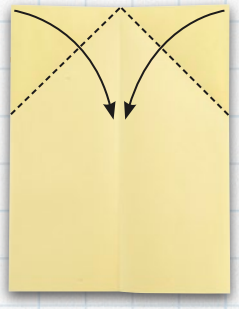
Materials

* 8.5- by 11-inch (22- by 28-cm) paper
* small binder clip

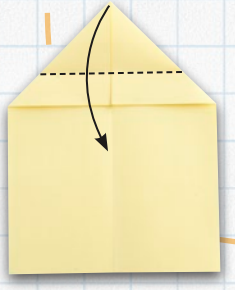
START HERE



1 Valley fold edge to edge and unfold.

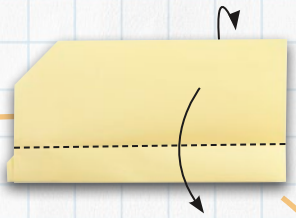


2 Valley fold the corners to the center.

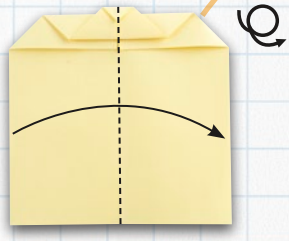


3 Valley fold the point.

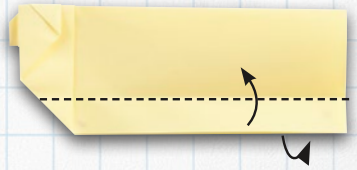
Continue ▶



7 Valley fold the top layer. Repeat behind.

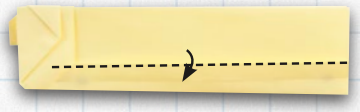


6 Valley fold the model in half and rotate.

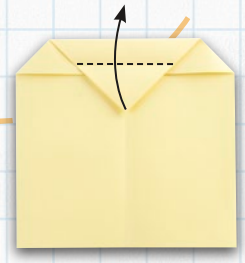


8 Valley fold the edge of the wing. Repeat behind.

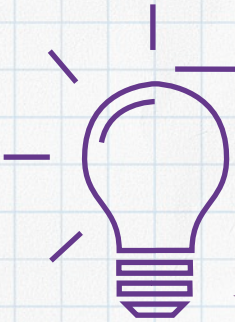
5 Valley fold the point.



9 Valley fold the wing flap even with the bottom edge. Repeat behind.



4 Valley fold the point.



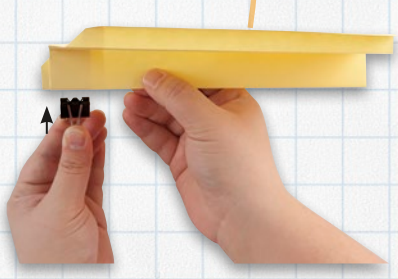
Most airplanes have wheels to create a smooth landing for passengers. Plane wheels are equipped with **shock absorbers**, which allow the wheels to move up and down to lessen the landing impact. Shock absorbers change kinetic energy (energy in motion) into another type of energy — heat.

END HERE

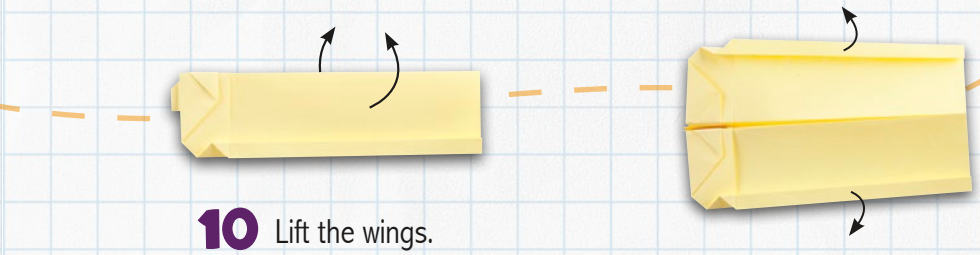
13 Finished Lazy Lander

FLYING TIP

Use a medium, level throw.



12 Add a binder clip to the front of the plane.



10 Lift the wings.

11 Pull the wing flaps up and out to the side.

HANG GLIDER

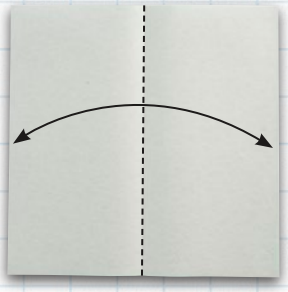
Traditional Model

The Hang Glider takes you soaring to new heights. With the right throw, this glider climbs into the air. When it can go no higher, it banks to the side and curves around the room.

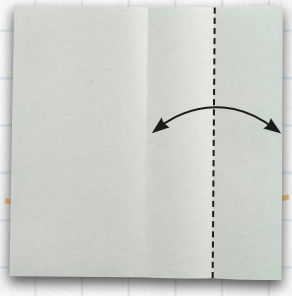
Materials

* 10-inch (25-cm) square of paper

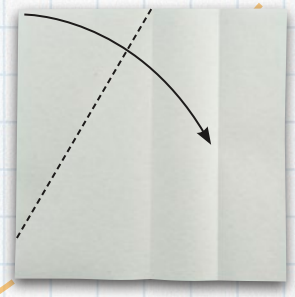
START HERE



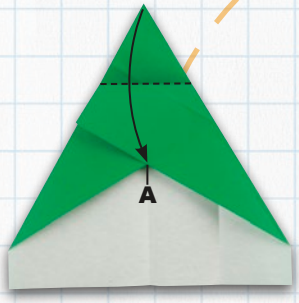
1 Valley fold edge to edge and unfold.



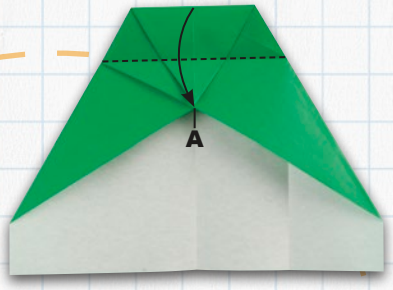
2 Valley fold to the center and unfold.



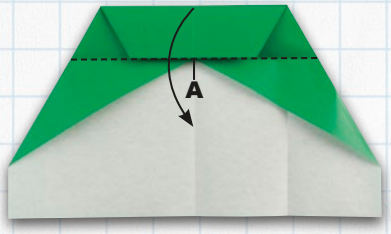
3 Valley fold the corner to the crease made in step 2.



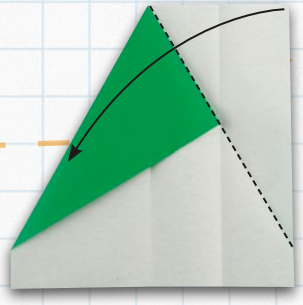
5 Valley fold the point to A.



6 Valley fold to A.

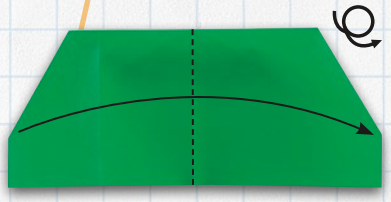


7 Valley fold at A.



4 Valley fold the corner to the edge.

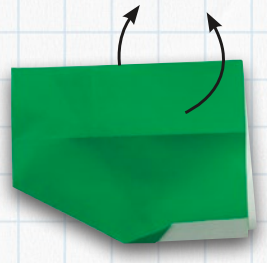
8 Turn the model over.



9 Valley fold the model in half and rotate.

A **hang glider** is a small, lightweight plane with one large wing. Because it has no motor, it must be launched from a high place, such as a cliff. Before taking flight, a pilot clips into a harness, holds tight to the airframe, and then quickly runs, allowing the wing to catch air. The pilot steers a hang glider by shifting his or her body weight.

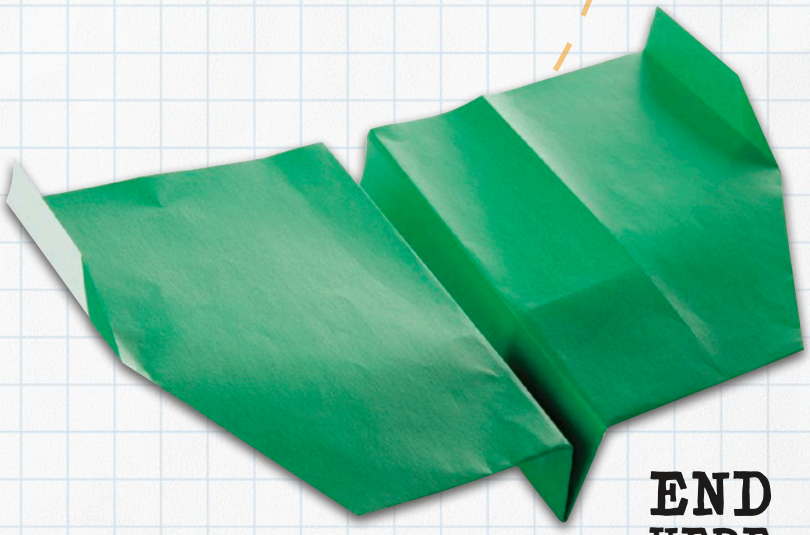
Continue ▶



12 Lift the wings.

13 Lift the wing flaps so they stand up at 90-degree angles.

11 Valley fold the edge of the wing. Repeat behind.



END HERE

14 Finished Hang Glider

10 Valley fold the top layer. Repeat behind.

FLYING TIP

Use a medium throw with a slight upward angle.

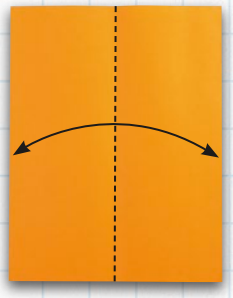
STEADY EDDIE

Designed by Christopher L. Harbo

Get ready for the Steady Eddie. Broad wings and slim wing flaps give this glider a smooth, stable flight. Two small paper clips beside the nose help guide the craft as it comes in for a landing.

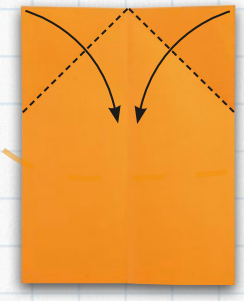
Materials

* 8.5- by 11-inch (22- by 28-cm) paper
* two small paper clips

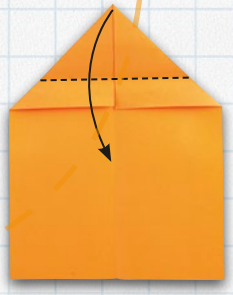


START HERE

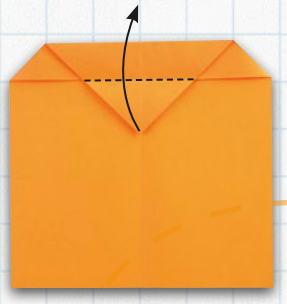
1 Valley fold edge to edge and unfold.



2 Valley fold the corners to the center.

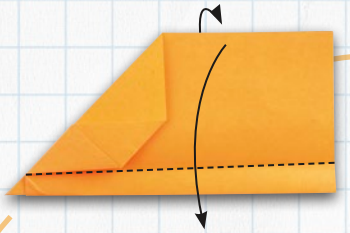


3 Valley fold the point.

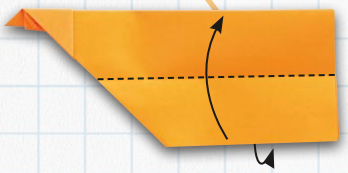


4 Valley fold the point.

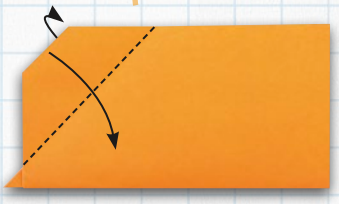
Continue ▶



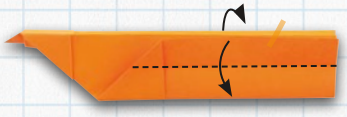
7 Valley fold the top layer. Repeat behind.



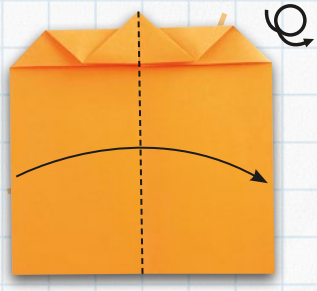
8 Valley fold the edge of the wing even with the top edge. Repeat behind.



6 Valley fold the left corner. Repeat behind.

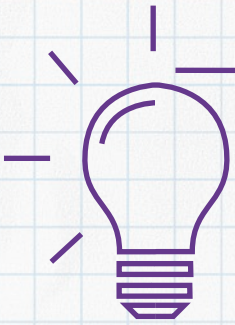


9 Valley fold the edge of the wing even with the bottom edge. Repeat behind.



5 Valley fold the model in half and rotate.

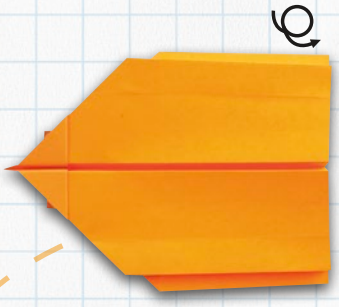
10 Valley fold the edge of the wing with the crease made in step 9. Repeat behind.



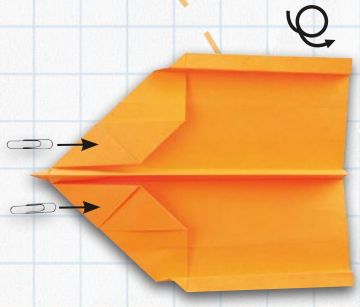
Space flight is much different than flight through Earth's atmosphere. In space, there's no air. Without the movement of air, there's no drag or lift. Of the four main forces needed for an airplane to fly, only weight and thrust affect a spacecraft's flight.

FLYING TIP

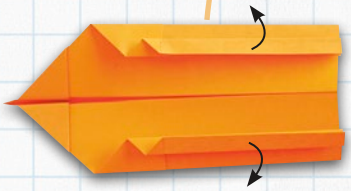
Use a medium throw with a steep upward angle.



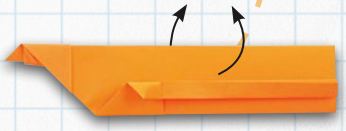
13 Turn the model over.



14 Insert a small paper clip on each side of the nose. Turn the model over.



12 Unfold the wing flaps on the creases made in step 8. Allow the edges of the wings to become L-shaped runners under the wings.



11 Lift the wings.

15 Finished Steady Eddie

END HERE

D-WING

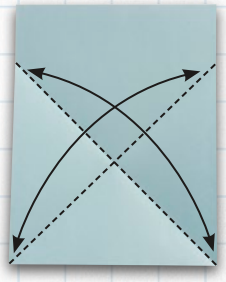
Traditional Model

The D-wing's flight depends on how you release it. One flight might be long, smooth, and straight. The next might wobble, curve, and dive. It's a model that will keep you guessing.

Materials

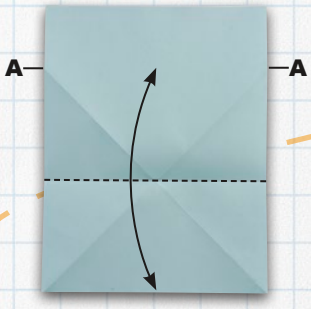
* 8.5- by 11-inch (22- by 28-cm) paper

START HERE

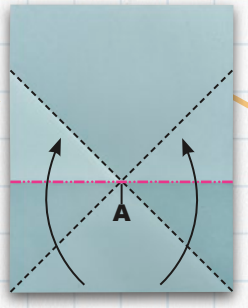


1 Valley fold in both directions and unfold.

2 Turn the paper over.

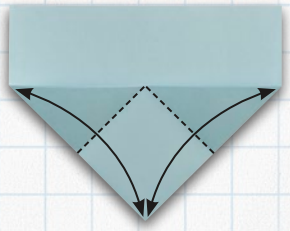


3 Valley fold so the corners meet at A and unfold.

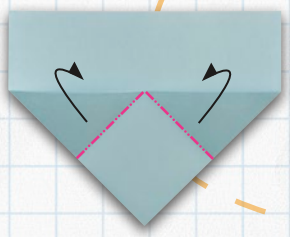


5 Push at point A. Collapse the paper on the existing creases to form a triangle.

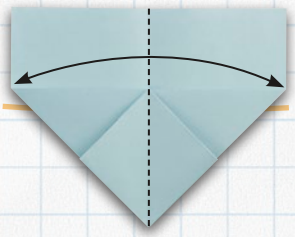
4 Turn the paper over.



6 Valley fold the top layers to the point and unfold.



7 Mountain fold the top layers on the creases made in step 6.

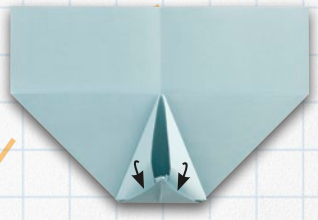


8 Valley fold the model in half and unfold.

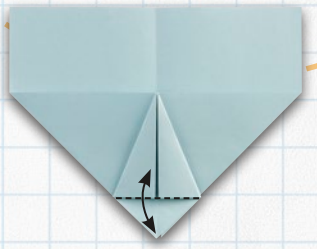
Continue ▶

Earth's gravity is the force that is constantly pulling objects with mass (including people) to the ground. Whenever someone slams on the brakes, blasts off in a rocket, or takes a sharp turn in a jet, he or she changes speed faster than gravity can pull. The measure of the change in speed is called **g-force**. High g-forces can be deadly. A person standing at sea level feels 1 G. Many race car drivers feel 5 Gs. Fighter jet pilots wearing special g-suits can endure 8 or 9 Gs.

9 Valley fold the corners of the top flap to the center.



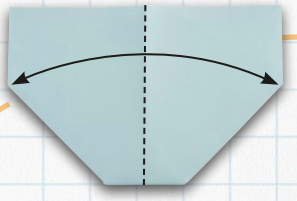
11 Tuck the flaps into the pockets of the point.



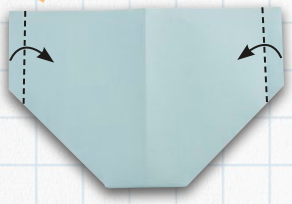
10 Valley fold the point and unfold.

FLYING TIP

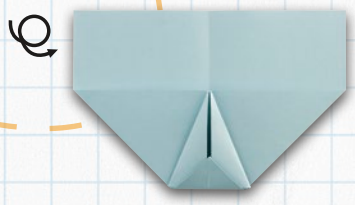
Pinch the back of the wing with two fingers and your thumb. The model will bend upward in the middle. Release with a strong forward flick of the wrist.



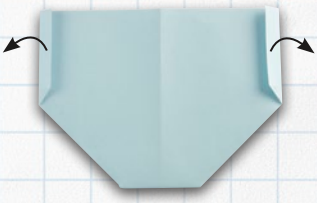
13 Valley fold the model in half and unfold.



14 Valley fold the edges of the wings.



12 Turn the model over.



15 Lift the wing flaps so they stand up at 90-degree angles.

16 Finished D-wing

END HERE

INSIDE THE HANGAR:

Hang Gliders and Paragliders

Although a hang glider doesn't have an engine to produce thrust, this small flying craft can soar for hours. Made of a lightweight metal frame and canvas, it has a high lift-to-drag ratio. This means that the amount of lift created by the glider's wing is far greater than the drag created by the glider and its pilot.

Areas with consistently hot, dry weather are the best places for hang gliders to take long flights. When the sun's rays heat up the ground, the air above it expands and rises. The rising columns of air are called thermals. Thermals push up on a hang glider's wing and keep the craft in flight.

The Guinness World Record for the longest hang glider flight is 474.7 miles (764 kilometers). The pilot, Dustin Martin, made his incredible 11-hour flight from Zapata, Texas, to Lubbock, Texas, on July 3, 2012.

A paraglider is similar to a hang glider. Both use thermals to fly, move at about the same speed, and are relatively easy to control. The biggest difference is that a hang glider has a rigid frame, whereas a paraglider is simply a harness hanging from a fabric wing.

A hang glider is essentially one big wing.

READ MORE

Collins, John M. *The New World Champion Paper Airplane Book: Featuring the Guinness World Record-Breaking Design, with Tear-Out Planes to Fold and Fly.* New York: Ten Speed Press, 2013.

LaFosse, Michael G. *Michael LaFosse's Origami Airplanes.* North Clarendon, Vt.: Tuttle Publishing, 2016.

Lee, Kyong Hwa. *Amazing Paper Airplanes: The Craft and Science of Flight.* Albuquerque, N.Mex.: University of New Mexico Press, 2016.

INTERNET SITES

Use FactHound to find Internet sites related to this book.

Visit *www.facthound.com*

Just type in 9781543507959 and go.

Special thanks to our adviser, Polly Kadolph, Associate Professor,
University of Dubuque (Iowa) Aviation Department, for her expertise.

Dabble Lab Books are published by Capstone Press,
1710 Roe Crest Drive, North Mankato, Minnesota 56003
www.mycapstone.com

Copyright © 2018 by Capstone Press, a Capstone imprint.
All rights reserved. No part of this publication may be reproduced in whole or in part,
or stored in a retrieval system, or transmitted in any form or by any means, electronic,
mechanical, photocopying, recording, or otherwise, without written permission of the publisher.

Library of Congress Cataloging-in-Publication data is available on the Library of Congress website.
ISBN: 978-1-5435-0795-9 (library binding)
ISBN: 978-1-5435-0799-7 (eBook PDF)

Summary: For young flight-school students who are ready to take the controls, “Needle Nose!”
delivers challenging paper-folding projects with step-by-step instructions and special 4D-component
support. Clear, informative sidebars and an “Inside the Hangar” feature explain the basic science and
engineering concepts related to flight.

Editorial Credits
Jill Kalz, editor; Heidi Thompson, designer; Eric Gohl, media researcher; Laura Manthe, production specialist

Photo Credits
Capstone Studio: Karon Dubke, all steps
Shutterstock: design elements, Alexandra Lande, 30

Printed in the United States of America.
010761S18