AN ILLUSTRATED GUIDE TO FLYING

BARRY SCHIFF

AN ILLUSTRATED GUIDE TO FLYING

BARRY SCHIFF

AVIATION SUPPLIES & ACADEMICS, INC.
NEWCASTLE, WASHINGTON

An Illustrated Guide to Flying
by Barry Schiff

Aviation Supplies & Academics, Inc.
7005 132nd Place SE
Newcastle, Washington 98059
asa@asa2fly.com | 425-235-1500 | asa2fly.com

ASA-IGF
ISBN 978-1-61954-401-7

Additional formats available:
eBook EPUB ISBN 978-1-61954-402-4
eBook PDF ISBN 978-1-61954-404-8

Printed in the United States of America
2026 2025 2024 2023 2022 9 8 7 6 5 4 3 2 1

Cover photo: Copyright Diamond Aircraft.

Library of Congress Cataloging-in-Publication Data

Names: Schiff, Barry J., author.
Title: An illustrated guide to flying / Barry Schiff.
Description: Newcastle, Washington : Aviation Supplies & Academics, Inc., [2022] | Includes index.
Identifiers: LCCN 2022035074 | ISBN 9781619544017 (trade paperback) | ISBN 9781619544024 (epub) | ISBN 9781619544048 (pdf)
Subjects: LCSH: Airplanes—Piloting.
Classification: LCC TL710 .S2925 2022 | DDC 629.132/52—dc23/eng/20220906
LC record available at https://lccn.loc.gov/2022035074

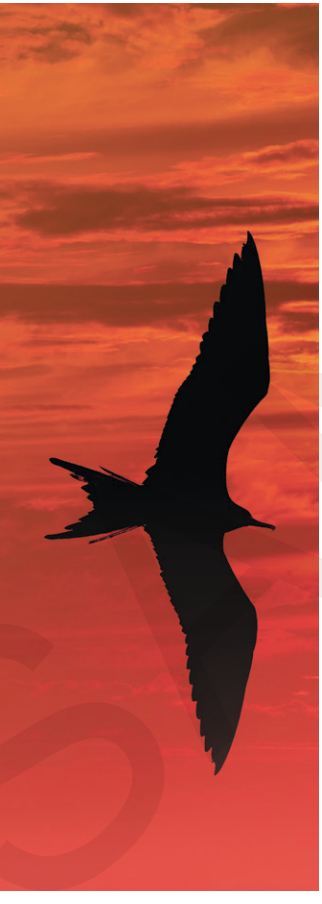
I am grateful that my wife, Dorie's, loving encouragement was sufficient to overcome my procrastination lest this literary labor of love might never have been completed.

CONTENTS


NC16072
UNITED
United Ai
UNITED
Mainliner

CHAPTER 1
AVIATION HISTORY

THIS IS HOW IT BEGAN • FAMOUS FLIGHTS



THIS IS HOW IT BEGAN. Man looked into the sky and saw birds. People had always been fascinated by flying. The ancient Chinese made drawings of flying contraptions, and there were Arabic fables about flying carpets.

In Greek mythology, Daedalus was a skilled craftsman who equipped his son, Icarus, with wings of wax with which to escape the maze where they had been held captive. Excited by the thrill of flight and contrary to his father's warning, Icarus flew too high, and the heat of the sun caused his wings to melt. He fell from the sky and was swallowed by the sea.

In the fifteenth century, Leonardo da Vinci designed and built a model of a helicopter that presumably flew. His drawings and designs were among the first recorded as practical contributions to human's eventual mastery of flight. He also designed an ornithopter, a machine with flapping wings, but this likely did not fly.

Balloons became the craze in the eighteenth century. Two Frenchmen, the Montgolfier brothers, experimented with paper balloons filled with hot air. They demonstrated their balloon to King Louis XVI and Queen Marie Antoinette. A sheep, a rooster, and a duck were sent aloft in the balloon, which reached 300 feet, proving that life could exist at such a great height.

During a subsequent balloon demonstration, Benjamin Franklin was asked by a bystander, What good is a balloon? What will it accomplish? Franklin famously replied, "Of what value is a new-born baby?"[1]

While balloonists were setting altitude and distance records, attempts were concurrently being made at heavier-than-air flight. A sea captain from Brittany built an artificial albatross with a 23-foot wingspan. It was launched like a kite by a horse-drawn cart. It lifted from the ground until the rope caught the driver and yanked him from the cart. The contraption was forced down by the added weight.

In the late nineteenth century, Otto Lilienthal made many successful glider flights that proved the concept of the wing. He was about to attempt powered flight when he suffered a fatal accident. Inspired by Lilienthal's achievements, the Wright brothers, Orville and Wilbur, began their own work with airplanes in their Dayton, Ohio, bicycle shop. Their progress, however, was delayed due to lack of availability of a sufficiently powerful, lightweight engine. They finally built their own 12-horsepower engine.

So it was that on a bleak, windy day, December 17, 1903, near Kitty Hawk, North Carolina, that the Wright brothers made their historic flight. Orville modestly said that "this flight lasted only 12 seconds, but it was nevertheless the first…in which a machine carrying a man had raised itself by its own power into the air in full flight, had sailed forward [120 feet] without reduction of speed, and had finally landed at a point as high as that from which it started."[2]

Two years later the Wrights established a record by flying 24 miles, and in 1910, Glenn Curtiss flew 152 miles. In 1911, Cal Rodgers made the first flight across the United States, which took 49 days and included 19 crashes, a record unto itself. By 1914, an airplane had flown over Mount Whitney at 16,000 feet, and with each succeeding year, humankind flew increasingly higher, farther, and faster.

Aviation began to play a more practical if not violent role during World War I. General William "Billy" Mitchell was the first American to fly over enemy lines, and men such as Eddie Rickenbacker, known as "America's Ace of Aces," quickened the public's interest in aviation. When the war ended, the U.S. military had 6,000 surplus airplanes, and there were many wanting to fly them.

In 1918, the U.S. Post Office inaugurated airmail service. At first, Army pilots flew these routes, but civilian pilots eventually replaced them. This early service laid the foundation for our present-day air transportation system. In 1921, the first transcontinental night flight was made with obliging farmers lighting bonfires to serve as beacons.

One of those early airmail pilots was Charles Lindbergh. In 1927, he flew alone from New York to Paris in the *Spirit of St. Louis*, and two continents went into hysterics over it. Lindbergh believed that his flight was a forerunner of an air service between America and Europe that would bring people closer together in understanding and friendship. The Lindbergh flight was adrenalin in the bloodstream of American aviation, and interest in flying exploded.

The 1920s saw the first aircraft built to effectively carry passengers from coast to coast (with many stops)—the Ford Tri-Motor, called the "Tin Goose" because of its corrugated metal skin. The Douglas DC-3 was introduced in the late 1930s and is considered to have been the first modern airliner.

Necessity being the mother of invention, World War II accelerated the advancement of aviation

technology. The war gave rise to giant bombers, near-supersonic fighters, rocket engines, and the birth of the jet age.

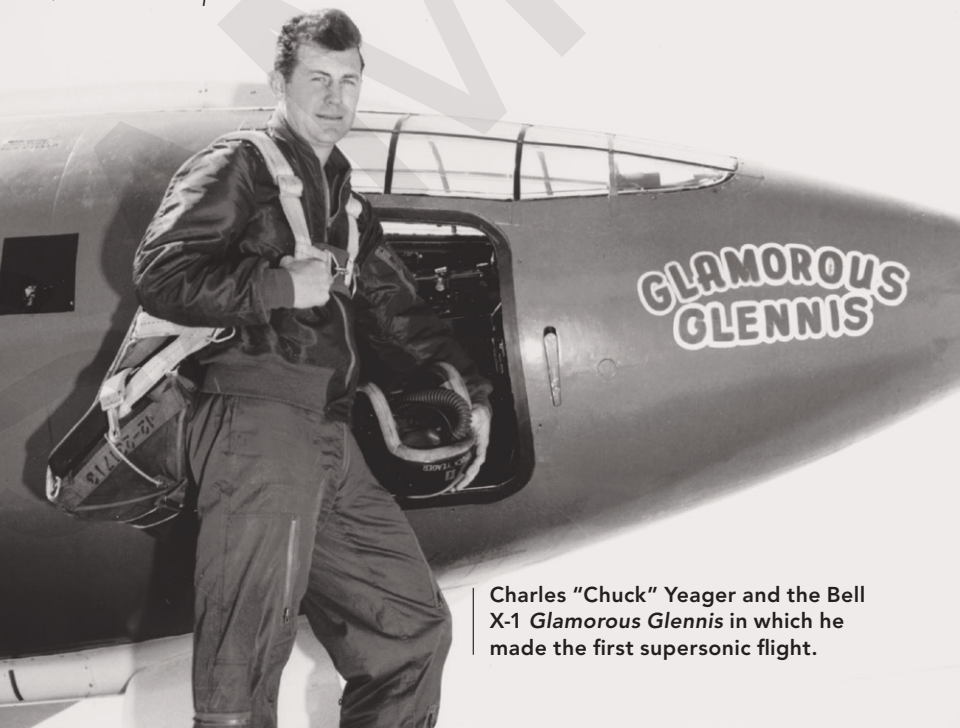
What does the future hold for aviation? Will there be hypersonic, suborbital flights between major cities of the world? Passenger flights to celestial destinations? Paraphrasing Napoleon Hill, "Whatever the mind of a man or a woman can conceive and believe, he or she can achieve."[3]

The first successful flight of the *Wright Flyer* *(above)***.**

Charles Lindbergh and the *Spirit of St. Louis* *(left)***.**

FAMOUS FLIGHTS

1783 First manned flight—J.F. Pilâtre de Rozier and the Marquis d'Arlandes in a balloon.
1797 First parachute descent—André J. Garnerin from a balloon over Paris.
1852 First flight in a dirigible—Henri Giffard using a 3 hp steam engine.
1903 First flight in an airplane—Orville Wright above Kill Devil Hills, Kitty Hawk, NC.
1907 First flight of a manned helicopter—Paul Cornu over Normandy, France.
1909 First flight across the English Channel—Louis Blériot in a monoplane of his own design.
1911 First flight across the U.S.—Calbraith Rodgers; the trip took 49 days and included 19 crashes.
1919 First flight across the Atlantic Ocean—Lt. Com. Albert Cushing Read in a Navy Curtiss flying boat.
1919 First nonstop flight across the Atlantic Ocean—John Alcock and Arthur Brown.
1922 First flight across the U.S. in less than a day (21 hr 20 min)—James Doolittle.
1924 First flight around the world—Lts. John Macready and Oakley Kelly in a Douglas World Cruiser.
1926 First flight over the North Pole—Richard Byrd and Floyd Bennett.
1927 First nonstop flight from New York to Paris—Charles Lindbergh in the *Spirit of St. Louis*.



Charles "Chuck" Yeager and the Bell X-1 *Glamorous Glennis* in which he made the first supersonic flight.

Wiley Post and *Winnie Mae*.

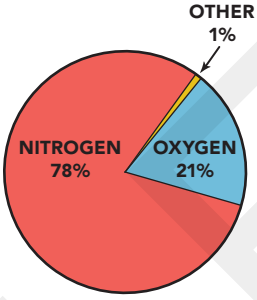
1927 First flight from California to Hawaii—Lester Maitland and Albert Hegenberger.
1929 First "blind" takeoff and landing using instruments only—James Doolittle.
1932 First transatlantic flight by a woman—Amelia Earhart.
1933 First solo flight around the world—Wiley Post in the *Winnie Mae*.
1937 Amelia Earhart disappeared during her attempted flight around the world.
1938 Howard Hughes and his crew set an around-the-world speed record of 3 days 19 hours.
1938 In a Curtiss Robin, Douglas "Wrong Way" Corrigan purported to go west from New York and instead headed in the opposite direction, ending up in Ireland.
1939 First flight of a jet-powered airplane—the Heinkel He-178 at Rostock, Germany.
1947 The first supersonic flight—Charles Yeager in the Bell X-1 rocket plane.
1954 The author of this book made his first solo flight.
1969 First manned flight to the surface of the moon—Neil Armstrong, Buzz Aldrin, and Michael Collins.
1976 Fastest speed ever attained in a jet-powered airplane—2,193 mph in a Lockheed SR-71 "Blackbird."
1981 First launch of the Space Shuttle.
1986 First nonstop flight around the world without refueling—Dick Rutan and Jeana Yeager in the Rutan Voyager.
1999 First nonstop flight around the world in a balloon (19 days 2 hrs)—Brian Jones and Bertrand Piccard in the *Breitling Orbiter 3*.

CHAPTER 2
THE SCIENCE OF FLIGHT

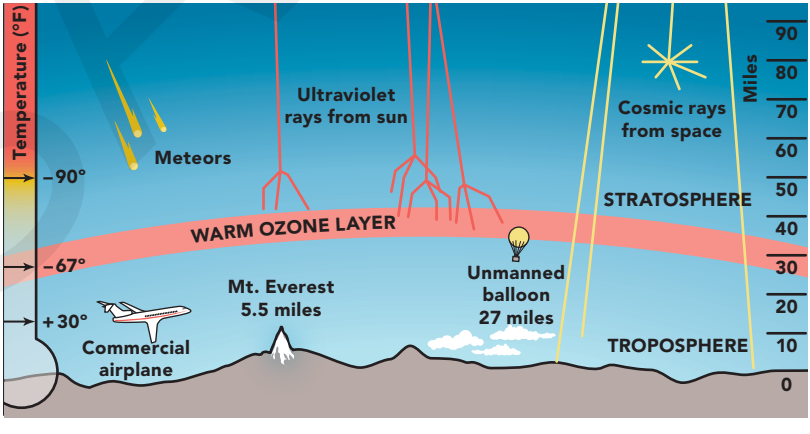
THE ATMOSPHERE • ATMOSPHERIC PRESSURE AND TEMPERATURE
AIRSPEED AND AIR PRESSURE • LIFT • DRAG • THRUST • AIRCRAFT DESIGN
FLIGHT CONTROLS • STABILITY • TRIMMING • RELATIVE WIND
ANGLE OF ATTACK • STALLS • FLAPS • TURNS

Flying is possible because of some inherent principles of science that operate in the world in which we live. We do not create these principles; we only use them. Because the atmosphere is the medium in which we fly, we need to begin with some important things to know about the atmosphere.

THE ATMOSPHERE is an ocean of air enveloping the Earth. It provides our lungs with life-supporting oxygen and our aircraft with the necessary support for flight. This air-ocean extends upward for many miles, thinning as it goes higher. There is no exact upper limit to the atmosphere, but it is considered to extend a few hundred miles above the Earth. However, 99 percent of it is less than 20 miles above sea level. If we were to compare the Earth and its atmosphere to an apple and its skin, the skin is 20 times thicker relative to the size of the apple than the atmosphere is to the size of the Earth.

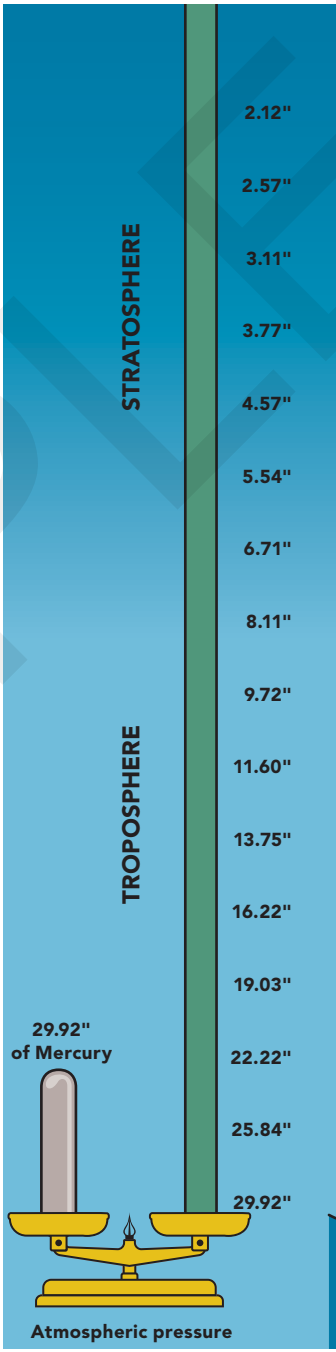


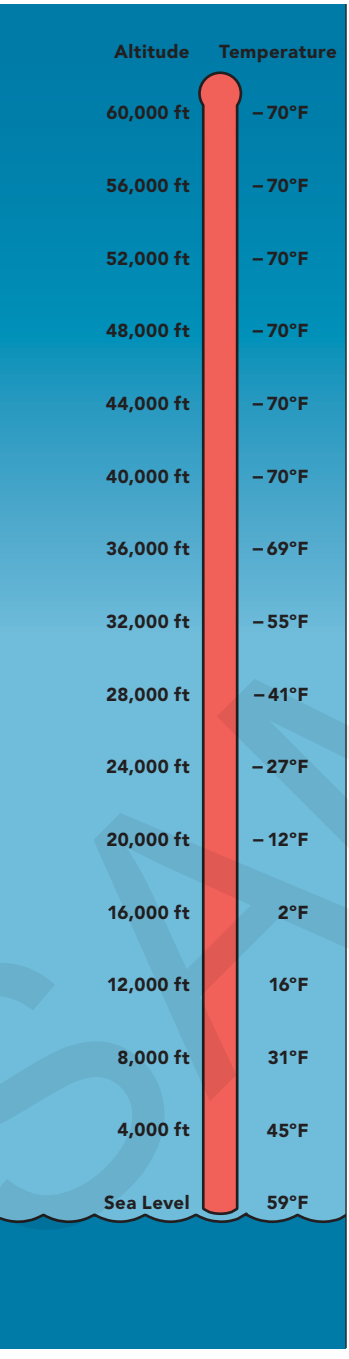
A given volume of pure, dry air contains about 78% nitrogen, 21% oxygen, and a 1% mixture of 11 other gases. Air also can contain water vapor, which varies from 0 to 5% by volume and takes the place of an equal volume of dry air.



THE WEIGHT of the Earth's atmosphere is tremendous: 5,000,000,000,000,000 (5 quadrillion) tons. The pressure of the air against the Earth (at sea level) is about 15 pounds per square inch. Because the surface area of the average person is 2,700 square inches, the air pressure against a human body is about 20 tons. The reason that the body does not collapse is that the atmospheric pressure outside of the body is counteracted by an equal amount of pressure from within. As a matter of fact, if the pressure outside the body were eliminated (as in outer space), the skin and tissue would rapidly swell as water in the body begins to vaporize. (It is a myth that the human body would explode.) This is why airplanes designed to fly at high altitude have pressurized cabins. This also is why astronauts and some military pilots wear pressure suits.

MERCURY IS USED in liquid barometers because it is such a heavy liquid; it weighs 13.6 times as much as water. Water could be used in place of mercury, but the column of water in such a barometer would have to be 34 feet tall (instead of 2.5 feet tall in the case of a mercurial barometer). The observer would have to climb a ladder to read the atmospheric pressure.

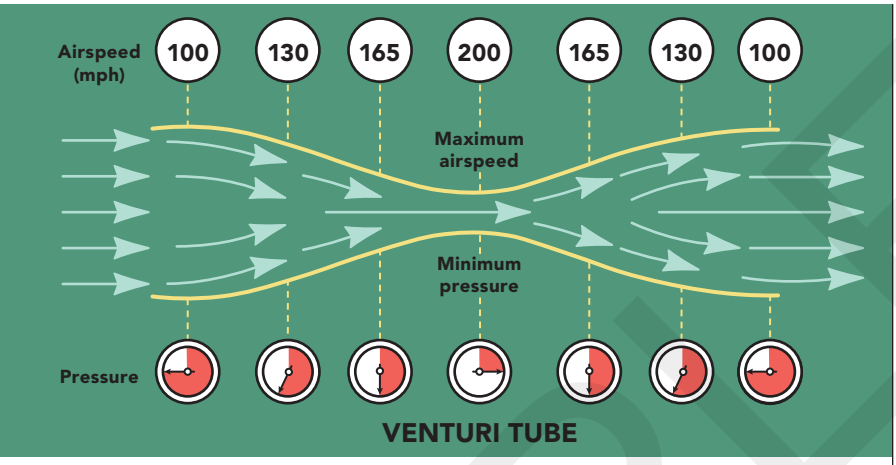




ATMOSPHERIC PRESSURE can be measured with a mercurial barometer, which consists of a calibrated glass tube sealed at one end and filled with liquid mercury. The open end is immersed in a container of mercury. At sea level, air pressing down on the mercury in the container keeps the mercury in the tube at a height of 29.92 inches. This is known as standard sea-level pressure.

As we fly higher in the atmosphere, the air becomes thinner (less dense), the pressure decreases, and the column of mercury in a barometer falls. At 18,000 feet, atmospheric pressure is only half as great (14.94 inches of mercury) as at sea level. The air pressure at 40,000 feet is only 5.54 inches. At the upper limits of the atmosphere, the air is extremely thin and has practically no pressure at all.

THE TEMPERATURE of the air at sea level over the Earth averages 59°F (15°C). As altitude increases, temperature decreases at the rate of 3.5°F (2°C) per 1,000 feet until it reaches about –70°F (–57°C) at 7 miles above the Earth. This marks the boundary between the lowest layer of the atmosphere, the *troposphere*, and the second layer, the *stratosphere*, which extends from 7 to 50 miles above the Earth. The temperature throughout the stratosphere remains relatively constant and does not decrease with altitude. The temperature in outer space is absolute zero, or –459°F (–273°C). The vast majority of light airplanes fly in the troposphere, and this is where most weather occurs.

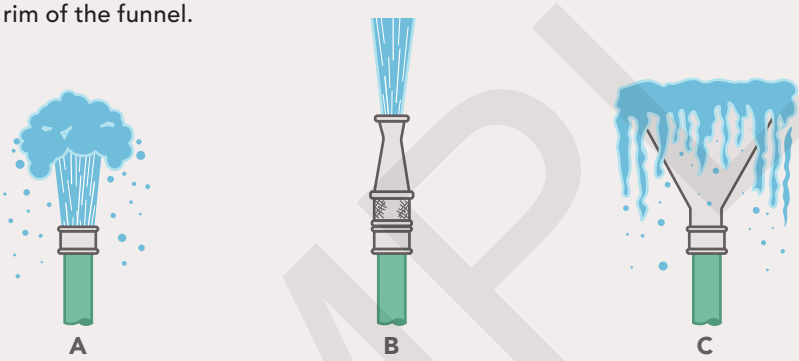


VENTURI TUBE

AIRSPEED AND AIR PRESSURE are related in a way that is crucial to flight. This relationship is illustrated by the flow of air through a *Venturi tube*. As air flows through the constricted throat at the center of the tube, it speeds up in the same way that water does when it flows through the nozzle of a garden hose. As the air leaves the constricted throat of the Venturi tube, its speed decreases.

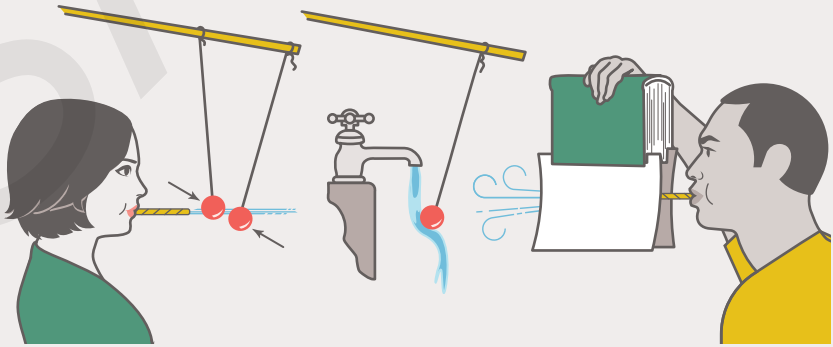
When air flows past a surface, it creates a low-pressure area, or partial vacuum, causing the air to exert a suction effect against the surface. The greater the airspeed, the lower will be the pressure. As air flows through a Venturi tube, its speed increases and its pressure decreases as the tube becomes narrower. The greatest speed and the least air pressure occur where the tube is narrowest. As the tube widens again, the airspeed decreases, and the air pressure increases. This inverse relationship between airspeed and air pressure is a key principle responsible for flight.

A BASIC PRINCIPLE OF FLIGHT can be demonstrated by the flow of water through a garden hose. **(A)** If the hose has no nozzle, water flows out the end at the same speed as it flows through the length of the hose. **(B)** If you add a nozzle to the hose or place your thumb over part of the hose opening, the water comes out faster (and travels farther). It constricts the flow and increases the speed. In each case, the water travels faster because it is flowing through a smaller area. The increase in speed enables the same amount of water to flow from the hose in a given period of time. **(C)** If a wide funnel replaces the nozzle, the area of the hose opening is enlarged. The water flows more slowly and sloshes over the rim of the funnel.



Air also is a fluid and behaves the same way as water. The effect of a constriction can be shown by blowing your breath against the palm of your hand. If you blow as hard as you can with your mouth wide open, the air leaves so slowly that you can barely feel it. But if you pucker your lips as though you were going to whistle and blow hard, the air comes out much faster. The air speeds up as it passes through the narrower opening formed by your lips.

If air is blown between two ping-pong balls suspended a few inches apart, the low pressure created by the air against the sides of the balls pulls them together. In the same way, a flow of water attracts a balloon, and a stream of air between two pieces of paper pulls them toward one another.

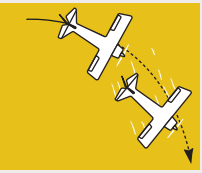
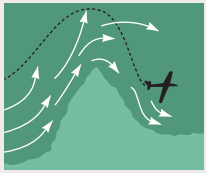
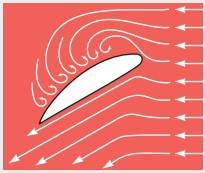
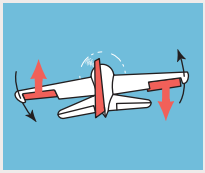


AN ILLUSTRATED GUIDE TO FLYING

BARRY SCHIFF

Inspired by the effortless soaring of birds, humans have taken to wing as the safest, fastest, and most enjoyable way to travel. Filled with prolific illustrations and photographs, this book is an exciting introduction to flying for aspiring pilots of all ages, explaining the principles and practice of flying with concise facts and exploring how pilots manage their aircraft and the elements through which they fly.

Either as a student, passenger, or future pilot, explore the mysteries of flight and enter a fascinating new world that offers challenge, fun, and adventure.

Aviation Supplies & Academics, Inc.
7005 132nd Place SE
Newcastle, Washington 98059 USA
asa2fly.com | 425-235-1500

ASA-IGF

TRANSPORTATION USD $19.95
ISBN 978-1-61954-401-7
51995 >
9 781619 544017