
Invention Project®
FLY GLIDERS
Innovation Exploration Kit™, Invention Project® Series

Read prior to using the product.

SAFETY & HYGIENE

Warning: Choking hazard–small parts.
Not for children under 3 years.

- Activities require adult supervision.
- Ages 10+.
- Read and follow all instructions.
- For safety and hygiene purposes, please wash your hands after each activity.
- Do not put materials in or near anyone's eyes, mouths, and ears.
- If anyone has an allergy, remove any materials that may trigger an allergic reaction for them.
- Do not play with or place plastic bags near the face or mouth.
- Ventilate the room when using markers.
- Do not operate the HandCopter or heliball near your eyes or hair. Wear safety glasses and pull back long hair.

Use this password to access your Fly Gliders experience:

airplane

For an enhanced experience, MUSIC and VIDEOS can be found online at **invent.org/Invention-Project/Fly-Gliders**

UP, UP, AND AWAY

Discover the freedom of flight.
Complete flight training to achieve liftoff!

MATERIALS

HandCopter | Safety glasses

How Do Flying Objects Lift Into the Air?

BERNOULLI'S PRINCIPLE

So how do flying objects lift into the air?

Bernoulli's Principle helps explain how a big heavy object, like an airplane, can fly. Due in part to an airplane wing's shape, air flows faster above the wing than below it. As the speed of air increases, air pressure decreases. Since high-pressure air moves toward low-pressure air, it causes the airplane to lift.

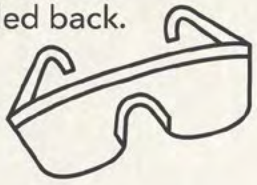
When lift is greater than weight, the airplane can fly!

Let's Get Ready For High-Flying Fun!

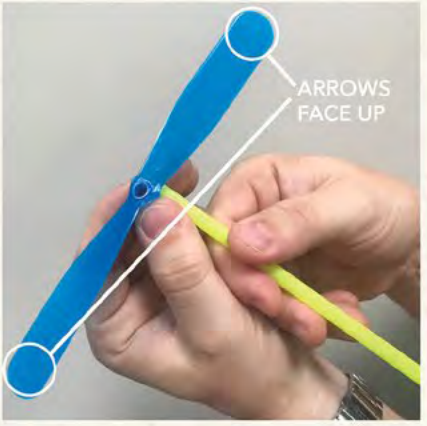
While you explore the science of flight, the most important discoveries you make will be the ones with your eyes and hands as you experiment with the HandCopter, heliball, and paper airplanes.

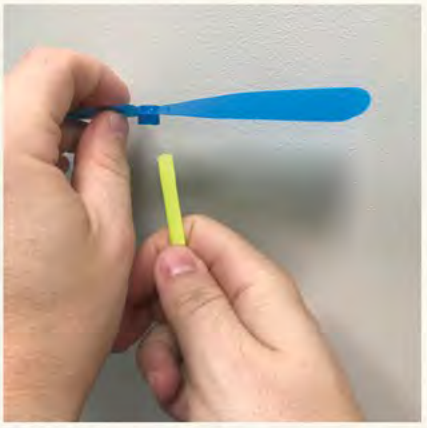
EXPERIMENT WITH LIFT

1. Get ready for takeoff! Put on your safety glasses and make sure long hair is pulled back.



2. Assemble the HandCopter by inserting the stick into the hole on the underside of the propeller. The arrows at each tip of the propeller blades should be facing up.



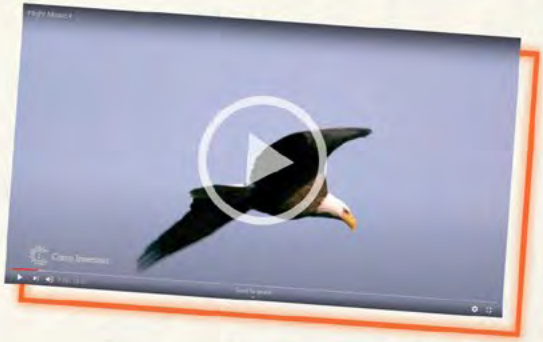


3. To achieve lift, start with the stick against your left palm. Keep both hands flat as you swiftly slide your right hand forward, away from your body, releasing the HandCopter. Try it a few times to get the hang of it.
   - How high did your HandCopter fly?
   - To gauge height, look at a nearby tall object such as a wall, tree, or building.

YOU ARE EXPLORING ALTITUDE!

For pilots, knowing their aircraft's altitude, or how high up they are, is essential.

If possible, play one of the Flight Music videos or one of your favorite songs.



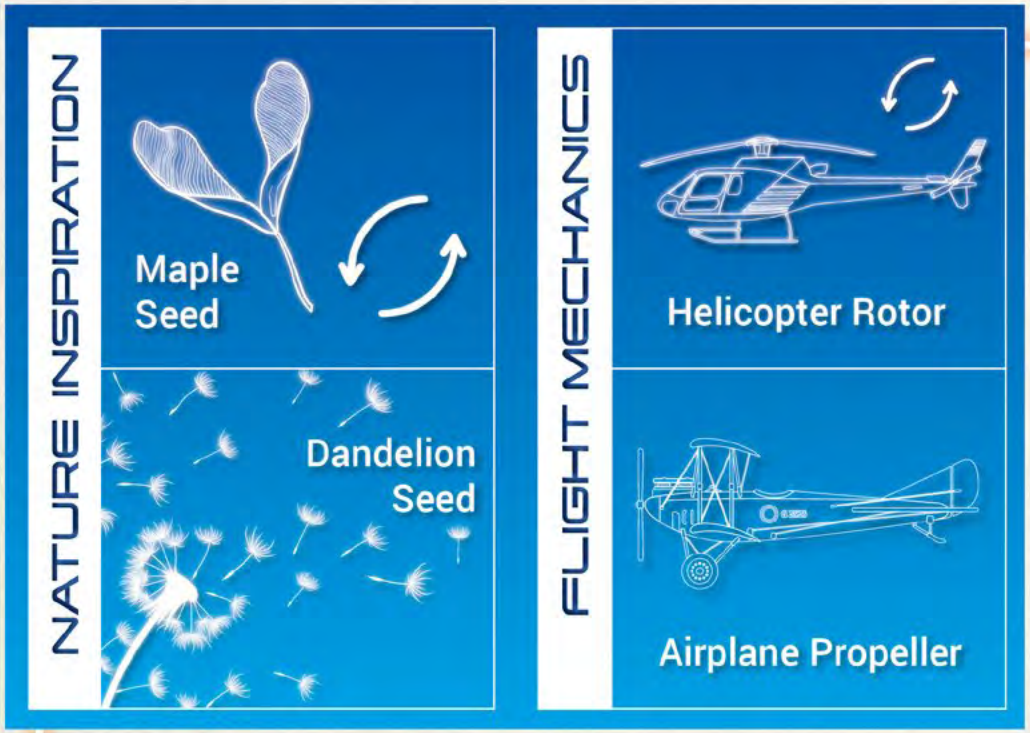
MEET A HALL OF FAMER

National Inventors Hall of Fame® (NIHF) Inductee Paul Kollsman invented a tool for measuring altitude—the Altimeter—so pilots can easily see the height of their plane in the cockpit control panel. An Altimeter uses air pressure to measure the height of an airplane from sea level. It is an important tool for pilots because it helps them stay at a safe altitude above the ground.

Learn more about Kollsman here: invent.org/inductees/paul-kollsman

PROPELLER, A WING WITH A TWIST

A propeller can be thought of as a spinning wing. Similar to a wing, it produces lift.



Can you think of any examples in nature that mimic the HandCopter?

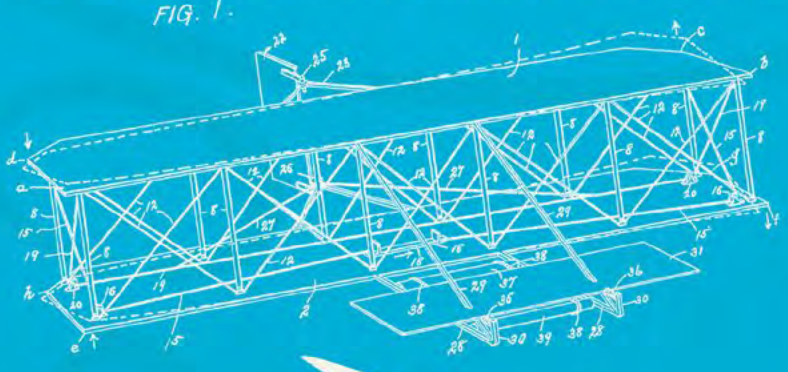
After watching maple seeds twirl in the air as they fell from a tree, Leonardo da Vinci was inspired to make his first sketch of a helicopter-like vehicle.

1. Explore the HandCopter's ability to lift straight up into the air, achieving vertical flight just like a helicopter, by watching as it flies.

2. Experiment with how weight affects lift by taping small objects from around the home onto your HandCopter near the top of the stick.
   - What do you notice?
   - Weight and lift are opposite forces involved in flight. Lift pushes a plane up. Weight pulls a plane down.

MORE TO EXPLORE

Scientists study birds and other animals that fly for many different reasons, including to explore their behavior and to discover how they fly. Some engineers build new types of aircraft inspired by what others have discovered from animals about flight. For example, biologists and engineers are working together to make an aircraft with wings that can change shape and fly without a pilot!



WINGING IT

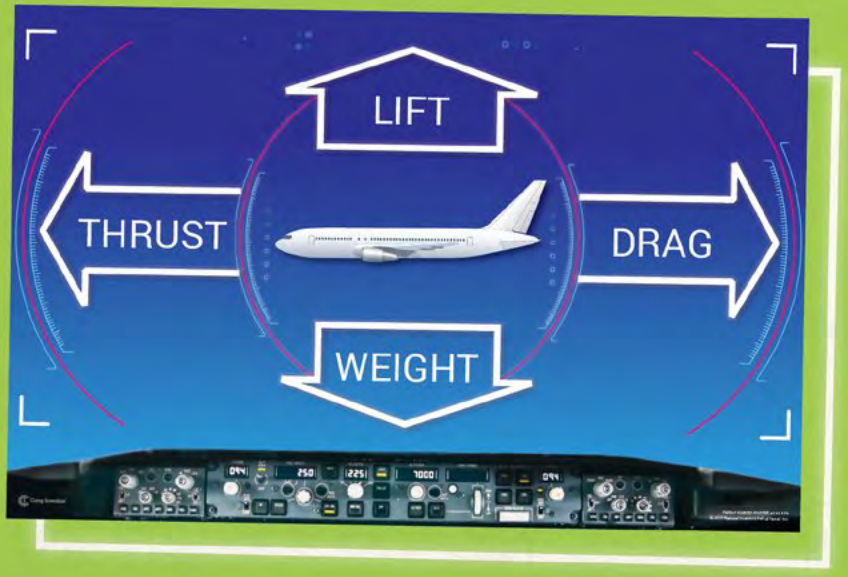
Explore wings and the power of thrust in flight!

MATERIALS

Classic Paper Airplane sheet | Colored copy paper | Markers | Masking tape | Paper clips | Scissors

WHAT IS THRUST?

Thrust pushes a plane forward. Drag pushes against the plane and is what slows a plane down. A simple way to think about thrust is to imagine air being pushed suddenly in a specific direction, like blowing air onto a pinwheel blade to make it spin.



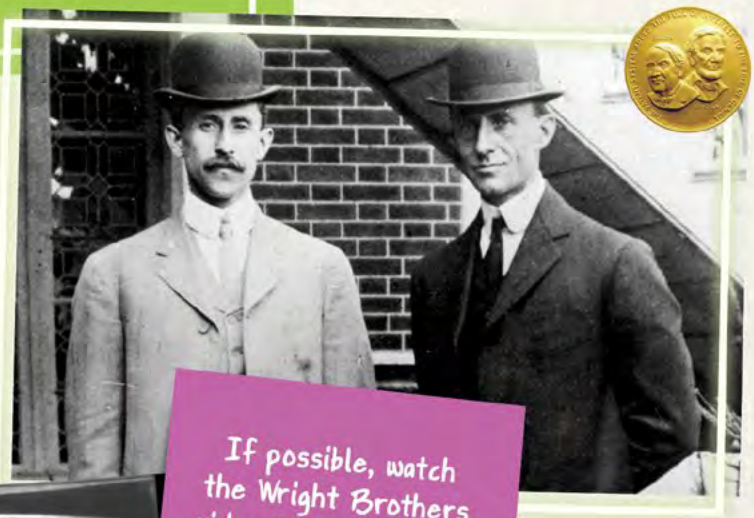
Animal wings, and the wing flaps and landing gear on an airplane, are all levers that can move up and down. Flapping wings is one way of providing thrust, giving the force needed to move flying objects forward after liftoff.

MEET THE HALL OF FAMERS

Aviation pioneers Orville and Wilbur Wright were inducted into the National Inventors Hall of Fame for their invention of the airplane. They were the first to achieve a powered, sustained, and controlled flight of an airplane with the Kitty Hawk in 1903. Before they tried to make a powered airplane, they built three biplane gliders to experiment with first!

You are now going to experiment with gliders, just like the Wright Brothers! Watch carefully, and see how they fly!

Learn more about the Wright Brothers here:
invent.org/inductees/wilbur-wright
invent.org/inductees/orville-wright

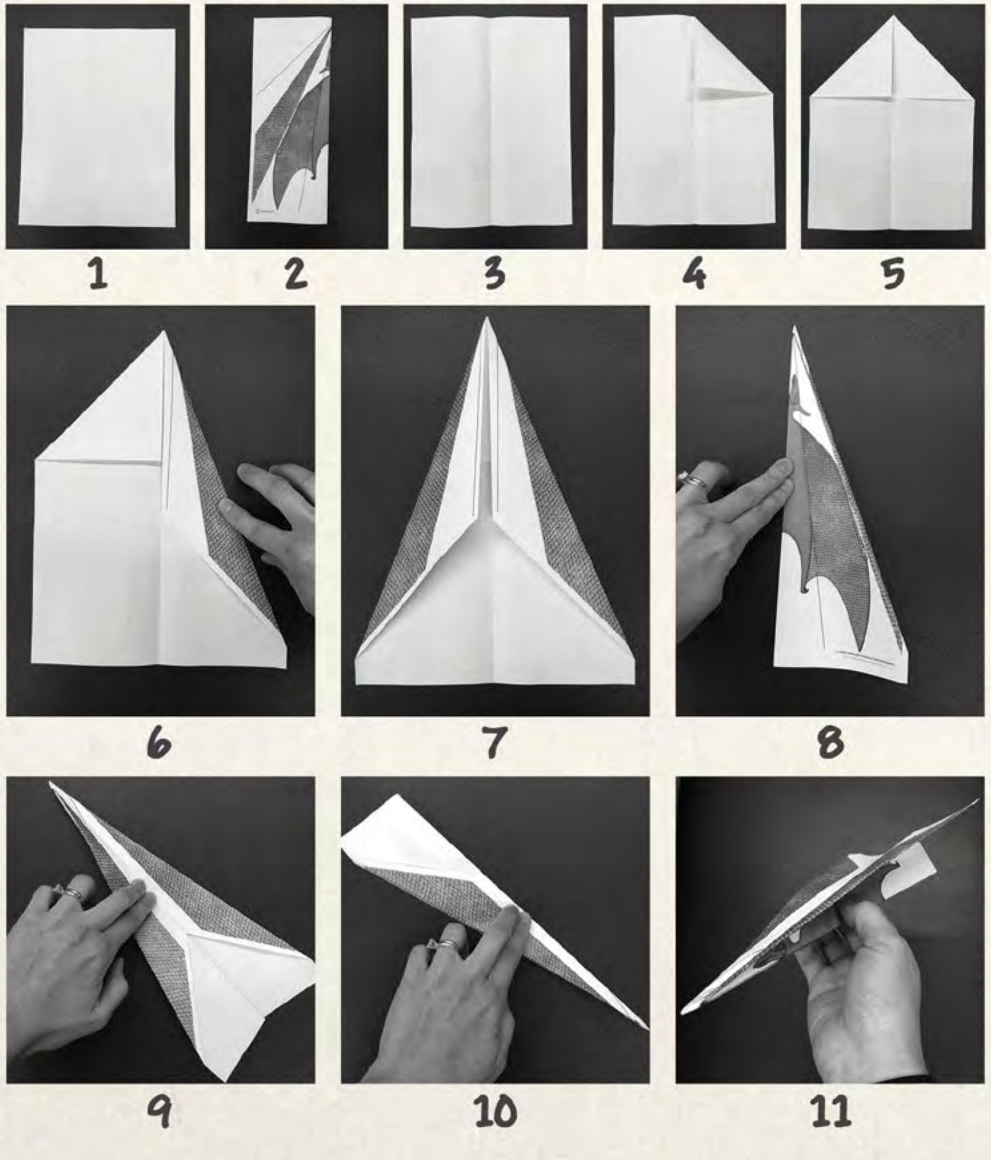


If possible, watch the Wright Brothers video to see an early test flight from 1909 in action.

EXPLORE THRUST WITH PAPER AIRPLANES

1. Let's experiment with wings and flight by folding paper airplanes. Start by folding a **Classic Airplane sheet** using these instructions.

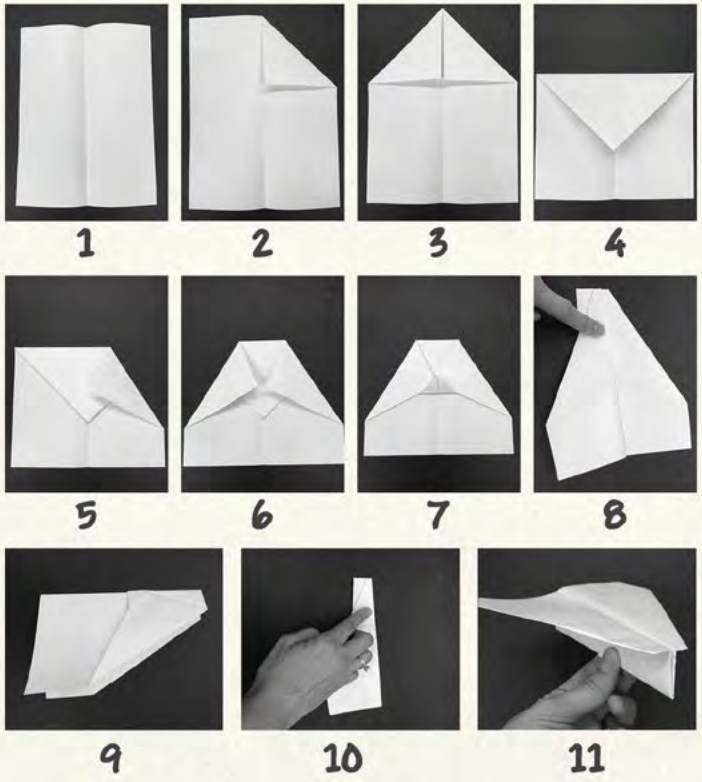
START WITH THE IMAGES FACING DOWN



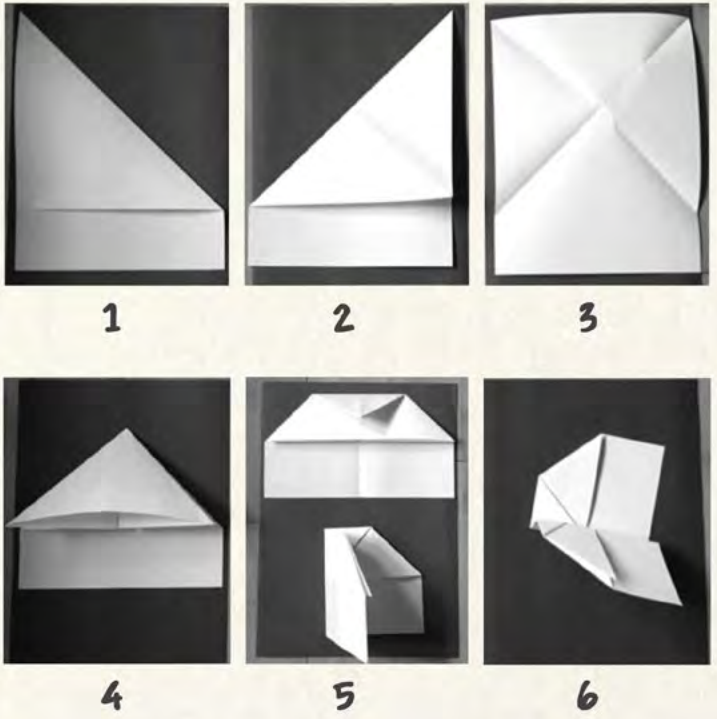
If possible, play one of the Flight Music videos or one of your favorite songs.

2. Use the colored copy paper and the images below to fold a Nakamura Lock and a Trickster airplane.

NAKAMURA LOCK INSTRUCTIONS



TRICKSTER INSTRUCTIONS



3. Create a set of targets for your paper airplanes to fly through or land on, using recyclables and other items from around your home.

4. Ready...aim...throw! Aim your airplanes at each target.

How do the trajectories, or flight paths, of the three airplane types differ?

Which was the most successful at landing on or flying through the targets?

Which one did you enjoy flying the most? Why?

By throwing your airplanes, you are providing thrust. After the initial launch, they will glide.

EXPERIMENT WITH WEIGHT

Modify your paper airplanes by adding weight and then test their flying abilities.

1. Observe how the different airplanes' trajectories change when you add paper clips to the:
   - Nose
   - Wings
   - Tail

Add paper clips to the nose

Add paper clips to the wings

Add paper clips to the tail

What did you notice?

2. Now try adjusting the location of the paper clips on the nose, wings, and tail.

3. Write down your notes and discoveries.

What happens when multiple paper clips are added to the nose, wings, or tail?

How does the location of the paper clips change the flight path of each airplane?

By adding paper clips onto parts of the plane, you are adding weight, which changes the center of gravity and the center of lift.

EXPERIMENT WITH WING SHAPE

The shape of an airplane's wing can also affect its flight patterns.

- What have you observed about the difference in the flight paths of the Classic, Nakamura Lock, and Trickster airplanes?
- How might their wing shapes influence their trajectories?

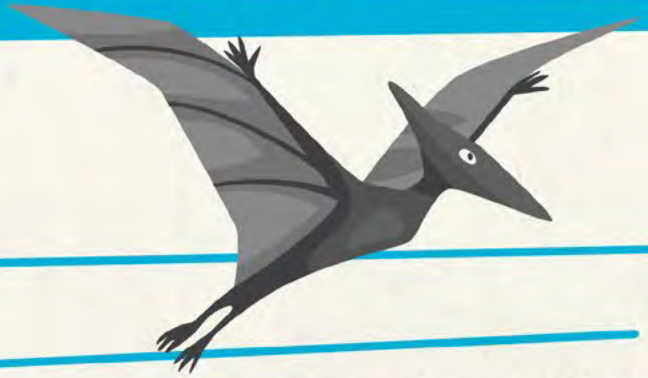
1. Keep experimenting! Test different wing shapes. Bend the wingtips of the paper airplanes, and test their trajectories.

Bend the wingtips up

Bend the wingtips down

Bend one wingtip up and one down

Bending the paper airplane's wingtips up or down affects drag, similar to how airplane wings have movable flaps that either give more lift during takeoff, or increase drag during landing.



2. Write down your notes and discoveries.

MORE TO EXPLORE

Nose weight, along with wing shapes and their position, affect the aeronautical abilities and flight dynamics of aircraft and flying animals alike. Pterosaurs, which included the largest animals ever to fly, had large sail-like wings that were thicker at the front than the back. This shape allowed air to flow around them and achieve lift. Pterosaurs also had a very large, heavy beak compared to the size and weight of the rest of its body. This weight at the front of the body affected how they were able to fly. Gravity pulled its beak down, which let air push the rest of the body and wings behind it up!

DESIGN AN INNOVATIVE AIRPLANE

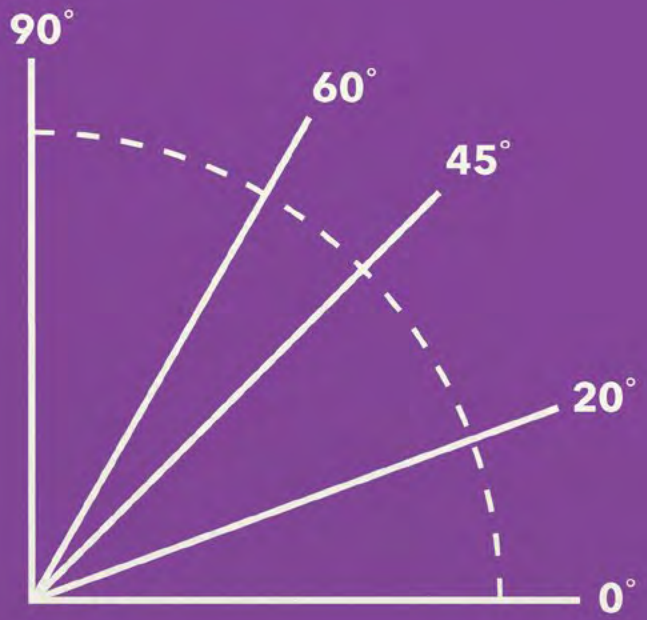
What will your plane be able to do? Fly far? Soar high? Swoop in a loop? Spiral? Or something else?

How might you alter your plane to test and improve its flying ability?

What innovative features will your airplane have?

1. Apply your flight insights from testing to design your own paper airplane!
2. Make a giant city using furniture or boxes.
3. Launch all of your paper airplanes above the city and watch them soar!

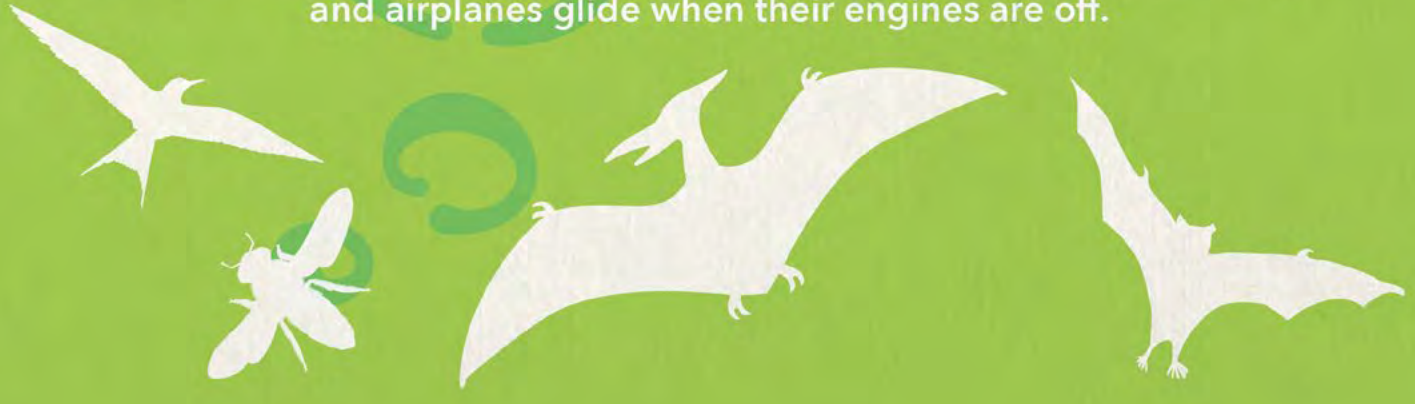
Understanding wing angle in relation to the oncoming air is important for pilots. Changing the angle of the wings helps pilots land the plane softly and safely. The ideal "angle of attack" allows for a smooth flight, balancing lift and drag. Experiment with the angle of attack as you launch.



MORE TO EXPLORE

While there are many types of airplanes that have powered flight, only four types of animals have ever existed that can truly fly and not just glide—insects, pterosaurs, birds, and bats. They all have similar wing shapes to each other and to an airplane! This special wing shape is the best for creating more lift, while also reducing drag. This makes it easier to fly higher and farther!

Gliding happens when an object or animal is soaring or drifting on the wind without creating more thrust, or power pushing forward. Birds, bats, insects, and pterosaurs glide when they stop flapping their wings, and airplanes glide when their engines are off.



HI-TECH HEIGHTS

Experience the power of sensors as you control a hi-tech heliball!

MATERIALS

Heliball | Masking tape | Safety glasses | Scissors

!

Do not use the heliball outside because the interaction between the sunlight and the heliball's infrared sensors will cause it to fly erratically

PILOT A HELIBALL

Get ready to launch and pilot your own heliball!

1. Start by charging the heliball for about 20 minutes.

!

Do not overcharge the heliball, as it may cause the heliball to fly up too high and remain out of reach.

The heliball's design is inspired by the dragonfly and the hummingbird, whose wings allow them to hover above objects and even fly backward.

Like the dragonfly and hummingbird, the heliball's flight can be very erratic. It does not always go where you expect, but that is part of the fun of exploring this flying machine!

2. Find a large, open, indoor space without obstacles where you can fly your heliball.

3. Using string, cardboard, a hula hoop, or other items from around your home, create a large, flat target on the floor.

4. Put on your safety glasses and make sure long hair is pulled back.

5. Hold the heliball and slide the switch on the bottom to turn it on. The rotor blades should start to spin after a few seconds.

6. To make the heliball fly upward, place your other hand underneath it, and let go.

7. Lower or remove your hand to lower the heliball's altitude.

8. Experiment with the heliball, trying to keep it up in the air and within the perimeter of the target on the floor as long as you can.

!

To make the heliball fly straight up, check that the rotor blades are spinning parallel to the ground before releasing it.

9. Using recyclables and other items from around your home, create a large hoop or other opening through which the heliball can fly.

10. Secure the obstacle to a wall so that it sticks out perpendicular to the wall. Try to fly the heliball through it.

CONGRATULATIONS!

Your discoveries about flight and your innovative paper airplane designs carried you to new heights.

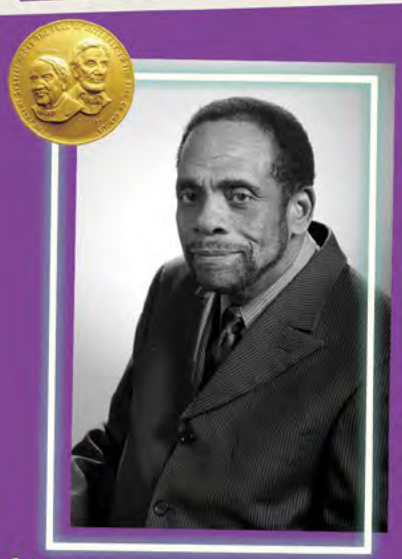
Continue to dream big and aim for the skies!

TROUBLESHOOTING TIPS

If the heliball's rotor blades do not spin, check the following:

- Turn the heliball off and on again by sliding the switch on the bottom of the heliball.
- Ensure there are four total rotor blades and two fly bar stabilizers.
- Ensure the rotor blades and fly bar stabilizers are not tangled with the blades.
- Try charging the heliball.

MEET THE HALL OF FAMERS



NIHF Inductee George Alcorn is a pioneering physicist and engineer noted for his aerospace and semiconductor inventions.

"An inventor changes, modifies, or adapts specific things to specific directions and recognizes connections."

– George Alcorn

NIHF Inductee Beatrice Hicks was one of the first women to pursue an engineering degree. She put the puzzle pieces together to make a gas density sensor that was used in the Apollo moon missions and Boeing 707™* aircraft.

*Boeing 707 is a trademark of The Boeing Company.

MORE TO EXPLORE

Have you ever wanted a job that would bring you close to helicopters or airplanes? Just like the variety of flight paths your aircraft can take, there are many career paths in aviation that go beyond being a Pilot, Flight Attendant, or Air Traffic Controller. Many of these jobs require you to know how all of the pieces and parts of the aircraft fit together and work, such as an Aviation Maitenance Technician or an Aircraft Manufacturing Engineer.

MEET A HALL OF FAMER

The world's first true production helicopter (as well as the world's first successful multimotor airplane) was invented by NIHF Inductee Igor Sikorsky. Unlike airplanes, helicopters have the ability to hover and fly backward and side-to-side, and they can take off and land vertically!

If possible, learn more about Sikorsky here: invent.org/inductees/igor-i-sikorsky

Check out Sikorsky's original patent for the helicopter.

Heliballs are named in part from helicopters because of the rotor blades at the top of the ball, just like the rotor blades at the top of a helicopter.

Invention Project is an educational program from the National Inventors Hall of Fame.

Learn more at **invent.org**

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