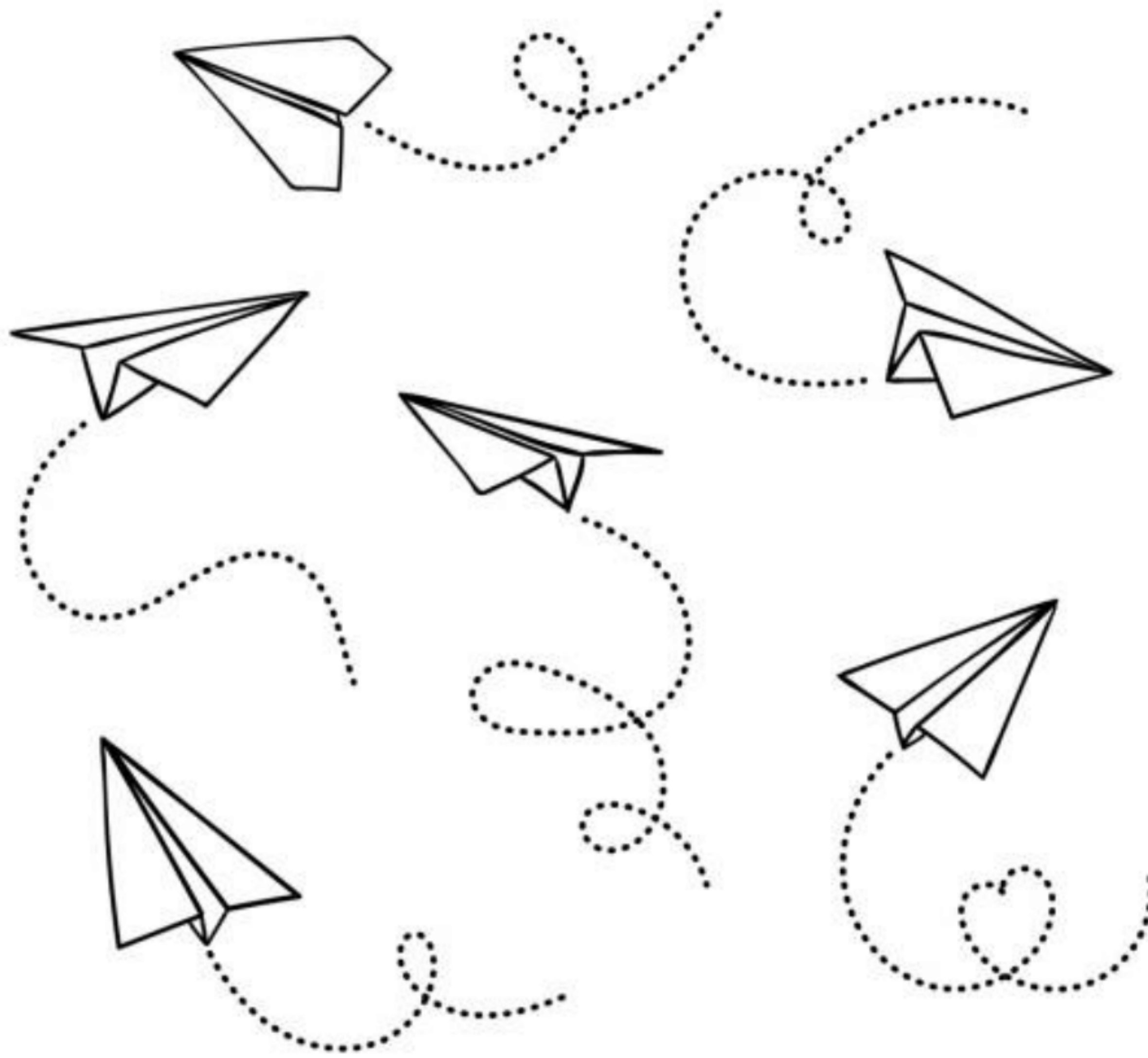


# Flight and Paper Airplanes



Guelph Civic Museum & the  
University of Guelph  
STEM Week 2021

## How does flight work?

There are four basic forces of flight: **thrust**, **drag**, **gravity**, and **lift**. **Thrust** is the force that pushes planes in the direction of their motion - this is what a plane's engine does! It's also seen in rockets and speedboats. **Drag** is the opposing force to thrust and it is caused by the plane interacting with the air, slowing it down as it flies. **Gravity** is the force that keeps everyone and everything grounded to Earth. It is the force that pulls two objects that have mass towards each other. Lastly, **lift** is the opposing force to gravity, keeping the plane from immediately crashing to the ground and easing the plane's descent to wherever it is landing.

## How can we modify the flight of the plane?

Two simple but effective ways to change the flight are **back flaps** and **stabilizers**. The back flaps are made by cutting symmetrical tabs out of the ends of the wings and folding them upwards. Stabilizers are made easily by bending the sides of the wings upwards. The back flaps add more drag whereas the stabilizers lessen the lift and correct the stability of the plane.

## Fun extra modifications to try!

- ❖ Fold the back of the left wing up and the back of the right wing down. What happens?
- ❖ Cut out a tab from the rudder of the plane and bend it left or right - what does that do?
- ❖ There are so many things you can experiment with!

## Flight Statistics

Below, you'll find some brief stats for each of three plane designs, which we've selected based on what parts of flight each plane showcases. We've given each plane model a score out of 3 - this is based on the design of each plane.

Model	Lift	Drag*	Distance	Flight Time	Thrust**
Dart	★	★	★ ★ ★	★ ★	★ ★ ★
The Raven	★ ★	★ ★	★ ★	★ ★	★ ★
The Lock-Bottom	★ ★ ★	★ ★ ★	★	★ ★ ★	★

*\*Lower star rating means there is less drag so the plane will fly faster.*

*\*\*The thrust statistic is the only one that doesn't depend on the physical plane itself - after all you're the one who's giving it thrust! The stars for each plane's thrust stat tell you how hard (or soft) you should be throwing your plane.*

**Fun Fact:** The longest period of time a paper airplane stayed in the air was 29.2 seconds, completed by Takuo Toda in Fukuyama City, Hiroshima, Japan, on 19 December 2010.





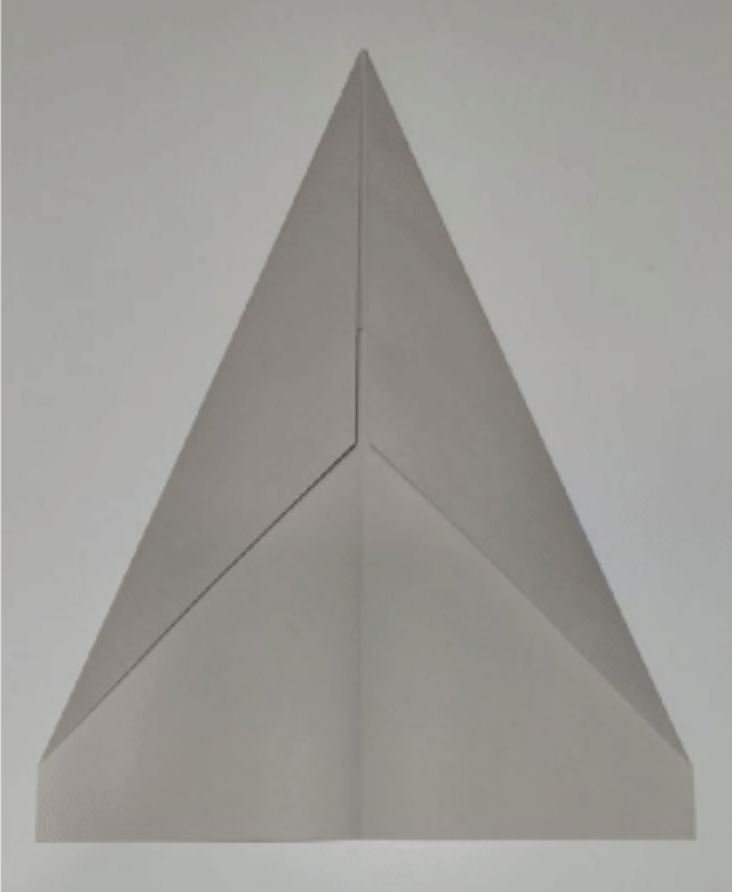

Now, throwing un-modified planes would work just fine - but some planes might have a weird way that they fly, or some planes might not fly too well at all. That's where changes, or modifications, come in.

<b>Back Flaps</b>	+ to Drag
<b>Stabilizers</b>	- to Lift

Are you finding that your planes are doing things differently? Maybe you fold a really floaty Dart that travels all the way down a hallway, or maybe you put some back flaps and stabilizers on a Lock-Bottom that helps it stay in the air for way longer. That's totally fine - science is all about challenging ideas. You never know what you might find!

**Paper Airplane Instructions**

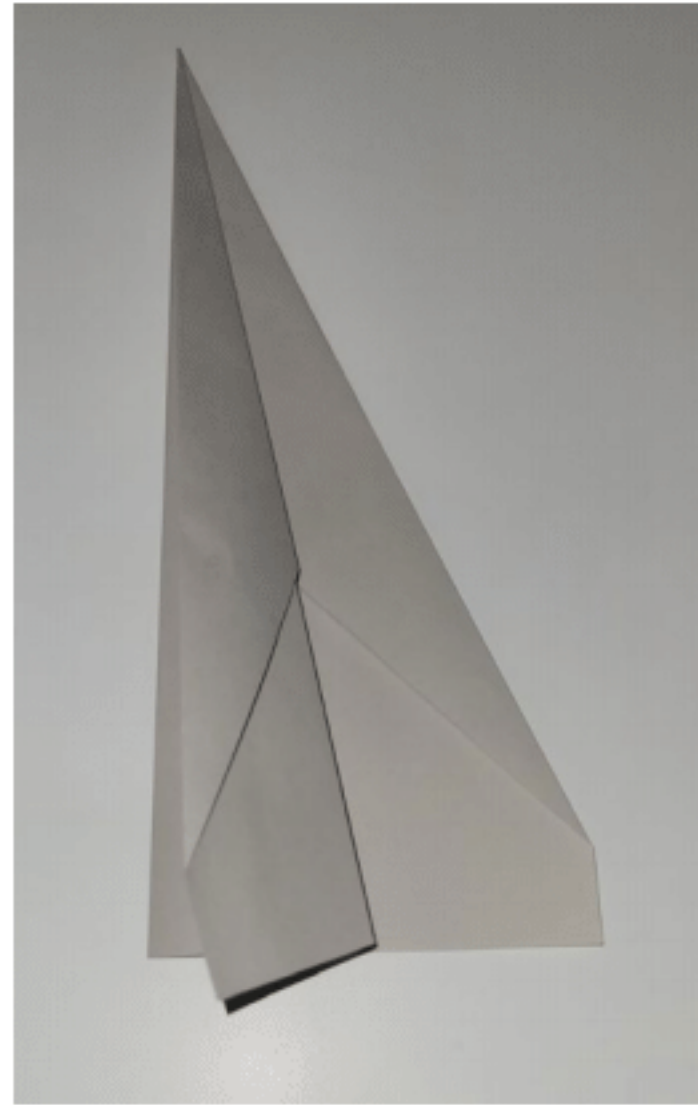
**The Dart**

1. Fold the paper in half hotdog style.		2. Fold the top corners towards the center line.	
3. Again, fold the top outer corners to the center.		4. Fold the plane in half, inwards.	

**Fun Fact:** The highest altitude a paper airplane was launched from was approximately 35,000 meters using a helium weather balloon!



5. Fold the wing down to meet the bottom edge of the plane's body.



6. Flip the plane over and fold the other wing down the same way



And voilà! You now have a dart!

### The Raven

1. Fold the paper in half hotdog style.



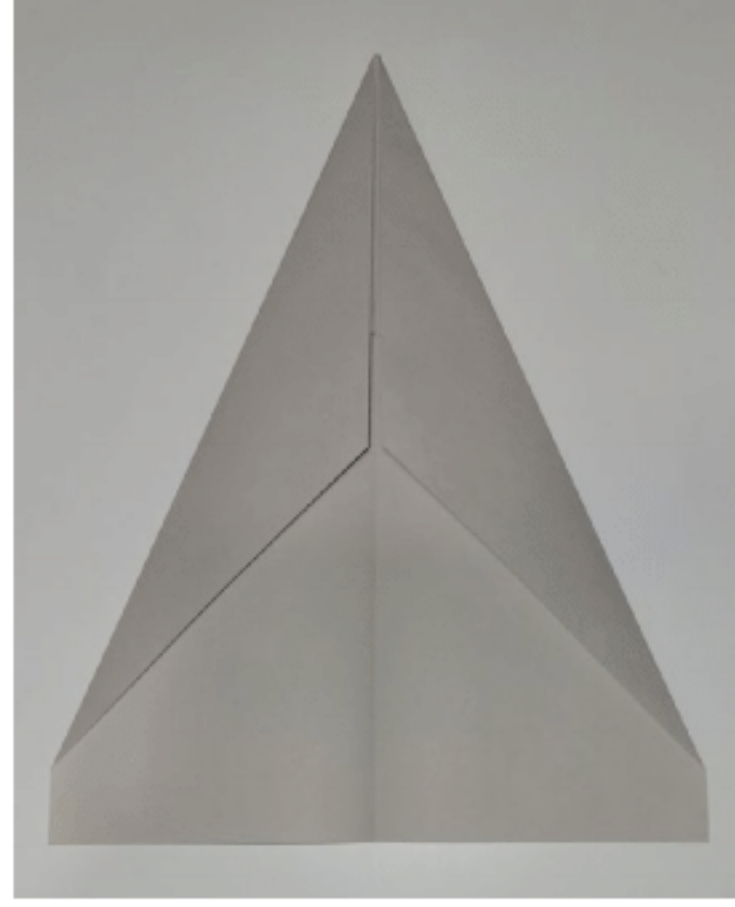
2. Fold the top corners towards the center line.



**Fun Fact:** The longest paper airplane flight path was 69.14 meters, achieved by Joe Ayoob using a plane designed by John Collins.



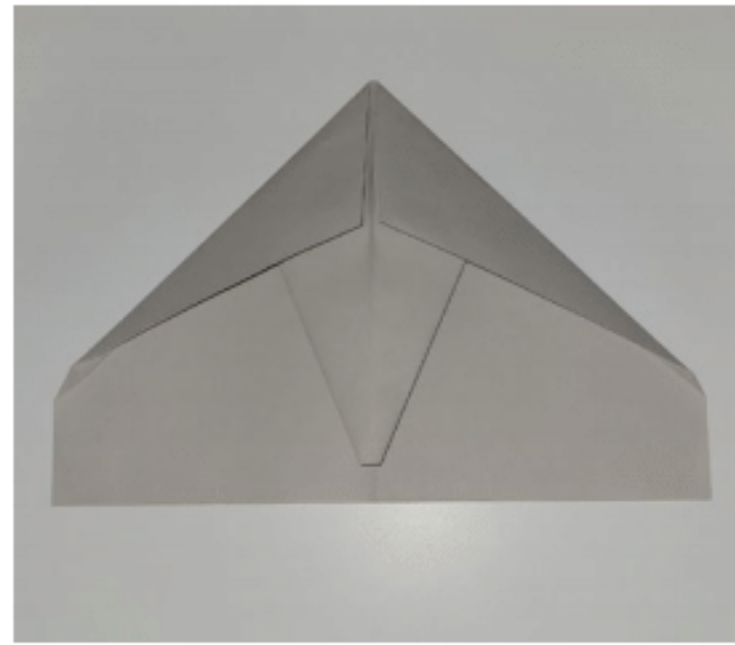
3. Again, fold the top outer corners to the center.



4. Fold the tip of the plane downwards.



5. Fold the top corners towards the centre.



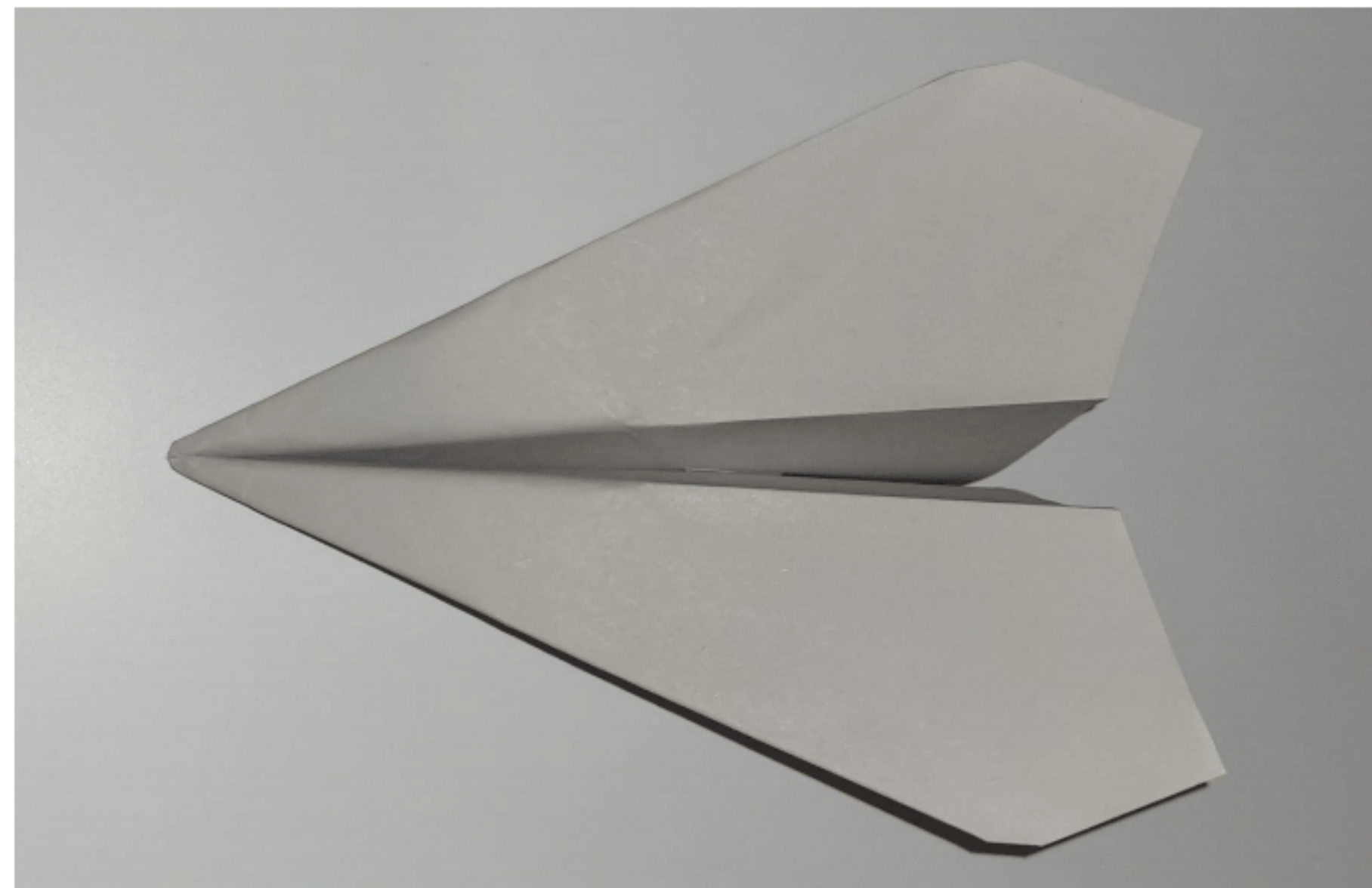
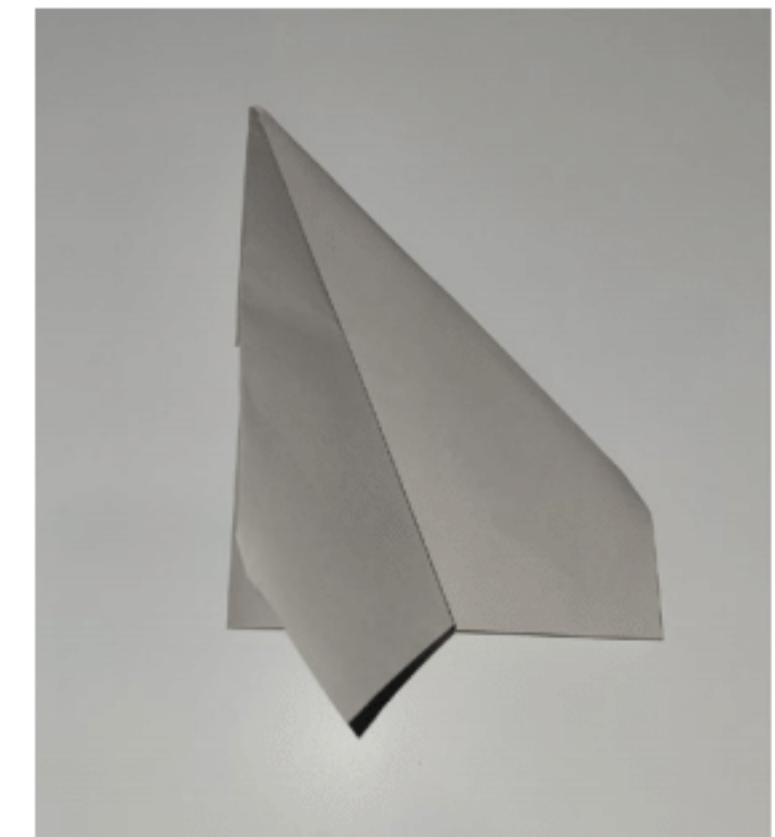
6. Fold the triangle shaped flap upwards to meet the point of the plane.



7. Flip the plane over and fold it in half, inwards.



8. Fold down both wings to meet the edge of the plane's body.



**GO FORTH, RELEASE THE RAVEN!**

**Fun Fact:** Some planes can fly for more than FIVE hours after one of their engines goes out!



## The Lock-Bottom

1. Fold the paper in half hotdog style.



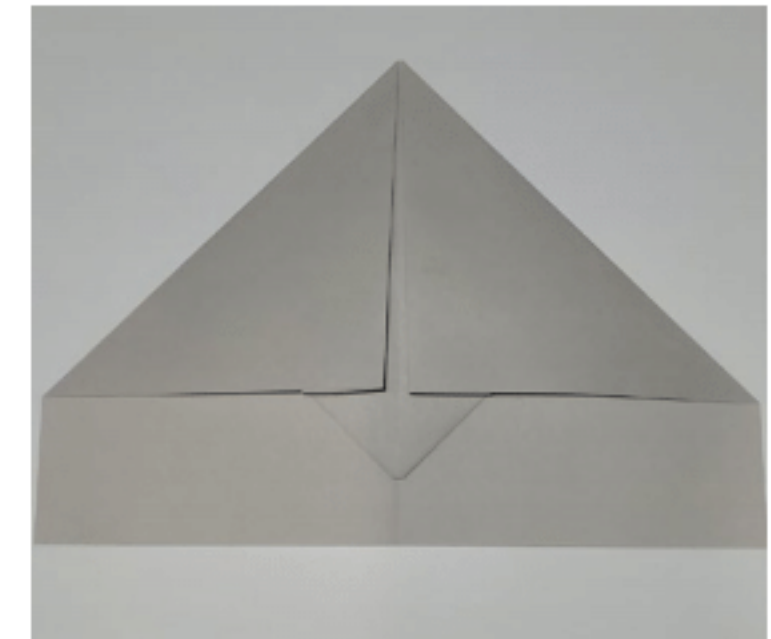
2. Fold the top corners towards the center line.



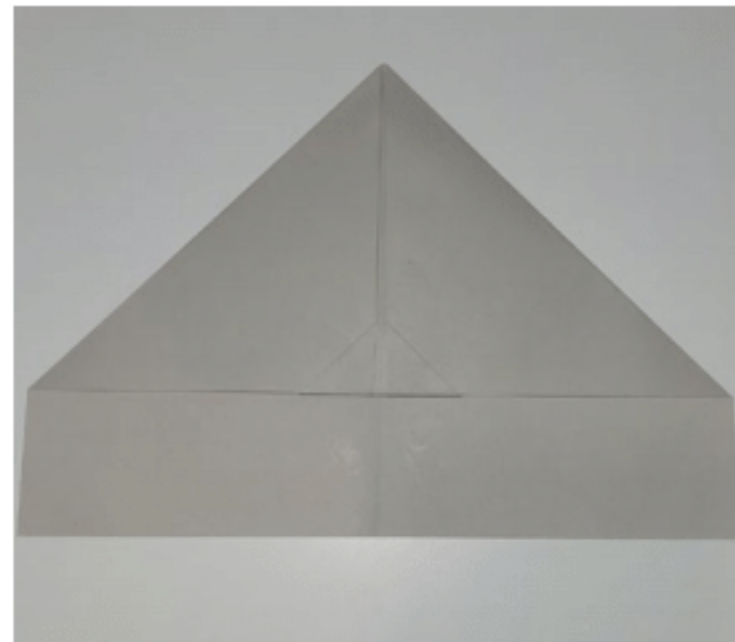
3. Fold the tip of the plane downwards.



4. Fold the top corners towards the centre.



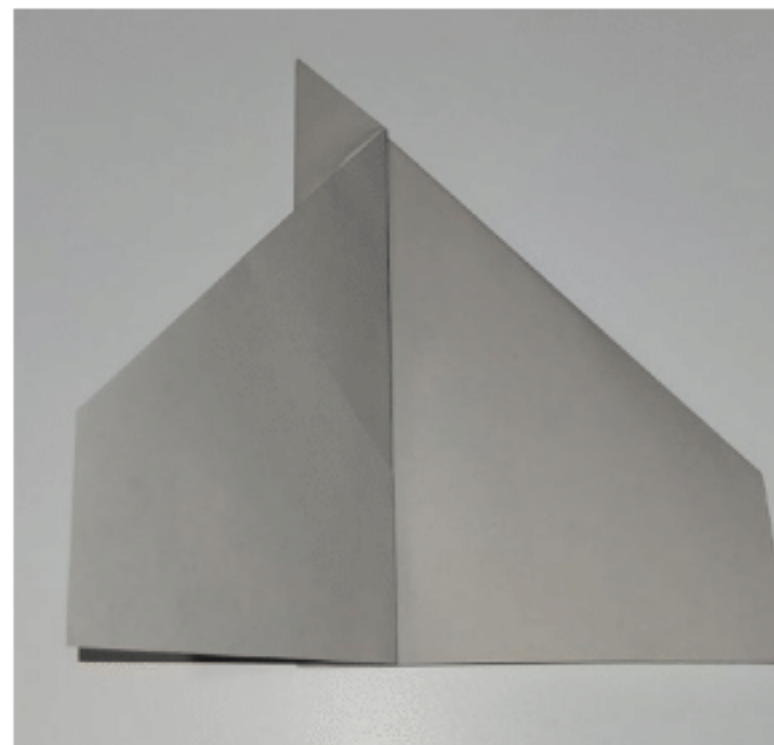
5. Fold the triangle shaped flap upwards to lock down the two flaps.



6. Flip the plane over and fold it in half, inwards.



7. Fold one wing down about one inch from the bottom of the plane.

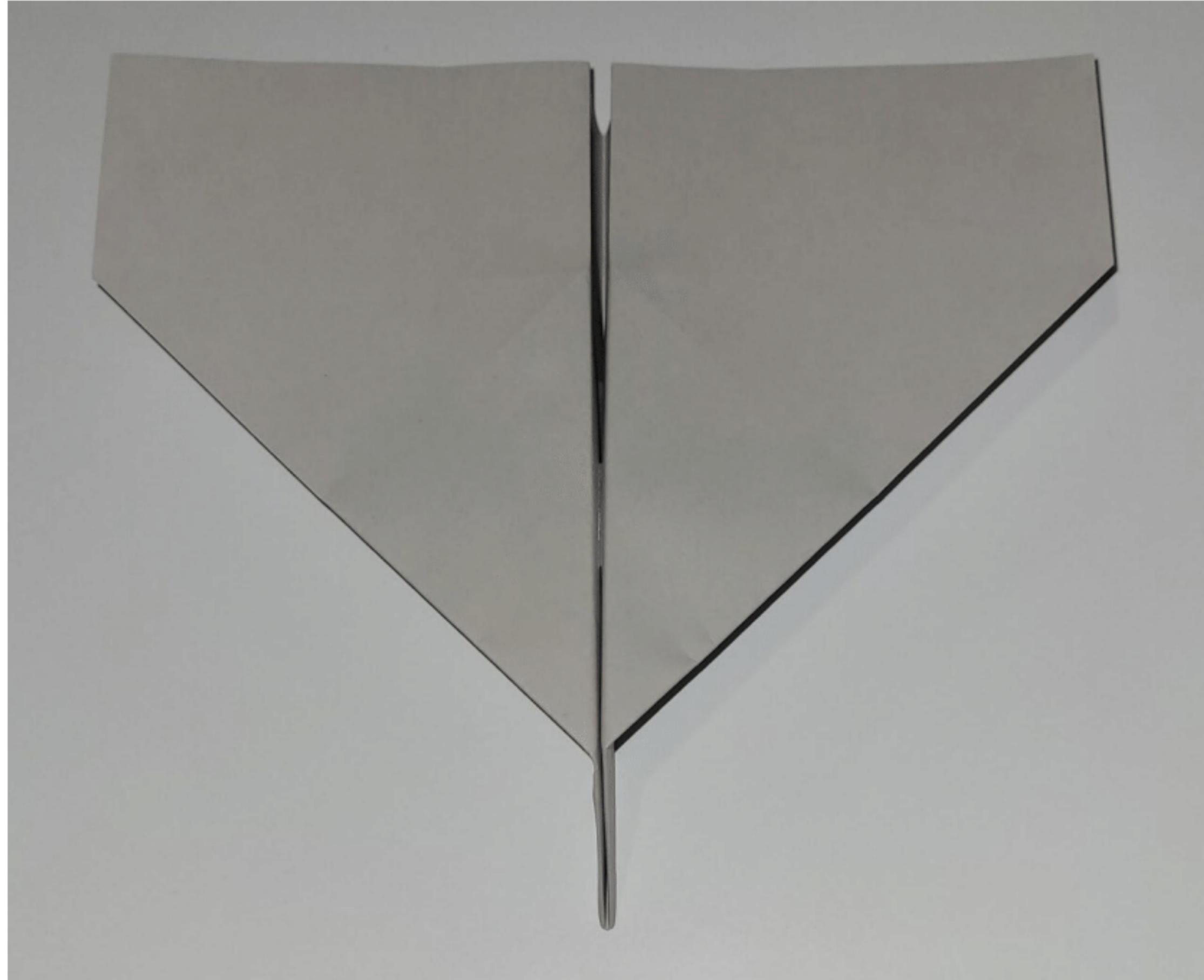


8. Fold the other wing down to meet the first.



**Fun Fact:** The earliest known date of the creation of modern paper planes was said to have been 1909!

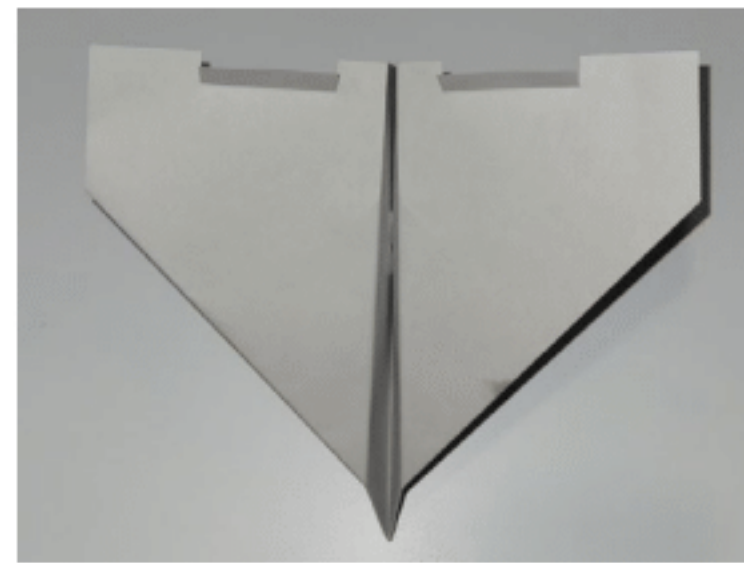




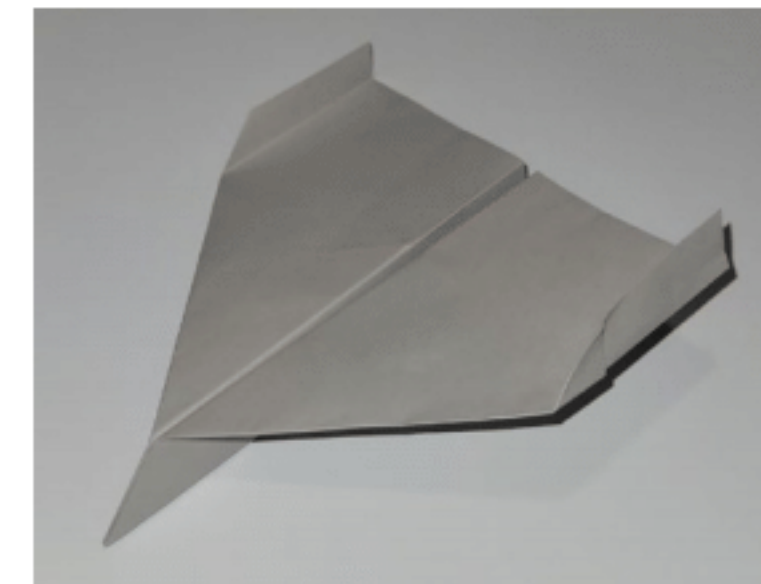
Now let it glide!

### Paper Airplane Modifications

**Backflaps:**  
Cut even flaps  
out of the ends of  
the wings like so.



**Stabilizers:**  
Fold up the sides of  
each wing so that  
they're pointed  
straight up.



**Fun Fact:** The largest paper airplane ever built had a wingspan of 18.21 meters! It was constructed by the students and employees at the Braunschweig Institute of Technology (Germany) in Braunschweig, Germany on September 28th, 2013.

### Link to Plane Video:

Here's the link to the video which shows how all these planes fly!

["How Paper Planes REALLY Work!" - https://youtu.be/vaEqTEjVNEs](https://youtu.be/vaEqTEjVNEs)