

Why Planes Fly

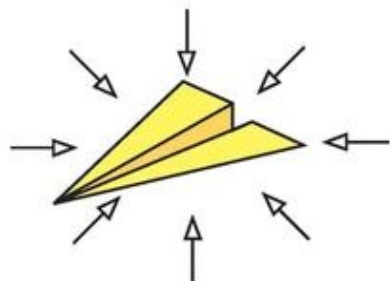
There are a lot of ways that things can fly. They can be lighter than air, like a party balloon, and float on the breeze. They can be picked up by the wind, like a kite, or a spider, or a dandelion seed. They can rise on a jet of hot air or gas, like a rocket. They can flap their wings, like hummingbirds and bees. They can be pushed or pulled by an engine, like a jumbo jet. Or they can glide on wide-spread wings, like sailplanes, eagles, and paper airplanes.

But what do we mean when we talk about flying? To be flying, an object has to stay in the air without falling down instantly. Some people might tell you that the best paper airplane, the one that goes farthest of all, is a tight wad of paper. That may seem clever, but the wad isn't flying. It's falling from the moment it leaves your hand, because it creates no lift to keep it up. To be flying, it has to have lift, and keep going steadily without slowing down or diving to the ground. Paper airplanes can't stay up forever, but they can glide a long way, down a long straight line, before hitting the ground.

This section will tell you how those wings of paper really fly.

"Lift" is what holds flying things up. In an airplane, lift is made by the wing moving through the air. How? Let's find out!

Did you know that air is pushing on us all the time? Still air pushes from every direction equally. Our bodies push back the same amount, which is why we don't usually feel it. We can feel wind, because that's moving air, which hits one side of us and feels like a bigger push.

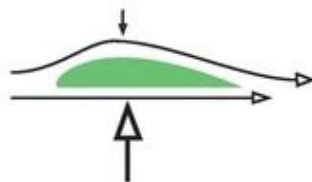


If air is pushing on both sides of the wing equally, nothing will happen. So a flat wing like a plank won't work. A shape that is curved on top and flat on the bottom is much better. It will create lift when air flows over it, because the air flows faster over the top, reducing the pressure pushing down on that surface. The greater pressure pushing on the bottom lifts the whole wing up. This kind of curve is called camber, and a cambered shape is called an airfoil.

Why does the air on the top of the wing speed up? And why does that reduce the air pressure there? It's because of three special effects: the Coanda Effect, the Kutta Condition, and Bernoulli's Principle.



The Coanda Effect says that fluids (like air and water) tend to stay attached to surfaces they flow over. This means that air follows the curve at the top of the wing. And because of the Kutta Condition, created by the sharp back edge of the airfoil, the air speeds up as it flows over the curve. In fact, the air going over the airfoil speeds up so much, it gets to the back of the wing faster than the air going under it!



Bernoulli's Principle says that the faster a fluid flows, the less pressure it exerts. So if the air on the top of the wing is going faster, there's less pressure pushing down. That means the higher pressure on the bottom of the wing pushes it up. And lift ensues!

Try it!



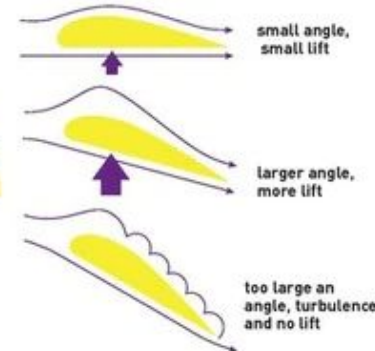
Here are two experiments you can try. First, blow over the top of a drooping sheet of paper. The paper will rise up and stand out straight, supported by the greater pressure of the still air under it. Next, try touching a steady flow of tap water with the bottom of a spoon. You'd expect the spoon to be pushed away, but in fact it is pulled into the flow. That's because the speed of the water reduces the pressure on the bottom of the spoon, and air on the other side pushes it into the flow.



Angle of Attack

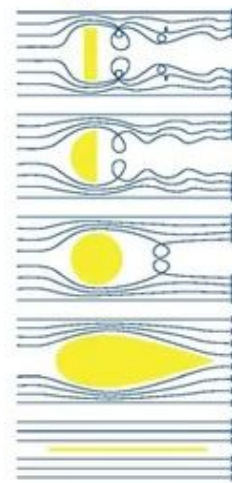
By increasing the angle of attack (the angle at which the wing hits the airflow) you can increase the amount of lift. The greater angle in effect increases the curve of the wing, so air goes over it faster, and air striking the bottom creates more direct pressure (like a kite). The bigger the angle, the more lift. But if the angle becomes too big, the Coanda Effect stops, and the air comes unstuck and gets turbulent. If that happens, the wing stops making lift and stalls. In other words, it stops flying.

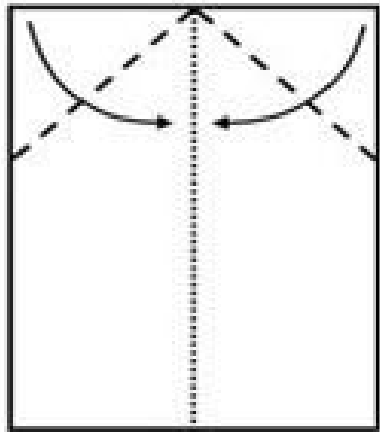
More speed also means more lift. But more lift is not necessarily better. Lift creates drag, which holds the wing and the airplane back. And drag increases much faster than the speed. When the airplane doubles its speed, the drag created by the wing quadruples! So more and more power is needed to go faster, in spite of the lift.



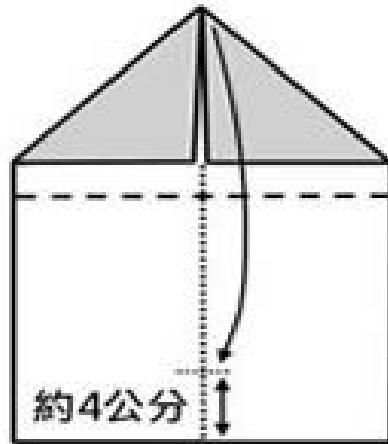
It's important for airplanes to be streamlined. They have to be smooth and slick to slip through the air easily. That's why sleek looking airplanes fly fast, and why fast airplanes look so sleek. Wings and airfoils need to be streamlined too.

The more streamlined a wing is, the more easily air can move around it. A blunt plate is the worst. It just about stops the air, and the flow behind it is turbulent and messy. A half circle also makes turbulence, because the air can't join up neatly behind it. Round is better, and flat is most streamlined of all. But remember, flat wings don't make much lift. So the best wing shape is the one with the least drag for the most lift. In origami airplanes, that is a thin wing with several layers at the front. Too many layers of paper folded up at the front make the wing draggy. Air can't go around it smoothly. A thinner (or more sharply creased) wing is much better. By the way, putting thick folds on the top side of the wing doesn't usually work very well either!

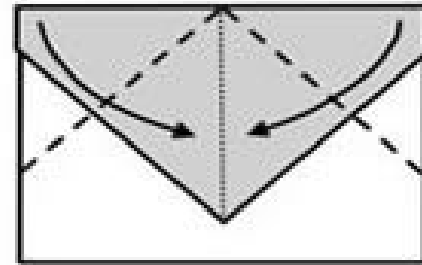




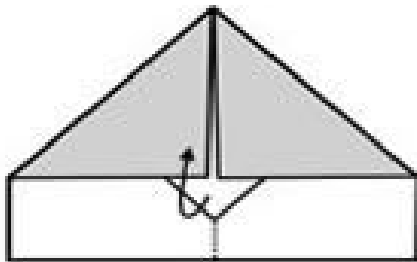
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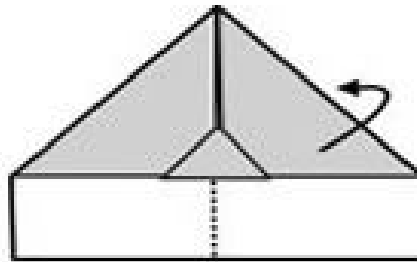
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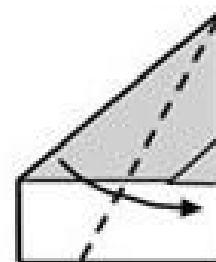
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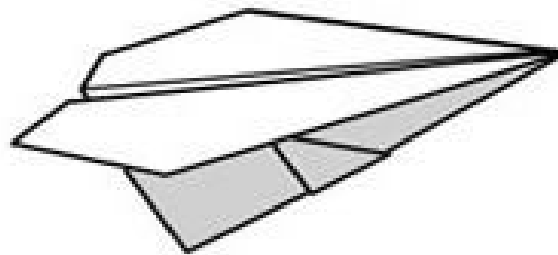
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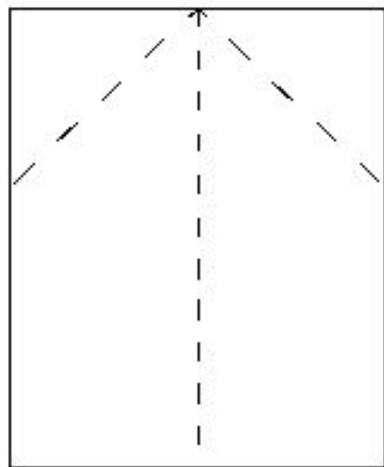


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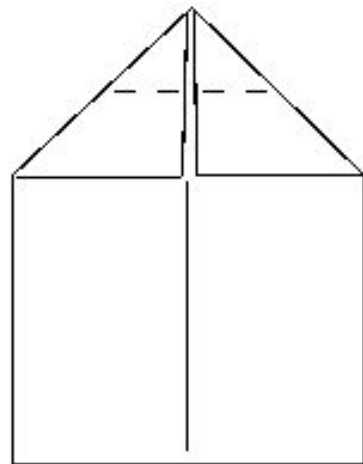


High Glider

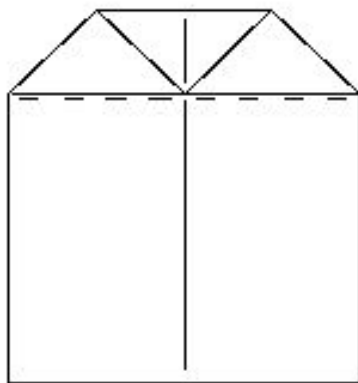
If you throw this one almost straight up, you may get flights of 10 seconds. It is also a good, straight indoor airplane.



Fold an 8.5 x 11 inch sheet of paper in half lengthwise and open back up. Fold the top corners down to the center.

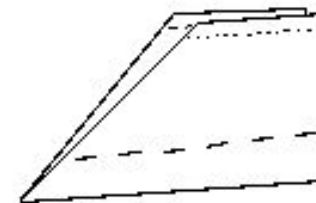
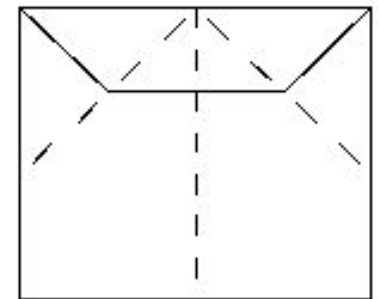


Now fold the point over to the bottom of the previous folds.

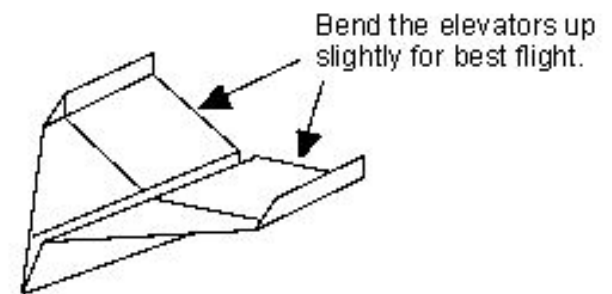


Fold the top down

Fold the top corners down to the center. Fold the plane in half towards you.



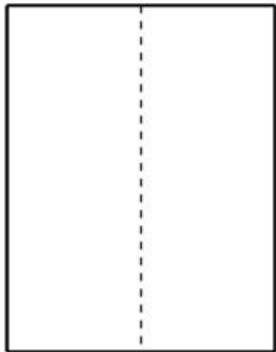
Now fold the wings out at an angle as shown. Fold the wingtips up.



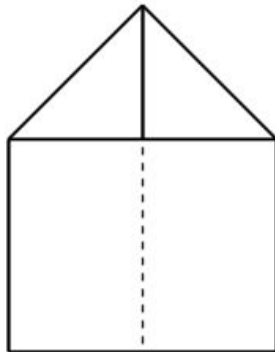
start with paper in portrait orientation



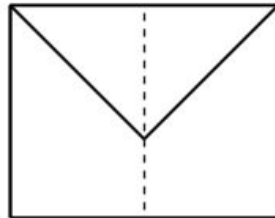
fold in half lengthwise



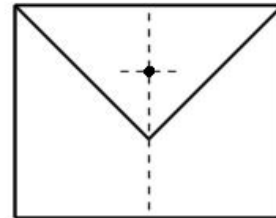
fold the upper edges to the centerline



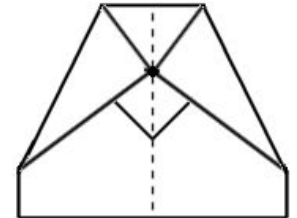
fold the triangle downwards along its lower edge



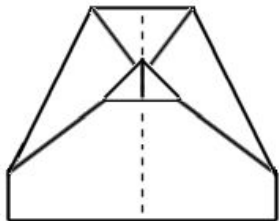
fold the tip of the triangle up to the top to locate the halfway point, then unfold



while firmly holding the center in place, fold both upper corners to the halfway point



fold the remaining tab up as far as it will go. it should slightly overlap the previous fold



fold in half along the centerline, with the tab on the outside



fold one wing such that the outer edge is brought colinear with the plane's centerline

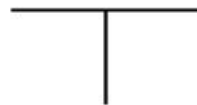


fold the other wing in a symmetrical fashion



unfold and fly!

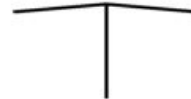
tips for flying:



neutral roll stability



high roll stability



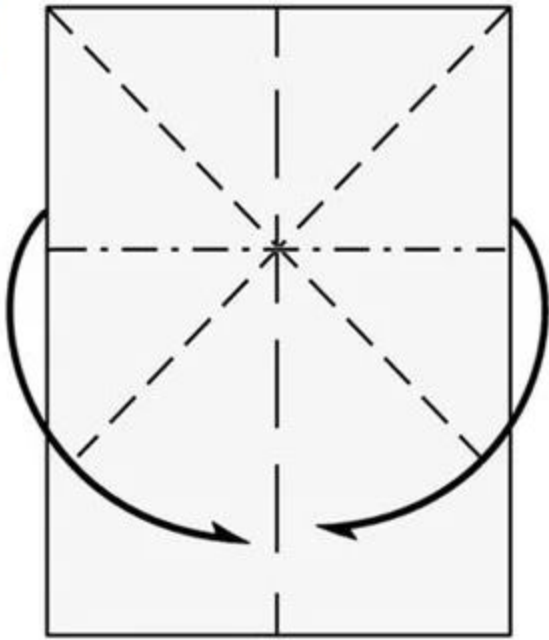
unstable in roll

throw the plane, holding it by the tab. throw it directly forward, but give the wings a small upward angle of attack. 5 degrees should be plenty.

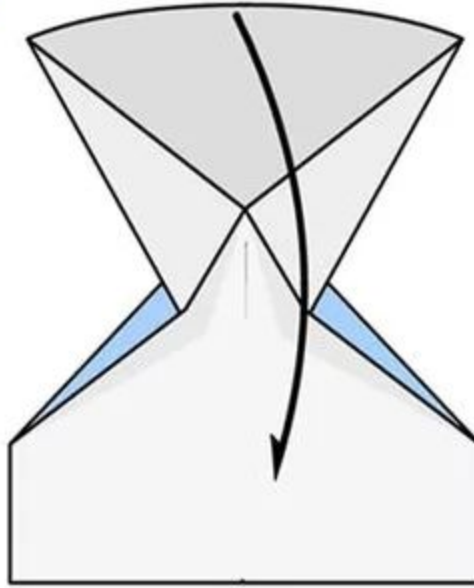
if the plane climbs, stalls, and crashes, curl the rear wingtips **downward** slightly.

if the plane nosedives rapidly, curl the rear wingtips **upward** slightly.

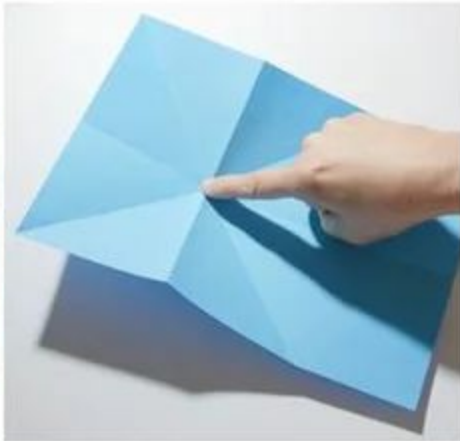
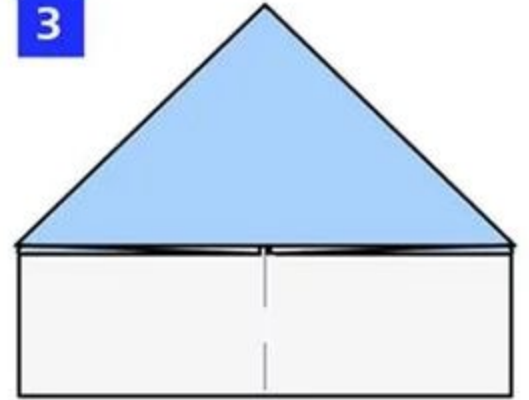
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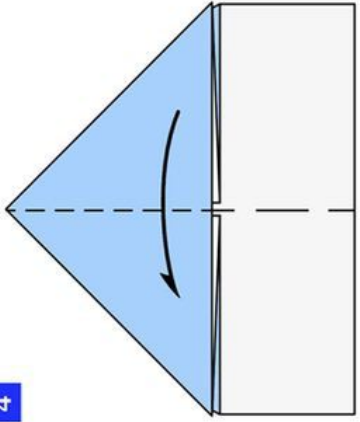
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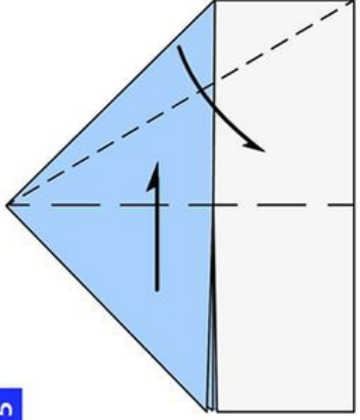
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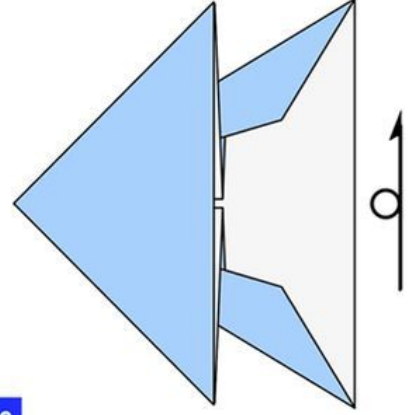
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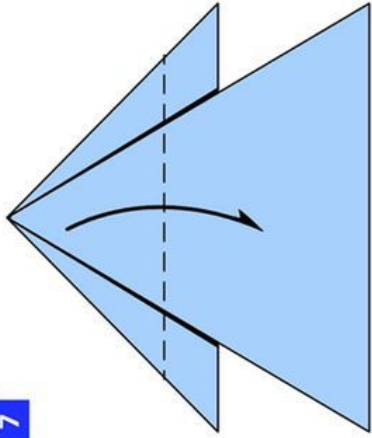
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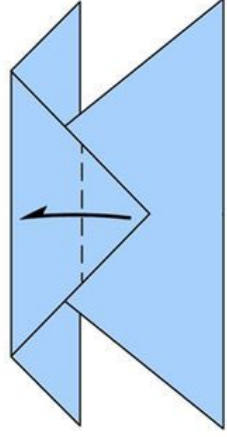
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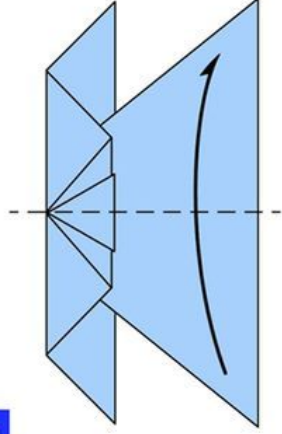
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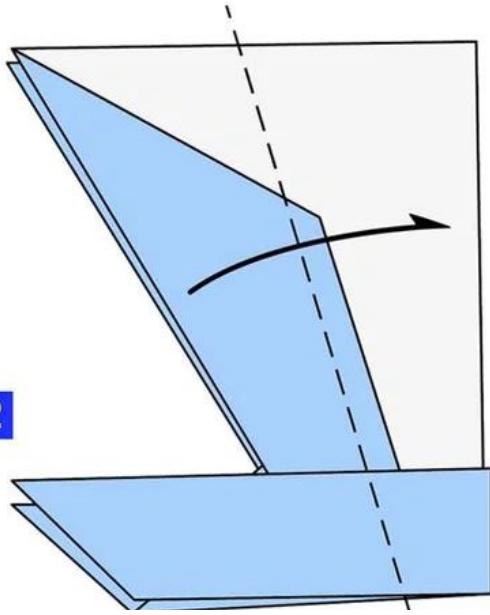
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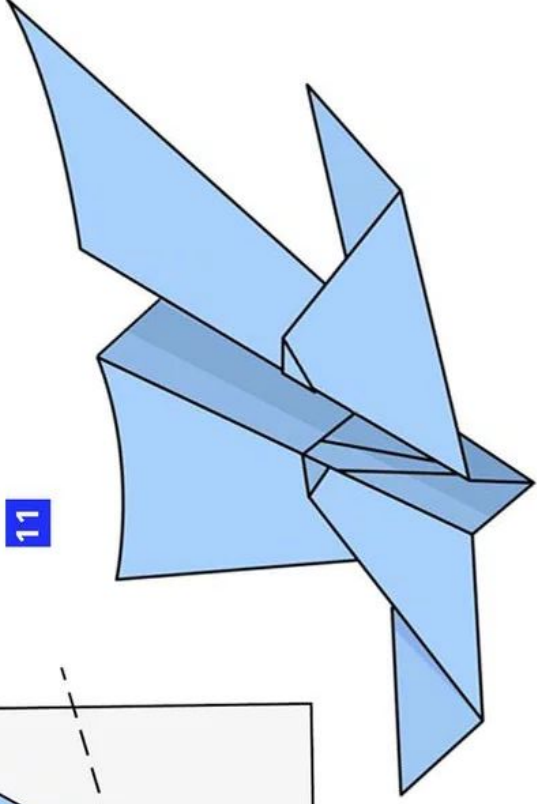
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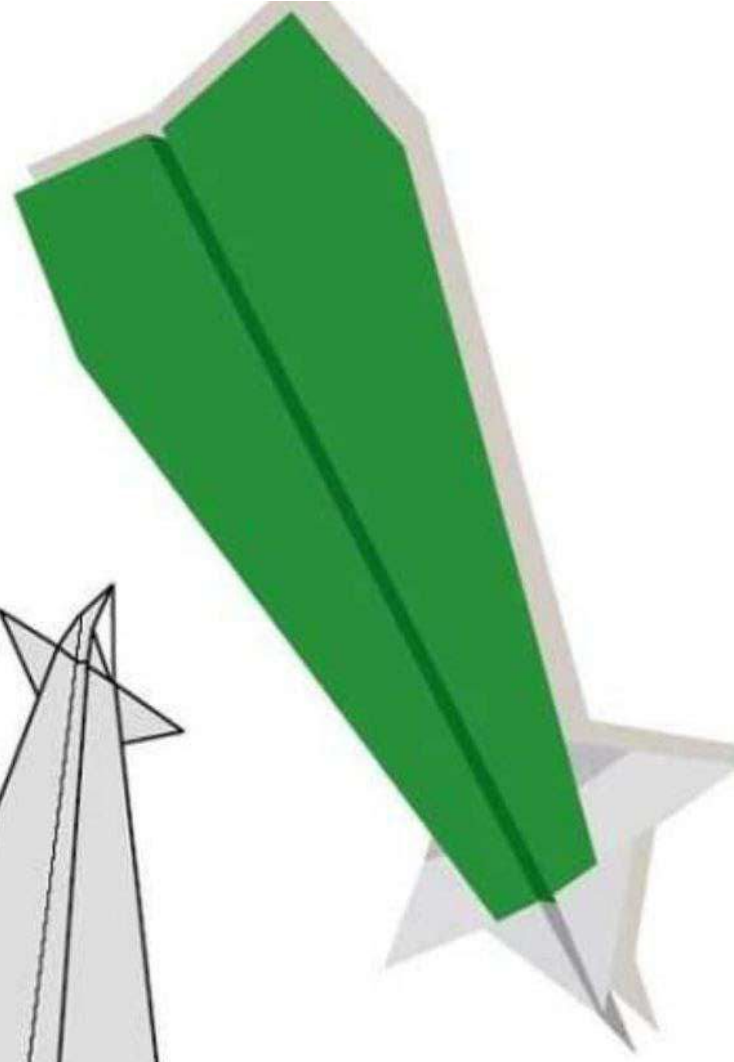
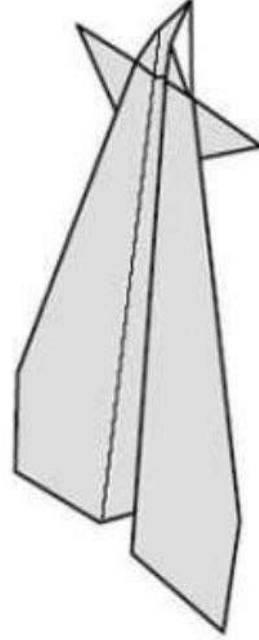
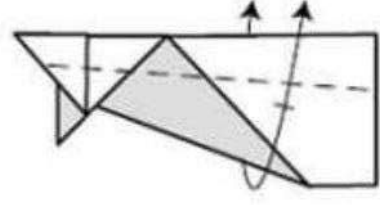
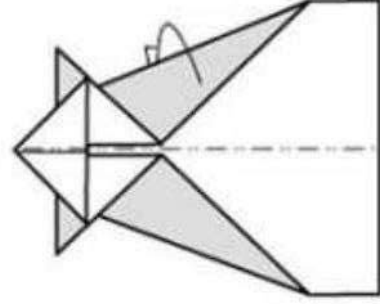
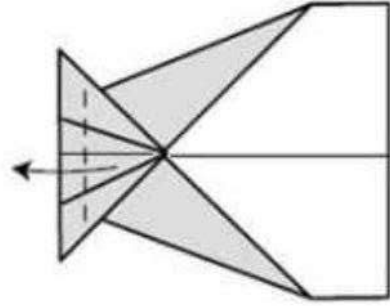
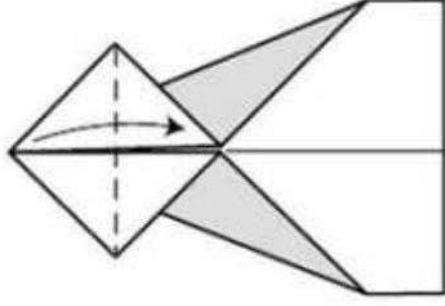
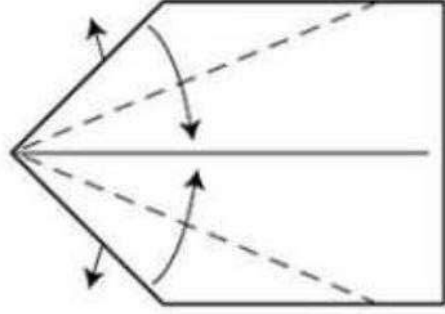
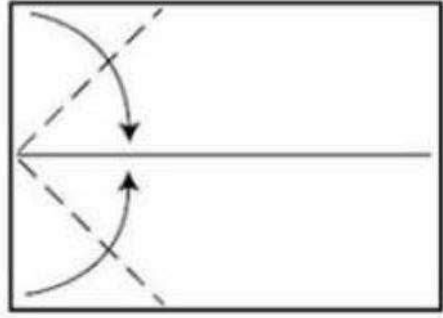
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11

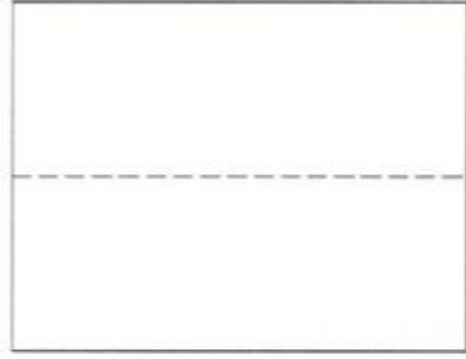


4) Canard



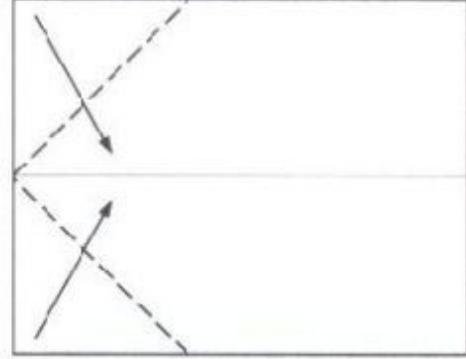
Namburka Lock

1



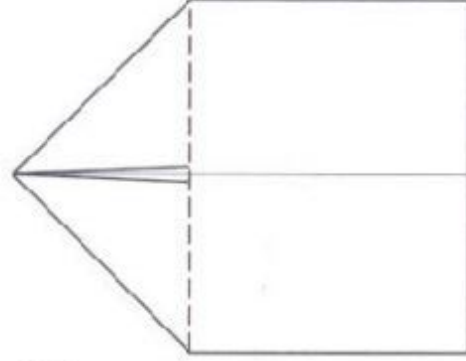
Start with an 8.5" by 11" sheet of paper. Crease as shown.

2



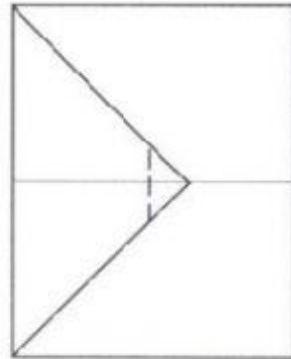
Valley fold the top left and right corners to the middle.

3



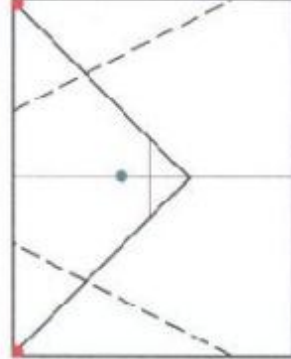
Valley fold the whole top triangle straight down.

4



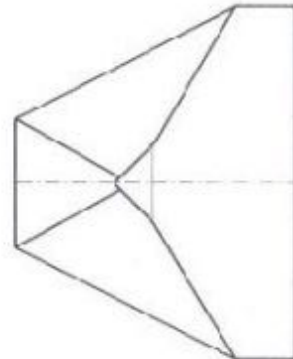
Valley fold the tip of the triangle up. (This doesn't have to be exact, just get it close to what I have)

5



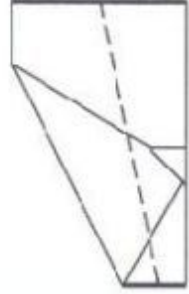
Valley fold the red corners so that they touch the green point. The edges will just touch the crease you made in step 4. (see step 6)

7



Mountain fold the whole plane in half.

8



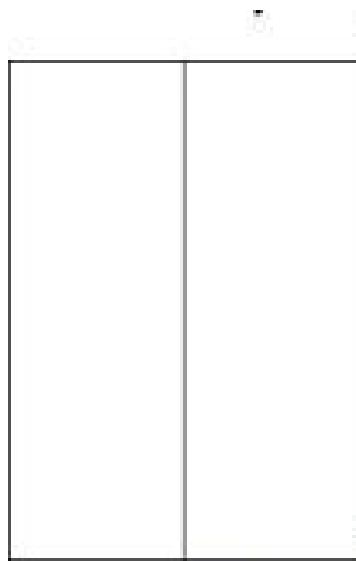
Fold the wings down, but make sure the crease goes from the **midpoint** of one bold line to the **midpoint** of the other bold line.

9

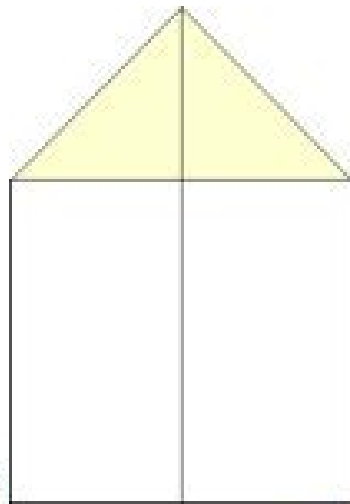


Pull the wings outward to make the rear view look like a "Y." See below.

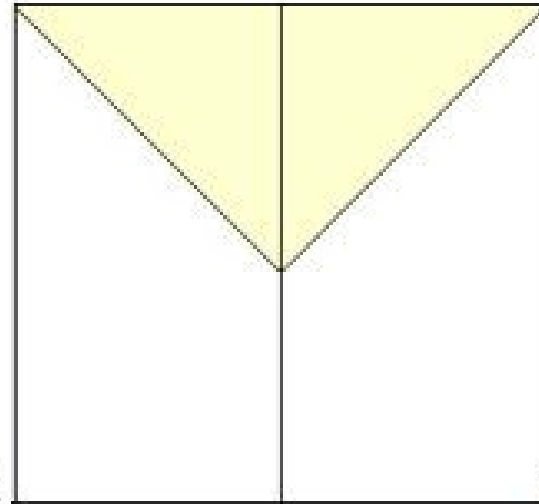




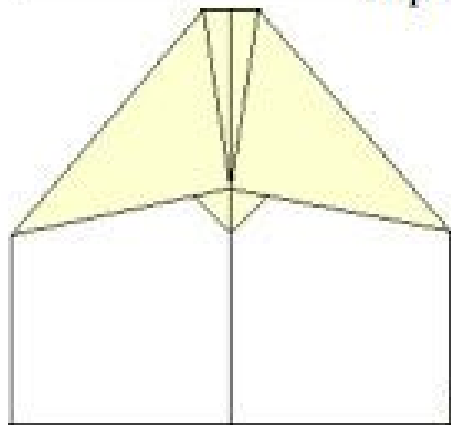
Step 1



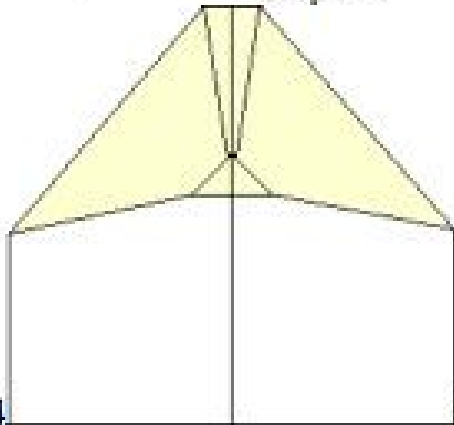
Step 2



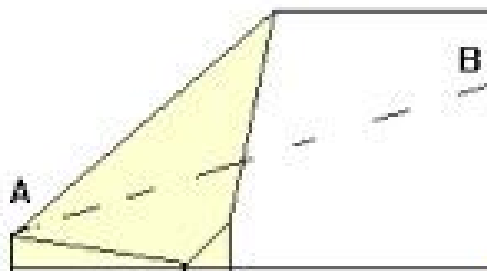
Step 3



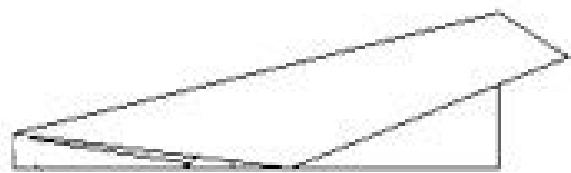
Step 4



Step 5



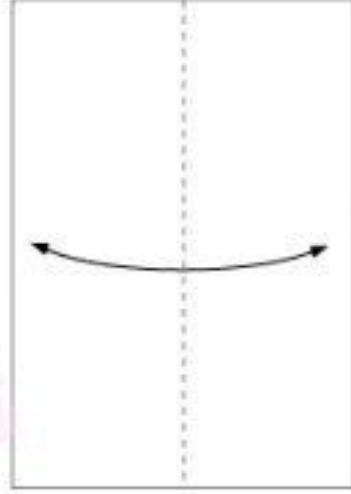
Step 6



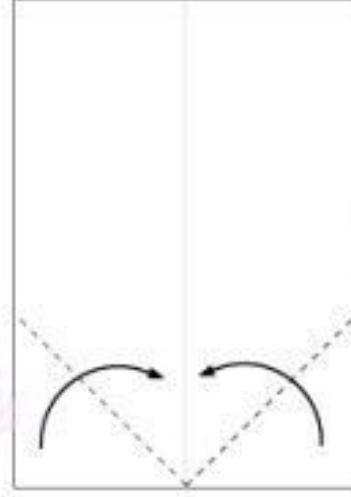
Step 7



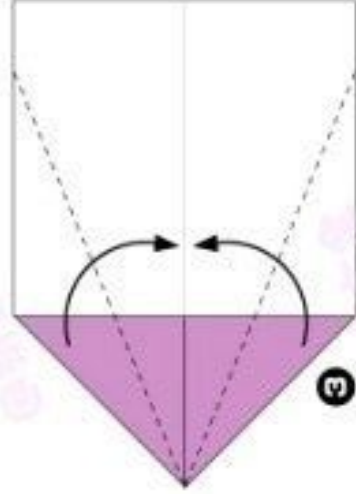
鸟型纸飞机



1 Fold in half to make creases and fold back

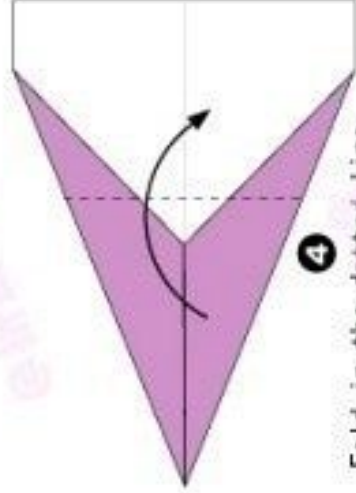


2 Fold to meet the center line



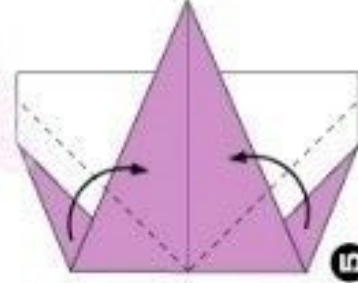
3

Fold to meet the center line



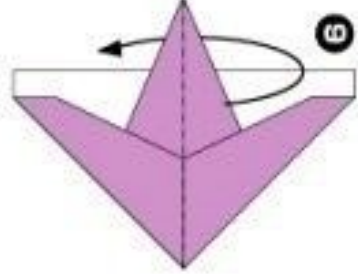
4

Fold in the dotted line



5

Fold to meet the center line



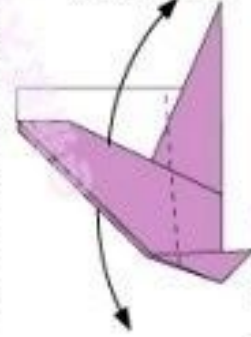
6

Fold in half



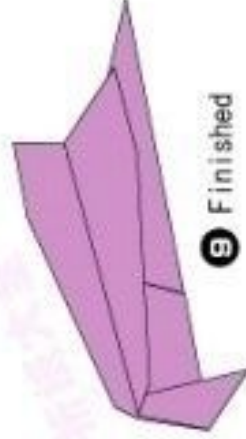
7 Hood fold

in the dotted line

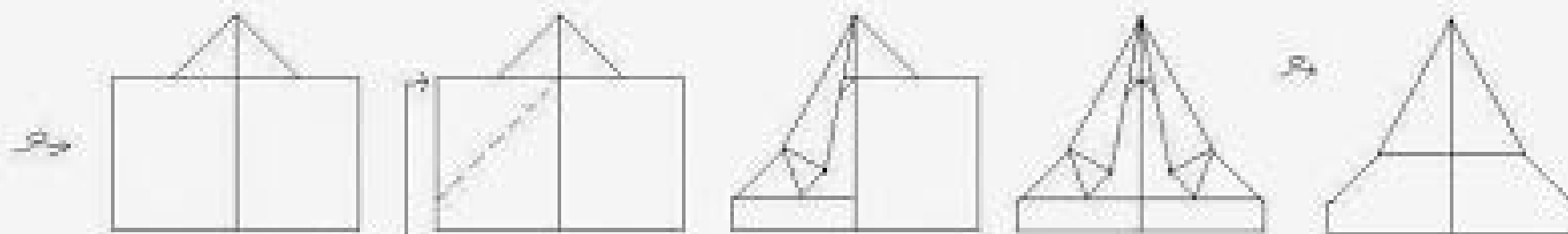
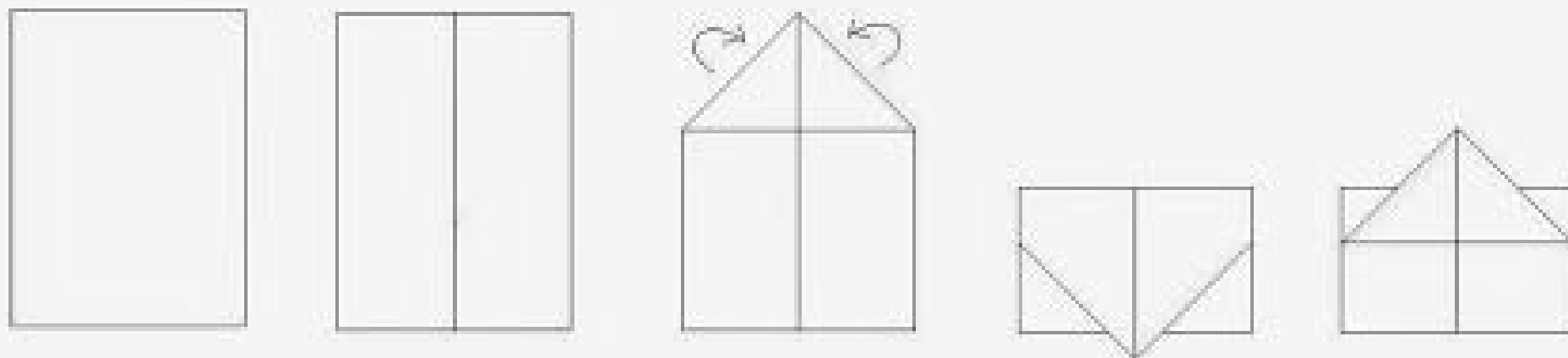


8

Fold both sides in the dotted lines and adjust in 90 degrees



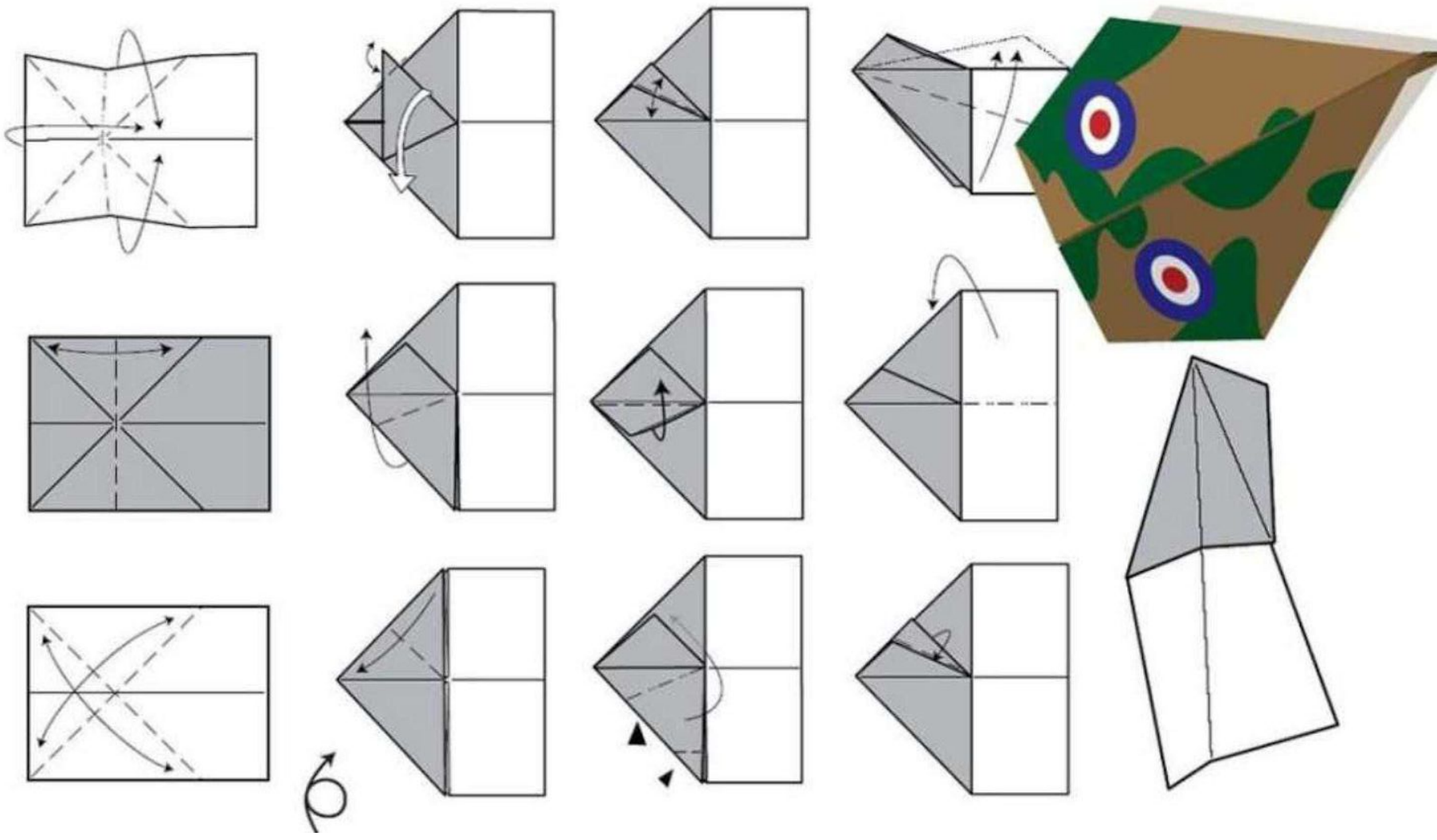
9 Finished

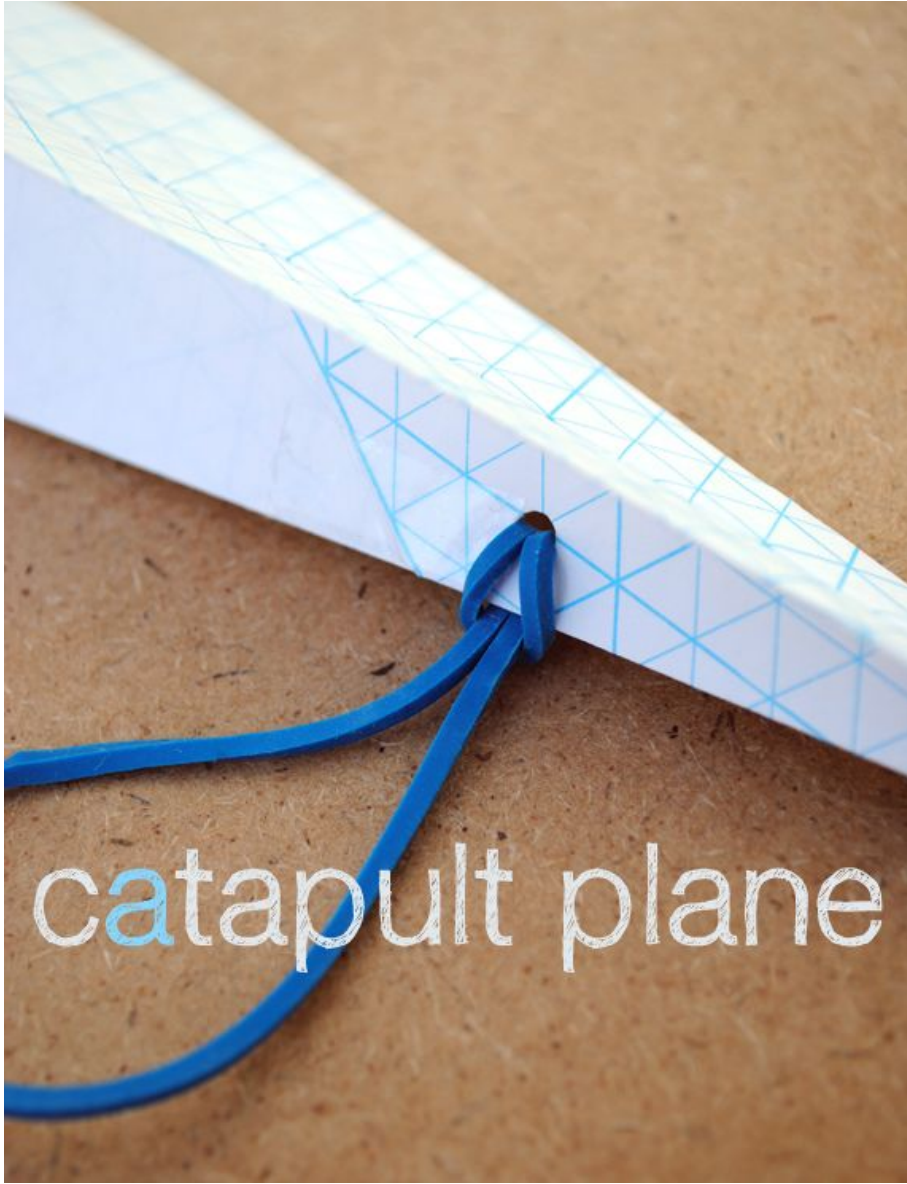


Hold this corner
Fold along dotted line



7) Gomez





catapult plane

