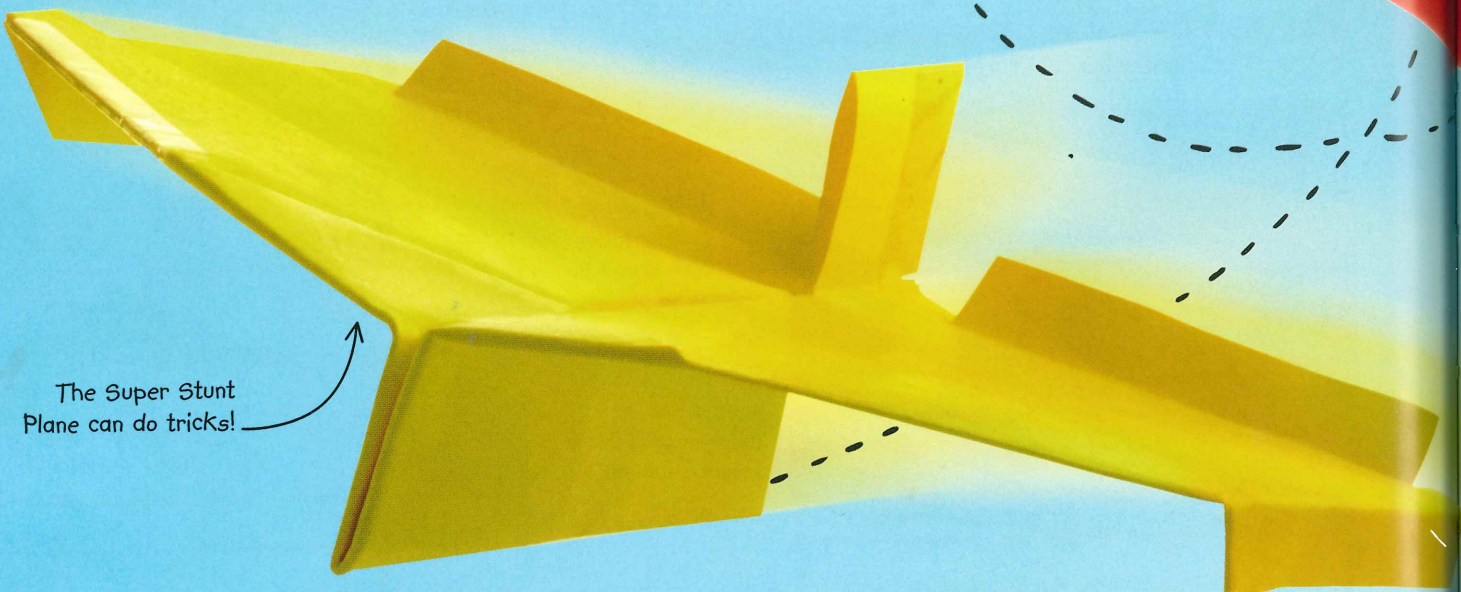
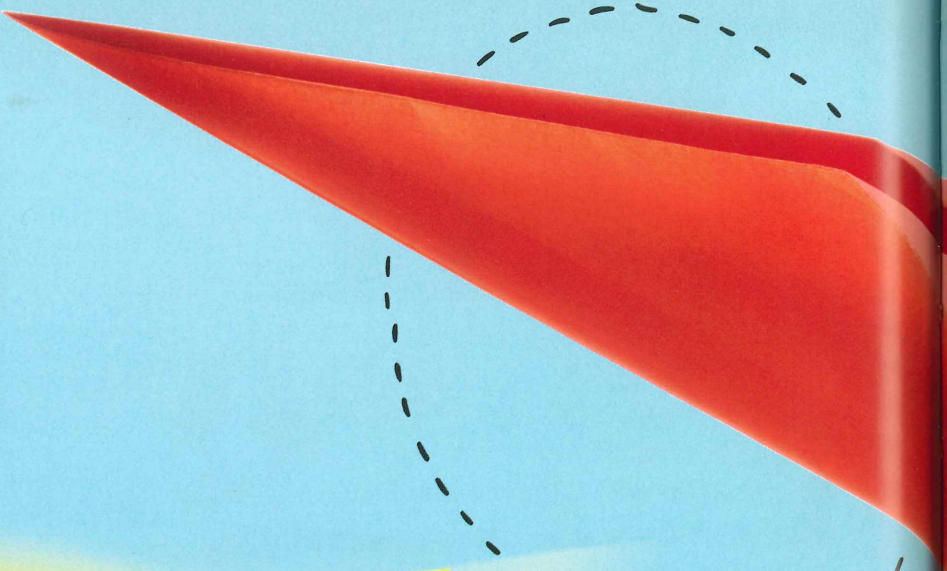
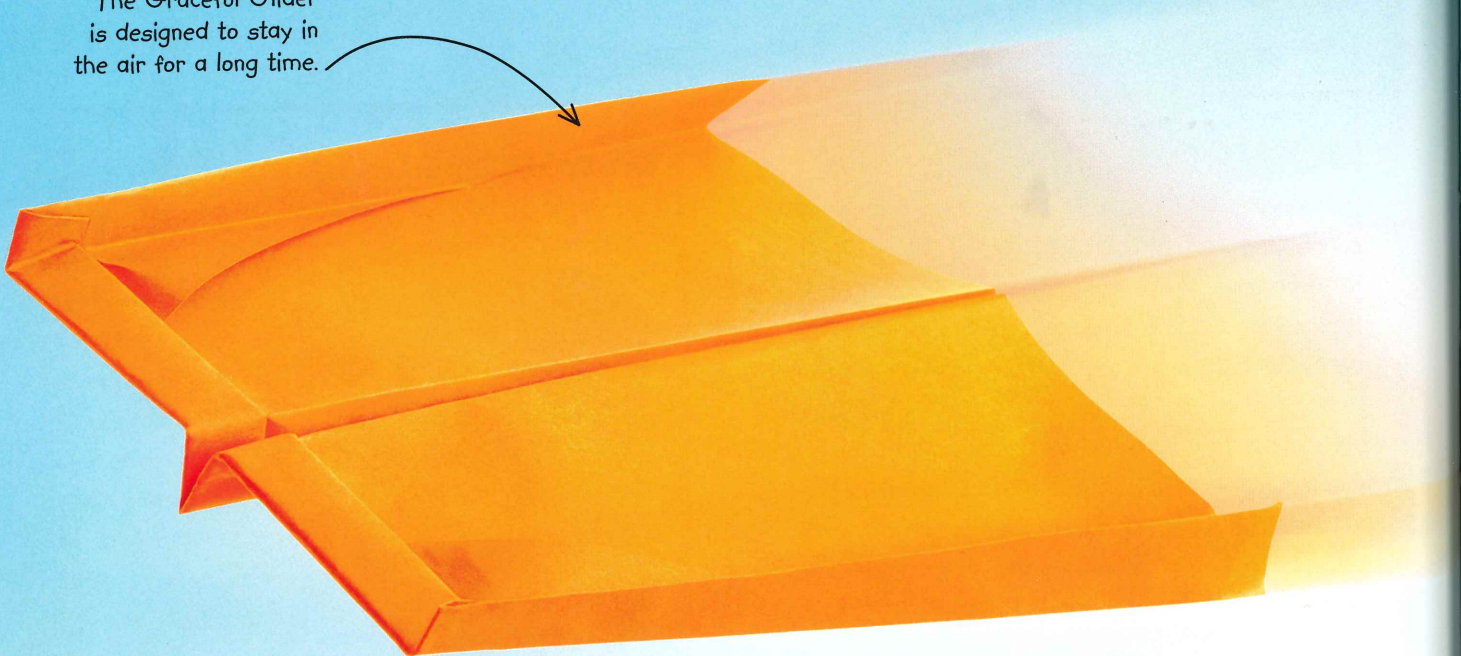


UP, UP, AND AWAY!

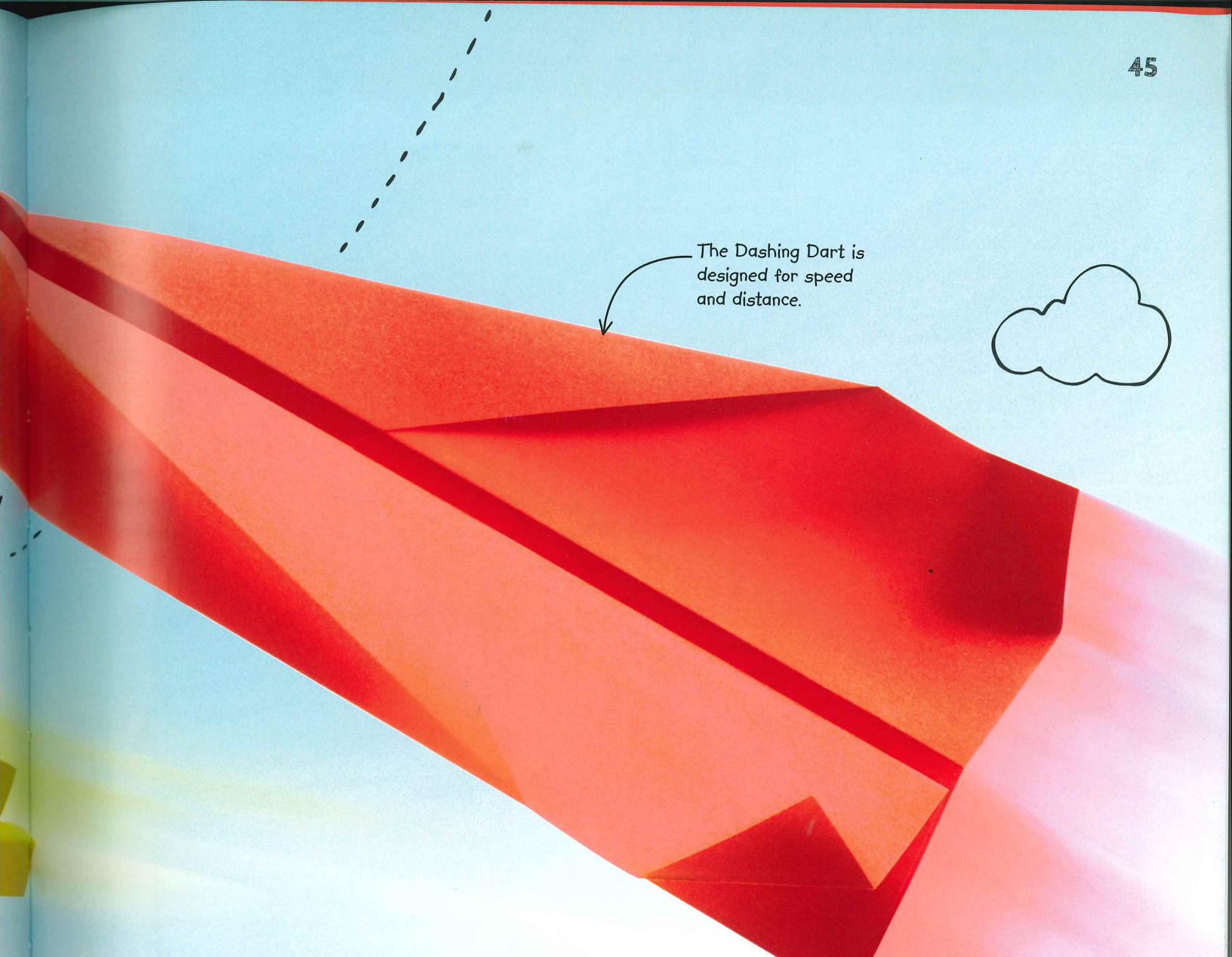
The three planes that you will create each behave differently from one another because of the way the air moves around them as they fly. Try out various ways of launching your planes—upward, downward, harder, and softer—and experiment by changing the shapes of the wings.



The Super Stunt Plane can do tricks!



The Graceful Glider is designed to stay in the air for a long time.



The Dashing Dart is designed for speed and distance.

PAPER PLANES

Drop a piece of paper and it will tumble to the ground, as air escapes chaotically around the flapping sides. With a few folds, a few cuts, and a little know-how, you can make that piece of paper dash along at high speed, glide gracefully, or make impressive maneuvers, as it flies through the air. In this experiment, you'll be testing out "aerodynamics"—the interaction between the air and objects moving through it. Let's get ready for take-off!

HOW TO MAKE PAPER PLANES

These three paper planes—an easy, a medium, and a hard one—are fun to make, but follow the instructions carefully for good results. All you really need is paper, but one of the designs requires a ruler, scissors, and tape. Be careful, though, as the Dashing Dart has a sharp nose, so don't throw it toward anyone's face.

WHAT YOU NEED



Ruler



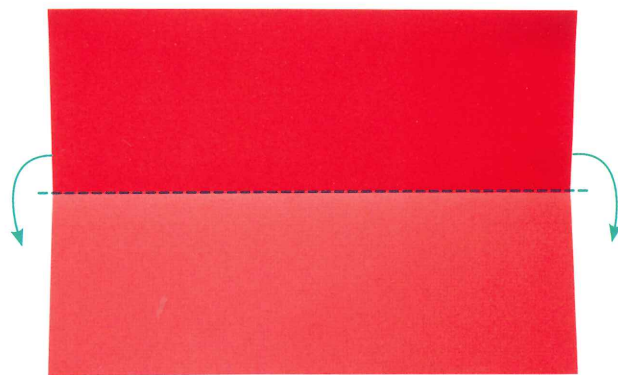
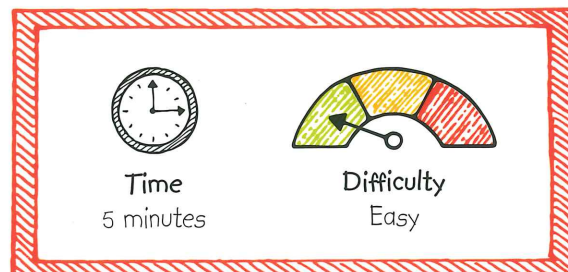
Scissors



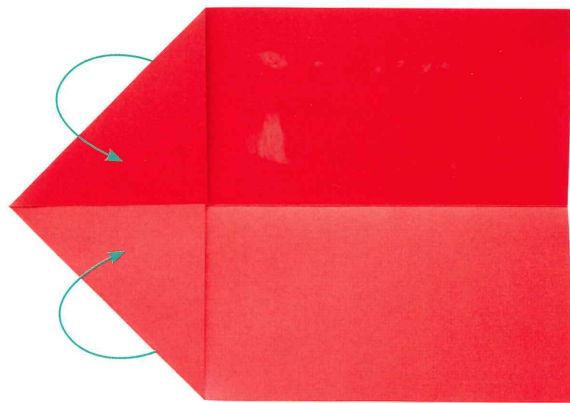
Masking tape

DASHING DART

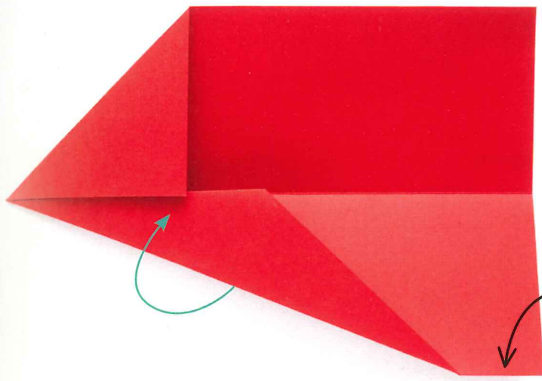
Built for speed, this simple, streamlined plane zips through the air. When you've made it, throw it at a slight upward angle—and watch it fly!



1 Fold a piece of paper in half lengthwise as accurately as you can. Make a crease with a fingernail or ruler, then unfold the paper again.

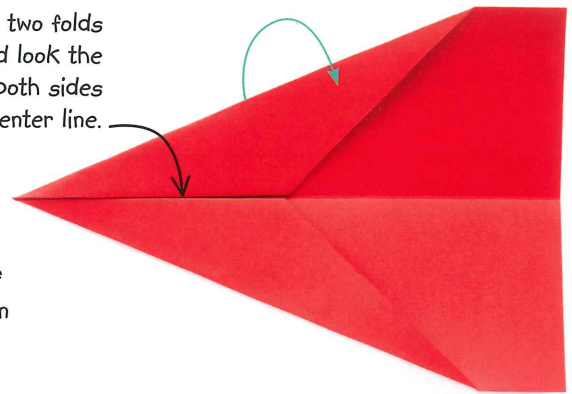


2 Fold down two corners so they meet at the center line. Leave a small gap between them, otherwise it will be difficult to fold the paper again.



Leave a couple of inches unfolded on each wing.

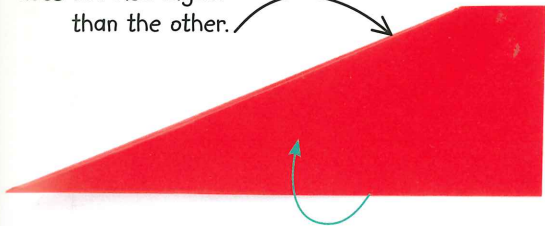
3 Now fold down one edge toward the center line. Again, don't fold it right onto the center line, as you will soon have to fold the paper lengthwise.



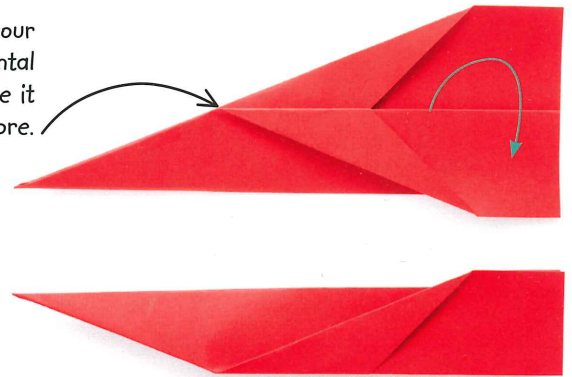
The two folds should look the same on both sides of the center line.

4 Do the same with the other edge, making sure the folds are symmetrical and meet close to the line. Check that all your folds are creased.

Make sure one side does not rise higher than the other.



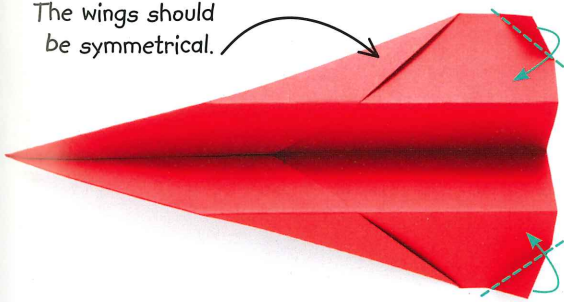
Make sure your fold is horizontal and crease it down as before.



5 Now fold the paper in half lengthwise, with the folded sections on the inside. The two sides should match up perfectly. Crease all the folds firmly.

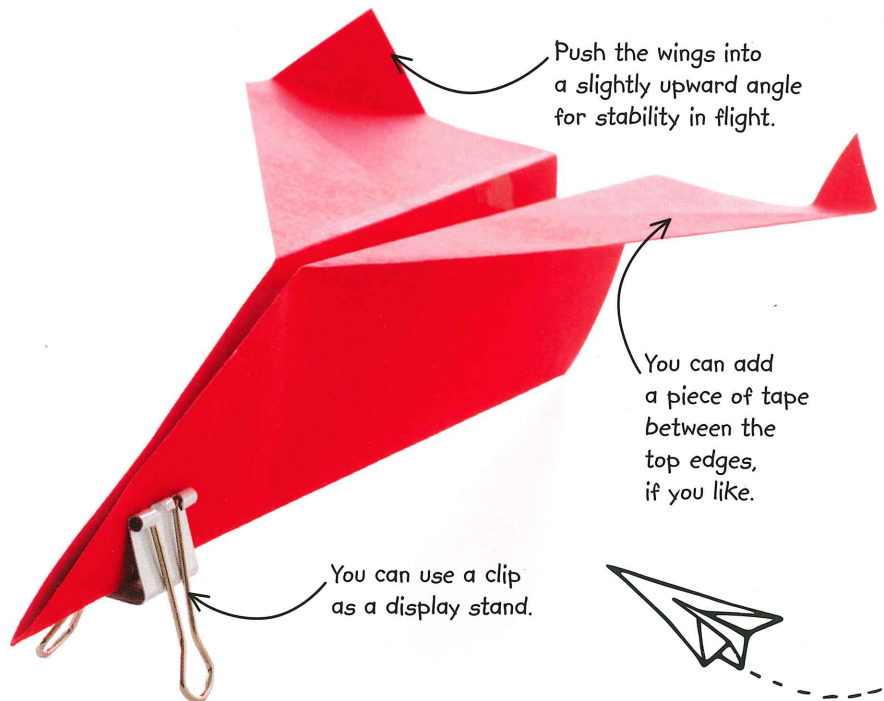
6 Fold down one side, making the fold parallel with the bottom of the plane and about halfway up the back, or tail. Now do the same to the other side.

The wings should be symmetrical.



Push the wings into a slightly upward angle for stability in flight.

7 Nearly there! Fold up the corners—these will push air upward as the plane flies, and that will nudge the tail down and the nose up.



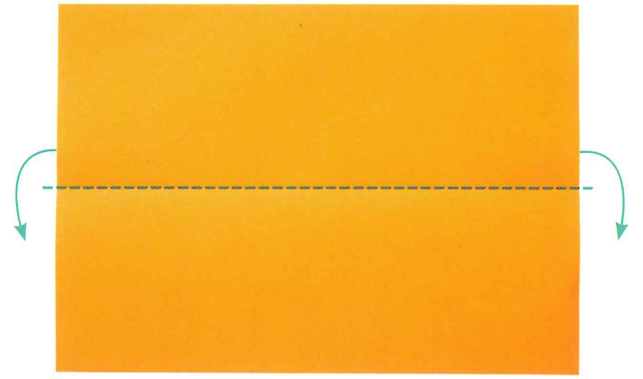
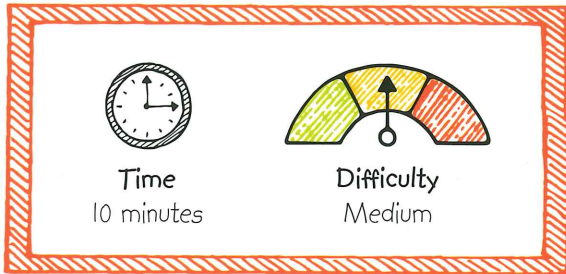
You can use a clip as a display stand.

You can add a piece of tape between the top edges, if you like.

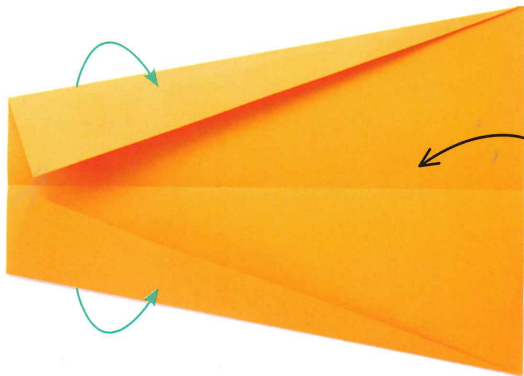


GRACEFUL GLIDER

Launch this plane gently—only slightly above horizontal—and it should glide through the air, staying aloft for longer than the Dashing Dart. But be patient, it's a little tricky to make.

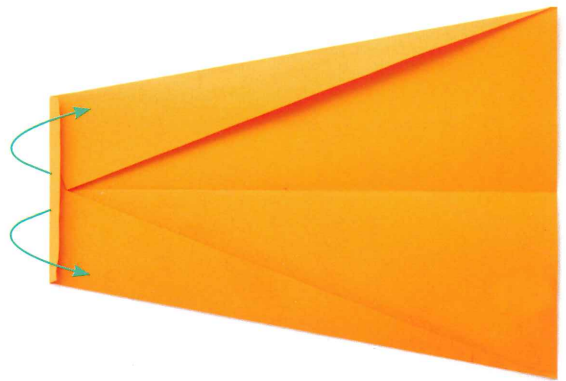


1 Start by carefully folding a piece of paper in half lengthwise. Make a crease with a fingernail or ruler, then unfold the paper again.



This area should be the same shape on either side of the center line.

2 Fold in both edges, so that each corner of what will be the front touches the center line. Both folds should meet at the back corners.

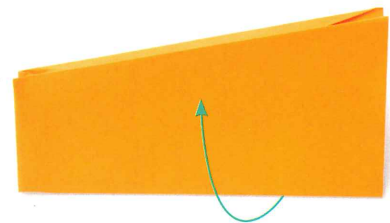


3 Fold down about $\frac{1}{2}$ in (1cm) of the tapered end of the paper. This will be the nose of the glider. Crease down the fold firmly.

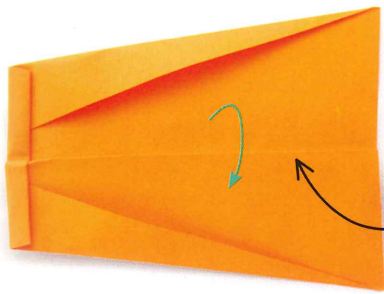


The plane will be noticeably shorter now, but that will help it glide.

4 Repeat step 3 six times, each fold over the last. The folded edges of what will be the wings will buckle, so keep pushing them under the folds.

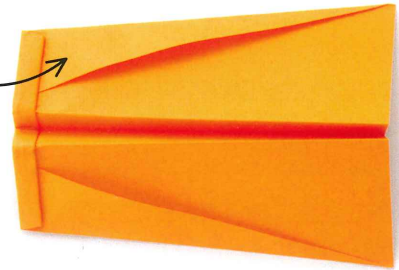


5 Now carefully fold the plane in half, making it as symmetrical as you can. Crease the fold well, especially around the bulky nose of the plane.



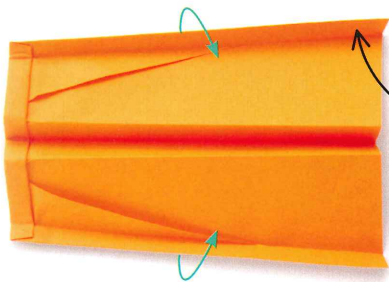
Try to make this line straight.

Tuck any ruffled up pieces under the fold as best as you can.



6 Fold down one side, about $\frac{3}{4}$ in (2cm) from the bottom. Once again, crease the fold well, especially at the nose, where the paper is chunky.

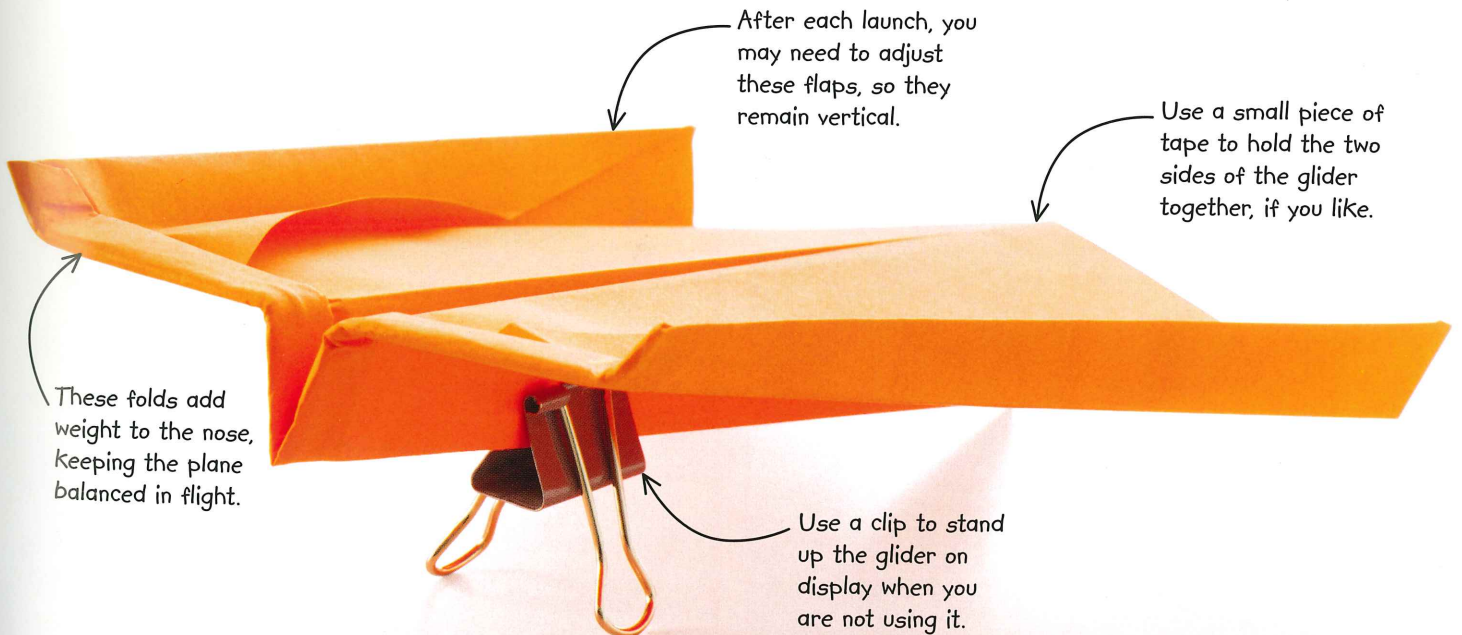
7 Do the same to other side, and make sure all of your folds are creased and that the glider is symmetrical. You now have two wings.



Make these flaps look the same on both wings.

Experts launch paper planes that stay airborne indoors for 30 seconds!

8 Finally, fold along the edges of the wings, making the edges parallel with the center line. Crease and lift them up, so they stand up vertically.



After each launch, you may need to adjust these flaps, so they remain vertical.

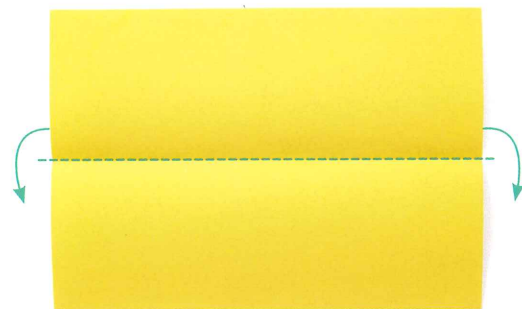
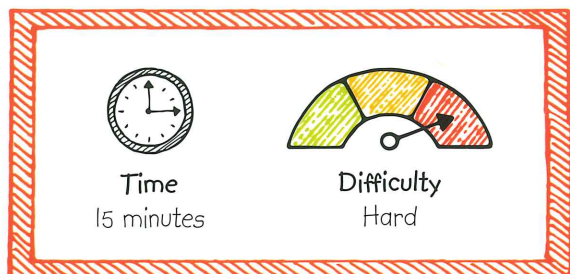
Use a small piece of tape to hold the two sides of the glider together, if you like.

These folds add weight to the nose, keeping the plane balanced in flight.

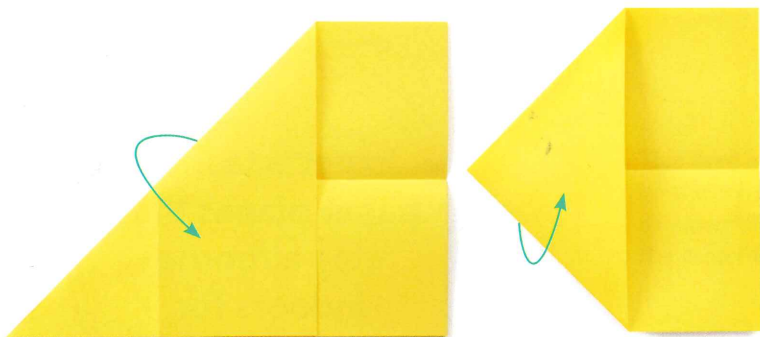
Use a clip to stand up the glider on display when you are not using it.

SUPER STUNT PLANE

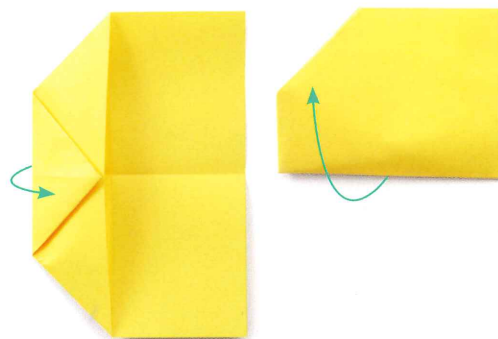
This plane has two flaps and a rudder. By changing the positions of these control surfaces, you can make the plane twist, climb, dive, and even loop-the-loop.



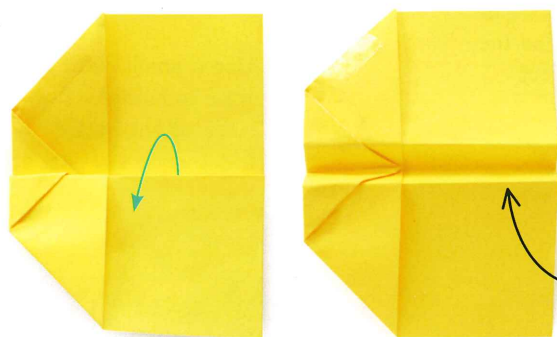
1 Begin by simply folding a piece of paper in half lengthwise. Make a crease with a fingernail or ruler, then unfold the paper again.



2 Fold one corner and make a firm crease. Then fold the sharply pointed corner, so you end up with a triangle. Tape around the open diagonal edge.

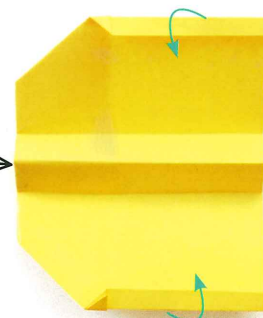


3 Fold back the point of the triangle, so that it meets the long base of the triangle. Now fold the paper around the center fold and crease it.



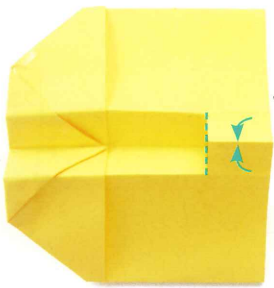
4 For the wings, fold down one side, about $\frac{3}{4}$ in (2cm) from the center fold. Do the same with the other side, and unfold both so that they lie flat.

Take this opportunity to crease all of the other folds.



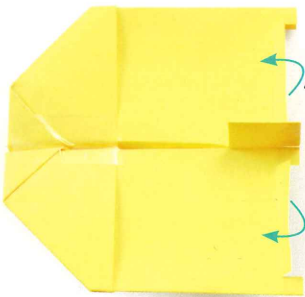
The plane should be symmetrical on both sides of the center fold.

5 Turn over the plane and fold down the edge of each wing $\frac{1}{2}$ in (1cm) in from the edge. Lift up both edges, so they sit at right angles to the surface.



Pinch the tailfin at the top, to ensure a smooth crease.

6 Cut from the center fold up to the base of the wings—about 1 in (2.5cm) in from the back of the plane—then push it up. This is the tailfin.



Try to make both slits on either side of the tailfin the same size.

7 Crease the tailfin so it stands up, taping the wings to keep it closed. Cut slits into the trailing edge of each wing and fold up the resulting flaps.

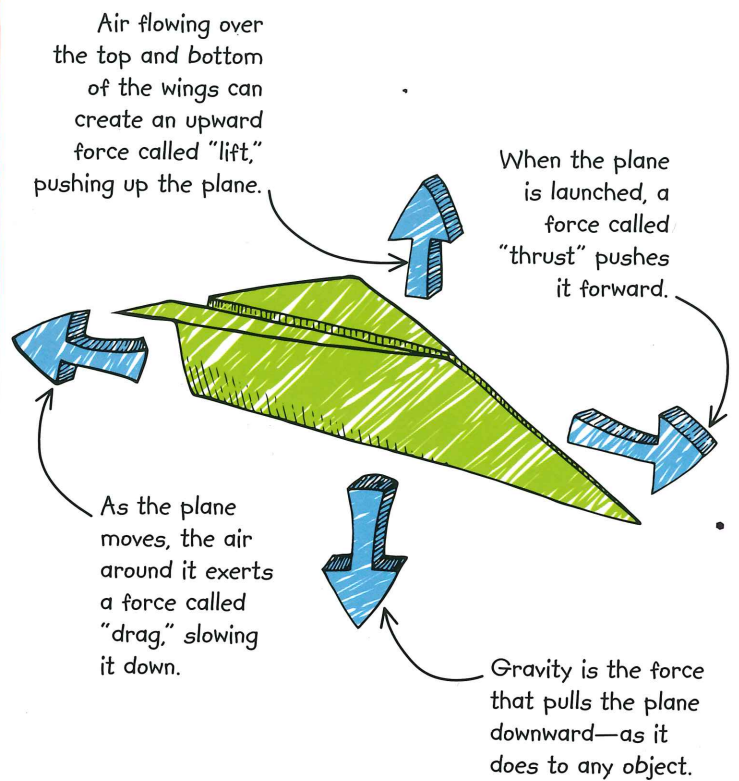
Bending the tailfin to the left or right will make the plane turn in the air.

Folding one flap up and the other down will make the plane twist as it flies.

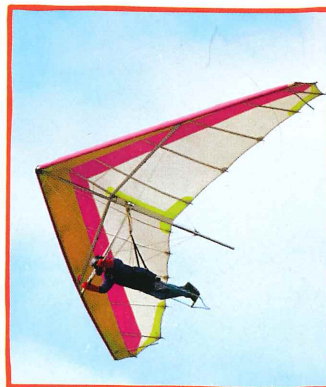
The folds along the wing edges give the plane stability in flight.

HOW IT WORKS

Flying objects experience four types of force: gravity, lift, thrust, and drag. The Dashing Dart speeds through the air because air passes around its streamlined shape easily without exerting much drag. The Graceful Glider experiences lots of lift because its wings have a large area—so it stays in the air for longer. The control surfaces at the back of the Super Stunt Plane change the airflow, creating lift forces that can act sideways or even downward, allowing the plane to change direction, or even spin.



REAL WORLD SCIENCE HANG GLIDER



In the right conditions, with warm air rising up from the ground, a hang glider can stay up for hours. The rising air, called a thermal, pushes up on the underside of the wings, providing lift. To steer, the pilot shifts his or her body to tilt the glider.