## Procedure

1. Go to the Amazing Paper Airplanes webpage with folding instructions for the basic dart design.

http://www.amazingpaperairplanes.com/Basic\_Dart.html

2. Fold your paper into the basic dart paper plane following the instructions. Fold carefully and make your folds as sharp as possible, such as by running a thumbnail along each fold to crease it. In step 6 of the folding instructions, skip the optional step of bending up the tailing edge of the wings.



- 3. Go to a large open area and, using string, a ruler, masking tape, rocks, or sticks, make a line in front of you that is at least 30 centimeters (cm) (or one foot) long, going from left to right. This will be the starting line from which you will fly the paper plane.
- 4. Place your toe on the line you prepared and throw the paper plane. How far does it fly?
- 5. Throw the plane at least four more times. Each time before you throw the plane, make sure it is still in good condition (that the folds and points are still sharp). When you throw it, place your toe on the line and try to throw the plane as similarly as possible, including holding it at the same spot.

## **Discuss with someone sitting next to you:** Did it go about the same distance each time? Why or why not?

7. Once you have a good idea of about how far your plane typically flies, change the plane to increase how much drag it experiences. To do this, cut slits that are about 2.5 cm (or 1 inch) long right where either wing meets the middle ridge. Fold up the cut section on both wings so that each now has a 2.5 cm-wide section at the end of the wing that is folded up, at about a 90 degree angle from the rest of the wing.



8. Throw your modified paper plane at least five more times, just as you did before.

**Discuss with someone sitting next to you:** How far does the paper plane fly now compared to before? Why do you think this is, and how does it have to do with drag?

## What Happened?

As a paper plane moves through the air, the air pushes against the plane, slowing it down. This force is called drag. To think about drag, imagine you are in a moving car and you put your hand out the window. The force of the air pushing your hand back as you move forward is drag, also sometimes called air resistance. In this activity, you increased how much drag acted upon the paper plane by making a one inch-high vertical strip on both wings. For example, this is what happens when you are in a moving car with your hand out the window and change your hand from being horizontal to being vertical. When your hand is held out vertically, it catches a greater amount of air and experiences a greater amount of drag than when your hand is horizontal. You could probably feel this, as your hand would be more forcefully pushed back as the car moves forward. This is what happened to the modified plane — it experienced a greater amount of drag, which pushed it back more than the original plane. Altering how just one force acts upon a paper plane can clearly change how well that plane flies.