

Prep Notes	Bring plenty of paper, to allow for throw-aways! Talk little, fold lots; spend most of your time actually folding.
Materials	Paper (plain white copy paper) Scissors (for some designs)
Teacher Background	
Opener Ideas	Consider referring back to the rockets launched a few months ago; recall the grammar (thrust, drag, apogee, etc.)? Which terms might apply to paper airplanes?
Grammar	<p>(Again, don't spend too much time on this – get to folding quickly!)</p> <ul style="list-style-type: none"> • Thrust: “push”, “propulsion”. For paper airplanes, this is your “throw”. • Lift: the force that opposes gravity; gravity pulls down, lift pulls up. The lift force is produced by the airplane's forward movement – it's derived from the thrust, and greatly influenced by the shape design of the airplane. A plane whose shape contributes to more lift will fly longer. • Drag: the force that opposes the forward motion of an object (like an airplane). Drag is a friction or resistance force, defined completely by the air or fluid through which the object (airplane) flows. In a vacuum, like space, there is no drag force. In a viscous fluid, like water, there is a lot of drag force. • Pitch: the “up” and “down” (“dive”) motion of the nose of an aircraft. • Roll: the “left” and “right” rolling motion of an aircraft, about it's body's axis. • Yaw: the “left” and “right” turning motion of an aircraft, about the vertical axis.
Scientific Method	
<p>The scientific method is not uniquely applicable here, but it can be employed to answer questions like,</p> <ul style="list-style-type: none"> • What variables will effect the pitch, roll, and yaw of a paper airplane? (Symmetry? Shape?) • What variables will decrease the drag of a paper airplane? (Profile? “Aerodynamics?” Paper type?) • How can I generate more thrust with my throw of a paper airplane? (Longer hold? Stronger muscles?) • How can I translate my thrust into more (or more sustained) lift? (Paper weight? Wing length?) • How can I increase (or decrease) stability? (Weighted nose? Weighted tail? Tail volume?) <p>Each could inspire some experimental design ideas which attempt to define the constants (all of the variables you try to keep the same; e.g., the shape and room conditions), modify the independent variable (e.g., the paper weight), and measure the dependent variable (e.g., the flight duration or distance)? If you do this, remember to always run multiple trials and take the average of the measurements you make.</p>	
More	
<ul style="list-style-type: none"> • Lots of interesting kid-centric Q&A at: http://www.paperplane.org/questions.html • Could a paper airplane fly in a vacuum, like space? Yes and no. The normal dynamics at play on an aircraft, which translate thrust into lift, will not operate in a vacuum. Rather, just as a feather and a bowling ball drop at the same rate in a vacuum on earth, so would a paper airplane. However, the thrown plane would continue in a straight line at constant speed (Newton's First Law), while falling, until it hit the ground. If you consider this horizontal travel, while falling, “flying”, then yes, the paper airplane (or a plate of spaghetti) can “fly” in a vacuum. In space, with essentially no gravity, a plane (or dinner) would fly forward constantly, whether it was thrown forward, sideways, or tail-first. • Couldn't a spacecraft accelerate to light-speed in a vacuum like space? Not easily; regardless of drag, it takes a lot of energy to accelerate a mass to near light speed. Theoretically, if you had a lot of fuel, you could eventually do it by continually applying the thrust force and increasing the velocity. 	