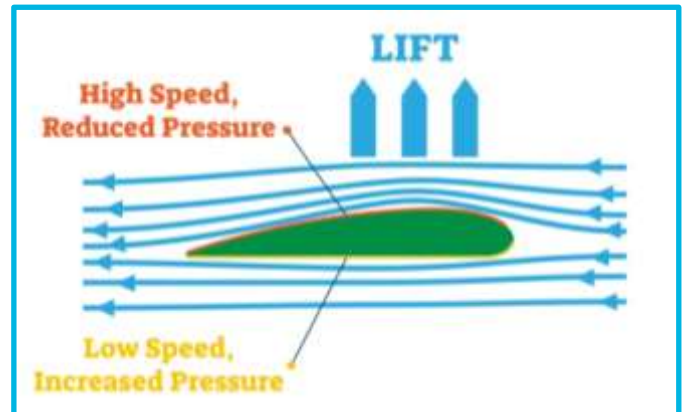


Student Resource: What Forces Impact Flight?

There are four forces that impact flight: Weight, Lift, Drag, and Thrust. All four forces have to be taken into consideration when designing and building a glider or airplane. In flight, each force has an opposite force that works against it.

Everything has **weight**, which is a result of gravitational forces. The materials selected for a glider design will have a weight that will need to be offset by "Lift" in order to fly.



Lift is an aerodynamic force that helps to counteract weight. The heavier an object is, the harder it is for lift to work against it and achieve flight. But, the forward motion (velocity) or **thrust** of an aircraft through the air along with the shape of the aircraft and its parts, especially its wings, all impact how strong the force of lift will be! Many wings have a curved shape on top and are flatter on the bottom so air moves faster over the top. When air moves faster, the pressure of the air decreases. If the pressure on the top of the wing is lower than the pressure on the bottom of the wing, the difference in pressure helps lift the wing up into the air.

The last of the four forces impacting flight is **drag**....and this force works to slow a glider or plane. Drag is a force that acts opposite to the relative motion of any object moving with respect to surrounding air (or water!). For example, drag acts opposite to the direction of movement of an object such as a car, bicycle, airplane, glider, or boat hull. It is impacted by the shape and material selection of a plane or boat, as well as other factors, including the humidity of the air. It is also impacted by the thrust or speed of the aircraft...the greater the thrust, the greater the drag.

In the case of the glider to be built as part of this lesson...the thrust is generated by the person who will push your plane through the air during testing! For a motorized plane, it is the motor that provides propulsion and the power to move through the air. A plane may have several motors to generate thrust, and the design of the motor also impacts how the surrounding air is moved, which in turn impacts thrust and drag.

All the forces impacting flight are interrelated. How a plane flies depends on the strength and direction of all four forces! If all are in balance, a plane will move along at a constant velocity. If there are any imbalances, the plane will move in the direction of that force...for example if weight overpowers lift, the plane will move down.

A plane goes up if the forces of lift and thrust are stronger than gravity and drag. If gravity and drag are stronger than lift and thrust, the plane goes down.

Take Flight!

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Student Resource: **The Wright Brothers**

Orville Wright (August 19, 1871 – January 30, 1948, left) and Wilbur Wright (April 16, 1867 – May 30, 1912, right), were two brothers and aviation pioneers who are generally credited with inventing, building, and flying the world's first successful airplane. They made the first controlled, sustained flight of a powered, heavier-than-air aircraft on December 17, 1903, near Kitty Hawk, North Carolina, US. In 1904–05 the brothers further developed their flying machine into the first practical fixed-wing aircraft. Although not the first to build and fly experimental aircraft, the Wright Brothers were the first to invent and fine tune aircraft controls that made fixed-wing powered flight possible.

The brothers' real breakthrough was their invention of three-axis control – this enabled a pilot to steer the aircraft and maintain equilibrium, or balance. This method still remains the standard for all kinds of fixed-wing aircrafts. While others of the era were focusing on making more powerful engines, the Wright brothers thought that finding a way to control an aircraft was the more pressing challenge.

Using a small homebuilt wind tunnel, the brothers tested and retested their ideas and designs. They collected lots of data that helped them design and build more efficient wings and propellers that could be controlled. Their first U.S. patent, 821,393, did not claim invention of a flying machine, but rather, the invention of a “system of aerodynamic control that manipulated a flying machine's surfaces.”

They gained the experience and skills essential for their success by working with printing presses, bicycles, motors, and other machines. Their work with bicycles in particular influenced their belief that an unstable vehicle like a flying machine could actually be controlled and balanced with practice! From 1900 until their first powered flights in late 1903, they conducted extensive glider tests that also developed their skills as pilots.



More details on the Invention Process of the Wright Brothers can be found at <https://wright.nasa.gov/overview.htm>.

Take Flight!

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