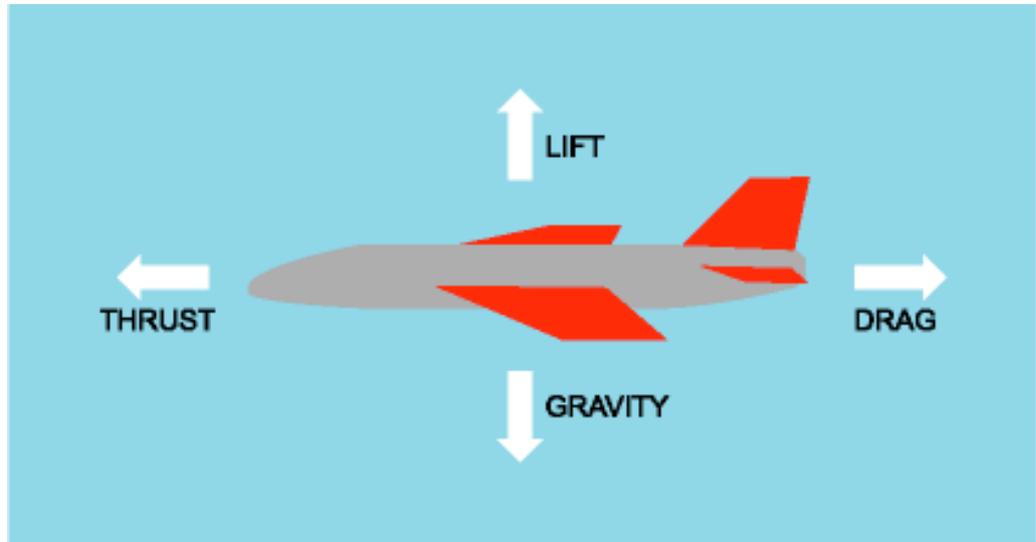


There are 4 main forces that act on a paper airplane (or a real airplane for that matter) while it is flying. These are:

- Lift
- Gravi
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- Thrus
t
- Drag



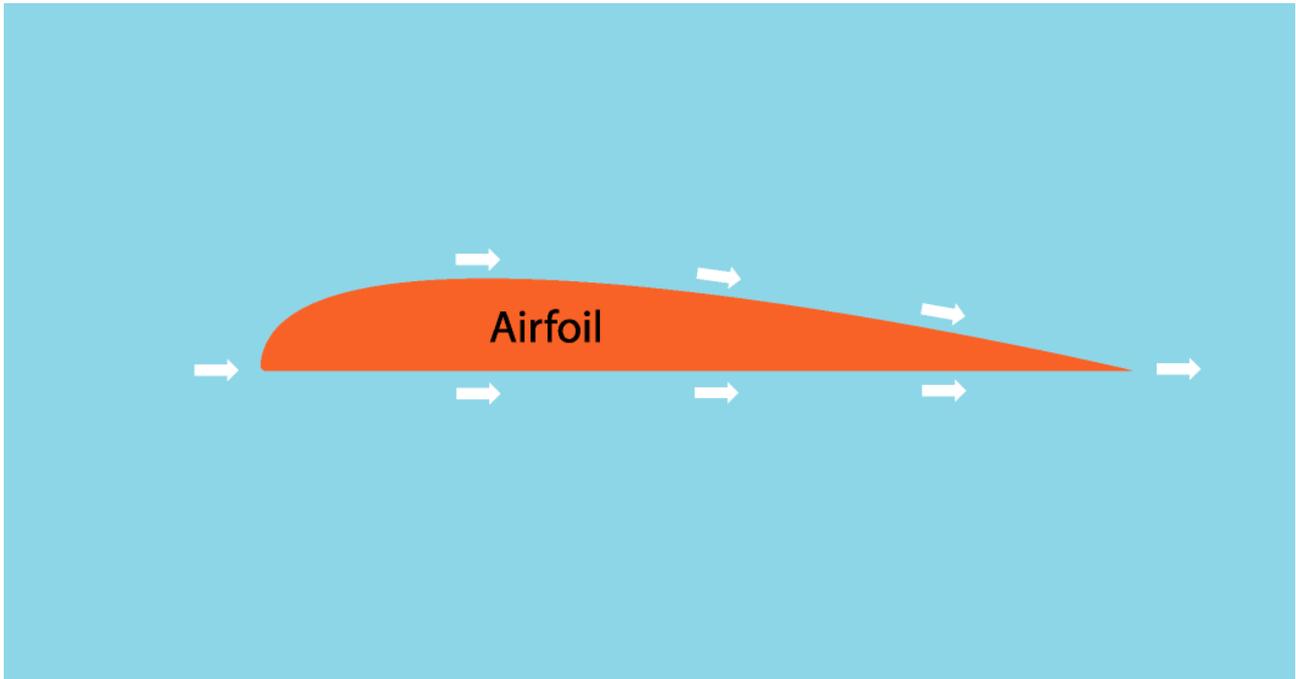
Lift is the force that keeps the airplane in the air. Without lift the plane would not fly. Lift can be a very complicated force to explain, but here are two basic models to give an intuitive understanding.

1. **Bernoulli's Principle** (named after Swiss Physicist Daniel Bernoulli):

If you ever look closely at the wings of an airplane from the side, you will notice that they are not flat. The wing has a curved shape to it. This shape is called an airfoil. Airfoils are specially designed to produce lift.

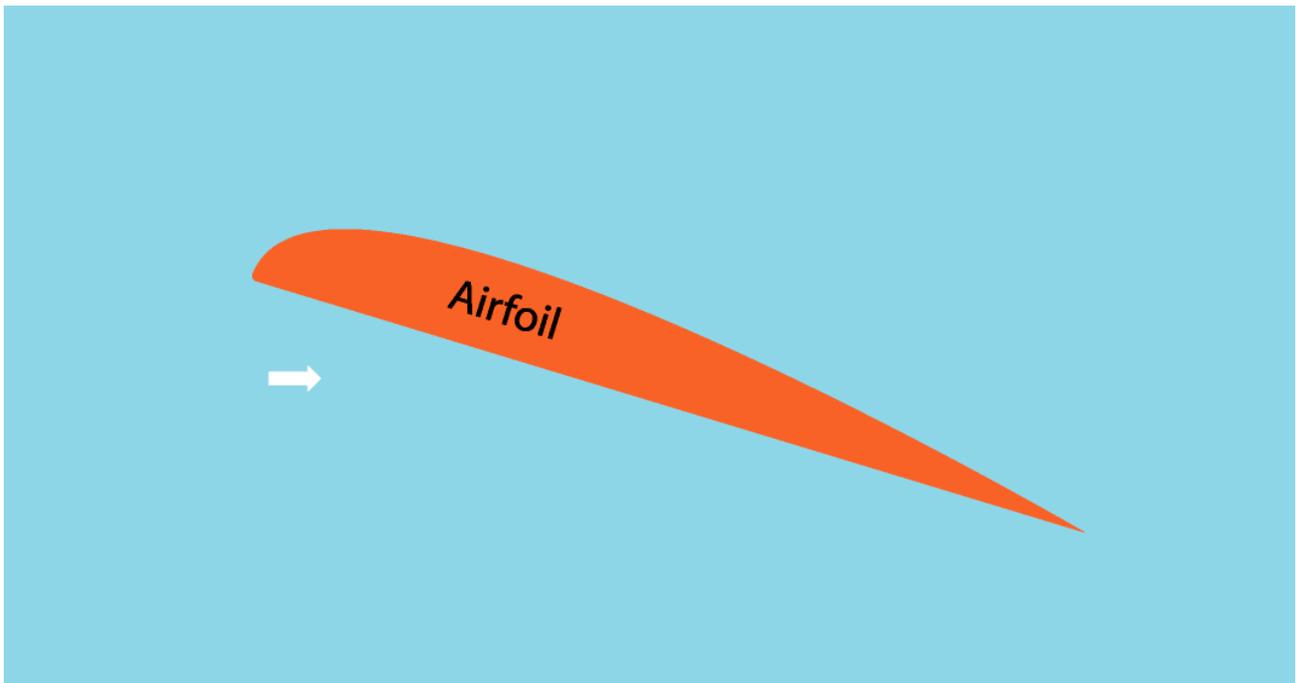
To understand how Bernoulli's principle causes lift, we must first understand that air usually presses equally on all sides of an object. Suppose that as the plane flies forward, the approaching air splits up when it hits the leading (front) edge of the wing and rejoins at the trailing (back) edge of the wing. The airfoil shape causes the air to go farther over the top of the wing than under the bottom, both in the same amount of time. This means the air on top of the wing must move faster. When air speeds up, its pressure gets lower. Since the air pressure on top of the wing is lower than the air

pressure on the bottom of the wing, the wing produces lift! This phenomenon is called Bernoulli's principle.



2. Newtonian Explanation

The famous scientist Sir Isaac Newton stated in his famous third law that , "For every action, there is an equal and opposite reaction." Newtonian lift largely depends on the tilt of the wing or "angle of attack". If the leading edge of the wing is pointing upward, the bottom surface is deflecting oncoming air downward. When this air bounces off the bottom surface of the wing (action), it pushes the wing upward (reaction)...or produces lift.



Gravity is a force that we are all familiar with. It's what causes any object you throw into the air to come back to the ground. Gravity is also what keeps us on the ground. Without gravity, we would all float away into space! With airplanes, gravity works against lift by pulling the airplane toward the ground.

Thrust is the force that causes the plane to move forward through the air. In a real airplane, this is produced by the turning propellers or jet engine. With a paper airplane, the thrust is produced when you throw the plane into the air. Without thrust, planes could not produce lift.

Drag is the force that tries to slow the airplane down. Drag is produced when air flowing over the plane causes friction. When the plane is flying, it must push oncoming air out of the way. As this air is pushed around the plane, it bumps into other air molecules. Air close to the surface of the airplane also wants to try to stick to it. All of this causes friction. Have you ever ridden your bike on a windy day? The wind hitting you in the face that makes it hard to keep moving is drag.

Lift and thrust help to keep a plane flying. Gravity and drag work against it. We can't do anything to change gravity, but we can try to

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minimize drag and increase lift and thrust. This will make a paper airplane fly well. Go to the [Plane Downloads](#) section to learn more about different types of paper airplanes.