

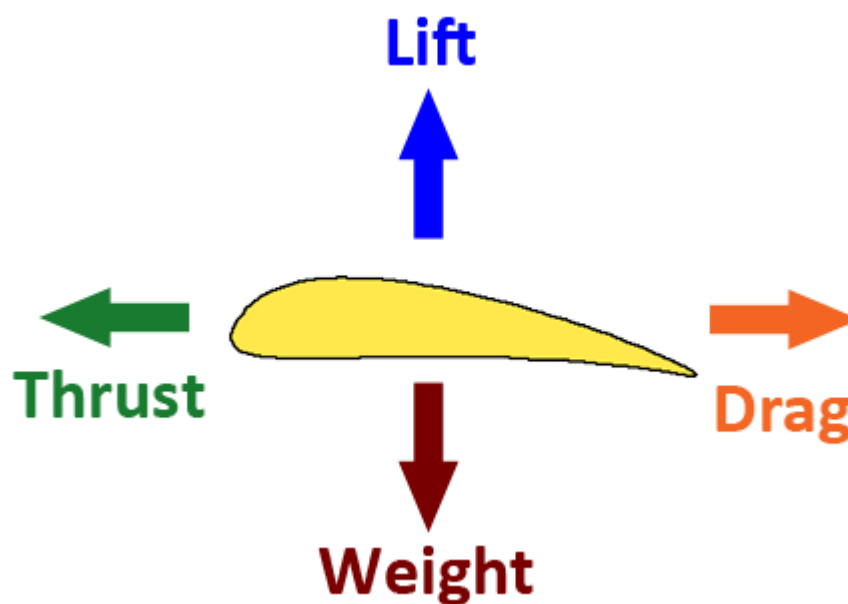
Fundamental Of Flight

Forces Acting on An Airplane

There are four forces acting on the airplane all the time during airplane is flying. The four forces are:

- (1) Lift
- (2) Gravity force or Weight
- (3) Thrust
- (4) Drag

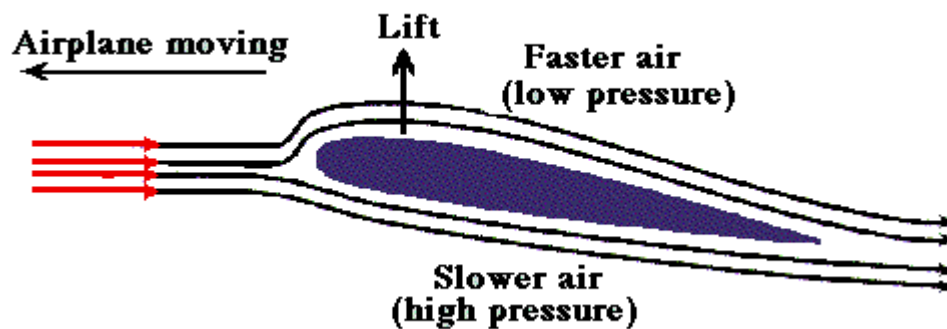
Lift and Drag are considered aerodynamics forces because they exist due to the movement of the Airplane through the Air.



Lift:

Lift is produced by a lower pressure created on the upper surface of an airplane's wings compared to the pressure on the wing's lower surfaces, causing the wing to be LIFTED upward. The special shape of the airplane wing (airfoil) is designed so that air flowing over it will have to travel a greater distance and faster resulting in

a lower pressure area (see illustration) thus lifting the wing upward. Lift is that force which opposes the force of gravity (or weight).



Lift depends upon:

- (1) Shape of the airfoil
- (2) Angle of attack
- (3) Area of the surface exposed to the airstream
- (4) Square of the air speed
- (5) Air Density.

LIFT EQUATION

$$L = C_L \times d \times \frac{V^2}{2} \times A$$

L = Lift **d = Density of Air**
C_L = Lift Coefficient **V = Velocity of Air**
A = Wing Area

Weight:

The weight acts vertically downward from the center of gravity (CG) of the airplane.

Thrust:

Thrust is defined as the forward direction pushing or pulling force developed by aircraft engine. This includes reciprocating engines, turbojet engines, and turboprop engines.

THRUST EQUATION

Thrust is a Force Force is the change in Momentum with time

$$F = \frac{([MV]_e - [MV]_0)}{(t_e - t_0)}$$

$m' = \text{mass flow rate} = \text{mass} / \text{time}$

$m' = d \times V \times A = \text{Density} \times \text{Velocity} \times \text{Area}$

Thus $F = m'_e V_e - m'_0 V_0$

Drag:

Drag is the force which opposes the forward motion of airplane. Specifically, drag is a retarding force acting upon a body in motion through a fluid, parallel to the direction of motion of a body. It is the friction of the air as it meets and passes over an airplane and its components. Drag is created by air impact force, skin friction, and displacement of the air.

DRAG EQUATION

$$D = C_D \times d \times \frac{V^2}{2} \times A$$

$D = \text{Drag}$ $d = \text{Density of Air}$

$C_D = \text{Drag Coefficient}$ $V = \text{Velocity of Air}$

$A = \text{Wing Area}$