

# Aerodynamics

## Control Surfaces

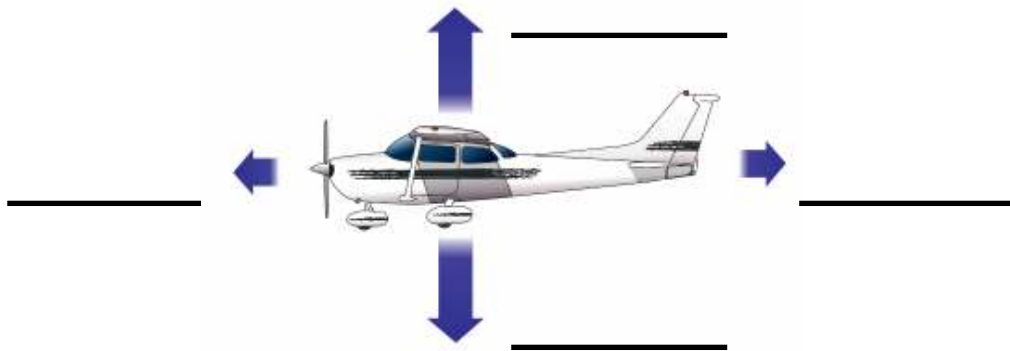
The \_\_\_\_\_ make the aircraft \_\_\_\_\_ around the lateral axis.

The \_\_\_\_\_ make the aircraft \_\_\_\_\_ around the longitudinal axis.

The \_\_\_\_\_ makes the aircraft \_\_\_\_\_ around the vertical axis.

## Forces of Flight

Label the four forces of flight:

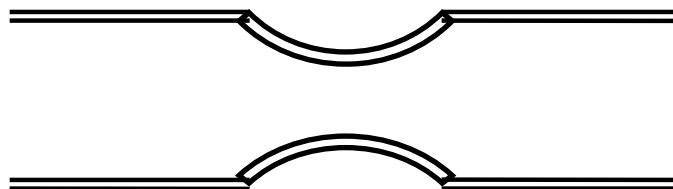


In straight and level, unaccelerated flight, \_\_\_\_\_ equals weight and \_\_\_\_\_ equals drag.

## Lift – Bernouli’s Principle

This principle accounts for approximately \_\_\_\_\_ % of lift.

A pipe with a narrowed section is called a \_\_\_\_\_ tube.

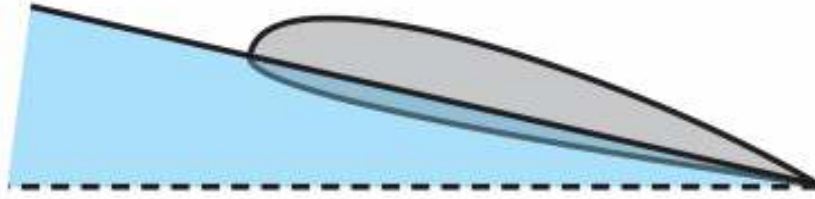


When water passes through the center, the velocity \_\_\_\_\_ and the pressure \_\_\_\_\_.

## Airfoils

An airfoil is any surface which provides aerodynamic force when it interacts with a moving stream of air.

Label/draw the leading edge, the trailing edge, the chord, the chamber of the upper surface, the chamber of the lower surface, the mean chamber line, and the angle of attack.



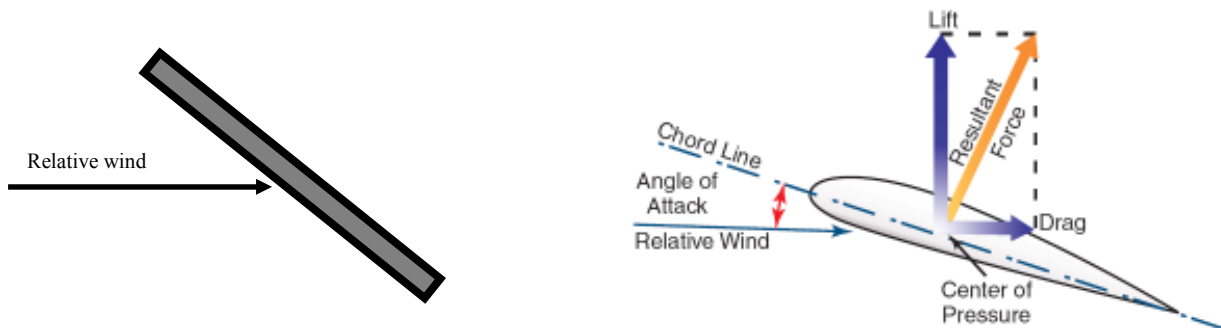
Not to be confused with the angle of attack, the angle of \_\_\_\_\_ is the angle at which the wing is attached to an airplane.

## Lift – Newton’s Third Law

Newtonian lift accounts for about \_\_\_\_\_% of the lift generated by a wing.

Newton’s third law states that: Whenever one body exerts a force on another, the second body always exerts on the first, a force that is \_\_\_\_\_ in magnitude but \_\_\_\_\_ in direction.

Draw the forces that would result if the wind impacted a “flat plate” and compare this to how the wind impacts a wing:



What is the backwards force on the plate called?

## Factors That Affect Lift

List the factors that affect lift:

$$\text{Lift} = \frac{1}{2} \rho V^2 \cdot C_L \cdot A$$

---

---

---

---

*“Thou shalt keep up thy airspeed, lest the ground reach up and smite thee.”*

## Drag

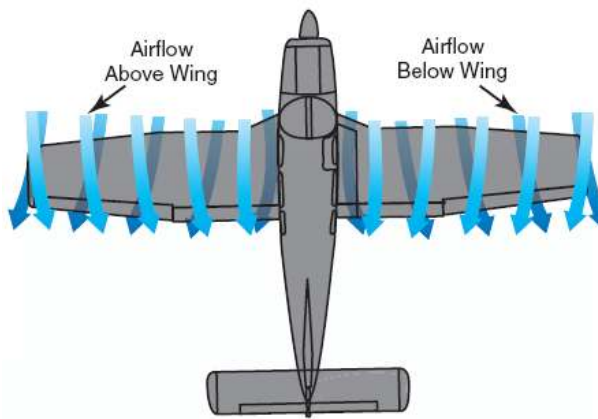
Drag is an aerodynamic force on a body acting parallel and opposite to the relative wind.

P \_\_\_\_\_ drag is the type of drag created by the form or shape of airplane parts. It is the result of air molecules “bumping into” an aircraft.

It can be created by:

1. Air impacting the front of the aircraft. (Form drag)
2. The skin friction of the aircraft. (Skin friction drag)
3. Air getting trapped in corners. (Interference drag)

I \_\_\_\_\_ drag is a by-product of lift.

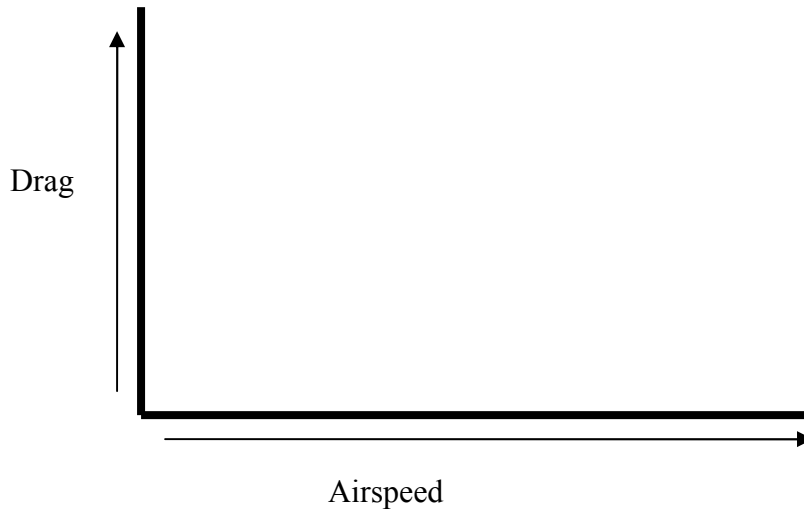


Why does the air move from the bottom of the wing to the top?

When the plane goes faster, will it experience more induced drag, or less?

## Total Drag

Plot induced drag, parasite drag, and total drag:



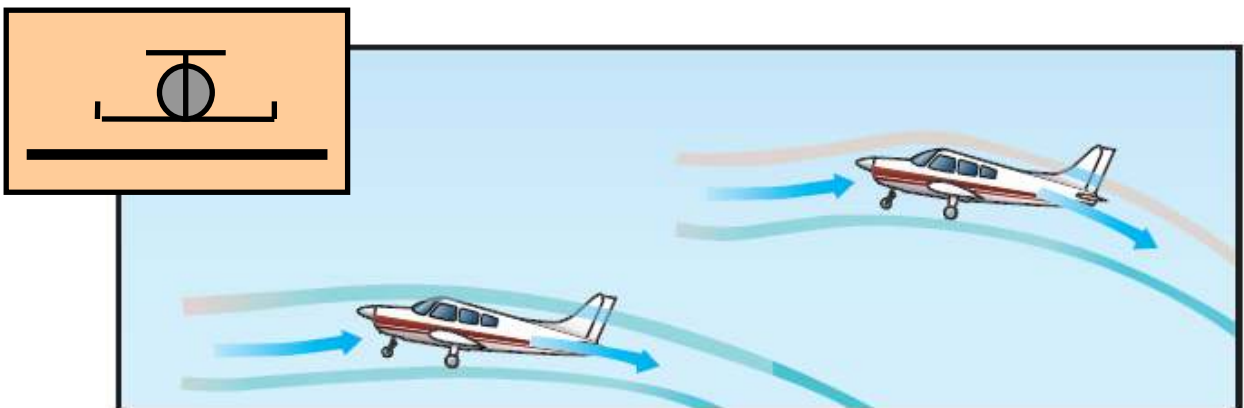
What is the lowest point on the “total drag” curve called?

When do we use this in flight?

What is another name for the backside of the power curve?

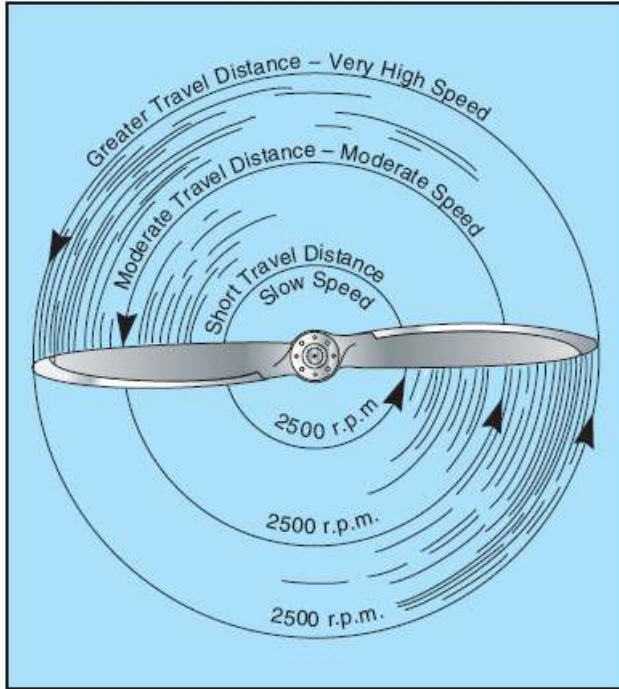
## Ground Effect

Ground effect is \_\_\_\_\_ induced drag. It occurs when the ground interferes with the airflow around the wings. It has been described as “a cushion of air” and is most noticeable within a wingspan of the ground.

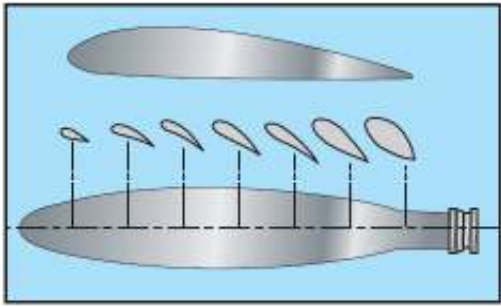


## Thrust

The propeller of an aircraft is an airfoil. It is driven by the engine and provides the thrust necessary to pull the aircraft through the air.



“The propeller is actually just a big fan to keep the pilots cool. When it stops spinning, the pilots start sweating.” – Anonymous



\_\_\_\_\_ thrust makes an airplane climb.

## Weight & Turns

The \_\_\_\_\_ component of lift makes an aircraft turn.

