THEORY OF FLIGHT PART I

"EVERY TAKE OFF IS OPTIONAL. EVERY LANDING IS MANDATORY."

1.1.1 THE AIRPLANE

- Definition

"a power driven heavier than air aircraft deriving its lift in flight from aerodynamic reactions on surfaces that remain fixed under given conditions of flight"

CLASSIFYING AN AIRPLANE

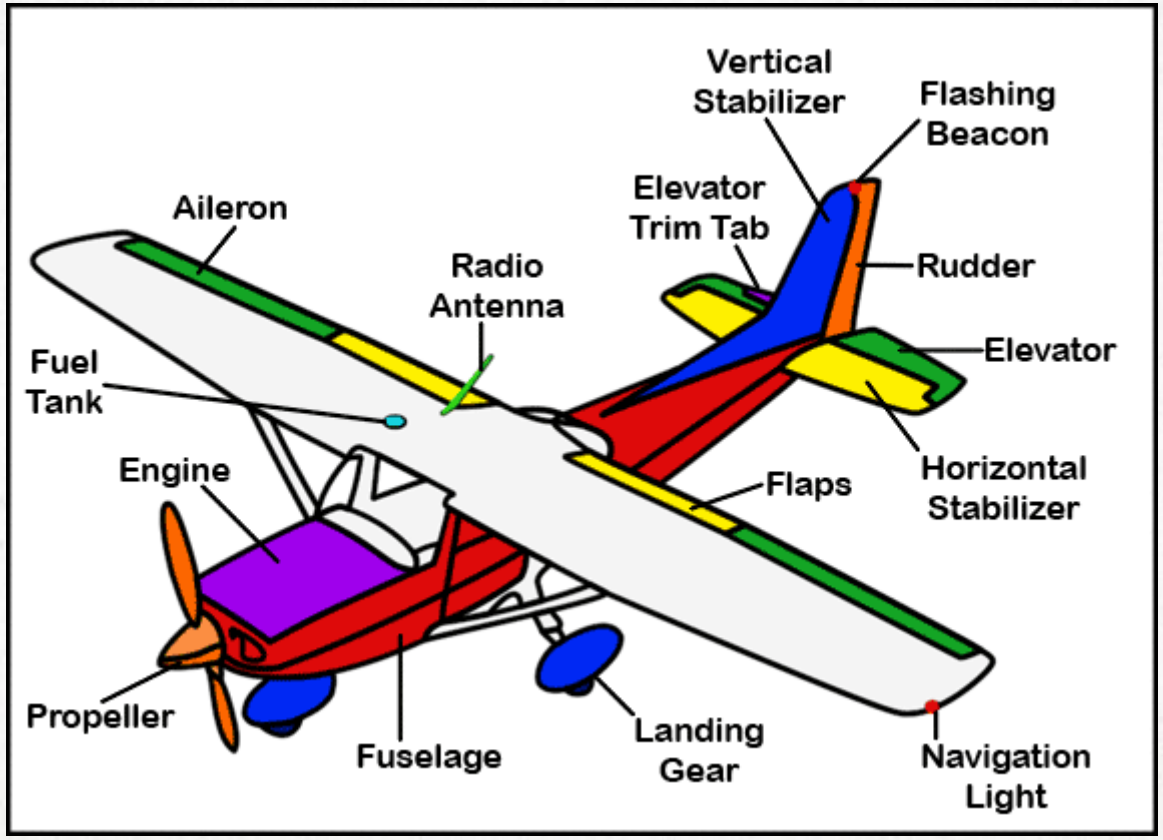
- Many different ways to do so
    - Position of its wings in relation to the fuselage
    - # of engines
    - Type of wings – high or low
    - Type of landing gear – conventional or retractable

1.1.2 PARTS OF AN AIRPLANE

- Components of an airplane are:

    1. The fuselage or body
    2. The wings or lifting surfaces
    3. The tail section (empennage)
    4. The propulsion system
    5. Undercarriage or landing gear

PARTS OF AN AIRPLANE



CHECKPOINT - *WUN*

AIR FRAME

- **Definition:** Includes everything listed on the slide 5 except engines. It also does NOT include instruments.

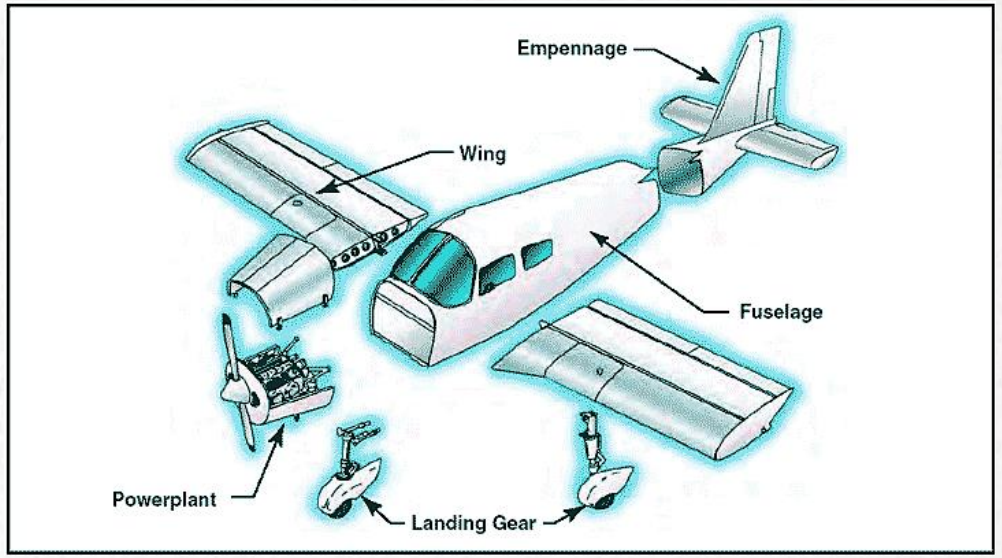
- Basically, air frame describes the structure of an airplane, including the fuel tanks and lines but without instruments and engines installed.

- Includes fuselage, wings, tail assembly and the landing gear.

FUSELAGE

- Central body of an aircraft
- Passengers, cargo and crew are located in here.
- Many other parts of the aircraft are attached to it.
- The fuselage is normally classified according to the type of construction:

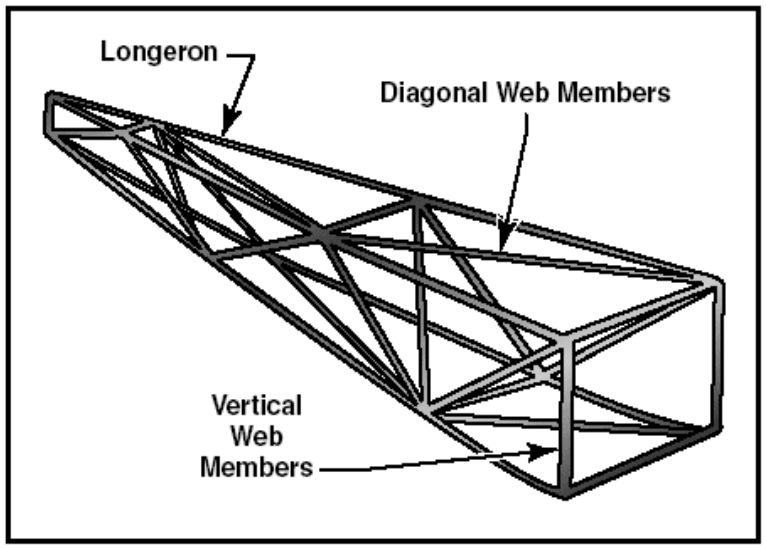
  a) Truss type b) Monocoque



FUSELAGE

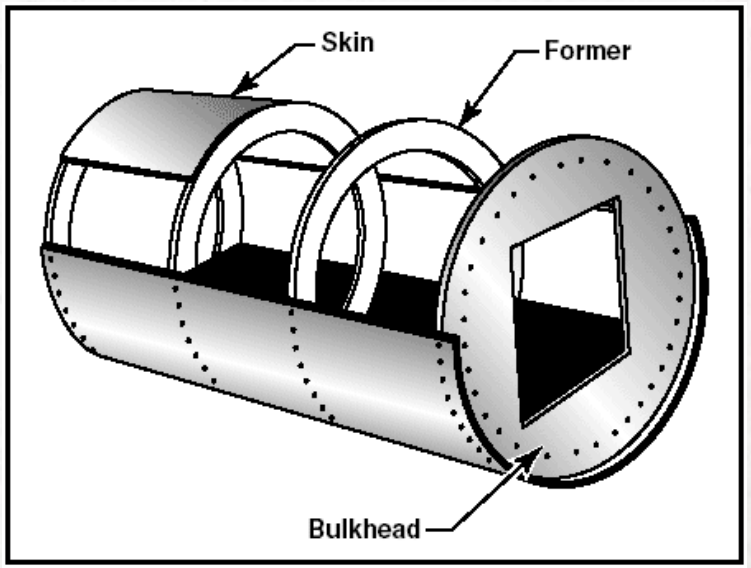
TRUSS TYPE

- Longerons are the principle members

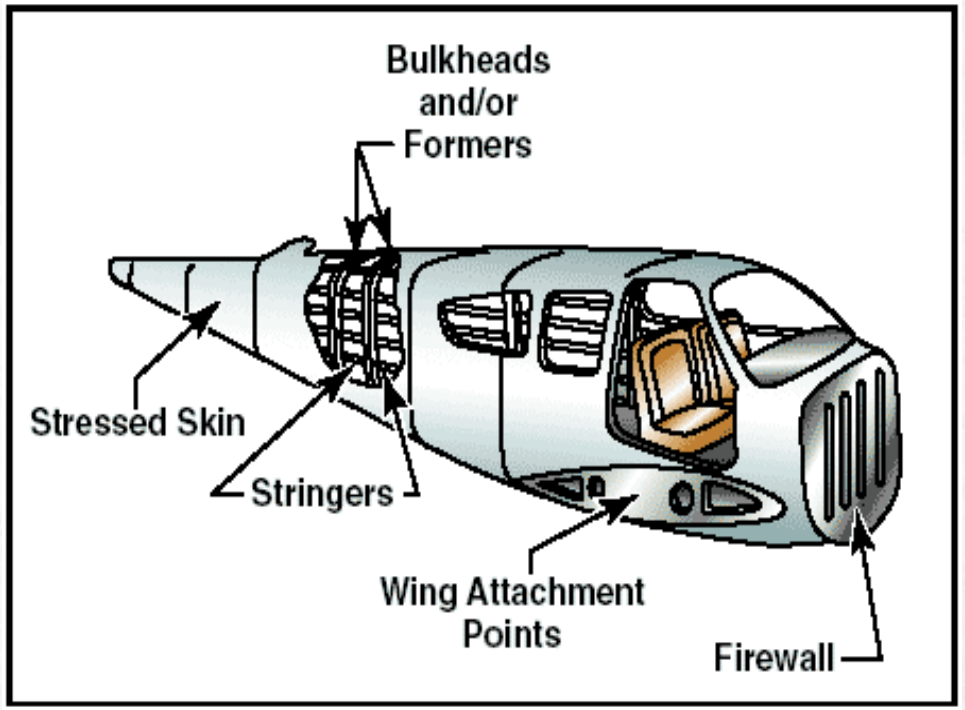


MONOCOQUE

- Consists of oval formers or bulkheads held together by stringers



FUSELAGE: SEMI-MONOCOQUE TYPE



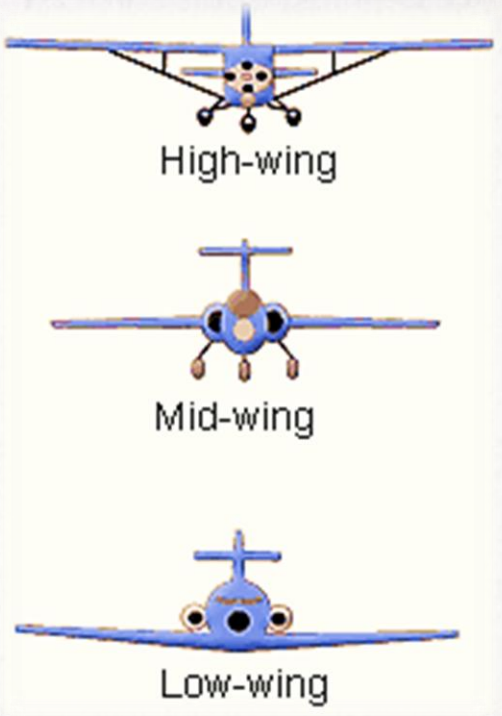
CHECK POINT - *TOO*

Is the cadet glider an “Airplane/Aeroplane”?

Why or why not?

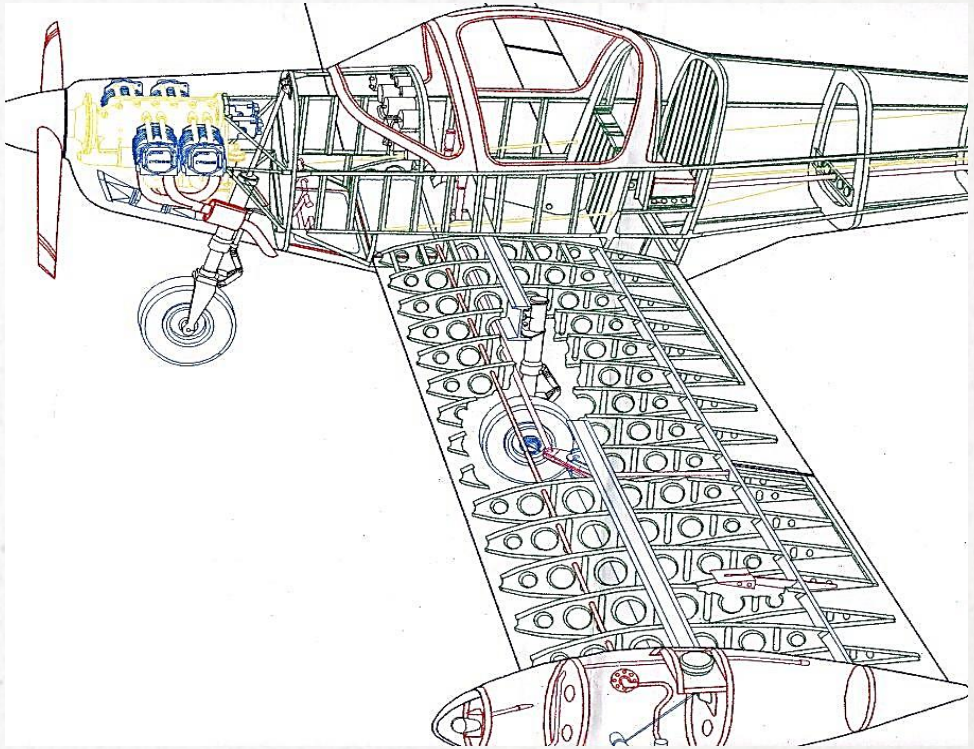
THE WINGS

- Biplanes – those with two pairs of wings
- Wing Layout
  a) High Wing
  b) Mid Wing
  c) Low Wing



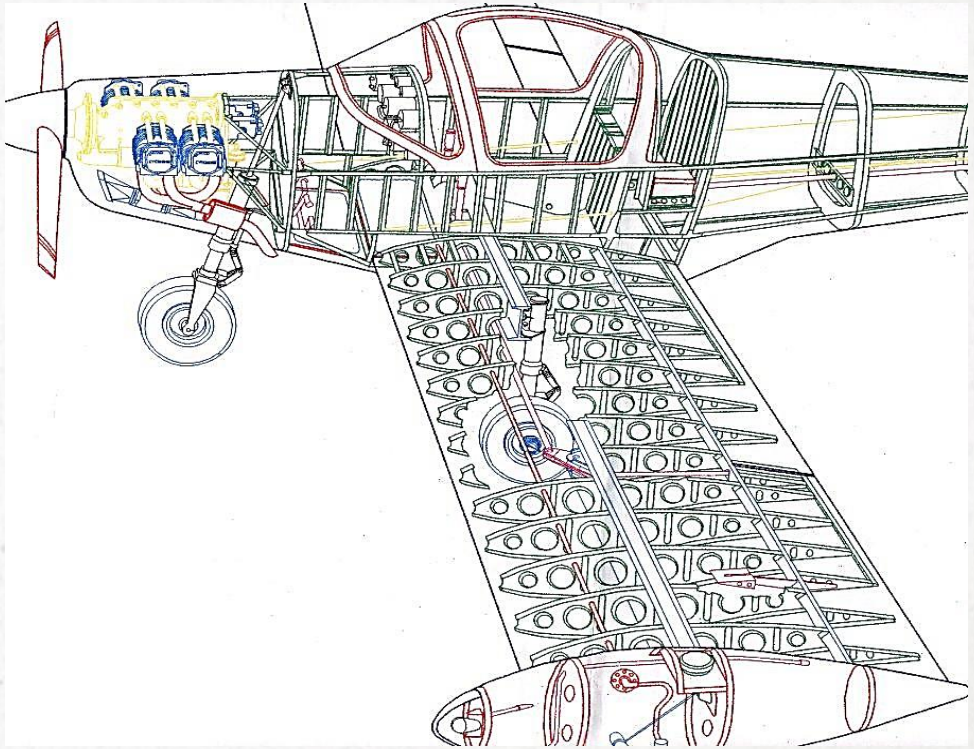
THE WINGS

- Wing Construction
  - Leading Edge
  - Trailing Edge
  - Wing Root
  - Wing Tip



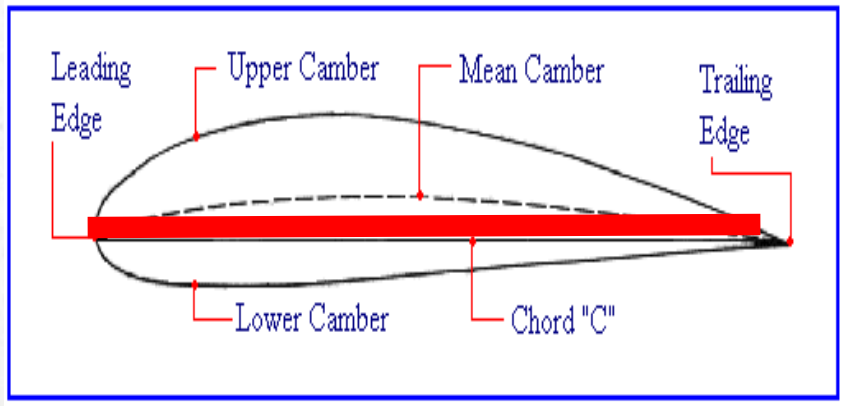
THE WINGS

- The main members of the wing are the spars.
  - Run from wing root to wing tip.
- The ribs run from the leading edge to the trailing edge.
  - Give the wind its shape and to provide a framework to which the covering is fastened.

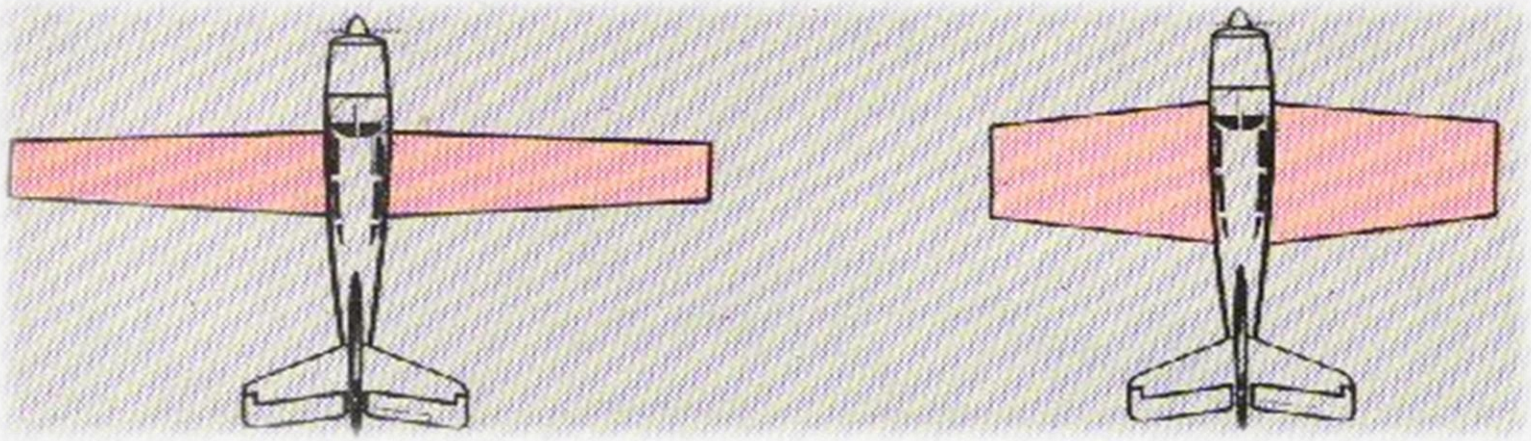


THE WINGS

- **Wing Span** is the maximum distance from **wing tip** to **wing tip**
- **Chord** is the imaginary line between the **leading edge** and **the trailing edge of the wing** (width of the wing).
- Important in calculating **aspect ratio**: span/chord.



CHECK POINT - *TREE*



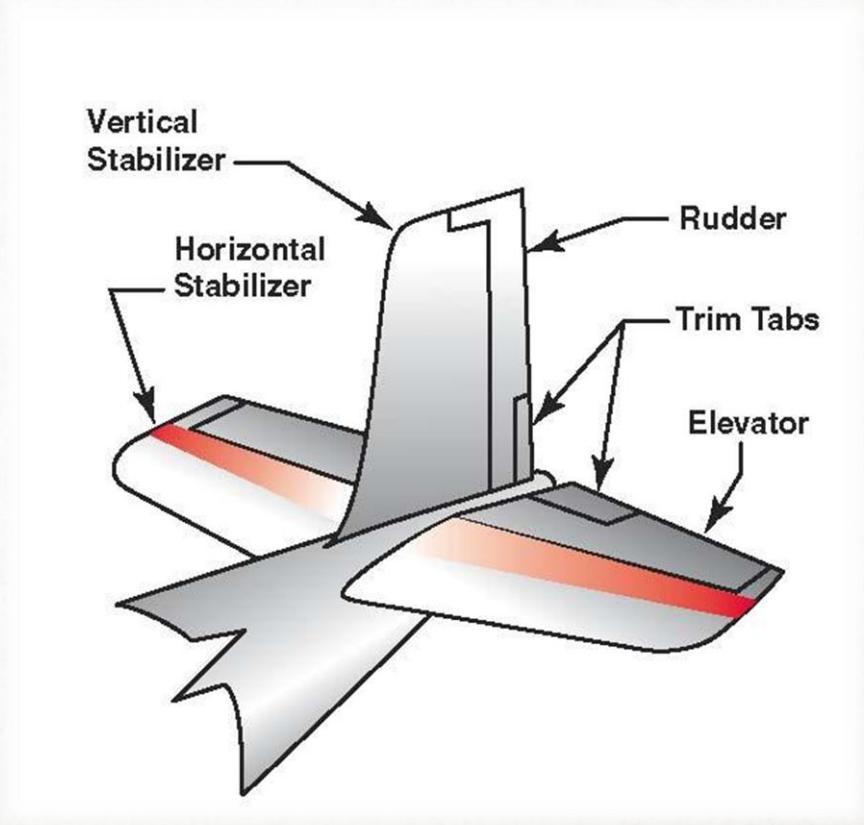
Which aircraft has a larger aspect ratio?

CHECK POINT - *FOWER*

In general aviation today, what kind fuselage frame is used?

THE EMPENNAGE

- The empennage is the rear portion of the airplane (also called the tail)
- It is integral to control and stability during flight
- Some **VERY** important controls include: yaw (directional), pitch (longitudinal).



LANDING GEAR

Type	Definition
Conventional (Tail-Dragger)	Two main wheels and a tail wheel
Tricycle	Two main wheels and a nose wheel (most Cessna)
Retractable	Wheels may be raised so that they are enclosed in wings or fuselage (reducing drag)
Fixed	Landing gear is not designed to retract

CHECKPOINT – *FIFE*

What kind of landing gear does this aircraft have?

CHECKPOINT – *SIX*

What might be some advantages and disadvantages of this kind of landing gear?

LANDING GEAR

- Brakes
  - Provide a means of stopping the aircraft quickly
  - Assist with steering on the ground – these are called differential brakes

CHECKPOINT – *SEVEN*

Name as many characteristics of this aircraft as you can!

Hint: There are about 4

THE PROPULSION SYSTEM – COVERED IN DETAIL LATER

- Generally a gasoline powered, air cooled, internal combustion engine that drives a 2 or 3 bladed propeller
- General Definitions
  - The cowling: encloses the engine and streamlines the front the airplane to reduce drag
  - Engine mount: the structure that supports the engine (steel tubes welded together)
  - Firewall: heavy sheets of stainless steel that separate the main structure and the engine

1.2.3 CONSTRUCTION MATERIALS

- **Stresses:** a force, or a combination of forces, exerting a strain
- **Strain:** distortion in form due to stress.
- Demo: BOX
- Current problem in industry – making an aircraft both **light** and **strong**.

1.2.3 CONSTRUCTION MATERIALS

- Types of Stress
  - Compression: “crushing” – What part of the aircraft may experience this?
  - Tension: “stretching” - What part of the aircraft may experience this?
  - Torsion: “twisting” - What part of the aircraft may experience this?
  - Shearing: “cutting” - What part of the aircraft may experience this?
  - Bending: “bending” due to a load or weight being imposed. What part of the aircraft may experience this?

1.3 AIRCRAFT CLASSES AND CATEGORIES

- Depends on their configuration and intended design application

1. Normal Category – most small planes, cannot handle excessive load
2. Utility Category –instructing training pilots in special maneuvers
3. Aerobatic Category – can handle excessive load (6X the gross weight)
4. Commuter Category – carry passengers, limited capacity and weight
5. Transport Category – airliners and other large airplanes
6. Additional Category – used for special applications such as aerial fire-fighting, aerial photography, some military aircrafts etc.

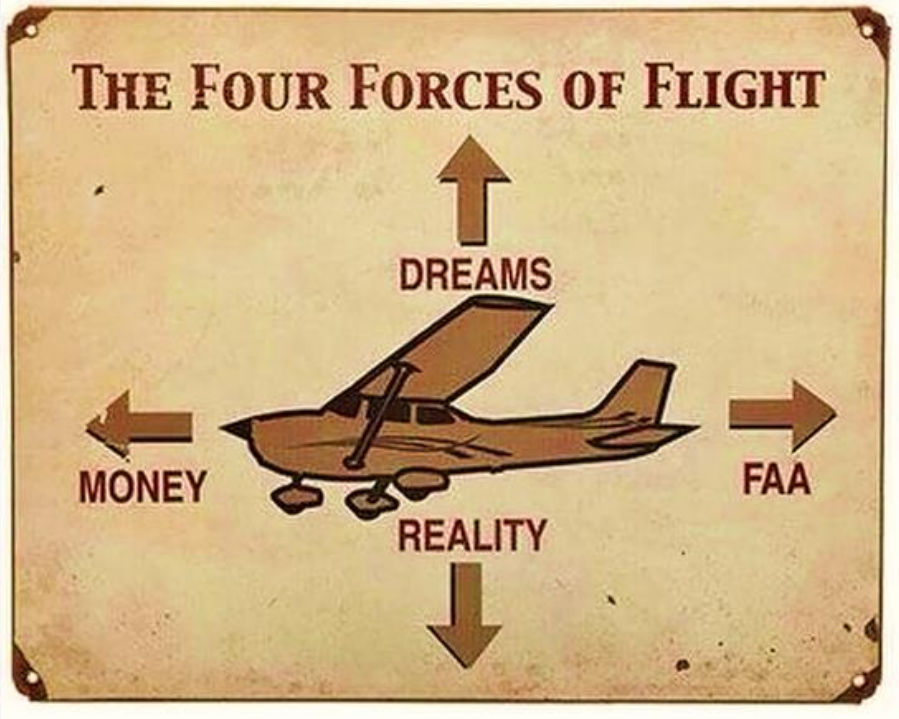
CHECK POINT - *AIT*

A stretched wire is an example of _____

a) Stress

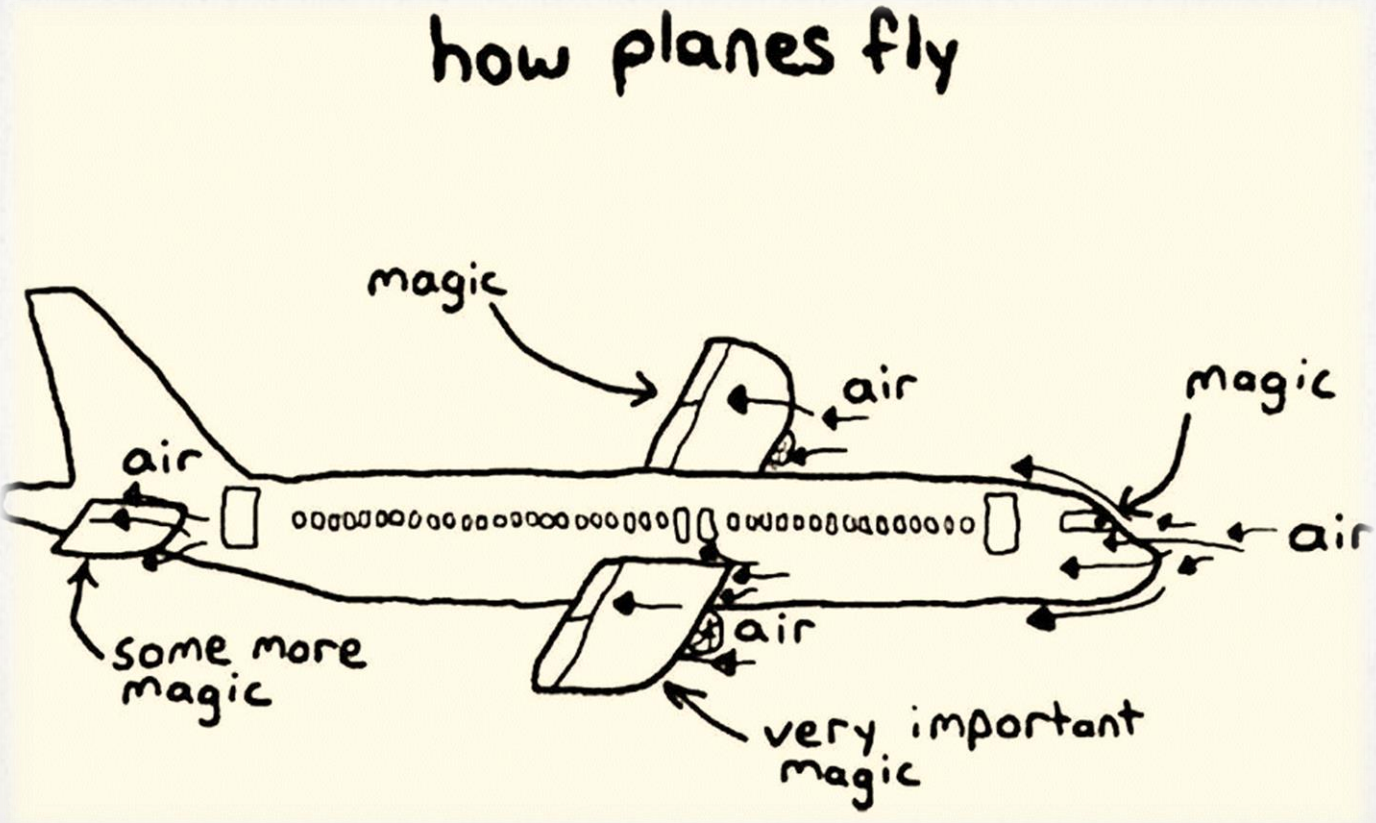
b) Strain

BREAK TIME!

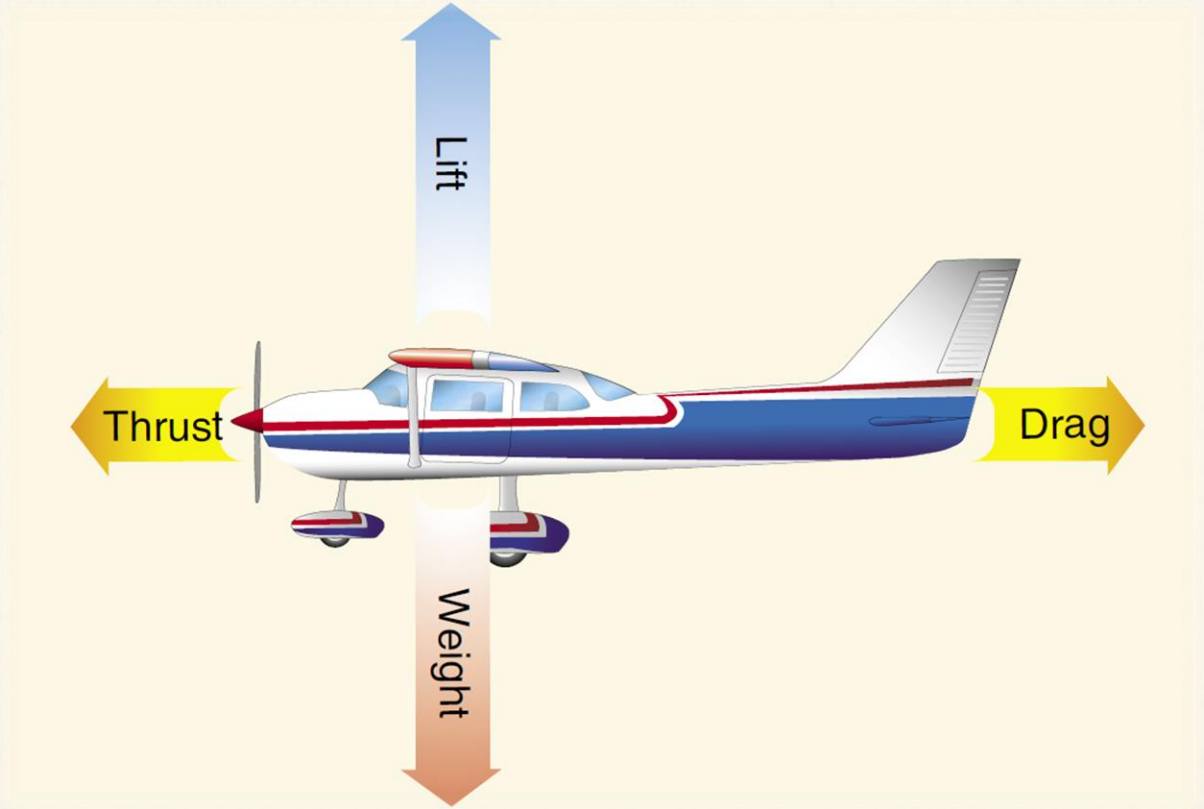


Be back in 10 mins exactly!

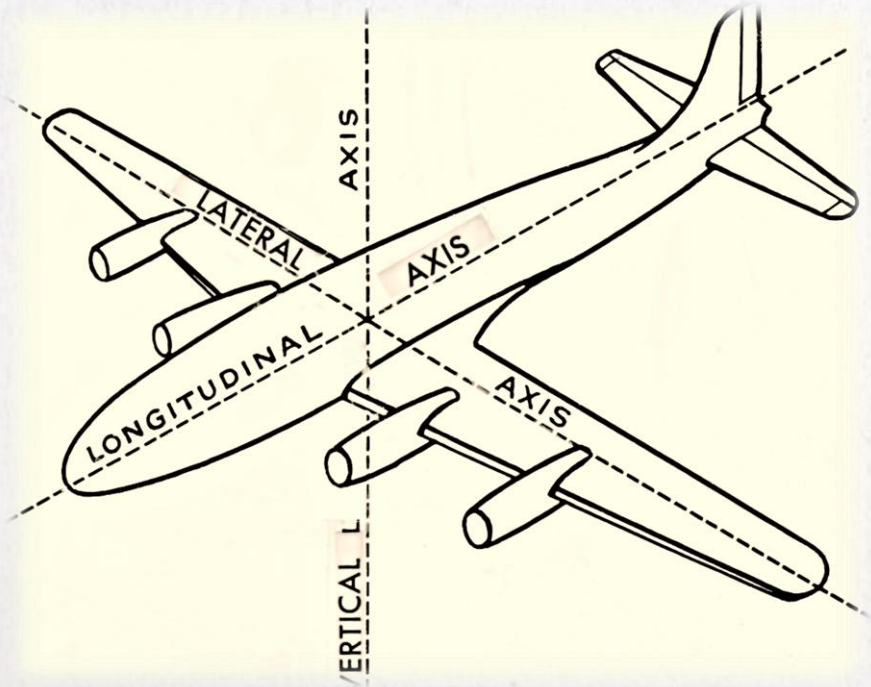
HOW DO PLANES FLY?

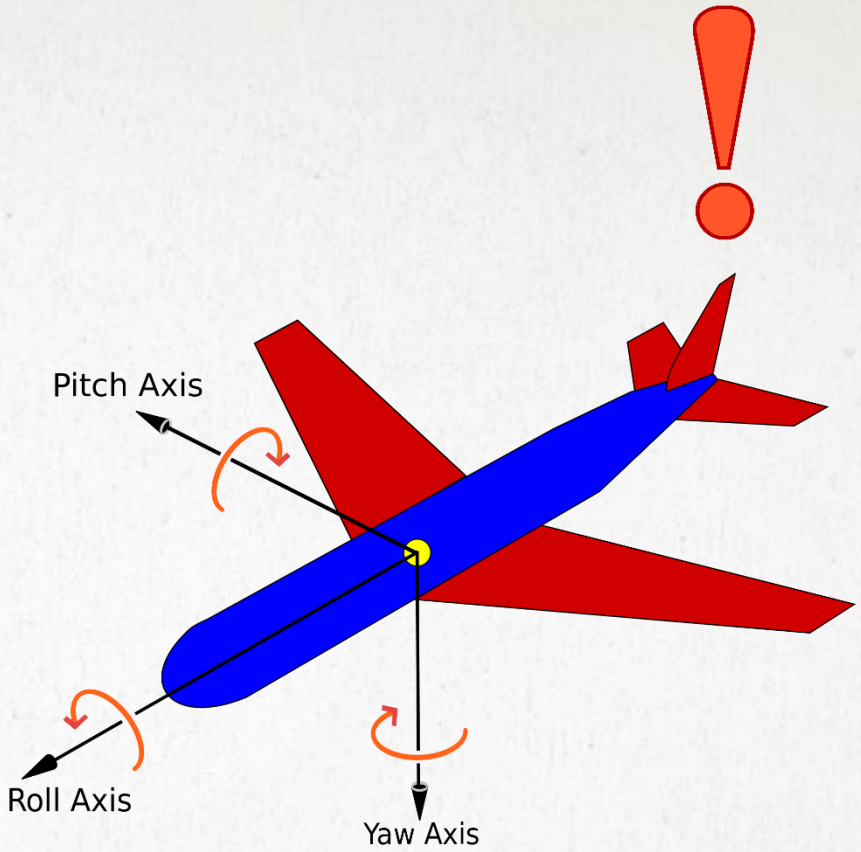


FOUR FORCES OF FLIGHT



AXIS OF ROTATION



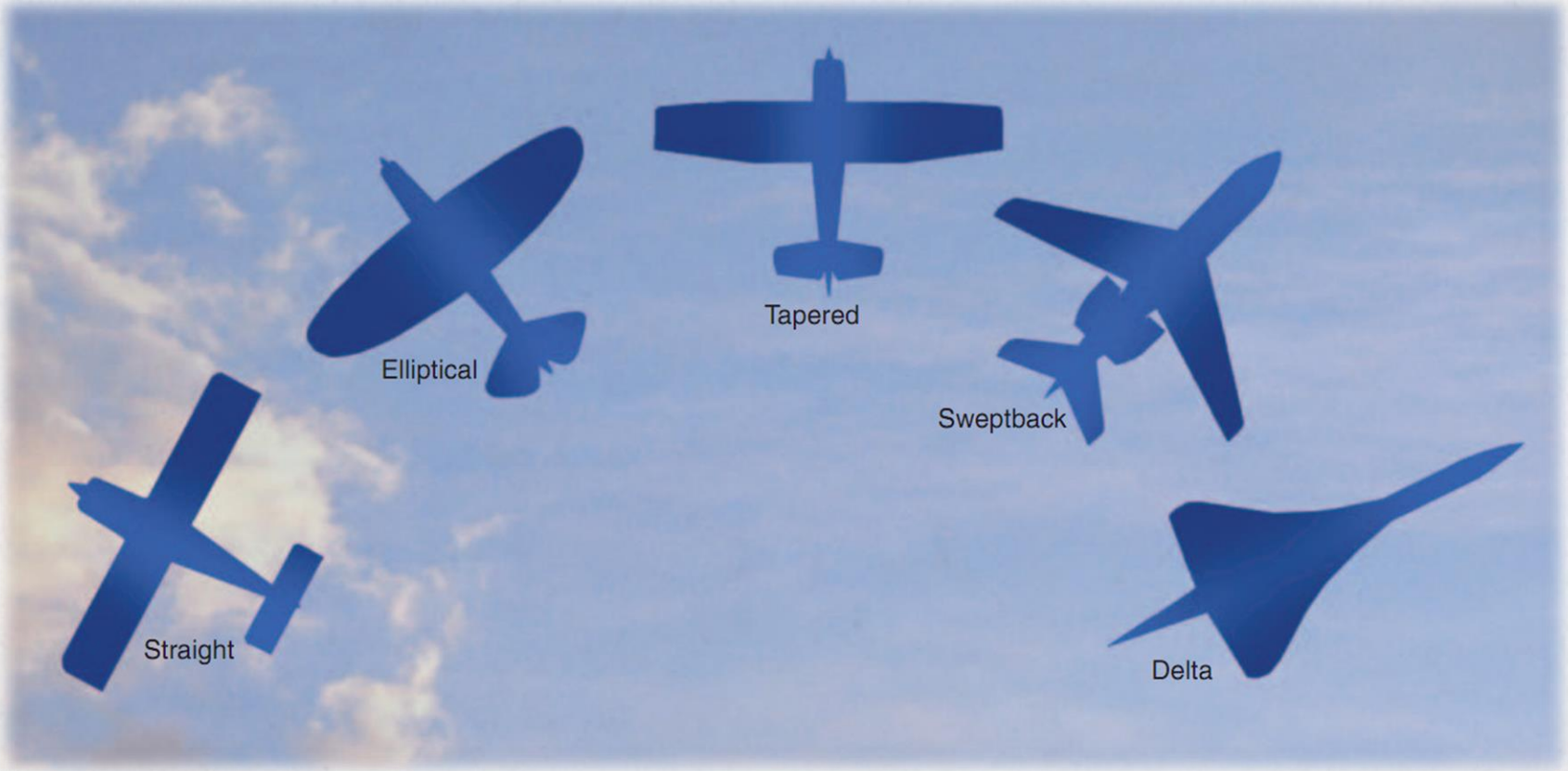


AERODYNAMIC COUPLES

- Lift and Weight
  - When **lift > weight** – the aircraft will **climb**
  - When **weight > lift** – the aircraft will **descend**

- Thrust and Drag
  - When **drag > thrust** – the aircraft will **slow down**
  - When **thrust > drag** – the aircraft will **speed up**

WING PLANFORM



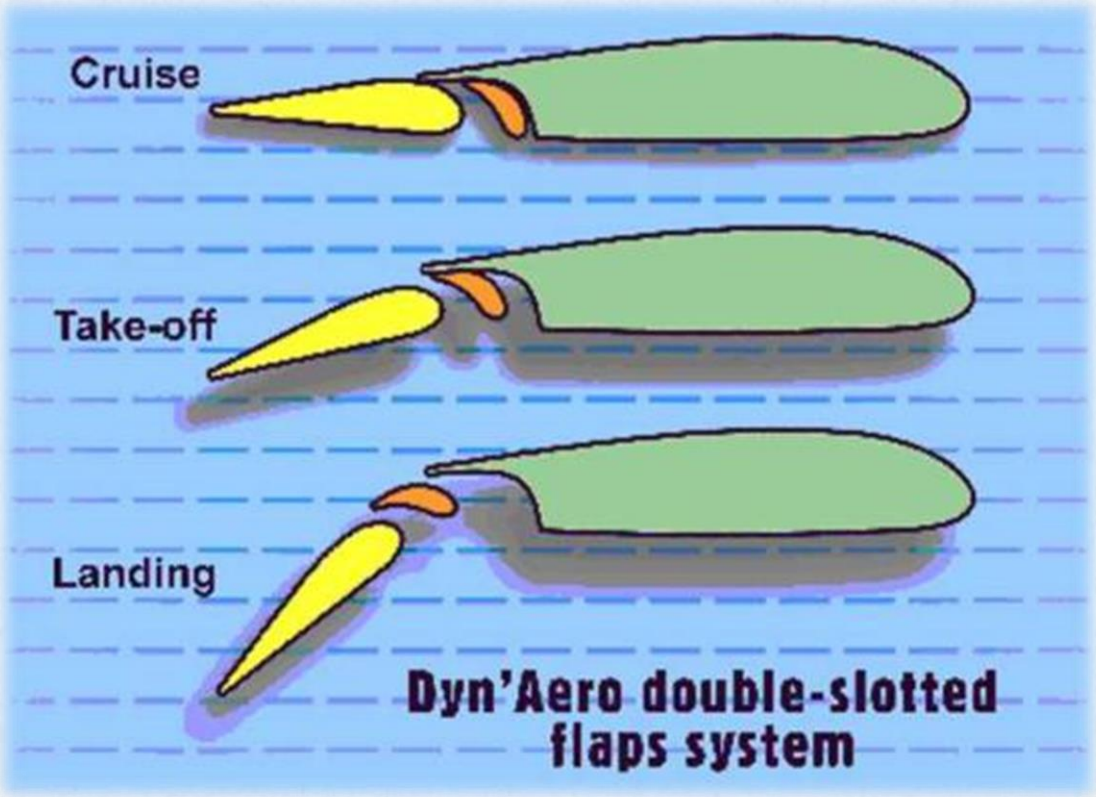
CHECKPOINT - *NINER*

What are the four forces that act on an airplane?

What happens if weight is ahead of lift?

FLAPS

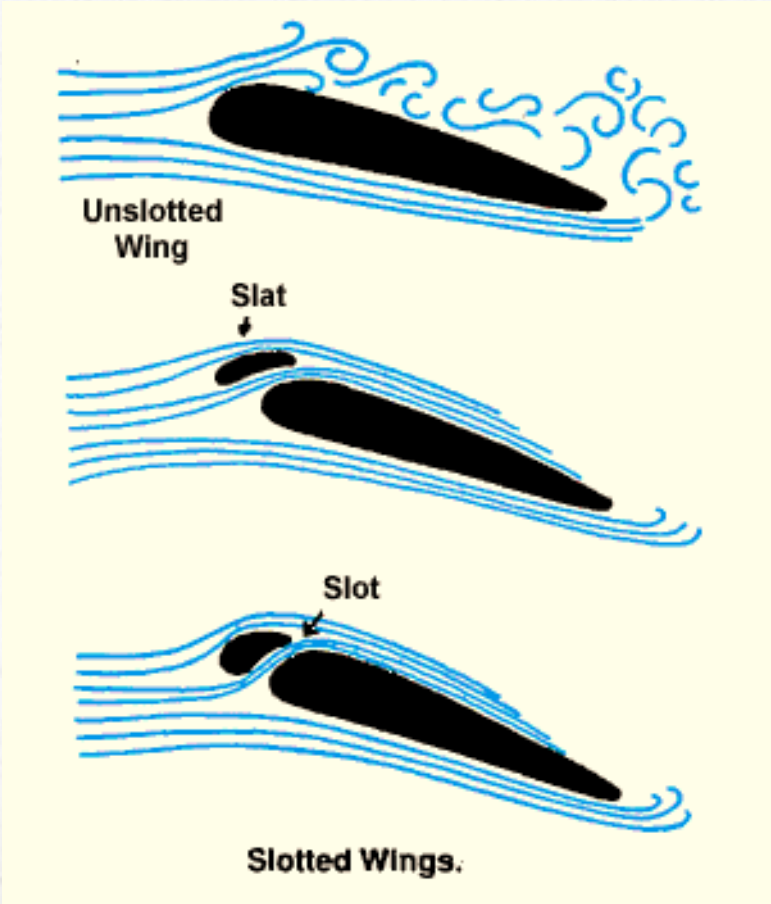
FLAPS


Cruise
Take-off
Landing
Dyn'Aero double-slotted
flaps system

SLATS

SLOTS

SLATS AND SLOTS



SPOILERS

SPEED BRAKES

AIRSPEED LIMITATIONS

AIRSPEED LIMITATIONS

- **VNE:** Never Exceed Speed
- **VNO:** Maximum Structural Cruising Speed or Normal Operating Limit Speed
- **VSL:** Power Off Stalling Speed (clean configuration)
- **VFE:** Maximum Flaps Extended Speed
- **VSO:** Power Off Stalling Speed (flaps and gear down)
- **VA:** Manoeuvring Speed
- **VB:** Maximum Gust Intensity Speed

AIRSPEED LIMITATIONS

V_{NE}

V_{SO}

V_{SL}

V_{FE}

V_{NO}

V_{A}

THAT'S IT!

- Topics to review for next week:
  - Angle of attack & center of pressure
  - Aileron Drag
  - Streamlining
  - Angle of Incidence
  - Wash in/wash out
  - Wing fences
  - Stability
  - Stall, spin and spiral dives
  - Flight instruments