FLIGHT THEORY

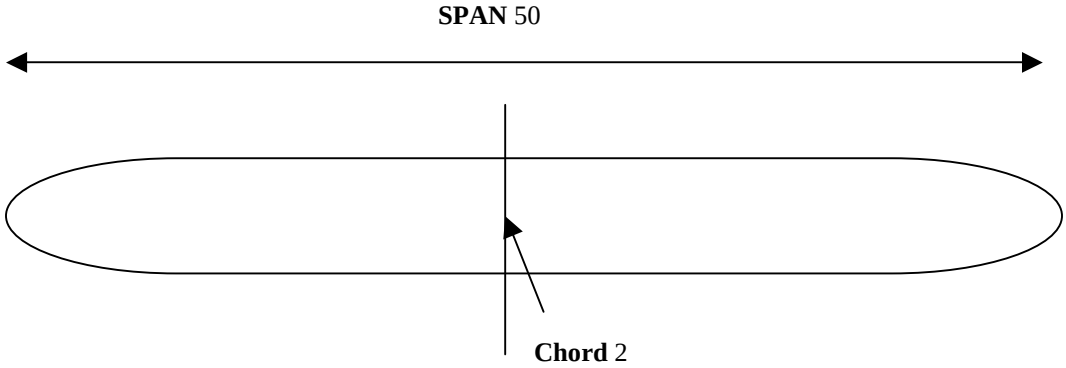
By Les Cowling

Sheet 1 Flight Theory

Wing Definitions

1.	Root	Centre of the wing. Where the wing meets the fuselarge on an aeroplane
2.	Cord Line	Centre line through the length of the airfoil leading edge to trailing edge
3.	Camber	The arc of the airfoil
4.	Angle of attack	The angle the chord meets the airflow
5.	Centre of Pressure	The point where the average lift occurs
6.	Aspect Ratio	The Span Divided By the Chord

There are two ways of calculating the Aspect Ratio.
1. Span divided by chord



50 = 25:1 **Aspect Ratio**

2

2. Aspect Ratio is $\frac{\text{Span Squared}}{\text{Area}}$ $\frac{50 \times 50}{2 \times 50} = \frac{2500}{100} = 25 : 1$

If you are dealing with a tapered wing you will have to use the Average chord.

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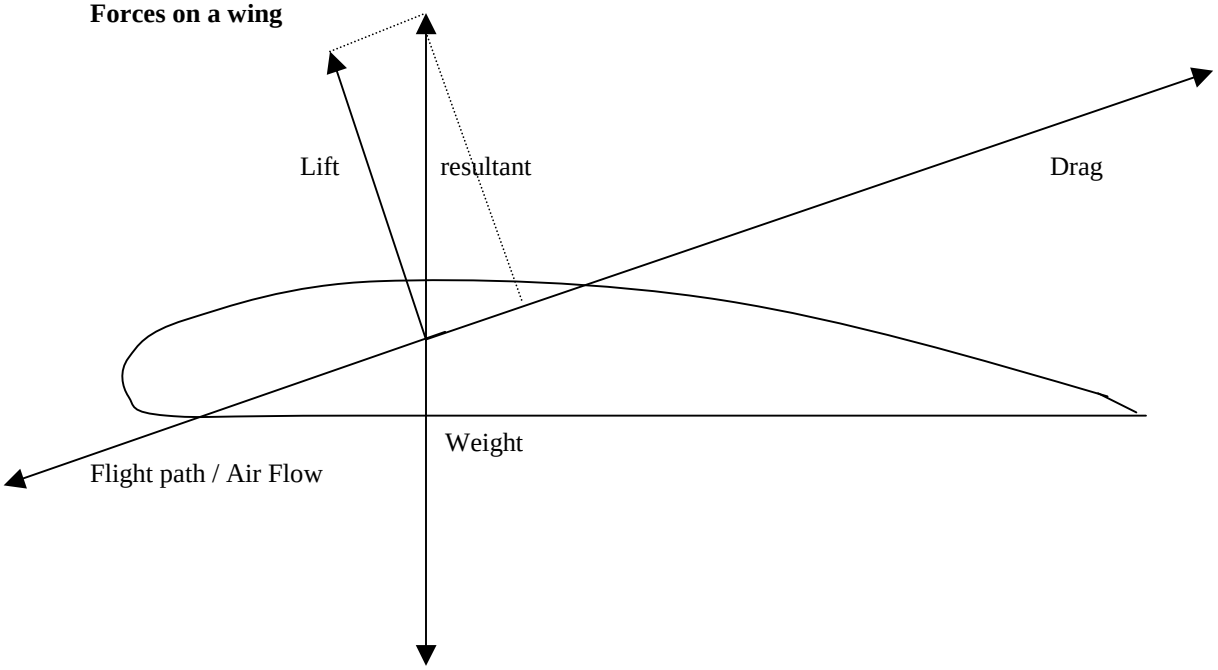
Sheet 2
Forces on a wing



Lift	90º to the Air flow
Drag	90º to Lift
Weight	Always acts vertically

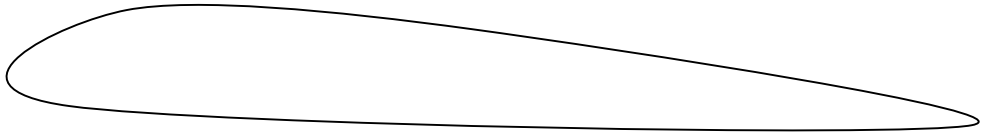
To find the resultant force we use Pythagoras to form a triangle.

Lift and drag combined = resultant = weight

If you were free falling any drag would slow you up therefore it's not lift but it assists lift to overcome weight.

<u>Aerodynamics</u>

2/3 lift



1/3 suction

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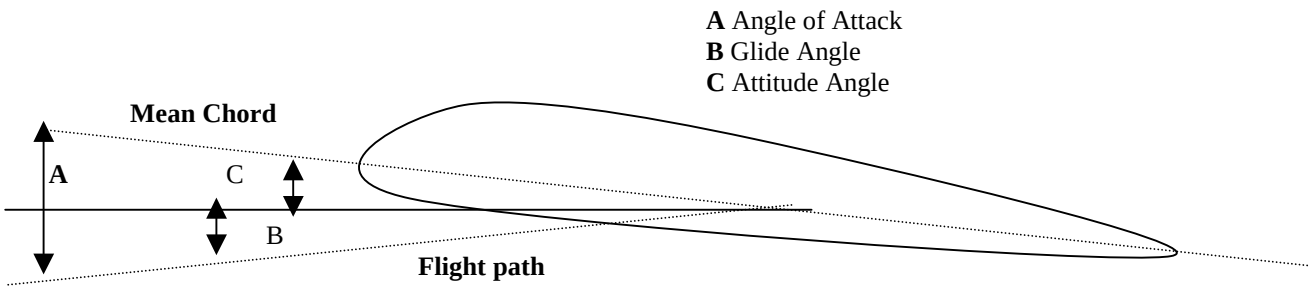
Sheet 3
ANGLE OF ATTACK



The **angle of attack** is set at manufacture and is the angle between the chord and the flight path.
The **glide angle** is between the horizontal and the flight path.
Note the angle of attack is constantly being changed in flight by the use of the brakes.
It can be seen that air will lift the under side of the wing shape as the air presses against it
And about one third of lift is created this way.

Don't forget, the air passing over the top and speeding up causing low pressure on the upper surface creates between 60 and 70 % of the lift.

The effect of ballast
Increases the wing loading, increases speed, faster landings.

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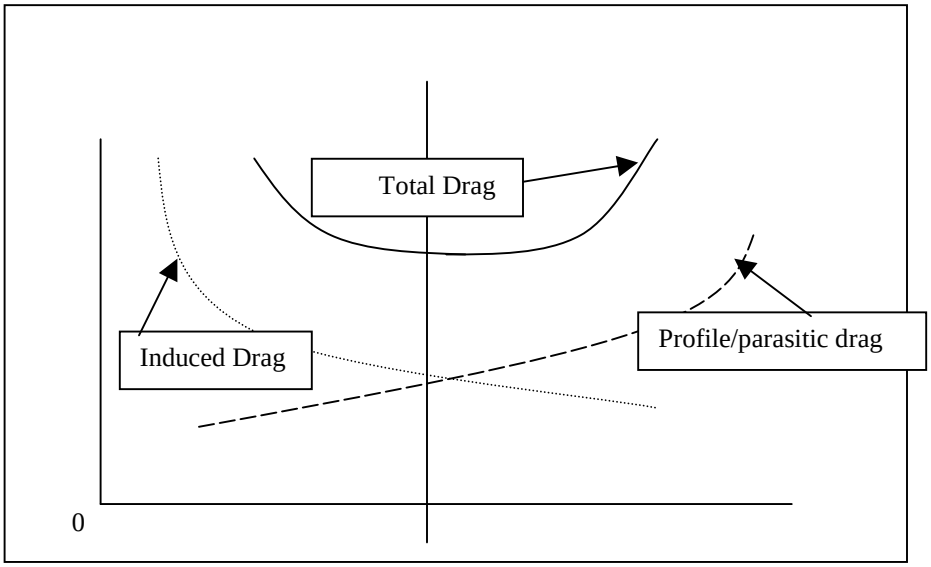
Sheet 4 Drag **TYPES**

TOTAL DRAG	
PARASITIC	INDUCED

FORM DRAG The drag caused by solid items exposed to the air such as the pilot harness and lines	PROFILE DRAG The drag caused by skin friction of the airfoil (canopy) itself	The drag caused by the rearwards directed forces on the airfoil that both lift, yet retard the wing.



Profile or parasitic drag (P) = Pilot + wing + lines + seat + risers

Induced Drag (In) = Infight drag (passage of the wing through the air)

Total Drag Combination of the two

If a wing has a Lift / Drag Ratio of say 6 : 1

Then it will fly 600 metres for a loss in altitude of 100 metres
NOTE . the L/D ratio is effectively the same as the Glide Ratio.

Remember

Double the speed 4 x the drag.

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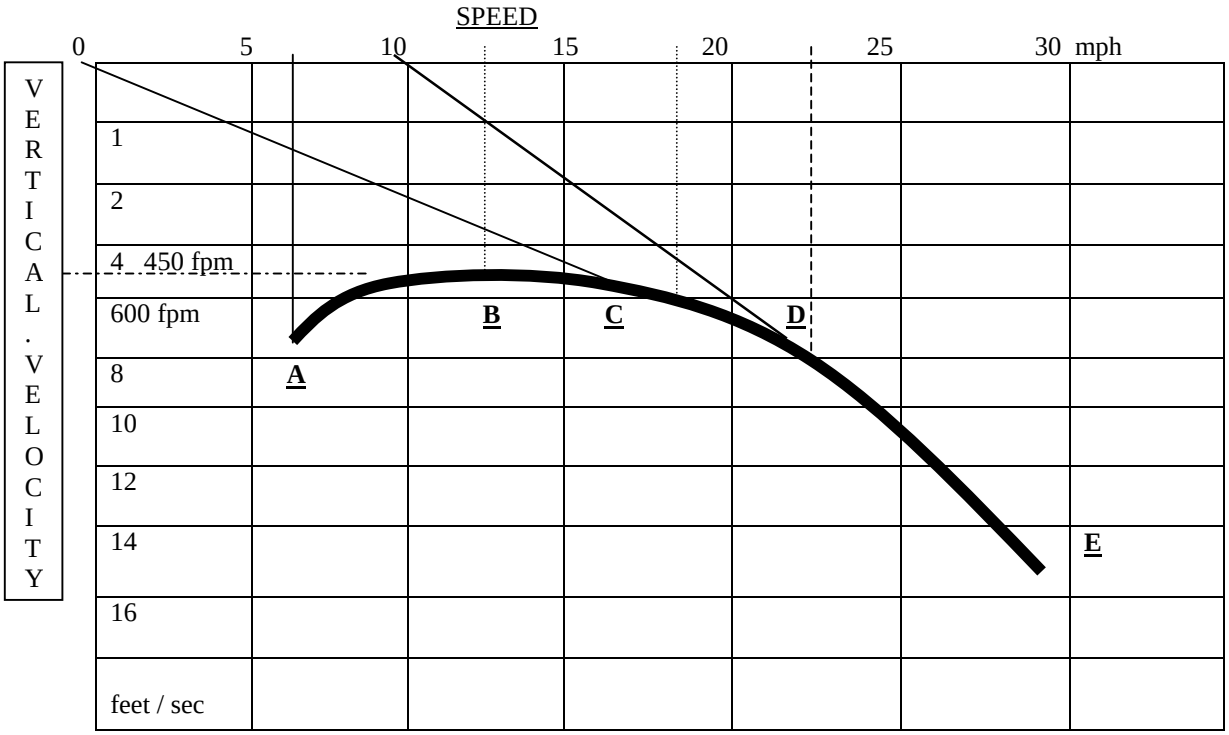
Sheet 5

Polar Curve



A = stall point
B = minimum sink 450fpm @ 13 mph
C = max glide at 19 mph @ 600 fpm sink
D = best speed to fly with a 10mph headwind =22mph
E = 28/29 mph
From the map we can see that the least sink is just before the stall, in this instance 450 fpm. So if we have lots of brake on we are staying up, (but we are not travelling over the ground.

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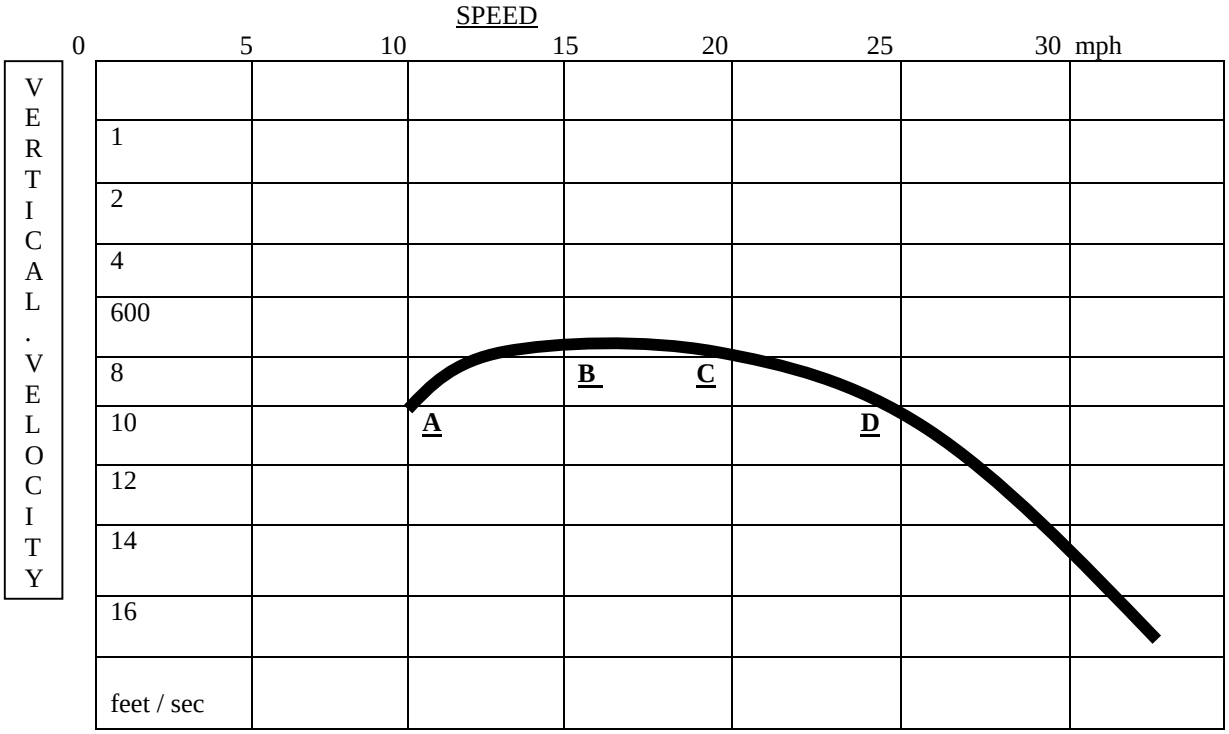
Sheet 6 Polar Curve



A = stall point
B = minimum sink __ _ fpm @ _ _ _ mph
C = max glide at _ _ mph @ 700 fpm sink
D = best speed to fly with a 15mph headwind =_ _ mph
E = max speed_____mph

Stalling It is where the laminar flow of air, brakes away from the surface of the wing.

Stalling can occur at any speed if the angle of attack is increased sufficient.
Another way of putting this is
A stall occurs at one angle of attack only.

Characteristics of a Stall

1. Lack of noise
2. Lack of wind on face
3. Mushy or no response
4. Controls heavier
5. Increased sink rate
6. Buffeting of wing

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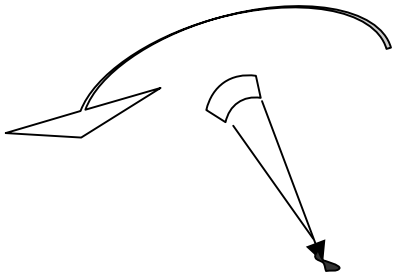
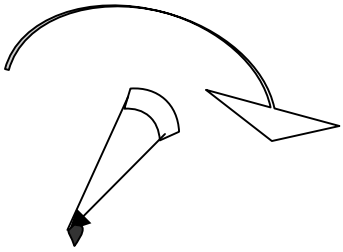
Sheet 7

PITCH STABILITY

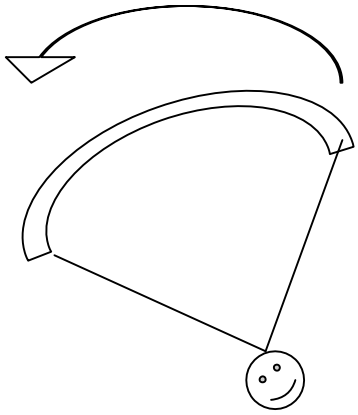
Nose up nose down

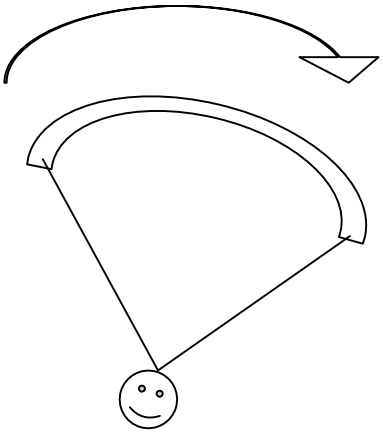




ROLL STABILITY

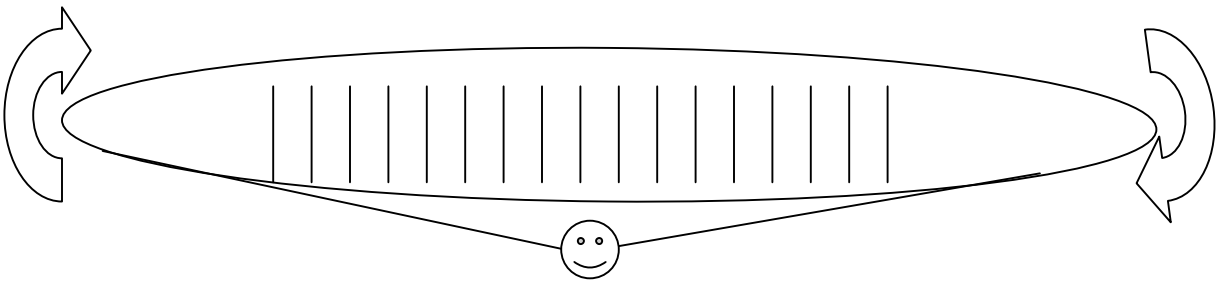
Wing tip down , wing tip up.





YAW

The aircraft rotates about it's centre of gravity .



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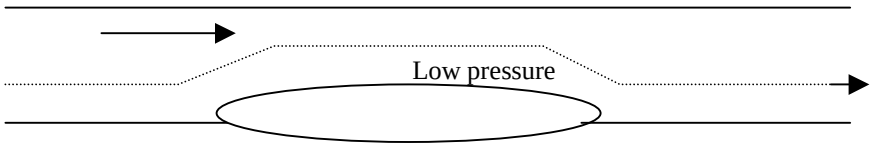
Sheet 8 Right Hand Rule

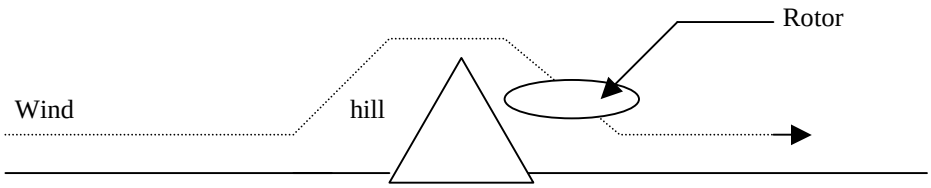
When flying always fly on the right hand side of the main feature
i.e. Motorways , rivers, railways, (opp. To the road system)

If two approaching aircraft stick to this rule then they should pass without collision.

The Ventury Principle



If a fluid flows through the pipe above, the particles passing over the obstruction have to speed up, to maintain the same speed as particles in the top of the tube.
This speeding up creates a reduction in pressure.
One serious consiquence of the venturi effect is illustrated below,



If the obsuruction is a hill then the venturi creates a low pressure / rotor behind the hill.

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