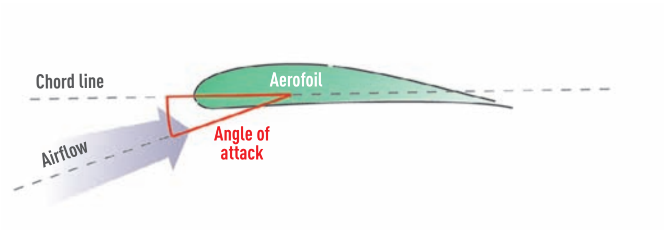
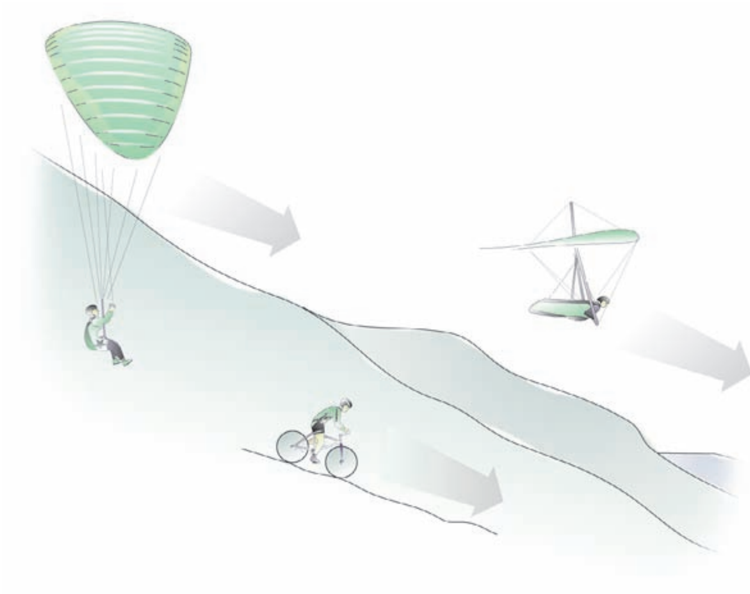
# how a glider **flies**

For any aircraft to fly it must produce enough upward force to support the weight of the machine and its pilot. A wing, such as a paraglider or a hang glider's, generates this upward force when it is moved through the air at a slight angle. The speed of movement through the air is termed airspeed, whilst the slight angle to the airflow is called the angle of attack.



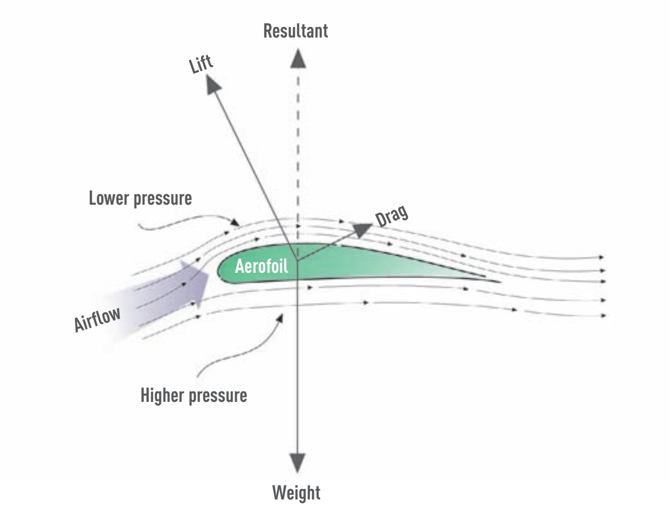

## airspeed

After take off, a glider maintains its airspeed by flying on a descending path through the air, using gravity to propel it, just like a cyclist or skier descending a hill.

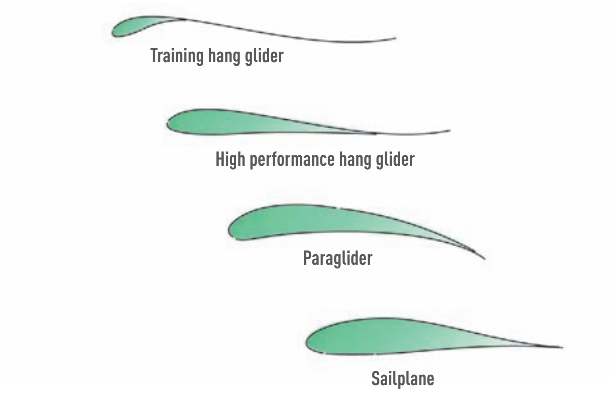


## the wing section

Any flattish surface, held at a slight positive angle to an airflow (an angle of attack) will produce an upward reaction. This is because the air pressure is slightly increased below the surface and slightly decreased above it. This upward (or total) reaction can be broken down into those elements acting at 90 degrees (upwards) to the direction of flight, which we call lift, and those elements acting at 180 degrees (opposite) to the direction of flight, which we call drag.

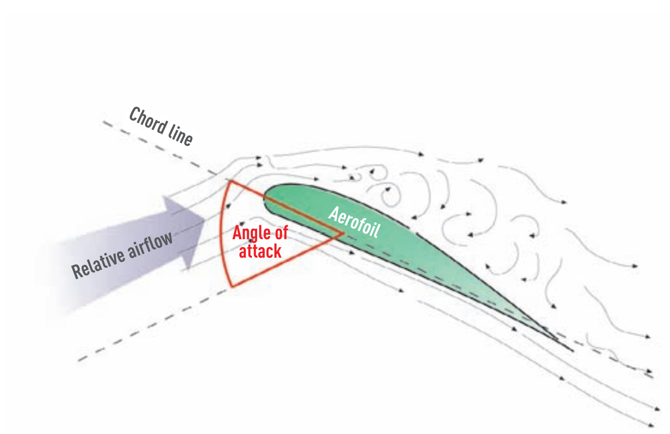



A crude flat surface is not very efficient as an aerofoil section. The amount of lift it produces compared to the amount of drag (i.e. its Lift/Drag ratio) drops off rapidly if the angle of attack is varied a few degrees above or below the optimum. An aerofoil with a curved top surface is more efficient: air passing over the top surface produces a greater reduction in pressure. This shape is also much less critical in respect of angle of attack. You will see that the wing sections used on paragliders and hang gliders are all variations on this same basic shape. Indeed all winged aircraft, from sailplanes to jumbo-jets, use variations of this shape, optimised for their particular application.




## the stall

In a hang glider we reduce airspeed by raising the glider's nose ('pushing out'). With a paraglider airspeed is reduced by lowering the trailing edge of the wing. Both control actions are actually doing the same thing: they are increasing the wing's angle of attack. Unfortunately, if we try to reduce airspeed too much (i.e. if we try to fly too slowly) we find that it is possible to raise the angle of attack past a critical angle. At this angle the airflow, which up to now has been smoothly following the contours of the wing, breaks away into turbulence and eddies, so destroying the lift-producing pressure differences. This is the stall.




## effect of the stall

Hang gliders are designed to recover automatically from stalls, but to do this they require sufficient height. In a full stall the nose will drop and the glider will dive, so lowering the angle of the attack and regaining airspeed, but losing perhaps 50 feet or so of height before normal flight is regained. In a very gentle stall the glider may 'mush' in a nose-high attitude, with an increased sink rate and reduced control. Recovery is simply a matter of allowing the glider's nose to drop a little (i.e. by 'pulling in' a little), so reducing the angle of attack and allowing airspeed to increase. A stall is not itself dangerous - but stalling inadvertently when close to the ground is! By switching on your brain before take-off and flying at a safe airspeed you should not run into this problem. (Later on in your training you will practice slow flight, stalls and recoveries, but at a safe height above the ground.)

With a paraglider the situation is rather different. Most modern paragliding canopies are unpredictable once stalled, so this manoeuvre is avoided. (Stall avoidance is simply a matter of ensuring that you avoid flying with the controls lowered excessively.)

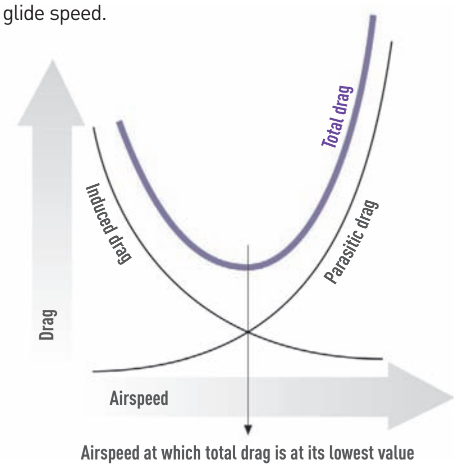
## drag

Anything moving through the air causes a disturbance, which is felt as a resistance to forward motion. This resistance is called drag.

The total drag on any aircraft is made up of Parasitic drag and Induced drag. Parasitic drag is made up of mainly of Form drag - generated when the blunt shape of the wing, pilot, lines (or wires) etc., is moved through the air - and Skin Friction, which is the name given to the drag force caused by the air's tendency to 'stick' to the exposed surfaces. Parasitic drag increases rapidly as speed is increased.

Induced drag is an inevitable by-product of a wing acting on the air to create lift. Trailing vortices formed at the wingtips play a large part in this, representing energy wasted in stirring up the air.

Induced drag lessens at higher speeds, but is quite large at low speeds (when the angle of attack is high). As a result there is a particular speed for any glider at which the total drag (parasitic drag + induced drag) is at a minimum. Flying at this airspeed produces the best (flattest) angle of glide, so it is known as the maximum (max.) glide speed.




## glide ratio

The glide ratio is a measure of a glider's performance. It expresses the relationship between the distance that a glider can travel horizontally (in still air) and the height loss involved. For instance, a glider that has a glide ratio of 10:1 will travel 100 metres horizontally for every ten metres of height lost (in still air). As explained above, for each glider there is a certain flying speed at which this best glide ratio is obtained. (The glide ratio is directly linked to the L/D ratio mentioned earlier.)

## sink rate

The sink rate is the rate at which the glider loses height in still air, and is normally expressed in hundreds of feet per minute. The lowest rate of descent is usually obtained by flying a little slower than max. glide speed (but don't stall!). This speed is known as the minimum (min.) sink speed.

(Note: All non-powered aircraft lose height in still air conditions - the secret of staying up (or 'soaring') is to find a mass of air which is rising faster than you are sinking. This is explained further under the heading 'Soaring' on page 42.)

## the balance of forces

In steady gliding flight the three forces on the glider - Lift, Drag and Weight - will balance (i.e. each force is balanced out by the other two - see illustration at foot of first column of previous page.).

## stability

Whilst we need control so that we can manoeuvre our gliders about in the sky, we also want our gliders to have a certain degree of stability; i.e. the glider should tend to continue flying normally if left to its own devices. Training gliders are carefully designed with plenty of built-in stability - though you may not think so on some of your early flights!

Your instructor will explain the design features of hang gliders (or paragliders as appropriate) which ensure their stability.

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