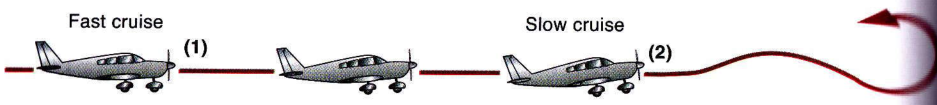
Airwork 10a

Slow Flying

Aim *To develop an awareness of the aeroplane's handling characteristics at abnormally low airspeeds, and to return the aeroplane to a safe flying speed.*

1. Establishing Slow Flight, Flaps Up



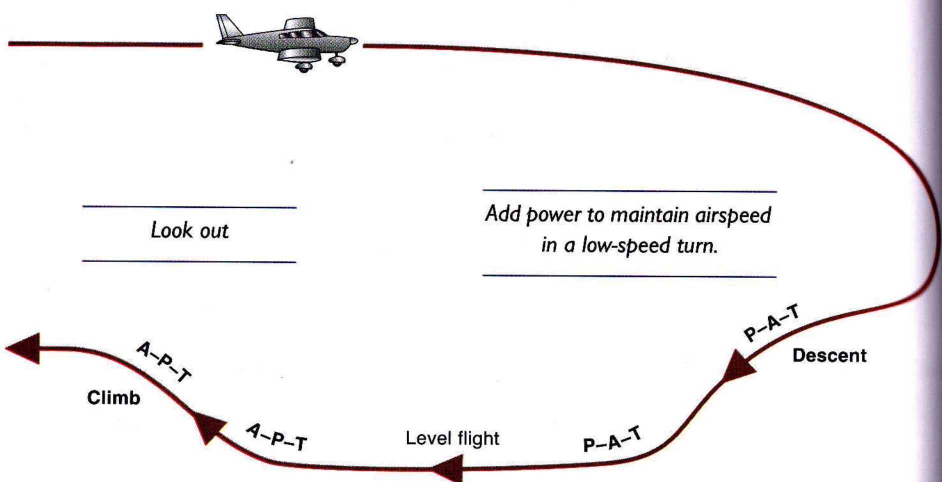
To adopt a slow cruise:

- Reduce power.
- Raise nose to reduce airspeed and maintain height.

To maintain a slow cruise:

- Set power and attitude to maintain height and airspeed.

NOTE The controls are less effective at low airspeed.



Practise gentle climbs, descents and turns at a constant airspeed.

2. Recovering from Slow Flight

- Increase power.
- Lower pitch attitude to maintain altitude.
- Adjust power as desired airspeed is approached.
- Trim.

Repeat the above procedure with flap extended.

Exercise 10b

Stalling

Aim

To recognise the stall, and to recover from it with a minimum loss of altitude.

Considerations

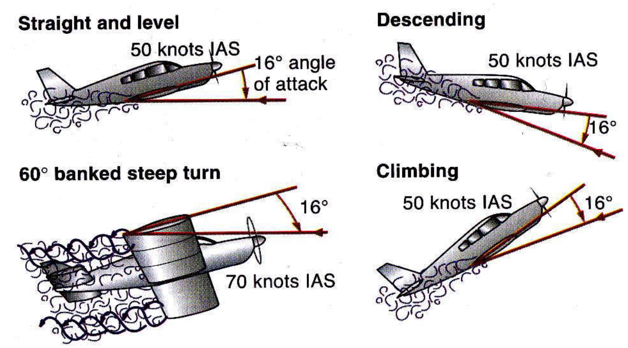
What is Stalling?

Stalling occurs when the critical angle of attack is exceeded, irrespective of airspeed.

Streamline flow over the wings breaks down and becomes turbulent when the critical (or stalling) angle of attack is exceeded. This causes:

- **buffeting** (shaking or shuddering) of the airframe, felt through the controls;
- **a marked decrease in lift,** resulting in sinking;
- **rearward movement of the centre of pressure** (through which the lift acts), resulting in the nose dropping;
- a marked drag increase.

Stalling will occur whenever the critical angle of attack is exceeded, irrespective of airspeed. The only way to recover is to decrease the angle of attack (i.e. relax the back pressure and/or move the control column forward).



■ *Figure 10b-1* ***Stalling occurs at the critical angle of attack***

The pilot can increase the angle of attack (and reduce airspeed) by pulling the control column back. This happens in many manoeuvres such as:

- establishing slow flight;
- turning (especially steep turns);

- pulling out of a dive; and
- landing.

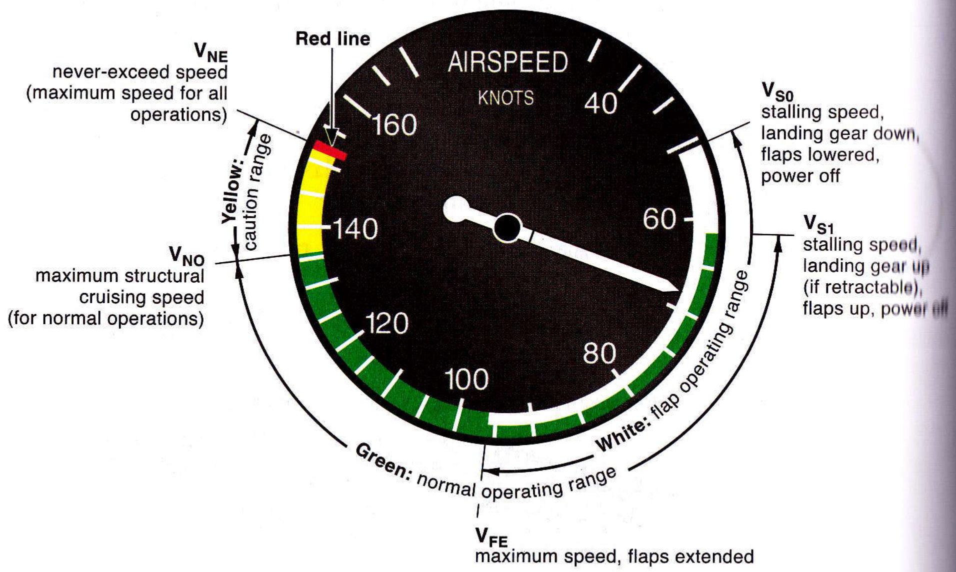
Also, an upward gust of wind encountering the wing will increase its angle of attack.

What Is Stalling Speed?

The basic stalling speed is considered to be the speed at which the aeroplane stalls when it is at maximum weight, with the wings 'clean' (i.e. no flap) and flying straight and level with the power removed. The stall is made to occur by the pilot progressively raising the nose.

The basic stalling speed is called V_{S1}. It is published in the Pilot's Operating Handbook and shown on the airspeed indicator as the lower end of the green arc. V_{S1} for your aeroplane should be memorised as it is a valuable guide.

The stalling speed with full flap extended (at maximum weight, straight and level, and idle power) is called V_{S0}. It is also found in the Pilot's Operating Handbook and at the lower end of the white arc on the airspeed indicator. The V_{S0} speed should also be memorised.



■ *Figure 10b-2* ***Colour coding on the ASI***

The published stalling speeds are only a guide, since stalling always happens at the same angle of attack and not the same indicated airspeed. Turns, pulling out of dives and contaminated wing surfaces (e.g. frost or snow) will increase the stalling speed; high power and decreased weight will reduce it.

Treat published stalling speeds as a guide only.

Effect of the Flight Controls in the Stall

The flight controls are less effective near the stall.

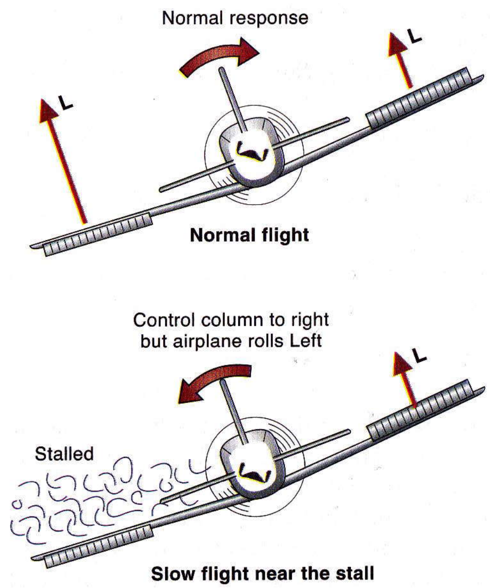
A reduced airflow over the controls will cause them to become less effective as speed reduces and the stall is approached. Control pressures will decrease and larger movements of the elevator and rudder will be required.

It is the main wing that stalls. The fin and the tailplane remain unstalled (by design) so that during the stall the elevator and rudder remain effective. The ailerons may or may not remain effective during a stall, depending on the aeroplane type.

The Ailerons

Be careful using ailerons near the stall.

A dropping wing can normally be 'picked-up' by moving the control column in the opposite direction. This causes the aileron on the dropping wing to deflect downwards, increasing the angle of attack, and producing more lift on that wing. If the wing is near the stalling angle, the aileron deflection could cause the critical angle to be exceeded on that wing and, instead of rising, the loss of lift would cause the wing to drop further. With any yaw, a spin could develop.

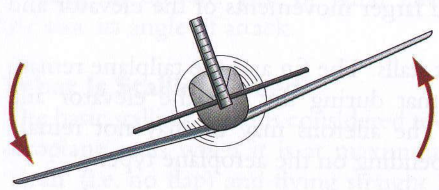


■ *Figure 10b-3* ***Near the stall, use of aileron may not pick-up the wing***

The ailerons on some more recently designed aeroplanes are effective right through the stall and their use, coordinated with rudder, may be possible. This point should be discussed with your flying instructor.

The Rudder

Near the stall, any tendency for the aeroplane to yaw can be prevented with opposite rudder.



■ *Figure 10b-4* ***If a wing drop is experienced during a stall, further yaw may be prevented with opposite rudder***

Flying the Manoeuvre

Stalling in Straight and Level Flight

Stalling is first practised in straight and level flight by reducing power and raising the nose to maintain height. The angle of attack will gradually increase.

Warnings of an impending stall include:

- **a reducing airspeed** and air noise level, decreasing control effectiveness and a 'sloppy' feel;
- **operation of a pre-stall warning** (such as a horn, buzzer, light or whistle);
- **the onset of buffet,** felt in the airframe and through the control column;
- **a high nose attitude** for the manoeuvre being flown.

The actual stall may be recognised by:

- **the nose and/or the wing dropping** (caused by the centre of pressure moving rearwards);
- a high sink rate.

Stall Recovery

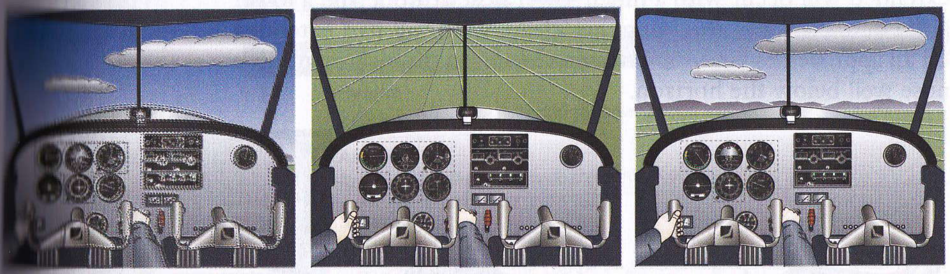
Stall recovery requires decreasing the angle of attack.

To recover from a stall **reduce the angle of attack** by moving the control column centrally forward (releasing the back pressure may be sufficient) until the buffet or stall warning stops.

Once the wings are unstalled buffeting ceases, the airspeed increases, and the aeroplane can be eased out of the slight dive back into normal flight. The altitude loss will be of the order of 200 ft. Power can be added to regain or maintain altitude, otherwise flying speed should be maintained in a glide.

...loss during a stall ...be minimised with power.

Altitude loss during the stall can be minimised with power. Adding power is not required to recover from the stall; however, altitude loss will be minimised if full power is applied as the control column is moved centrally forward (back pressure is released) and the nose is lowered. Recovery can be achieved with a altitude loss of less than 50 ft.



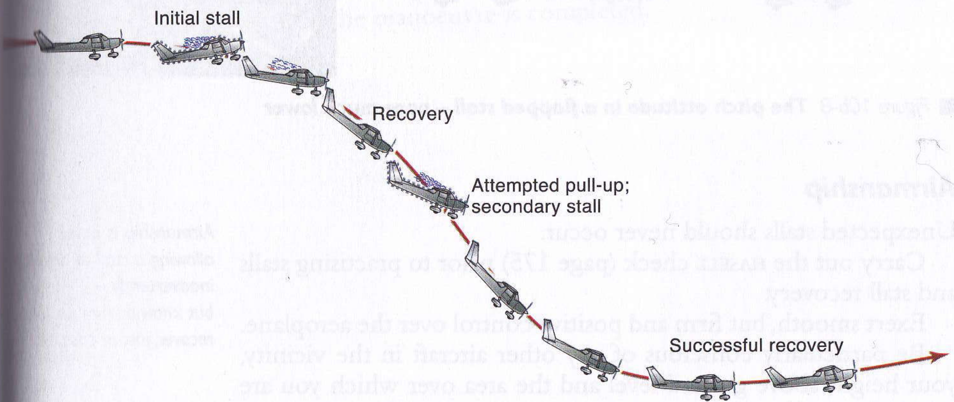
■ *Figure 10b-5* ***Stall and recovery attitudes***

After Stalling

...entering a secondary ...during a stall recovery.

Following stall recovery, ease the aeroplane into normal flight by gently raising the nose and applying power as the nose passes through the horizon.

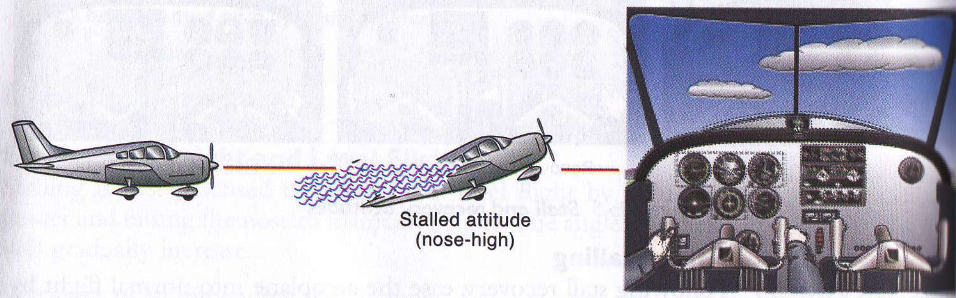
The inertia of an aeroplane causes it to follow the original flightpath for a brief time before the change in attitude and resulting change in forces move it into a new flightpath. Pulling the nose up too sharply during the stall recovery may not give the aeroplane time enough to react and ease out of the dive, but may merely increase the angle of attack beyond the stalling angle again. A **secondary stall** will be induced, and a second recovery from the stall will be necessary.



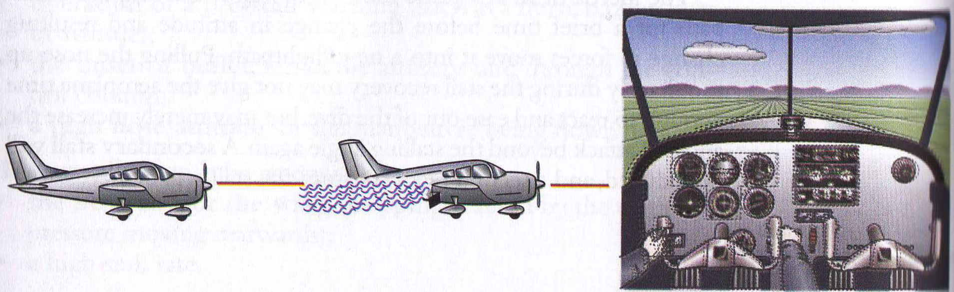
■ *Figure 10b-6* ***Raising the nose too sharply during recovery may induce a secondary stall***

Stalling with Flap Extended

When the trailing-edge flaps are lowered, the angle of incidence is increased, which allows a lower nose attitude for the same angle of attack. This allows the aeroplane to fly at a slower speed with a lower nose attitude. In addition, flap extension increases camber and/or wing area, which lowers the stall speed. The stall with flap extended will occur with a much lower nose attitude and a lower airspeed than when the wings are clean. With full flap extended on an approach to land, for instance, the stall could occur with the nose well below the horizon.



■ *Figure 10b-7* ***The clean stall***



■ *Figure 10b-8* ***The pitch attitude in a flapped stall – nose much lower***

Airmanship

Unexpected stalls should never occur.

Carry out the HASELL check (page 175) prior to practising stalls and stall recovery.

Exert smooth, but firm and positive control over the aeroplane.

Be particularly conscious of any other aircraft in the vicinity, your height above ground level and the area over which you are flying. Ensure that stalling is only practised at altitude. Note landmarks and the direction to the airfield. Maintain a high visual awareness.

Airmanship is never allowing a stall to develop inadvertently – but knowing how to recover, just in case.

The Pre-Aerobatic HASELL Checklist

Stalling is the first aerobatic-type manoeuvre that you will perform.

Prior to doing any aerobatics, it is usual to carry out a series of checks to ensure safe operation. The Pilot's Operating Handbook will contain a suitable check covering items such as those in the HASELL check below. The items it contains start with these letters.

PRE-AEROBATIC 'HASELL' CHECKLIST	
H	***Height*** *Sufficient to recover by 3,000 ft above ground level.*
A	***Airframe*** *Flaps and landing gear as desired, brakes off, in trim.*
S	***Security*** *– hatches and harnesses secure;* *– no loose articles in the cockpit (e.g. fire extinguishers, tie-down kits, etc.);* *– gyros caged (if necessary).*
E	***Engine*** *– normal engine operation;* *– fuel contents and selection checked (fullest tank selected, fuel pump on if appropriate);* *– Mixture and carburettor heat as required.*
L	***Location satisfactory*** *– away from controlled airspace, towns, active aerodromes and other aircraft, and in visual conditions.*
L	***Look out*** *– make an inspection turn (usually 180°, or 2 x 90°) to clear the area around and below you. Begin the manoeuvre immediately on completion of the clearing turn.*

NOTE Realign the direction indicator with the magnetic compass once the manoeuvre is completed.

Airwork 10b

The Standard Stall and Recovery Procedure

Aim *To stall the aeroplane fully and then recover with a minimum loss of altitude.*

1 Prior to Entry

Pre-aerobatic check (see also expanded version on previous page):

H – Height sufficient to recover by 3,000 ft agl.

A – Airframe (flaps AS DESIRED, in trim).

S – Security:
hatches and harnesses secure;
no loose articles;
gyros CAGED (if applicable).

E – Engine:
operating normally;
fuel contents and selection checked;
mixture and carburettor heat as required.

L – Location satisfactory.

L – Look out: clearing turn to check for any other aircraft.

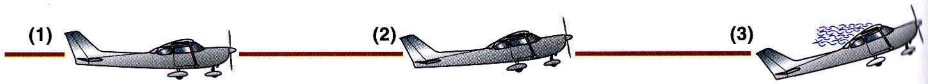
Begin the manoeuvre as soon as area is clear.

2. Stall Entry

- Power OFF – throttle CLOSED (carburettor heat HOT).
- Prevent yaw and maintain balance with rudder.
- Maintain height with elevator.
- Continue bringing control column fully back.

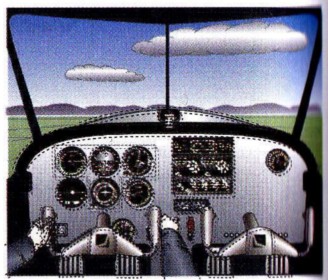
3. Symptoms of an Approaching Stall

- Decreasing airspeed and noise level.
- Controls less firm and less effective.
- Pre-stall warning (light, horn or buzzer).
- Shuddering airframe.
- A relatively high nose-up attitude.



Look out *and clear the area.*

During the stall use rudder only to prevent further yaw.



Recognise the actual stall:

- nose drop
- sink rate

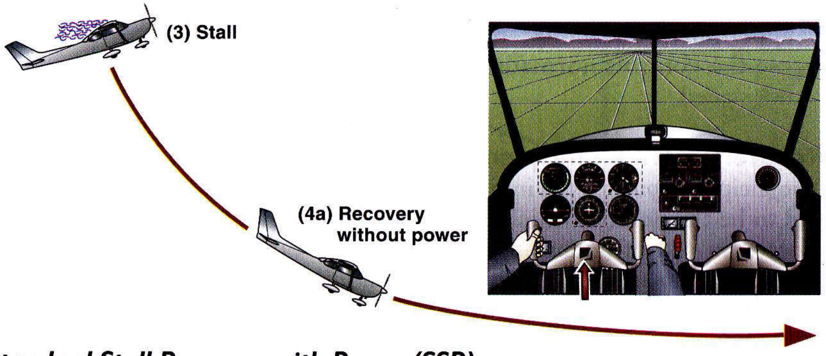
Practise stalls in various configurations:
Clean, power off
Clean, power on
Flapped, power off
Flapped, power on
Climbing, descending and turning

Airwork 10b

4a Stall Recovery without Power

- Move the control column centrally forward to unstall the wings.
- Prevent yaw or further yaw with rudder.
- Level wings with aileron if necessary.
- Attain safe flying speed.
- Resume normal flight and regain altitude as required.

Height loss approximately 200 to 300 ft.



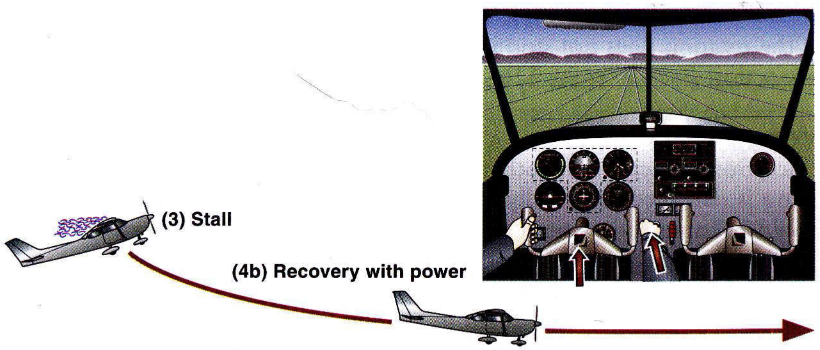
4b. Standard Stall Recovery with Power (SSR)

Simultaneously:

- Move the control column centrally forward to unstall the wings.
- Add full power – throttle smoothly FULLY OPEN (carb heat COLD).
- Prevent yaw or further yaw with rudder.
- Level wings with aileron if necessary.
- Attain safe flying speed and regain altitude.

Should the wing *not* drop at the point of stall, maintain aircraft balance on application of power with rudder.

Height loss approximately 50 ft.



Variations on the Basic Stall

Recovery at the Incipient Stall Stage

Recover immediately at the first sign of an inadvertent stall.

The term incipient stall means the beginning stages of a stall. It precedes the actual stall. If ever an unwanted stall appears imminent, then recover at the incipient stage. This is especially applicable if the aeroplane is near the ground, say during take-off, approach to land, going around or low-level flying.

The recovery from an incipient stall is simply:
- **move the control column centrally forward** (relaxing the back pressure may be sufficient); and simultaneously
- **apply power smoothly;** and
- **use the controls normally** (i.e. the ailerons), since the wing is not stalled.

Recovery from an Incipient Spin

The incipient spin (i.e the initial stages of a spin) generally may be said to be the point at which the wing has dropped or flicked by more than 45° of undemanded roll and autorotated up to one complete rotation; beyond this point a full spin can be considered to be developing.

The incipient spin recovery action is to:
- **centralise the control column and rudder.**

When the rotation has stopped:
- **level the wings** with aileron;
- **apply full power** and regain lost altitude.

NOTE If the nose is significantly below the horizon:
- **close the throttle;**
- **centralise control column and rudder** when the rotation has stopped;
- **level the wings** with aileron;
- **ease out of the dive;**
- **apply full power** when the nose has pitched above the horizon.

If the rotation does not stop immediately, initiate full spin recovery action – see Exercise 11b.

Wing Surface

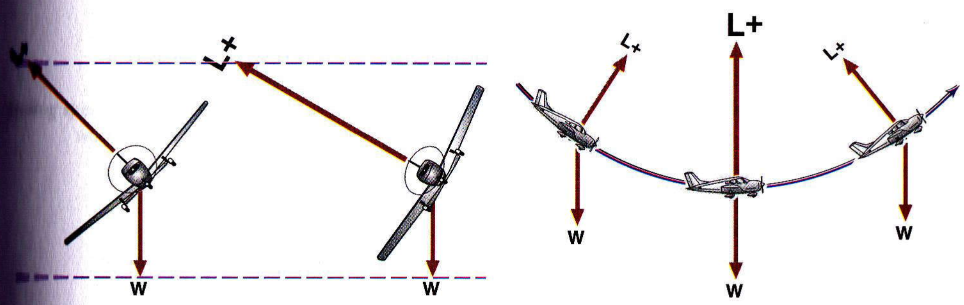
Contaminated or damaged wings increase stalling speed.

If ice, frost, insects or any other contaminant is on a wing or if the wing is damaged (especially its upper leading edge), the airflow could become turbulent at a lesser angle of attack than normal. Stalling will then occur sooner and at a higher airspeed. **Always check the surface condition of the wings** (especially the upper leading edges) in your pre-flight inspection.

Stalls during Manoeuvres

Stalling speed increases in manoeuvres.

To turn or pull out of a dive, the wings must produce more lift. This is achieved by the pilot using back pressure on the control column to increase the angle of attack. The relative air flow striking the wings at a greater angle causes the **stalling angle** to be reached at a *higher* indicated airspeed. For example, the stalling speed increases by 7% at 30° bank angle and by 40% when pulling 2g in a 60° banked turn or dive recovery.



■ *Figure 10b-9* ***Increased wing loading (g-factor) means increased stall speed***

You can physically recognise an increased load factor by the increased g-loading, so any time your *apparent weight* is increased in manoeuvres, the stall speed is increased.

When the aeroplane approaches a stall in manoeuvres (say in a steep turn or pulling out of a dive), releasing back pressure is usually sufficient to prevent the stall occurring.

Stalling in a Turn

Accelerated stalls – at a higher stalling speed than straight and level – can occur with the higher g-loading in manoeuvres such as turns.

Back pressure on the control column increases the angle of attack and may cause a stall. Since the load factor is increased in a turn, the stall will occur at a higher speed than in straight and level flight – by how much depends on the g-loading. Stalls at a higher speed than normal are called **accelerated stalls.**

Follow the standard recovery of moving the control column centrally forward (relaxing the back pressure may be sufficient), and when the wings are unstalled, use coordinated rudder and ailerons to roll the wings level. Apply power as required and resume the desired flightpath.

The Effect of Flaps

Extending flap lowers the stalling speed and affects the stall characteristics.

The stall with flaps extended will differ somewhat from the clean stall. For a start, flaps increase the lifting capability of the wings, allowing the required lift to be generated at a lower speed. The stalling speed will be lower. The increased drag will cause the aeroplane to decelerate more rapidly when power is reduced and the lower speed may make the controls feel very 'sloppy'. Also, the changed distribution of lift on the wings may cause a greater tendency for a wing to drop.

With flaps extended, the nose attitude will be lower in each phase of flight, therefore stalling will occur at a lower pitch attitude than when 'clean'.

The recovery from a stall with flaps extended is standard. Altitude loss can be minimised by applying full power as the control column is moved centrally forward, but be prepared to hold forward pressure on the control column so that the nose does not rise too far with the strong pitch-up moment that full power produces. Do not use ailerons to roll the wings level until the wings are unstalled. If full flap is used, a climb-away may be difficult unless some flap is raised once a safe speed is attained.

Stalling on Final Approach

Do not stall on final approach.

Initiate a recovery immediately you suspect an impending stall on approach to land. Lower the nose and apply power to minimise height loss.

Never allow a stall to occur near the ground.

It is worthwhile practising the developed stall in the approach configuration at altitude so as to familiarise yourself with it. This should ensure that you never allow a stall to occur near the ground.

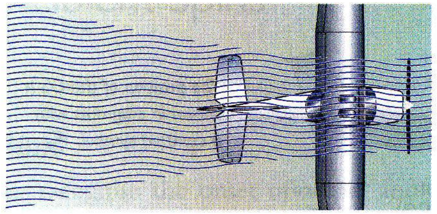
A situation in which a stall might occur could be an approach that has got out of hand: for example, full flap extended and a tendency to undershoot, with the pilot raising the nose (instead of adding power). The airspeed will decrease and the undershoot will worsen. If the pilot continues to pull the control column back, a stall could occur. With full flap and possibly high power applied, the stall could be fairly sudden and with a wing drop.

The standard recovery technique would be used. The control column may have to be moved well forward to unstall the wings, and care should be taken to avoid using ailerons until the wing is unstalled. The substantial drag from full flap may make a climb-away difficult; gain speed in level flight or a slight climb, reduce the flap in stages and then climb away as desired.

Power-On Stalls

Power decreases the stalling speed.

With power on, the propeller creates a slipstream over the inner sections of the wings which may delay the stall. This will occur at a higher nose position. The slipstream makes the elevator and rudder more effective, but not the ailerons. The increased airflow may delay the stall on the inner sections of the wing – the stall occurring first on the outer sections, perhaps leading to a greater wing-dropping tendency. Standard recovery technique is used, any further yaw being prevented with opposite rudder to prevent a spin developing.

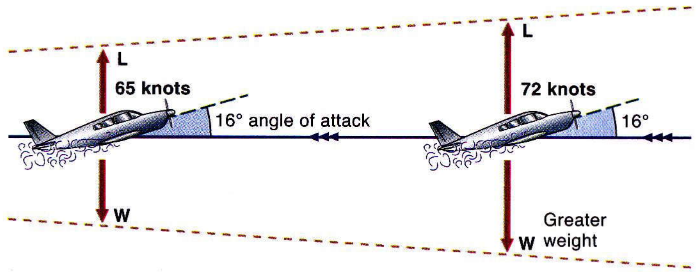


■ *Figure 10b-10* ***Power reduces stalling speed***

The Effect of Weight

Stalling speed decreases as weight decreases.

The lighter the aeroplane is, the less lift the wings must generate for straight and level flight, and so the smaller the required angle of attack at a given speed. Therefore a light aeroplane can be flown at a slower airspeed before the stalling angle of attack is reached.

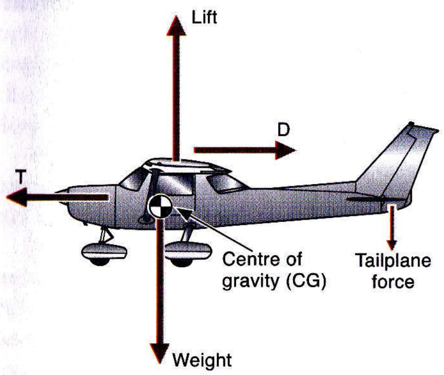


■ *Figure 10b-11* ***Stalling speed is less at lower weights***

Centre of Gravity Position

A forward centre of gravity increases the stalling speed.

In many aircraft, the tailplane generates a small downward force to balance the four main forces and prevent the aeroplane pitching. The lift from the main wings in straight and level flight will therefore have to support both the weight and this downward aerodynamic force on the tail.



The position of the CG is shown in diagrams with a centroid symbol:

■ *Figure 10b-12* ***The forces straight and level***

The further forward the CG, the greater the downward tailplane force and so the greater is the lift required from the main wings. This requires a greater angle of attack at a given airspeed, therefore the stalling angle will be reached at a higher airspeed. This is one very good reason why the aeroplane must be correctly loaded with the CG within approved limits.

Exercise 11a

Incipient Spins

Aim

To recognise the onset of a spin and recover before a full spin develops.

Considerations

Incipient spin means the beginning or onset of a spin. It is, if you like, a recovery from a spin before the spin actually occurs – with a minimum loss of height.

While spinning is not permitted in many training aeroplanes, the incipient spin is. Recovery should be made before the wings go through a bank angle exceeding 90°.

Flying the Manoeuvre

An incipient spin can be induced from almost any flight conditions by:

- flying slowly, continually bringing the control column back and then, when almost at the stall, applying rudder to generate yaw in the desired spin direction; or
- entering a shallow climbing or level turn (10–15° of bank) with a little power to the point of the stall, which will frequently ensure an incipient spin in the opposite direction of the turn.

NOTE Turns should normally be to the right with right-hand turning propellers and vice versa.

To recover from an incipient spin, simultaneously:

- **move the control column to the central position** (while keeping the ailerons neutral and holding the rudder central).

When the rotation has stopped:

- **level the wings** with coordinated use of ailerons and rudder; and
- **apply maximum power and regain altitude** (see note below).

NOTE If the nose has dropped steeply below the horizon, close the throttle, move the control column to the central position, hold ailerons and rudder neutral, and when the rotation has stopped, level the wings, ease out of the dive and regain lost altitude with power.

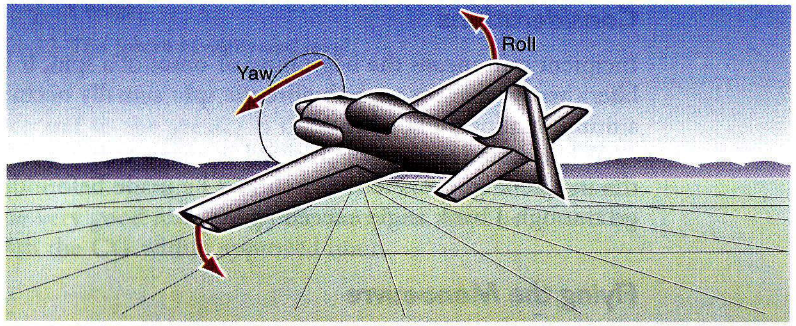
Airwork 11a

The Incipient Spin

Aim *To recognise the onset of a spin and recover before a full spin develops.*

1. *To Induce an Incipient Spin*

- Fly slowly, applying progressive back pressure, maintaining altitude as the speed reduces.
- Just prior to the stall, apply rudder in the desired spin direction.



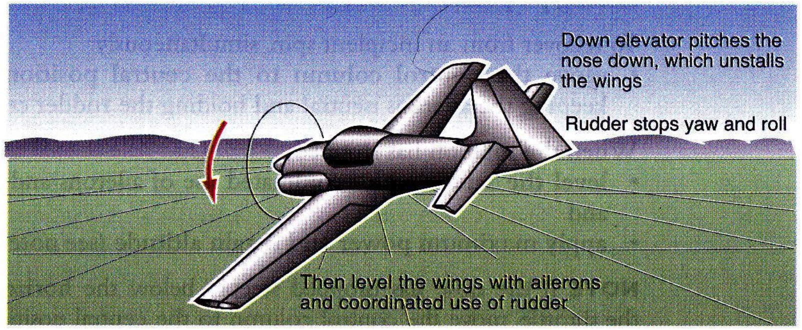
2. *Recovery Procedure*

As the spin commences, simultaneously:

- move the control column to the central position (sufficient to unstall the wings); and
- centralise the rudder.

When the rotation has stopped (ailerons and rudder held in neutral position):

- level the wings with coordinated use of ailerons and rudder; and
- apply maximum power and regain altitude (see note below).



NOTE If the nose has dropped steeply below the horizon, close the throttle, move the control column to the central position(ailerons and rudder held neutral). When rotation has stopped, level the wings, ease out of the dive, then regain lost altitude with power.

Exercise 11b

Full Spins

Aim

To enter, maintain and recover from a fully-developed spin (provided it is an approved manoeuvre for the aeroplane).

NOTE This exercise is not mandatory.

Considerations

What is a Developed Spin?

A spin is a condition of stalled flight in which the aeroplane describes a spiral descent.

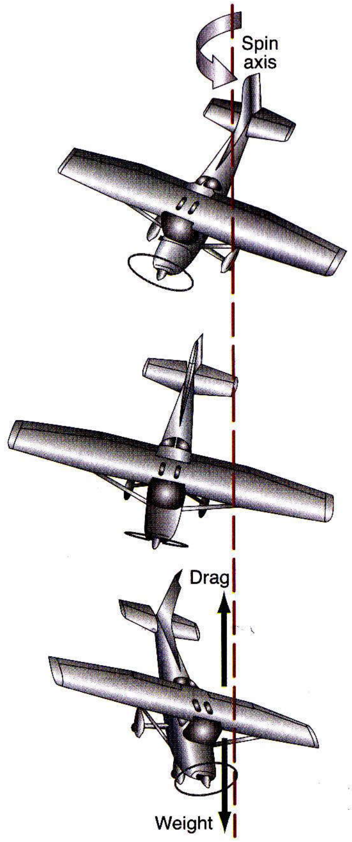
As well as the aeroplane being in a stalled condition, one wing is producing more lift than the other (caused by a roll at low speed). Greater drag from the stalled lower wing results in further yaw, further roll, etc., etc. Pitching of the nose may also occur.

The aeroplane is in motion about all three axes. In other words, lots of things are happening!

In a spin, the aeroplane is:

- stalled;
- rolling;
- yawing;
- pitching;
- sideslipping; and
- **rapidly losing height,** even though the airspeed may not be increasing.

NOTE In a developed spin the aircraft is also acting as a gyroscope. Therefore mass distribution will have an effect on the form the spin takes and how easily it will recover.



■ *Figure 11b-1* ***The spin***

In a spin the wings will not produce much lift, since they are stalled. The aeroplane will accelerate downwards until it reaches a vertical rate of descent where the greatly increased drag balances the weight. The height loss will be rapid as the aeroplane spins downwards about the vertical spin axis.

Characteristics of a developed spin include a **low indicated airspeed** (which does not increase until recovery action is initiated) and a **high rate of descent.** A vital part of the spin recovery is to unstall the wings by moving the control column centrally forward (which reduces the angle of attack), and to build up flying speed.

A well-flown spin will not stress a properly certificated aeroplane any more than a normal stall.

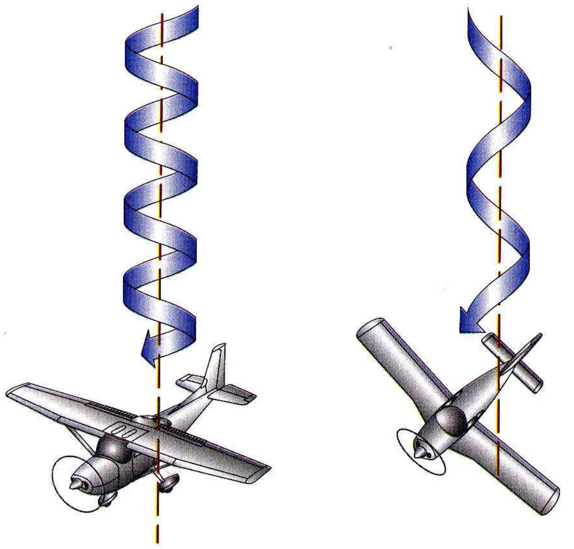
Spin Rotation

If the aeroplane adopts a higher nose attitude and the spin flattens:

- **the rate of rotation will decrease;** and
- **the rate of descent will reduce** (due to increased drag from the higher angle of attack).

The flatness of the spin determines the rate of rotation.

A spinning ice-skater moves her arms in and out from her body to alter the rate of rotation. The same effect occurs in an aeroplane. In a steep nose-down attitude, the mass of the aeroplane is close to the spin axis and the rate of rotation is high. If the spin flattens, some of the aeroplane's mass is distributed further from the spin axis and the rate of rotation decreases.



■ Figure 11b-2 **A steep spin (left) and a flat spin**

If the nose pitches up and down in the spin, the rate of rotation will vary – becoming slower when the spin is flatter and faster when the nose position is steeper. Since the nose is purposely lowered in the recovery from a spin, you can expect a temporary increase in the rate of rotation until the recovery is complete.

A rearward CG will encourage a flatter spin and it will be more difficult to lower the nose in the recovery. This is one (very important) reason for ensuring that you never fly an aeroplane loaded outside its approved weight and balance limits.

Conversely, **a forward CG** normally results in a steeper spin with a higher rate of descent and a higher rate of rotation. It may make recovery much easier and, in fact, may even prevent a spin occurring.

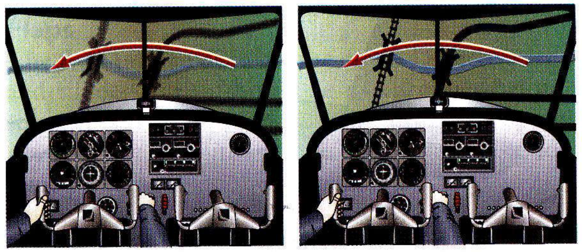
Spiral Dives

Do not confuse a spin (stalled) with a spiral dive (not stalled).

A manoeuvre that must not be confused with a spin is the spiral dive, which can be thought of as a steep turn that has gone wrong. In a spiral dive the nose attitude is low, the wing is not stalled, the airspeed is high and rapidly increasing and the rate of descent is high. Because the wing is not stalled, there is no need, in the recovery from a spiral dive, to move the nose forward. Spiral dives are considered in Section 15 on Advanced Turning.

Practising Spins

During your first spin, you will probably be a little overcome by the sensations and not really know exactly what is happening. After a few practice spins, however, you will become reasonably comfortable and the whole manoeuvre will seem to slow down enough for you to recognise the characteristics, count the turns, recognise landmarks and so on.



■ Figure 11b-3 **The spin as you first see it, and as you will see it**

The Three Stages in a Spin Manoeuvre

The incipient phase is said to begin when an uncommanded (or commanded) yaw and roll occurs at the point of the stall and can last from one, even up to three, rotations.

The spin manoeuvre can be considered in three stages:

1. **The incipient spin** (or the beginning of the spin), which is an unsteady manoeuvre in which the entry path of the aeroplane is combined with a phenomenon called autorotation.
2. **The fully developed spin,** in which the aeroplane has settled into a comparatively steady rate of rotation and a steady rate of descent at a low airspeed and a high angle of attack. Gyroscopic forces will now be stablilised.

3. **The recovery from a spin,** initiated by the pilot who:
   - opposes the rotation with rudder;
   - unstalls the wings with forward control column;
   - centralising all controls when the spin stops; and
   - eases out of the ensuing dive.

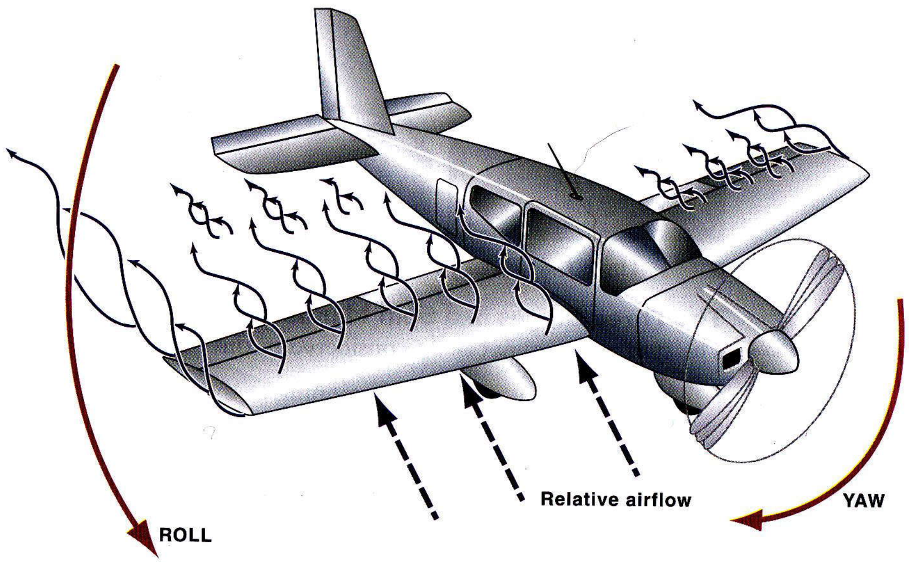
How a Spin Develops

A spin is a condition of stalled flight, so the first prerequisite is that the wings be at a high angle of attack. This is achieved by moving the control column progressively back, as in a normal **stall entry.**

A **wing drop** is essential to enter a spin and this may occur by itself or (more likely) be induced by the pilot yawing the aeroplane with rudder or 'misusing' the ailerons just prior to the aeroplane stalling.

Autorotation will commence through the dropping wing becoming further stalled, with a consequent decrease in lift and increase in drag. The aeroplane will roll, a sideslip will develop and the nose will drop. If no corrective action is taken, the rate of rotation will increase and a spin will develop. It will be an unsteady manoeuvre with the aeroplane appearing to be very nose-down. The rate of rotation may increase quite quickly and the pilot will experience a change of g-loading.

An aeroplane will not usually go straight from the stall into a spin. There is usually a transition period which may vary from aeroplane to aeroplane, typically taking two or three turns in the unsteady and steep autorotation mode, before settling into a fully-developed and stable spin.

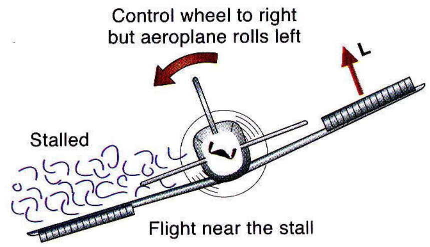


■ *Figure 11b-4* ***The aeroplane in a spin***

Misuse of Ailerons

Misuse of ailerons can cause a spin.

Trying to raise a dropped wing with opposite aileron may have the reverse effect when the aeroplane is near the stall. If, as the aileron goes down, the stalling angle of attack is exceeded, instead of the wing rising it may drop quickly, resulting in a spin. This is the spin entry technique on some aircraft types.



■ *Figure 11b-5* ***Inducing a spin with opposite aileron***

Use of Power

Power may destabilise an aeroplane before and during a spin.

At the incipient (early) stage of a stall, having power on may cause a greater tendency for a wing to drop, which could lead to a spin. Once the aeroplane is in a spin, power may destabilise it as the slip-stream will tend to flow across the outer wing, increasing its lift and consequently increasing the rate of roll. If power is applied, the entire spin manoeuvre may be speeded up or flatten and slow down.

It is essential, therefore, to remove power by closing the throttle either before or during the spin recovery.

Flaps

The flaps should be raised for spinning.

The flaps tend to decrease the control effectiveness of the elevator and rudder and so should be raised either before or during the spin recovery. For many aircraft, practising spinning with flaps down is not permitted, since the aerodynamic loads on the flap structure may cause structural failure.

Flying the Manoeuvre

Entering a Spin

It is usual to enter a spin by yawing with rudder to generate a low-speed roll just prior to the stall.

About 5 to 10 kt prior to the aeroplane stalling, with the control column being progressively moved fully back, a smooth and firm large-scale deflection of the rudder will speed up one wing and cause it to generate more lift. The aeroplane will begin to roll and a spin will develop.

The spin entry may require full travel of the rudder. If the left rudder pedal is pushed fully forward, the aeroplane will yaw and roll to the left and a spin to the left will develop. If the right rudder is pushed fully forward, the aeroplane will yaw and roll to the right and a spin to the right will develop.

Maintaining the Spin

To allow a steady spin to develop and continue:

- hold the control column fully back;
- hold on full rudder;
- keep ailerons neutral.

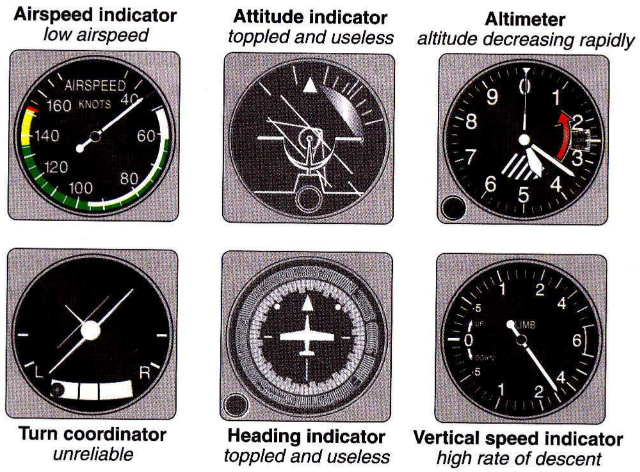
Note: In many aircraft relaxing of rudder or elevator pressures during the manoeuvre may induce a high rotational spin.

Recognition of a Spin

You can recognise a spin by the following characteristics:

- a steep nose-down attitude;
- continuous rotation;
- buffeting (possibly);
- an almost constant low airspeed;
- a rapid loss of height at a steady rate of descent.

The gyroscopes may topple in a spin, so information from the attitude indicator will be of no value. Some aircraft have gyroscopic instruments (e.g. the AI) which should be caged (locked) prior to performing any aerobatic manoeuvre in order to protect them.



■ Figure 11b-6 ***The flight instruments in a spin***

The precise spin recovery depends on the **spin direction.** In practice, of course, you will know the direction of the spin that you have induced. In an inadvertent spin, however, where the direction of spin may not be obvious, it can be obtained from the turn coordinator indicating left or right. Pay no attention to the balance ball in a spin. Your outside view of the ground may also assist you, but the turn coordinator is the best clue to spin direction.

The turn coordinator is the best clue to spin direction.

Standard Spin Recovery

CAUTION: You must consult the Pilot's Operating Handbook for your aircraft type prior to spinning, as the spin entry and recovery techniques may not be standard.

The technique is:

- check throttle closed and flaps up;
- **verify direction of spin** on the turn coordinator;
- apply full opposite rudder;
- **pause** (to allow the rudder to become effective and stop the yaw, which turns a stall into a spin);
- **move the control column centrally forward** to unstall the wings (full forward if necessary);
- **as soon as the rotation stops, centralise the rudder** (it may take one, two or more complete turns for the rotation to stop);
- **level the wings** and ease out of the ensuing dive;
- **as the nose comes up** through the horizon **add power** and **climb** to regain height.

In the process of unstalling the wings, the nose attitude will become steeper and the mass of the aeroplane will move closer to the spin axis. The result may be a noticeable increase in the rate of rotation just before recovery.

Airmanship

Airmanship is knowing how to recover from a spin, even though you may never have to do it.

Ensure that your aeroplane is certified for spins and that weight and balance aspects are correct.

Ensure that you know the correct spin recovery technique for your aeroplane type (found in the Pilot's Operating Handbook).

The spin is an aerobatic manoeuvre and so the pre-aerobatic HASELL check should be performed prior to practising. A proper aerobatic harness should be worn. A thorough **lookout** is essential as a spin and recovery will consume a lot of height (possibly 500 ft per rotation). Commence your practice at a height plus an allowance that will allow you to fully **recover before 3,000 ft agl.**

Exert firm control over the spin entry and recovery. You should fly the aeroplane – not vice versa.

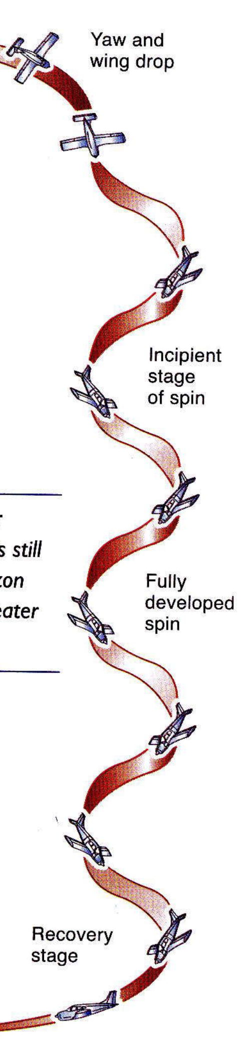
Moving your head during a spin can cause severe disorientation – it is better to just move your eyes to check inside and outside the aircraft.

Never spin inadvertently! When climbing away after each spin recovery, reorientate yourself using familiar landmarks.

Airwork 11b
Full Spins

Aim *To enter, maintain and recover from a fully developed spin (provided that it is an approved manoeuvre for the aeroplane).*

NOTE Full recovery from the spin should be made before 3,000 ft agl.



1. *Complete the Pre-Aerobatic 'HASELL' Check (see page 175)*

2. *Inducing a Spin*

Normal stall entry:
- Power OFF (carb heat HOT).
- Maintain altitude with increasing control back pressure, wings level, balance with rudder.

Just prior to stall:
- Smoothly apply full rudder in desired direction of spin.
- Hold control column fully back.

3. *Maintaining the Spin*
- Control column fully back.
- Full rudder in direction of spin.
- Hold ailerons neutral.

Applying power while the nose is still below the horizon will cause a greater loss of height.

4. *Recovery from the Spin*
- Throttle CLOSED (check flaps UP).
- Ailerons neutral.
- Confirm spin direction on turn coordinator.
- Apply **full** opposite rudder.
- Pause (if required) and move the control column centrally forward progressively (to unstall wings) until the rotation stops.
- When rotation stops, centralise rudder and level the wings.
- Ease out of the ensuing dive.
- As the nose rises past the horizon, add power (carb heat COLD) and climb away.

NOTE The spin entry and recovery technique in the Pilot's Operating Handbook for your aircraft may differ slightly from this procedure. For example, T-tail aircraft may not require a pause before moving the control column forward. Use the technique recommended for your aeroplane.

Exercise 12
Standard Take-Off and Climb to Downwind Leg

Aim

To take off into wind and climb out in the circuit pattern to downwind leg.

Considerations

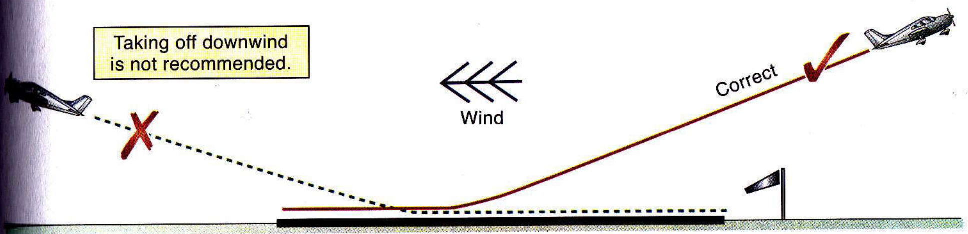
This manoeuvre involves:
- **flying the aeroplane off the ground** and clearing any obstacles;
- **a climb to circuit altitude;** and
- **positioning the aeroplane on downwind leg.**

The Take-Off

Take-off into wind if possible.

During the take-off, the aeroplane must be accelerated to an airspeed at which it is capable of flying. Having a headwind component on a runway 'gives' you airspeed even before you have started rolling. For example, a 10 knot headwind component gives you 10 kt of airspeed over and above the groundspeed on take-off.

Taking off into wind is good airmanship because it gives:
- the shortest ground run;
- **the lowest groundspeed** for the required take-off airspeed;
- **the best directional control,** especially at the start of the ground run, when there is not much airflow over the control surfaces;
- **no side forces** on the undercarriage (as in a crosswind);
- **the best obstacle clearance** because of the shorter ground run and the steeper flightpath over ground;
- **the best position in the climb-out** from which to make an into-wind landing straight ahead (or slightly to one side) in the case of engine failure immediately after take-off.



■ *Figure 12-1* ***Take-off into wind***