Straight and level Flight Exercise n°6.

Background Briefing

The Four Forces Acting on the Aircraft in Flight.

Weight : The weight of the aircraft always act vertically down.

Lift : Most of the lift is created by the airflow around the wings

Thrust: Thrust is provided by the engine through the propeller

Drag : Drag is the resistance to the passage of the aircraft through the air.

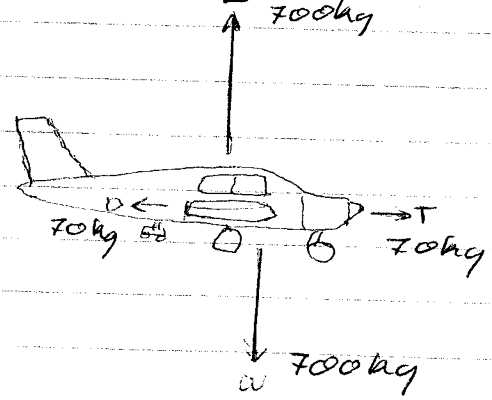
Equilibrium

When an aircraft is in straight and unaccelerated flight

Lift is equal and opposite to Weight

Thrust is equal and opposite to Drag.

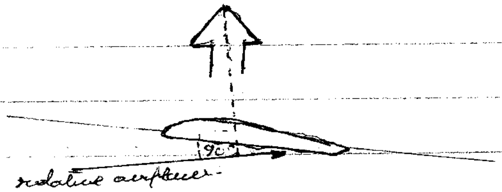
If the forces are not in equilibrium the aircraft will not fly truly straight and level at a constant speed.



Lift and Factors Affecting Lift.

Lift is created by the airflow around the wings.

The airflow meeting the wing is often referred to as the relative airflow. For practical purposes lift acts a about 90° of the relative airflow



The angle at which the relative airflow meets the wings is called the angle of attack.

There are several factors affecting the amount of lift produced by the wings. The main two factors controlled by the pilot are the airspeed and the angle of attack.

The airspeed is literally the speed of the aircraft through the air. A faster airspeed implies a faster airflow around the wing and more lift is produced if all other factors remain the same. A slower airspeed implies that less lift is produced.

The amount of lift produced by the wing is also determined by the angle of attack. The wing of an average light aircraft produces lift over an angle of attack range from -2 to +19°. The greater the angle of attack, the greater the lift produced until the critical angle (about 19) is exceeded. Typically, in cruising flight the angle of attack will be about 4°

So if an aircraft is flying at a fast airspeed, only a small angle of attack is needed to produce the lift necessary to maintain level flight. At a slower airspeed a greater angle of attack is need to produce the required lift

As the airspeed is changed, so the angle of attack must be changed to produce the same amount of lift.

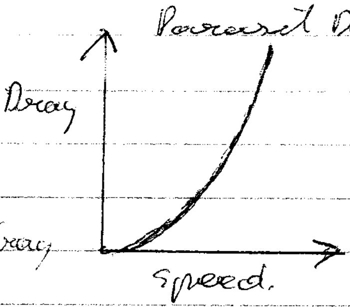
Look at the Air Speed Indicator (ASI)
- Normal cruise air speed → angle of attack +4.
- High ~~speed~~ cruise → angle of attack -1°
- Slow speed cruise → angle of attack +10.

The concept of angle of attack is an important one to grasp. There is no instrument in a light aircraft to measure the angle of attack and it is not necessarily the same angle as the aircraft's pitch attitude. However changing the aircraft attitude does alter the angle of attack in the same sense i.e pitching the aircraft nose down reduce the angle of attack.

Drag and Factors Affecting Drag

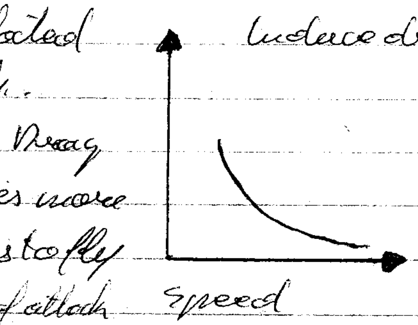
Drag is the resistance to the passage of the aircraft through the air. There are two element of drag - parasit drag and induced drag.

Parasit drag affect any moving object (car). The faster the aircraft moves through the air the greater the Parasite drag and vice versa



Parasit drag increase as airspeed increases.

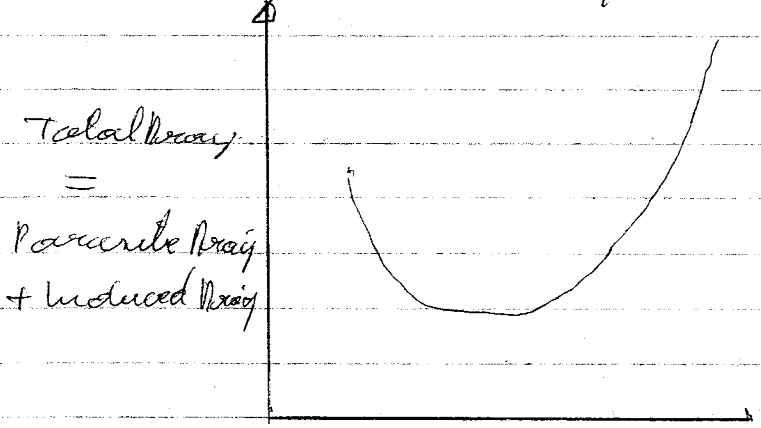
Induced drag is related to the angle of attack.



induced drag decreases as airspeed increases

As an aircraft flies more slowly and so has to fly at a greater angle of attack to maintain level flight, the amount of induced drag increase

Drag acts parallel to the flight path, through a point that varies with the aircraft attitude and configuration.



change of Total drag with airspeed.

Stability in Pitch.

The stability of the aircraft is largely determined by the arrangement of the lift and weight forces.

Most aircraft are designed to be stable in pitch - This is done by arranging the forces in such a way that weight acts through a point (CG) that is ahead of the centre of the lift force. The couple between the lift and weight forces exerts a pitch down force which is instrumental in making the aircraft stable in pitch.

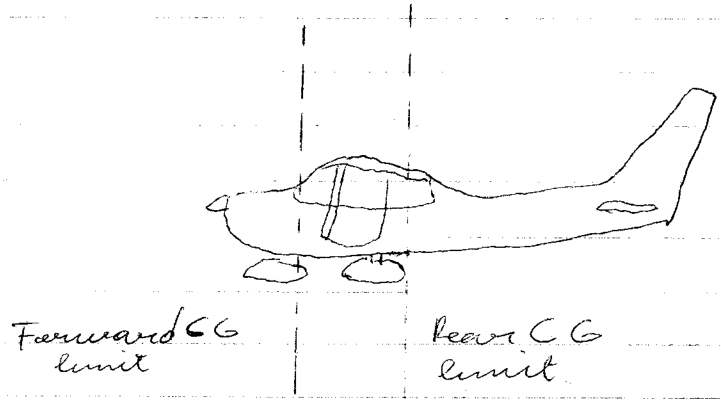
There is also a couple between the thrust and drag forces (see ex n°8) which exerts a pitch up forces

In practice the thrust / drag couple is not strong enough to counterbalance the lift / weight couple and the aircraft is left with a residual pitch down forces
This pitch down force is balanced by the tailplane or stabilator. The tailplane or stabilator can produce lift either up or down. Where there is a pitch down effect, the tailplane will produce a down force to balance the strong lift / weight couple.

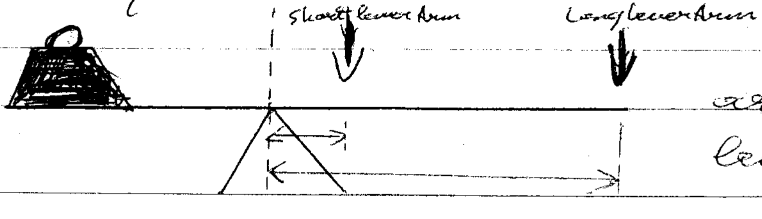
The tailplane also aids stability in pitch if the aircraft meet a wind gust or some turbulence - If a gust causes the nose to rise, for example, the tailplane (or stabilator) will meet the airflow at a greater angle - Therefore it will produce less down force (or more lift eg). and cause the aircraft to pitch down. back to its original attitude

The position of the centre of gravity is a key factor in ensuring stability in pitch. The CG position varies with aircraft loading (ie passengers etc..) and can be calculated by the pilot from the info provided in the POH/FM.
The POH/FM will state the forward and rear limit of the Centre of Gravity (CG) position

The aircraft must never be flown with a CG Position outside the stated limits-



When the CG is closest to the forward edge of its permitted limit there will be a long lever arm between the CG and the Tailplane. This will make the aircraft very stable as a result of the increased leverage the tailplane force exerts.



The longer the lever arm, the greater the leverage applied.

if however, the CG is forward (fore) of its permitted limit the aircraft will become overstable and the pilot will have difficulty in manoeuvring. In an extreme case the aircraft may become uncontrollably nose heavy, especially at low airspeed when the ~~air~~ tailplane is less effective and the pilot may be unable to prevent it pitching nose down.

A forward CG gives the tailplane a long lever arm so it has a strong leverage.

When the CG is close to the permitted rear (aft) limit there is a shorter lever arm between the CG and the tailplane. This will make the aircraft less stable and and easier to manoeuvre.

If the CG is behind (aft of) the rear ~~of~~ limit the aircraft will become unstable and difficult to control. It will seem tail heavy and the pilot may be unable to prevent the aircraft pitching nose up.

A rearward CG gives the tailplane a short lever arm so it has a reduced leverage.

It's Obviously important to ensure that the CG will be within its permitted limit. It is illegal to fly with a CG outside permitted limit (and very dangerous). You will come to appreciate that in most light aircraft it is simply ~~no~~ not possible to fill the aircraft with full fuel, full passenger and full baggage load and remain with the permitted CG Range.

Stability in Roll.

Stability in roll is largely provided by the angle of the wings to the horizontal - the dihedral - angle.

When an aircraft is in straight flight but not wings level the sideways components of lift and weight cause the aircraft to slip toward the lower wing.

The airflow now meet the lower wing at a greater angle of attack than the higher wing. Therefore increased lift is produced from the lower wing, returning the aircraft to wings level flight.

You may notice that low wing aircraft tend to have more dihedral than high wing aircraft. The CG position in a high wing aircraft (below the wing) gives it a greater natural stability in Roll and so it need less dihedral; (This op is sub to dire)

Stability in Yaw

Stability in yaw is provided by the fin. When an aircraft skids (yaws) through the air, the airflow meet the fin at a angle (ie, angle of attack) which causes the fin to produce lift sideways. This pivots the aircraft around the CG to yaw the aircraft into the airflow and out of the skid.

- Power + Attitude = Performance

Performance can be measured in terms of airspeed and rate of climb (or rate of descent). Airspeed is controlled through the control column (controlling the attitude). The rate of climb or rate of descent is controlled through the Throttle (setting the power). So power controls ~~attitu~~ altitude (or height). Attitude controls airspeed

To maintain level flight, the pilot set the power required for level flight and adjusts the attitude to attain the correct airspeed. If the airspeed is correct but the aircraft is descending more power is required. Conversely if the airspeed is correct but the aircraf is climbing, less power is required

You will come to recognise the correct attitude and normal cruise power setting to maintain level flight at the normal cruise airspeed

It is ~~is~~ also worth noting that if the aircraft is fitted with a fixed pitch propeller l. a change in airspeed will induce a small change to the engine RPM.
(a car moves faster the engine RPM increases, even any movement of the throttle. Conversely as the car (or aircraft) move slower, the engine RPM decreases.
The significance of this is that if increasing or decreasing airspeed significantly, it will often be necessary to make further minor correction with the Throttle to maintain the RPM

Slow Safe Cruise

During the flight exercise you will practice cruise at a slower than normal ~~sp~~ airspeed. - usually with one stage of the flap selected down (initial flaps) - This speed is known as slow safe cruise.
The use of the flap allows a lower nose attitude (improving the view ahead) and by reducing the stall speed, use of flap ensures that a safe margin of airspeed remains between the slower cruising speed and the stall airspeed.

Slow safe cruise has several application; ~~apart from~~ in situation where a pilot is lost, flying at slow safe cruise will give more time to locate its position while using less fuel, the same in case of bad weather in order to read map ~~easily~~.

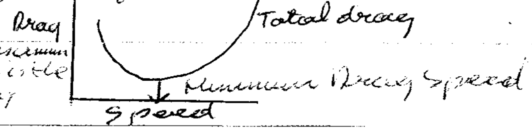
Maximum Range Airspeed

At the maximum range airspeed, the aircraft will fly the maximum distance for a given fuel load.
There are many factors affecting best range airspeed such as aerodynamic effeciency, engine power, propeller design, air density etc. ~~Ex~~,

Theoretically the maximum range airspeed is the airspeed at which there is the minimum drag.
In practice the maximum-range airspeed is a compromise between airframe (aerodynamic) consideration and engine (power) consideration.
The aircraft's POH / FM will have a section detailing technique and figures for maximum-range flying ~~and~~

Maximum range = Maximum distance for the fuel load.

Theoretical maximum range airspeed is the minimum drag airspeed



Maximum Endurance

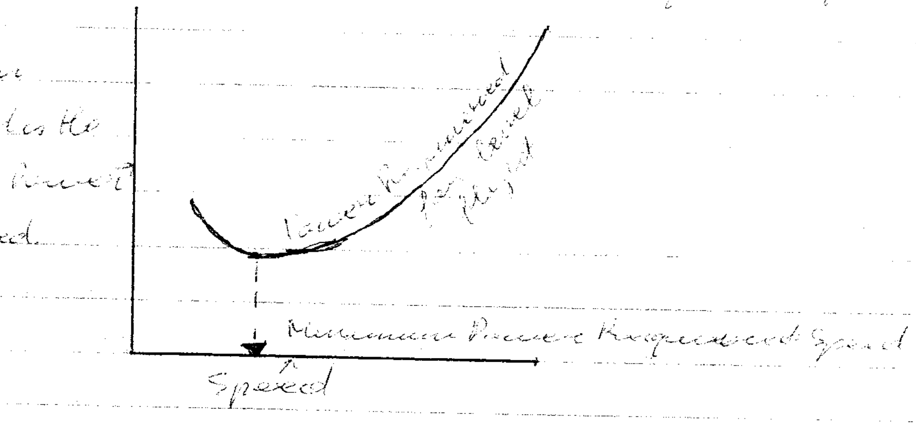
At the maximum-endurance airspeed the aircraft will be able to stay airborne for the maximum time with a given fuel load. However as the maximum-endurance airspeed will be slower than the best-range airspeed, the aircraft cannot travel as far with its given fuel load, even though it is in the air for longer.

It is therefore important not to confuse endurance with range.

There are many factors which affect the best-endurance airspeed. Theoretically the **best** endurance airspeed is the airspeed at which the minimum power is required to maintain level flight. The pilot should refer to POH/FM.

Maximum endurance = Maximum airborne time for the fuel load

Theoretical maximum endurance airspeed is the minimum power required airspeed.



Power Required = Airspeed x Drag

Flight at Critically High Airspeed

Even a light aircraft is capable of flying straight and level over a surprisingly wide range of airspeeds. As the speed increase toward the faster end of the scale, it is important for the pilot to have a good awareness of the airspeed-related factors that restricted the operation of the aircraft.

The aircraft will have a manoeuvring speed (called VA) ~~wit~~ which is the maximum airspeed at which full and abrupt control movement can be made without ~~over~~ over stressing the aircraft. The Va airspeed is specified in the POH/FM and is usually placarded in the cockpit. The Va speed is often quite close to the aircraft's normal cruising speed, so an appreciation of this airspeed limitation is important.

If you look at Airspeed Indicator (ASI) you should notice that it is colour-coded ~~white~~ with White, green and Yellow arc. The yellow arc represent the caution airspeed range beyond the maximum Normal Operating airspeed (VNC). The aircraft should only be flown in this range (which is above the Va airspeed with caution in effect you must avoid large or sudden flying control movement and ~~ab~~ only operate in the yellow arc in smooth (ie not turbulent) flying condition.

Flight Exercise n°6.

Purpose

To learn to fly the aircraft at a constant altitude, in a constant direction, at a specified airspeed, with the aircraft in balance

Airmanship

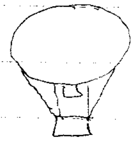
VFE: make sure that the speed is below VFE when lowering flaps

Location..

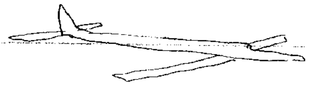
Try to find your location by spotting landmark so you can find your way back.

Lookout

When aircraft are converging and are of different classes the following priority apply.



1s Balloons



2e Glider (Planeur).

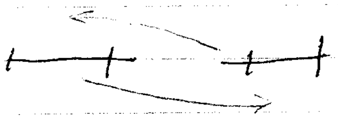
3rd Airships (dirigeable)

4~~th~~ Aircraft towing an object or glider

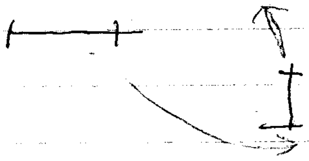
5t Aircraft

The aircraft commander must take all possible measures to avoid a collision. Do not fly close to another aircraft and in ~~formation~~ formation without agreement of the commander. To fly in formation you must receive proper instruction.

Rights of Way in the Air and Collision Avoidance



Where 2 aircraft are approaching head on each aircraft shall alter course to the right.



Where two aircraft are converging, the aircraft on the right has right of way

(on the right, in the right

An aircraft overtaking another in the air shall alter course to the right

To maintain Constant Altitude

1 - Maintain a good lookout

2 - POWER - Set the normal cruising power

3 - ATTITUDE - Use the elevator to select the straight and level attitude

4 - TRIM - Use the elevator trimmer to relieve any force on the control column

5 - Cross check the flight instruments.
    Altimeter - constant level
    Airspeed - normal cruise speed.

Tamasiko

To maintain constant direction

1 - Lookout

2 - Use the ailerons to keep the wing level.

3 - Use a distant landmark to confirm that a constant direction is being maintained

4 Cross-Check the flight instrument. Heading indicator should be reading a constant direction

To Maintain Balanced Flight

[1] - Lookout.

[2] - Unless the aircraft is extremely out of balance there is no outside indication of balance.

[3] Cross check flight instrument - Turn Co-ordinator.
The balance ball should be in the centre.

[4] If the ball is displaced to the left, left rudder is required until the ball is centred. (Tread on the ball.

[5] - If the ball is displaced to the right right rudder is required until the ball is centred ('Tread on the ball')

At an increased Airspeed

$\boxed{1}$ Lookout, Note the normal straight and level attitude.

$\boxed{2}$ - POWER - increase power. Compensate for the pitch and yaw changes.

$\boxed{3}$ ATTITUDE - as airspeed increase, the nose attitude must be progressively lowered to maintain level flight until the target airspeed is attained.

$\boxed{4}$ TRIM. Remember to trim to relieve any control forces

At a decreased Airspeed

$\boxed{1}$ Lookout Note the normal straight and level attitude

$\boxed{2}$ - POWER - Reduce power, compensate for the pitch and yaw changes.

$\boxed{3}$ Attitude - As airspeed decrease, the nose attitude must be progressively raised to maintain level flight until the target airspeed is attained.

$\boxed{4}$ Trim - Remember to trim to relieve any control forces

Slow Safe Cruise

1 Lookout : note the normal str & lev att.

2 POWER - Reduce power. Compensate for the pitch and yaw changes.

3 When airspeed is within the white arc (ie below VFE) Lower initial flap.

4 Attitude - Adjust the cruise attitude to attain the target airspeed

5 Remember to trim to relieve control loads. Make minor corrections as necessary.

6 Nose Attitude should be similar to the normal straight and level attitude.

Exercise n°6 - Straight and Level flight

Lookout supplement:

Look first and scan the instrument second.

The greatest threat is in an area between 10° up and 10° down and 60° either side of the straight ahead.

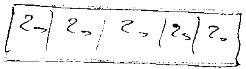
Look up before beginning climb

Look down before beginning a descent

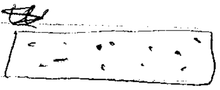
Look over your shoulder before turning

Focus on distant object. cloud, horizon.

Develop a scanning technique



Block Method

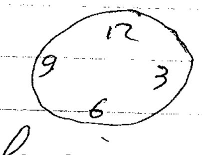


wandering method.

Constand bearing = constant danger.
When an aircraft is on a colision course with yours it is most likely to appear as a stationary dot on the screen - a constant relative bearing.

If you spot an aircraft and it appears to be moving relative to you the chance are you are not on a collision course

Use the clock code



Keep the ~~screen~~ windscreen clean
Look after your eyes

Climbing : Ex n° 7.

During a climb the four force (Drag, Thrust, lift and weight. are of course still acting on the aircraft. However the relationship is changed.

Thrust and drag stil act parallel to the flight path of the aircraft. and lift still acts at around 90° of the relative airflow. However, weight continues to act vertically toward the centre of the earth and so no longer completely balanced by the lift.

In fact a component of weight is now activing in the same direction as drag so that ~~it~~ in climb thrust has to balance drag and a component of weight. The steep the climb, the greater the component of weight acting with drag and the greater thrust needed for the aircraft to climb.

It follows that climbing performance is essentially dictated by the power of the engine.
Although in a climb the aircraft is still producing lift, this is not the major factor in climb performance. In fact in a climb lift may be less than weight

10° climb $\Rightarrow$ $T = D + 17\%$ weight

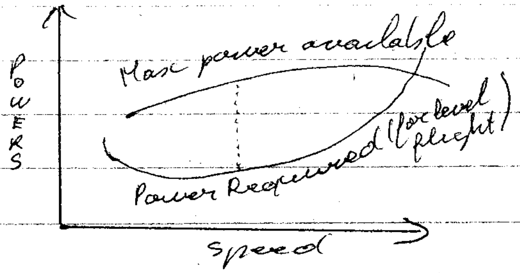
45 climb $\Rightarrow T = D + 71$ of weight

90 climb $\Rightarrow$ $T = D \times W$

The steeper the climb the greater the component of weight acting with ~~the~~ drag and so the greater the amount of thrust required to sustain the climb.

The Best Rate of Climb Airspeed

The best rate of climb airspeed is the airspeed at which there is the greatest excess of power available over power required.



Power Required = Drag × Airspeed

Power Available = Thrust × Airspeed

The climbing performance of the aircraft and recommended climbing speed will be POH/FM.

The airspeed for the best rate of climb is referred to as V_y

Best rate of climb airspeed gives the maximum height gain in a given time.

The VSI (Vertical Speed Indicator) reads the rate of climb or rate of descent.

Effect of Flap.

It depends on the aircraft type & design and the type of flap.

During the flight exercise, flap is lowered during the climb and the original climb airsp maintained. The extra drag created by the

flap lead to a decrease in the rate of climb
As more flap is lowered (intermediate to full flap) the further increase in drag reduces the rate of climb. In fact if the original climb airspeed is maintained some light aircraft may display little or no rate of climb once full flap is lowered.

Flap can be beneficial, tx when considering the best angle of climb.
The use of initial flap allows a slower airspeed to be used in the climb, which may improve the climb gradient. It will be noted in POH / FM if flap can be use in this way -

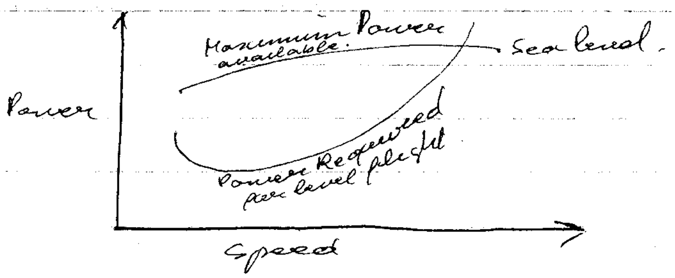
Effect of Altitude

As altitude increases, the reduction in air density mean that the power required increase but the power available decrease.
This decrease in power available is true of a normally aspirated piston engine - training aircraft
Where the engine is fitted with a turbocharger or supercharger, the engine will be able to maintain it maximum power output to a greater altitude

With increasing altitude, the excess of power available over power required is reduced and occurs at a faster speed. Eventually the aircraft will reach an altitude where even the full power, power available is equal to the power required. so the aircraft can maintain level flight but cannot climb. This altitude is known as the aircraft absolute ceiling and may be noted in the POH/FM.

Another ceiling, the performance ceiling may also be noted, this is the altitude at which rate of climb will become unacceptably low - ~~100ft~~ less 100 fpm. For training aircraft the service ceiling is a generally a couple of thousand feet lower than the absolute ceiling.

PA-38 Tomahawk POH/FM Service ceiling 12000ft
Absolute ceiling 18000ft



As altitude increase air density reduces. Therefore engine power reduces but the power required increases.

When the maximum power available = minimum power required the aircraft cannot climb any higher and has reached its absolute ceiling

Effect of Weight

Similar to altitude, climb performance is reduced if weight increase, a faster airspeed is required to maintain climb performance ~~and~~ if overloaded it may not climb at all.

The aircraft will have a certified maximum weight and climb performance will be calculated using the weight. Overweight is dangerous & illegal

The Best Angle of Climb Airspeed

It gives the maximum height gain over the shortest distance and in practice is used to clear obstacles.

Best angle of climb occurs when there is the maximum excess of thrust over Drag, which will be at a slower airspeed than the best rate of climb airspeed

Where there is a practical difference between best angle of climb airspeed and best rate of climb airspeed, it will be detailed in POH/FM.

Best angle of climb (sometime also referred to as best gradient of climb) airspeed is referred to as Vx.

Quite often the best angle of climb is achieved with initial flap extended which allows the slower climb airspeed (See POH/FM).

You will appreciate that obstacle clearance for which the best angle of climb airspeed is used is most vital immediately after take off, so the POH FM will often recommend the flap ~~the~~ setting and airspeed to be used to obtain the shortest take off distance and the best angle of climb in the initial climb. Once the obstacles are safely cleared, the aircraft is accelerated to the best rate of climb airspeed and the flap is retracted.

Airspeed Vx gives the best Angle of climb.
Airspeed Vy gives the best rate of climb.

The Cruise climb.

Cruise climb is flown at a higher airspeed than V_y or V_x, probably the normal cruise airsp
Cruise climb can be useful when there is no pressing need to gain altitude quickly and the reduced climb performance

Because the airspeed is faster than the normal climb airspeed, the groundspeed is faster the view ahead is improved (due to the lower nose attitude) and the increased airflow help keep the engine cool.

Effect of Wind

When flying in wind the aircraft will attain a better climb angle or gradient than when flying in zero wind or with a tailwind

The rate of climb is not affected by the wind.

Engine consideration

During a climb the engine is working very hard but due to the slower airspeed there is less airflow cooling the engine. Monitor the engine gauges carefully. Should engine temperature approaches their permissible limits it may be necessary to reduce power or increase airspeed to reduce T°.

Flight Exc n° 7. - Climbing

Look in the area the aircraft will be ~~climbing~~ flying

During the ~~the~~ climb the nose high attitude may cause a blind spot, weave the aircraft sideways (every 500 ft or so) to check visually the area ahead. Alternatively "dip" the nose to check ahead. Visually clear the area you are flying into as you level off.

Engine Considerations.

Monitor the engine instrument carefully during the climb (ever 500 ft or so) do not allow the maximum permitted Temperature to be exceeded.

VFE

When using flap airspeed must stay in the white arc VFE.

Entering the climb.

[1] Lookout esp above & ahead
Choose an attitude reference such a cloud or position of the sun to monitor direct

[2] Power – Set full power, anticipate the effect of the yaw and use the rudder to stay in balance

[3] Attitude Pitch up to the climbing attitude

[4] Trim – to relieve any control forces.

Note: Do not chase the airspeed. After selecting a pitch attitude allow the airspeed 5/10 seconds to settle before making a further adjustment.

Maintaining the climb

[1] Maintain climb airspeed through the nose attitude

[2] Maintain ~~level~~ wings level. Cross check outside reference and heading indicator.

[3] Maintain balanced flight by reference to the balance ball

[4] Maintain look out scan. Weave the nose regularly to check ahead.

[5] Maintain the engine T° and pressure.

[6] Maintain the altimeter to anticipate required level.

Levelling off-

[1] Anticipate required level by about 50-100 feet.

[2] Attitude. Lower the nose to the straight and level attitude

[3] Power. As airspeed reaches normal cruise reduce the normal setting. Maintain Balan

[4] Trim to relieve any control forces.

[5] Make minor correction.

Note: Cross check altimeter and airspeed indicator

The Effect of Flap.

[1] In a established climb, note the nose attitude and the rate of climb.

[2] Check airspeed is in "white" arc
lower first stage (initial) flap.

[3] Pitch nose down to maintain climb airspeed,
Trim

[4] Note the lower nose attitude and reduced rate of climb

[5] As more flap is lowered, the nose attitude become lower to maintain airspeed and rate of climb reduce further.

Best Angle of Climb.

1 Lookout.

2 POWER - ATTITUDE - TRIM.
Nose attitude will need to be higher to maintain the slower best angle of climb airspeed.

3 Note the rate of climb is less than in a normal climb, but the angle of climb is steeper

4 The slower airspeed will require more accurate airspeed control.

Cruise climb

[1] Lookout

[2] Power Attitude Trim Lookout

[3] Nose attitude is only slightly higher than for the straight and level flight.

[4] Note normal cruising airspeed,
better view ahead and reduced rate of climb

Descending Ex n°7.

We saw that an excess power over that needed to for level flight allow the aircraft to climb. Not surprisingly the reverse is true. ~~If~~ If power is below that needed for level flight the aircraft will descend.

In a descent. Thrust has been reduced or removed altogether. In a glide the nose down of the aircraft allow ~~a~~ a component of the weight to act ~~as~~ in the same direction as thrust would normally (ahead of the aircraft) so balancing drag and maintaining a safe airspeed.
Weight is balanced by the resultant of the lift and the drag forces.

in the descent a component of weight replace thrust to balance drag.

The gliding range of the aircraft is governed by it aerodynamic efficiency - specifically its lift to drag ratio. When gliding the ideal is for the the airframe to produce the maximum amount of lift for the minimum amount of drag this is known as a good lift/drag (L/D) ratio.

Gliding for Best Range.

The glide angle is dictated by the L/D ratio.

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The gliding angle of the aircraft is the same as the angle between the lift vector and the resultant.

An aircraft that has a good L/D ratio (the maximum lift produced for the minimum drag penalty) will have a narrow angle between the lift vector and the resultant. The gliding angle is flat & gliding range good. An aircraft with a poor L/D ratio has a steeper gliding angle & gliding range is less.

The greater the lift generated and the less drag produced, the smaller the angle between the lift vector and the resultant.

This equates to a more shallow gliding angle & therefore a greater range.

A typical training aircraft will have a best L/D ratio of around 10:1 meaning that it is producing 10 units of lift for every 1 unit of drag, 10 feet forward for every 1 feet lost in height or 10000 feet horizontally (1.6 nautical miles) for each 1000 feet lost in height. So the gliding angle and range are determined by the aerodynamic efficiency of the aircraft, providing it is flown at the recommended gliding speed at which the best L/D ratio occurs.

L/Dx

Only at the recommended glide airspeed can the maximum glide range attained

Effect of Wind

Gliding with a tailwind increase glide range

Gliding into a headwind decrease glide range

Reducing airspeed by about 5 knot when gliding with a strong tailwind (increase gliding)

Increasing airspeed by about 5 knot when gliding with strong head wind.

The Rate of Descent is not affected by the prevailing wind (head or Tail), the aircraft will still reach the ground in the same time. What will alter is the distance it covers in the glide.

Effect of Weight

Weight does not alter the gliding angle. Remember that the glide angle is governed by L/D Ratio
A heavier aircraft will have a faster best gliding speed than a light.

A training aircraft with a small range of take off weights will not benefit significantly from being flown at different glide airspeeds for different weight. Normally just one gliding speed (that for maximum weight) will be noted in the aircraft's POH/FM.

Weight does not alter the glide angle, on the glide airspeed. At a higher weight the length of the vector is longer. Therefore the length of the lift vector is longer and because of the faster airspeed the drag vector is longer - the L/D ratio is unchanged and so the glide angle is unchanged.

Gliding for Best Endurance

A pilot might want to glide with a view to stay airborne as long as possible. (with minimum rate of descent) even though the gliding range will be reduced

The best glide endurance (minimum height lost in a certain time) occurs at a slower airspeed than the best gliding range airspeed - in fact at the minimum power required airspeed.

The best glide endurance (the greatest time airborne is achieved at the minimum power required airspeed

Effect of Flap.

The use of flap increases drag so worsens L/D ratio, leading to a steeper descent. Without increasing airspeed which is a major consideration when approaching to land

Effect of Power

When Power is used during the descent, the increased thrust mean that a reduced component of weight is required to balance drag. The aircraft can be pitch nose up to maintain a constant airspeed and the descent angle is reduced (and descent range increased.

As power is increased, the rate of descent and angle of descent decrease (if a constant airspeed is maintained

In practical term power is used to control the rate of descent, whilst the elevator control the attitude and therefore the airspeed.
Power control attitude (in this case rate of descent)
Attitude control airspeed.

Sideslipping.

Flaps can be used in the descent to increase drag and steepen the descent. There is also sideslipping which give similar effect.

To sideslip, the aircraft is banked and rudder applied to the opposite direction the bank, so that the aircraft does not turn toward the lower wing. The result is that the aircraft slips sideways through the air. This causes a marked increase in drag so lead too steeper gliding angle and an increased rate of descent, without the airspeed increasing.

Before aircraft were fitted with flaps ~~add~~ sideslipping was standard manoeuvre especially during the final approach to land. Sideslipping does have several disadvantage. Flying the aircraft in such an out of balance condition can be uncomfortable for passenger and requires some skill on the part of the pilot to keep the aircraft descending in a straight line while maintaining the correct airspeed.
Airspeed control can also be more difficult because the airspeed indicator may give incorrect reading in this out of balance situation. Rate of descent can become very high in a sideslip and when the sideslip is corrected (and so the drag reduced) the airspeed can increase rapidly.

Not all aircraft are cleared to sideslip, especially with flaps down. The aircraft's POH/FM will advise if sideslipping is restricted or prohibited and there may be a warning placard in the cockpit

The Cruise Descent

To lose height in more gradual descent than gliding use cruise descent,

In a cruise descent, the engine power is reduced typically by 200-300 RPM) but the airspeed is maintain ~~and the~~ cruising speed by pitching the nose down to a shallow descent attitude. The result is a gradual descent (typically 500 feet per minute) whilst maintaining the cruise airspeed which give a faster groundspeed. It is also kinder to the engine. In this type of descent you can use a simple rule of thumb to gauge a ideal point to start the descent toward an airfield.
Read the height above the ground in thousand of feet multiply by 3 and the result is the distance required (in nautical miles) to descend to ground level at height 5000 start the descent 15 nautical mile from the destination
Groundspeed, aircraft type, wind affect this rule of thumb.

Flight Exercise n°8.

Look out in descent, scan and weave nose regularly. It is difficult to spot an aircraft below because it merges with the ground features.

The Altimeter

During flight exercise you will be using an altimeter pressure setting called QNH. When QNH is set on the altimeter, the altimeter will read Altitude that is vertical distance Above Mean Sea Level (AMSL). The altitude read on the altimeter is not necessarily your height Above Ground Level (AGL). The ground you are flying over will be higher than sea level and so your height Above Ground Level (AGL) may be considerably less than your altitude between mean sea level (AMSL). Terrain marking on your map give you an appreciation of the average ground level in the training area above sea level.

If you are descending toward an airfield you can check its altitude (in feet AMSL) which will be shown on the chart.

VFE to be respected when using flap.

Engine Considerations

In glide descent, ie with a low power setting the engine will cool and become susceptible to spark plug fouling - oily deposit build up

on the spark plugs and reduce engine efficiency
The engine will also be particularly vulnerable
to carburettor icing.

It will be standard practice to "warm", the
engine every 1000 feet or so in the descent
by gently increasing the power a few seconds
and then reducing power again - Operate
the throttle smoothly - nice to engine

Entering the Glide Descent

[1] - Lookout
Select an aiming point ahead.

[2] - Power: Select carburettor heat to hot.
Reduce power to Idle, anticipate pitch down and yaw, use the rudder to stay in balance

[3] Attitude: Pitch down to the glide attitude
Establish glide airspeed

[4] Trim: Trim to relieve

Note Do not "chase the airspeed, after selecting a pitch attitude allow the airspeed 5/10s to settle before making a further adjustment

Maintaining the Descent

1. Lookout.
2. Maintain airspeed with attitude
3. Check external landmark and heading indicator to maintain direction.
4. Maintain balance by reference to the balance ball.
5. Monitor altimeter to anticipate required.

Note: Remember to "warm" the engine at regular intervals.

levelling off

[1] Anticipate required level by 50 to 100 feet, to allow for the aircraft's inertia. Lookout.

[2] Power: Set carburetter heat ~~[illegible]~~ to cold increase power to normal cruise power setting anticipate pitch & yaw.

[3] Attitude Pitch up to the normal straight and level attitude

[4] Trim As airspeed reaches normal cruise Trim to remove control loads

[5] Correction

Effect of the flap.

1. ~~Note the~~ In an established descent, note the nose attitude and rate of descent.

2. Check airspeed is slower than VFE.
Lower initial flap.

3. Pitch down to maintain airspeed trim

4. Note the lower nose attitude & increase rate of descent.

5. As more flap is lowered, nose attitude become lower to maintain airspeed and rate of descent increases.

6. Raise flap in stages to return to normal glide.

Summary: When maintaining a constant airspeed in the descent, power is used to control the rate of descent.

Descending with Flaps and Power

1 - Lookout before beginning descent

2 POWER - Reduce power to about 1800 RPM.
Check airspeed to is below VFE.
Lower initial flaps-

3 Attitude: Maintain approach airspeed.

4 Trim

5 Flaps allow a steeper descent & view because
lower nose attitude.

6 Power is used to control the rate of descent.

Sideslipping

1. In standard glide descent note airspeed & rate of descent.
2. Lookout.
3. Apply about 15° angle of bank
4. Apply "opposite" rudder to prevent the aircraft turning.
5. Correction ⇒ airspeed, angle of bank & direct
6. Note increased rate of descent
7. Centralise the control to return to the normal descent.

The Cruise Descent

[1] From straight & level flight

[2] POWER. Reduce power by about 200/300 RPM from the normal cruise setting

[3] Attitude – Pitch down to maintain the cruise airspeed.

[4] Trim

[5] Make ~~[illegible]~~ care to maintain cruise airspeed & rate of descent.

[6] Note the nose attitude is higher than in a glide & rate of descent is less.

Carburettor Icing Supplement

The most common cause of engine rough running and complete engine failures is ~~car~~ carburettor icing.

How Carburettor Icing forms.

Impact Icing occurs when ice forms over the external air inlet (air filter) and inside the induction system leading to the carburettor. This type of icing occurs with the Temperatures below 0c whilst flying in cloud or rain, sleet, snow).
This condition are also conducive to airframe icing and most light aircraft are not cleared for flight into known icing conditions.

Carburettor icing is caused by temperature drops inside the carburettor which can happen even in condition where other form of icing will not occur. The cause of this T° drop are twofold.

1 Fuel Icing: the evaporation of fuel inside the carburettor, liquid fuel changes to fuel vapours and mixes with the induction air. This evaporation of fuel causes a large temperature drop with the carburettor. If the T° inside the carburettor falls below 0°C, water vapour in the atmosphere condense into ice, usually on the wall of the carburettor passage adjacent to the fuel jet and on the throttle valve.
Fuel icing icing is responsible for around 70% of the T° drop in the carburettor

2. Throttle Icing: The T° drop caused by the acceleration of air and consequent pressure drop around the throttle valve. This effect may reduce T° below 0°C and water vapour in the induction air will condense into ice on the throttle valve.

As fuel & Throttle icing generally occurs together they are covered just as carburettor icing.

Condition likely to lead To Carburettor Icing.

Two criteria govern the likelihood of carburettor icing conditions: the Air Temperature and the Relative Humidity.

The ambient air temperature is important But not because the T° need to below below 0° or Even close to freezing. The T° drop in the carbur can be as much as 30° and still icing does happen. It is also called Refrigeration icing. It is possible at T° range of -10°C to 30°C

The relative humidity (a measure of the water content of the atmosphere) is the major factor. The greater the water content in the atmosphere (the higher the Relative humidity), the greater the risk of carburettor icing. The Relative Humidity (RH) does not to have to be 100% (visible water droplet, cloud rain) for carburettor icing to occur. It is possible at RH of 30% not usual in Europe. Icing happening occurs in a wide range of condition, the pilot must be alert at all time. Flight in or near cloud or rain may be in dangerous obvious cause of carburettor icing, but visible moisture does not need to be present for [redacted] ettor icing to occur.

Symptoms of Carburettor Icing

In aircraft fitted with a fixed pitch propeller the symptoms of carburettor icing are straight forward. A loss of RPM will be the first symptom although this is often noticed as a loss of altitude. As the icing became more serious, engine rough running may occur.

Carburettor icing is often detected during the use of the carburettor heat control. When the carburettor heat is used a small drop in RPM occurs. When control is returned to cold (off). the RPM Return to its value before the use of CH. If the RPM returns to a higher figure than before the carbu Heat was used, some icing was present.

Use of carburettor Heat

Apart from the normal check of carburett heat during the power check, it may be necessary to use the carburettor heat on the ground if carburettor icing is suspected..

Safety consideration apart the use of carb H on the ground should be kept to a minimum becau the hot air inlet is unfiltered and so sand or dust can enter the engine, increasing engine wear

Carbu Icing is generally considered to be very unlikely with the engine operating at above ~~Ft~~ 75% power, during take off & ~~landing~~ climbs. ~~&~~ It must not be used a 75% power (full throttle) as detonation may occur. Detonation is the ~~out~~ uncontrolled burning of fuel in the cylinder - literally an explosion and will cause serious damage to the engine very quickly. It also reduces the power of the engine. Where full power is required (Take off to climb, go around the carbu heat must be off.

A normal carburettor icing check will involve the carburettor heat on (hot) for 5-10s, although the pilot may wish to vary according to condition. The use of carburettor heat does increase the fuel consumption and this may be a factor to consider if the aircraft is being flown toward the limits of its range/endurance in possible carburettor icing condition

With carburettor icing present, the use of carburettor heat may lead to a large drop in RPM and rough running. The instinctive reaction is to put the carburettor heat back to cold (off) quickly - this is the wrong action. The carbu heat has melted a large amount of accumulated icing and it is passing through the engine causing temporary rough running.

Care should be taken when flying in very cold ambient condition (below -10°c). In these condition the ~~of~~ use of carbu heat may actually raise the T° in the carbu to that most conducive to carbu icing. Generally when the T° in the carbu is below -8°C, moisture change directly into ice crystals which pass through the engine

The RPM loss normally associated with the use of carburettor heat is caused by the reduced density of the hot air entering the carburettor leading to an over-rich fuel-air mixture entering the engine. If the carburettor heat has to be left constantly on (hot) during flight in heavy rain and cloud it may be advisable to lean the mixture in order to maintain RPM and smooth engine running.

It is during the descent (and particularly the glide descent) that carburettor icing is most likely to occur. The position of the throttle valve (almost closed) is a contributory factory factor and even though the carburettor heat is normally applied throughout a glide descent, the low engine power will reduce the T° of the hot air selected by the carbu heat control.