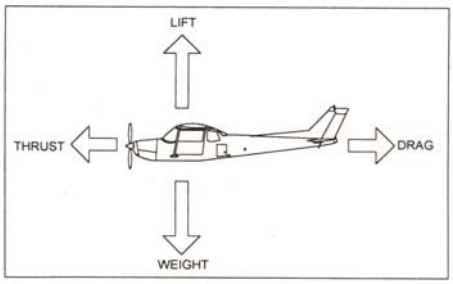
AERODYNAMICS (Chapter 1)

FLAPS AND RUDDER

1. One of the main functions of flaps during the approach and landing is to increase wing lift, which allows an increase in the angle of descent without increasing airspeed.
2. The rudder is used to control the yaw about the airplane's vertical axis.

AERODYNAMIC FORCES



The four aerodynamic forces acting on an airplane during flight are

a. Lift --the upward-acting force -
b. Weight --the downward-acting force
c. Thrust --the forward-acting force
d. Drag --the rearward-acting force

2. These forces are at equilibrium when the airplane is in unaccelerated flight:

Lift = **Weight**
Thrust = **Drag**

ANGLE OF ATTACK

1. The angle of attack is the angle between the wing chord line and the direction of the relative wind.

   a. The wing chord line is an imaginary straight line from the leading edge to the trailing edge of the wing

   b. The relative wind is the direction of airflow relative to the wing when the wing is moving through the air

2. The angle of attack at which a wing stalls remains constant regardless of weight, airplane loading, etc.

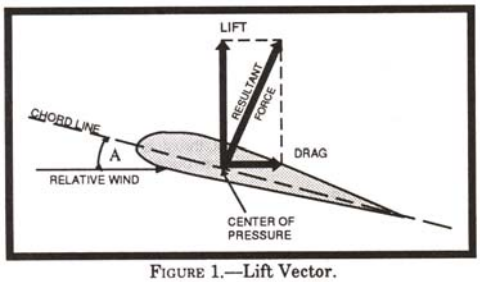


FIGURE 1.—Lift Vector.

STALLS AND SPINS

1. An airplane can be stalled at any airspeed in any flight attitude. A stall results whenever the critical angle of attack is exceeded.
2. An airplane in a given configuration will stall at the same indicated airspeed regardless of altitude because the airspeed indicator is directly related to air density.
3. An airplane spins when one wing is less stalled than the other wing. a. To enter a spin, an airplane must always be stalled first.

FROST

1. Frost forms when the temperature of the collecting surface is at or below the dewpoint of the adjacent air, and the dewpoint is below freezing. :r a. The water vapor sublimates directly as ice crystals on the wing surface.
2. Frost on wings disrupts the smooth airflow over the airfoil by causing early airflow separation from the wing. This

   a. Decreases lift, and
   b. Causes friction and increases drag.

3. Frost may make it difficult or impossible for an airplane to take off. 4. Frost should be removed before attempting to take off.

GROUND EFFECT

1. Ground effect is the result of the interference of the ground (or water) surface with the airflow patterns about an airplane.
2. The vertical component of the airflow around the wing is restricted, which alters the wing's upwash, downwash, and wingtip vortices.
3. The reduction of the wingtip vortices alters the spanwise lift distribution and reduces the induced angle of attack and induced drag.
    a. Thus, the wing will require a lower angle of attack in ground effect to produce the same lift coefficient, or, if a constant angle of attack is maintained, an increase in the lift coefficient will result.

4. An airplane is affected by ground effect when it is within the length of the airplane's wingspan above the ground. The ground effect is most often recognized when the airplane ~ is less than one-half the wingspan's length above the ground. ,

5. Ground effect may cause an airplane to float on landings or permit it to become airborne \ c with insufficient airspeed to stay in flight above the area of ground effect.
    a. An airplane may settle back to the surface abruptly after flying through the ground effect if the pilot has not attained recommended takeoff airspeed.

AIRPLANE TURN

1. The horizontal component of lift makes an airplane turn.
    a. To attain this horizontal component of lift, the pilot coordinates rudder, aileron, and elevator
2. The rudder on an airplane controls the yaw, i.e., rotation about the vertical axis, but does not cause the airplane to turn.

AIRPLANE STABILITY

1. An inherently stable airplane returns to its original condition (position or attitude) after being disturbed. It requires less effort to control.
2. The location of the center of gravity (CG) with respect to the center of lift determines the longitudinal stability of an airplane.
3. Airplanes (except a T -tail) normally pitch down when power is reduced (and the controls not adjusted) because the downwash on the elevators from the propeller slipstream is reduced and elevator effectiveness is reduced. This allows the nose to drop.
4. When the CG in an airplane is located at, or rear of, the aft CG limit, the airplane
    a. Develops an inability to recover from stall conditions, and b. Becomes less stable at all airspeeds.

TORQUE AND P-FACTOR

1. The torque effect (left-turning tendency) is greatest at low airspeed, high angles of attack, and high power, e.g., on takeoff.
2. P-factor (asymmetric propeller loading) causes the airplane to yaw to the left when at high angles of attack because the descending right side of the propeller (as seen from the rear) has a higher angle of attack (than the upward-moving blade on the left side) and provides more thrust.

LOAD FACTOR

1. Load factor refers to the additional weight carried by the wings due to the airplane's weight plus the centrifugal force.

    a. The amount of excess load that can be imposed on an airplane's wings varies directly with the airplane's speed and the excess lift available.

        1) At low speeds, very little excess lift is available, so very little excess load can be imposed.

        2) At high speeds, the wings' lifting capacity is so great that the load factor can quickly exceed safety limits.

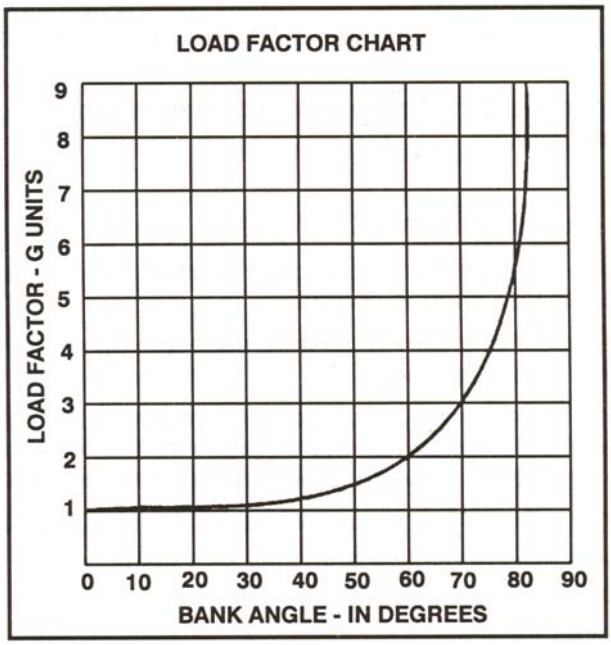
    b. An increased load factor will result in an airplane stalling at a higher airspeed.

    c. As bank angle increases, the load factor increases. The wings not only have to carry the airplane's weight, but the centrifugal force as well.

2. On the exam, a load factor chart is given with the amount of bank on the horizontal axis (along the bottom of the graph), and the load factor on the vertical axis (up the left side of the graph).

    a. Compute the load factor by moving up from the stated degree of bank angle until ~ intersecting the load factor curve. Then move across from the point of intersection to the left side of the graph and read the amount of load factor.

    b. Example load factor chart:



3. Load factor (or G units) is a multiple of the regular weight or, alternatively, a multiple of the force of gravity.

    a. Straight-and-level flight has a load factor at 1.0. (Verify on the chart above.)

    b. A 60° level bank has a load factor of 2.0. Due to centrifugal force, the wings must hold up twice the amount of weight.

    c. A 50° level bank has a load factor of about 1.5.