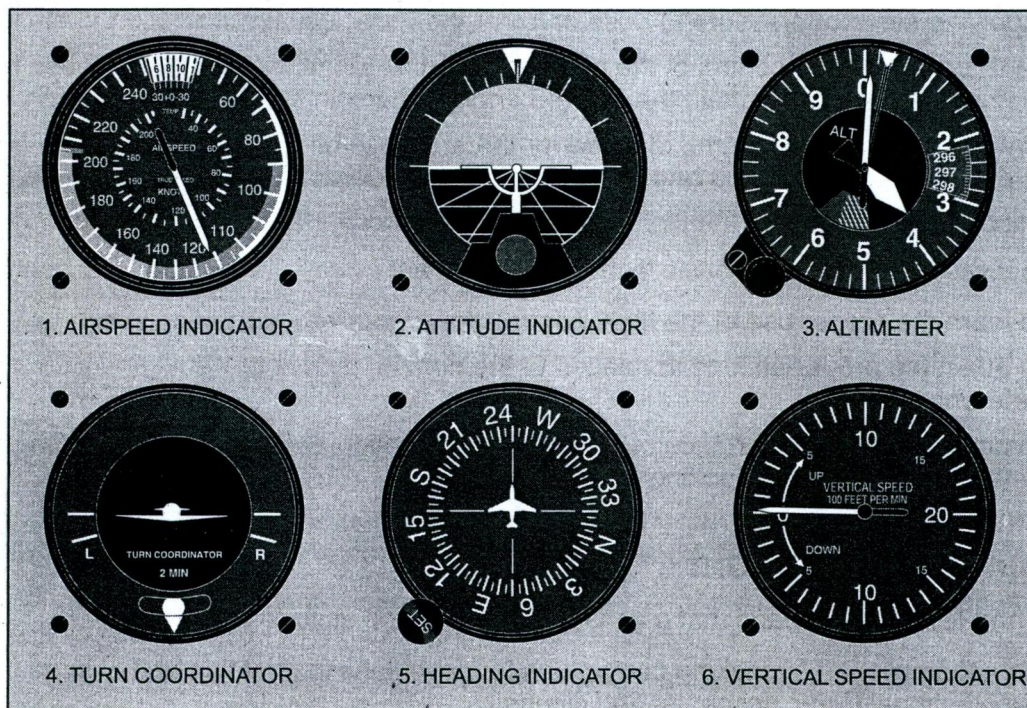


## BASIC FLIGHT MANEUVERS

In this section, we will provide you with more detailed information on the basic flight maneuvers (straight-and-level, turns, climbs, and descents). Do not feel overwhelmed. Just read and try to understand the basic concepts. Write down questions to ask your instructor. At the beginning of each flight lesson, your instructor will sit down with you to go over what you will do during the lesson. This is called a preflight briefing. It is a discussion between you and your CFI that should answer all of your questions. Your home study before the lesson will reduce the time spent on the preflight briefing and provide you with quality flight training time -- all of which will help keep costs down.

### 4.1 FLIGHT INSTRUMENTS

- A. When you are sitting in the airplane, you will probably notice six flight instruments in front of you. Your instructor will refer to them. The typical arrangement of these instruments is shown below.



1. The airspeed indicator (ASI) displays the speed at which the airplane is moving through the air. The ASI in the figure is indicating an airspeed of 115 knots.
2. The attitude indicator (AI) displays the attitude of the airplane (nose up, nose down, wings banked) in relation to the horizon. The AI in the figure is indicating level flight (nose and wings are level in relation to the horizon).
3. The altimeter (ALT) displays the altitude of the airplane above mean sea level (MSL) when properly adjusted to the current pressure setting. The ALT in the figure is indicating an altitude of 4,000 ft. MSL.

Sport Pilots: You may not have all six flight instruments. At a minimum, you will have:

1. Airspeed indicator
2. Altimeter
3. Compass to determine direction in lieu of a heading indicator

4. The turn coordinator (TC) displays the rate at which a turn is being made. The miniature airplane banks in the direction of the turn. At the bottom of the instrument is a ball in a glass tube called an inclinometer. The inclinometer indicates whether the airplane is in coordinated flight (ball centered) or uncoordinated flight. The TC in the figure is indicating wings level and coordinated flight.
5. The heading indicator (HI) displays the heading (direction) the airplane is flying. The HI in the figure is indicating a heading of 250°.
6. The vertical speed indicator (VSI) displays whether the airplane is in level flight, climbing, or descending. The rate of climb or descent is indicated in hundreds of feet per minute. The VSI in the figure indicates level flight.

## 4.2 AIRPLANE CONTROL

- A. Airplane control is composed of three components: pitch control, bank control, and power control.
1. **Pitch control** is the control of the airplane about its lateral axis (i.e., wingtip to wingtip) by applying elevator pressure to raise or lower the nose, usually in relation to the horizon.
  2. **Bank control** is the control of the airplane about its longitudinal axis (i.e., nose to tail) by use of the ailerons to attain the desired angle of bank in relation to the horizon.
  3. **Power control** is the control of power or thrust by use of the throttle to establish or maintain a desired airspeed, climb rate, or descent rate in coordination with the attitude changes.
- For additional information on the flight controls and control surfaces, see page 17.
- B. The objectives of the following basic flight maneuvers are
1. To learn the proper use of the flight controls for maneuvering the airplane
  2. To attain the proper attitude in relation to the horizon by use of visual and instrument references
  3. To emphasize the importance of dividing your attention and constantly checking all reference points while looking for other traffic

## 4.3 STRAIGHT-AND-LEVEL FLIGHT

- A. Straight-and-level flight means that a constant heading and altitude are maintained.
1. It is accomplished by making corrections for deviations in direction and altitude from unintentional turns, descents, and climbs.
- B. The pitch attitude for **level flight** (i.e., constant altitude) is obtained by selecting some portion of the airplane's nose or instrument glare shield as a reference point and then keeping that point in a fixed position relative to the horizon.
1. That position should be cross-checked occasionally against the altimeter to determine whether or not the pitch attitude is correct for the power setting being used.
    - a. If altitude is being lost or gained, the pitch attitude should be readjusted in relation to the horizon, and then the altimeter should be checked to determine if altitude is being maintained.
  2. The application of forward or back elevator pressure is used to control this attitude.
  3. The pitch information obtained from the attitude indicator will also show the position of the nose relative to the horizon.

- C. To achieve **straight flight** (i.e., constant heading), you should select two or more outside visual reference points directly ahead of the airplane (e.g., roads, section lines, towns, lakes, etc.) to form an imaginary line and then keep the airplane headed along that line.
1. While using these references, you should occasionally check the heading indicator (HI) to determine that the airplane is maintaining a constant heading.
  2. Both wingtips should be equidistant above or below the horizon (depending on whether your airplane is a high-wing or low-wing type). Any necessary adjustment should be made with the ailerons to return to a wings level flight attitude.
  3. The attitude indicator (AI) should be checked for small bank angles, and the heading indicator (HI) should be checked to note deviations from the desired direction.
- D. Straight-and-level flight requires almost no application of control pressure if the airplane is properly trimmed and the air is smooth.
1. Trim the airplane so it will fly straight and level without constant assistance.
    - a. This is called "hands-off flight."
    - b. Improper trim technique usually results in flying that is physically tiring, particularly in prolonged straight-and-level flight.
  2. The airplane should be trimmed by first applying control pressure to establish the desired attitude, and then adjusting the trim so that the airplane will maintain that attitude without control pressure in hands-off flight.
- E. The airspeed will remain constant in straight-and-level flight with a constant power setting.
1. Significant changes in airspeed (e.g., power changes) will require considerable changes in pitch attitude to maintain altitude.
  2. Pronounced changes in pitch attitude will also be necessary as the flaps and landing gear (if retractable) are operated.

#### 4.4 TURNS

- A. A turn is a basic flight maneuver used to change from, or return to, a desired heading. This maneuver involves the coordinated use of the ailerons, rudder, and elevator.
- B. To enter a turn, you should simultaneously turn the control wheel (i.e., apply aileron control pressure) and apply rudder pressure in the desired direction.
1. The speed (or rate) at which your airplane rolls into a bank depends on the rate and amount of control pressure you apply.
    - a. The amount of bank depends on how long you keep the ailerons deflected.
  2. Rudder pressure must be enough to keep the ball of the inclinometer (part of the turn coordinator) centered.
    - a. If the ball is not centered, "step on the ball" to recenter it.
    - b. **EXAMPLE:** If the ball is to the right, apply right rudder pressure (i.e., step on the ball) to recenter it.
  3. The best outside reference for establishing the degree of bank is the angle made by the top of the engine cowling or the instrument panel with respect to the horizon.
    - a. Since on most light airplanes the engine cowling is fairly flat, its angle relative to the horizon will give some indication of the approximate degree of bank.
  4. Information obtained from the attitude indicator (AI) will show the angle of the wings in relation to the horizon. Referring to this information will help you learn to judge the degree of bank based on outside references.

- C. The lift produced by the wings is used to turn the airplane, as discussed in "How Airplanes Turn," on page 18.
1. To maintain a constant altitude, you will need to apply enough back elevator pressure (i.e., raise the nose of the airplane in order to increase the angle of attack) to prevent a descent.
- D. As the desired angle of bank is established, aileron and rudder pressures should be released. The bank will not continue to increase since the aileron control surfaces will be neutral in their streamlined position.
1. The back elevator pressure should not be released but should be held constant or sometimes increased to maintain a constant altitude.
  2. Throughout the turn, you should cross-check the outside references and occasionally include the altimeter to determine whether the pitch attitude is correct.
  3. If you are gaining or losing altitude, adjust the pitch attitude in relation to the horizon, and then recheck the altimeter and vertical speed indicator to determine if altitude is now being maintained.
- E. The roll-out from a turn to straight flight is similar to the roll-in to the turn from straight flight except that control pressures are used in the opposite direction. Aileron and rudder pressures are applied in the direction of the roll-out (i.e., toward the high wing).
1. As the angle of bank decreases, the elevator pressure should be released smoothly as necessary to maintain altitude. Remember, when the airplane is no longer banked, the vertical component of lift increases.
  2. Since the airplane will continue turning as long as there is any bank, the roll-out must be started before reaching the desired heading.
    - a. The time the roll-out should begin, in order to lead the desired heading, will depend on the rate of turn and the rate at which the roll-out will be made.
  3. As the wings become level, the control pressures should be gradually and smoothly released so that the controls are neutralized as the airplane resumes straight-and-level flight.
  4. As the roll-out is completed, attention should be given to outside visual references as well as to the attitude indicator and heading indicator to determine that the wings are leveled precisely and that the turn is stopped.

#### 4.5 CLIMBS

- A. Climbs and climbing turns are basic flight maneuvers in which the pitch attitude and power setting result in a gain in altitude. In a straight climb, the airplane gains altitude while traveling straight ahead. In climbing turns, the airplane gains altitude while turning.
- B. To enter the climb, simultaneously advance the throttle and apply back elevator pressure.
1. As the power is increased to the climb setting, the airplane's nose will tend to rise to the climb attitude.
    - a. In most trainer-type airplanes, the climb setting will be full power.
  2. While the pitch attitude increases and airspeed decreases, progressively more right-rudder pressure must be used to compensate for torque effects and to maintain direction.
    - a. Because the angle of attack is relatively high, the airspeed is relatively slow, and the power setting is high, the airplane will have a tendency to roll and yaw to the left due to turning tendencies created by the rotating propeller.
      - 1) While right-rudder pressure will correct for the yaw, some aileron pressure may also be required to keep the wings level.

- C. When the climb is established, back elevator pressure must be maintained to keep the pitch attitude constant.
1. As the airspeed decreases, the elevators may try to return to their streamlined or neutral position, which will cause the nose to lower.
    - a. Nose-up trim will therefore be required.
  2. You will need to cross-check the airspeed indicator (ASI) because you want to climb at a specific airspeed and because the ASI will provide an indirect indication of the pitch attitude.
    - a. If the airspeed is higher than desired, you need to raise the nose.
    - b. If the airspeed is lower than desired, you need to lower the nose.
  3. After the climbing attitude, power setting, and airspeed have been established, trim the airplane to relieve all pressures from the controls.
    - a. If further adjustments are made in pitch, power, and/or airspeed, you must retrim the airplane.
  4. If a straight climb is being performed, you need to maintain a constant heading with the wings level.
    - a. If a climbing turn is being performed, maintain a constant angle of bank.
- D. To return to straight-and-level flight from a climbing attitude, you should start the level-off below the desired altitude in order to avoid climbing through it.
1. To level off, the nose should be lowered.
  2. The nose must be lowered gradually, however, because a loss of altitude will result if the pitch attitude is decreased too abruptly before allowing the airspeed to increase adequately.
    - a. As the nose is lowered, retrim the airplane.
    - b. When the airspeed reaches the desired cruise speed, reduce the throttle setting to appropriate cruise power setting and trim the airplane.
- E. **Climbing Turns.** The following factors should be considered:
1. With a constant power setting, the same pitch attitude and airspeed cannot be maintained in a bank as in a straight climb due to the decrease in the vertical lift and airspeed during a turn.
    - a. The loss of vertical lift becomes greater as the angle of bank is increased, so shallow turns may be used to maintain an efficient rate of climb. If a medium- or steep-banked turn is used, the airplane's rate of climb will be reduced.
    - b. The airplane will have a greater tendency towards nose heaviness than in a straight climb, due to the decrease of vertical lift.
  2. As in all maneuvers, attention should be divided among all references equally.
- F. There are two ways to establish a climbing turn: either establish a straight climb and then turn, or establish the pitch and bank attitudes simultaneously from straight-and-level flight.
1. The second method is usually preferred because you can more effectively check the area for other aircraft while the climb is being established.

## 4.6 DESCENTS

- A. A descent is a basic maneuver in which the airplane loses altitude in a controlled manner. Descents can be made
1. With partial power, as used during an approach to a landing
  2. Without power, i.e., a glide
  3. At cruise airspeeds, during en route descents
- B. To enter a descent, you should first apply carburetor heat (if recommended by the manufacturer) and then reduce power to the desired setting or to idle.
1. Maintain a constant altitude by applying back elevator pressure as required until the airspeed decreases to the desired descent airspeed.
  2. Once the descent airspeed has been reached, lower the pitch attitude to maintain that airspeed and adjust the trim.
- C. When the descent is established, cross-check the airspeed indicator (ASI) to ensure that you are descending at the desired airspeed.
1. If the airspeed is higher than desired, slightly raise the nose and allow the airspeed to stabilize in order to confirm the adjustment.
  2. If the airspeed is lower than desired, slightly lower the nose and allow the airspeed to stabilize.
  3. Once you are descending at the desired airspeed, note the position of the airplane's nose relative to the horizon and the indications of the attitude indicator (AI).
    - a. Trim the airplane to relieve all control pressures.
  4. Maintain either straight or turning flight, as desired.
- D. The level-off from a descent must be started before reaching the desired altitude in order to avoid descending through it.
1. To level off, you should simultaneously raise the nose to a level attitude and increase power to the desired cruise setting.
    - a. The addition of power and the increase in airspeed will tend to raise the nose. You will need to apply appropriate elevator control pressure and make a trim adjustment to relieve the control pressures.
- E. **Turning Descents**
1. As with climbing turns, you can either enter the turn after the descent has been established or simultaneously adjust the bank and pitch attitudes.
  2. At a desired power setting during a descending turn, maintain airspeed with pitch as you would in a straight descent.