ADDENDUM: BASIC INSTRUMENT MANEUVERS (A student training requirement for a sport pilot certificate)

Basic instrument maneuvers are not covered in the Sport Pilot PTS. However, these maneuvers have to be included in the Sport Pilot student's flight training per 14 CFR 61.93(e)(12) before the student can fly a solo cross country flight. There are no time requirements listed in this regulation.

Flying inadvertently into (simulated) instrument meteorological conditions may be tested by the FAA or a Designated Practical Examiner, under Emergency Operations.

If any pilot who does not have an instrument rating (and is current), and inadvertently flies into IMC, is to do a 180° turn and exit the IMC. Never continue into IMC thinking it will be clear in a few moments.

This module explains Basic Instrument Maneuvers. These tasks include both knowledge and skill. Your examiner is not required to test you on these maneuvers.

Accident investigations reveal that weather continues to be cited as a factor in general aviation accidents more frequently than any other cause. The data also show that weather-involved accidents are more likely to result in fatalities than are other accidents. Low ceilings, rain, and fog continue to head the list in the fatal, weather-involved, general aviation accidents. This type of accident is usually the result of inadequate preflight preparation and/or planning, continued VFR flight into adverse weather conditions, and attempted operation beyond the pilot's experience/ability level.

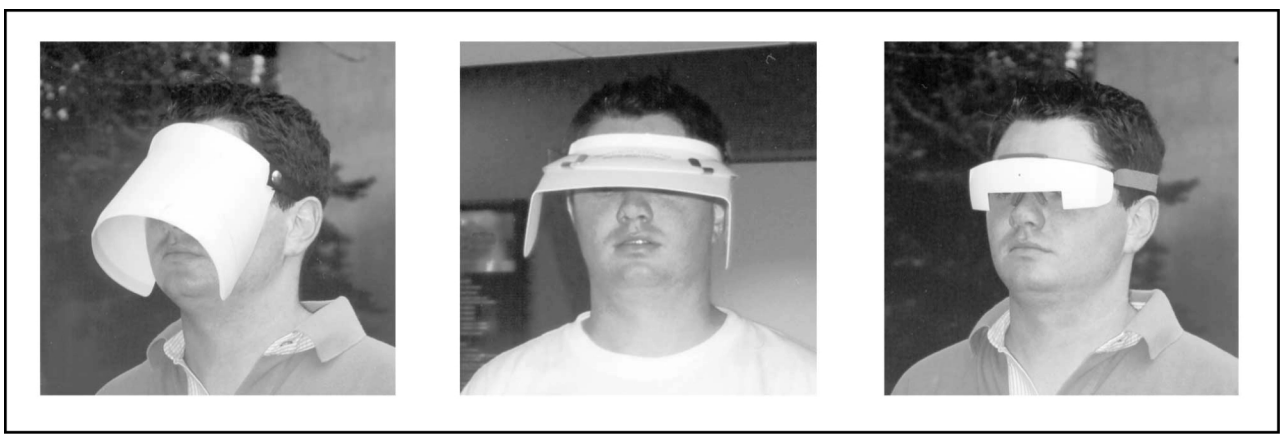
A pilot cannot cope with flight when external visual references are obscured unless visual reference is transferred to the flight instruments. The motion sensing by the inner ear in particular tends to confuse the pilot. False sensations often are generated, leading the pilot to believe the attitude of his/her airplane has changed when, in fact, it has not. These sensations result in spatial disorientation.

This training in the use of flight instruments does not prepare you for unrestricted operations in instrument weather conditions. It is intended as an emergency measure only (although it is also excellent training in the smooth control of an airplane). Intentional flight in such conditions should be attempted only by those who have been thoroughly trained and hold their instrument rating.

The objective of learning basic instrument maneuvers as part of your sport pilot (VFR) training is to allow you to return to VFR conditions should you inadvertently/accidentally find yourself in instrument conditions. Having some experience flying by instruments and entering instrument conditions unintentionally will prepare you for this eventuality as a sport pilot.

View-Limiting Devices

A. In order to learn how to fly by instrument reference only, you will use an easily removable device (e.g., a hood, an extended visor cap, or foggles) that will limit your vision to the instrument panel. There are numerous sizes and shapes available. Some of these are illustrated below.



B. These view-limiting devices obviously require acclimation. You should spend a few minutes in "your" airplane with "your" device on before you meet your CFI for your first flight lesson that prescribes flying by instrument reference only. This added familiarity with (1) the view-limiting device and (2) the location of the instruments and their appearance will make it easier for you to concentrate on flight maneuvers once in the air.

Attitude Instrument Flying

A. Attitude instrument flying may be defined in general terms as the control of an airplane's spatial position by use of instruments rather than by outside visual reference. Thus, proper interpretation of the flight instruments provides the same information as visual references outside the airplane.

1. Attitude control is stressed in this book (and by the FAA) in terms of pitch control, bank control, power control, and trim control. Instruments are divided into the following three categories:
    a. Pitch instruments
        1) Attitude indicator (AI)
        2) Altimeter (ALT)
        3) Airspeed indicator (ASI)
        4) Vertical speed indicator (VSI)
    b. Bank instruments
        1) Attitude indicator (AI)
        2) Heading indicator (HI)
        3) Turn coordinator (TC) or turn-and-slip indicator (T&SI)
        4) Magnetic compass
    c. Power instruments
        1) Manifold pressure gauge (MP), if equipped
        2) Tachometer (RPM)
        3) Airspeed indicator (ASI)
2. Write the name of each instrument and the related abbreviation while thinking about how the instrument looks and what information it provides.
    a. See Study Unit 2, "Airplane Instruments, Engines, and Systems," in *Pilot Handbook* for a discussion of these instruments.
3. For a particular maneuver or condition of flight, the pitch, bank, and power control requirements are most clearly indicated by certain key instruments.
    a. Those instruments that provide the most pertinent and essential information are referred to as primary instruments.
    b. Supporting instruments back up and supplement the information shown on the primary instruments.
    c. For each maneuver, there will be one primary instrument from each of the categories on the previous page. There may be several supporting instruments from each category.
4. This concept of primary and supporting instruments in no way lessens the value of any particular instrument.
    a. The AI is the basic attitude reference, just as the real horizon is used in visual conditions. It is the only instrument that portrays instantly and directly the actual flight attitude.
        1) It should always be used, when available, in establishing and maintaining pitch and bank attitudes.

5. Remember, the primary instruments (for a given maneuver) are the ones that will show the greatest amount of change over time if the maneuver is being improperly controlled (pitch, bank, power).

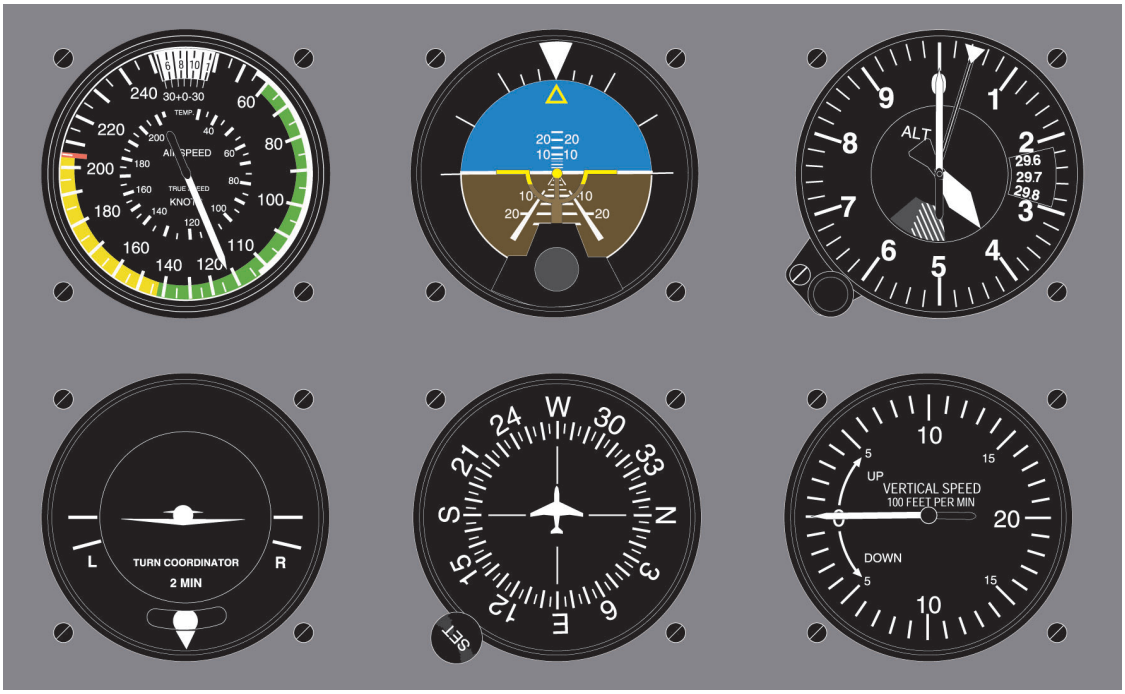
B. During your attitude instrument training, you should develop three fundamental skills involved in all instrument flight maneuvers: instrument cross-check, instrument interpretation, and airplane control. Trim technique is a skill that should be refined.

1. **Cross-checking** (also called scanning) is the continuous and logical observation of instruments for attitude and performance information.

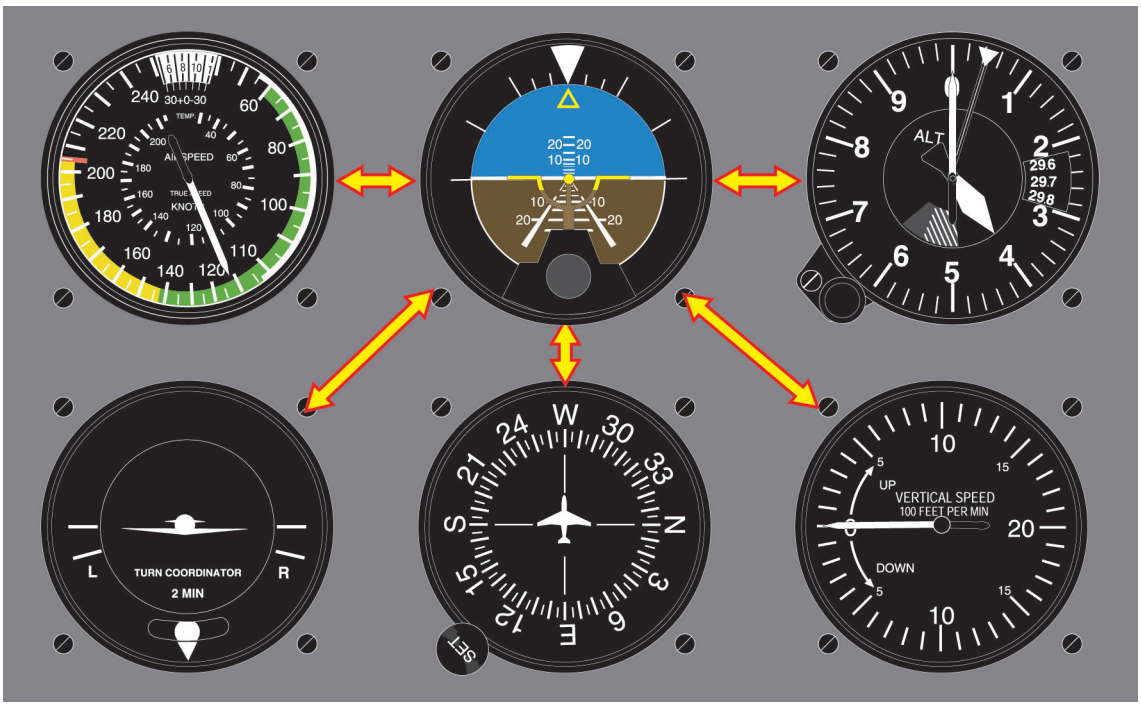
   a. You will maintain your airplane's attitude by reference to instruments that will produce the desired result in performance. Your author suggests always knowing

      1) Your airplane's pitch and bank (AI)
      2) Your present heading (HI)
         a) And your desired heading
      3) Your present altitude
         a) And your desired altitude (ALT)

The instruments below show straight-and-level flight.



b. Since your AI is your reference instrument for airplane control and provides you with a quick reference as to your pitch and bank attitude, it should be your start (or home base) for your instrument scan. You should begin with the AI and scan one instrument (e.g., the HI) and then return to the AI before moving to a different instrument, as shown below.



1) Thus, you continuously visualize your present attitude, heading, and altitude in conjunction with your intended heading and altitude.
2) Last and certainly not least, interrupt your flight instrument scan every few minutes to review all your other instruments, including
   a) Compass to HI for precession (resetting HI as necessary)
   b) Engine RPM and/or MP, as appropriate
   c) Engine temperatures (oil, cylinder head, and EGT)
   d) Oil pressure
   e) Fuel level
   f) Vacuum pressure
   g) Ammeter
3) Your CFI will have his/her suggested approach to the instrument scan.
4) You should write down (using pencil and paper) your scan -- what you do and why.
   a) This will force you to think “what and why” and avoid haphazard scanning of your instruments.

c. Frequent cross-check faults are
1) Fixation, or staring at a single instrument
2) Omission of an instrument from cross-check
3) Emphasis on a single instrument, instead of a combination of instruments necessary for attitude information

2. **Instrument interpretation** requires you to understand each instrument's construction, operating principle, and relationship to the performance of your airplane.
    a. This understanding enables you to interpret the indication of each instrument during the cross-check.
3. **Airplane control** requires you to maintain your airplane's attitude or change it by interpretation of the instruments. It is composed of three elements.
    a. **Pitch control** is controlling the rotation of your airplane about the lateral axis by movement of the elevators.
        1) After interpreting the pitch attitude from the proper flight instruments, you will exert control pressures to effect the desired pitch with reference to the AI.
    b. **Bank control** is controlling the angle made by the wing and the horizon.
        1) After interpreting the bank attitude from the appropriate instruments, you will exert the necessary pressures to move the ailerons and roll your airplane about the longitudinal axis with reference to the AI.
        2) The rudder should be used as necessary to maintain coordinated flight.
    c. **Power control** is used when interpretation of the flight instruments indicates a need for a change with reference to the RPM.
4. **Trim** is used to relieve all possible control pressures held after a desired attitude has been attained.
    a. The pressure you feel on the controls must be those that you apply while controlling a planned change in airplane attitude, not pressures held because you let the airplane control you.
    b. An improperly trimmed airplane requires constant control pressures, produces tension, distracts your attention from cross-checking, and contributes to abrupt and erratic attitude control.

Straight-and-Level Flight

A. General Information
    1. The objective of this maneuver is for you to demonstrate your ability to perform straight-and-level flight solely by reference to instruments.

B. Maneuver Objectives
    1. **Exhibit your knowledge of the elements related to attitude instrument flying during straight-and-level flight.**
        a. Flying straight means to maintain a constant heading on the HI, which is done by keeping the wings level on the AI and the ball centered on the TC.
        b. Flying level means to maintain a constant altitude on the ALT, which is done by holding a level pitch attitude on the AI.
        c. Steady airspeed is maintained by holding a constant power (RPM) setting.
    2. **Maintain straight-and-level flight solely by reference to instruments using proper instrument cross-check and interpretation, and coordinated control applications.**
        a. The figure on the next page illustrates the instrument indications for straight-and-level flight.
        b. Maintain straight flight by holding the wings level on the AI and maintaining your heading on the HI.
            1) Since you want to maintain a specific heading, the HI is primary for bank.
                a) The supporting instruments for bank are the AI and the TC.

2) If you deviate from your heading, use the AI to level your wings and ensure the ball of the TC is centered.
   a) Determine the direction you must turn to return to your desired heading, and use the AI to establish a bank in the proper direction.
      i) Use an angle of bank no greater than the number of degrees to be turned, but limit the bank angle to that required for a standard-rate turn.
   b) Use coordinated aileron and rudder.
3) The ball of the TC should be centered. If not, you may be holding rudder pressure, or your airplane is improperly trimmed (if rudder trim is available).

c. Maintain level flight by adjusting your pitch as necessary on the AI to maintain your altitude.
   1) Since you want to maintain a specific altitude, the ALT is primary for pitch.
      a) The supporting instruments for pitch are the AI and VSI.
         i) As a trend instrument, the VSI will show immediately, even before your ALT, the initial vertical movement of your airplane.
   2) If you deviate from your altitude, use the AI to return to level flight and determine if you need to climb or descend to return to your desired altitude.
      a) Use the AI to make a small pitch adjustment in the proper direction, and use the VSI to ensure that you are moving in the proper direction.
      b) Small altitude deviations (i.e., 100 ft. or less) should be corrected with pitch only, using a rate of approximately 200 fpm on the VSI.
      c) Large altitude deviations (i.e., greater than 100 ft.) may be more easily corrected by adjusting both pitch and power, using a greater rate of return to altitude (approximately double your error in altitude).
   3) The VSI becomes the primary pitch instrument while returning to altitude after a deviation is noticed during level flight.

d. During straight-and-level flight, you should maintain a constant airspeed; thus, the ASI is the primary power instrument. Maintain airspeed with power.

e. You will need to learn to overcome a natural tendency to make a large control movement for a pitch change and learn to apply small control pressures smoothly, cross-checking rapidly for the results of the change and continuing with the pressures as your instruments show the desired results at a rate that you can interpret.

1) Small attitude changes can be easily controlled, stopped, and corrected.
2) Large changes are more difficult to control.

f. Coordination of controls requires that the ball of the TC be kept centered and that the available trim control devices be used whenever a change in flight conditions disturbs the existing trim.

1) Trim is used to relieve all possible control pressures held after a desired attitude has been attained.
2) The pressure you feel on the control yoke must be that which you apply while controlling a planned change in airplane attitude, not pressure held because you are letting the airplane control you.

3. **Maintain altitude, ±200 ft.; heading, ±20°; and airspeed, ±10 kt.**

C. Common Errors during Straight-and-Level Flight

1. **Fixation, omission, and emphasis errors during instrument cross-check**

a. Fixation, or staring at a single instrument, usually occurs for a good reason, but with poor results.

1) You may stare at (or fixate on) the ALT, which reads 200 ft. below assigned altitude, wondering how the needle got there. During that time, perhaps with increasing tension on the controls, a heading change occurs unnoticed, and more errors accumulate.
2) It may not be entirely a cross-checking error. It may be related to difficulties with one or both of the other fundamental skills (i.e., interpretation and control).

b. Omission of an instrument from the cross-check may be caused by failure to anticipate significant instrument indications following attitude changes.

1) All instruments should be included in the scan.

c. Emphasis on a single instrument, instead of on the combination of instruments necessary for attitude information, is normal during the initial stages of instrument training.

1) You may tend to rely on the instrument that you understand the best, e.g., the ALT.
2) The VSI can give more immediate pitch information than the ALT.

2. **Improper instrument interpretation**

a. This error may indicate that you do not fully understand each instrument's operating principle and relationship to the performance of your airplane.

b. You must be able to interpret small changes in your instrument indications from your cross-checking.

3. **Improper control applications**

a. This error normally occurs when you incorrectly interpret the instruments and then apply the improper controls to obtain a desired performance, e.g., using rudder pressure to correct for a heading error.

b. It may also occur when you apply control inputs (pitch and bank) without referring to the AI.

4. **Failure to establish proper pitch, bank, or power adjustments during altitude, heading, or airspeed corrections**
    a. You must understand which instruments provide information for pitch, bank, and power.
        1) The AI is the only instrument for pitch and bank control inputs.
    b. This error may indicate that you do not fully understand instrument cross-check, interpretation, and/or control.
5. **Faulty trim technique**
    a. Trim should be used, not to substitute for control with the control yoke and rudder, but to relieve pressures already held to stabilize attitude.
    b. Use trim frequently and in small amounts.
    c. Improper adjustment of seat or rudder pedals for comfortable positioning of legs and feet may contribute to trim errors.
        1) Tension in the ankles makes it difficult to relax rudder pressures.

Constant Airspeed Climbs

A. General Information
1. The objective of this maneuver is for you to demonstrate your ability to perform constant airspeed climbs solely by reference to instruments.
2. When adverse weather is encountered, a climb by reference to instruments may be required to ensure clearance of obstructions or terrain or to climb above a layer of fog, haze, or low clouds.

B. Maneuver Objectives
1. **Exhibit your knowledge of the elements related to attitude instrument flying during constant airspeed climbs.**
    a. For a constant airspeed climb with a given power setting, a single pitch attitude will maintain the desired airspeed.
        1) For some airspeeds, such as V_X or V_Y, the climb power setting and airspeed that will determine this climb attitude are given in the performance data found in your POH.
            a) Most trainer-type airplane manufacturers recommend using maximum power.
    b. Flying straight means to maintain a constant heading on the HI, which is done by keeping the wings level on the AI and the ball centered on the TC.
2. **Establish the climb configuration specified by your examiner.**
    a. Normally this maneuver is done in the clean configuration using climb power and a cruise climb airspeed.
    b. You should form a habit of repeating instructions given to you for all maneuvers. This ensures that you understand your examiner's instructions.
3. **Transition to the climb pitch attitude and power setting on an assigned heading using proper instrument cross-check and interpretation, and coordinated control application.**
    a. To enter a constant airspeed climb, use the AI to raise the nose to the approximate pitch attitude for the desired climb speed. Thus, during entry, the AI is primary for pitch.

1) As the airspeed approaches the desired climb speed, advance the power to the climb power setting (e.g., full power).

b. In straight flight, the primary instrument for bank is the HI.

1) In turning flight, the primary bank instrument is the TC.

c. As you establish the climb, you must increase your rate of instrument cross-check and interpretation.

d. You will need to learn to overcome a natural tendency to make a large control movement for a pitch change and learn to apply small control pressures smoothly, cross-checking rapidly for the results of the change and continuing with the pressures as your instruments show the desired results at a rate that you can interpret.

1) Small pitch changes can be easily controlled, stopped, and corrected.
2) Large changes are more difficult to control.

e. Coordination of controls requires that the ball of the TC be kept centered and that the available trim control devices be used whenever a change in flight conditions disturbs the existing trim.

1) Trim is used to relieve all possible control pressures held after a desired attitude has been attained.

2) The pressure you feel on the control yoke must be that which you apply while controlling a planned change in airplane attitude, not pressure held because you are letting the airplane control you.

4. **Demonstrate climbs solely by reference to instruments at a constant airspeed to specified altitudes in straight flight and turns.**

a. The figure below illustrates the instrument indications for straight, constant airspeed climbs.

b. During a constant airspeed climb, the ASI becomes the primary pitch instrument.
   1) If the airspeed is higher than desired, the pitch must be increased. Use the AI to make a small increase in pitch, and then check the ASI to determine if additional corrections are necessary.
   2) If the airspeed is lower than desired, the pitch must be decreased. Use the AI to make a small decrease in pitch, and check the ASI.

c. The RPM remains the primary power instrument, which is used to ensure that the proper climb power is maintained.

5. **Level off at your assigned altitude and maintain that altitude, ±200 ft.; maintain heading, ±20°; maintain airspeed, ±10 kt.**

a. To level off from a climb, it is necessary to start the level-off before reaching the desired altitude. An effective practice is to lead the altitude by 10% of the vertical speed (e.g., at 500 fpm, the lead would be 50 ft.).

b. Apply smooth, steady forward elevator pressure toward level flight attitude for the speed desired. As the AI shows the pitch change, the VSI will move toward zero, the ALT will move more slowly, and the ASI will increase.

c. Once the ALT, AI, and VSI show level flight, constant changes in pitch and application of nose-down trim will be required as the airspeed increases.

d. Maintain straight flight by holding the wings level on the AI and maintaining your heading on the HI.

e. Once again, increase the rate of your cross-check and interpretation during level-off until straight-and-level flight is resumed at cruise airspeed and power.

C. Common Errors during Constant Airspeed Climbs by Reference to Instruments

1. **Fixation, omission, and emphasis errors during instrument cross-check**

a. Fixation, or staring at a single instrument, usually occurs for a good reason, but with poor results.
   1) You may stare at the ASI, which reads 20 kt. below assigned airspeed, wondering how the needle got there. During that time, perhaps with increasing tension on the controls, a heading change occurs unnoticed, and more errors accumulate.
   2) It may not be entirely a cross-checking error. It may be related to difficulties with one or both of the other fundamental skills (i.e., interpretation and control).

b. Omission of an instrument from the cross-check may be caused by failure to anticipate significant instrument indications following attitude changes.
   1) All instruments should be included in the scan.

c. Emphasis on a single instrument, instead of on the combination of instruments necessary for attitude information, is normal during the initial stages of instrument training.
   1) You may tend to rely on the instrument that you understand the best, e.g., the AI.
   2) The ALT will be changing; however, the ASI is primary for pitch during this maneuver.

2. **Improper instrument interpretation**

a. This error may indicate that you do not fully understand each instrument's operating principle and relationship to the performance of the airplane.

b. You must be able to interpret even the slightest changes in your instrument indications from your cross-checking.

3. **Improper control applications**
    a. This error occurs when you incorrectly interpret the instruments and/or apply the improper controls to obtain a desired performance, e.g., using power instead of pitch to correct a minor airspeed error.
4. **Failure to establish proper pitch, bank, or power adjustments during heading and airspeed corrections**
    a. You must understand which instruments provide information for pitch, bank, and power.
        1) The AI is the only instrument for pitch and bank control inputs.
    b. This error may indicate that you do not fully understand instrument cross-check, interpretation, and/or control.
5. **Improper entry or level-off technique**
    a. Until you learn and use the proper pitch attitudes in climbs, you may tend to make larger-than-necessary pitch adjustments.
        1) You must restrain the impulse to change a flight attitude until you know what the result will be.
            a) Do not chase the needles.
            b) The rate of cross-check must be varied during speed, power, or attitude changes.
            c) During leveling off, you must note the rate of climb to determine the proper lead.
                i) Failure to do this will result in overshooting or undershooting the desired altitude.
        2) You must maintain an accelerated cross-check until straight-and-level flight is positively established.
6. **Faulty trim technique**
    a. Trim should be used, not to substitute for control with the control yoke and rudder, but to relieve pressures already held to stabilize attitude.
    b. Use trim frequently and in small amounts.
        1) Trim should be expected during any pitch, power, or airspeed change.
    c. Improper adjustment of seat or rudder pedals for comfortable positioning of legs and feet may contribute to trim errors.
        1) Tension in the ankles makes it difficult to relax rudder pressures.

Constant Airspeed Descents

A. General Information
    1. The objective of this maneuver is for you to demonstrate your ability to perform constant airspeed descents.
    2. When unexpected adverse weather is encountered, the most likely situation is that of being trapped in or above a broken or solid layer of clouds or haze, requiring that a descent be made to an altitude where you can reestablish visual reference to the ground.

B. Maneuver Objectives

1. **Exhibit your knowledge of the elements related to attitude instrument flying during constant descents.**
   a. A descent can be made at a variety of airspeeds and attitudes by reducing power, adding drag, and lowering the nose to a predetermined attitude. Sooner or later, the airspeed will stabilize at a constant value (i.e., a single pitch attitude will maintain the desired airspeed).
   b. While a constant airspeed descent can be done at cruise speed, above cruise speed, or below cruise speed, we will limit our discussion to a descent airspeed that is below cruise speed.
      1) Remember that this instrument training is to prepare you for emergency situations, and a descent at a speed below cruise speed is easier to control.
2. **Establish the descent configuration specified by your examiner.**
   a. Establish the descent configuration, landing gear (if retractable), and flaps, as specified by your examiner.
      1) The landing gear, if retractable, and flaps should be positioned as specified by your examiner.
         a) Ensure that your airspeed is below V_{FE} and V_{LO} before extending flaps or landing gear.
      2) Establishing the desired configuration before starting the descent will permit a more stabilized descent and require less division of your attention once the descent is started.
   b. You should form a habit of repeating instructions given to you for all maneuvers. This ensures that you understand your examiner's instructions.
3. **Transition to the descent pitch attitude and power setting on an assigned heading using proper instrument cross-check and interpretation and coordinated control application.**
   a. To enter a constant airspeed descent at an airspeed lower than cruise, use the following method:
      1) Reduce power to a predetermined setting for the descent; thus, RPM is the primary power instrument.
      2) Maintain straight-and-level flight as the airspeed decreases.
      3) As the airspeed approaches the desired speed for the descent, lower the nose on the AI to maintain constant airspeed, and trim off control pressures. The ASI is now the primary pitch instrument.
   b. In straight flight, the HI is the primary bank instrument.
      1) In turning flight, the primary bank instrument is the TC.
   c. As you establish the descent, you must increase your rate of instrument cross-check and interpretation.
   d. You will need to learn to overcome a natural tendency to make a large control movement for a pitch change and learn to apply small control pressures smoothly, cross-checking rapidly for the results of the change and continuing with the pressures as your instruments show the desired results at a rate that you can interpret.
      1) Small pitch changes can be easily controlled, stopped, and corrected.
      2) Large changes are more difficult to control.

e. Coordination of controls requires that the ball of the TC be kept centered and that the available trim control devices be used whenever a change in flight conditions disturbs the existing trim.

1) Trim is used to relieve all possible control pressures held after a desired attitude has been attained.

2) The pressure you feel on the control yoke must be that which you apply while controlling a planned change in airplane attitude, not pressure held because you are letting the airplane control you.

4. **Demonstrate descents solely by reference to instruments at a constant airspeed to specific altitudes in straight flight and turns.**

a. The figure below illustrates the instrument indications for straight, constant airspeed descent, which is similar to that of a climb except the ALT and VSI will indicate a descent.

b. During a constant airspeed descent, the ASI becomes the primary pitch instrument. Make small pitch changes to maintain the desired airspeed.

1) If the airspeed is higher than desired, the pitch must be increased. Use the AI to raise the nose, and then check the ASI to determine if additional corrections are necessary.

2) If the airspeed is lower than desired, the pitch must be decreased. Use the AI to lower the nose, and then check the ASI.

c. The RPM remains the primary power instrument, which is used to ensure that the proper descent power is maintained.

5. **Level off at your assigned altitude and maintain that altitude, ±200 ft.; maintain heading, ±20°; maintain airspeed, ±10 kt.**
    a. The level-off from a descent must be started before you reach the desired altitude. Assuming a 500-fpm rate of descent, lead the altitude by 100 to 150 ft. for a level-off at an airspeed higher than descending speed (i.e., to level off at cruise airspeed).
        1) At the lead point, add power to the appropriate level flight cruise setting. Since the nose will tend to rise as the airspeed increases, hold forward elevator pressure to maintain the descent until approximately 50 ft. above the altitude; then smoothly adjust pitch to the level flight attitude.
        2) Application of trim will be required as you resume normal cruise airspeed.
    b. Increase your rate of instrument cross-check and interpretation throughout the level-off.
        1) Maintain a constant heading by using the HI.

C. Common Errors during Straight, Constant Airspeed Descents by Reference to Instruments
1. **Fixation, omission, and emphasis errors during instrument cross-check**
    a. Fixation, or staring at a single instrument, usually occurs for a good reason, but with poor results.
        1) You may stare at the ASI, which reads 20 kt. below assigned airspeed, wondering how the needle got there. During that time, perhaps with increasing tension on the controls, a heading change occurs unnoticed, and more errors accumulate.
        2) It may not be entirely a cross-checking error. It may be related to difficulties with one or both of the other fundamental skills (i.e., interpretation and control).
    b. Omission of an instrument from the cross-check may be caused by failure to anticipate significant instrument indications following attitude changes.
        1) All instruments should be included in the scan.
    c. Emphasis on a single instrument, instead of on the combination of instruments necessary for attitude information, is normal during the initial stages of instrument training.
        1) You may tend to rely on the instrument that you understand the best, e.g., the AI.
        2) The ALT will be changing; however, the ASI is primary for pitch during this maneuver.
2. **Improper instrument interpretation**
    a. This error may indicate that you do not fully understand each instrument's operating principle and relationship to the performance of the airplane.
    b. You must be able to interpret even the slightest changes in your instrument indications from your cross-checking.
3. **Improper control applications**
    a. This error occurs when you incorrectly interpret the instruments and/or apply the improper controls to obtain a desired performance, e.g., using power instead of pitch to correct a minor airspeed error.
4. **Failure to establish proper pitch, bank, or power adjustments during heading and airspeed corrections**
    a. You must understand which instruments provide information for pitch, bank, and power.
        1) The AI is the only instrument for pitch and bank control inputs.

b. This error may indicate that you do not fully understand instrument cross-check, interpretation, and/or control.

5. **Improper entry or level-off technique**
   a. Until you learn and use the proper power setting and pitch attitudes in descents, you may tend to make larger-than-necessary pitch adjustments.
      1) You must restrain the impulse to change a flight attitude until you know what the result will be.
         a) Do not chase the needles.
         b) The rate of cross-check must be varied during speed, power, or attitude changes on descents.
         c) During leveling off, you must note the rate of descent to determine the proper lead.
            i) Failure to do this will result in overshooting or undershooting the desired altitude.
      2) "Ballooning" (allowing the nose to pitch up) on level-off results when descent attitude with forward elevator pressure is not maintained as power is increased.
      3) You must maintain an accelerated cross-check until straight-and-level flight is positively established.
6. **Faulty trim technique**
   a. Trim should be used, not to substitute for control with the control yoke and rudder, but to relieve pressures already held to stabilize attitude.
   b. Use trim frequently and in small amounts.
      1) Trim should be expected during any pitch, power, or airspeed change.
   c. Improper adjustment of seat or rudder pedals for comfortable positioning of legs and feet may contribute to trim errors.
      1) Tension in the ankles makes it difficult to relax rudder pressures.

Turns to Headings

A. General Information
   1. The objective of this maneuver is for you to demonstrate your ability to perform turns to headings solely by reference to instruments.

B. Maneuver Objectives
   1. **Exhibit your knowledge of the elements related to attitude instrument flying during turns to headings.**
      a. Sometimes upon encountering adverse weather conditions, it is advisable for you to use radio navigation aids or to obtain directional guidance from ATC facilities.
         1) Such guidance usually requires that you make turns and/or maintain specific headings.
      b. When making turns in adverse weather conditions, you gain nothing by maneuvering your airplane faster than your ability to keep up with the changes that occur in the flight instrument indications.
         1) You should limit all turns to a standard rate, which is a heading change of 3° per sec.
            a) This rate is shown on a TC when the wingtip of the representative airplane is opposite the standard rate marker.

b) On T&SIs, this rate is shown when the needle is deflected to the doghouse marker.

c) Most training airplanes require no more than 15° to 20° of bank for a standard-rate turn.

2) For small heading changes (less than 15° to 20°), use a bank angle no greater than the number of degrees of turn desired.

a) The rate at which a turn should be made is dictated generally by the amount of turn desired.

2. **Transition to the level-turn attitude using proper instrument cross-check and interpretation and coordinated control application.**

a. Before starting the turn to a new heading, you should hold the airplane straight and level and determine in which direction the turn is to be made. Then decide the rate or angle of bank required to reach the new heading.

b. To enter a turn, use coordinated aileron and rudder pressure to establish the desired bank angle on the AI. If using a standard-rate turn, check the miniature airplane of the TC for the standard rate indication.

1) Control pitch attitude and altitude throughout the turn.

c. To roll out on a desired heading, apply coordinated aileron and rudder pressure to level the wings on the AI and stop the turn.

1) Begin the rollout about 10° before the desired heading (less for small heading changes).

2) Adjust elevator pressure referencing the AI to maintain altitude on the ALT.

d. The figure below illustrates the instrument indications while in a turn.

e. Coordination of controls requires that the ball of the TC be kept centered and that the available trim control devices be used whenever a change in flight conditions disturbs the existing trim.

1) Trim is used to relieve all possible control pressures held after a desired attitude has been attained.

2) The pressure you feel on the control yoke must be that which you apply while controlling a planned change in airplane attitude, not pressure held because you are letting the airplane control you.

3. **Demonstrate turns to headings solely by reference to instruments; maintain altitude, ±200 ft.; maintain a standard-rate turn and roll out on the assigned heading, ±10°; maintain airspeed, ±10 kt.**

C. Common Errors during Turns to Headings by Reference to Instruments

1. **Fixation, omission, and emphasis errors during instrument cross-check**

a. Fixation, or staring at a single instrument, usually occurs for a good reason, but with poor results.

1) You may stare at the TC to maintain a standard-rate turn. During this time, an altitude change occurs unnoticed, and more errors accumulate.

b. Omission of an instrument from your cross-check may be caused by a failure to anticipate significant instrument indications following attitude changes.

1) All instruments should be included in your scan.

c. Emphasis on a single instrument, instead of on the combination of instruments necessary for attitude information, is normal in your initial stages of flight solely by reference to instruments.

1) You will tend to rely on the instrument you understand the best, e.g., the AI.

2. **Improper instrument interpretation**

a. You can avoid this error by understanding each instrument's operating principle and relationship to the performance of your airplane.

3. **Improper control applications**

a. Before you start your turn, look at the HI to determine your present heading and the desired heading.

b. Decide in which direction to turn and how much bank to use; then apply control pressure to turn the airplane in that direction.

c. Do not rush yourself.

4. **Failure to establish proper pitch, bank, and power adjustments during altitude, bank, and airspeed corrections**

a. You must understand which instruments provide information for pitch, bank, and power.

1) The AI is the only instrument for pitch and bank control inputs.

b. As control pressures change with bank changes, your instrument cross-check must be increased and pressure readjusted.

5. **Improper entry or rollout technique**

a. This error is caused by overcontrolling, resulting in overbanking on turn entry, and overshooting and undershooting headings on rollout.

1) Enter and roll out at the rate of your ability to cross-check and interpret the instruments.

b. Maintain coordinated flight by keeping the ball centered.
c. Remember the heading you are turning to.

6. **Faulty trim technique**
   a. The trim should not be used as a substitute for control with the control yoke and rudder pedals, but to relieve pressures already held to stabilize attitude.
   b. Use trim frequently and in small amounts.
   c. You cannot feel control pressures with a tight grip on the control yoke.
      1) Relax and learn to control with the eyes and the brain instead of only the muscles.

Recovery from Unusual Flight Attitudes

A. General Information
   1. The objective of this maneuver is for you to demonstrate your ability to recover from unusual flight attitudes.
   2. When visual references are inadequate or lost, you may unintentionally let your airplane enter a critical (unusual) attitude. Since such attitudes are unintentional and unexpected, the inexperienced pilot may react incorrectly and stall or overstress the airplane.

B. Maneuver Objectives
   1. **Exhibit your knowledge of the elements related to attitude instrument flying during unusual flight attitudes.**
      a. As a general rule, any time there is an instrument rate of movement or indication other than those associated with basic instrument flight maneuvers, assume an unusual attitude and increase the speed of cross-check to confirm the attitude, instrument error, or instrument malfunction.
      b. When a critical attitude is noted on the flight instruments, the immediate priority is to recognize what your airplane is doing and decide how to return it to straight-and-level flight as quickly as possible.
      c. To avoid aggravating the critical attitude with a control application in the wrong direction, the initial interpretation of the instruments must be accurate.

d. Nose-high attitudes are shown by the rate and direction of movement of the ALT, VSI, and ASI needles, in addition to the obvious pitch and bank attitude on the AI (see the figure below).

Unusual Attitude -- Nose High

1. ASI is decreasing from 140 kt. down to 75 kt.
2. ALT is increasing from 4,500 ft. toward 5,000 ft.
3. TC indicates a right turn.
4. HI indicates a right turn from 270° toward 360°.
5. VSI indicates a positive rate of climb.

e. Nose-low attitudes are shown by the same instruments, but in the opposite direction, as shown in the figure below.

Unusual Attitude -- Nose Low

1. ASI is increasing from 140 kt. up to 190 kt.
2. ALT is decreasing from 6,500 ft. toward 6,000 ft.
3. TC indicates a right turn.
4. HI indicates a right turn from 270° toward 360°.
5. VSI indicates a negative vertical speed (i.e., descent).

2. **Recognize unusual flight attitudes solely by reference to instruments and recover promptly to a stabilized level flight attitude using proper instrument cross-check and interpretation and smooth, coordinated control application in the correct sequence.**
    a. Recovery from a Nose-High Attitude
        1) Nose-high unusual attitude is indicated by
            a) Nose high and wings banked on AI
            b) Decreasing airspeed
            c) Increasing altitude
            d) A turn on the TC
        2) Take action in the following sequence:
            a) Add power. If the airspeed is decreasing or below the desired airspeed, increase power (as necessary in proportion to the observed deceleration).
            b) Reduce pitch. Apply forward elevator pressure to lower the nose on the AI and prevent a stall.
                i) Deflecting ailerons to level the wings before the angle of attack is reduced could result in a spin.
            c) Level the wings. Correct the bank (if any) by applying coordinated aileron and rudder pressure to level the miniature airplane of the AI and center the ball of the TC.
        3) The corrective control applications should be made almost simultaneously but in the sequence above.
        4) After initial control has been applied, continue with a fast cross-check for possible overcontrolling, since the necessary initial control pressures may be large.
            a) As the rate of movement of the ALT and VSI needles decrease, the attitude is approaching level flight. When the needles stop and reverse direction, your airplane is passing through level flight.
        5) When airspeed increases to normal speed, set cruise power.
    b. Recovery from a Nose-Low Attitude
        1) Nose-low unusual attitude is indicated by
            a) Nose low and wings banked on AI
            b) Increasing airspeed
            c) Decreasing altitude
            d) A turn on the TC
        2) Take action in the following sequence:
            a) Reduce power. If the airspeed is increasing or is above the desired speed, reduce power to prevent excessive airspeed and loss of altitude.
            b) Level the wings. Correct the bank attitude with coordinated aileron and rudder pressure to straight flight by referring to the AI and TC.
                i) Increasing elevator back pressure before the wings are leveled will tend to increase the bank and make the situation worse.
                ii) Excessive G-loads may be imposed, resulting in structural failure.
            c) Raise the nose. Smoothly apply back elevator pressure to raise the nose on the AI to level flight.
                i) With the higher-than-normal airspeed, it is vital to raise the nose very smoothly to avoid overstressing the airplane.

3) The corrective control applications should be made almost simultaneously but in the sequence above.
4) After initial control has been applied, continue with a fast cross-check for possible overcontrolling, since the necessary initial control pressures may be large.
   a) As the rate of movement of the ALT and VSI needles decrease, the attitude is approaching level flight. When the needles stop and reverse direction, your airplane is passing through level flight.
5) When airspeed decreases to normal speed, set cruise power.

c. As the indications of the ALT, TC, and ASI stabilize, the AI and TC should be checked to determine coordinated straight flight; i.e., the wings are level and the ball is centered.
   1) Slipping or skidding sensations can easily aggravate disorientation and retard recovery.
   2) You should return to your last assigned altitude after stabilizing in straight-and-level flight.

d. Unlike the control applications in normal maneuvers, larger control movements in recoveries from unusual attitudes may be necessary to bring the airplane under control.
   1) Nevertheless, such control applications must be smooth, positive, prompt, and coordinated.
   2) Once the airplane is returned to approximately straight-and-level flight, control movements should be limited to small adjustments.

C. Common Errors during Unusual Flight Attitudes

1. **Failure to recognize an unusual flight attitude**
   a. This error is due to poor instrument cross-check and interpretation.
   b. Once you are in an unusual attitude, determine how to return to straight-and-level flight, NOT how your airplane got there.
   c. Unusually loud or soft engine and wind noise may provide an indication.
2. **Attempting to recover from an unusual flight attitude by "feel" rather than by instrument indications**
   a. The most hazardous illusions that lead to spatial disorientation are created by the information received by your motion-sensing system located in each inner ear.
   b. The motion-sensing system is not capable of detecting a constant velocity or small changes in velocity, nor can it distinguish between centrifugal force and gravity.
   c. The motion-sensing system, functioning normally in flight, can produce false sensations.
   d. During unusual flight attitudes, you must believe and interpret the flight instruments because spatial disorientation is normal in unusual flight attitudes.
3. **Inappropriate control applications during recovery**
   a. Accurately interpret the initial instrument indications before recovery is started.
   b. Follow the recovery steps in sequence.
   c. Control movements may be larger, but must be smooth, positive, prompt, and coordinated.

4. **Failure to recognize from instrument indications when the airplane is passing through level flight**
   a. With an operative attitude indicator, level flight attitude exists when the miniature airplane is level with the horizon.
   b. Without an attitude indicator, level flight is indicated by the reversal and stabilization of the airspeed indicator and altimeter needles.

END OF STUDY UNIT