

PRIVATE PILOT GROUND SCHOOL

MODULE 1-7 — FLIGHT INSTRUMENTS

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FACTS TO REMEMBER

KNOW THESE COLD

– The pitot-static instruments are the airspeed indicator, altimeter, and vertical speed indicator; the gyroscopic instruments are the attitude indicator, heading indicator, and turn coordinator; the magnetic compass stands alone.

Source: PHAK ch. 8

– The airspeed indicator is the only instrument that uses both pitot (ram) and static pressure — it displays their difference.

Source: PHAK ch. 8

– Indicated airspeed is what the dial shows; calibrated corrects it for installation error; true airspeed corrects calibrated for density altitude.

Source: PHAK ch. 8

– Airspeed indicator markings: white arc V_{SO} to V_{FE} (flap range), green arc V_{S1} to V_{NO} (normal), yellow arc caution (smooth air only), red line V_{NE} .

Source: PHAK ch. 8; PA-28-151 AFM 3-2

– The altimeter is a stack of sealed aneroid wafers reading static pressure against the setting dialed in the Kollsman window.

Source: PHAK ch. 8

– Altimeter setting is updated in flight to the nearest reporting station; standard sea-level pressure is 29.92 inches Hg.

Source: PHAK ch. 8; 14 CFR 91.121

– One inch of altimeter setting is worth roughly 1,000 feet of indicated altitude.

Source: PHAK ch. 8

– Flying from high pressure toward low pressure (or hot to cold) without resetting makes the altimeter read higher than you are: "high to low, look out below."

Source: PHAK ch. 8

– The altitude vocabulary: indicated (dial), pressure (29.92 set), density (pressure corrected for temperature), true (above sea level), absolute (above ground).

Source: PHAK ch. 8

– The VSI shows rate of climb or descent from the lag in a calibrated static leak; the needle trend is instant but the rate value lags several seconds.

Source: PHAK ch. 8

– The attitude indicator is the only instrument giving pitch and bank directly; its gyro holds rigid in space while the case moves around it.

Source: PHAK ch. 8

– The heading indicator drifts from gyro precession and must be realigned with the magnetic compass every 10–15 minutes, in straight-and-level unaccelerated flight.

Source: PHAK ch. 8

- The turn coordinator's canted gyro shows rate of turn and roll rate; the miniature aircraft says nothing about bank angle or pitch.

Source: PHAK ch. 8

- Standard rate is 3 degrees per second — a full circle in two minutes — marked by the turn coordinator's index.

Source: PHAK ch. 8

- The inclinometer ball shows coordination: ball toward the inside of the turn is a slip, toward the outside is a skid — step on the ball.

Source: PHAK ch. 8

- A left turn with the ball out to the right is a skid: too much left rudder for the bank — and the skidded, slow version of this picture is the base-to-final killer.

Source: PHAK ch. 8

- Magnetic variation is the angle between true and magnetic north; deviation is the compass error from the airplane's own fields, corrected by the card below the compass.

Source: PHAK ch. 8

- Compass acceleration error (northern hemisphere, east/west headings): Accelerate-North, Decelerate-South — ANDS. (Mnemonic object.)

Source: PHAK ch. 8

- Compass turning error: turning from a northerly heading the compass lags (shows a turn the opposite way at first); from a southerly heading it leads — Undershoot North, Overshoot South (UNOS). (Mnemonic object.)

Source: PHAK ch. 8

- The magnetic compass is reliable only in straight, level, unaccelerated flight — every other moment it is lying by a known recipe.

Source: PHAK ch. 8

- The instrument cross-check (scan) keeps the eyes moving through the panel with the attitude indicator as hub; staring at one instrument is fixation, skipping one is omission, and trusting one too much is emphasis.

Source: IFH ch. 6; PHAK ch. 8

- Instruments are read as a committee: no single indication is acted on until a second instrument confirms it — that is how a failed instrument is caught before it flies the airplane.

Source: IFH ch. 6

GOING DEEPER

- True airspeed exceeds calibrated by roughly 2 percent per 1,000 ft of altitude — same indicated, faster over the ground as you climb.

Source: PHAK ch. 8

- The Warrior's Flight Manual publishes speeds in MPH calibrated while the pilot flies indicated — the correction table is on POH 7-9.

Source: PA-28-151 POH 7-9

- Cold outside temperature makes true altitude lower than indicated — terrain clearance shrinks on cold days even with the right setting.

Source: PHAK ch. 8; AIM 7-3

- Older attitude gyros have pitch/bank limits and small acceleration errors (slight pitch-up indication on takeoff acceleration); they precess slowly out of true and re-erect in level flight.

Source: PHAK ch. 8; IFH ch. 5

- The lead/lag of the compass in turns is roughly equal to the latitude of the flight.

Source: IFH ch. 5

- Control and performance: set attitude and power first, then trim, then cross-check the performance instruments to confirm — attitude flying works identically on instruments.

Source: IFH ch. 6

THE REGULATIONS BEHIND THIS MODULE

14 CFR 91.121 – Altimeter settings

Below 18,000 feet the altimeter is set to the current reported setting of a station along the route within 100 nautical miles. With no such station, to an appropriate available station. With no radio, to the departure airport's elevation. At and above 18,000 feet, to 29.92.

Where it goes deeper: This module, in the altimeter Leg.