

The ATPL Cheat Sheet

040 Human Performance and Limitations

The facts that actually get tested, stripped to the bone: definitions, key numbers, formulas, mnemonics and the classic exam traps for each subject. Built for the night before, the commute, and the last scroll before you walk into the exam hall.

040 Human Performance and Limitations

62 memory items

One of 14 subjects; the full set is free at skystudyatpl.com/atpl-cheat-sheet

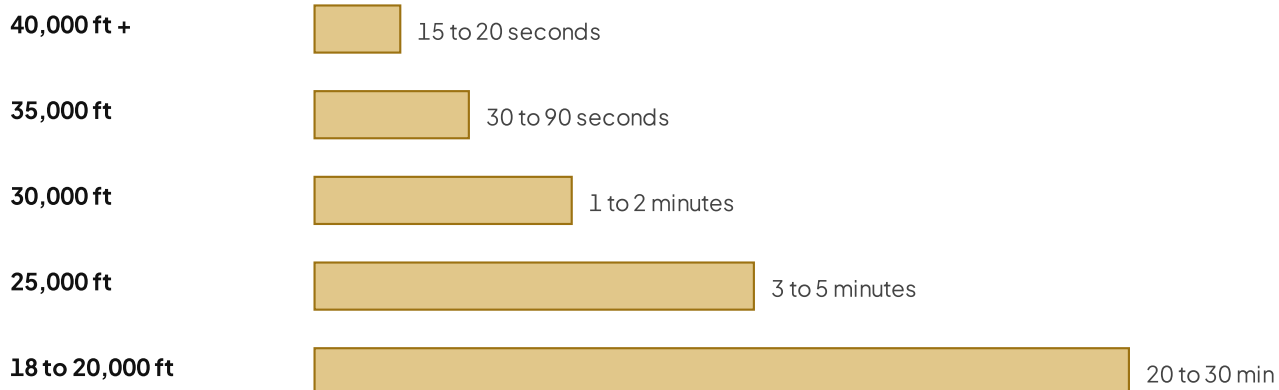
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Human Performance and Limitations

Physiology, hypoxia, vision, illusions, sleep and fatigue, CRM and error.

◆ TIME OF USEFUL CONSCIOUSNESS VERSUS ALTITUDE



Approximate, seated at rest. A rapid or explosive decompression roughly halves these times. TUC is the time to loss of useful action, not the time to unconsciousness. Values vary by individual, so confirm against current teaching.

◆ MUST-KNOW DEFINITIONS AND CONCEPTS

- Atmosphere by volume: about **21% oxygen**, **78% nitrogen**, roughly 1% other gases.
- Partial pressure of a gas = total pressure x fractional concentration (Dalton's Law); alveolar oxygen partial pressure falls with altitude even though the 21% fraction is constant.
- **Hypoxic hypoxia**: too little oxygen reaching the blood from reduced ambient partial pressure (the classic altitude hypoxia).
- **Hypemic (anaemic) hypoxia**: reduced oxygen-carrying capacity (anaemia, blood loss, or carbon monoxide binding to haemoglobin).
- **Stagnant hypoxia**: enough oxygen in the blood but poor circulation (cold, positive G, shock, poor posture).
- **Histotoxic hypoxia**: oxygen delivered but tissues cannot use it (alcohol, some drugs, cyanide).
- **Hyperventilation**: over-breathing washes out CO₂ (hypocapnia), mimicking hypoxia but with normal or high oxygen.
- Stages of hypoxia: indifferent, compensatory, disturbance, critical.
- **Time of Useful Consciousness (TUC)**: time from onset of hypoxia to the loss of effective corrective action.
- Pressurised cabins are typically held around **6,000 to 8,000 ft** equivalent, not sea level.
- Explosive/rapid decompression is more dangerous than gradual because TUC is shortened and lung barotrauma risk rises.
- G-force sequence with increasing positive G: **grey-out** (peripheral vision loss), **blackout** (total vision loss, still conscious), then **G-LOC** (loss of consciousness). Negative G gives redout.
- The retina has **rods** (peripheral, low light, motion, no colour) and **cones** (central, colour,

detail, need light).

- Dark adaptation of rods takes around **30 minutes** and is lost quickly in bright light; use off-centre viewing at night.
- **Empty-field myopia**: in a featureless field the eyes default-focus short (about arm's length), reducing distant traffic detection.
- The vestibular system (semicircular canals plus otoliths) senses angular acceleration (canals) and linear acceleration/gravity (otoliths), not attitude directly.
- **The leans**: a slow roll below the canals' detection threshold is not sensed, so the pilot feels wings-level when banked.
- **Coriolis illusion**: a head movement during a sustained turn stimulates several canals at once, causing strong disorientation.
- **Somatogravic illusion**: forward acceleration (e.g. takeoff) feels like a nose-up pitch, tempting a nose-down input.
- **Somatogyral illusion**: a sustained turn feels to slow or stop, so rolling level feels like a turn the other way (graveyard spiral risk).
- **Black hole approach**: over dark, featureless terrain with only runway lights, pilots feel too high and fly dangerously low.
- Middle ear and sinus barotrauma is worse on **descent**. Decompression sickness (DCS) is a separate problem: nitrogen leaving solution as pressure falls.
- **Circadian rhythm** is the roughly 24-hour body clock; the **WOCL** (window of circadian low) is the least-alert period, roughly 02:00 to 06:00 body time.
- **Yerkes-Dodson law**: performance rises with arousal to an optimum, then falls (inverted-U).
- Memory has three stores: sensory (very brief), short-term/working (limited), and long-term (large, durable).

- The **SHELL model** describes the interfaces around the central Liveware (Software, Hardware, Environment, other Liveware).
- **Reason's Swiss cheese** model: accidents happen when weaknesses in successive defences line up.
- Error types: **slips** (attention, right intent wrong action), **lapses** (memory), **mistakes** (wrong plan), **violations** (deliberate rule deviation).
- **CRM** is the effective use of all resources (people, procedures, equipment) through communication, teamwork and workload management, not stick-and-rudder skill.

◆ KEY NUMBERS, LIMITS AND VALUES

- Sea level composition about 21% oxygen, 78% nitrogen; sea level pressure 1013.25 hPa **VERIFY**.
- Typical maximum cabin altitude around **8,000 ft** **VERIFY**.
- TUC (seated, at rest, approximate, verify): **18,000 to 20,000 ft** about 20 to 30 min; **25,000 ft** about 3 to 5 min; **30,000 ft** about 1 to 2 min; **35,000 ft** about 30 to 90 s; **40,000 ft+** about 15 to 20 s.
- Sudden/explosive decompression roughly **halves** TUC versus gradual **VERIFY**.
- Dark adaptation to near-maximum rod sensitivity takes up to about **30 minutes** **VERIFY**.
- WOCL roughly **02:00 to 06:00** body-clock time; a sleep cycle is about **90 minutes** **VERIFY**.
- Adults need about **7 to 8 hours** sleep per 24 hours **VERIFY**.
- Working memory capacity is classically **7 plus or minus 2** chunks, held for about 15 to 30 seconds without rehearsal **VERIFY**.
- Flying after diving: commonly at least **12 hours** after a single no-decompression dive, at least **24 hours** after repetitive or decompression dives **VERIFY**.
- Alcohol is metabolised at roughly **one unit per hour**; a commonly cited minimum is 8 hours bottle to throttle **VERIFY**.
- Unprotected positive-G tolerance before G-LOC is roughly **4 to 6 G** depending on onset rate and the individual **VERIFY**.

◆ MNEMONICS AND MEMORY ITEMS

- Hypoxia types **HSSH**: Hypoxic, Hypemic, Stagnant, Histotoxic (ambient, blood, circulation, cellular).
- **Hypoxia hides, hyperventilation hurries**: hypoxia creeps in unnoticed, hyperventilation shows a fast breathing rate.
- **SHELL**: Liveware in the centre, surrounded by Software, Hardware, Environment and other Liveware.
- **Swiss cheese**: the holes must line up; single failures rarely cause the accident.
- **Grey before Black**: grey-out precedes blackout before full G-LOC.
- **Gravic** tricks you on acceleration (false pitch); **gyral** tricks you on turn rate.
- Yerkes-Dodson inverted-U: too little arousal is slow, too much is sloppy, the middle is best.
- DCS signs: **bends** (joints), **chokes** (breathing), **creeps** (skin), **staggers** (neurological).

◆ COMMON EXAM TRAPS

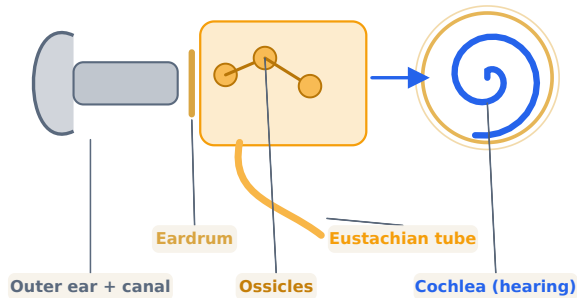
- Do not confuse **hypoxia** (low oxygen) with **hyperventilation** (low CO₂); symptoms overlap heavily.
- **Blackout** keeps consciousness; **G-LOC** is loss of consciousness. They are different events.
- The 21% oxygen fraction does **not** change with altitude; the **partial pressure** falls.
- TUC is shorter with **rapid** decompression; altitude alone does not set it.
- **Rods** handle night and peripheral vision; **cones** handle central, colour, daylight vision.
- Use **off-centre** viewing at night; looking straight at a target uses cone-poor central vision.
- The **leans** comes from a slow undetected roll; distinguish it from the **Coriolis** head-movement illusion.
- **Somatogравic** is a false pitch-up on acceleration; **somatogравal** is a misperceived turn rate.
- Eustachian tube blockage hurts more on **descent** than climb.
- A **slip** is an attention failure with correct intent; a **lapse** is a memory failure; do not swap them.
- A **mistake** follows a wrong plan; a **violation** is a deliberate rule deviation.
- **Chronic fatigue** is not fixed by one night's sleep the way acute fatigue is.
- The **WOCL** follows body-clock (home-base) time, not local night, which matters for jet-lagged crews.
- CRM is resource management and teamwork, not technical proficiency.

The ear: hearing and the vestibular balance organs

040 • PHYSIOLOGY

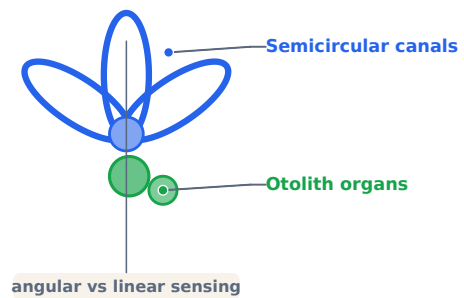
1

Hearing: the conduction path



2

Balance: the vestibular organs



1 Hearing

Sound moves the eardrum, the three ossicles amplify it and the fluid-filled cochlea turns it into nerve signals. Loud noise and age cause permanent high-tone loss.

2 Balance organs

The three semicircular canals sense angular (rotational) acceleration; the otolith organs sense linear acceleration and the pull of gravity.

3 Equalising pressure

The Eustachian tube vents the middle ear. It opens easily on climb but must be actively cleared on descent, which a head cold makes painful (otic barotrauma).

4 False sensations

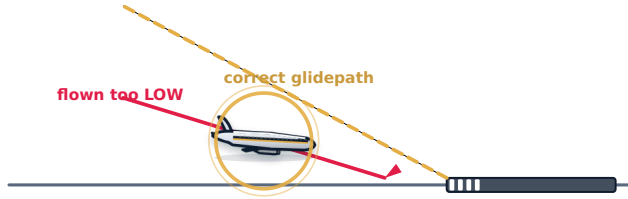
The balance organs are easily fooled without outside vision, so sub-threshold rolls and head turns cause disorientation. Trust the instruments, not the seat.

The cochlea hears; the semicircular canals sense angular and the otoliths linear acceleration; the Eustachian tube equalises the middle ear, hardest on descent. Drawn in code.

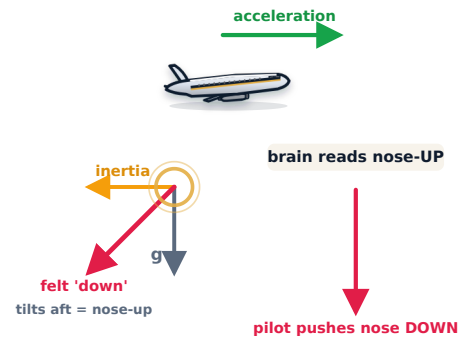
1 Glidepath illusions: feel HIGH, fly LOW

All make you fly too LOW:

- narrow runway
- up-slope
- black hole (night)
- haze



2 Somatogravic: feel PITCH-UP, push DOWN



1 Runway width & slope

A narrow OR up-sloping runway looks too high, so the pilot flies a low approach (undershoot). A wide OR down-sloping runway looks too low, so the pilot flies high (overrun). Cross-check the PAPI.

2 Black-hole approach

At night over dark ground or water with only runway lights, the eye builds a slope lower than the real one, so the pilot flies dangerously low. Use PAPI, a stabilised instrument approach and the radio altimeter.

3 Somatogravic illusion

Forward acceleration (go-around) feels like pitch-up, so the pilot pushes down into the ground; deceleration feels like pitch-down and invites a pull-up and stall. Fly the attitude indicator.

4 Night visual traps

Autokinesis: a fixed light seems to drift after 6 to 12 s, so scan, never stare. A sloping cloud or shore-light line makes a false horizon; empty-field myopia rests the eyes at 1 to 2 m.

Most approach illusions make the runway look too high, so the pilot flies dangerously low, and forward acceleration feels like pitch-up; fly the PAPI and the attitude indicator, not the view or the seat. Drawn in code.

Two of the 369 code-drawn study figures inside the SkyStudy question bank. Try them with the free demo at skystudyatpl.com/demo.

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