At night, your peripheral vision is effective but central vision is obscured due to the way your eye works.
Aviation Physiology – Vision

At night you must see lighting to determine movement of other aircraft.

If you see a steady green and flashing red light, an aircraft is passing from left to right.

If you see a red position light to the right of a green light, an aircraft is flying toward you.

A steady red and flashing red light indicate an aircraft is crossing to your left.

A steady white light combined with a flashing red light identify an aircraft flying away from you.
CAUTION
Twilight can cause you to misinterpret the horizon. Cloud banks are sometimes mistaken for the horizon.
Aviation Physiology – Vision

Elements that create any type of visual obstruction, such as rain or haze, can cause you to fly a low approach.

Over water, at night, or over featureless terrain, such as snow-covered ground, there is a natural tendency to fly a lower-than-normal approach.

Penetration of fog can create the illusion of pitching up which can cause you to steepen your approach.

Due to the illusion of greater height, you may fly a lower approach than normal to a narrow runway. A wide runway can have the opposite effect and produce higher-than-normal approaches.
SLOPE can cause you to misjudge your approach. CHECK the AIRPORT FACILITIES DIRECTORY to know that slope could occur BEFORE you take-off.
DO YOU SCUBA DIVE?

• If you or a passenger scuba dives be careful. The divers body must have sufficient time to expel and nitrogen build up from the dive before flying.

WAIT TIMES

Flight altitudes below 8,000 feet: Wait at least 12 hrs after dives not requiring controlled ascent. Wait at least 24 hrs after dives requiring controlled ascents.

Flight altitudes above 8,000 feet. Wait at least 24 hours after any scuba dive.
Aviation Physiology

- **Illness** - Do I have any symptoms?
- **Medication** - Have I been taking prescription or over-the-counter drugs?
- **Stress** - Am I under psychological pressure from the job? Worried about financial matters, health problems, or family discord?
- **Alcohol** - Have I been drinking within 8 hours? Within 24 hours?
- **Fatigue** - Am I tired and not adequately rested?
- **Eating** - Am I adequately nourished?
AIRCRAFT SYSTEMS
Aircraft Systems – Parts of the Airplane

- Vertical Stabilizer
- Rudder
- Elevator vs Stabilator
- Horizontal Stabilizer
- Flaps
- Ailerons
- Powerplant
- Wing
- Fuselage
- Landing Gear
THE 4 CONTROL SURFACES OF AN FIXED WING AIRCRAFT

- **Elevator**: Control the movement about the lateral axis called pitch.
- **Ailerons**: Control the airplanes movement about it’s longitudinal axis called roll.
- **Rudder**: Controls movement about the vertical axis called yaw.
- **TRIM TABS**: Small, adjustable hinged-surfaces on ailerons, rudder, or elevator control surfaces easing manual pressure by pilot to control other surfaces.
Aircraft Systems – 3 Axes of Flight
Aircraft Systems – 3 Axes of Flight

ROLL - AILERONS ➔

← ELEVATORS - PITCH

YAW – RUDDER ➔
Aircraft Systems – Landing Gear

- Tricycle vs. Conventional
- Retractable vs. Fixed Gear
- Others
  - Skids
  - Floats
Aircraft Systems – Powerplants
Aircraft Systems – High Performance Powerplants

Turboprop- 350 Kts

Turbojet- 550 Kts

Rocket- 2600 Kts (above X-15)

Scramjet-13,000 Kts (15,000 mph): X43A
(5,000 last year, 10,000 this year)
X43D coast to coast US in 12 minutes.
Aircraft Systems – Reciprocating Engine

4-Cycles of the reciprocating engine

Intake → Compression → Power → Exhaust

Starting – tendency to over-rev, Immediately adjust to proper RPM, And insure oil pressure/temperature OK
THE IGNITION SYSTEM

- In a spark ignition engine the ignition system provides a spark that ignites the fuel/air mixture in the cylinders and is made up of magnetos, spark plugs, high-tension leads, and the ignition switch.
- A magneto uses a permanent magnet to generate an electrical current completely independent of the aircraft’s electrical system. The magneto generates sufficiently high voltage to jump a spark across the spark plug gap in each cylinder. The system begins to fire when the starter is engaged and the crankshaft begins to turn. It continues to operate whenever the crankshaft is rotating.
- Most standard certificated aircraft incorporate a dual ignition system with two individual magnetos, separate sets of wires, and spark plugs to increase reliability of the ignition system. Each magneto operates independently to fire one of the two spark plugs in each cylinder. The firing of two spark plugs improves combustion of the fuel/air mixture and results in a slightly higher power output. If one of the magnetos fails, the other is unaffected.
Aircraft Systems – Induction System

The induction system brings in air from the outside, mixes it with fuel, and delivers the fuel/air mixture to the cylinder where combustion occurs.
Types of Induction Systems

• The carburetor system, which mixes the fuel and air in the carburetor before this mixture enters the intake manifold

• The fuel injection system, which mixes the fuel and air immediately before entry into each cylinder or injects fuel directly into each cylinder
Carburetors are classified as either float type or pressure type. The float type of carburetor, complete with idling, accelerating, mixture control, idle cutoff, and power enrichment systems is probably the most common of all carburetor types. Pressure carburetors are usually not found on small aircraft. The basic difference between a float-type and a pressure-type carburetor is the delivery of fuel. The pressure-type carburetor delivers fuel under pressure by a fuel pump.

In the operation of the float-type carburetor system, the outside air first flows through an air filter, usually located at an air intake in the front part of the engine cowling. This filtered air flows into the carburetor and through a venturi, a narrow throat in the carburetor. When the air flows through the venturi, a low-pressure area is created, which forces the fuel to flow through a main fuel jet located at the throat. The fuel then flows into the airstream where it is mixed with the flowing air.

The fuel/air mixture is then drawn through the intake manifold and into the combustion chambers where it is ignited. The float-type carburetor acquires its name from a float, which rests on fuel within the float chamber. A needle attached to the float opens and closes an opening at the bottom of the carburetor bowl. This meters the correct amount of fuel into the carburetor, depending upon the position of the float, which is controlled by the level of fuel in the float chamber. When the level of the fuel forces the float to rise, the needle valve closes the fuel opening and shuts off the fuel flow to the carburetor. The needle valve opens again when the engine requires additional fuel. The flow of the fuel/air mixture to the combustion chambers is regulated by the throttle valve, which is controlled by the throttle in the flight deck.
Disadvantages: First, the effect of abrupt maneuvers have on the float action. Second, the fact that its fuel must be discharged at low pressure leads to incomplete vaporization and difficulty in discharging fuel into some types of supercharged systems. The chief disadvantage of the float carburetor, however, is its icing tendency.
Aircraft Systems – Carburetor Heat

CARBURETOR ICING

Application of Carb Heat > decrease in RPM followed by increase to normal.

Carburetor Heat is an anti-icing system that preheats the air before it reaches the carburetor, and is intended to keep the fuel/air mixture above the freezing temperature to prevent the formation of carburetor ice. It can be used to melt ice that has already formed in the carburetor if the accumulation is not too great, but using carburetor heat as a preventative measure is the better option.
Mixture Control

Carburetors are normally calibrated at sea-level pressure, where the correct fuel-to-air mixture ratio is established with the mixture control set in the FULL RICH position. However, as altitude increases, the density of air entering the carburetor decreases, while the density of the fuel remains the same. This creates a progressively richer mixture, which can result in engine roughness and an appreciable loss of power. The roughness normally is due to spark plug fouling from excessive carbon buildup on the plugs. Carbon buildup occurs because the rich mixture lowers the temperature inside the cylinder, inhibiting complete combustion of the fuel. This condition may occur during takeoff run-up at high-elevation airports and during climbs or cruise flight at high altitudes. To maintain the correct fuel/air mixture, the mixture must be leaned using the mixture control. Leaning the mixture decreases fuel flow, which compensates for the decreased air density at high altitude.

During a descent from high altitude, the mixture must be enriched, or it may become too lean. An overly lean mixture causes detonation, which may result in rough engine operation, overheating, and a loss of power. The best way to maintain the proper mixture is to monitor the engine temperature and enrich the mixture as needed. Proper mixture control and better fuel economy for fuel-injected engines can be achieved by use of an exhaust gas temperature (EGT) gauge. Since the process of adjusting the mixture can vary from one aircraft to another, it is important to refer to the airplane flight manual (AFM) or the pilot’s operating handbook (POH) to determine the specific procedures for a given aircraft.
Aircraft Systems – Induction

**FADEC**

FADEC is the acronym for *Full Authority Digital Engine Control* is a system consisting of a digital computer (called EEC /Electronic Engine Control/ or ECU /Electronic Control Unit/) and its related accessories which control all aspects of aircraft engine performance.

**NO MIXTURE REQUIRED – SAMPLES EACH CYLINDER & ADJUSTED FUEL-AIR RATION ON EACH FIRING !!!**
In a fuel injection system, the fuel is injected directly into the cylinders, or just ahead of the intake valve. Six basic components: an engine-driven fuel pump, a fuel/air control unit, fuel manifold (fuel distributor), discharge nozzles, an auxiliary fuel pump, and fuel pressure/flow indicators. It is less susceptible to icing than the carburetor system, but impact icing on the air intake is a possibility in either system. Impact icing occurs when ice forms on the exterior of the aircraft, and blocks openings such as the air intake for the injection system.
Supercharged Engines

A supercharger is an **engine-driven air pump or compressor** that provides compressed air to the engine to provide additional pressure to the induction air so the engine can produce additional power. It increases manifold pressure and forces the fuel/air mixture into the cylinders. The higher the manifold pressure, the more dense the fuel/air mixture. Superchargers are especially valuable at high altitudes (such as 18,000 feet) where the air density is 50 percent that of sea level.

**Turbo supercharged Engines:** booster uses the **engine’s exhaust gases** to drive an air compressor to increase the pressure of the air going into the engine through the carburetor or fuel injection system to boost power at higher altitude.
Aircraft Systems – Firing the spark plugs to ignite the fuel (dual ignition) system.
Aircraft Systems – Fuel System

**Detonation**: “Uncontrolled, explosive ignition of the fuel/air mixture within the cylinder’s combustion chamber causing excessive heat and pressure. Characterized by high cylinder head temperature at higher RPMs.

=What to do? Reduce power, reduce rate of climb, enrich mixture, open cowl.

**Pre-ignition**: Explosion of fuel prior to normal ignition (premature explosion) and can be accompanied by Detonation. Overheated exhaust valves, carbon, cracked spark insulators-plugs/electrodes heated to incandescent state cause premature firing.

= What to do? Same as above. If you are on the ground, shut down and fix problem!!! ESPECIALLY IF FUEL RELATED.
Aircraft Systems – Fuel System

**Equalizes-prevent vacuum in tank**

**Inject fuel to start**

**GRAVITY-FEED SYSTEM**

**FUEL-PUMP SYSTEM**

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Guided Flight Discovery Private Pilot Manual
Aircraft Systems – Fuel System
Uncoordinated turns on landings and takeoffs without full fuel can cause engine failures.

VAPOR LOCK – If air allowed to get into fuel line – fuel cannot flow. Should the fuel VENT get block (bug) a vacuum is created and fuel cannot flow. Should you not tighten the fuel CAP, the lift of the wing can suck the tank dry!
Aircraft Systems – REFUELING

STATIC

FUEL GRADES (100LL)

Grade 80=Red, 100=Green, 100LL=blue
Turbine=colorless (80 & 100 no longer available.

NEVER use grade LESS than recommended => Detonation. If your grade not available use a HIGHER grade of fuel. NEVER allow ETHANOL into your fuel systems !!!
Check Fuel strainer for water contamination, top of tanks at end to prevent condensation
Aircraft Systems – Oil System

Insufficient oil pressure or sudden drop spells TROUBLE

Excessive Temperature damages engine

Oil/Engine temperature causes include operating with too much power, climbing too steeply in hot weather, using fuel at lower-than normal octane, too lean mixture (descending or set incorrectly, and/or low oil levels.)
Aircraft Systems – Cooling System
Aircraft Systems – Exhaust System

CABIN HEAT FROM HEATED AIR OF EXHAUST SYSTEM

Airflow

Defroster
Cabin Heat Control
Air Inlet
Muffler and Shroud
To Rear Cabin
Aircraft Systems – Propellers

WHEN HAND STARTING AN AIRPLANE – A COMPETENT PILOT MUST BE AT THE CONTROLS. THIS CAN BE EXTREMELY DANGEROUS.
Propeller Blade angle changes from root to tip producing differences in Angle of Attack (AOA). Byproducts are Torque and Corkscrew Effect.

Figure 4-35. Airfoil sections of propeller blade.

Figure 4-38. Propeller tips travel faster than the hub.

Figure 4-39. Torque reaction.

Figure 4-40. Corkscrewing slipstream.
Aircraft Systems – Electrical System

28 volt, direct current (DC) powered by a 60-amp alternator and a 24-volt battery.
Aircraft Systems – Electrical System

**Alternator (AC->14/28 VDC)**

**WARNING:** ENGINES CAN BE STARTED WITHOUT THE BATTERY (HAND PROP WITH ALTERNATOR ON-EXTREMELY DANGEROUS)
Aircraft Instruments
FLIGHT INSTRUMENTS

Initially you may feel overwhelmed.

DON'T FEEL OVERWHELMED, IT IS SIMPLER THAN IT APPEARS
Think of them as functional groups of information (i.e., Engine, Flight Control, Communication, Electrical, Power, etc.) and it makes sense and easier to manage.
Flight Instruments: Pitot-Static System

Relies on atmospheric pressure to measure altitude, rate of climb and impact pressure to measure speed.

These constants are important to both flight instruments and meteorology.
Flight Instruments: Pitot-Static

**PITOT HEAT SWITCH**
Electrical heating elements may be installed to remove ice from the pitot tube.

**PITOT TUBE**
Ram air pressure enters the system through a hole in the forward end of the pitot tube.

**DRAIN OPENING**
An opening normally is located near the aft portion of the pressure chamber to drain moisture from the pitot tube.

**STATIC PORT**
A static port is normally located on the side of the fuselage. An airplane may have one or two static ports. When two ports are used, they are usually located on each side of the fuselage to provide an average static pressure reading. This allows for a more accurate reading under certain flight conditions.
The one instrument that utilizes the pitot tube is the ASI. The total pressure is transmitted to the ASI from the pitot tube’s pressure chamber via a small tube. The static pressure is also delivered to the opposite side of the ASI which serves to cancel out the two static pressures, thereby leaving the dynamic pressure to be indicated on the instrument. The two remaining instruments (altimeter and VSI) utilize only the static pressure which is derived from the static port.

When the alternate static source pressure is used, the following instrument indications are observed:
1. The altimeter indicates a slightly higher altitude than actual.
2. The ASI indicates an airspeed greater than the actual airspeed.
3. The VSI shows a momentary climb and then stabilizes if the altitude is held constant.
Blocked Static System

The pitot system can become blocked completely or only partially if the pitot tube drain hole remains open. If the pitot tube becomes blocked and its associated drain hole remains clear, ram air no longer is able to enter the pitot system. Air already in the system will vent through the drain hole, and the remaining pressure will drop to ambient (outside) air pressure. Under these circumstances, the airspeed indicator reading decreases to zero, because the airspeed indicator senses no difference between ram and static air pressure.

If the pitot tube, drain hole, and static system all become blocked in flight, changes in airspeed will not be indicated, due to the trapped pressures. However, if the static system remains clear, the airspeed indicator acts as an altimeter.
Blocked Static System

If the static system becomes blocked but the **pitot tube remains clear**, the airspeed indicator continues to operate; however, it is **inaccurate**. Airspeed indications are **slower** than the actual speed when the airplane is operated **above the altitude where the static ports became blocked**, because the trapped static pressure is higher than normal for that altitude. When operating at a **lower altitude**, a **faster than actual airspeed is displayed** due to the relatively low static pressure trapped in the system.

A blockage of the static system also affects the **altimeter and VSI**. Trapped static pressure causes the altimeter to **freeze at the altitude where the blockage occurred**. In the case of the VSI, a blocked static system produces a continuous zero indication.
Flight Instruments: Pitot-Static System – Airspeed Indicator

HOW IT WORKS

AIRSPEED INDICATOR IS ONLY INSTRUMENT TO USE “RAM AIR” FROM THE PITOT TUBE.
Flight Instruments: Pitot-Static System – Airspeed Indicator

- **V_{NE} (RED LINE)**
- **Yellow Arc**
- **Max. Structural Cruise** → **V_{NO}**
- **Green Arc**
- **V_{FE}** → Max. Flap Extension
- **White Arc**
- **V_{S1}**
- **V_{SO}**
- **Stall: Flaps & Gear Down**
- **Stall: Flaps & Gear Up**

**NOT marked on airspeed indicator:** **V_{A}** Maneuvering Speed

Created by Steve Reisser
Important Single-Engine V-Speeds

\( V_A \) - Maneuvering speed, the maximum speed at which application of full available aerodynamic control will not overstress the airplane; usually decreases as gross weight decreases. More on next slide.

\( V_{FE} \) - Maximum flap-extended speed, the highest speed permissible with wing flaps in a prescribed extended position; top of white arc.

\( V_{LE} \) - Maximum landing gear extended speed.

\( V_{LO} \) - Maximum landing gear operating speed.

\( V_{NE} \) - Never-exceed speed, the speed that may not be exceeded at any time; redline.

\( V_{NO} \) - Maximum structural cruising speed, the speed that should not be exceeded except in smooth air and then only with caution; top of green arc.

\( V_{REF} \) - Reference speed for final approach, usually 1.3 times VSO.

\( V_S \) - Stall speed or minimum steady flight speed at which the airplane is controllable.

\( V_{S1} \) - Stall speed or minimum steady flight speed obtained in a specific configuration; bottom of the green arc.

\( V_{SO} \) - Stall speed or minimum steady flight speed at which the airplane is controllable in the landing configuration; bottom of white arc.

\( V_X \) - Best angle-of-climb speed, the airspeed that delivers the greatest gain of altitude in the shortest possible horizontal distance.

\( V_Y \) - Best rate-of-climb speed, the airspeed that delivers the greatest gain in altitude in the shortest possible time.

Know green V-speeds on AS Indicator!