



Aviation Merit Badge





1. a. Define “Aircraft”

- “a weight-carrying structure for navigation of the air that is supported either by its own buoyancy or by the dynamic action of the air against its surfaces.” – **Websters**
- “a device that is used or intended to be used for flight in the air.” - **FAA**



What types of Aircraft Can You Name?





1. a. Types of Aircraft

- Lighter-than-air
- Glider
- Airplane
- Rotorcraft
- Powered-lift

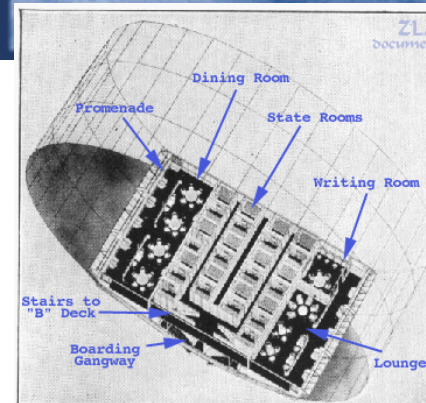
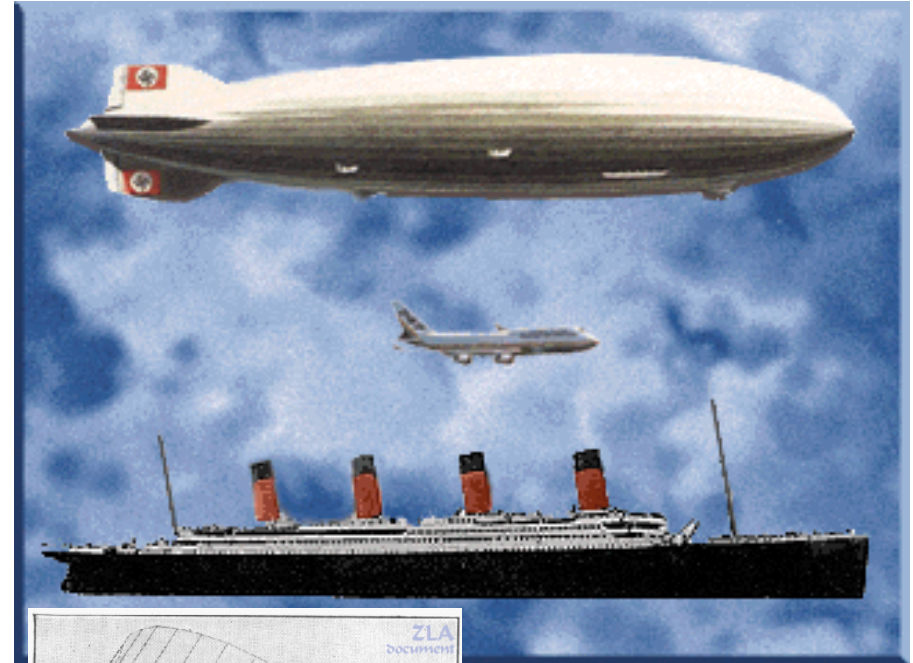


Lighter-than-Air

“Balloons and Airships”



The National Eagle Scout Association and Order of the Arrow hot air balloons at the 2001 National Boy Scout Jamboree



Graf Zeppelin compared to a Boeing 747 and the HMS Titanic

12. Anordnung der Fahrgasträume im Luftschiff LZ 120.

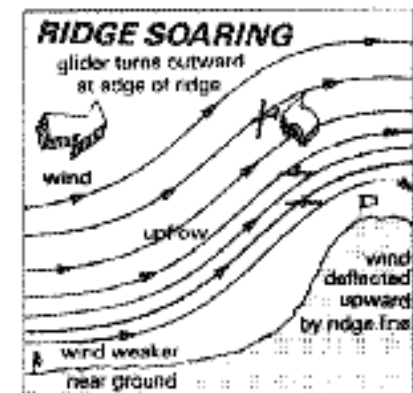
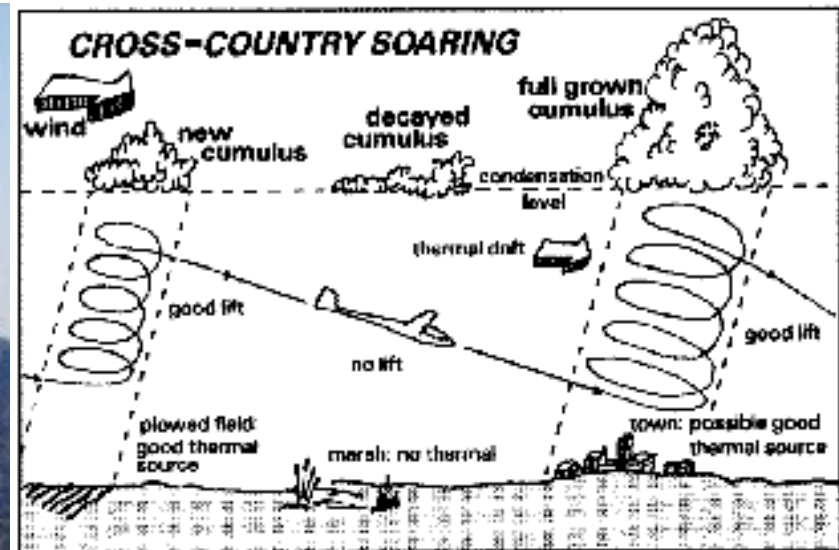


Glider

“Sailplanes”



Sailplane over Tennessee





Airplanes

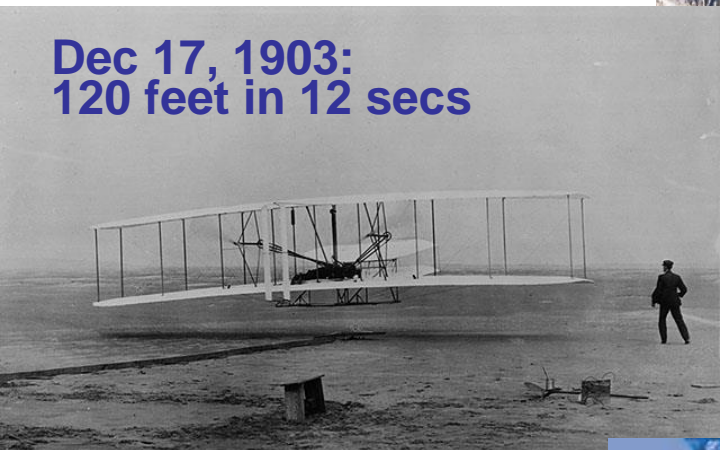
Predator, USAF



SR-71, USAF



Dec 17, 1903:
120 feet in 12 secs



Caravan Amphibian,
Cessna



Sky Hawk, Cessna



B-2, USAF





Rotorcraft

“Helicopters and Gyroplanes”



Gyrocopter



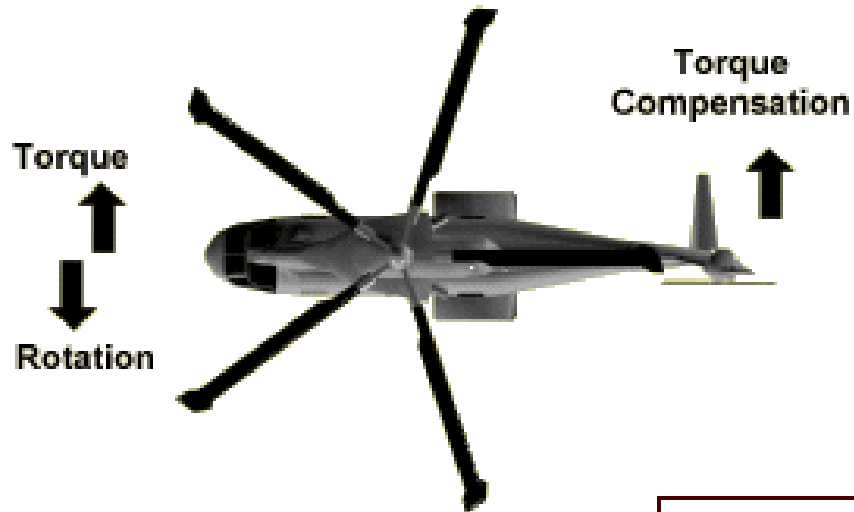
MH-53J, USAF



Gyroplane



How Helicopters Fly ??





Powered-Lift

“V-22”



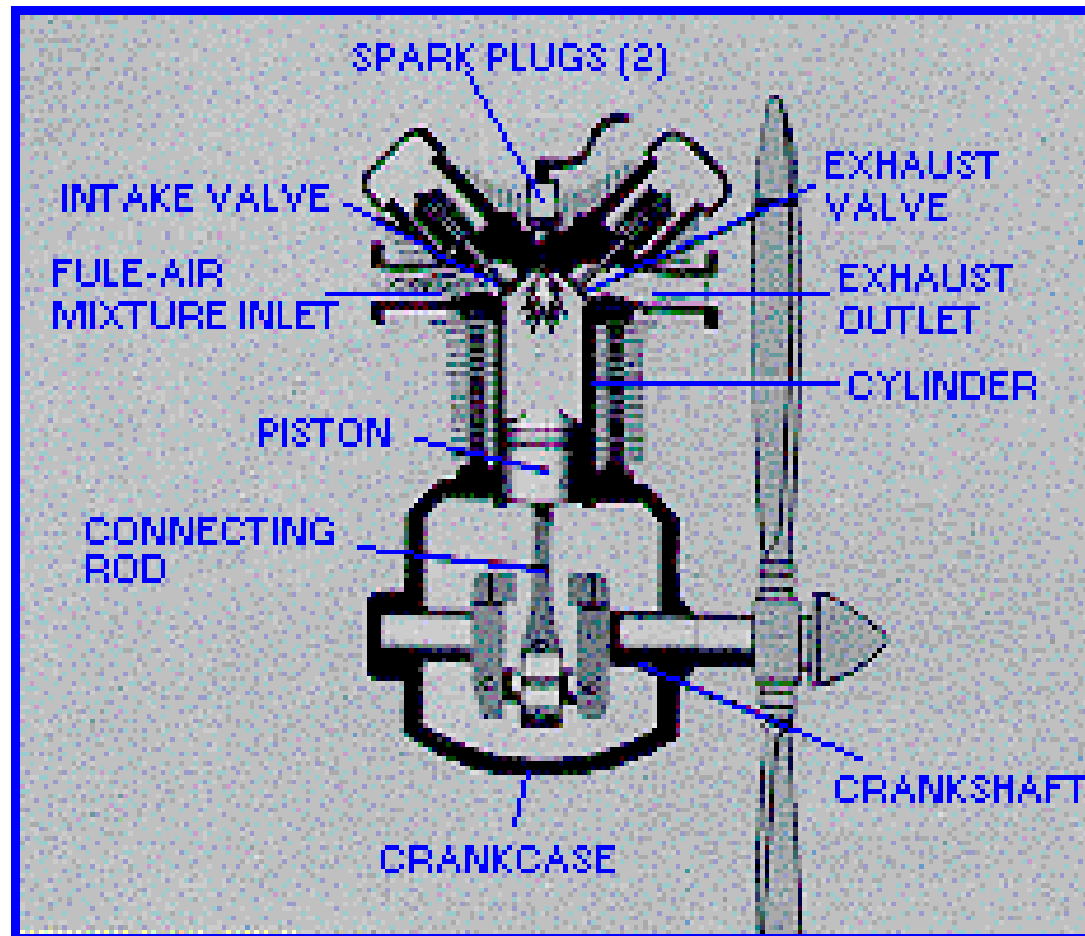


1.a. Engines

- Piston
- Turboprop
- Jet Engines



Piston Engine



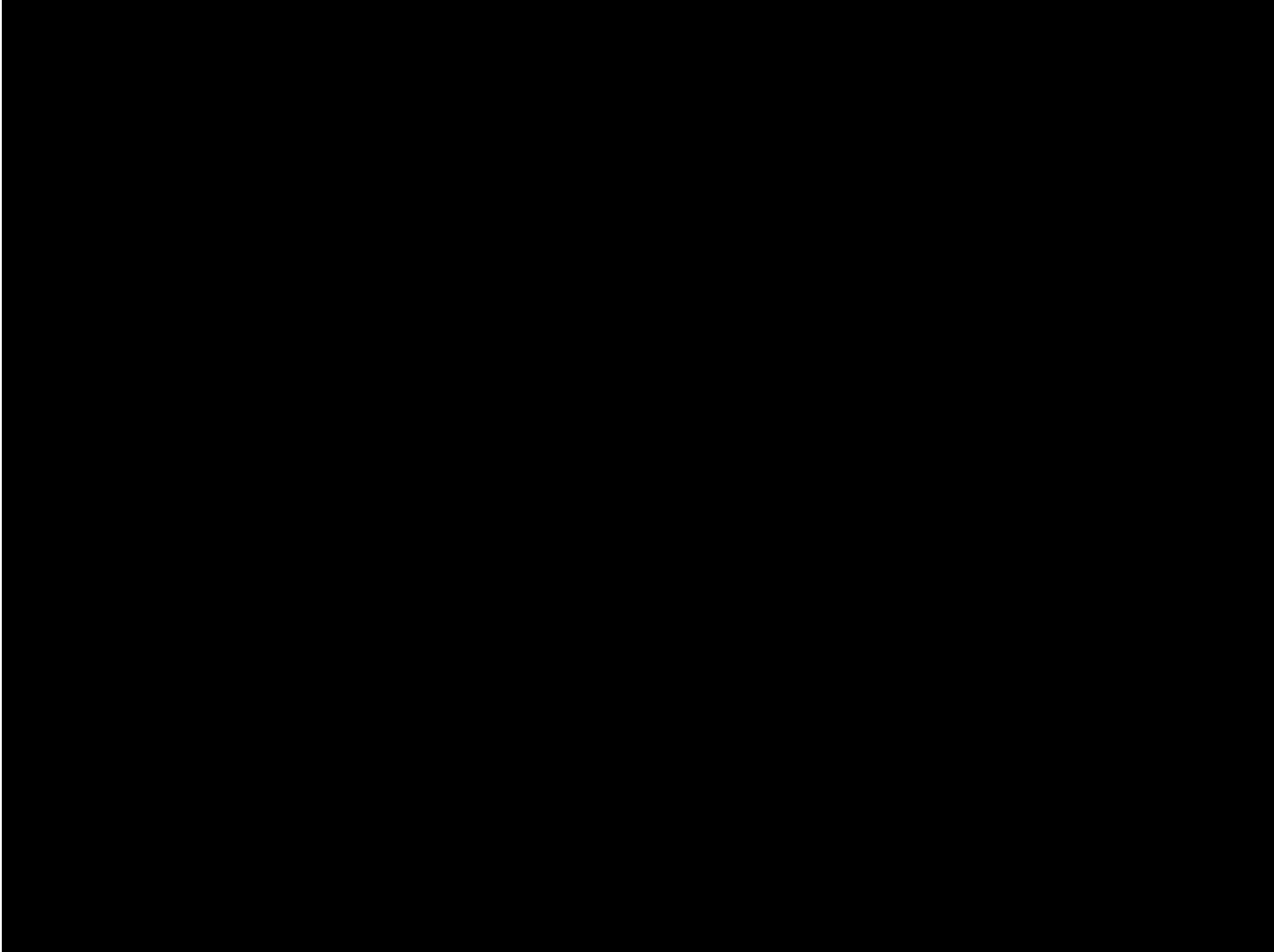


Piston Engine

- The piston engine is also referred to as a “reciprocating-engine” in an aircraft.
- Because the fuel mixture is burned within the engine the reciprocating engine is also known as an internal-combustion engine.
- Cars and Trucks use this type of engine.
- They are common in light aircraft.
- Limited to lower altitudes



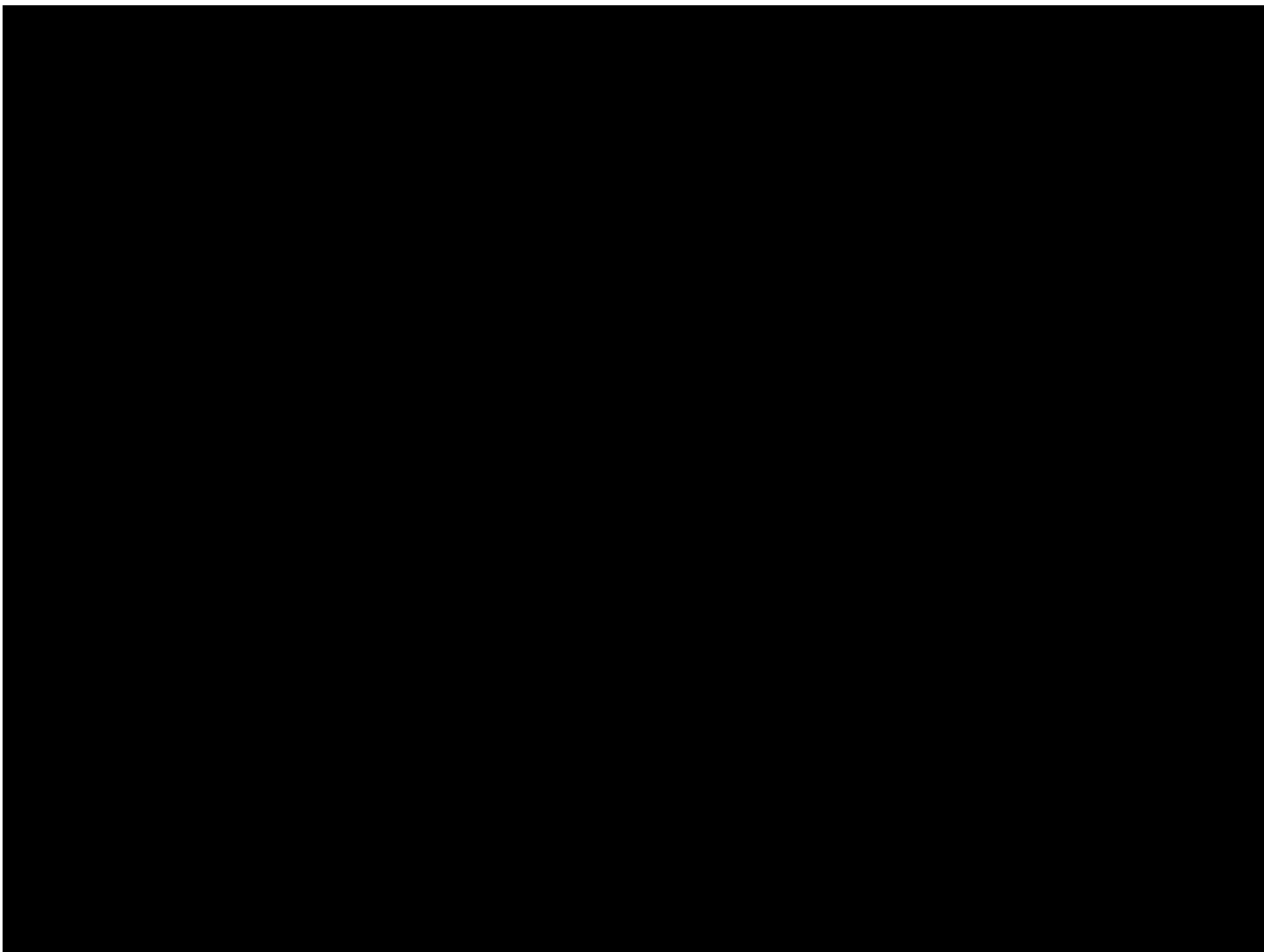
Piston Engine





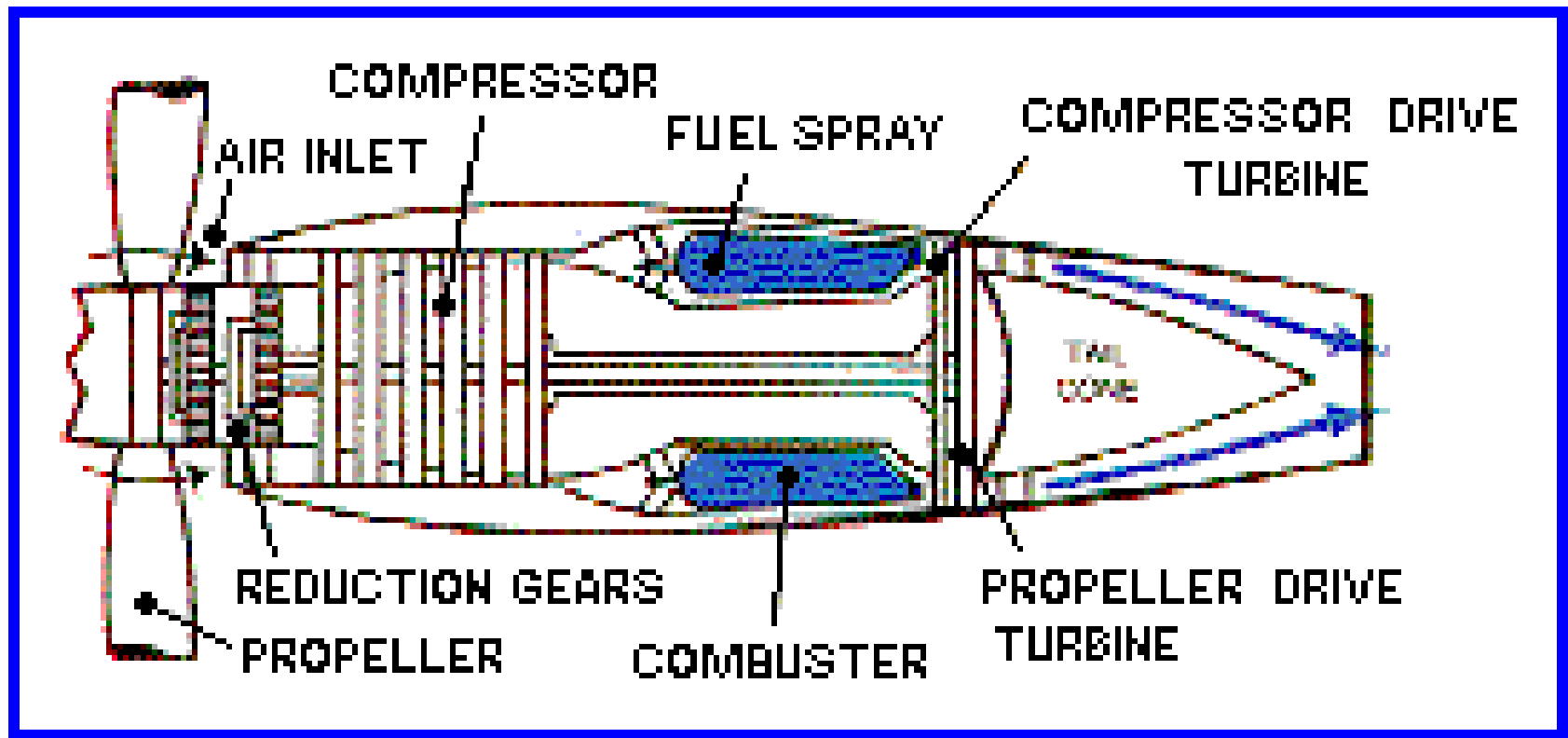
Turbine Engines

- Gas turbine engines have a great **power-to-weight ratio** compared to reciprocating engines. That is, the amount of power you get out of the engine compared to the weight of the engine itself is very good.
- Gas turbine engines are **smaller** than their reciprocating counterparts of the same power.
- The main disadvantage of gas turbines is that, compared to a reciprocating engine of the same size, they are **expensive**. Because they spin at such high speeds and because of the high operating temperatures, designing and manufacturing gas turbines is a tough problem from both the engineering and materials standpoint. Gas turbines also tend to use more fuel when they are idling, and they prefer a constant rather than a fluctuating load. That makes gas turbines great for things like transcontinental jet aircraft and power plants, but explains why you don't have one under the hood of your car.





Turboprop Engine





Jet Engine

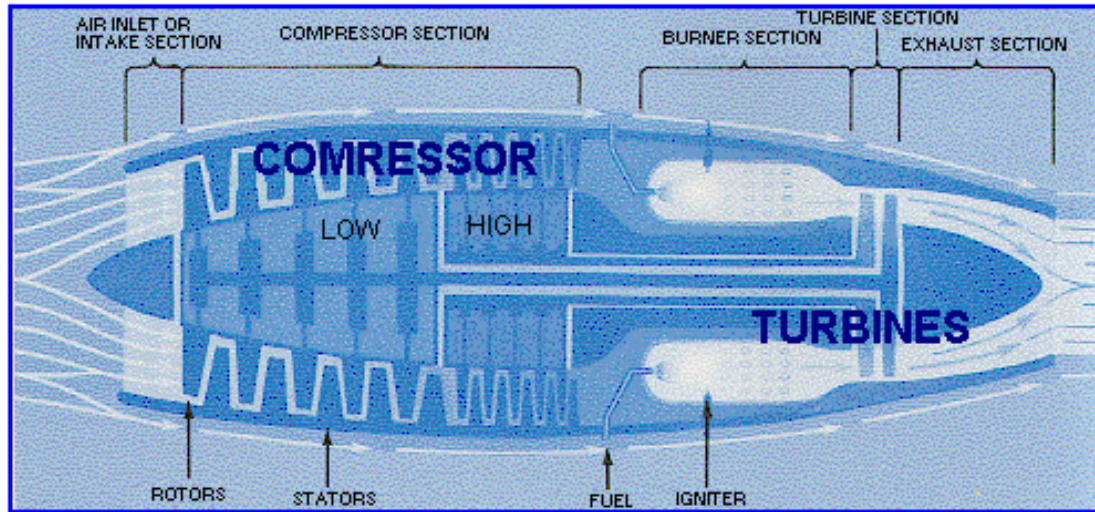


Figure 6-7 Simplified view of a turbojet engine.

Turbojet Engine

Turbofan Engine

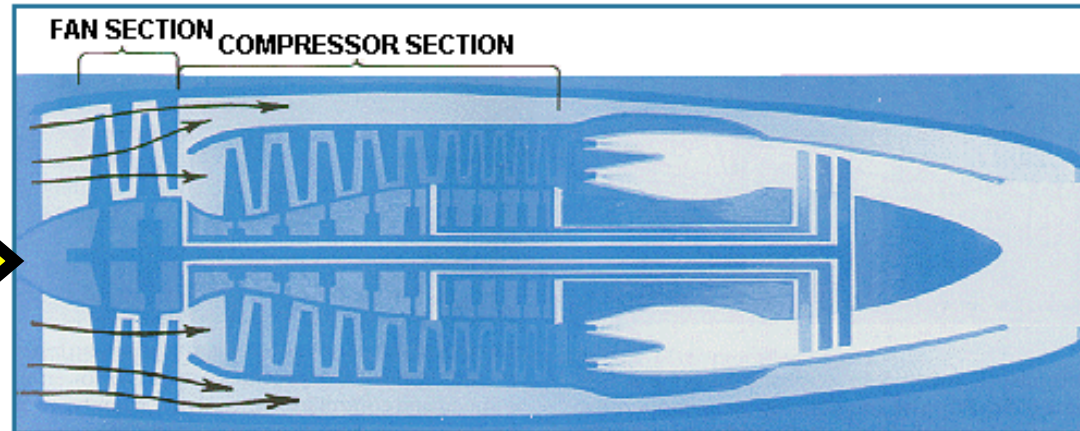
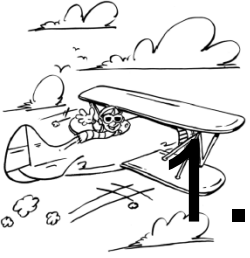


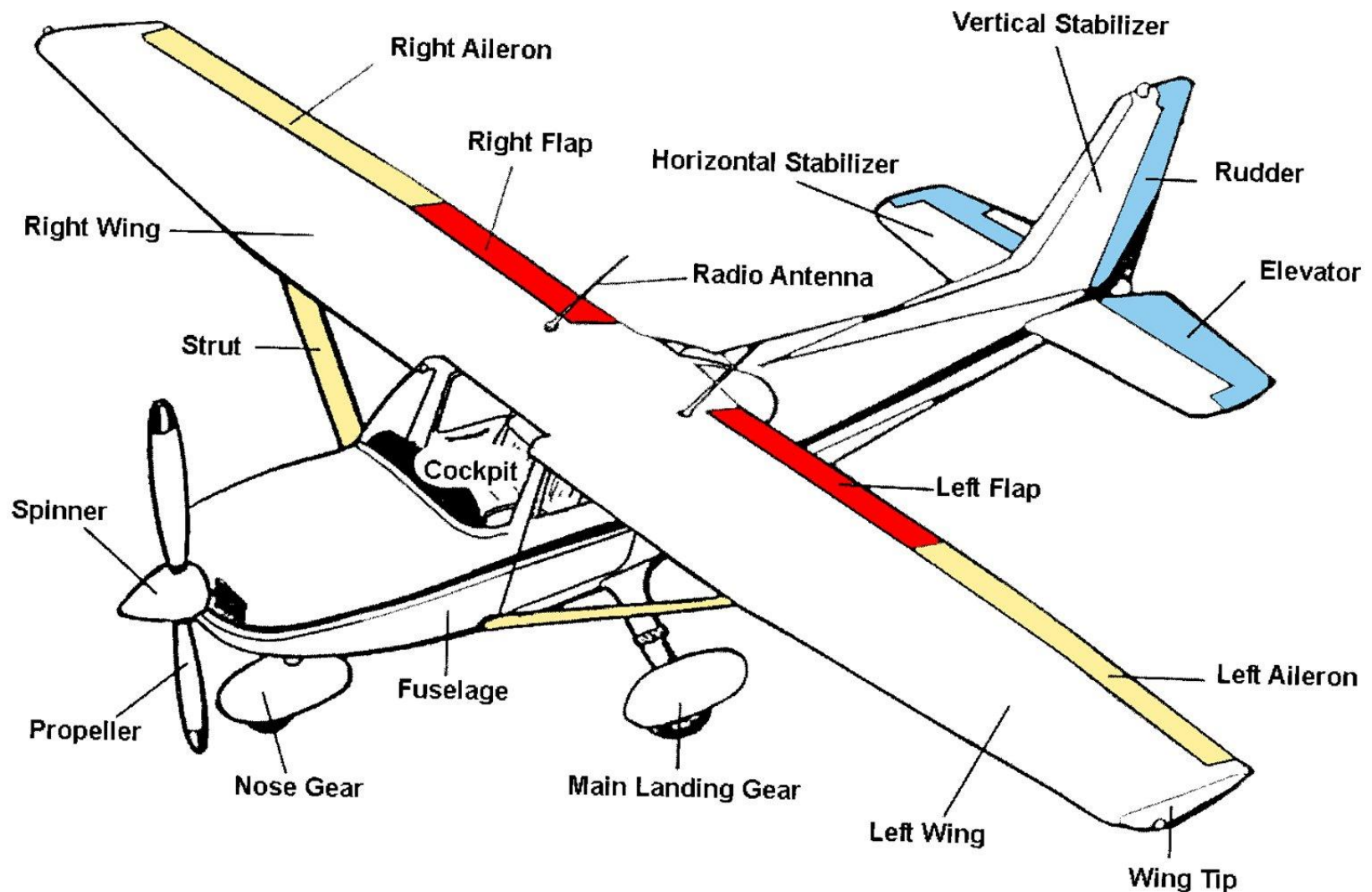
Figure 6-8 Turbofan engine.



1. b. Forces Acting on Airplane

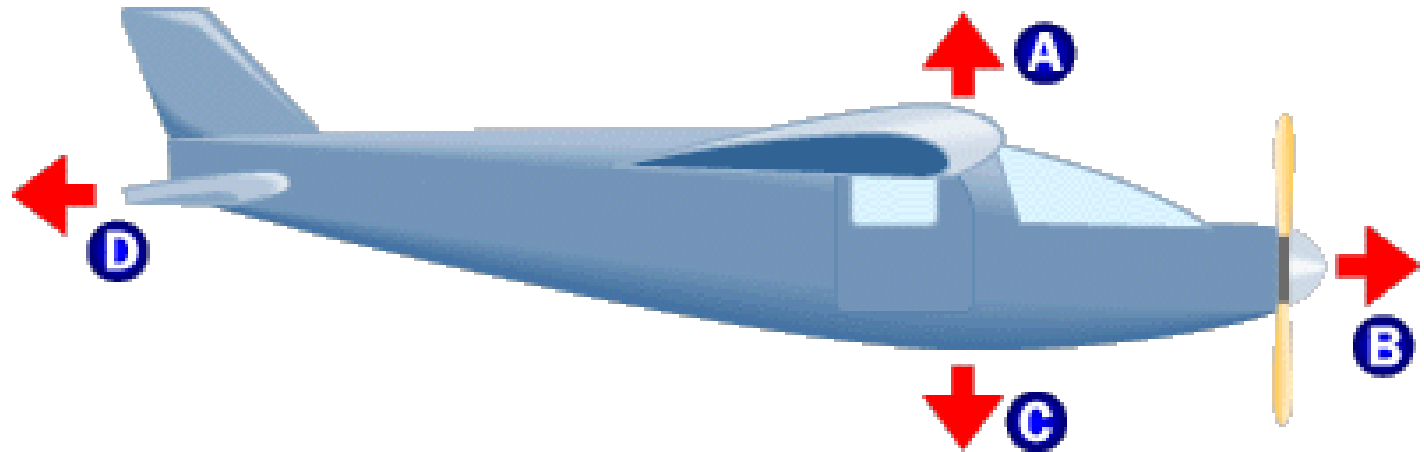


Parts of the Airplane





Forces Acting on Airplanes



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- A. Lift
- B. Thrust
- C. Weight
- D. Drag



Straight and Level Flight

- In order for an airplane to fly straight and level, the following relationships must be true:

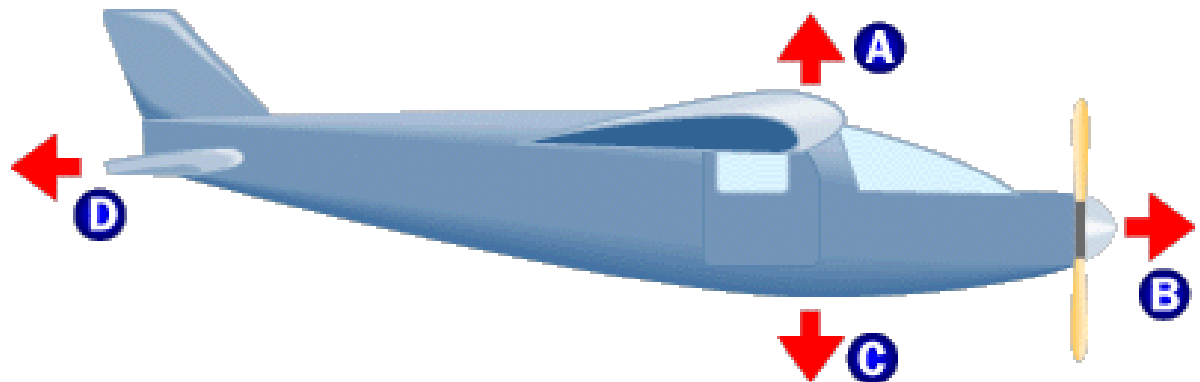
Thrust = Drag

Lift = Weight



Lift

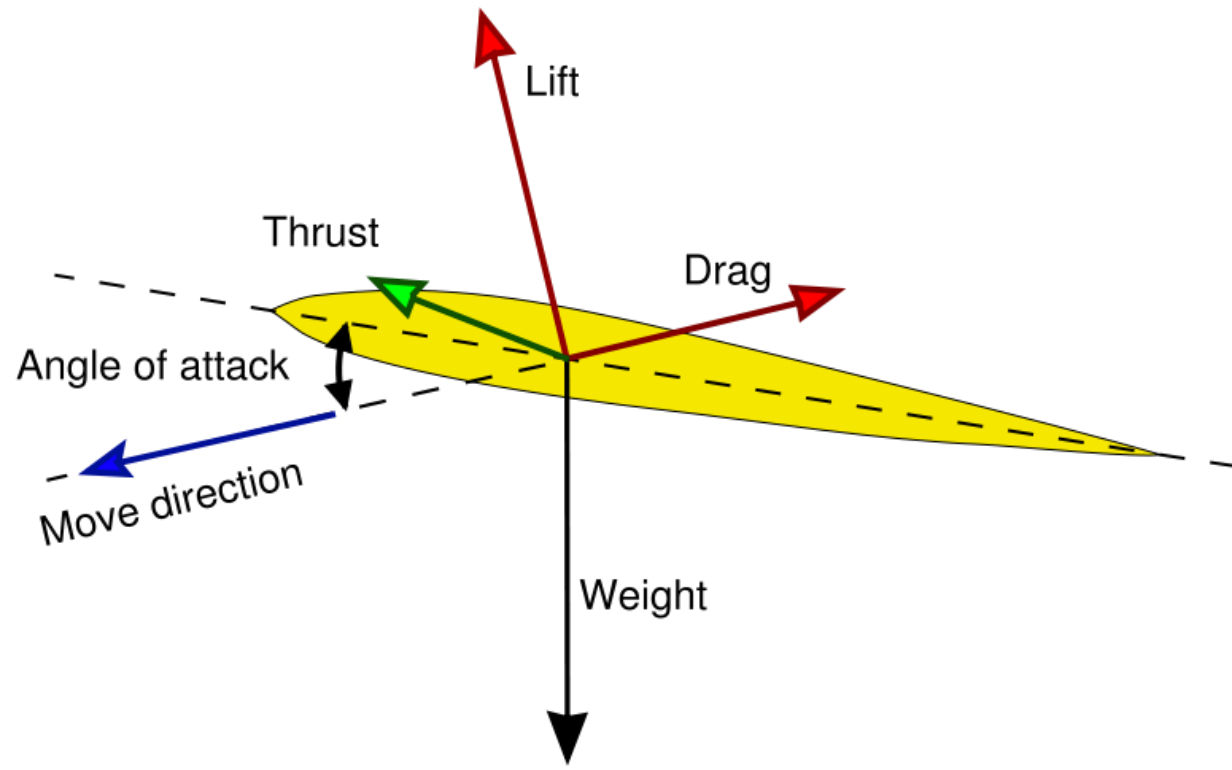
- Lift is the aerodynamic force that holds an airplane in the air.
- On airplanes, most of the lift required to keep the plane aloft is created by the wings (although some is created by other parts of the structure).





Lift

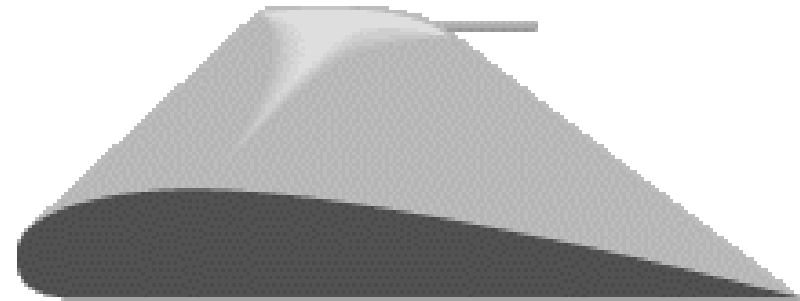
- Lift is created by:
 - The “Angle of Attack”
 - The wing moving through the air



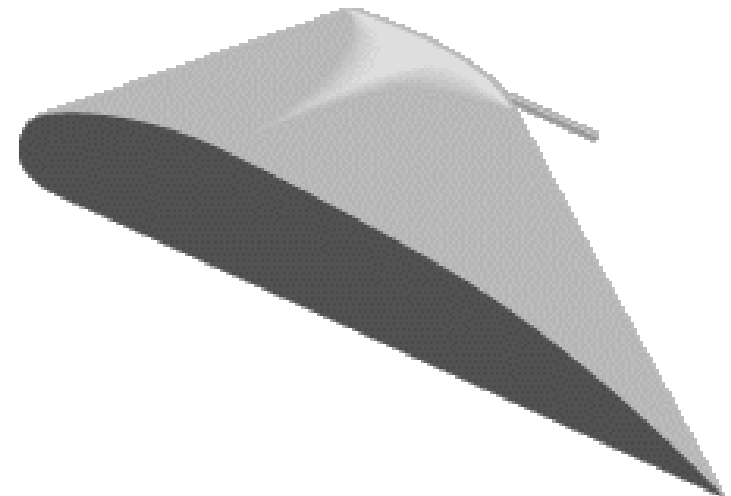


Angle of Attack

- The angle of attack is the angle that the wing presents to oncoming air
- Lift is created by the deflection of air downward.



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Bernoulli's Principle

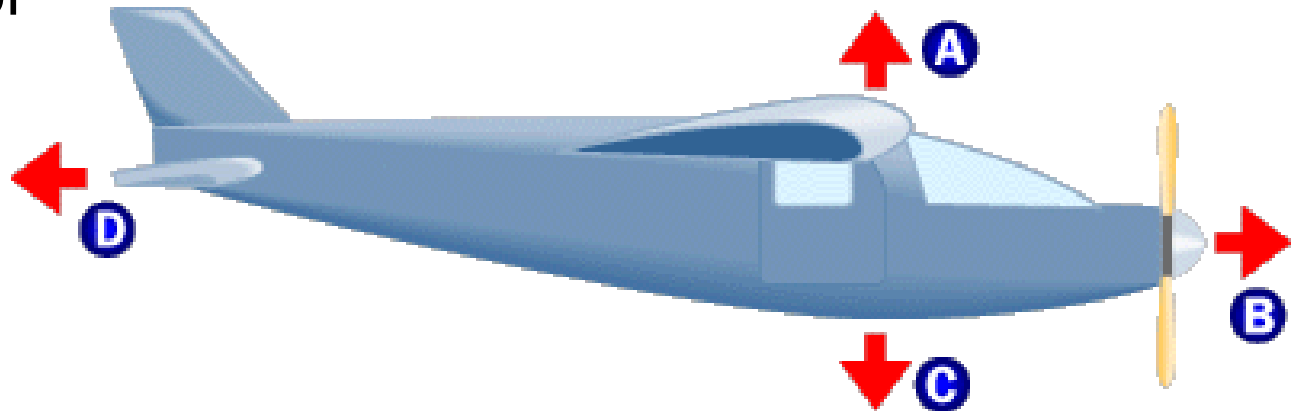
- Air traveling past a wing creates low pressure above the wing because the air moves faster over the wing
- The “higher” pressure below the wing creates an upward force on the wing.
- NOTE: This is not a simple process to describe and wing shape has little to do with lift.
- The propeller is a rotating wing and creates thrust the same way a wing creates lift.





Thrust

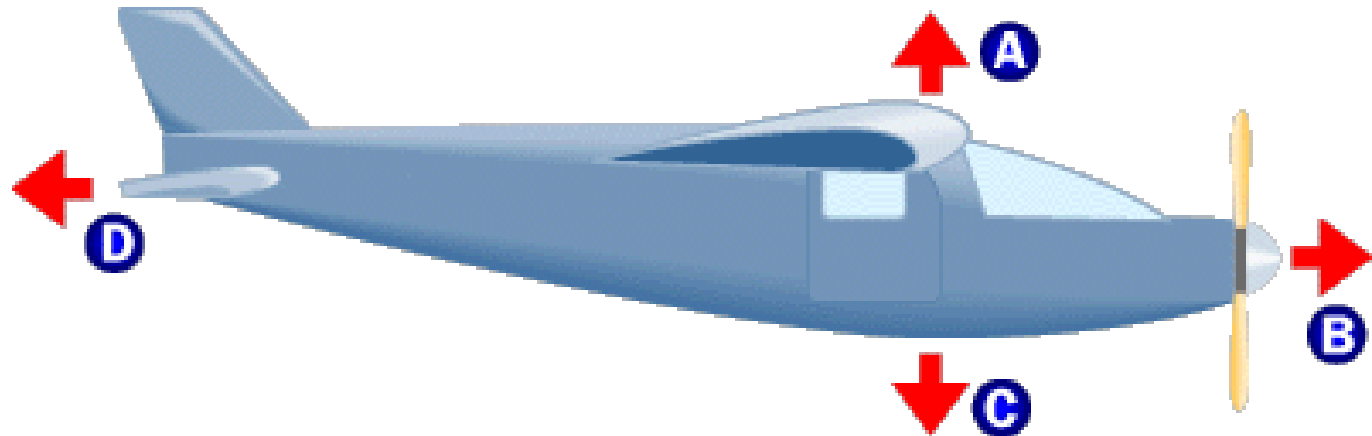
- Thrust is an aerodynamic force that must be created by an airplane in order to overcome the drag (notice that thrust and drag act in opposite directions in the figure above).
- Airplanes create thrust using
 - propellers,
 - jet engines or
 - rockets.





Weight

- Every object on earth has weight (including air). A 747 can weigh up to 870,000 pounds (that's 435 tons!) and still manage to get off the runway.
- Typical light airplanes weight 2000-10,000 pounds.





Drag

- Drag is an aerodynamic force that resists the motion of an object moving through a fluid (air and water are both fluids).
- Drag is related to speed. If the speed doubles the drag increases by 4 times.
- If you stick your hand out of a car window while moving, you will experience a very simple demonstration of this effect.
 - The amount of drag that your hand creates depends on a few factors, such as the size of your hand, the speed of the car and the density of the air.
 - If you were to slow down, you would notice that the drag on your hand would decrease.



1. c. Air Plane Control Surfaces

- Flaps
- Ailerons
- Elevators
- Rudder



Flaps

- Flaps are control surfaces near the wing root that change the shape of the wing.
- Flaps increase the lift at low speeds
- Flaps increase the drag of the aircraft.





Empennage

- The “empennage” is the tail section of the aircraft
- The parts of the empennage are the horizontal and vertical stabilizers



Horizontal Stabilizers

- The horizontal stabilizers control the “Attitude” or “pitch” of the aircraft.
- The “elevators” are the control surfaces that move when the pilot pulls back and forth on the yoke





Vertical Stabilizers

- The “rudder” is attached to the vertical stabilizer.
- The rudder is controlled by foot peddles
- The rudder is used to control the “yaw” of the aircraft.

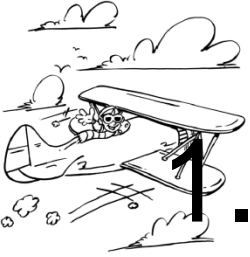




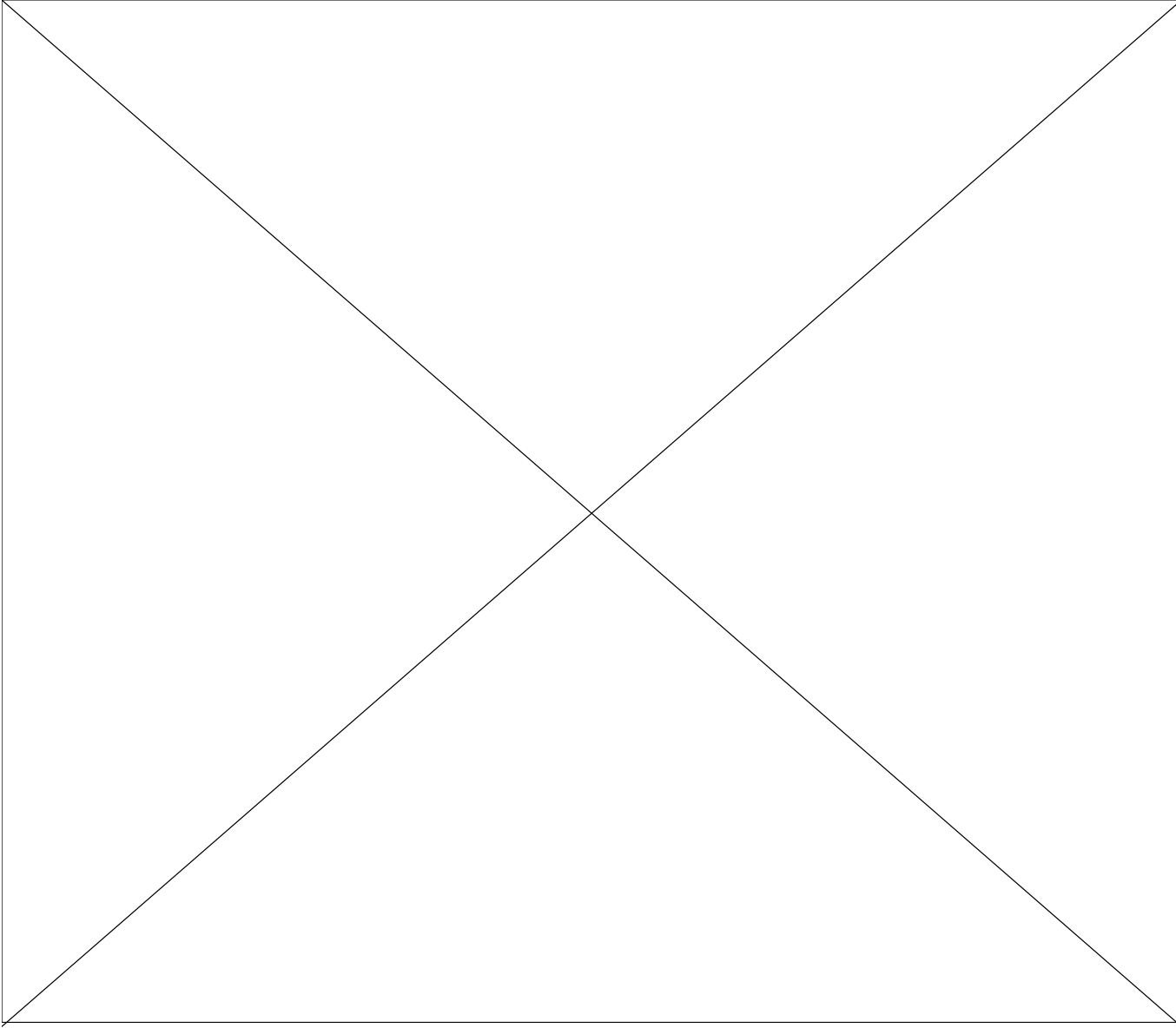
Ailerons

- On the outer ends of the wing, there are **ailerons** used to turn the plane and keep it level.
- Ailerons control the “roll” of the aircraft.





1. d. Airplane Control Surfaces





1. e. Pilot Certificates

- Light Sport
- Recreation
- Private
- Instrument Rating
- Commercial
- Airline Transport Pilot (ATP)



Light Sport

- To qualify for the Sport pilot certificate, an applicant must:^[9]
 - Be at least 17 years of age (16 for glider or balloon)
 - Be able to read, speak, write, and understand English
 - Log at least 20 hours of flight time of which at least
 - 15 hours must be dual instruction with a qualified flight instructor
 - 2 hours must be cross-country dual instruction
 - 5 hours must be solo flight
 - Fly one solo cross-country flight over a total distance of 75 or more nautical miles to two different destinations to a full-stop landing. At least one leg of this cross-country must be over a total distance of at least 25 nautical miles (46 km).
 - Have received 2 hours of dual instruction in the preceding 60 days, in preparation for the Practical Test
 - Pass a Knowledge (written) test
 - Pass a Practical (oral and flight) test
 - Have a valid US State drivers license or a current 3rd class or higher Airman Medical Certificate
 - The above requirements are for heavier-than-air powered aircraft (airplanes). The requirements for gliders, balloons, helicopters, and dirigibles vary slightly.
- Sport Pilots are only eligible to fly aircraft that are either certified specifically as light-sport aircraft (LSA) or were certified prior to the LSA regulations and are within the maximum weight and performance limitations of [light-sport aircraft](#).
- The restrictions placed on a Pilot exercising the privileges of a Sport pilot certificate are:
 - No more than one passenger
 - Daytime flight only ([civil twilight](#) is used to define day/night)
 - [Maximum Takeoff Weight](#) of 1320 lbs,^[10] compared to 12,500 lb (5,700 kg) of the [Private Pilot Certificate](#) or the [Recreational Pilot Certificate](#).
 - No flight above 10,000 feet (3,000 m) [MSL](#) or 2,000 feet (610 m) [AGL](#), whichever is higher (this automatically excludes flight in [Class A airspace](#))
 - No flight in any of the airspace classes that require radio communication ([B](#), [C](#), or [D](#)) without first obtaining additional instruction and instructor endorsement
- The Sport pilot certificate is also ineligible for additional ratings (such as an [Instrument rating](#)), although time in light-sport aircraft can be used towards the experience requirement of other ratings on higher certificate types.



Recreational

- Eligibility requirements:
 - Be at least 17 years old
 - Be able to read, speak, write and understand the English language
 - Pass a required knowledge test
 - Pass a required oral and practical flight test administered by a FAA designated examiner
 - Hold either a student or sport pilot certificate.^[12]
 - Meet the following experience requirements:
 - 30 hours of flight time (15 hours of flight training, 3 hours of solo time, 2 hours of cross country > 25NM)^[13]
- Limitations and restrictions:
 - May not carry more than one passenger
 - May not fly to an airport further than 50 nmi from the departure point without an instructor endorsement to the specific airport.
 - May not fly in Class B, C, D airspace or to any controlled airport without an instructor endorsement to the specific airport.
 - May not fly an aircraft that has more than four seats, more than one engine, more than 180HP, retractable landing gear or between sunset and sunrise.
 - If pilot has logged less than 400 hours and has not acted as pilot in command within 180 days, a flight review is required.
 - May not fly above 10,000 ft MSL or 2,000 ft AGL (whichever is higher)^[14]



Private

- The requirements to obtain a private pilot certificate for "airplane, single-engine, land", or [ASEL](#), (which is the most common certificate) are:^[15]
 - Be at least 17 years old (16 years old for glider or balloon rating)
 - Be able to read, speak, write and understand the English language
 - Obtain at least a third class medical certificate from an Aviation Medical Examiner (except for glider or balloon)
 - Pass a computerized aeronautical knowledge test
 - Accumulate and log a specified amount of training and experience, including the following:
 - If training under Part 61, Title 14 of the Code of Federal Regulations (CFR) section 61.109, requires at least 40 hours of flight time, including 20 hours of flight with an instructor and 10 hours of solo flight (i.e., by yourself), and other requirements including cross-country flight, which include
 - Solo requirements:
 - » 5 hours of solo cross-country time
 - » One solo cross-country flight of at least 150 nmi (280 km) total distance, with full-stop landings at a minimum of three points and with one segment of the flight consisting of a straight-line distance of at least 50 nmi (93 km) between the takeoff and landing locations
 - » Three solo takeoffs and landings to a full stop at an airport with an operating control tower.
 - Night requirements:
 - » 3 hours of night flight training
 - » One cross-country flight of over 100 nautical miles (190 km) total distance
 - » 10 takeoffs and 10 landings to a full stop (with each landing involving a flight in the traffic pattern) at an airport
 - 3 hours of flight training on the control and maneuvering solely by reference to instruments
 - 3 hours of flight training for cross country flights
 - 3 hours of flight training with an authorized instructor in preparation for the practical test, which must have been performed within the preceding 2 calendar months from the month of the test
 - If training under Part 141, at least 35 hours of piloting time including 20 hours with an instructor and 5 hours of solo flight, and other requirements including cross-country and night flights
 - Pass an oral test and flight test administered by an FAA inspector, FAA-designated examiner, or authorized check instructor



Instrument Rating

- **Required to fly under Instrument Flight Rules (IFR) – Limited Visibility**
- Accumulate flight experience per [FAR](#) 61.65:
 - The candidate must have at least 50 hours of cross-country flight time as pilot in command, which can include solo cross-country time as a student pilot. Each cross-country must have a landing at an [airport](#) that is at least a straight-line distance of more than 50 NM from the original departure point.
 - The candidate must make at least one cross-country flight that is performed under IFR and transits a distance of at least 250 NM along airways or ATC-directed routing and includes an [instrument approach](#) at each airport so that a total of three different kinds of instrument approaches are performed.
 - **The candidate also needs a total of 40 hours of actual or simulated instrument time**, including a minimum of 15 hours of instrument flight training from a Flight Instructor certified to teach the instrument rating ([CFII](#))
 - Up to 10 hours of the instrument training may be accomplished in an approved flight simulator or flight training device if the training was provided by an authorized instructor. (CFI)
 - In the 2 calendar months prior to the practical test, the candidate needs to log 3 hours of instrument training in an airplane that is appropriate to the instrument-airplane rating from a CFII in preparation for the test.
 - Receive and log training, as well as obtain a logbook endorsement from your CFII on the following areas of operation: preflight preparation, preflight procedures, air traffic control clearances and procedures, flight by reference to instruments, navigation systems, instrument approach procedures, emergency operations, and postflight procedures.
- Successfully complete the instrument rating practical test (an oral and flight test), as specified in Practical Test Standards (PTS) for the instrument rating, which will be conducted by an FAA designated examiner.



Commercial

- A commercial airplane pilot must be able to operate a complex airplane, as a specific number of hours of complex (or turbine-powered) aircraft time are among the prerequisites, and at least a portion of the practical examination is performed in a complex aircraft.
- The requirements are:
 - Be at least 18 years of age
 - Hold a private pilot certificate
 - Be able to read, speak, write, and understand the English language
 - Accumulate and log a specified amount of training and experience; the following are part of the airplane single-engine land class rating requirements:
 - If training under Part 61, at least 250 hours of piloting time including 20 hours of training with an instructor and 10 hours of solo flight, and other requirements including several "cross-country" flights, i.e. more than 50 nautical miles (93 km) from the departure airport (which include Day VFR and Night VFR 100 nmi (190 km) between points, with a time of at least 2hrs; also one cross country which is done solo 250 nmi (460 km) one way, 300 nmi (560 km) total distance with landings at 3 airports) and both solo and instructor-accompanied night flights
 - If training under Part 141, at least 190 hours of training time including 55 hours with an instructor and 10 hours of solo flight, and other requirements including several cross-country, solo, and night flights
 - Pass a 100-question aeronautical knowledge test
 - Pass an oral test and flight test administered by an FAA inspector, FAA-designated examiner, or authorized check instructor
- A commercial pilot can be paid for certain types of operation, such as banner towing, agricultural applications, and photography, and can be paid for instructing if he holds a flight instructor certificate (In the case of lighter-than-air, only a commercial pilot certificate is required to teach for that category). To fly for hire, the pilot must hold a second class medical certificate, which is valid for 12 months.



ATP

- An airline transport pilot is tested to the highest level of piloting ability. The certificate is a prerequisite for acting as a pilot-in-command (Captain) in scheduled airline operations.
- The minimum pilot experience is 1,500 hours of flight time (1200 for Helicopters), 500 hours of cross-country flight time, 100 hours of night flight time, and 75 hours instrument operations time (simulated or actual).
- Other requirements include being 23 years of age, an instrument rating, being able to read, write, speak, and understand the English language, a rigorous written examination, and being of good moral character.

