

1.1 Physical Properties of Air

- Air possesses several key physical properties that are fundamental to understanding flight:
- ☐ Mass: Air has mass, meaning it has substance and is affected by gravity.
- ☐ Compressibility: Air is a compressible fluid, able to flow or change its shape when subjected to even a minute pressure difference.
- ☐ Viscosity: Air's viscosity is its internal friction or resistance to flow. It is very low, meaning small forces can move air molecules relative to each other. For example, water flows more easily than honey because honey has a much higher viscosity.

1.2 Static Pressure (SP)

- Static pressure is the pressure exerted by the air when it is stationary or not moving.
- ☐ Definition and Unit: Static pressure is the result of the weight of the atmosphere pressing down on the air beneath it. Its unit is the
- Newton per meter square (N/m^2), also known as a Pascal (Pa). 100 Pascals equal
- Hectopascal.
- ☐ Formula: Static Pressure = Force / Area.
- ☐ Effect of Altitude: Static pressure exerts the same force per square meter on all surfaces of
- an aeroplane at a given altitude. The lower the altitude, the greater the force per square
- meter, as there is more atmosphere pressing down. Pressure falls steadily with increasing
- altitude.

1.3 Temperature

- Temperature is a measure of the kinetic energy of the molecules in the air.
- ☐ Units: The primary units are degrees Celsius ($^{\circ}\text{C}$), measured relative to the freezing point of
- water, and Kelvin (K), measured relative to absolute zero.
- $0^{\circ}\text{C} = 273^{\circ}\text{K}$.

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- ☐ Absolute Zero: This is the lowest possible temperature where no heat energy remains in a substance. As seen in the comparison diagram, absolute zero is
- 0°K , -273°C , and -459°F .
- ☐ Lapse Rate: In the ICAO Standard Atmosphere (ISA), temperature falls steadily with
- increasing altitude up to about 36,000 ft, after which it remains constant through the lower
- stratosphere.

1.4 Density (ρ)

- Density is the mass of air per unit of volume.
- ☐ Unit and Symbol: The unit is kilogram per cubic meter (kg/m^3). The symbol for density
- is the Greek letter
- ρ (rho).
- ☐ Relationship with Other Properties: Density varies with static pressure, temperature, and
- humidity. It is directly proportional to static pressure and inversely proportional to
- temperature and humidity.
- ☐ Effect of Altitude: Density decreases with increasing altitude primarily because of the
- decreasing static pressure.

1.5 Dynamic Pressure (q)

- Dynamic pressure is the kinetic energy (energy of motion) of the air per unit volume.
- ☐ Formula: The formula for dynamic pressure is:
- $q = \frac{1}{2} \rho v^2$
- Where:
- q = Dynamic Pressure
- ρ = Air Density
- v = True Air Speed (TAS)
- ☐ Total Pressure: The sum of static and dynamic pressures is known as Total Pressure or
- Pitot Pressure.

- Total Pressure = Static Pressure + Dynamic Pressure

1.6 Measuring Pressure and Airspeed

- ☐ Sensing Pressures: An aircraft's instruments measure these pressures to determine airspeed.
- A
- Static Vent, a hole parallel to the airflow, senses static pressure.
- A
- Pitot Tube, facing into the airflow, senses Total Pressure (Static + Dynamic).
- ☐ The Air Speed Indicator (ASI): The ASI is a pressure gauge that mechanically calculates the difference between Total Pressure and Static Pressure to find the Dynamic Pressure. The needle then indicates this dynamic pressure as airspeed. The instrument is calibrated to ISA density at sea level (1.225kg/m³).

1.7 Airspeed Relationships

- The speed displayed on the ASI is not the true speed through the air. Several corrections must be applied.
- 1. Indicated Air Speed (IAS): The speed read directly from the ASI.
- 2. Calibrated Air Speed (CAS): IAS corrected for position and pressure error.
- 3. Equivalent Air Speed (EAS): CAS corrected for compressibility error, which becomes significant at higher speeds and altitudes.
- 4. True Air Speed (TAS): EAS corrected for density error. This is the actual speed of the aircraft through the air. TAS is the true measure of velocity; all the other "speeds" are actually pressure measurements.
- 5. Ground Speed (GS): TAS corrected for the effect of wind.