

Atmosphere Model

The equations presented below can be used in lieu of values found in standard atmosphere tables. Note that if z_0 is mean sea level (MSL), then T_0 is 288.15 K and P_0 is 1.01325×10^5 Pascals or 1013.25 millibars (1 Pascal = 1 N/m²).

Temperature is modeled using a constant lapse rate up to 11 km. MSL.

$$T(z) = T_0 + L(z - z_0) \quad (1)$$

where L is the lapse rate, T_0 is the temperature in K at z_0 and z is the altitude. In equation (1)

$$L = -0.0065 \text{ K/m} \quad (\text{for } z < 11 \text{ km.}) \quad (2)$$

Atmospheric pressure is

$$P(z) = P_0 \left(\frac{T(z)}{T_0} \right)^{-\left(\frac{g}{LR}\right)} \quad (3)$$

where P_0 is the surface pressure, g is the acceleration due to gravity and R (287.05 J/kg-K) is the universal gas constant. The atmospheric density is

$$\rho(z) = \frac{P(z)}{RT(z)} \quad (4)$$

where pressure is in Pascals and density is in kg./m.³ .

The acoustic speed is

$$a(z) = \sqrt{\gamma RT(z)} \quad (5)$$

where γ is the adiabatic constant and is 1.4 for air. Mach number is the ratio of vehicle speed to acoustic speed

$$M = \frac{|\mathbf{v}|}{a(z)} \quad (6)$$

where $|\mathbf{v}|$ is the magnitude of the vehicle velocity, or speed.