Important Atmosphere and Gas Properties Formulas PDF

Formulas
Examples
with Units

List of 14
Important Atmosphere and Gas Properties Formulas

1) Absolute altitude Formula

Evaluate Formula

Formula

$$h_a = h_G + [\text{Earth-R}]$$

Example with Units

$$6.4\text{E+6}\,\text{m} = 28991\,\text{m} + 6371.0088\,\text{km}$$

2) Ambient air density given dynamic pressure Formula

Evaluate Formula

Formula

$$\rho = 2 \cdot \frac{q}{V^2}$$

Example with Units

$$1.25\,\text{kg/m}^3 = 2 \cdot \frac{10\,\text{Pa}}{4\,\text{m/s}^2}$$

3) Ambient air density given mach number Formula

Evaluate Formula

Formula

$$\rho = 2 \cdot \frac{q}{(M \cdot a)^2}$$

Example with Units

$$1.2345\,\text{kg/m}^3 = 2 \cdot \frac{10\,\text{Pa}}{(0.23 \cdot 17.5\,\text{m/s})^2}$$

4) Ambient Air Density given Mach Number and Temperature Formula

Evaluate Formula

Formula

$$\rho = \frac{2 \cdot q}{M^2 \cdot Y \cdot R \cdot T}$$

Example with Units

$$1.2266\,\text{kg/m}^3 = \frac{2 \cdot 10\,\text{Pa}}{0.23^2 \cdot 1.4 \cdot 4.1\,\text{J/(kg*K)} \cdot 53.7\,\text{K}}$$

5) Ambient Pressure given Dynamic Pressure and Mach Number Formula

Evaluate Formula

Formula

$$P_{static} = \frac{2 \cdot q}{Y \cdot M^2}$$

Example with Units

$$270.0513\,\text{Pa} = \frac{2 \cdot 10\,\text{Pa}}{1.4 \cdot 0.23^2}$$

6) Equivalent Airspeed given Static Pressure Formula

Evaluate Formula

Formula

$$EAS = a_o \cdot M \cdot \left(P_{static} \cdot \frac{6894.7573}{P_o} \right)^{0.5}$$

Example with Units

$$335.189\,\text{m/s} = 340\,\text{m/s} \cdot 0.23 \cdot \left(270\,\text{Pa} \cdot \frac{6894.7573}{101325\,\text{Pa}} \right)^{0.5}$$

7) Gas constant given dynamic pressure Formula

Evaluate Formula

Formula

$$R = \frac{2 \cdot q}{\rho \cdot M^2 \cdot Y \cdot T}$$

Example with Units

$$4.1052\,\text{J/(kg*K)} = \frac{2 \cdot 10\,\text{Pa}}{1.225\,\text{kg/m}^3 \cdot 0.23^2 \cdot 1.4 \cdot 53.7\,\text{K}}$$

8) Geometric altitude Formula

Evaluate Formula

Formula

$$h_G = h_a - [\text{Earth-R}]$$

Example with Units

$$28991.2\,\text{m} = 6.4\text{E}6\,\text{m} - 6371.0088\,\text{km}$$

9) Geometric altitude for given geopotential altitude Formula

Evaluate Formula

Formula

$$h_G = [\text{Earth-R}] \cdot \frac{h}{[\text{Earth-R}] - h}$$

Example with Units

$$28990.3185\,\text{m} = 6371.0088\,\text{km} \cdot \frac{28859\,\text{m}}{6371.0088\,\text{km} - 28859\,\text{m}}$$

10) Geopotential altitude Formula

Evaluate Formula

Formula

$$h = [\text{Earth-R}] \cdot \frac{h_G}{[\text{Earth-R}] + h_G}$$

Example with Units

$$28859.6753\,\text{m} = 6371.0088\,\text{km} \cdot \frac{28991\,\text{m}}{6371.0088\,\text{km} + 28991\,\text{m}}$$

11) Lapse rate Formula

Evaluate Formula

Formula

$$\lambda = \frac{\Delta T}{\Delta h}$$

Example with Units

$$0.7\,\text{K/m} = \frac{3.5\,\text{K}}{5\,\text{m}}$$

12) Mach Number given Dynamic Pressure Formula

Evaluate Formula

Formula

$$M = \sqrt{\frac{2 \cdot q}{\rho \cdot Y \cdot R \cdot T}}$$

Example with Units

$$0.2301 = \sqrt{\frac{2 \cdot 10\,\text{Pa}}{1.225\,\text{kg/m}^3 \cdot 1.4 \cdot 4.1\,\text{J/(kg*K)} \cdot 53.7\,\text{K}}}$$

13) Mach Number given Static and Dynamic Pressure Formula

Evaluate Formula

Formula

$$M = \sqrt{\frac{2 \cdot q}{P_{static} \cdot Y}}$$

Example with Units

$$0.23 = \sqrt{\frac{2 \cdot 10\,\text{Pa}}{270\,\text{Pa} \cdot 1.4}}$$

14) Temperature given Dynamic Pressure and Mach Number Formula

Evaluate Formula

Formula

$$T = \frac{2 \cdot q}{\rho \cdot M^2 \cdot R \cdot Y}$$

Example with Units

$$53.7683\,\text{K} = \frac{2 \cdot 10\,\text{Pa}}{1.225\,\text{kg/m}^3 \cdot 0.23^2 \cdot 4.1\,\text{J/(kg*K)} \cdot 1.4}$$

Variables used in list of Atmosphere and Gas Properties Formulas above

- ΔT Change in Temperature *(Kelvin)*
- **a** Sonic Speed *(Meter per Second)*
- a_o Sonic Speed at Sea Level *(Meter per Second)*
- **EAS** Equivalent Airspeed *(Meter per Second)*
- **h** Geopotential altitude *(Meter)*
- h_a Absolute Altitude *(Meter)*
- h_G Geometric Altitude *(Meter)*
- **M** Mach Number
- P_o Static Sea Level Pressure *(Pascal)*
- P_{static} Static Pressure *(Pascal)*
- **q** Dynamic Pressure *(Pascal)*
- **R** Specific Gas Constant *(Joule per Kilogram per K)*
- **T** Static Temperature *(Kelvin)*
- **V** Flight Speed *(Meter per Second)*
- **Y** Heat Capacity Ratio
- **Δh** Altitude difference *(Meter)*
- **λ** Lapse Rate *(Kelvin Per Meter)*
- **ρ** Ambient Air Density *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used in list of Atmosphere and Gas Properties Formulas above

- constant(s): **[Earth-R]**, 6371.0088
  Earth mean radius
- Functions: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Temperature Difference** in Kelvin (K)
  Temperature Difference Unit Conversion
- Measurement: **Specific Heat Capacity** in Joule per Kilogram per K (J/(kg*K))
  Specific Heat Capacity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Temperature Gradient** in Kelvin Per Meter (K/m)
  Temperature Gradient Unit Conversion

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