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Atmosphere and Gas Properties Formulas

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List of 14 Atmosphere and Gas Properties Formulas

Atmosphere and Gas Properties

1) Absolute altitude

Open Calculator

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

ex $6.4\text{E}\hat{}6\text{m} = 28991\text{m} + [\text{Earth-R}]$

2) Ambient air density given dynamic pressure

Open Calculator

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

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

3) Ambient air density given mach number

Open Calculator

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

ex $1.23452\text{kg/m}^3 = 2 \cdot \frac{10\text{Pa}}{(0.23 \cdot 17.5\text{m/s})^2}$

4) Ambient Air Density given Mach Number and Temperature

Open Calculator

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

ex $$1.226558\text{kg/m}^3 = \frac{2 \cdot 10\text{Pa}}{(0.23)^2 \cdot 1.4 \cdot 4.1\text{J/(kg*K)} \cdot 53.7\text{K}}$$

5) Ambient Pressure given Dynamic Pressure and Mach Number

Open Calculator

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

ex $$270.0513\text{Pa} = \frac{2 \cdot 10\text{Pa}}{1.4 \cdot (0.23)^2}$$

6) Equivalent Airspeed given Static Pressure

Open Calculator

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

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

7) Gas constant given dynamic pressure

Open Calculator

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

ex $$4.105215\text{J/(kg*K)} = \frac{2 \cdot 10\text{Pa}}{1.225\text{kg/m}^3 \cdot (0.23)^2 \cdot 1.4 \cdot 53.7\text{K}}$$

8) Geometric altitude

Open Calculator

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

ex $$28991.2\text{m} = 6.4\text{E6m} - [\text{Earth-R}]$$

9) Geometric altitude for given geopotential altitude

Open Calculator

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

ex $$28990.32\text{m} = [\text{Earth-R}] \cdot \frac{28859\text{m}}{[\text{Earth-R}] - 28859\text{m}}$$

10) Geopotential altitude

Open Calculator

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

ex $$28859.68\text{m} = [\text{Earth-R}] \cdot \frac{28991\text{m}}{[\text{Earth-R}] + 28991\text{m}}$$

11) Lapse rate

Open Calculator

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

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

12) Mach Number given Dynamic Pressure

Open Calculator

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

ex $$0.230146 = \sqrt{\frac{2 \cdot 10\text{Pa}}{1.225\text{kg/m}^3 \cdot 1.4 \cdot 4.1\text{J/(kg*K)} \cdot 53.7\text{K}}}$$

13) Mach Number given Static and Dynamic Pressure

Open Calculator

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

ex $$0.230022 = \sqrt{\frac{2 \cdot 10\text{Pa}}{270\text{Pa} \cdot 1.4}}$$

14) Temperature given Dynamic Pressure and Mach Number

Open Calculator

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

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

Variables Used

- 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

- Constant: **[Earth-R]**, 6371.0088
  Earth mean radius
- Function: **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

Check other formula lists

- **Atmosphere and Gas Properties Formulas**

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