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Preliminary Aerodynamics Formulas

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List of 17 Preliminary Aerodynamics Formulas

Preliminary Aerodynamics

1) Aerodynamic Force

Open Calculator

fx $F_R = F_D + F_L$

ex $100.5\text{N} = 80.05\text{N} + 20.45\text{N}$

2) Dynamic pressure aircraft

Open Calculator

fx $q = \frac{1}{2} \cdot \rho \cdot V_{fs}^2$

ex $70.5189\text{Pa} = \frac{1}{2} \cdot 1.225\text{kg/m}^3 \cdot (10.73\text{m/s})^2$

3) Dynamic Pressure given Drag Coefficient

Open Calculator

fx $q = \frac{F_D}{C_D}$

ex $70.59083\text{Pa} = \frac{80.05\text{N}}{1.134}$

4) Dynamic Pressure given Gas Constant

Open Calculator

fx $q = \frac{1}{2} \cdot \rho \cdot M_r^2 \cdot cp \cdot R \cdot T$

ex $70.51347\text{Pa} = \frac{1}{2} \cdot 1.225\text{kg/m}^3 \cdot (7.67)^2 \cdot 0.003\text{J/(kg*K)} \cdot 4.1\text{J/(kg*K)} \cdot 159.1\text{K}$

5) Dynamic Pressure given Induced Drag

Open Calculator

$$q = \frac{F_L^2}{\pi \cdot D_i \cdot b_W^2}$$

$$70.54406\text{Pa} = \frac{(20.45\text{N})^2}{\pi \cdot 1.2\text{N} \cdot (1.254\text{m})^2}$$

6) Dynamic Pressure given Lift Coefficient

Open Calculator

$$q = \frac{F_L}{C_L}$$

$$70.51724\text{Pa} = \frac{20.45\text{N}}{0.29}$$

7) Dynamic Pressure given Mach Number

Open Calculator

$$q = \frac{1}{2} \cdot \rho \cdot (M_r \cdot a)^2$$

$$70.52324\text{Pa} = \frac{1}{2} \cdot 1.225\text{kg/m}^3 \cdot (7.67 \cdot 1.399\text{m/s})^2$$

8) Dynamic Pressure given Normal Pressure

Open Calculator

$$q = \frac{1}{2} \cdot cp \cdot p \cdot M_r^2$$

$$70.59468\text{Pa} = \frac{1}{2} \cdot 0.003\text{J/(kg*K)} \cdot 800\text{Pa} \cdot (7.67)^2$$

9) Flight Speed given Dynamic Pressure

Open Calculator

fx $$V_{fs} = \sqrt{\frac{2 \cdot q}{\rho}}$$

ex $$10.72856\text{m/s} = \sqrt{\frac{2 \cdot 70.5\text{Pa}}{1.225\text{kg/m}^3}}$$

10) Mach Number of Moving Object

Open Calculator

fx $$M_r = \frac{v}{c}$$

ex $$7.6793 = \frac{2634\text{m/s}}{343\text{m/s}}$$

11) Mach Number-2

Open Calculator

fx $$M = \sqrt{\left(\frac{((Y-1) \cdot M_r^2 + 2)}{2 \cdot Y \cdot M_r^2 - (Y-1)}\right)}$$

ex $$0.394178 = \sqrt{\left(\frac{\left((1.4-1) \cdot (7.67)^2 + 2\right)}{2 \cdot 1.4 \cdot (7.67)^2 - (1.4-1)}\right)}$$

12) Power required at Altitude

Open Calculator

$$P_{R,alt} = \sqrt{\frac{2 \cdot W_{body}^3 \cdot C_D^2}{\rho_0 \cdot S \cdot C_L^3}}$$

$$700.0602\text{W} = \sqrt{\frac{2 \cdot (750\text{N})^3 \cdot (1.134)^2}{997\text{kg/m}^3 \cdot 91.05\text{m}^2 \cdot (0.29)^3}}$$

13) Power required at Altitude given Power at sea-level

Open Calculator

$$P_{R,alt} = P_{R,0} \cdot \sqrt{\frac{[\text{Std-Air-Density-Sea}]}{\rho_0}}$$

$$700.0894\text{W} = 19940\text{W} \cdot \sqrt{\frac{[\text{Std-Air-Density-Sea}]}{997\text{kg/m}^3}}$$

14) Power required at sea-level conditions

Open Calculator

$$P_{R,0} = \sqrt{\frac{2 \cdot W_{body}^3 \cdot C_D^2}{[\text{Std-Air-Density-Sea}] \cdot S \cdot C_L^3}}$$

$$19939.17\text{W} = \sqrt{\frac{2 \cdot (750\text{N})^3 \cdot (1.134)^2}{[\text{Std-Air-Density-Sea}] \cdot 91.05\text{m}^2 \cdot (0.29)^3}}$$

15) Velocity at Altitude

Open Calculator

$$V_{alt} = \sqrt{2 \cdot \frac{W_{body}}{\rho_0 \cdot S \cdot C_L}}$$

$$0.238704\text{m/s} = \sqrt{2 \cdot \frac{750\text{N}}{997\text{kg/m}^3 \cdot 91.05\text{m}^2 \cdot 0.29}}$$

16) Velocity at Altitude given Velocity at Sea-Level

Open Calculator

$$V_{alt} = V_0 \cdot \sqrt{\frac{[\text{Std-Air-Density-Sea}]}{\rho_0}}$$

$$0.235236\text{m/s} = 6.7\text{m/s} \cdot \sqrt{\frac{[\text{Std-Air-Density-Sea}]}{997\text{kg/m}^3}}$$

17) Velocity at Sea-Level given Lift Coefficient

Open Calculator

$$V_0 = \sqrt{\frac{2 \cdot W_{body}}{[\text{Std-Air-Density-Sea}] \cdot S \cdot C_L}}$$

$$6.798776\text{m/s} = \sqrt{\frac{2 \cdot 750\text{N}}{[\text{Std-Air-Density-Sea}] \cdot 91.05\text{m}^2 \cdot 0.29}}$$

Variables Used

- **a** Sonic Speed *(Meter per Second)*
- **b_W** Lateral Plane Span *(Meter)*
- **c** Speed of Sound *(Meter per Second)*
- **C_D** Drag Coefficient
- **C_L** Lift Coefficient
- **cp** Specific Heat of Air *(Joule per Kilogram per K)*
- **D_i** Induced Drag *(Newton)*
- **F_D** Drag Force *(Newton)*
- **F_L** Lift Force *(Newton)*
- **F_R** Aerodynamic Force *(Newton)*
- **M** Mach Number 2
- **M_r** Mach Number
- **p** Pressure *(Pascal)*
- **$P_{R,0}$** Power Required at Sea-level *(Watt)*
- **$P_{R,alt}$** Power Required at Altitude *(Watt)*
- **q** Dynamic Pressure *(Pascal)*
- **R** Gas Constant *(Joule per Kilogram per K)*
- **S** Reference Area *(Square Meter)*
- **T** Temperature *(Kelvin)*
- **v** Velocity *(Meter per Second)*
- **V_0** Velocity at Sea-Level *(Meter per Second)*
- **V_{alt}** Velocity at an Altitude *(Meter per Second)*
- **V_{fs}** Flight Speed *(Meter per Second)*
- **W_{body}** Weight of Body *(Newton)*

- **Y** Heat Capacity Ratio
- **ρ** Ambient Air Density *(Kilogram per Cubic Meter)*
- **ρ_0** Density *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[Std-Air-Density-Sea]**, 1.229
  Standard air density at sea-level conditions
- 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: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Force** in Newton (N)
  Force 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

Check other formula lists

- **Aircraft Dynamics Nomenclature Formulas**
- **Atmosphere and Gas Properties Formulas**
- **Lift and Drag Polar Formulas**
- **Preliminary Aerodynamics Formulas**

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