Important Climbing Flight Formulas PDF

Formulas
Examples
with Units

List of 16
Important Climbing Flight Formulas

1) Centrifugal Force in Accelerated Flight Formula

Evaluate Formula

Formula

$$F_c = F_L + T \cdot \sin\left(\sigma_T\right) - m \cdot [g] \cdot \cos\left(\gamma\right)$$

Example with Units

$$28.0393\,\text{N} = 200\,\text{N} + 700\,\text{N} \cdot \sin\left(0.034\,\text{rad}\right) - 20\,\text{kg} \cdot 9.8066\,\text{m/s}^2 \cdot \cos\left(0.062\,\text{rad}\right)$$

2) Drag in Accelerated Flight Formula

Evaluate Formula

Formula

$$F_D = T \cdot \cos\left(\sigma_T\right) - m \cdot [g] \cdot \sin\left(\gamma\right) - m \cdot a$$

Example with Units

$$80.043\,\text{N} = 700\,\text{N} \cdot \cos\left(0.034\,\text{rad}\right) - 20\,\text{kg} \cdot 9.8066\,\text{m/s}^2 \cdot \sin\left(0.062\,\text{rad}\right) - 20\,\text{kg} \cdot 30.37\,\text{m/s}^2$$

3) Excess power Formula

Evaluate Formula

Formula

$$P_{excess} = v \cdot \left(T - F_D\right)$$

Example with Units

$$37197.6\,\text{W} = 60\,\text{m/s} \cdot \left(700\,\text{N} - 80.04\,\text{N}\right)$$

4) Excess power for given rate of climb Formula

Evaluate Formula

Formula

$$P_{excess} = RC \cdot W$$

Example with Units

$$37197.6\,\text{W} = 3.71976\,\text{m/s} \cdot 10000\,\text{N}$$

5) Flight path angle at given rate of climb Formula

Evaluate Formula

Formula

$$\gamma = a\sin\left(\frac{RC}{v}\right)$$

Example with Units

$$0.062\,\text{rad} = a\sin\left(\frac{3.71976\,\text{m/s}}{60\,\text{m/s}}\right)$$

6) Lift in Accelerated Flight Formula

Evaluate Formula

Formula

$$F_L = m \cdot [g] \cdot \cos(\gamma) + m \cdot \frac{v^2}{R_{curvature}} - T \cdot \sin(\sigma_T)$$

Example with Units

$$199.653\,\text{N} = 20\,\text{kg} \cdot 9.8066\,\text{m/s}^2 \cdot \cos(0.062\,\text{rad}) + 20\,\text{kg} \cdot \frac{60\,\text{m/s}^2}{2600\,\text{m}} - 700\,\text{N} \cdot \sin(0.034\,\text{rad})$$

7) Rate of Climb Formula

Evaluate Formula

Formula

$$RC = v \cdot \sin(\gamma)$$

Example with Units

$$3.7176\,\text{m/s} = 60\,\text{m/s} \cdot \sin(0.062\,\text{rad})$$

8) Rate of Climb for given excess power Formula

Evaluate Formula

Formula

$$RC = \frac{P_{excess}}{W}$$

Example with Units

$$3.7198\,\text{m/s} = \frac{37197.6\,\text{W}}{10000\,\text{N}}$$

9) Rate of Climb of Aircraft Formula

Evaluate Formula

Formula

$$RC = \frac{P_a - P_r}{W}$$

Example with Units

$$3.7199\,\text{m/s} = \frac{38199\,\text{W} - 1000\,\text{W}}{10000\,\text{N}}$$

10) Thrust available for given excess power Formula

Evaluate Formula

Formula

$$T = F_D + \left(\frac{P_{excess}}{v}\right)$$

Example with Units

$$700\,\text{N} = 80.04\,\text{N} + \left(\frac{37197.6\,\text{W}}{60\,\text{m/s}}\right)$$

11) Thrust in Accelerated Flight Formula

Evaluate Formula

Formula

$$T = \left(\sec(\sigma_T)\right) \cdot \left(F_D + \left(m \cdot [g] \cdot \sin(\gamma)\right) + \left(m \cdot a\right)\right)$$

Example with Units

$$699.997\,\text{N} = \left(\sec(0.034\,\text{rad})\right) \cdot \left(80.04\,\text{N} + \left(20\,\text{kg} \cdot 9.8066\,\text{m/s}^2 \cdot \sin(0.062\,\text{rad})\right) + \left(20\,\text{kg} \cdot 30.37\,\text{m/s}^2\right)\right)$$

12) Total Drag for given Excess Power Formula

Evaluate Formula

Formula

$$F_D = T - \left(\frac{P_{excess}}{v} \right)$$

Example with Units

$$80.04\,\text{N} = 700\,\text{N} - \left(\frac{37197.6\,\text{W}}{60\,\text{m/s}} \right)$$

13) Velocity in Accelerated Flight Formula

Evaluate Formula

Formula

$$v = \left(\frac{R_{curvature}}{m} \cdot \left(F_L + T \cdot \sin\left(\sigma_T \right) - m \cdot [g] \cdot \cos\left(\gamma \right) \right) \right)^{\frac{1}{2}}$$

Example with Units

$$60.3747\,\text{m/s} = \left(\frac{2600\,\text{m}}{20\,\text{kg}} \cdot \left(200\,\text{N} + 700\,\text{N} \cdot \sin\left(0.034\,\text{rad} \right) - 20\,\text{kg} \cdot 9.8066\,\text{m/s}^2 \cdot \cos\left(0.062\,\text{rad} \right) \right) \right)^{\frac{1}{2}}$$

14) Velocity of aircraft at given rate of climb Formula

Evaluate Formula

Formula

$$v = \frac{RC}{\sin\left(\gamma \right)}$$

Example with Units

$$60.0346\,\text{m/s} = \frac{3.71976\,\text{m/s}}{\sin\left(0.062\,\text{rad} \right)}$$

15) Velocity of Aircraft for given Excess Power Formula

Evaluate Formula

Formula

$$v = \frac{P_{excess}}{T - F_D}$$

Example with Units

$$60\,\text{m/s} = \frac{37197.6\,\text{W}}{700\,\text{N} - 80.04\,\text{N}}$$

16) Weight of Aircraft for given Excess Power Formula

Evaluate Formula

Formula

$$W = \frac{P_{excess}}{RC}$$

Example with Units

$$10000\,\text{N} = \frac{37197.6\,\text{W}}{3.71976\,\text{m/s}}$$

Variables used in list of Climbing Flight Formulas above

- **a** Acceleration *(Meter per Square Second)*
- F_c Centrifugal Force *(Newton)*
- F_D Drag Force *(Newton)*
- F_L Lift Force *(Newton)*
- **m** Mass of Aircraft *(Kilogram)*
- P_a Power Available *(Watt)*
- P_{excess} Excess Power *(Watt)*
- P_r Power Required *(Watt)*
- $R_{curvature}$ Radius of Curvature *(Meter)*
- **RC** Rate of Climb *(Meter per Second)*
- **T** Thrust *(Newton)*
- **v** Velocity *(Meter per Second)*
- **W** Aircraft Weight *(Newton)*
- **γ** Flight Path Angle *(Radian)*
- σ_T Thrust Angle *(Radian)*

Constants, Functions, Measurements used in list of Climbing Flight Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **asin**, asin(Number)
  The inverse sine function, is a trigonometric function that takes a ratio of two sides of a right triangle and outputs the angle opposite the side with the given ratio.
- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Functions: **sec**, sec(Angle)
  Secant is a trigonometric function that is defined ratio of the hypotenuse to the shorter side adjacent to an acute angle (in a right-angled triangle); the reciprocal of a cosine.
- Functions: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Acceleration** in Meter per Square Second (m/s²)
  Acceleration Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Radian (rad)
  Angle Unit Conversion

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