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Climbing Flight Formulas

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List of 16 Climbing Flight Formulas

Climbing Flight

1) Centrifugal Force in Accelerated Flight

Open Calculator

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

ex $28.03926\text{N} = 200\text{N} + 700\text{N} \cdot \sin(0.034\text{rad}) - 20\text{kg} \cdot [g] \cdot \cos(0.062\text{rad})$

2) Drag in Accelerated Flight

Open Calculator

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

ex $80.04298\text{N} = 700\text{N} \cdot \cos(0.034\text{rad}) - 20\text{kg} \cdot [g] \cdot \sin(0.062\text{rad}) - 20\text{kg} \cdot 30.37\text{m/s}^2$

3) Excess power

Open Calculator

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

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

4) Excess power for given rate of climb

Open Calculator

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

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

5) Flight path angle at given rate of climb

Open Calculator

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

ex $0.062036\text{rad} = a \sin\left(\frac{3.71976\text{m/s}}{60\text{m/s}}\right)$

6) Lift in Accelerated Flight

Open Calculator

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

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

7) Rate of Climb

Open Calculator

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

$$3.717617\text{m/s} = 60\text{m/s} \cdot \sin(0.062\text{rad})$$

8) Rate of Climb for given excess power

Open Calculator

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

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

9) Rate of Climb of Aircraft

Open Calculator

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

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

10) Thrust available for given excess power

Open Calculator

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

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

11) Thrust in Accelerated Flight

Open Calculator

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

ex

$$699.997\text{N} = (\sec(0.034\text{rad})) \cdot (80.04\text{N} + (20\text{kg} \cdot [g] \cdot \sin(0.062\text{rad})) + (20\text{kg} \cdot 30.37\text{m/s}^2))$$

12) Total Drag for given Excess Power

Open Calculator

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

ex

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

13) Velocity in Accelerated Flight

Open Calculator

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

ex

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

14) Velocity of aircraft at given rate of climb

Open Calculator

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

ex

$$60.03458\text{m/s} = \frac{3.71976\text{m/s}}{\sin(0.062\text{rad})}$$

15) Velocity of Aircraft for given Excess Power

Open Calculator

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

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

16) Weight of Aircraft for given Excess Power

Open Calculator

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

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

Variables Used

- **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

- Constant: **[g]**, 9.80665
  Gravitational acceleration on Earth
- Function: **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.
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **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.
- Function: **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

Check other formula lists

- **Climbing Flight Formulas**
- **Range and Endurance Formulas**
- **Take-off and Landing Formulas**
- **Turning Flight Formulas**

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