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# Thrust and Power Requirements Formulas

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# List of 19 Thrust and Power Requirements Formulas

## Thrust and Power Requirements

### 1) Minimum Thrust of aircraft required

$$fx \quad T = P_{\text{dynamic}} \cdot S \cdot (C_{D,0} + C_{D,i})$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b\_img.jpg\)](#)

$$ex \quad 99.2\text{N} = 10\text{Pa} \cdot 8\text{m}^2 \cdot (0.31 + 0.93)$$

### 2) Minimum Thrust required for given Lift Coefficient

$$fx \quad T = P_{\text{dynamic}} \cdot A \cdot \left( C_{D,0} + \left( \frac{C_L^2}{\pi \cdot e \cdot AR} \right) \right)$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d\_img.jpg\)](#)

$$ex \quad 99.76029\text{N} = 10\text{Pa} \cdot 20\text{m}^2 \cdot \left( 0.31 + \left( \frac{(1.1)^2}{\pi \cdot 0.51 \cdot 4} \right) \right)$$

### 3) Minimum Thrust required for given weight

 $fx$ 
[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d\_img.jpg\)](#)

$$T = (P_{\text{dynamic}} \cdot A \cdot C_{D,0}) + \left( \frac{W_{\text{body}}^2}{P_{\text{dynamic}} \cdot A \cdot \pi \cdot e \cdot AR} \right)$$

$$ex \quad 100.1043\text{N} = (10\text{Pa} \cdot 20\text{m}^2 \cdot 0.31) + \left( \frac{(221\text{N})^2}{10\text{Pa} \cdot 20\text{m}^2 \cdot \pi \cdot 0.51 \cdot 4} \right)$$



#### 4) Power required for given aerodynamic coefficients

$$fx \quad P = W_{\text{body}} \cdot V_{\infty} \cdot \frac{C_D}{C_L}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$ex \quad 3013.636W = 221N \cdot 30m/s \cdot \frac{0.5}{1.1}$$

#### 5) Power required for given required thrust of aircraft

$$fx \quad P = V_{\infty} \cdot T$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$ex \quad 3000W = 30m/s \cdot 100N$$

#### 6) Power required for given total drag force

$$fx \quad P = F_D \cdot V_{\infty}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$ex \quad 2999.7W = 99.99N \cdot 30m/s$$

#### 7) Thrust Angle for Unaccelerated Level Flight for given Drag

$$fx \quad \sigma_T = a \cos\left(\frac{F_D}{T}\right)$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$ex \quad 0.014142rad = a \cos\left(\frac{99.99N}{100N}\right)$$



8) Thrust Angle for Unaccelerated Level Flight for given Lift 

$$fx \quad \sigma_T = a \sin\left(\frac{W_{\text{body}} - F_L}{T}\right)$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)

$$ex \quad 0.01\text{rad} = a \sin\left(\frac{221\text{N} - 220\text{N}}{100\text{N}}\right)$$

9) Thrust for given coefficients of lift and drag 

$$fx \quad T = C_D \cdot \frac{W_{\text{body}}}{C_L}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)

$$ex \quad 100.4545\text{N} = 0.5 \cdot \frac{221\text{N}}{1.1}$$

10) Thrust for Level and Unaccelerated Flight 

$$fx \quad T = \frac{F_D}{\cos(\sigma_T)}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7\_img.jpg\)](#)

$$ex \quad 99.995\text{N} = \frac{99.99\text{N}}{\cos(0.01\text{rad})}$$

11) Thrust of aircraft required for given Lift-to-drag ratio 

$$fx \quad T = \frac{W_{\text{body}}}{LD}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b\_img.jpg\)](#)

$$ex \quad 100\text{N} = \frac{221\text{N}}{2.21}$$



## 12) Thrust of Aircraft required for given required Power

$$\text{fx } T = \frac{P}{V_{\infty}}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$\text{ex } 100\text{N} = \frac{3000\text{W}}{30\text{m/s}}$$

## 13) Thrust of Aircraft required for Level, Unaccelerated Flight

$$\text{fx } T = P_{\text{dynamic}} \cdot A \cdot C_D$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$\text{ex } 100\text{N} = 10\text{Pa} \cdot 20\text{m}^2 \cdot 0.5$$

## 14) Thrust-to-weight ratio

$$\text{fx } TW = \frac{C_D}{C_L}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$\text{ex } 0.454545 = \frac{0.5}{1.1}$$

## 15) Weight of Aircraft for given Coefficients of Lift and Drag

$$\text{fx } W_{\text{body}} = C_L \cdot \frac{T}{C_D}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80\_img.jpg\)](#)

$$\text{ex } 220\text{N} = 1.1 \cdot \frac{100\text{N}}{0.5}$$



## 16) Weight of Aircraft for given Lift-to-Drag Ratio

$$fx \quad W_{\text{body}} = T \cdot LD$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0\_img.jpg\)](#)

$$ex \quad 221N = 100N \cdot 2.21$$

## 17) Weight of aircraft for given required power

$$fx \quad W_{\text{body}} = P \cdot \frac{C_L}{V_{\infty} \cdot C_D}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5\_img.jpg\)](#)

$$ex \quad 220N = 3000W \cdot \frac{1.1}{30m/s \cdot 0.5}$$

## 18) Weight of Aircraft for Level, Unaccelerated Flight at Negligible Thrust Angle

$$fx \quad W_{\text{body}} = P_{\text{dynamic}} \cdot A \cdot C_L$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60\_img.jpg\)](#)

$$ex \quad 220N = 10Pa \cdot 20m^2 \cdot 1.1$$

## 19) Weight of Aircraft in Level, Unaccelerated Flight

$$fx \quad W_{\text{body}} = F_L + (T \cdot \sin(\sigma_T))$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487\_img.jpg\)](#)

$$ex \quad 221N = 220N + (100N \cdot \sin(0.01rad))$$








## Variables Used

- **A** Area (Square Meter)
- **AR** Aspect Ratio of a Wing
- **C<sub>D</sub>** Drag Coefficient
- **C<sub>D,0</sub>** Zero Lift Drag Coefficient
- **C<sub>D,i</sub>** Coefficient Of Drag Due to Lift
- **C<sub>L</sub>** Lift Coefficient
- **e** Oswald Efficiency Factor
- **F<sub>D</sub>** Drag Force (Newton)
- **F<sub>L</sub>** Lift Force (Newton)
- **LD** Lift-to-Drag Ratio
- **P** Power (Watt)
- **P<sub>dynamic</sub>** Dynamic Pressure (Pascal)
- **S** Reference Area (Square Meter)
- **T** Thrust (Newton)
- **TW** Thrust-to-Weight Ratio
- **V<sub>∞</sub>** Freestream Velocity (Meter per Second)
- **W<sub>body</sub>** Weight of Body (Newton)
- **σ<sub>T</sub>** Thrust Angle (Radian)



## Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **Function:** **acos**, `acos(Number)`  
*The inverse cosine function, is the inverse function of the cosine function. It is the function that takes a ratio as an input and returns the angle whose cosine is equal to that ratio.*
- **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:** **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:** **Area** in Square Meter (m<sup>2</sup>)  
*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: Angle** in Radian (rad)  
*Angle Unit Conversion* 



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- [Lift and Drag Requirements Formulas](#) 
- [Thrust and Power Requirements Formulas](#) 

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