# Important Propeller-Driven Airplane Formulas PDF



# List of 22

**Important Propeller-Driven Airplane Formulas** 

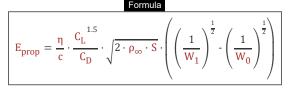
# 1) Cruise Weight Fraction for Prop-Driven Aircraft Formula 🕝



#### Example with Units

$$0.7778 = \exp\left(\frac{7126.017 \,\mathrm{m} \,\cdot\,(\,\,-\,1\,) \,\cdot\, 0.6 \,\mathrm{kg/h/W}}{5.081527 \cdot\,0.93}\right)$$

# 2) Endurance of Propeller-Driven Airplane Formula 🕝



$$454.2055_{s} = \frac{0.93}{0.6 \, \text{kg/h/W}} \cdot \frac{5^{1.5}}{2} \cdot \sqrt{2 \cdot 1.225 \, \text{kg/m}^{3} \cdot 5.11 \, \text{m}^{2}} \cdot \left( \left( \frac{1}{3000 \, \text{kg}} \right)^{\frac{1}{2}} \cdot \left( \frac{1}{5000 \, \text{kg}} \right)^{\frac{1}{2}} \right)$$

## 3) Lift to Drag for Maximum Endurance given Preliminary Endurance for Prop-Driven Aircraft Formula C

$$\begin{aligned} & & & \text{Formula} \\ & & & LDEmax_{ratio\;prop} = \frac{E \cdot V_{Emax} \cdot c}{\eta \cdot ln \bigg(\frac{W_{L,beg}}{W_{L,end}}\bigg)} \end{aligned}$$

 $\label{eq:ldemax} \text{LDEmax}_{ratio\;prop} = \frac{E \cdot V_{Emax} \cdot c}{\eta \cdot \ln\!\left(\frac{W_{L,beg}}{W_{L,end}}\right)} \; \middle| \; \; \middle| \; \; 85.0491 = \frac{452.0581_{s} \cdot 15.6\,\text{m/s} \cdot 0.6\,\text{kg/h/W}}{0.93 \cdot \ln\!\left(\frac{400\,\text{kg}}{394.1\,\text{kg}}\right)}$ 

### 4) Lift to Drag Ratio for Maximum Endurance given Max Lift to Drag Ratio for Prop-Driven Aircraft Formula

Formula

Example

Evaluate Formula 🕝

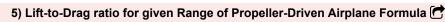
Evaluate Formula

Evaluate Formula

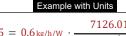
Evaluate Formula (

 $LDEmax_{ratio} = 0.866 \cdot LDmax_{ratio}$ 

 $4.4006 = 0.866 \cdot 5.081527$ 



$$LD = c \cdot \frac{R_{prop}}{\eta \cdot \ln \left( \frac{W_0}{W_1} \right)} \qquad 2.5 = 0.6 \, \text{kg/h/W} \cdot \frac{7126.017 \, \text{m}}{0.93 \cdot \ln \left( \frac{5000 \, \text{kg}}{3000 \, \text{kg}} \right)}$$





#### 6) Maximum Lift to Drag Ratio given Lift to Drag Ratio for Max Endurance of Prop-Driven Aircraft Formula 🕝

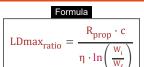


Evaluate Formula 🕝

Evaluate Formula

Evaluate Formula (

7) Maximum Lift to Drag Ratio given Range for Prop-Driven Aircraft Formula 🕝



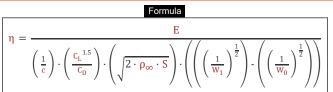


8) Power Available for Reciprocating Engine-Propeller Combination Formula 🕝



Example with Units  $P_A = \eta \cdot BP$  20.6553w = 0.93 \cdot 22.21w Evaluate Formula (

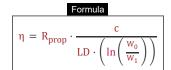
9) Propeller Efficiency for given Endurance of Propeller-Driven Airplane Formula 🕝 Evaluate Formula (



Example with Units

$$0.9256 = \frac{452.0581 \, s}{\left(\frac{1}{0.6 \, kg/h/W}\right) \cdot \left(\frac{5^{1.5}}{2}\right) \cdot \left(\sqrt{2 \cdot 1.225 \, kg/m^3 \cdot 5.11 \, m^2}\right) \cdot \left(\left(\left(\frac{1}{3000 \, kg}\right)^{\frac{1}{2}}\right) - \left(\left(\frac{1}{5000 \, kg}\right)^{\frac{1}{2}}\right)\right)}$$

#### 10) Propeller Efficiency for given Range and Lift-to-Drag Ratio of Propeller-Driven Airplane Formula 🗂

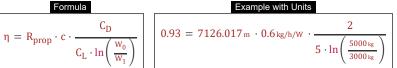


0.93 = 7126.017 m 
$$\cdot \frac{0.6 \, \text{kg/h/W}}{2.50 \cdot \left( \ln \left( \frac{5000 \, \text{kg}}{3000 \, \text{kg}} \right) \right)}$$

Evaluate Formula 🕝

# 11) Propeller Efficiency for given Range of Propeller-Driven Airplane Formula 🕝

$$\eta = R_{prop} \cdot c \cdot \frac{C_D}{C_L \cdot ln \left(\frac{W_0}{W}\right)}$$



# Evaluate Formula (

12) Propeller Efficiency for Reciprocating Engine-Propeller Combination Formula



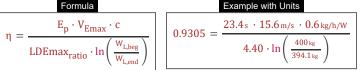
Formula Example with Units 
$$\eta = \frac{P_A}{BP} \qquad 0.93 = \frac{20.656 \text{ w}}{22.21 \text{ w}}$$

Evaluate Formula (

Evaluate Formula (

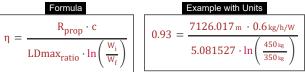
13) Propeller Efficiency given Preliminary Endurance for Prop-Driven Aircraft Formula 🕝

$$\eta = \frac{E_{p} \cdot V_{Emax} \cdot c}{LDEmax_{ratio} \cdot ln\left(\frac{W_{L,beg}}{W_{L,end}}\right)}$$



14) Propeller Efficiency given Range for Prop-Driven Aircraft Formula C





Evaluate Formula (

15) Range of Propeller-Driven Airplane Formula 🕝

Formula  $R_{\text{prop}} = \left(\frac{\eta}{c}\right) \cdot \left(\frac{C_{L}}{C_{D}}\right) \cdot \left(\ln\left(\frac{W_{0}}{W_{1}}\right)\right)$  Evaluate Formula 🕝

T126.0175 m =  $\left( \frac{0.93}{0.6 \, \text{kg/h/W}} \right) \cdot \left( \frac{5}{2} \right) \cdot \left( \ln \left( \frac{5000 \, \text{kg}}{3000 \, \text{kg}} \right) \right)$ 

# 16) Range of Propeller-Driven Airplane for given lift-to-drag ratio Formula 🕝

EvaluateFormula 🦳

$$R_{\text{prop}} = \left(\frac{\eta}{c}\right) \cdot \left(LD\right) \cdot \left(\ln\left(\frac{W_0}{W_1}\right)\right)$$

Example with Units

$$7126.0175 \,\mathrm{m} = \left(\frac{0.93}{0.6 \,\mathrm{kg/h/W}}\right) \cdot \left(2.50\right) \cdot \left(\ln\left(\frac{5000 \,\mathrm{kg}}{3000 \,\mathrm{kg}}\right)\right)$$

17) Shaft Brake Power for Reciprocating Engine-Propeller Combination Formula 🕝



18) Specific Fuel Consumption for given Endurance of Propeller-Driven Airplane Formula 🕝

$$c = \frac{\eta}{E} \cdot \frac{C_L^{1.5}}{C_D} \cdot \sqrt{2 \cdot \rho_{\infty} \cdot S} \cdot \left( \left( \frac{1}{W_1} \right)^{\frac{1}{2}} - \left( \frac{1}{W_0} \right)^{\frac{1}{2}} \right)$$

$$0.6029\,\mathrm{kg/h/W}\,=\frac{0.93}{452.0581\,\mathrm{s}}\cdot\frac{5^{1.5}}{2}\cdot\sqrt{2\cdot1.225\,\mathrm{kg/m^3}\cdot5.11\,\mathrm{m^2}}\cdot\left(\left(\frac{1}{3000\,\mathrm{kg}}\right)^{\frac{1}{2}}-\left(\frac{1}{5000\,\mathrm{kg}}\right)^{\frac{1}{2}}\right)$$

19) Specific Fuel Consumption for given Range and Lift-to-Drag Ratio of Propeller-Driven Airplane Formula C

Formula
$$c = \left(\frac{\eta}{R_{prop}}\right) \cdot \left(LD\right) \cdot \left(\ln\left(\frac{W_0}{W_1}\right)\right)$$

$$0.6\,\text{kg/h/W} = \left(\frac{0.93}{7126.017\,\text{m}}\right) \cdot \left(2.50\right) \cdot \left(\ln\left(\frac{5000\,\text{kg}}{3000\,\text{kg}}\right)\right)$$

#### 20) Specific Fuel Consumption for given Range of Propeller-Driven Airplane Formula 🕝



Evaluate Formula (

Evaluate Formula (

Evaluate Formula 🕝

$$c = \left(\frac{\eta}{R_{prop}}\right) \cdot \left(\frac{C_L}{C_D}\right) \cdot \left(\ln\left(\frac{W_0}{W_1}\right)\right)$$

Example with Units

$$0.6 \, \text{kg/h/W} = \left(\frac{0.93}{7126.017 \,\text{m}}\right) \cdot \left(\frac{5}{2}\right) \cdot \left(\ln\left(\frac{5000 \,\text{kg}}{3000 \,\text{kg}}\right)\right)$$

# 21) Specific Fuel Consumption given Preliminary Endurance for Prop-Driven Aircraft Formula



Formula

$$= \frac{\text{LDEmax}_{\text{ratio prop}} \cdot \eta \cdot \ln \left( \frac{W_{\text{L,beg}}}{W_{\text{L,end}}} \right)}{\text{E} \cdot V_{\text{Emax}}}$$

Example with Units

$$0.6\,\text{kg/h/W} \, = \frac{85.04913 \cdot 0.93 \cdot \ln \left(\frac{400\,\text{kg}}{394.1\,\text{kg}}\right)}{452.0581\,\text{s} \, \cdot 15.6\,\text{m/s}}$$

22) Specific Fuel Consumption given Range for Prop-Driven Aircraft Formula 🕝

Formula

$$c = \frac{\eta \cdot LDmax_{ratio} \cdot ln\left(\frac{w_i}{w_f}\right)}{R_{prop}}$$

Example with Units

$$_{\text{g/h/W}} = \frac{0.93 \cdot 5.081527 \cdot \ln\left(\frac{450 \, \text{kg}}{350 \, \text{kg}}\right)}{7126.017 \, \text{m}}$$

# Variables used in list of Propeller-Driven Airplane Formulas above

- **BP** Brake Power (Watt)
- C Specific Fuel Consumption (Kilogram per Hour per Watt)
- C<sub>D</sub> Drag Coefficient
- · C1 Lift Coefficient
- E Endurance of Aircraft (Second)
- Ep Preliminary Endurance of Aircraft (Second)
- E<sub>prop</sub> Endurance of Propeller Aircraft (Second)
- FW<sub>cruise prop</sub> Cruise Weight Fraction Propeller Aircraft
- · LD Lift-to-Drag Ratio
- LDEmax<sub>ratio prop</sub> Lift to Drag Ratio at Maximum Endurance Prop
- LDEmax<sub>ratio</sub> Lift to Drag Ratio at Maximum Endurance
- LDmax<sub>ratio</sub> Maximum Lift-to-Drag Ratio
- P<sub>▲</sub> Available Power (Watt)
- R<sub>prop</sub> Range of Propeller Aircraft (Meter)
- S Reference Area (Square Meter)
- V<sub>Emax</sub> Velocity for Maximum Endurance (Meter per Second)
- Wn Gross Weight (Kilogram)
- W<sub>1</sub> Weight without Fuel (Kilogram)
- W<sub>f</sub> Weight at End of Cruise Phase (Kilogram)
- Wi Weight at Start of Cruise Phase (Kilogram)
- W<sub>L,beg</sub> Weight at Start of Loiter Phase (Kilogram)
- W<sub>L.end</sub> Weight at End of Loiter Phase (Kilogram)
- n Propeller Efficiency
- ρ<sub>∞</sub> Freestream Density (Kilogram per Cubic Meter)

# Constants, Functions, Measurements used in list of Propeller-Driven Airplane Formulas above

- Functions: exp, exp(Number)
   n an exponential function, the value of the
   function changes by a constant factor for every
   unit change in the independent variable.
- Functions: In, In(Number)
   The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Functions: 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: Weight in Kilogram (kg)
   Weight Unit Conversion
- Measurement: Time in Second (s)

  Time Unit Conversion
- Measurement: Area in Square Meter (m²)
   Area Unit Conversion
- Measurement: Speed in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: Power in Watt (W)

  Power Unit Conversion
- Measurement: Density in Kilogram per Cubic Meter (kg/m³)
   Density Unit Conversion
- Measurement: Specific Fuel Consumption in Kilogram per Hour per Watt (kg/h/W)
   Specific Fuel Consumption Unit Conversion

# **Download other Important Range and Endurance PDFs**

- Important Jet Airplane Formulas
- Important Propeller-Driven Airplane
   Formulas

# **Try our Unique Visual Calculators**

- **Percentage** of number
- LCM calculator

Simple fraction

Please SHARE this PDF with someone who needs it!

# This PDF can be downloaded in these languages

English Spanish French German Russian Italian Portuguese Polish Dutch

7/9/2024 | 5:58:51 AM UTC