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# Newtonian Flow Formulas

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# List of 14 Newtonian Flow Formulas

## Newtonian Flow

### 1) Coefficient of Drag Equation with Angle of Attack

$$fx \quad C_D = 2 \cdot (\sin(\alpha))^3$$

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

$$ex \quad 0.013671 = 2 \cdot (\sin(10.94^\circ))^3$$

### 2) Coefficient of Drag Equation with Coefficient of Normal Force

$$fx \quad C_D = \mu \cdot \sin(\alpha)$$

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

$$ex \quad 0.085401 = 0.45 \cdot \sin(10.94^\circ)$$

### 3) Coefficient of Lift Equation with Angle of Attack

$$fx \quad C_L = 2 \cdot (\sin(\alpha))^2 \cdot \cos(\alpha)$$

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

$$ex \quad 0.070724 = 2 \cdot (\sin(10.94^\circ))^2 \cdot \cos(10.94^\circ)$$

### 4) Coefficient of Lift Equation with Coefficient of Normal Force

$$fx \quad C_L = \mu \cdot \cos(\alpha)$$

[Open Calculator !\[\]\(83bbbd261710c59db0214aa27b2edc0d\_img.jpg\)](#)

$$ex \quad 0.441822 = 0.45 \cdot \cos(10.94^\circ)$$



### 5) Drag Force with Angle of Attack

$$fx \quad F_D = \frac{F_L}{\cot(\alpha)}$$

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

$$ex \quad 77.41415N = \frac{400.5N}{\cot(10.94^\circ)}$$

### 6) Exact Normal Shock Wave Maximum Coefficient of Pressure

$$fx \quad C_{p,max} = \frac{2}{Y \cdot M^2} \cdot \left( \frac{P_T}{P} - 1 \right)$$

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

$$ex \quad 2.910156 = \frac{2}{1.6 \cdot (8)^2} \cdot \left( \frac{120000Pa}{800Pa} - 1 \right)$$

### 7) Force Exerted on Surface given Static Pressure

$$fx \quad F = A \cdot (p - p_{static})$$

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

$$ex \quad 2.52N = 2.1m^2 \cdot (251.2Pa - 250Pa)$$

### 8) Lift Force with Angle of Attack

$$fx \quad F_L = F_D \cdot \cot(\alpha)$$

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

$$ex \quad 413.8778N = 80N \cdot \cot(10.94^\circ)$$



### 9) Mass Flux Incident on Surface Area

$$fx \quad G = \rho \cdot v \cdot A \cdot \sin(\theta)$$

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

$$ex \quad 2.406764 \text{kg/s/m}^2 = 0.11 \text{kg/m}^3 \cdot 60 \text{m/s} \cdot 2.1 \text{m}^2 \cdot \sin(10^\circ)$$

### 10) Maximum Pressure Coefficient

$$fx \quad C_{p,\max} = \frac{P_T - P}{0.5 \cdot \rho \cdot V_\infty^2}$$

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

$$ex \quad 225.6635 = \frac{120000 \text{Pa} - 800 \text{Pa}}{0.5 \cdot 0.11 \text{kg/m}^3 \cdot (98 \text{m/s})^2}$$

### 11) Modified Newtonian Law

$$fx \quad C_p = C_{p,\max} \cdot (\sin(\theta))^2$$

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

$$ex \quad 0.018092 = 0.60 \cdot (\sin(10^\circ))^2$$

### 12) Pressure Coefficient for Slender 2D Bodies

$$fx \quad C_p = 2 \cdot \left( (\theta)^2 + k_{\text{curvature}} \cdot y \right)$$

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

$$ex \quad 0.540923 = 2 \cdot \left( (10^\circ)^2 + 0.2 \text{m} \cdot 1.2 \text{m} \right)$$



### 13) Pressure Coefficient for Slender Bodies of Revolution

$$fx \quad C_p = 2 \cdot (\theta)^2 + k_{\text{curvature}} \cdot y$$

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

$$ex \quad 0.300923 = 2 \cdot (10^\circ)^2 + 0.2m \cdot 1.2m$$

### 14) Time Rate of Change of Momentum of Mass Flux

$$fx \quad F = \rho_{\text{Fluid}} \cdot u_{\text{Fluid}}^2 \cdot A \cdot (\sin(\theta))^2$$

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

$$ex \quad 1.353524N = 9.5\text{kg}/\text{m}^3 \cdot (1.5\text{m}/\text{s})^2 \cdot 2.1\text{m}^2 \cdot (\sin(10^\circ))^2$$



## Variables Used









- **A** Area (Square Meter)
- **C<sub>D</sub>** Drag Coefficient
- **C<sub>L</sub>** Lift Coefficient
- **C<sub>p</sub>** Pressure Coefficient
- **C<sub>p,max</sub>** Maximum Pressure Coefficient
- **F** Force (Newton)
- **F<sub>D</sub>** Drag Force (Newton)
- **F<sub>L</sub>** Lift Force (Newton)
- **G** Mass Flux(g) (Kilogram per Second per Square Meter)
- **k<sub>curvature</sub>** Curvature of Surface (Meter)
- **M** Mach Number
- **p** Surface Pressure (Pascal)
- **P** Pressure (Pascal)
- **P<sub>static</sub>** Static Pressure (Pascal)
- **P<sub>T</sub>** Total Pressure (Pascal)
- **u<sub>Fluid</sub>** Fluid Velocity (Meter per Second)
- **v** Velocity (Meter per Second)
- **V<sub>∞</sub>** Freestream Velocity (Meter per Second)
- **y** Distance of Point from Centroidal Axis (Meter)
- **Y** Specific Heat Ratio
- **α** Angle of Attack (Degree)
- **θ** Angle of Inclination (Degree)



- $\mu$  Coefficient of Force
- $\rho$  Density of Material (*Kilogram per Cubic Meter*)
- $\rho_{\text{Fluid}}$  Density of Fluid (*Kilogram per Cubic Meter*)









## Constants, Functions, Measurements used

- **Function: cos**,  $\cos(\text{Angle})$   
*Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- **Function: cot**,  $\cot(\text{Angle})$   
*Cotangent is a trigonometric function that is defined as the ratio of the adjacent side to the opposite side in a right triangle.*
- **Function: sin**,  $\sin(\text{Angle})$   
*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: Area** in Square Meter ( $\text{m}^2$ )  
*Area Unit Conversion* 
- **Measurement: Pressure** in Pascal (Pa)  
*Pressure Unit Conversion* 
- **Measurement: Speed** in Meter per Second (m/s)  
*Speed Unit Conversion* 
- **Measurement: Force** in Newton (N)  
*Force Unit Conversion* 
- **Measurement: Angle** in Degree ( $^\circ$ )  
*Angle Unit Conversion* 
- **Measurement: Mass Flux** in Kilogram per Second per Square Meter ( $\text{kg/s/m}^2$ )  
*Mass Flux Unit Conversion* 
- **Measurement: Density** in Kilogram per Cubic Meter ( $\text{kg/m}^3$ )  
*Density Unit Conversion* 





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