



Three-Dimensional Incompressible Flow Formulas

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List of 29 Three-Dimensional Incompressible Flow Formulas

Three-Dimensional Incompressible Flow **2**

3D Elementry Flows

1) Doublet Strength for 3D Incompressible Flow

$$\mu = -rac{4\cdot\pi\cdot\phi\cdot\mathrm{r}^2}{\cos(heta)}$$

Open Calculator 🚰

$$\boxed{ 9463.181 \mathrm{m}^{_{3}}/\mathrm{s} = -\frac{4 \cdot \pi \cdot -75.72 \mathrm{m}^{_{2}}/\mathrm{s} \cdot \left(2.758 \mathrm{m}\right)^{2}}{\cos(0.7 \mathrm{rad})} }$$

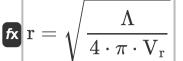
2) Radial Coordinate for 3D Doublet Flow given Velocity Potential

$$\mathbf{f} \mathbf{x} = \sqrt{rac{\mathrm{modulus}(\mu) \cdot \mathrm{cos}(\theta)}{4 \cdot \pi \cdot \mathrm{modulus}(\phi_{\mathrm{s}})}}$$

Open Calculator



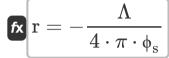
3) Radial Coordinate for 3D Source Flow given Radial Velocity



Open Calculator 🚰

ex
$$2.756995 \mathrm{m} = \sqrt{rac{277 \mathrm{m}^2/\mathrm{s}}{4 \cdot \pi \cdot 2.9 \mathrm{m/s}}}$$

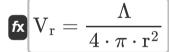
4) Radial Coordinate for 3D Source Flow given Velocity Potential



Open Calculator

$$=$$
 $2.75537 ext{m} = -rac{277 ext{m}^2/ ext{s}}{4 \cdot \pi \cdot -8 ext{m}^2/ ext{s}}$

5) Radial Velocity for 3D Incompressible Source Flow



Open Calculator

$$ext{ex} 2.897887 ext{m/s} = rac{277 ext{m}^2/ ext{s}}{4 \cdot \pi \cdot (2.758 ext{m})^2}$$

6) Source Strength for 3D Incompressible Source Flow given Radial Velocity

fx
$$\Lambda = 4 \cdot \pi \cdot \mathrm{V_r} \cdot \mathrm{r}^2$$

Open Calculator

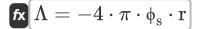
$$ext{ex} \ 277.202 ext{m}^2/ ext{s} = 4 \cdot \pi \cdot 2.9 ext{m/s} \cdot (2.758 ext{m})^2$$



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7) Source Strength for 3D Incompressible Source Flow given Velocity Potential



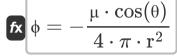
Open Calculator 2

Open Calculator 2

$$\mathbf{ex} \ 277.2644 \mathrm{m}^2/\mathrm{s} = -4 \cdot \pi \cdot -8 \mathrm{m}^2/\mathrm{s} \cdot 2.758 \mathrm{m}^2$$

8) Velocity Potential for 3D Incompressible Doublet Flow





$$oxed{ex} egin{aligned} -75.71855 \mathrm{m^2/s} = -rac{9463 \mathrm{m^3/s \cdot cos(0.7 rad)}}{4 \cdot \pi \cdot (2.758 \mathrm{m})^2} \end{aligned}$$

9) Velocity Potential for 3D Incompressible Source Flow

$$egin{aligned} egin{aligned} egin{aligned} egin{aligned} egin{aligned} egin{aligned} egin{aligned} egin{aligned} \Lambda \ 4 \cdot \pi \cdot \mathbf{r} \end{aligned} \end{aligned}$$

Open Calculator 2

$$ext{ex} ext{ -7.992371} ext{m}^2/ ext{s} = -rac{277 ext{m}^2/ ext{s}}{4 \cdot \pi \cdot 2.758 ext{m}}$$

Flow over Sphere G



Pressure Coefficient

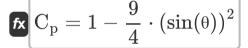
10) Polar Coordinate given Surface Pressure Coefficient

$$\theta = a \sin \left(\sqrt{rac{4}{9} \cdot (1 - \mathrm{C_p})}
ight)$$

Open Calculator

 $0.700096 \mathrm{rad} = a \sin \left(\sqrt{\frac{4}{9}} \cdot (1 - 0.066) \right)$

11) Surface Pressure Coefficient for Flow over Sphere



Open Calculator

ex $0.066213 = 1 - \frac{9}{4} \cdot (\sin(0.7\text{rad}))^2$

Radial Velocity

12) Doublet Strength given Radial Velocity

$$\mu = 2 \cdot \pi \cdot \mathrm{r}^3 \cdot \left(\mathrm{V}_{\infty} + rac{\mathrm{V}_{\mathrm{r}}}{\cos(heta)}
ight)$$

Open Calculator

 $ext{ex} \left[9463.166 ext{m}^3/ ext{s} = 2 \cdot \pi \cdot (2.758 ext{m})^3 \cdot \left(68 ext{m/s} + rac{2.9 ext{m/s}}{\cos(0.7 ext{rad})}
ight)^3$



13) Freestream Velocity given Radial Velocity

 $\left| \mathbf{V}_{\infty} = rac{\mu}{2 \cdot \pi \cdot \mathbf{r}^3} - rac{\mathbf{V_r}}{\cos(heta)}
ight|$

Open Calculator 🗗

14) Polar Coordinate given Radial Velocity

 $heta = a \cos igg(rac{{
m V_r}}{rac{\mu}{2 \cdot \pi \cdot {
m r}^3} - {
m V_{\infty}}} igg)$

Open Calculator

ex $0.699604 \mathrm{rad} = a \cos \left(\frac{2.9 \mathrm{m/s}}{\frac{9463 \mathrm{m}^3/\mathrm{s}}{2 \cdot \pi \cdot (2.758 \mathrm{m})^3} - 68 \mathrm{m/s}} \right)$

15) Radial Coordinate given Radial Velocity

 $\mathbf{f}\mathbf{x} = \left(rac{\mu}{2 \cdot \pi \cdot \left(\mathrm{V}_{\infty} + rac{\mathrm{V}_{\mathrm{r}}}{\cos(heta)}
ight)}
ight)^{rac{1}{3}}$

Open Calculator





16) Radial Velocity for Flow over Sphere

 $\left| \mathbf{V}_{\mathrm{r}} \right| = - \left(\mathbf{V}_{\infty} - rac{\mu}{2 \cdot \pi \cdot \mathbf{r}^3}
ight) \cdot \cos(heta)$

Open Calculator 🗗

Stagnation Point

17) Doublet Strength given Radial Coordinate of Stagnation Point

fx $\mu = 2 \cdot \pi \cdot V_{\infty} \cdot R_s^3$

Open Calculator 🗗

 $ext{ex} \left[9469.87 ext{m}^3/ ext{s} = 2 \cdot \pi \cdot 68 ext{m/s} \cdot (2.809 ext{m})^3
ight]$

18) Freestream Velocity at Stagnation Point for Flow over Sphere

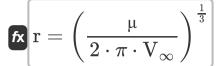
 $\left| \mathbf{V}_{\infty}
ight| = rac{\mu}{2 \cdot \pi \cdot \mathrm{R}^3_{-}}$

Open Calculator 🗗

 $ext{ex} \ 67.95067 ext{m/s} = rac{9463 ext{m}^3/ ext{s}}{2 \cdot \pi \cdot \left(2.809 ext{m}
ight)^3}$



19) Radial Coordinate of Stagnation Point for Flow over Sphere 🗗

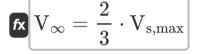


Open Calculator 🗗

ex
$$2.808321 \mathrm{m} = \left(\frac{9463 \mathrm{m}^3/\mathrm{s}}{2 \cdot \pi \cdot 68 \mathrm{m/s}} \right)^{\frac{1}{3}}$$

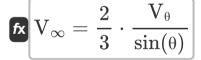
Surface Velocity

20) Freestream Velocity given Maximum Surface Velocity



Open Calculator 🗗

21) Freestream Velocity given Surface Velocity for Flow over Sphere



Open Calculator 🗗

ex
$$68.29989 \text{m/s} = \frac{2}{3} \cdot \frac{66 \text{m/s}}{\sin(0.7 \text{rad})}$$



22) Maximum Surface Velocity for Flow over Sphere

 $\left| \mathbf{V}_{\mathrm{s,max}} = rac{3}{2} \cdot \mathrm{V}_{\infty}
ight|$

Open Calculator

 $\boxed{\texttt{ex}} \ 102 \text{m/s} = \frac{3}{2} \cdot 68 \text{m/s}$

23) Polar Coordinate given Surface Velocity for Flow over Sphere

 $\theta = a \sin\!\left(rac{2}{3}\cdotrac{{
m V}_{ heta}}{{
m V}_{\infty}}
ight)^{2}$

Open Calculator

 $\boxed{0.703721 \text{rad} = a \sin \left(\frac{2}{3} \cdot \frac{66 \text{m/s}}{68 \text{m/s}}\right)}$

24) Surface Velocity for Incompressible Flow over Sphere 🗗

 $\left| \mathbf{V}_{ heta}
ight| \mathrm{V}_{ heta} = rac{3}{2} \cdot \mathrm{V}_{\infty} \cdot \sin(heta)$

Open Calculator

 $65.7102 \text{m/s} = \frac{3}{2} \cdot 68 \text{m/s} \cdot \sin(0.7 \text{rad})$



Tangential Velocity

25) Doublet Strength given Tangential Velocity

 $\mu = 4 \cdot \pi \cdot \mathrm{r}^3 \cdot \left(rac{\mathrm{V}_{\mathrm{ heta}}}{\sin(\mathrm{ heta})} - \mathrm{V}_{\infty}
ight)$

Open Calculator 🗗

 $ext{ex} \ 9081.966 ext{m}^3/ ext{s} = 4 \cdot \pi \cdot \left(2.758 ext{m}
ight)^3 \cdot \left(rac{66 ext{m/s}}{\sin(0.7 ext{rad})} - 68 ext{m/s}
ight)$

26) Freestream Velocity given Tangential Velocity

 $\left| V_{\infty}
ight| = rac{V_{\, heta}}{\sin(heta)} - rac{\mu}{4 \cdot \pi \cdot r^3}$

Open Calculator

 $ext{ex} 66.55466 ext{m/s} = rac{66 ext{m/s}}{\sin(0.7 ext{rad})} - rac{9463 ext{m}^3/ ext{s}}{4 \cdot \pi \cdot (2.758 ext{m})^3}$

27) Polar Coordinate given Tangential Velocity

 $heta = a \sin igg(rac{{
m V}_{
m heta}}{{
m V}_{\infty} + rac{\mu}{4 \cdot \pi \cdot {
m r}^3}}igg)$

Open Calculator 🗗

 $oxed{egin{align*} egin{align*} \mathbf{ex} \ 0.688339 \mathrm{rad} = a \sin \Bigg(rac{66 \mathrm{m/s}}{68 \mathrm{m/s} + rac{9463 \mathrm{m}^3/\mathrm{s}}{4 \cdot \pi \cdot (2.758 \mathrm{m})^3}} \Bigg) \end{aligned}}$



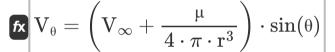
28) Radial Coordinate given Tangential Velocity 🗗

$$\mathbf{f}$$
 $\mathbf{r} = \left(rac{\mu}{4 \cdot \pi \cdot \left(rac{V_{ heta}}{\sin(heta)} - V_{\infty}
ight)}
ight)^{rac{1}{3}}$

Open Calculator

ex
$$2.796043 \mathrm{m} = \left(rac{9463 \mathrm{m}^3/\mathrm{s}}{4 \cdot \pi \cdot \left(rac{66 \mathrm{m/s}}{\sin(0.7 \mathrm{rad})} - 68 \mathrm{m/s}
ight)}
ight)^{rac{3}{3}}$$

29) Tangential Velocity for Flow over Sphere



Open Calculator

ex
$$66.93112 \text{m/s} = \left(68 \text{m/s} + \frac{9463 \text{m}^3/\text{s}}{4 \cdot \pi \cdot (2.758 \text{m})^3}\right) \cdot \sin(0.7 \text{rad})$$



Variables Used

- C_p Pressure Coefficient
- r Radial Coordinate (Meter)
- R_s Radius of Sphere (Meter)
- V_∞ Freestream Velocity (Meter per Second)
- **V**_r Radial Velocity (Meter per Second)
- V_{s.max} Maximum Surface Velocity (Meter per Second)
- V_A Tangential Velocity (Meter per Second)
- Polar Angle (Radian)
- ↑ Source Strength (Square Meter per Second)
- µ Doublet Strength (Cubic Meter per Second)
- **\(\Phi \)** Velocity Potential (Square Meter per Second)
- Φ_S Source Velocity Potential (Square Meter per Second)





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: modulus, modulus
 Modulus of a number is the remainder when that number is divided by another number.
- 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.
- Function: 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: Speed in Meter per Second (m/s)
 Speed Unit Conversion





- Measurement: Angle in Radian (rad)

 Angle Unit Conversion
- Measurement: Volumetric Flow Rate in Cubic Meter per Second (m³/s)

 Volumetric Flow Rate Unit Conversion
- Measurement: Velocity Potential in Square Meter per Second (m²/s)

 Velocity Potential Unit Conversion





Check other formula lists

- Fundamentals of Inviscid and Incompressible Incompressible Flow Formulas
 Flow Formulas
- Three-Dimensional Incompressible Flow Formulas

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