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Three-Dimensional Incompressible Flow Formulas

Calculators! Examples! Conversions!

List of 29 Three-Dimensional Incompressible Flow Formulas

Three-Dimensional Incompressible Flow

3D Elementry Flows

1) Doublet Strength for 3D Incompressible Flow

Open Calculator

fx $$\mu = -\frac{4 \cdot \pi \cdot \phi \cdot r^2}{\cos(\theta)}$$

ex $$9463.181\text{m}^3/\text{s} = -\frac{4 \cdot \pi \cdot -75.72\text{m}^2/\text{s} \cdot (2.758\text{m})^2}{\cos(0.7\text{rad})}$$

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

Open Calculator

fx $$r = \sqrt{\frac{\text{modulus}(\mu) \cdot \cos(\theta)}{4 \cdot \pi \cdot \text{modulus}(\phi_s)}}$$

ex $$8.484972\text{m} = \sqrt{\frac{\text{modulus}(9463\text{m}^3/\text{s}) \cdot \cos(0.7\text{rad})}{4 \cdot \pi \cdot \text{modulus}(-8\text{m}^2/\text{s})}}$$

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

Open Calculator

fx $$r = \sqrt{\frac{\Lambda}{4 \cdot \pi \cdot V_r}}$$

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

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

Open Calculator

fx $$r = -\frac{\Lambda}{4 \cdot \pi \cdot \phi_s}$$

ex $$2.75537\text{m} = -\frac{277\text{m}^2/\text{s}}{4 \cdot \pi \cdot -8\text{m}^2/\text{s}}$$

5) Radial Velocity for 3D Incompressible Source Flow

Open Calculator

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

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

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

Open Calculator

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

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

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

fx $$\Lambda = -4 \cdot \pi \cdot \phi_s \cdot r$$

Open Calculator

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

8) Velocity Potential for 3D Incompressible Doublet Flow

fx $$\phi = -\frac{\mu \cdot \cos(\theta)}{4 \cdot \pi \cdot r^2}$$

Open Calculator

ex $$-75.71855 \text{m}^2/\text{s} = -\frac{9463 \text{m}^3/\text{s} \cdot \cos(0.7 \text{rad})}{4 \cdot \pi \cdot (2.758 \text{m})^2}$$

9) Velocity Potential for 3D Incompressible Source Flow

fx $$\phi_s = -\frac{\Lambda}{4 \cdot \pi \cdot r}$$

Open Calculator

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

Flow over Sphere

Pressure Coefficient

10) Polar Coordinate given Surface Pressure Coefficient

Open Calculator

fx $$\theta = a\sin\left(\sqrt{\frac{4}{9}\cdot\left(1 - C_p\right)}\right)$$

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

11) Surface Pressure Coefficient for Flow over Sphere

Open Calculator

fx $$C_p = 1 - \frac{9}{4}\cdot\left(\sin(\theta)\right)^2$$

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

Radial Velocity

12) Doublet Strength given Radial Velocity

Open Calculator

fx $$\mu = 2\cdot\pi\cdot r^3\cdot\left(V_\infty + \frac{V_r}{\cos(\theta)}\right)$$

ex $$9463.166\text{m}^3/\text{s} = 2\cdot\pi\cdot(2.758\text{m})^3\cdot\left(68\text{m/s} + \frac{2.9\text{m/s}}{\cos(0.7\text{rad})}\right)$$

13) Freestream Velocity given Radial Velocity

Open Calculator

fx $$V_\infty = \frac{\mu}{2 \cdot \pi \cdot r^3} - \frac{V_r}{\cos(\theta)}$$

ex $$67.99874\text{m/s} = \frac{9463\text{m}^3\text{/s}}{2 \cdot \pi \cdot (2.758\text{m})^3} - \frac{2.9\text{m/s}}{\cos(0.7\text{rad})}$$

14) Polar Coordinate given Radial Velocity

Open Calculator

fx $$\theta = a\cos\left(\frac{V_r}{\frac{\mu}{2 \cdot \pi \cdot r^3} - V_\infty}\right)$$

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

15) Radial Coordinate given Radial Velocity

Open Calculator

fx $$r = \left(\frac{\mu}{2 \cdot \pi \cdot \left(V_\infty + \frac{V_r}{\cos(\theta)}\right)}\right)^{\frac{1}{3}}$$

ex $$2.757984\text{m} = \left(\frac{9463\text{m}^3\text{/s}}{2 \cdot \pi \cdot \left(68\text{m/s} + \frac{2.9\text{m/s}}{\cos(0.7\text{rad})}\right)}\right)^{\frac{1}{3}}$$

16) Radial Velocity for Flow over Sphere

Open Calculator

fx $$V_r = -\left(V_\infty - \frac{\mu}{2 \cdot \pi \cdot r^3}\right) \cdot \cos(\theta)$$

ex $$2.899034\text{m/s} = -\left(68\text{m/s} - \frac{9463\text{m}^3/\text{s}}{2 \cdot \pi \cdot (2.758\text{m})^3}\right) \cdot \cos(0.7\text{rad})$$

Stagnation Point

17) Doublet Strength given Radial Coordinate of Stagnation Point

Open Calculator

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

ex $$9469.87\text{m}^3/\text{s} = 2 \cdot \pi \cdot 68\text{m/s} \cdot (2.809\text{m})^3$$

18) Freestream Velocity at Stagnation Point for Flow over Sphere

Open Calculator

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

ex $$67.95067\text{m/s} = \frac{9463\text{m}^3/\text{s}}{2 \cdot \pi \cdot (2.809\text{m})^3}$$

19) Radial Coordinate of Stagnation Point for Flow over Sphere

Open Calculator

fx $$r = \left(\frac{\mu}{2 \cdot \pi \cdot V_{\infty}} \right)^{\frac{1}{3}}$$

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

Surface Velocity

20) Freestream Velocity given Maximum Surface Velocity

Open Calculator

fx $$V_{\infty} = \frac{2}{3} \cdot V_{s,max}$$

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

21) Freestream Velocity given Surface Velocity for Flow over Sphere

Open Calculator

fx $$V_{\infty} = \frac{2}{3} \cdot \frac{V_{\theta}}{\sin(\theta)}$$

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

Open Calculator

fx $$V_{s,max} = \frac{3}{2} \cdot V_{\infty}$$

ex $$102\mathrm{m/s} = \frac{3}{2} \cdot 68\mathrm{m/s}$$

23) Polar Coordinate given Surface Velocity for Flow over Sphere

Open Calculator

fx $$\theta = a\sin\left(\frac{2}{3} \cdot \frac{V_{\theta}}{V_{\infty}}\right)$$

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

24) Surface Velocity for Incompressible Flow over Sphere

Open Calculator

fx $$V_{\theta} = \frac{3}{2} \cdot V_{\infty} \cdot \sin(\theta)$$

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

Tangential Velocity

25) Doublet Strength given Tangential Velocity

Open Calculator

fx $$\mu = 4 \cdot \pi \cdot r^3 \cdot \left(\frac{V_\theta}{\sin(\theta)} - V_\infty \right)$$

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

26) Freestream Velocity given Tangential Velocity

Open Calculator

fx $$V_\infty = \frac{V_\theta}{\sin(\theta)} - \frac{\mu}{4 \cdot \pi \cdot r^3}$$

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

27) Polar Coordinate given Tangential Velocity

Open Calculator

fx $$\theta = a\sin\left(\frac{V_\theta}{V_\infty + \frac{\mu}{4 \cdot \pi \cdot r^3}} \right)$$

ex $$0.688339\text{rad} = a\sin\left(\frac{66\text{m/s}}{68\text{m/s} + \frac{9463\text{m}^3/\text{s}}{4 \cdot \pi \cdot (2.758\text{m})^3}} \right)$$

28) Radial Coordinate given Tangential Velocity

Open Calculator

fx $$r = \left(\frac{\mu}{4 \cdot \pi \cdot \left(\frac{V_\theta}{\sin(\theta)} - V_\infty \right)} \right)^{\frac{1}{3}}$$

ex $$2.796043\text{m} = \left(\frac{9463\text{m}^3/\text{s}}{4 \cdot \pi \cdot \left(\frac{66\text{m/s}}{\sin(0.7\text{rad})} - 68\text{m/s} \right)} \right)^{\frac{1}{3}}$$

29) Tangential Velocity for Flow over Sphere

Open Calculator

fx $$V_\theta = \left(V_\infty + \frac{\mu}{4 \cdot \pi \cdot r^3} \right) \cdot \sin(\theta)$$

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_θ Tangential Velocity *(Meter per Second)*
- θ Polar Angle *(Radian)*
- Λ Source Strength *(Square Meter per Second)*
- μ Doublet Strength *(Cubic Meter per Second)*
- ϕ 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 (m^3/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Velocity Potential** in Square Meter per Second (m^2/s)
  Velocity Potential Unit Conversion

Check other formula lists

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

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