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Hyperbolic Orbits Formulas

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List of 11 Hyperbolic Orbits Formulas

Hyperbolic Orbits

1) Aiming Radius in Hyperbolic Orbit given Semi-Major Axis and Eccentricity

Open Calculator

fx $$\Delta = a_h \cdot \sqrt{e_h^2 - 1}$$

ex $$18334.59\text{km} = 20590\text{km} \cdot \sqrt{(1.339)^2 - 1}$$

2) Perigee Radius of Hyperbolic Orbit given Angular Momentum and Eccentricity

Open Calculator

fx $$r_{perigee} = \frac{h^2}{[GM.Earth] \cdot (1 + e_h)}$$

ex $$4636.855\text{km} = \frac{(65750\text{km}^2/\text{s})^2}{[GM.Earth] \cdot (1 + 1.339)}$$

3) Radial Position in Hyperbolic Orbit given Angular Momentum, True Anomaly, and Eccentricity

Open Calculator

fx $$r = \frac{h^2}{[GM.Earth] \cdot (1 + e_h \cdot \cos(\theta))}$$

ex $$19227.6\text{km} = \frac{(65750\text{km}^2/\text{s})^2}{[GM.Earth] \cdot (1 + 1.339 \cdot \cos(109^\circ))}$$

4) Semi-Major Axis of Hyperbolic Orbit given Angular Momentum and Eccentricity

Open Calculator

fx $$a_h = \frac{h^2}{[GM.Earth] \cdot \left(e_h^2 - 1\right)}$$

ex $$13678.04\text{km} = \frac{(65750\text{km}^2/\text{s})^2}{[GM.Earth] \cdot \left((1.339)^2 - 1\right)}$$

5) True Anomaly of Asymptote in Hyperbolic Orbit given Eccentricity

Open Calculator

fx $$\theta_{inf} = a\cos\left(-\frac{1}{e_h}\right)$$

ex $$138.3162^\circ = a\cos\left(-\frac{1}{1.339}\right)$$

6) Turn Angle given Eccentricity

Open Calculator

fx $$\delta = 2 \cdot a\sin\left(\frac{1}{e_h}\right)$$

ex $$96.63236^\circ = 2 \cdot a\sin\left(\frac{1}{1.339}\right)$$

Orbital Position as Function of Time

7) Hyperbolic Eccentric Anomaly given Eccentricity and True Anomaly

Open Calculator

fx $$F = 2 \cdot a\tanh\left(\sqrt{\frac{e_h - 1}{e_h + 1}} \cdot \tan\left(\frac{\theta}{2}\right)\right)$$

ex $$1.190676\text{rad} = 2 \cdot a\tanh\left(\sqrt{\frac{1.339 - 1}{1.339 + 1}} \cdot \tan\left(\frac{109^\circ}{2}\right)\right)$$

8) Mean Anomaly in Hyperbolic Orbit given Hyperbolic Eccentric Anomaly

Open Calculator

fx $$M_h = e_h \cdot \sinh(F) - F$$

ex $$4.310592\text{rad} = 1.339 \cdot \sinh(2.3\text{rad}) - 2.3\text{rad}$$

9) Time since Periapsis in Hyperbolic Orbit given Hyperbolic Eccentric Anomaly

Open Calculator

fx $$t = \frac{h^3}{[GM.Earth]^2 \cdot \left(e_h^2 - 1\right)^{\frac{3}{2}}} \cdot \left(e_h \cdot \sinh(F) - F\right)$$

ex $$10922.04\text{s} = \frac{(65750\text{km}^2/\text{s})^3}{[GM.Earth]^2 \cdot \left((1.339)^2 - 1\right)^{\frac{3}{2}}} \cdot (1.339 \cdot \sinh(2.3\text{rad}) - 2.3\text{rad})$$

10) Time since Periapsis in Hyperbolic Orbit given Mean Anomaly

Open Calculator

fx $$t = \frac{h^3}{[GM.Earth]^2 \cdot \left(e_h^2 - 1\right)^{\frac{3}{2}}} \cdot M_h$$

ex $$28378.2\text{s} = \frac{(65750\text{km}^2/\text{s})^3}{[GM.Earth]^2 \cdot \left((1.339)^2 - 1\right)^{\frac{3}{2}}} \cdot 11.2\text{rad}$$

11) True Anomaly in Hyperbolic Orbit given Hyperbolic Eccentric Anomaly and Eccentricity

Open Calculator

fx $$\theta = 2 \cdot a\tan\left(\sqrt{\frac{e_h + 1}{e_h - 1}} \cdot \tanh\left(\frac{F}{2}\right)\right)$$

ex $$130.0718^\circ = 2 \cdot a\tan\left(\sqrt{\frac{1.339 + 1}{1.339 - 1}} \cdot \tanh\left(\frac{2.3\text{rad}}{2}\right)\right)$$

Variables Used

- a_h Semi Major Axis of Hyperbolic Orbit *(Kilometer)*
- e_h Eccentricity of Hyperbolic Orbit
- F Eccentric Anomaly in Hyperbolic Orbit *(Radian)*
- h Angular Momentum of Orbit *(Square Kilometer per Second)*
- M_h Mean Anomaly in Hyperbolic Orbit *(Radian)*
- r Radial Position of Satellite *(Kilometer)*
- $r_{perigee}$ Perigee Radius *(Kilometer)*
- t Time since Periapsis *(Second)*
- δ Turn Angle *(Degree)*
- Δ Aiming Radius *(Kilometer)*
- θ True Anomaly *(Degree)*
- θ_{inf} True Anomaly of Asymptote in Hyperbolic Orbit *(Degree)*

Constants, Functions, Measurements used

- Constant: **[GM.Earth]**, 3.986004418×10^14 m^3 s^−2
  Earth's Geocentric Gravitational Constant
- Function: **acos**, acos(Number)
  Inverse trigonometric cosine function
- Function: **asin**, asin(Number)
  Inverse trigonometric sine function
- Function: **atan**, atan(Number)
  Inverse trigonometric tangent function
- Function: **atanh**, atanh(Number)
  Inverse hyperbolic tangent function
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **sinh**, sinh(Number)
  Hyperbolic sine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Function: **tan**, tan(Angle)
  Trigonometric tangent function
- Function: **tanh**, tanh(Number)
  Hyperbolic tangent function
- Measurement: **Length** in Kilometer (km)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Angle** in Degree (°), Radian (rad)
  Angle Unit Conversion

- Measurement: **Specific Angular Momentum** in Square Kilometer per Second (km²/s)
  Specific Angular Momentum Unit Conversion

Check other formula lists

- **Elliptical Orbits Formulas**
- **Hyperbolic Orbits Formulas**
- **Parabolic Orbits Formulas**

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