Hyperbolic Orbits Formulas

List of 11 Hyperbolic Orbits Formulas

Hyperbolic Orbits

Hperbolic Orbit Parameters

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 $$12161.92\text{km} = 13658\text{km} \cdot \sqrt{(1.339)^2 - 1}$$

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

Open Calculator

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

ex $$4629.805\text{km} = \frac{(65700\text{km}^2/\text{s})^2}{[\text{GM.Earth}] \cdot (1 + 1.339)}$$

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

Open Calculator

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

ex $$19198.37\text{km} = \frac{(65700\text{km}^2/\text{s})^2}{[\text{GM.Earth}] \cdot (1 + 1.339 \cdot \cos(109°))}$$

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

Open Calculator

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

ex $$13657.24\text{km} = \frac{(65700\text{km}^2/\text{s})^2}{[GM.Earth] \cdot \left((1.339)^2 - 1\right)}$$

5) True Anomaly of Asymptote in Hyperbolic Orbit given Eccentricity

Open Calculator

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

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

6) Turn Angle given Eccentricity

Open Calculator

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

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

Orbital Position as Function of Time

7) Hyperbolic Eccentric Anomaly given Eccentricity and True Anomaly

Open Calculator

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

ex $$68.22073° = 2 \cdot a\tanh\left(\sqrt{\frac{1.339 - 1}{1.339 + 1}} \cdot \tan\left(\frac{109°}{2}\right)\right)$$

8) Mean Anomaly in Hyperbolic Orbit given Hyperbolic Eccentric Anomaly

Open Calculator

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

ex $$46.29253° = 1.339 \cdot \sinh(68.22°) - 68.22°$$

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

Open Calculator

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

ex $$2042.509\mathrm{s} = \frac{\left(65700\mathrm{km^2/s}\right)^3}{[\mathrm{GM.Earth}]^2 \cdot \left((1.339)^2 - 1\right)^{\frac{3}{2}}} \cdot \left(1.339 \cdot \sinh(68.22°) - 68.22°\right)$$

10) Time since Periapsis in Hyperbolic Orbit given Mean Anomaly

Open Calculator

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

ex $$2042.397s = \frac{\left(65700km^2/s\right)^3}{[GM.Earth]^2 \cdot \left((1.339)^2 - 1\right)^{\frac{3}{2}}} \cdot 46.29°$$

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 $$108.9995° = 2 \cdot a\tan\left(\sqrt{\frac{1.339 + 1}{1.339 - 1}} \cdot \tanh\left(\frac{68.22°}{2}\right)\right)$$

Variables Used

- a_h Semi Major Axis of Hyperbolic Orbit *(Kilometer)*
- e_h Eccentricity of Hyperbolic Orbit
- F Eccentric Anomaly in Hyperbolic Orbit *(Degree)*
- h_h Angular Momentum of Hyperbolic Orbit *(Square Kilometer per Second)*
- M_h Mean Anomaly in Hyperbolic Orbit *(Degree)*
- r_h Radial Position in Hyperbolic Orbit *(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]**, 3.986004418E+14
  Earth's Geocentric Gravitational 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: **atan**, atan(Number)
  Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.
- Function: **atanh**, atanh(Number)
  The inverse hyperbolic tangent function returns the value whose hyperbolic tangent is a number.
- 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: **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: **sinh**, sinh(Number)
  The hyperbolic sine function, also known as the sinh function, is a mathematical function that is defined as the hyperbolic analogue of the sine function.
- 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.
- Function: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.

- Function: **tanh**, tanh(Number)
  The hyperbolic tangent function (tanh) is a function that is defined as the ratio of the hyperbolic sine function (sinh) to the hyperbolic cosine function (cosh).
- Measurement: **Length** in Kilometer (km)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Specific Angular Momentum** in Square Kilometer per Second (km^2/s)
  Specific Angular Momentum Unit Conversion

Check other formula lists

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

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