Important Parabolic Orbits Formulas PDF

Formulas
Examples
with Units

List of 14
Important Parabolic Orbits Formulas

1) Orbital Position as Function of Time Formulas

1.1) Mean Anomaly in Parabolic Orbit given Time since Periapsis Formula

Evaluate Formula

Formula

$$M_p = \frac{[GM.Earth]^2 \cdot t_p}{h_p^3}$$

Example with Units

$$82.0039° = \frac{4E+14 \, m^3/s^2{}^2 \cdot 3578 \, s}{73508 \, km^2/s{}^3}$$

1.2) Mean Anomaly in Parabolic Orbit given True Anomaly Formula

Evaluate Formula

Formula

$$M_p = \frac{\tan\left(\frac{\theta_p}{2}\right)}{2} + \frac{\tan\left(\frac{\theta_p}{2}\right)^3}{6}$$

Example with Units

$$81.9007° = \frac{\tan\left(\frac{115°}{2}\right)}{2} + \frac{\tan\left(\frac{115°}{2}\right)^3}{6}$$

1.3) Time since Periapsis in Parabolic Orbit given Mean Anomaly Formula

Evaluate Formula

Formula

$$t_p = \frac{h_p^3 \cdot M_p}{[GM.Earth]^2}$$

Example with Units

$$3577.8282 \, s = \frac{73508 \, km^2/s{}^3 \cdot 82°}{4E+14 \, m^3/s^2{}^2}$$

1.4) True Anomaly in Parabolic Orbit given Mean Anomaly Formula

Evaluate Formula

Formula

$$\theta_p = 2 \cdot atan\left(\left(3 \cdot M_p + \sqrt{\left(3 \cdot M_p\right)^2 + 1}\right)^{\frac{1}{3}} - \left(3 \cdot M_p + \sqrt{\left(3 \cdot M_p\right)^2 + 1}\right)^{-\frac{1}{3}}\right)$$

Example with Units

$$115.0331° = 2 \cdot atan\left(\left(3 \cdot 82° + \sqrt{\left(3 \cdot 82°\right)^2 + 1}\right)^{\frac{1}{3}} - \left(3 \cdot 82° + \sqrt{\left(3 \cdot 82°\right)^2 + 1}\right)^{-\frac{1}{3}}\right)$$

2) Parabolic Orbit Parameters Formulas

2.1) Angular Momentum given Perigee Radius of Parabolic Orbit Formula

Evaluate Formula

Formula

$$h_p = \sqrt{2 \cdot [GM.Earth] \cdot r_{p,perigee}}$$

Example with Units

$$73508.0104\,\mathrm{km^2/s} = \sqrt{2 \cdot 4E{+}14\,\mathrm{m^3/s^2} \cdot 6778\,\mathrm{km}}$$

2.2) Escape Velocity given Radius of Parabolic Trajectory Formula

Evaluate Formula

Formula

$$v_{p,esc} = \sqrt{\frac{2 \cdot [GM.Earth]}{r_p}}$$

Example with Units

$$5.827\,\mathrm{km/s} = \sqrt{\frac{2 \cdot 4E{+}14\,\mathrm{m^3/s^2}}{23479\,\mathrm{km}}}$$

2.3) Parameter of Orbit given X Coordinate of Parabolic Trajectory Formula

Evaluate Formula

Formula

$$p_p = x \cdot \frac{1 + \cos(\theta_p)}{\cos(\theta_p)}$$

Example with Units

$$10801.1897\,\mathrm{km} = -7906\,\mathrm{km} \cdot \frac{1 + \cos(115°)}{\cos(115°)}$$

2.4) Parameter of Orbit given Y Coordinate of Parabolic Trajectory Formula

Evaluate Formula

Formula

$$p_p = y \cdot \frac{1 + \cos(\theta_p)}{\sin(\theta_p)}$$

Example with Units

$$10800.2521\,\mathrm{km} = 16953\,\mathrm{km} \cdot \frac{1 + \cos(115°)}{\sin(115°)}$$

2.5) Perigee Radius of Parabolic Orbit given Angular Momentum Formula

Evaluate Formula

Formula

$$r_{p,perigee} = \frac{h_p^{\,2}}{2 \cdot [GM.Earth]}$$

Example with Units

$$6777.9981\,\mathrm{km} = \frac{\left(73508\,\mathrm{km^2/s}\right)^2}{2 \cdot 4E{+}14\,\mathrm{m^3/s^2}}$$

2.6) Radial Position in Parabolic Orbit given Angular Momentum and True Anomaly Formula

Evaluate Formula

Formula

$$r_p = \frac{h_p^{\,2}}{[GM.Earth] \cdot \left(1 + \cos(\theta_p)\right)}$$

Example with Units

$$23478.3944\,\mathrm{km} = \frac{\left(73508\,\mathrm{km^2/s}\right)^2}{4E{+}14\,\mathrm{m^3/s^2} \cdot \left(1 + \cos(115°)\right)}$$

2.7) Radial Position in Parabolic Orbit given Escape Velocity Formula

Evaluate Formula

Formula

$$r_p = \frac{2 \cdot [GM.Earth]}{v_{p,esc}^2}$$

Example with Units

$$23478.9961\,km = \frac{2 \cdot 4E{+}14\,m^3/s^2}{5.826988\,km/s^2}$$

2.8) True Anomaly in Parabolic Orbit given Radial Position and Angular Momentum Formula

Evaluate Formula

Formula

$$\theta_p = acos\left(\frac{h_p^2}{[GM.Earth] \cdot r_p} - 1\right)$$

Example with Units

$$115.0009° = acos\left(\frac{73508\,km^2/s^2}{4E{+}14\,m^3/s^2 \cdot 23479\,km} - 1\right)$$

2.9) X Coordinate of Parabolic Trajectory given Parameter of Orbit Formula

Evaluate Formula

Formula

$$x = p_p \cdot \left(\frac{\cos(\theta_p)}{1 + \cos(\theta_p)}\right)$$

Example with Units

$$-7905.1292\,km = 10800\,km \cdot \left(\frac{\cos(115°)}{1 + \cos(115°)}\right)$$

2.10) Y Coordinate of Parabolic Trajectory given Parameter of Orbit Formula

Evaluate Formula

Formula

$$y = p_p \cdot \frac{\sin(\theta_p)}{1 + \cos(\theta_p)}$$

Example with Units

$$16952.6042\,km = 10800\,km \cdot \frac{\sin(115°)}{1 + \cos(115°)}$$

Variables used in list of Parabolic Orbits Formulas above

- h_p Angular Momentum of Parabolic Orbit *(Square Kilometer per Second)*
- M_p Mean Anomaly in Parabolic Orbit *(Degree)*
- p_p Parameter of Parabolic Orbit *(Kilometer)*
- r_p Radial Position in Parabolic Orbit *(Kilometer)*
- $r_{p,perigee}$ Perigee Radius in Parabolic Orbit *(Kilometer)*
- t_p Time since Periapsis in Parabolic Orbit *(Second)*
- $v_{p,esc}$ Escape Velocity in Parabolic Orbit *(Kilometer per Second)*
- **x** X Coordinate Value *(Kilometer)*
- **y** Y Coordinate Value *(Kilometer)*
- θ_p True Anomaly in Parabolic Orbit *(Degree)*

Constants, Functions, Measurements used in list of Parabolic Orbits Formulas above

- constant(s): **[GM.Earth]**, 3.986004418E+14
  Earth's Geocentric Gravitational Constant
- Functions: **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.
- Functions: **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.
- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Functions: **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.
- Functions: **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.
- Functions: **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.
- Measurement: **Length** in Kilometer (km)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Speed** in Kilometer per Second (km/s)
  Speed Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Specific Angular Momentum** in Square Kilometer per Second (km²/s)
  Specific Angular Momentum Unit Conversion

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