Elliptical Orbits Formulas

List of 23 Elliptical Orbits Formulas

Elliptical Orbits

Elliptical Orbit Parameters

1) Angular Momentum in Elliptic Orbit Given Apogee Radius and Apogee Velocity

Open Calculator

fx $h_e = r_{e,apogee} \cdot v_{apogee}$

ex $65750 \text{km}^2/\text{s} = 27110 \text{km} \cdot 2.425304316 \text{km/s}$

2) Angular Momentum in Elliptic Orbit Given Perigee Radius and Perigee Velocity

Open Calculator

fx $h_e = r_{e,perigee} \cdot v_{perigee}$

ex $65749.99 \text{km}^2/\text{s} = 6778 \text{km} \cdot 9.7005 \text{km/s}$

3) Apogee Radius of Elliptic Orbit Given Angular Momentum and Eccentricity

Open Calculator

fx $$r_{e,apogee} = \frac{h_e^2}{[\text{GM.Earth}] \cdot (1 - e_e)}$$

ex $$27114.01 \text{km} = \frac{(65750 \text{km}^2/\text{s})^2}{[\text{GM.Earth}] \cdot (1 - 0.6)}$$

4) Apogee Velocity in Elliptic Orbit Given Angular Momentum and Apogee Radius

Open Calculator

fx $$v_{apogee} = \frac{h_e}{r_{e,apogee}}$$

ex $$2.425304\text{km/s} = \frac{65750\text{km}^2/\text{s}}{27110\text{km}}$$

5) Azimuth-Averaged Radius Given Apogee and Perigee Radii

Open Calculator

fx $$r_\theta = \sqrt{r_{e,apogee} \cdot r_{e,perigee}}$$

ex $$13555.5\text{km} = \sqrt{27110\text{km} \cdot 6778\text{km}}$$

6) Eccentricity of Elliptical Orbit given Apogee and Perigee

Open Calculator

fx $$e_e = \frac{r_{e,apogee} - r_{e,perigee}}{r_{e,apogee} + r_{e,perigee}}$$

ex $$0.599976 = \frac{27110\text{km} - 6778\text{km}}{27110\text{km} + 6778\text{km}}$$

7) Eccentricity of Orbit

Open Calculator

fx $$e_e = \frac{d_{foci}}{2 \cdot a_e}$$

ex $$0.602125 = \frac{20400\text{km}}{2 \cdot 16940\text{km}}$$

8) Elliptical Orbit Time Period given Angular Momentum and Eccentricity

Open Calculator

fx $$T_e = \frac{2 \cdot \pi}{[GM.Earth]^2} \cdot \left(\frac{h_e}{\sqrt{1 - e_e^2}} \right)^3$$

ex $$21954.4s = \frac{2 \cdot \pi}{[GM.Earth]^2} \cdot \left(\frac{65750km^2/s}{\sqrt{1 - (0.6)^2}} \right)^3$$

9) Radial Velocity in Elliptic Orbit given Radial Position and Angular Momentum

Open Calculator

fx $$v_r = \frac{h_e}{r_e}$$

ex $$3.48529km/s = \frac{65750km^2/s}{18865km}$$

10) Radial Velocity in Elliptic Orbit given True Anomaly, Eccentricity, and Angular Momentum

Open Calculator

fx $$v_r = [GM.Earth] \cdot e_e \cdot \frac{\sin(\theta_e)}{h_e}$$

ex $$2.567101km/s = [GM.Earth] \cdot 0.6 \cdot \frac{\sin(135.11°)}{65750km^2/s}$$

11) Semimajor Axis of Elliptic Orbit given Apogee and Perigee Radii

Open Calculator

fx $$a_e = \frac{r_{e,apogee} + r_{e,perigee}}{2}$$

ex $$16944\text{km} = \frac{27110\text{km} + 6778\text{km}}{2}$$

12) Specific Energy of Elliptic Orbit given Angular Momentum

Open Calculator

fx $$\varepsilon_e = -\frac{1}{2} \cdot \frac{[\text{GM.Earth}]^2}{h_e^2} \cdot \left(1 - e_e^2\right)$$

ex $$-11760.722845\text{kJ/kg} = -\frac{1}{2} \cdot \frac{[\text{GM.Earth}]^2}{(65750\text{km}^2/\text{s})^2} \cdot \left(1 - (0.6)^2\right)$$

13) Specific Energy of Elliptic Orbit given Semi Major Axis

Open Calculator

fx $$\varepsilon_e = -\frac{[\text{GM.Earth}]}{2 \cdot a_e}$$

ex $$-11765.066169\text{kJ/kg} = -\frac{[\text{GM.Earth}]}{2 \cdot 16940\text{km}}$$

14) Time Period for One Complete Revolution given Angular Momentum

Open Calculator

fx $$T_e = \frac{2 \cdot \pi \cdot a_e \cdot b_e}{h_e}$$

ex $$21230.77\text{s} = \frac{2 \cdot \pi \cdot 16940\text{km} \cdot 13115\text{km}}{65750\text{km}^2/\text{s}}$$

15) Time Period of Elliptical Orbit given Angular Momentum

Open Calculator

fx $$T_e = \frac{2 \cdot \pi}{[\text{GM.Earth}]^2} \cdot \left(\frac{h_e}{\sqrt{1 - e_e^2}} \right)^3$$

ex $$21954.4\text{s} = \frac{2 \cdot \pi}{[\text{GM.Earth}]^2} \cdot \left(\frac{65750\text{km}^2/\text{s}}{\sqrt{1 - (0.6)^2}} \right)^3$$

16) Time Period of Elliptical Orbit given Semi-Major Axis

Open Calculator

fx $$T_e = 2 \cdot \pi \cdot a_e^2 \cdot \frac{\sqrt{1 - e_e^2}}{h_e}$$

ex $$21938.2\text{s} = 2 \cdot \pi \cdot (16940\text{km})^2 \cdot \frac{\sqrt{1 - (0.6)^2}}{65750\text{km}^2/\text{s}}$$

17) True Anomaly in Elliptic Orbit Given Radial Position, Eccentricity, and Angular Momentum

Open Calculator

fx $$\theta_e = a\cos\left(\frac{\frac{h_e^2}{[GM.Earth] \cdot r_e} - 1}{e_e}\right)$$

ex $$135.1122° = a\cos\left(\frac{\frac{(65750 km^2/s)^2}{[GM.Earth] \cdot 18865 km} - 1}{0.6}\right)$$

Orbital Position as Function of Time

18) Eccentric Anomaly in Elliptic Orbit given True Anomaly and Eccentricity

Open Calculator

fx $$E = 2 \cdot a\tan\left(\sqrt{\frac{1 - e_e}{1 + e_e}} \cdot \tan\left(\frac{\theta_e}{2}\right)\right)$$

ex $$100.8744° = 2 \cdot a\tan\left(\sqrt{\frac{1 - 0.6}{1 + 0.6}} \cdot \tan\left(\frac{135.11°}{2}\right)\right)$$

19) Mean Anomaly in Elliptic Orbit given Eccentric Anomaly and Eccentricity

Open Calculator

fx $$M_e = E - e_e \cdot \sin(E)$$

ex $$67.1138° = 100.874° - 0.6 \cdot \sin(100.874°)$$

20) Mean Anomaly in Elliptic Orbit given Time since Periapsis

Open Calculator

fx $$M_e = \frac{2 \cdot \pi \cdot t_e}{T_e}$$

ex $$67.39726° = \frac{2 \cdot \pi \cdot 4100s}{21900s}$$

21) Time since Periapsis in Elliptic Orbit given Eccentric Anomaly and Time Period

Open Calculator

fx $$t_e = (E - e_e \cdot \sin(E)) \cdot \frac{T_e}{2 \cdot \Pi(6)}$$

ex $$4275.452s = (100.874° - 0.6 \cdot \sin(100.874°)) \cdot \frac{21900s}{2 \cdot \Pi(6)}$$

22) Time since Periapsis in Elliptic Orbit given Mean Anomaly

Open Calculator

fx $$t_e = M_e \cdot \frac{T_e}{2 \cdot \pi}$$

ex $$4091.042s = 67.25° \cdot \frac{21900s}{2 \cdot \pi}$$

23) True Anomaly in Elliptic Orbit given Eccentric Anomaly and Eccentricity

Open Calculator

fx $$\theta_e = 2 \cdot a\tan\left(\sqrt{\frac{1+e_e}{1-e_e}} \cdot \tan\left(\frac{E}{2}\right)\right)$$

ex $$135.1097° = 2 \cdot a\tan\left(\sqrt{\frac{1+0.6}{1-0.6}} \cdot \tan\left(\frac{100.874°}{2}\right)\right)$$

Variables Used

- a_e Semi Major Axis of Elliptic Orbit *(Kilometer)*
- b_e Semi Minor Axis of Elliptic Orbit *(Kilometer)*
- d_{foci} Distance Between Two Foci *(Kilometer)*
- E Eccentric Anomaly *(Degree)*
- e_e Eccentricity of Elliptical Orbit
- h_e Angular Momentum of Elliptic Orbit *(Square Kilometer per Second)*
- M_e Mean Anomaly in Elliptical Orbit *(Degree)*
- r_e Radial Position in Elliptical Orbit *(Kilometer)*
- $r_{e,apogee}$ Apogee Radius in Elliptic Orbit *(Kilometer)*
- $r_{e,perigee}$ Perigee Radius in Elliptic Orbit *(Kilometer)*
- $r_θ$ Azimuth Averaged Radius *(Kilometer)*
- t_e Time since Periapsis in Elliptical Orbit *(Second)*
- T_e Time Period of Elliptic Orbit *(Second)*
- v_{apogee} Velocity of Satellite at Apogee *(Kilometer per Second)*
- $v_{perigee}$ Velocity of Satellite at Perigee *(Kilometer per Second)*
- v_r Radial Velocity of Satellite *(Kilometer per Second)*
- $ε_e$ Specific Energy of Elliptical Orbit *(Kilojoule per Kilogram)*
- $θ_e$ True Anomaly in Elliptical Orbit *(Degree)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- 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: **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: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **Pi**, Pi(Number)
  The prime-counting function is a function in mathematics that counts the number of prime numbers that are less than or equal to a given real 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.
- 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.

- 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 Energy** in Kilojoule per Kilogram (kJ/kg)
  Specific Energy Unit Conversion
- Measurement: **Specific Angular Momentum** in Square Kilometer per Second (km^2/s)
  Specific Angular Momentum Unit Conversion

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