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Circular Orbits Formulas

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List of 18 Circular Orbits Formulas

Circular Orbits

Circular Orbit Parameters

1) Circular Orbital Radius

$$\text{fx } r = \frac{h_c^2}{[GM.Earth]}$$

Open Calculator 

$$\text{ex } 10858.47\text{km} = \frac{(65789\text{km}^2/\text{s})^2}{[GM.Earth]}$$

2) Circular Orbital Radius Given Time Period of Circular Orbit

$$\text{fx } r = \left(\frac{T_{\text{or}} \cdot \sqrt{[GM.Earth]}}{2 \cdot \pi} \right)^{\frac{2}{3}}$$

Open Calculator 

$$\text{ex } 10859.33\text{km} = \left(\frac{11262\text{s} \cdot \sqrt{[GM.Earth]}}{2 \cdot \pi} \right)^{\frac{2}{3}}$$



3) Circular Orbital Radius Given Velocity of Circular Orbit

$$fx \quad r = \frac{[GM.Earth]}{v_{cir}^2}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 10889.98km = \frac{[GM.Earth]}{(6.05km/s)^2}$$

4) Escape Velocity given Speed of Satellite in Circular Orbit

$$fx \quad v_{esc} = \sqrt{2} \cdot v_{cir}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 8.555992km/s = \sqrt{2} \cdot 6.05km/s$$

5) Orbital Period

$$fx \quad T_{or} = 2 \cdot \pi \cdot \sqrt{\frac{r^3}{[G.] \cdot M}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 11235.52s = 2 \cdot \pi \cdot \sqrt{\frac{(10859km)^3}{[G.] \cdot 6E^{24}kg}}$$

6) Orbital Radius Given Specific Energy of Circular Orbit

$$fx \quad r = -\frac{[GM.Earth]}{2 \cdot \epsilon}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 10858.68km = -\frac{[GM.Earth]}{2 \cdot -18354kJ/kg}$$



7) Specific Energy of Circular Orbit

[Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5_img.jpg\)](#)

$$\text{fx } \varepsilon = - \frac{[\text{GM.Earth}]^2}{2 \cdot h_c^2}$$

$$\text{ex } -18354.349007\text{kJ/kg} = - \frac{[\text{GM.Earth}]^2}{2 \cdot (65789\text{km}^2/\text{s})^2}$$

8) Specific Energy of Circular Orbit Given Orbital Radius

[Open Calculator !\[\]\(ec9132f1d27c8919987d92907322654d_img.jpg\)](#)

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

$$\text{ex } -18353.459886\text{kJ/kg} = - \frac{[\text{GM.Earth}]}{2 \cdot 10859\text{km}}$$

9) Speed of Satellite in Circular LEO as Function of Altitude

[Open Calculator !\[\]\(758ebdf4629c903da74c2e079717ae32_img.jpg\)](#)

$$\text{fx } v = \sqrt{\frac{[\text{GM.Earth}]}{[\text{Earth-R}] + z}}$$

$$\text{ex } 3.142202\text{km/s} = \sqrt{\frac{[\text{GM.Earth}]}{[\text{Earth-R}] + 34000\text{km}}}$$



10) Time Period of Circular Orbit

$$\text{fx } T_{\text{or}} = \frac{2 \cdot \pi \cdot r^{\frac{3}{2}}}{\sqrt{[GM.\text{Earth}]}}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$\text{ex } 11261.49\text{s} = \frac{2 \cdot \pi \cdot (10859\text{km})^{\frac{3}{2}}}{\sqrt{[GM.\text{Earth}]}}$$

11) Velocity of Circular Orbit

$$\text{fx } v_{\text{cir}} = \sqrt{\frac{[GM.\text{Earth}]}{r}}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$\text{ex } 6.058624\text{km/s} = \sqrt{\frac{[GM.\text{Earth}]}{10859\text{km}}}$$

Geostationary Earth Satellite

12) Absolute Angular Velocity given Geo Radius of Earth and Geo Speed



$$\text{fx } \Omega_E = \frac{v}{R_{\text{gso}}}$$

[Open Calculator !\[\]\(799877f5c2f906134441300079881630_img.jpg\)](#)

$$\text{ex } 7.3\text{E}^{-5}\text{rad/s} = \frac{3.07\text{km/s}}{42164.17\text{km}}$$



13) Absolute Angular Velocity of Earth given Geo Radius

[Open Calculator !\[\]\(eafc244b53721dd1ec133f0772f70fc7_img.jpg\)](#)

$$\text{fx } \Omega_E = \sqrt{\frac{[\text{GM.Earth}]}{R_{\text{gso}}^3}}$$

$$\text{ex } 7.3\text{E}^{-5}\text{rad/s} = \sqrt{\frac{[\text{GM.Earth}]}{(42164.17\text{km})^3}}$$

14) Geo Radius given Absolute Angular Velocity of Earth

[Open Calculator !\[\]\(10f8862fc183b400327470ea85afe9ae_img.jpg\)](#)

$$\text{fx } R_{\text{gso}} = \left(\frac{[\text{GM.Earth}]}{\Omega_E^2} \right)^{\frac{1}{3}}$$

$$\text{ex } 42164.17\text{km} = \left(\frac{[\text{GM.Earth}]}{(7.2921159\text{E}^{-05}\text{rad/s})^2} \right)^{\frac{1}{3}}$$

15) Geo Radius given Absolute Angular Velocity of Earth and Geo Speed

[Open Calculator !\[\]\(35dc653d59570f8f891c312eeece91a2_img.jpg\)](#)

$$\text{fx } R_{\text{gso}} = \frac{v}{\Omega_E}$$

$$\text{ex } 42100.26\text{km} = \frac{3.07\text{km/s}}{7.2921159\text{E}^{-05}\text{rad/s}}$$



16) Geo Radius given Speed of Satellite in its Circular Geo Orbit

$$fx \quad R_{gso} = \frac{[GM.Earth]}{v^2}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$ex \quad 42292.27km = \frac{[GM.Earth]}{(3.07km/s)^2}$$

17) Geo Speed along its Circular Path given Absolute Angular Velocity of Earth

$$fx \quad v = \Omega_E \cdot R_{gso}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

$$ex \quad 3.07466km/s = 7.2921159E^{-05}rad/s \cdot 42164.17km$$

18) Speed of Satellite in its Circular GEO of Radius

$$fx \quad v = \sqrt{\frac{[GM.Earth]}{R_{gso}}}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2_img.jpg\)](#)

$$ex \quad 3.07466km/s = \sqrt{\frac{[GM.Earth]}{42164.17km}}$$










Variables Used

- h_c Angular Momentum of Circular Orbit (Square Kilometer per Second)
- M Central Body Mass (Kilogram)
- r Orbit Radius (Kilometer)
- R_{gso} Geostationary Radius (Kilometer)
- T_{or} Time Period of Orbit (Second)
- v Speed of Satellite (Kilometer per Second)
- v_{cir} Velocity of Circular Orbit (Kilometer per Second)
- v_{esc} Escape Velocity (Kilometer per Second)
- z Height of Satellite (Kilometer)
- ϵ Specific Energy of Orbit (Kilojoule per Kilogram)
- Ω_E Angular Speed of the Earth (Radian per Second)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Constant:** **[Earth-R]**, 6371.0088
Earth mean radius
- **Constant:** **[GM.Earth]**, 3.986004418E+14
Earth's Geocentric Gravitational Constant
- **Constant:** **[G.]**, 6.67408E-11
Gravitational constant
- **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 Kilometer (km)
Length Unit Conversion 
- **Measurement:** **Weight** in Kilogram (kg)
Weight Unit Conversion 
- **Measurement:** **Time** in Second (s)
Time Unit Conversion 
- **Measurement:** **Speed** in Kilometer per Second (km/s)
Speed Unit Conversion 
- **Measurement:** **Angular Velocity** in Radian per Second (rad/s)
Angular Velocity Unit Conversion 
- **Measurement:** **Specific Energy** in Kilojoule per Kilogram (kJ/kg)
Specific Energy Unit Conversion 
- **Measurement:** **Specific Angular Momentum** in Square Kilometer per Second (km²/s)
Specific Angular Momentum Unit Conversion 



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- [Elliptical Orbits Formulas](#) 
- [Hyperbolic Orbits Formulas](#) 
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