Important Circular Orbits Formulas PDF

Formulas
Examples
with Units

List of 18
Important Circular Orbits Formulas

1) Circular Orbit Parameters Formulas

1.1) Circular Orbital Radius Formula

Evaluate Formula

Formula

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

Example with Units

$$10858.474\,\text{km} = \frac{65789\,\text{km}^2/\text{s}^2}{4\text{E}{+}14\,\text{m}^3/\text{s}^2}$$

1.2) Circular Orbital Radius Given Time Period of Circular Orbit Formula

Evaluate Formula

Formula

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

Example with Units

$$10859.3299\,\text{km} = \left(\frac{11262\,\text{s} \cdot \sqrt{4\text{E}{+}14\,\text{m}^3/\text{s}^2}}{2 \cdot 3.1416}\right)^{\frac{2}{3}}$$

1.3) Circular Orbital Radius Given Velocity of Circular Orbit Formula

Evaluate Formula

Formula

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

Example with Units

$$10889.9786\,\text{km} = \frac{4\text{E}{+}14\,\text{m}^3/\text{s}^2}{6.05\,\text{km/s}^2}$$

1.4) Escape Velocity given Speed of Satellite in Circular Orbit Formula

Evaluate Formula

Formula

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

Example with Units

$$8.556\,\text{km/s} = \sqrt{2} \cdot 6.05\,\text{km/s}$$

1.5) Orbital Period Formula

Evaluate Formula

Formula

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

Example with Units

$$11235.5229\,\text{s} = 2 \cdot 3.1416 \cdot \sqrt{\frac{10859\,\text{km}^3}{6.7\text{E}{-}11 \cdot 6\text{E}{+}24\,\text{kg}}}$$

1.6) Orbital Radius Given Specific Energy of Circular Orbit Formula

Evaluate Formula

Formula

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

Example with Units

$$10858.6804\,\text{km} = -\frac{4E{+}14\,\text{m}^3/\text{s}^2}{2 \cdot -18354\,\text{kJ/kg}}$$

1.7) Specific Energy of Circular Orbit Formula

Evaluate Formula

Formula

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

Example with Units

$$-18354.349\,\text{kJ/kg} = -\frac{4E{+}14\,\text{m}^3/\text{s}^2\,^2}{2 \cdot 65789\,\text{km}^2/\text{s}^2}$$

1.8) Specific Energy of Circular Orbit Given Orbital Radius Formula

Evaluate Formula

Formula

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

Example with Units

$$-18353.4599\,\text{kJ/kg} = -\frac{4E{+}14\,\text{m}^3/\text{s}^2}{2 \cdot 10859\,\text{km}}$$

1.9) Speed of Satellite in Circular LEO as Function of Altitude Formula

Evaluate Formula

Formula

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

Example with Units

$$3.1422\,\text{km/s} = \sqrt{\frac{4E{+}14\,\text{m}^3/\text{s}^2}{6371.0088\,\text{km} + 34000\,\text{km}}}$$

1.10) Time Period of Circular Orbit Formula

Evaluate Formula

Formula

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

Example with Units

$$11261.4867\,\text{s} = \frac{2 \cdot 3.1416 \cdot 10859\,\text{km}^{\frac{3}{2}}}{\sqrt{4E{+}14\,\text{m}^3/\text{s}^2}}$$

1.11) Velocity of Circular Orbit Formula

Evaluate Formula

Formula

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

Example with Units

$$6.0586\,\text{km/s} = \sqrt{\frac{4E{+}14\,\text{m}^3/\text{s}^2}{10859\,\text{km}}}$$

2) Geostationary Earth Satellite Formulas

2.1) Absolute Angular Velocity given Geo Radius of Earth and Geo Speed Formula

Evaluate Formula

Formula

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

Example with Units

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

2.2) Absolute Angular Velocity of Earth given Geo Radius Formula

Evaluate Formula

Formula

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

Example with Units

$$7.3E\text{-}5\,\text{rad/s} = \sqrt{\frac{4E{+}14\,\text{m}^3/\text{s}^2}{42164.17\,\text{km}^3}}$$

2.3) Geo Radius given Absolute Angular Velocity of Earth Formula

Evaluate Formula

Formula

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

Example with Units

$$42164.1695\,\text{km} = \left(\frac{4E{+}14\,\text{m}^3/\text{s}^2}{7.2921159E\text{-}05\,\text{rad/s}^2}\right)^{\frac{1}{3}}$$

2.4) Geo Radius given Absolute Angular Velocity of Earth and Geo Speed Formula

Evaluate Formula

Formula

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

Example with Units

$$42100.2634\,\text{km} = \frac{3.07\,\text{km/s}}{7.2921159E\text{-}05\,\text{rad/s}}$$

2.5) Geo Radius given Speed of Satellite in its Circular Geo Orbit Formula

Evaluate Formula

Formula

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

Example with Units

$$42292.2728\,\text{km} = \frac{4E{+}14\,\text{m}^3/\text{s}^2}{3.07\,\text{km/s}^2}$$

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

Evaluate Formula

Formula

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

Example with Units

$$3.0747\,\text{km/s} = 7.2921159E\text{-}05\,\text{rad/s} \cdot 42164.17\,\text{km}$$

2.7) Speed of Satellite in its Circular GEO of Radius Formula

Evaluate Formula

Formula

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

Example with Units

$$3.0747\,\text{km/s} = \sqrt{\frac{4E{+}14\,\text{m}^3/\text{s}^2}{42164.17\,\text{km}}}$$

Variables used in list of Circular Orbits Formulas above

- 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 in list of Circular Orbits Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- constant(s): **[Earth-R]**, 6371.0088
  Earth mean radius
- constant(s): **[GM.Earth]**, 3.986004418E+14
  Earth's Geocentric Gravitational Constant
- constant(s): **[G.]**, 6.67408E-11
  Gravitational constant
- 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.
- 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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