Important Gravitation Formulas PDF

Formulas
Examples
with Units

List of 20
Important Gravitation Formulas

1) Fundamental Concepts in Gravitation Formulas

1.1) Gravitational Field Intensity Formula

Evaluate Formula

Formula

$$E = \frac{F}{m}$$

Example with Units

$$0.0758\,\text{N/Kg} = \frac{2.5\,\text{N}}{33\,\text{kg}}$$

1.2) Gravitational Field Intensity due to Point Mass Formula

Evaluate Formula

Formula

$$E = \frac{[G.] \cdot m' \cdot m_o}{r}$$

Example with Units

$$0.0736\,\text{N/Kg} = \frac{6.7\text{E-}11 \cdot 9000\,\text{kg} \cdot 9800\,\text{kg}}{0.08\,\text{m}}$$

1.3) Gravitational Field of Ring Formula

Evaluate Formula

Formula

$$I = -\frac{[G.] \cdot m \cdot a}{\left(r_{ring}^{\,2} + a^2\right)^{\frac{3}{2}}}$$

Example with Units

$$-3.2\text{E-}16\,\text{N/Kg} = -\frac{6.7\text{E-}11 \cdot 33\,\text{kg} \cdot 25\,\text{m}}{\left(6\,\text{m}^{\,2} + 25\,\text{m}^{\,2}\right)^{\frac{3}{2}}}$$

1.4) Gravitational Field of Ring given Angle at any Point Outside Ring Formula

Evaluate Formula

Formula

$$I = -\frac{[G.] \cdot m \cdot \cos(\theta)}{\left(a^2 + r_{ring}^{\,2}\right)^2}$$

Example with Units

$$-3.2\text{E-}16\,\text{N/Kg} = -\frac{6.7\text{E-}11 \cdot 33\,\text{kg} \cdot \cos(86.4°)}{\left(25\,\text{m}^{\,2} + 6\,\text{m}^{\,2}\right)^2}$$

1.5) Gravitational Field of Thin Circular Disc Formula

Evaluate Formula

Formula

$$I = -\frac{2 \cdot [G.] \cdot m \cdot (1 - \cos(\theta))}{r_c^{\,2}}$$

Example with Units

$$-2.8\text{E-}20\,\text{N/Kg} = -\frac{2 \cdot 6.7\text{E-}11 \cdot 33\,\text{kg} \cdot (1 - \cos(86.4°))}{3.84\text{E+}5\,\text{m}^{\,2}}$$

1.6) Gravitational Field when Point is Inside of Non Conducting Solid Sphere Formula

Evaluate Formula

Formula

$$I = -\frac{[G.] \cdot m \cdot a}{R^3}$$

Example with Units

$$-3.5E\text{-}15\,N/Kg = -\frac{6.7E\text{-}11 \cdot 33\,kg \cdot 25\,m}{250\,m^3}$$

1.7) Gravitational Field when Point is Outside of Non Conducting Solid Sphere Formula

Evaluate Formula

Formula

$$I = -\frac{[G.] \cdot m}{a^2}$$

Example with Units

$$-3.5E\text{-}12\,N/Kg = -\frac{6.7E\text{-}11 \cdot 33\,kg}{25\,m^2}$$

1.8) Gravitational Potential Formula

Evaluate Formula

Formula

$$V = -\frac{[G.] \cdot m}{s_{body}}$$

Example with Units

$$-2.9E\text{-}9\,J/kg = -\frac{6.7E\text{-}11 \cdot 33\,kg}{0.75\,m}$$

1.9) Gravitational Potential Energy Formula

Evaluate Formula

Formula

$$U = -\frac{[G.] \cdot m_1 \cdot m_2}{r_c}$$

Example with Units

$$-7.6E+31\,J = -\frac{6.7E\text{-}11 \cdot 7.34E+22\,kg \cdot 5.97E+24\,kg}{3.84E+5\,m}$$

1.10) Gravitational Potential of Ring Formula

Evaluate Formula

Formula

$$V = -\frac{[G.] \cdot m}{\sqrt{r_{ring}^2 + a^2}}$$

Example with Units

$$-8.6E\text{-}13\,J/kg = -\frac{6.7E\text{-}11 \cdot 33\,kg}{\sqrt{6\,m^2 + 25\,m^2}}$$

1.11) Gravitational Potential of Thin Circular Disc Formula

Evaluate Formula

Formula

$$V = -\frac{2 \cdot [G.] \cdot m \cdot \left(\sqrt{a^2 + R^2} - a\right)}{R^2}$$

Example with Units

$$-1.6E\text{-}11\,J/kg = -\frac{2 \cdot 6.7E\text{-}11 \cdot 33\,kg \cdot \left(\sqrt{25\,m^2 + 250\,m^2} - 25\,m\right)}{250\,m^2}$$

1.12) Gravitational Potential when Point is Inside of Conducting Solid Sphere Formula

Evaluate Formula

Formula

$$V = -\frac{[G.] \cdot m}{R}$$

Example with Units

$$-8.8E\text{-}12\,\text{J/kg} = -\frac{6.7E\text{-}11 \cdot 33\,\text{kg}}{250\,\text{m}}$$

1.13) Gravitational Potential when Point is Inside of Non Conducting Solid Sphere Formula

Evaluate Formula

Formula

$$V = -\frac{[G.] \cdot m \cdot \left(3 \cdot r_c^2 - a^2\right)}{2 \cdot R^3}$$

Example with Units

$$-3.1E\text{-}5\,\text{J/kg} = -\frac{6.7E\text{-}11 \cdot 33\,\text{kg} \cdot \left(3 \cdot 3.84E{+}5\,\text{m}^2 - 25\,\text{m}^2\right)}{2 \cdot 250\,\text{m}^3}$$

1.14) Gravitational Potential when Point is Outside of Conducting Solid Sphere Formula

Evaluate Formula

Formula

$$V = -\frac{[G.] \cdot m}{a}$$

Example with Units

$$-8.8E\text{-}11\,\text{J/kg} = -\frac{6.7E\text{-}11 \cdot 33\,\text{kg}}{25\,\text{m}}$$

1.15) Gravitational Potential when Point is Outside of Non Conducting Solid Sphere Formula

Evaluate Formula

Formula

$$V = -\frac{[G.] \cdot m}{a}$$

Example with Units

$$-8.8E\text{-}11\,\text{J/kg} = -\frac{6.7E\text{-}11 \cdot 33\,\text{kg}}{25\,\text{m}}$$

1.16) Time Period of Satellite Formula

Evaluate Formula

Formula

$$T = \left(\frac{2 \cdot \pi}{[\text{Earth-R}]}\right) \cdot \sqrt{\frac{\left([\text{Earth-R}] + h\right)^3}{g}}$$

Example with Units

$$11.1171\,\text{h} = \left(\frac{2 \cdot 3.1416}{6371.0088\,\text{km}}\right) \cdot \sqrt{\frac{\left(6371.0088\,\text{km} + 1.89E{+}7\,\text{m}\right)^3}{9.8\,\text{m/s}^2}}$$

1.17) Universal Law of Gravitation Formula

Evaluate Formula

Formula

$$F' = \frac{[G.] \cdot m_1 \cdot m_2}{r_c^2}$$

Example with Units

$$2E{+}26\,\text{N} = \frac{6.7E\text{-}11 \cdot 7.34E{+}22\,\text{kg} \cdot 5.97E{+}24\,\text{kg}}{3.84E{+}5\,\text{m}^2}$$

2) Gravitational Field Formulas

3) Gravitational Potential Formulas

4) Variation of Acceleration due to Gravity Formulas

4.1) Variation of Acceleration due to Gravity on Altitude Formula

Evaluate Formula

Formula

$$g_v = g \cdot \left(1 - \frac{2 \cdot h'}{[Earth\text{-}R]}\right)$$

Example with Units

$$9.7999\,\text{m/s}^2 = 9.8\,\text{m/s}^2 \cdot \left(1 - \frac{2 \cdot 33.2\,\text{m}}{6371.0088\,\text{km}}\right)$$

4.2) Variation of Acceleration due to Gravity on Depth Formula

Evaluate Formula

Formula

$$g_v = g \cdot \left(1 - \frac{D}{[Earth\text{-}R]}\right)$$

Example with Units

$$9.8\,\text{m/s}^2 = 9.8\,\text{m/s}^2 \cdot \left(1 - \frac{3\,\text{m}}{6371.0088\,\text{km}}\right)$$

4.3) Variation of Acceleration on Surface of Earth due to Gravity Effect Formula

Evaluate Formula

Formula

$$g_v = g \cdot \left(1 - \frac{[Earth\text{-}R] \cdot \omega}{g}\right)$$

Example with Units

$$9.7873\,\text{m/s}^2 = 9.8\,\text{m/s}^2 \cdot \left(1 - \frac{6371.0088\,\text{km} \cdot 2\text{E-}9\,\text{rad/s}}{9.8\,\text{m/s}^2}\right)$$

Variables used in list of Gravitation Formulas above

- **a** Distance from Center to Point *(Meter)*
- **D** Depth *(Meter)*
- **E** Gravitational Field Intensity *(Newton per Kilogram)*
- **F** Force *(Newton)*
- **F'** Gravitational Force *(Newton)*
- **g** Acceleration due to Gravity *(Meter per Square Second)*
- g_v Variation of Acceleration due to Gravity *(Meter per Square Second)*
- **h** Altitude *(Meter)*
- **h'** Altitude for Acceleration *(Meter)*
- **I** Gravitational Field *(Newton per Kilogram)*
- I_{disc} Gravitational Field of Thin Circular Disc *(Newton per Kilogram)*
- I_{ring} Gravitational Field of Ring *(Newton per Kilogram)*
- **m** Mass *(Kilogram)*
- **m'** Mass 3 *(Kilogram)*
- m_1 Mass 1 *(Kilogram)*
- m_2 Mass 2 *(Kilogram)*
- m_o Mass 4 *(Kilogram)*
- **r** Distance between Two Bodies *(Meter)*
- **R** Radius *(Meter)*
- r_c Distance between Centers *(Meter)*
- r_{ring} Radius of Ring *(Meter)*
- s_{body} Displacement of Body *(Meter)*
- **T** Time period of Satellite *(Hour)*
- **U** Gravitational Potential Energy *(Joule)*
- U_{Disc} Gravitational Potential of Thin Circular Disc *(Joule)*
- **V** Gravitational Potential *(Joule per Kilogram)*
- V_{ring} Gravitational Potential of Ring *(Joule per Kilogram)*
- **θ** Theta *(Degree)*

Constants, Functions, Measurements used in list of Gravitation Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- constant(s): **[Earth-R]**, 6371.0088
  Earth mean radius
- constant(s): **[G.]**, 6.67408E-11
  Gravitational constant
- 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: **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 Meter (m)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Time** in Hour (h)
  Time Unit Conversion
- Measurement: **Acceleration** in Meter per Square Second (m/s²)
  Acceleration Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Angular Velocity** in Radian per Second (rad/s)
  Angular Velocity Unit Conversion
- Measurement: **Gravitational Potential** in Joule per Kilogram (J/kg)
  Gravitational Potential Unit Conversion
- Measurement: **Gravitational Field Intensity** in Newton per Kilogram (N/Kg)
  Gravitational Field Intensity Unit Conversion

- **ω** Angular Velocity *(Radian per Second)*

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