Gravity

Gravitational force and acceleration

Force of gravity between two masses

$$F = G\frac{m_1 m_2}{r^2}$$

Gravitational Field Strength (Acceleration)

$$g = G\frac{M}{r^2}$$

F - Force, N; ***m_1, m_2*** - mass, kg; ***M*** - mass of primary, kg; ***r*** - distance between mass' centers, m

Gravitational Constant

$G = 6.67 \times 10^{-11}$

Gravitational Potential Energy and Potential

Gravitational Potential Energy

$$U = -G\frac{m_1 m_2}{r}$$

Gravitational Potential

$$V = -G\frac{M}{r}$$

U - Gravitational PE, J; ***V*** - Gravitational Potantial, J/kg; ***m_1, m_2*** - mass, kg; ***M*** - mass of primary, kg; ***r*** - distance between mass' centers, m

Orbits

Orbital Velocity

$$V_{orb} = \sqrt{G\frac{M}{r}}$$

Orbital Period

$$T = \frac{2\pi r}{V_{orb}} \qquad T^2 = \frac{4\pi^2 a^3}{GM}$$

Total Orbital Energy (PE + KE)

$$E = -G\frac{Mm}{2a}$$

V_{orb} - *Orbital velocity, m/s;* ***T*** - *orbital period, sec;* ***M,m*** - *mass of primary, secondary, kg;* ***r*** - *distance to primary center, m;* ***a*** - *semi-major axis, m*

Miscellaneous

Escape Velocity

$$V_{esc} = \sqrt{2G\frac{M}{r}} \qquad V_{esc} = \sqrt{2}\, V_{orb}$$

Kepler's Third Law: Orbital Period vs Radius

$$T^2 = \frac{4\pi^2}{GM} a^3$$

For solar orbits: $\frac{T^2}{R^3} = 1$

V_{esc} - *Escape velocity, m/s;* ***M*** - *mass of primary, kg;* ***r*** - *distance to center, m;* ***T*** - *period;* ***R*** - *orbital radius;* ***a*** - *semi-major axis*

Note that this works only if T is in earth years and R is in a.u.