Planetary Physics Formulas

Volume of a Sphere (Planet Volume)

The volume of a planet can be calculated using the formula for a sphere:

$$V = \frac{4}{3}\pi R^3 \tag{1}$$

Where:

- R is the radius of the planet (in m).
- V is the volume (in m^3).

Mass, Density, Volume Relationship

The relationships between mass, density, and volume are:

- $\text{Density} = \frac{\text{Mass}}{\text{Volume}}$
- $\text{Mass} = \text{Density} \times \text{Volume}$
- $\text{Volume} = \frac{\text{Mass}}{\text{Density}}$

Newton's Law of Universal Gravitation

The gravitational force between two objects is given by:

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

Where:

- F is the gravitational force (in N).
- G is the gravitational constant, $G = 6.674\,30 \times 10^{-11}\ \mathrm{m}^3\mathrm{kg}^{-1}\mathrm{s}^{-2}$.
- m_1, m_2 are the masses of the two objects (in kg).
- r is the distance between their centers (in m).

Escape Velocity

The escape velocity from a planet is calculated as:

$$v_e = \sqrt{\frac{2GM}{R}} \tag{3}$$

Where:

- v_e is the escape velocity (in $\mathrm{m\,s^{-1}}$).
- G is the gravitational constant.
- M is the mass of the planet (in kg).
- R is the radius of the planet (in m).

Planet Mass from Radius and Density

The mass of a planet can be derived from its radius and density:

$$M = \frac{4}{3}\pi R^3 \cdot \rho \tag{4}$$

Where:

- M is the mass of the planet (in kg).
- R is the radius (in m).
- ρ is the density (in $\mathrm{kg\,m^{-3}}$).

Orbital Period (Kepler's 3rd Law Approximation)

The orbital period of a planet can be approximated using Kepler's Third Law:

$$T = \sqrt{a^3} \tag{5}$$

$$\text{Days} = T \cdot 365 \tag{6}$$

Where:

- a is the semi-major axis (in astronomical units, AU).
- T is the orbital period (in years).