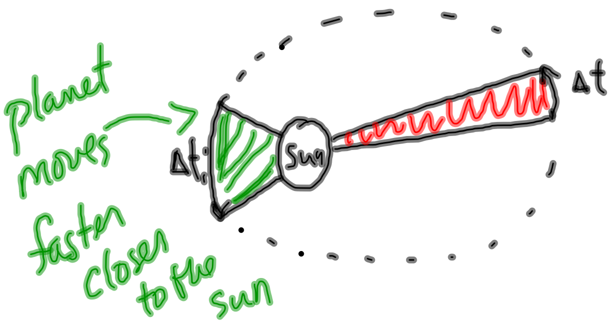
Kepler's Laws

1. elliptical orbits
2. equal areas in equal times



3. $K = \frac{R^3}{T^2}$ (for a given central body)

$$K_{sun} = 3.35 \times 10^{18} \frac{m^3}{s^2}$$

Newton's Law of Universal Gravitation

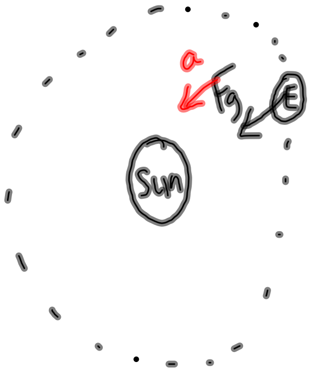
$$\left.\begin{array}{l} F_g \propto m_1 \\ F_g \propto m_2 \\ F_g \propto \frac{1}{r^2} \end{array}\right\} \rightarrow \quad F_g \propto \frac{m_1 m_2}{r^2}$$

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

where $G = 6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$

Newton's Hypothesis

Newton proposed that F_g was the force responsible for the motion of the planets in a "circular" path around.



$\vec{F}_{net} = m\vec{a}$

$F_g = \frac{mv^2}{r} \leftarrow F_c$ essentially

F_g provides the centripetal force.

orbiting body $F_g = \frac{4\pi^2 m r}{T^2}$ ← orbiting body $\quad a = \frac{4\pi^2 r}{T^2}$

$\frac{G \cancel{m_1} m_2}{r^2} = \frac{4\pi^2 \cancel{m_1} r}{T^2}$

$\frac{G m_{sun}}{r^2} = \frac{4\pi^2 r}{T^2}$

$m_{sun} = \frac{4\pi^2 r^3}{G T^2}$ Kepler's constant.

MP|585

$m_{sun} = ?$

$r_{earth} = 1.49 \times 10^{11}\,m$

$T_{earth} = 365.25\,d$

31557600 s

$$m_{sun} = \frac{4\pi^2 (1.49 \times 10^{11}\,m)^3}{\left(6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}\right)(31557600\,s)^2}$$

$$\boxed{m_{sun} \doteq 1.97 \times 10^{30}\,kg}$$

TO DO

1. PP|580
2. PP|586
3. Solar System Case Study.