- Kepler's Laws:
- According to Newton's law of gravitation the pull of the Sun on the Earth is contained in: $F_G = \frac{GM_S M_E}{r^2}$
- Expanding on this we get from Newton's second law: $\frac{d^2x}{dt^2} = \frac{F_{G,x}}{M_E}, \frac{d^2y}{dt^2} = \frac{F_{G,y}}{M_E}$
- We then have to expand further to cover the X and Y components of the force such as : $F_{G,x} = -\frac{GM_S M_E}{r^2}cos(\theta) = -\frac{GM_S M_E x}{r^3}$
- The difference between the X and Y components are the cosine versus sine components.
- The rest of this section discusses in further detail the other planets in the solar system and their relation to the sun in their orbits.
- Inverse Square Law:
- The orbital trajectory of a body of reduced mass in polar coordinates is given by: $\frac{d^2}{d\theta^2}(\frac{1}{r}) + \frac{1}{r} = -\frac{\mu r^2}{L^2}F(r)$ where μ is the reduced mass of the body.
- $\rightarrow r = (\frac{L^2}{\mu GM_S M_P})\frac{1}{1-e\cdot cos(\theta)}$
- $v_{max} = \sqrt{GM_S} \cdot \sqrt{\frac{(1+e)}{a(1+e)}(1 + \frac{M_P}{M_S})}$
- $v_{min} = \sqrt{GM_S} \cdot \sqrt{\frac{(1-e)}{a(1-e)}(1 + \frac{M_P}{M_S})}$
- When examining the equation $F_G = \frac{GM_S M_E}{r^\beta}$ we obtain the Inverse Square Law for a beta value of 2. Any change in this beta value results in a mathematical shift in the elliptical orbit.
- Gravitational force predicted by general relativity is given by: $F_G \approx \frac{GM_S M_M}{r^2}(1 + \frac{\alpha}{r^2})$ where M_M is the Mass of mercury and α = 1.1E-8 AU^2
- Three Body Problem: $F_{E,J} = \frac{GM_J M_E}{r^2_{E,J}}$
- Once again breaking this equation down to its components works roughly the same as the equation above for the relation between the Earth and the Sun.
- The graphs of the orbits in the three body problem interact and change based primarily on the masses of the planets involved in the observation.