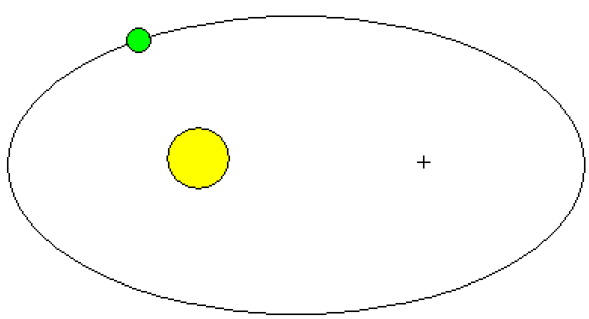
Kepler's Laws
of
Planetary Motion

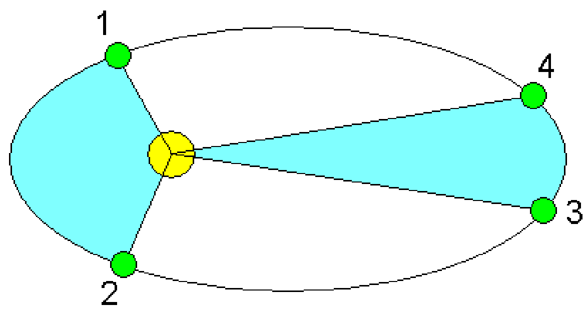
Kepler's 1st Law

- The path of each planet around the Sun is an elipse with the Sun at one focus.



Kepler's 2^{nd} Law

- Each planet moves so that an imaginary line drawn from the sun to the planet sweeps out equal areas in equal periods of time.



Kepler's 3^{rd} Law

- The ratio of the squares of the periods of any two planets revolving around the sun is equal to the ratio of the cubes of their mean distances from the sun.

$$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{R_1}{R_2}\right)^3$$

Kepler’s 3rd Law continued

- Rearranging gives us:

$$\frac{T_1^2}{R_1^3} = \frac{T_2^2}{R_2^3} = \text{constant}$$

Deriving Kepler’s 3rd Law

- We will use the special case where the orbit is a perfect circle.

$$\sum F = ma$$

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

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

m_s = mass of sun

m_p = mass of planet

R = mean distance of planet from sun

Deriving Kepler's Law continued

$$F = ma$$

$$G\frac{m_p m_s}{R^2} = m_p \frac{4\pi^2 R}{T^2}$$

$$G\frac{m_s}{R^2} = \frac{4\pi^2 R}{T^2}$$

$$\frac{T^2}{R^3} = \frac{4\pi^2}{Gm_s} \quad \text{(a constant)}$$