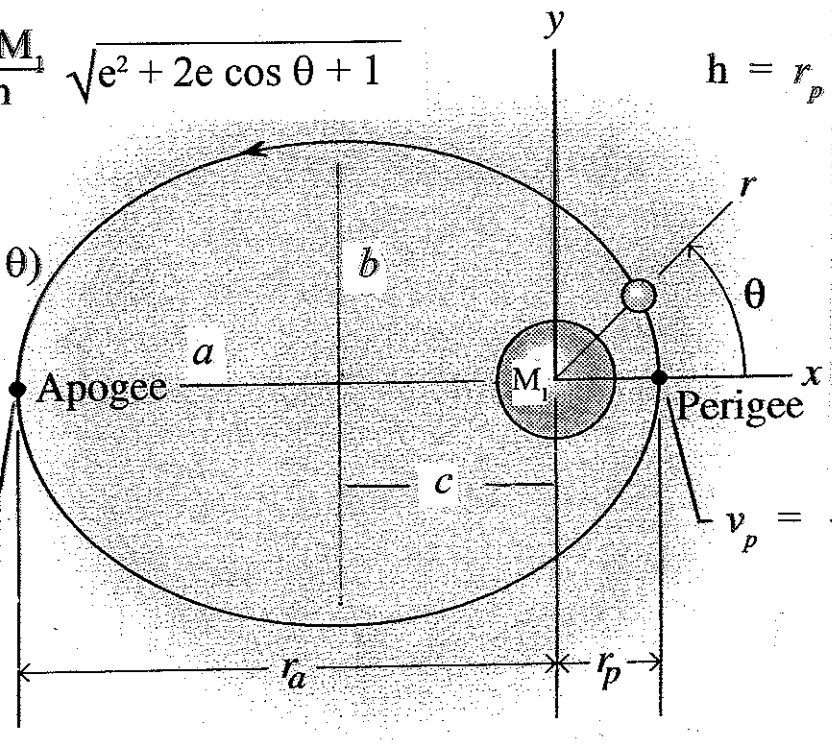
# Central Force Motion

Eccentricity $e < 1$ for elliptical orbit. $e = 0$ for a circular orbit.
Orbit not established for $e < 0$, or for $e \geq 1$.

$$v = \frac{GM_1}{h}\sqrt{e^2 + 2e\cos\theta + 1} \qquad h = r_p v_p = r_a v_a$$

$$r = \frac{h^2}{GM_1(1 + e\cos\theta)}$$




$$v_a = \frac{GM_1(1-e)}{h} \qquad v_p = \frac{GM_1(1+e)}{h}$$

$$r_a = \frac{h^2}{GM_1(1-e)} \qquad e = \frac{c}{a} \qquad r_p = \frac{h^2}{GM_1(1+e)}$$

Period (time for one revolution) $T = \left[\frac{4\pi^2 a^3}{GM_1}\right]^{1/2} = \frac{\pi}{h}(r_p + r_a)\sqrt{r_a r_p}$

Note from the equations above $\frac{1+e}{1-e} = \frac{r_a}{r_p} = \frac{v_p}{v_a}$

# Central Force Constants

## Metric System (SI System):

Mass of the Earth: $M_e = 5.976 \times 10^{24}$ kg

Gravitational Constant: $G = 66.73 \times 10^{-12}$ $m^3/kg\ s^2$

Radius of the Earth: $r_e = 6370$ km

$GM_e = 3.988 \times 10^{14}$ $m^3/s^2$

## U.S. Customary System - USCS (or English System):

Mass of the Earth: $M_e = 4.095 \times 10^{23}$ slugs

Gravitational Constant; $G = 3.439 \times 10^{-8}$ $ft^3/slug\ s^2$

Radius of the Earth: $r_e = 3960$ miles

$GM_e = 1.408 \times 10^{16}$ $ft^3/s^2$