Gravity

Observation I

$F_G \propto m_1 m_2$

First object and equal and opposite

Observation II

Earth rotating around sun

$\sum \vec{F} = F_G = M_E a_c$

$a_c = R\omega^2$

Everywhere on same sphere of influence has same F_G

F_G is constant on the sphere

S.A. $= 4\pi r^2$

$$F_G \propto \frac{1}{r^2}$$

$$\vec{F_G} = -G\frac{m_1 m_2}{r^2}\hat{r}$$

$$N = \frac{\text{Nm}^2}{\text{kg}^2}\frac{\text{kg}^2}{\text{m}^2}$$

$-\hat{r}$ is towards center $\hat{r}$ is away from center

Always

$$G = 6.67 \times 10^{-11}\frac{\text{Nm}^2}{\text{kg}^2}$$

g is only acceleration near surface of Earth

$$\vec{F_G} = \frac{-Gm_1m_2}{r^2}\hat{r}$$

$$F_G = \frac{Gm_oM_E}{R_E^2} = m_og$$

$$M_E = \frac{{R_E}^2 g}{G}$$

$$M_E = \frac{(6.37 \times 10^6 m)^2(9.8 m/s^2)}{6.67 \times 10^{-11} kgm/s^2 * m^2/kg^2}$$

$$M_E = \frac{(6.37)^2(9.8)}{6.67} \times \frac{10^{12}}{10^{-11}}$$

$$M_E = 5.96 \times 10^{24} \text{ kg}$$

$$M_s = 2 \times 10^{30} \text{ kg}$$