Law of Gravity

$$\vec{F}_{12} = G \frac{m_1 m_2}{r_{12}^2} \hat{r}_{12}$$

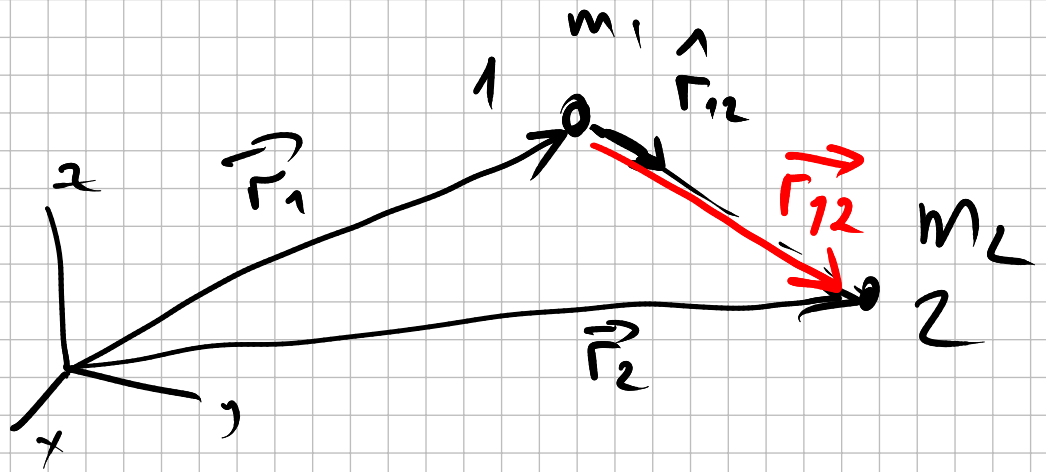
$$G = 6.67 \cdot 10^{-11} \left[\frac{N m^2}{kg^2}\right]$$

$\vec{F}_{12}$: Force acting on 1 by 2

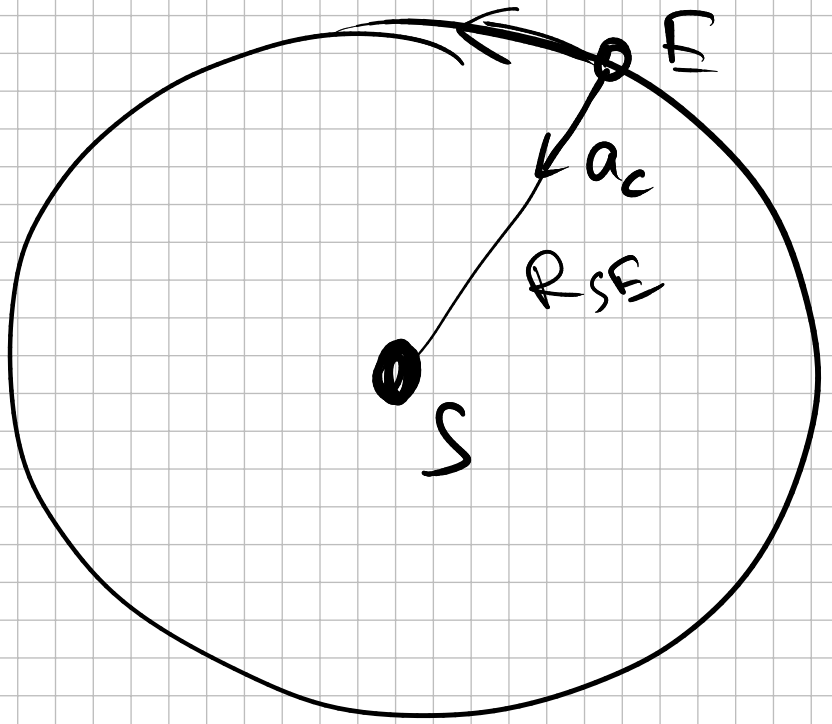
r_{12}: distance between 1 and 2

$\hat{r}_{12}$: unit vector (direction) from 1 to 2

$$\hat{r}_{12} = \frac{\vec{r}_2 - \vec{r}_1}{|\vec{r}_2 - \vec{r}_1|}$$



$$\cancel{m}\vec{g} = \frac{\vec{F_g}}{m} = G\frac{\cancel{m}\, m_E}{R_E^2}$$



$$a_c = \frac{F_g}{m_E} = G\frac{\cancel{m_E}\, m_S}{R_{SE}^2\,\cancel{m_E}}$$

$$\frac{v^2}{R_{SE}} = \omega^2 R_{SE}$$

$$\omega = \frac{2\pi}{P}$$

P ← period

Useful numbers

$G = 6.67 \cdot 10^{-11} \left[\frac{N \cdot m^2}{kg^2}\right]$

$g = 9.8 \left[m/s^2\right]$

$R_E = 6.38 \cdot 10^6 \, [m]$ Earth radius

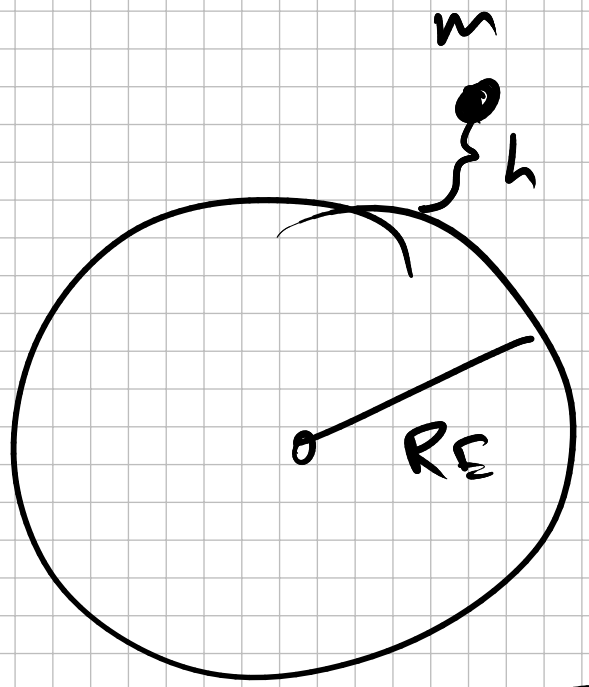
Earth - Moon distance $= 384 \cdot 10^6 \, [m]$

Earth - Sun distance $= 149.6 \cdot 10^9 \, [m]$

Moon - Earth period $= 27.3$ days

$M_E = 5.98 \cdot 10^{24} \, [kg]$ Earth mass

$M_M = 7.35 \cdot 10^{22} \, [kg]$ Moon mass



$$g(h) = \frac{F_g}{m} = \frac{G M_E m}{(R_E + h)^2} \frac{}{m}$$

$$= \frac{G M_E}{(R_E + h)^2} =$$

$$= \frac{G M_E}{\left(R_E \left(1 + \frac{h}{R_E}\right)\right)^2} =$$

$$= \frac{G M_E}{R_E^2} \frac{1}{(1 + h/R_E)^2} = g(h=0) \cdot \frac{1}{(1 + h/R_E)^2}$$

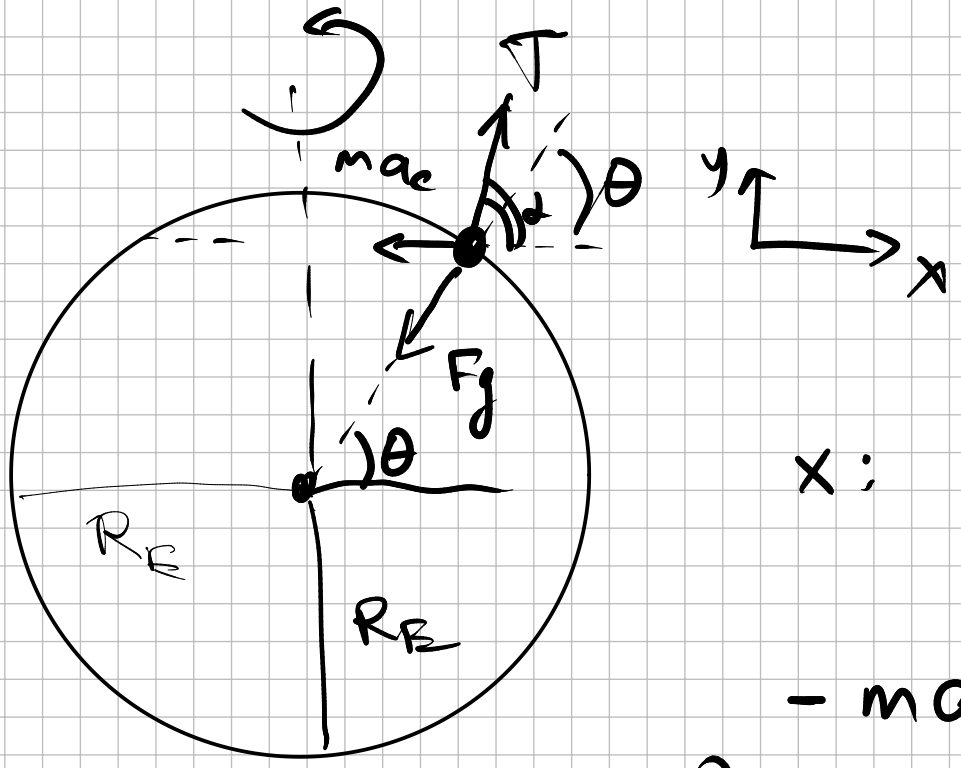
x

$$\frac{1}{(1+x)^2} \approx 1 - 2x \quad , x \ll 1$$

$$g(h) = g(h=0) \cdot \left(1 - 2\frac{h}{R_E}\right)$$

$h = 10\ km$ $\quad g(h=10km) = 9.83 \cdot \left(1 - 2\frac{10 \cdot 10^3}{6.4 \cdot 10^6}\right)$

$$= 9.83 \cdot \left(1 - 2 \cdot 10^{-3}\right)$$



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

x: $ma_x = T\cos\alpha - F_g \cdot \cos\theta$

$-ma_c = T\cos\alpha - mg\cos\theta$

y: $ma_y = 0 = T\sin\alpha - mg\sin\theta$

$\theta \approx 0$: x-> $-ma_c = T \cdot 1 - mg \cdot 1$

$T = m(g - a_c)$ equator

$\theta = 90°$: $T = mg$ poles