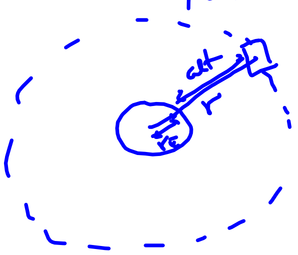
The moon's average radius of orbit is about 384,000km and the period of its orbit is approximately 27.3 days. At what height above the Earth's surface would a geostationary satellite have to be placed to maintain this orbit?

altitude



$$\frac{r_{moon}^3}{T_{moon}^2} = \frac{r_{sat}^3}{T_{sat}^2}$$

$$\frac{(3.84\times10^8 m)^3}{(27.3d)^2} = \frac{r_{sat}^3}{(1d)^2}$$

$$r_{sat} = 4.24\times10^7 m$$

radius of earth

$$alt = r - r_E$$

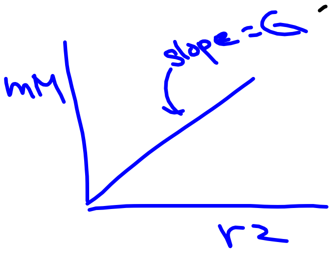
$$alt = 4.24\times10^7 - 0.64\times10^7$$

$$= 3.6\times10^7 m$$

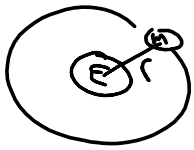
Newton's Law of Universal Gravitation

$$F_g \propto \frac{mM}{r^2}$$ ← from Kepler's $\frac{r^3}{T^2}$ = const.

he has no way to calculate G.



$$F_g = G\frac{Mm}{r^2}$$ Law of universal gravitation



$$F_c = F_g$$

$$\frac{\cancel{m}v^2}{r} = \frac{GM\cancel{m}}{r^2}$$

$$\frac{\left(\frac{2\pi r}{T}\right)^2}{\cancel{r}} = \frac{GM}{r^{\cancel{2}}}$$

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

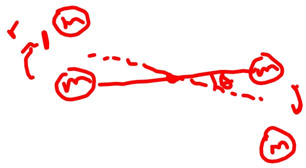
$$K = \frac{r^3}{T^2} = \frac{G}{4\pi^2}M$$

Massing the Earth

We know at the surface of the Earth

$$F_g = mg = \frac{GMm}{r_E^2}$$

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



Solve for G

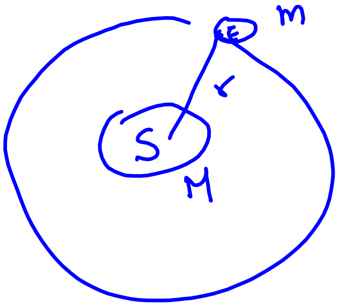
$$G = 6.67 \times 10^{-11} \frac{Nm^2}{kg^2}$$

- measure F to rotate through angle θ
- measure r between masses
- measure masses.

So $M_E = \frac{g r_E^2}{G} = \frac{(9.807)(6.38\times10^6 m)^2}{6.67\times10^{-11}}$

$= \underline{5.97\times10^{24}\ kg}$

Massing the Sun?



$r = 1.50 \times 10^{11}$ m

$T = 3.16 \times 10^{7}$ s

$$\frac{m 4\pi^2 r}{T^2} = \frac{G M_{sun} m}{r^2}$$

$$M_{sun} = \frac{4\pi^2 r^3}{G T^2}$$

$$= \frac{4\pi^2 (1.5 \times 10^{11})^3}{6.67 \times 10^{-11} (3.16 \times 10^{7})^2}$$

$$= 2.0 \times 10^{30} \text{ kg}$$

4 3.375

13.5

$\rho_E = 5 \times 10^3$ kg/m^3

$$V = \frac{4}{3}\pi r^3$$

$$= \frac{4}{3}\pi (6.38 \times 10^6)^3$$

$$= 1 \times 10^{21}$$

$m = \rho V = 5 \times 10^{24}$