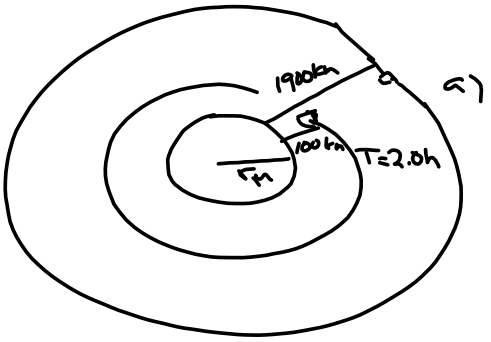
$r_M = 1.74 \times 10^6 m$
$= 1740 km$



a)

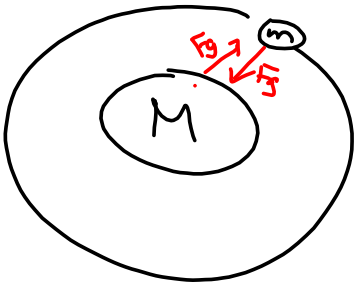
$$\left(\frac{r^3}{T^2}\right)_{LM} = \left(\frac{r^3}{T^2}\right)_S$$

$$\frac{(1840km)^3}{(2.0h)^2} = \frac{(3640km)^3}{T_S^2}$$

$$T_S = 5.6h$$

$$V = \frac{2\pi r}{T} = \frac{2\pi(3640km)}{5.6h} = 4084 \frac{km}{h}$$

Newton's Law of Universal Gravitation



Newton reasons
since $\Sigma F = ma$
the force acting on the moon

$F_g \propto m$

But if Earth pulls moon,
then moon pulls Earth the same

$F_g \propto M$

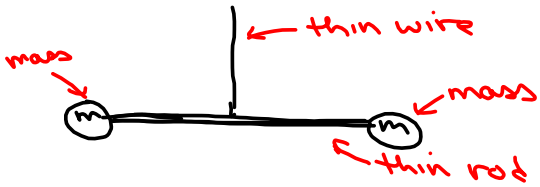
From Kepler's 3rd Law, he determined that F_g is an inverse square with distance,
i.e. $F_g \propto \frac{1}{r^2}$

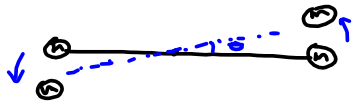
$F_g \propto \frac{Mm}{r^2}$

$F_g = \frac{GMm}{r^2} = \frac{Gm_1m_2}{r^2}$ G = universal gravitational constant.

What about G

- was determined about 150y later using a Cavendish apparatus





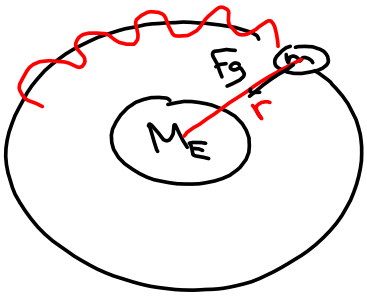
By twisting the apparatus through an angle θ, we can measure the force, F.

We can measure the masses and r.

$$F = \frac{Gmm}{r^2}$$

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

Massing the Earth



$r = 3.84 \times 10^8 m$

$T = 27.3 d$

$$F_c = \frac{m 4\pi^2 r}{T^2} = F_g = \frac{GMm}{r^2}$$

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

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

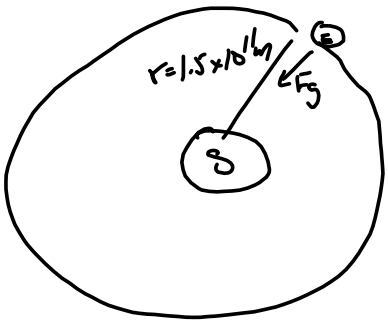
$$M = \frac{4\pi^2}{6.67 \times 10^{-11}} \frac{(3.84 \times 10^8)^3}{(27.3 \times 24 \times 3600)^2}$$

$$= 6.0 \times 10^{24} kg$$

(actual value = $5.98 \times 10^{24} kg$)

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

Massing the Sun?



$T = 365.24d = 3.16 \times 10^7 s$

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

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

$$= \frac{4\pi^2}{6.67\times10^{-11}} \frac{(1.5\times10^{11})^3}{(3.16\times10^7)^2}$$

$$= \frac{6(1.5\times10^{11})^3}{10^4} = 2.0\times10^{30}\ kg$$

Homework UG sheet #1-4