Newton's Law of Universal Gravitation

$$F_g = \frac{GM_1m_2}{r^2}$$

where $g = \frac{GM_1}{r^2}$ ← mass of central body

$$F_g = g m_2$$

$(F_g = mg)$

Kepler's 3rd Law

$$K = \frac{r^3}{T^2}$$

(this is unique for every central object)

$K_{sun} = 3.35 \times 10^{18} \frac{m^3}{s^2}$

Newton's Hypothesis:

central mass ← $F_g = F_c$ → orbiting mass

$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$

$$\frac{GM}{r^2} = \frac{v^2}{r} \quad (g = a)$$

Recall: $v = \frac{2\pi r}{T}$

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

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

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

$\frac{GM}{4\pi^2}$ ▽ Kepler's Constant

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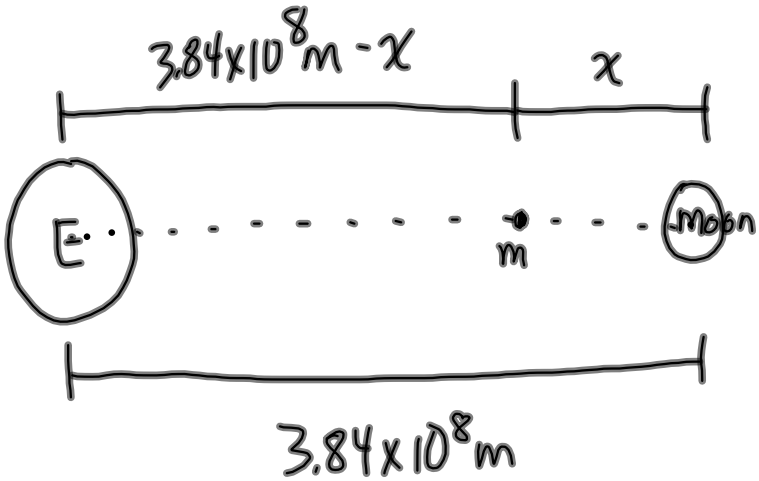
8.



$$F_{g(earth)} = F_{g(moon)}$$

$$\frac{G m_{earth} m}{r_1^2} = \frac{G m_{moon} m}{r_2^2}$$

$$\frac{m_{earth}}{(3.84\times10^8 - x)^2} = \frac{m_{moon}}{x^2}$$

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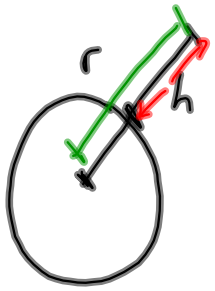
11. $T = 90.0$ min

$m_{earth} = 5.98\times10^{24}$ kg



$$F_g = F_c$$

$$\frac{G m_{earth} m_{sat}}{r^2} = \frac{m_{sat} 4\pi^2 r}{T^2}$$

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

Geostationary Orbit

Also called **geosynchronous** orbit => the satellite has the same period as the earth's own rotation on its axis. (i.e. 24h)

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At what velocity and altitude must a satellite orbit in order to be geostationary?

$M_{earth} = 5.98 \times 10^{24}\,kg$

$T = 24h = 86400s$

$v = ?$

h (need r first!) $= ?$

$F_g = F_c$

$$\frac{G M_{earth} m_{sat}}{r^2} = \frac{m_{sat} 4\pi^2 r}{T^2}$$

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

$$r^3 = \frac{\left(6.67\times10^{-11}\,\frac{N\cdot m^2}{kg^2}\right)(5.98\times10^{24}\,kg)(86400s)^2}{4\pi^2}$$

$$r = 4.2\times10^7\,m$$

$$h = 4.2\times10^7\,m - 6.38\times10^6\,m$$

$$h = 3.59\times10^7\,m$$

$$v = \frac{2\pi r}{T}$$

$$v = \frac{2\pi (4.2\times10^7\,m)}{86400s}$$

$$v = 3.1\times10^3\,m/s$$

To Do

1. PP|591
2. Assignment P597|22-33 (Thurs)
3. Play with Newton's Canon Animation