13.36 Planet with 1.5× Mearth in same radius orbit. Find period T (time to orbit Sun).

$F_{gravity}$ drives orbital motion. Currently,

$$F_g = F_c$$

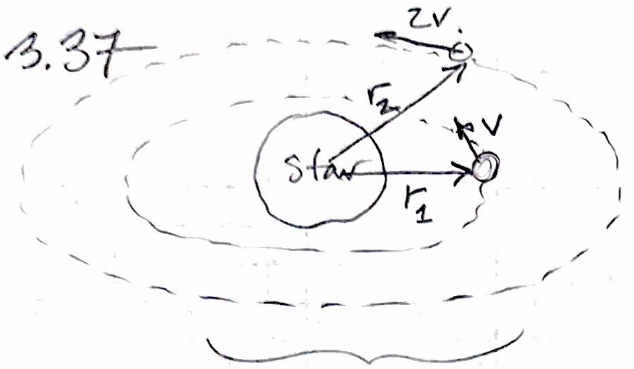
$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$, where M is mass of sun, m = earth

$$v = \sqrt{\frac{GM}{r}}$$ } M_{sun} is the same, r is the same...

Mearth is not a factor!

T is the same! (1 year)

13.37



Planets have orbital speeds of v & 2v.

Did I draw these correctly? Is farther planet travelling faster?

a) Ratio of orbital radii?

In general $F_c = F_g \rightarrow \frac{mv^2}{r} = \frac{GMm}{r^2}$

$$\rightarrow v = \sqrt{\frac{GM}{r}}$$

Solving for r:

$r = \frac{GM}{v^2}$, an inverse square relationship:

As v increases, r decreases by the square of that factor. Twice the velocity = $\boxed{\frac{1}{4} \text{ the radius.}}$

$$\frac{r_1}{r_2} = \frac{v_2^2}{v_1^2}$$

b) Ratio of their periods?

$v = \frac{d}{T} = \frac{2\pi r}{T}$, so $T = \frac{2\pi r}{v}$, &

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

$$\frac{r_1}{r_2} = \frac{\left(\frac{2\pi r_2}{T_2}\right)^2}{\left(\frac{2\pi r_1}{T_1}\right)^2}$$

$$\frac{r_1}{r_2} = \frac{4\pi^2 r_2^2 T_1^2}{T_2^2 4\pi^2 r_1^2}$$

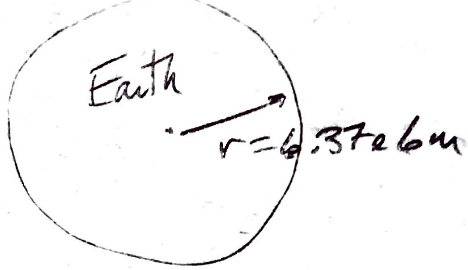
$$\frac{r_1^3}{r_2^3} = \frac{T_1^2}{T_2^2} \rightarrow T_2^2 = T_1^2 \frac{r_2^3}{r_1^3} \rightarrow T_2 = T_1 \sqrt{\frac{r_2^3}{r_1^3}}$$

$$\sqrt{\frac{(4r_1)^3}{(r_1)^3}} = \sqrt{\frac{r_1^3 4^3}{r_1^3}} = 8$$

$T_2 = T_1 8$, so $\frac{T_1}{T_2} = \frac{1}{8} \boxed{= 0.125}$

13.39 Find $v_{orbital}$ for satellite of Earth w/ period $T = 1.00$ hr. Why unreasonable?

$v = \frac{d}{t}$; $v = \frac{2\pi r}{T}$



$v = \frac{2\pi r}{3600s}$

How to relate v & r?

$F_c = F_g$

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

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

$\left(\frac{2\pi r}{3600s}\right)^2 = \frac{GM}{r}$

$\frac{4\pi^2 r^3}{3600^2} = (6.672e{-11})(5.98e24)$

$r^3 = 1.3098e20$

$r = \boxed{5.078e6\ m}$

Ummm... the radius of the earth is 6.37e6m. This orbit would be subterranean. !!