Satellite Motion

Geosynchronous | Geostationary – the satellite has the same period as the Earth's rotation on its axis.

$T = 24\,h$

MP|589

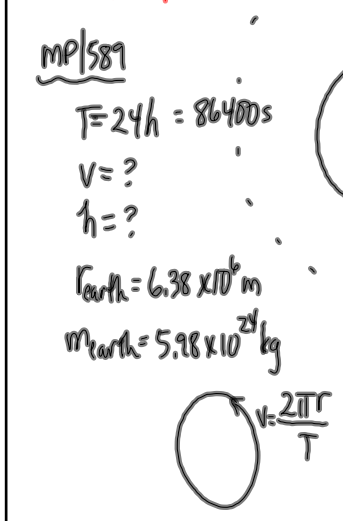
$T = 24\,h = 86400\,s$

$v = ?$

$h = ?$

$r_{earth} = 6.38 \times 10^6\,m$

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



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

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

$\frac{G m_{sat} m_{earth}}{r^2} = \frac{m_{sat} v^2}{r}$

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

$\frac{G m_{earth}}{r} = v^2$

$\frac{G m_{earth}}{r} = \left(\frac{2\pi r}{T}\right)^2$

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

Kepler's constant for earth.

Recall the Solar System case study: $\Rightarrow$ $r^3 = KT^2$

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

$r^3 = \frac{\left(6.67 \times 10^{-11}\,\frac{N \cdot m^2}{kg^2}\right)\left(5.98 \times 10^{24}\,kg\right)\left(86400\,s\right)^2}{4\pi^2}$

$r^3 \doteq 7.54 \times 10^{22}\,m^3$

$r \doteq 4.23 \times 10^7\,m$

$42.3 \times 10^6\,m$

$h = 4.23 \times 10^7\,m - 6.38 \times 10^6\,m$ (radius of earth)

$h = 35.87 \times 10^6\,m$

$h \doteq 35.9 \times 10^6\,m$

$h \doteq 3.59 \times 10^7\,m$

$3.59 \times 10^4\,km$

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

$v = \frac{2\pi (4.23 \times 10^7\,m)}{86400\,s}$

$v = 3.08 \times 10^3\,m/s$

So we can find g:

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

$a = \frac{(3.08 \times 10^3\,m/s)^2}{4.23 \times 10^7\,m}$

$a = 0.22\,m/s^2$

$K = \frac{r^3}{T^2}$ (Kepler's constant)

↳ unique for every central body

$F_g = \frac{G m_1 m_2}{r^2}$ $\left(G = 6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}\right)$

$F_g = \frac{G m_{earth} m_{object}}{r^2}$ (just like: $F_g = mg$)

↳ $g = 9.81 m/s^2$

$F_c = \frac{mv^2}{r} = \frac{4\pi^2 mr}{T^2} = 4\pi^2 m f^2$ $\left(\vec{F}_{net} = m\vec{a}\right)$

F_c is really the net force.

Newton's Hypothesis:

$F_g = F_c$

$\frac{G m_1 m_2}{r^2} = \frac{m_1 v^2}{r}$

m_1: mass of the orbiting object

m_2: mass of Central body

To DO:

1. PP/591
2. Newton's Cannon
3. Assignment: p597/22-33 (Thurs)

Dec 6-12:30 PM