Chapter 12 - Universal Gravitation

Keplers Law ① Elliptical Orbits

② Equal Areas in Equal Times

③ $K = \frac{R^3}{T^2}$ OR $\frac{R_A^3}{T_A^2} = \frac{R_B^3}{T_B^2}$

Newton's Law of Universal Gravitation

$F_g = \frac{G m_1 m_2}{r^2}$ (g, g_T)

Newton's Hypothesis:

$F_g = F_c$

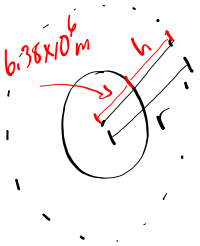
$\frac{G m M}{r^2} = m a_c$ (mass of central object; mass of object)

$\rightarrow a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2} = 4\pi^2 r f^2$

PP|586

11. $T = 90.0\ min = 5400\ s$

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



$F_g = F_c$

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

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

K_{earth}

$r^3 = \frac{(6.67\times10^{-11})(5.98\times10^{24})(5400)^2}{4\pi^2}$

14. $(2.00\times10^5\ m/s)$

$v = 2.00\times10^2\ km/s$

$r = 5\times10^9\ AU$

$(7.45\times10^{20}\ m)$

$F_g = F_c$

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

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

§12-2 Planetary + Satellite Motion

"geosynchronous" or "geostationary" satellite → in "sync" with the Earth's rotation ($T = 24\,h$) ($86400\,s$)

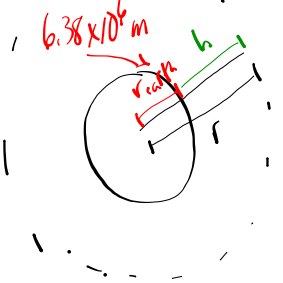
MP|589

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

$V = ?$

$h = ?$ (geosynchronous)

$T = 86400\,s$



$F_g = F_c$

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

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

$$r^3 = \frac{(6.67\times10^{-11})(5.98\times10^{24})(86400\,s)^2}{4\pi^2}$$

$$r = 4.22\times10^7\,m$$

altitude: $h = 4.22\times10^7\,m - 6.38\times10^6\,m$

$0.638\times10^7\,m$

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

orbital speed: $V = \frac{2\pi r}{T}$

$$V = \frac{2\pi(4.22\times10^7\,m)}{86400\,s}$$

$$V = 3.07\times10^3\,m/s$$

TO DO

① PP|591

② Assignment: p597|22-33

#23 + 24 give reason think about the "basic" Newton's Laws

#32. a) find K for each moon (watch units) (m^3/s^2)

b) use K_{ave} to find m_{saturn}

#33. Answers wrong in book.