Satellites & Energy

Tuesday, April 24, 2018 12:44 PM

1) Geosynchronous : always over the same location on earth

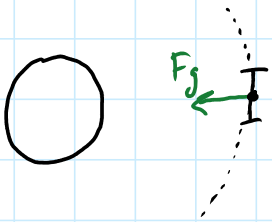
: Period = T = 24 hrs = 86400 s, same r, v

: Communication, telescope

2) Non geo.... : orbit at different T, r, v

: Camera, spy, weather, space station

Ex Find the radius & velocity of a geosync. sat., T = 86400 s



$F_{net} = F_g$

$F_c = F_g$

$\frac{m 4\pi^2 r}{T^2} = \frac{G m_1 m_2}{r^2}$ (Me)

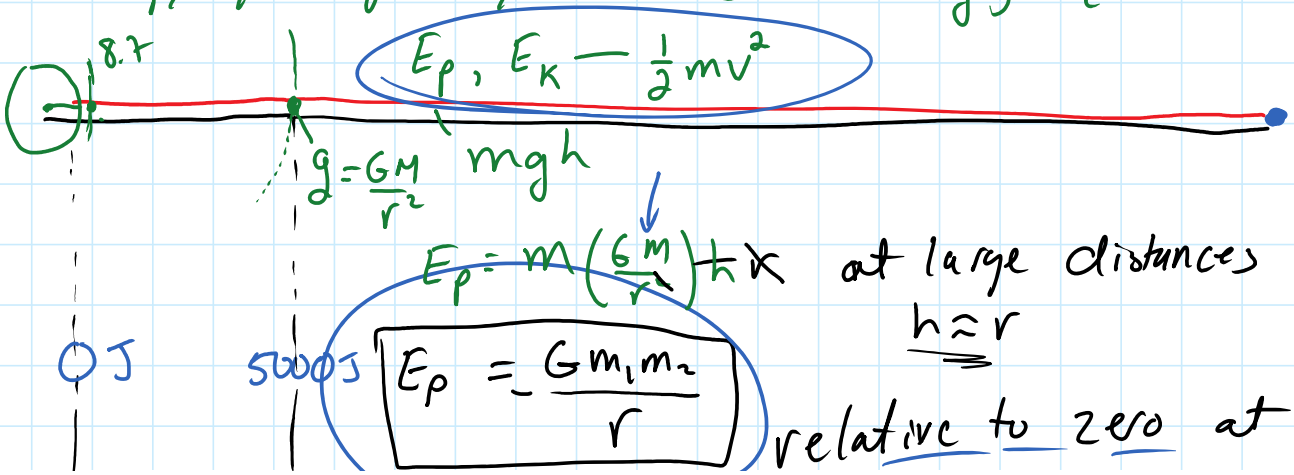
$\frac{mv^2}{r} = \frac{G m_1 m_2}{r^2}$

$v^2 = \frac{GM}{r}$ ⇒ $v = 3074 m/s$

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

$r = 4.22\times10^7 m$ ← $42.2\times10^6 m$

Total energy of a geo sync sat ($m = 1000 kg$) $r_e = 6.38\times10^6 m$



at large distances $h \simeq r$

relative to zero at

$E_p = -\frac{Gm_1m_2}{r}$ relative to zero at infinity

-200000J -150000J

$E_T = E_p + E_K$

$= -\frac{Gm_1m_2}{r} + \frac{1}{2}mv^2$

$= -\frac{(6.67\times10^{-11})(5.98\times10^{24})(1000kg)}{4.22\times10^{7}m} + \frac{1}{2}(1000)(3074)^2$

$= -9.45\times10^{9}J + 4.72\times10^{9}J$

$= -4.73\times10^{9}J$

E_T: negative answer

: exponent (8 − 13)

: $E_T = E_K = \frac{1}{2}E_p$