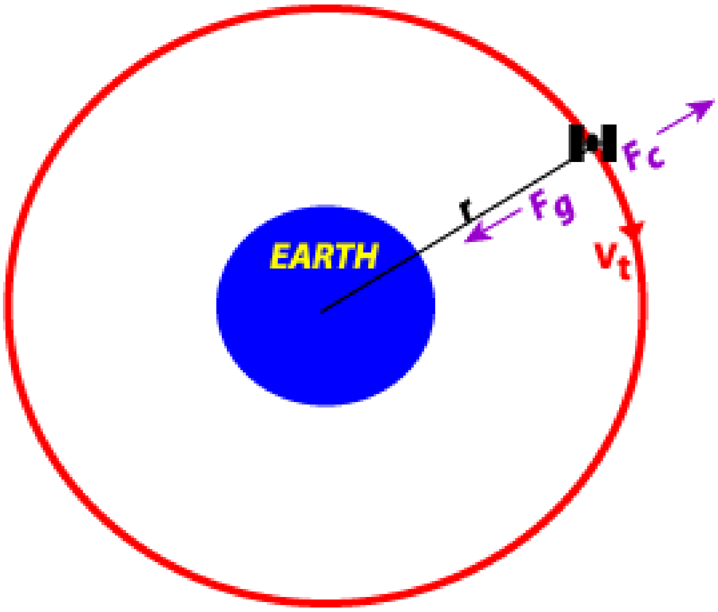
THEORY FOR GOES ORBIT

Q: Why are GOES 35,800 km from the center of the earth so that they are in geosynchronous orbit???

There are two relevant forces involved in this problem:



1. gravitational force of attraction between any two objects, given by:

2. centrifugal force an outward-directed force that normally balances the inward-directed centripital force,

given by: . These forces are required to help maintain the circular trajectory of an object.

In our situation of a satellite in geosynchronous orbit, the outward-directed centrifugal force balances the inward-directed gravitational force. Hence, for a steady-state orbit, the force balance becomes:

or (1)

Solving for v_s, the tangential velocity of the satellite, from (1) yields:

(2)

Notice, that in (2), the mass of the satellite does not appear.

REALITY CHECK – what are we trying to solve for?????

OK, so what is v_s?

The tangential velocity of the satellite (v_s) is related to its orbital period, T through:

or or (3)

Eliminating between (3) and (2) gives:

Solving for the orbital period, T, gives:

(4)

OK, we still do not know *r*………but we're getting closer. To find *r*, we still need to determine what *T* is…..

What is the constraint, in terms of angular velocity, on the satellite if it is to be in a geosynchronous orbit??????

Yes, where ω_s and ω_e are the angular velocities of the satellite and earth, respectively.

The angular velocity (from basic physics) for the satellite is:

(5)

but from (3), recall that or (6)

Substituting (6) into (5) gives:

or solving for *T*, or (7)

recall that so (7) can be rewritten as: (8)

From (8), we now know the satellites orbital period, *T*.

By substituting (8) into (4) to eliminate T^2 we get:

or solving for *r* yields: (9)

We know:

$G = 6.67 \times 10^{-11}$ Nm^{2}kg^{-2}

$m_e = 5.97 \times 10^{24}$ kg

$\omega_e = 7.29 \times 10^{-5}$ rad s^{-1}

Hence, substituting the above constants into (9) gives:

R = 35,786 km for GOES

There it is……

Back Index Next