Chapter 4   Problem 97 †

Given

$r = 42,250.0\ km = 4.22500 \times 10^7\ m$

Solution

What is the centripetal acceleration of the geosynchronous satellite?

Geosynchronous satellites orbit the earth once per day. Therefore, the time for the satellite to travel one circumfernce is one day. The distance traveled in one circumference is

$$d = 2\pi r = 2\pi(4.22500 \times 10^7\ m) = 2.65465 \times 10^8\ m$$

Converting one day into seconds, gives the time for one orbit

$$t = 1\ day \left(\frac{24\ hr}{1\ day}\right)\left(\frac{3600\ s}{1\ hr}\right) = 8.6400 \times 10^4\ s$$

The velocity of the satellite is

$$v = \frac{d}{t} = \frac{2.65465 \times 10^8\ m}{8.6400 \times 10^4\ s} = 3,072.5\ m/s$$

Centripetal acceleration is given by

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

Substituting in the appropriate values gives

$$a_c = \frac{(3,072.5\ m/s)^2}{4.22500 \times 10^7\ m} = 0.22344\ m/s^2$$

† Problem from University Physics by Ling, Sanny and Moebs (OpenStax)