Question #82835, Physics / Mechanics | Relativity |

A spacecraft was placed in an orbit around the earth. This orbit was circular, maintaining an almost constant distance of 189km from the earth's surface.
A) calculate the speed of the spacecraft in this orbit
B) the time to complete one orbit

Solution

a) The equation for universal gravitation thus takes the form:

$F = G\frac{Mm}{(R+r)^2}$, where $G = 6{,}67 \times 10^{-11} m^3 kg^{-1} s^{-2}$, $M = 5{,}97 \times 10^{24} kg$, $R = 6{,}4 \times 10^6\ m$,

$r = 189 \times 10^3\ m$

M – mass of Earth, G-gravitational constant, R- radius of Earth, r – distance to the Earth

$F = m\frac{v^2}{R+r}$, then $G\frac{Mm}{(R+r)^2} = m\frac{v^2}{R+r} \rightarrow G\frac{M}{R+r} = v^2 \rightarrow v = \sqrt{G\frac{M}{R+r}}$

$$v = \sqrt{6{,}67 \times 10^{-11}\frac{5{,}97 \times 10^{24}}{6{,}4 \times 10^6 + 189 \times 10^3}} \approx 7{,}79 \times 10^3 (^m/_s)$$

b) $T = \frac{2\pi(R+r)}{v} \rightarrow \frac{2\pi(6{,}4\times10^6+189\times10^3)}{7{,}79\times10^3} = 5{,}31 \times 10^3\ s = 1\ hour\ 28\ minutes\ 30\ s$

Answer: $v = 7{,}79 \times 10^3 (^m/_s)$, $T = 5{,}31 \times 10^3\ s = 1\ hour\ 28\ minutes\ 30\ s$