HP Prime Application Note Physics:

04. Orbiting Satellites

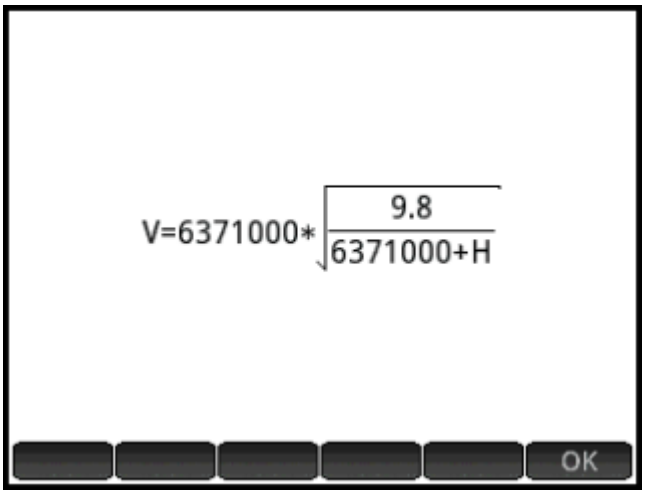
What is the speed and the period of satellites revolving around the Earth? All this is just mechanics going back to Isaac Newton's 1687 *Philosophiæ Naturalis Principia Mathematica*.

Watch the video *How Do Satellites Get & Stay in Orbit?* at https://www.youtube.com/watch?v=IC1JQu9xGHQ.

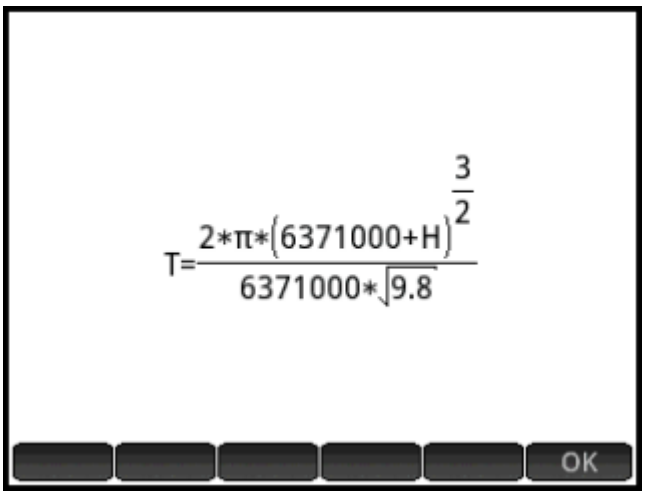
The speed of a satellite moving around our planet is: $\boldsymbol{v_{\text{orbit}} = R_{\text{Earth}} \cdot \sqrt{\frac{g}{R_{\text{Earth}}+H}}}$

(in m/s) where $R_{\text{Earth}} = 6\,371\,000$ m, g = 9.8 m/s² and H being the height of the satellite above the surface of the Earth.

Enter the formula in the Solve app:



The satellite's orbital period is: $\boldsymbol{T_{\text{orbit}} = \frac{2\pi\cdot(R_{\text{Earth}}+H)^{\frac{3}{2}}}{R_{\text{Earth}}\cdot\sqrt{g}}}$ (in s):



Now, use the Solve app to calculate the height of a geostationary satellite. For this, you must compute using —not the solar day but— the sidereal day. That is the length of a day with respect to the stars, which is about 23 hours, 56 minutes and 4 seconds (86 164 s). So solving the formula with the HP Prime, geostationary satellites orbit the Earth at a height of some 35,764 km and at a speed of about 3.1 km/s.

The GPS constellation was conceived in such a manner that each satellite sets and rises twice a day, reaching the same position in the sky at the same time as the day before. So GPS satellites circulate around the Earth in half a sidereal day (43 082 s). Using the Solve app in the HP Prime, the corresponding height of the GPS satellites is 20 172 km, their speed being 3.9 km/s.