Scientists want to place a 4100.0 kg satellite in orbit around Mars. They plan to have the satellite orbit a distance equal to 1.5 times the radius of Mars above the surface of the planet. Here is some information that will help solve this problem:

$M_{mars} = 6.4191 \cdot 10^{23}\ kg;\ R_{mars} = 3.397 \cdot 10^{6}\ m;\ G = 6.67428 \cdot 10^{-11}\ \frac{N \cdot m^2}{kg^2}$

What speed should the satellite have to be in a perfectly circular orbit?

**Solution.**

The gravitational force between Mars and the satellite is given by:

$$F_g = G\frac{M_{mars}M_{sat}}{R^2},$$

where $R = R_{mars} + 1.5R_{mars} = 2.5R_{mars} = 8.49425 \cdot 10^{6}\ m$ is the distance between the center of Mars and the satellite; $M_{sat} = 4100\ kg$ is the mass of the satellite.

According to Newton's second law, this force produces a centripetal acceleration if the orbit of the satellite is perfectly circular:

$$F_g = M_{sat}a,$$

where $a = \frac{v^2}{R}$ is the centripetal acceleration, $v$ is the speed of the satellite.

So we have an equation:

$$G\frac{M_{mars}M_{sat}}{R^2} = M_{sat}\frac{v^2}{R}.$$

Find $v$ solving this equation:

$$v = \sqrt{\frac{GM_{mars}}{R}} = 2{,}246\ \frac{km}{s}.$$

**Answer:** $2{,}246\ \frac{km}{s}$.