

Kepler's Third Law - Examples

1. Kepler's third law says that a^3/P^2 is the same for all objects orbiting the Sun. Vesta is a minor planet (asteroid) that takes 3.63 years to orbit the Sun. Calculate the average Sun-Vesta distance.

$$\text{Solution: } 1 = a^3/P^2 = a^3/(3.63)^2 = a^3/(13.18) \Rightarrow a^3 = 13.18 \Rightarrow \underline{a = 2.36 \text{ AU}}$$

2. Phobos orbits Mars with an average distance of about 9380 km (about 5720 miles) from the center of the planet and a rotational period of about 7 hr 39 min. Calculate the mass of Mars from this information.

Use $a^3/P^2 = (G / 4\pi^2) (m_1 + m_2)$, but first convert "a" and "P" to the proper units.

$$a = 9380 \text{ km} = 9.380 \times 10^6 \text{ meters}$$

$$P = 7 \text{ hr } 39 \text{ min} = 7.65 \text{ hr} = 27540 \text{ sec}$$

$$\therefore (9.380 \times 10^6 \text{ meters})^3 / (27540)^2 = [(6.67 \times 10^{-11}) / 4(3.14159)^2] (m_1 + m_2)$$

$$\therefore (m_1 + m_2) = \underline{6.44 \times 10^{23} \text{ kg}}$$

This mass is essentially the mass of Mars, since Phobos is so small by comparison.

$$\therefore m_{\text{Mars}} = \underline{6.44 \times 10^{23} \text{ kg}}$$

Bonus Trivia

In classical mythology, Vesta was _____, and in Victorian England a vesta is _____.

Phobos was discovered by _____ in the neighborhood known today as _____.