Answer on Question #54560-Physics-Mechanics-Kinematics-Dynamics

What is the mass of Jupiter? (Assume that Callisto's mass is negligible compared with that of Jupiter and use the modified version of Kepler's third law).

Solution

We have to use Kepler's law that $\frac{MP^2}{a^3}$ is constant. If we use solar mass, the Earth year and the AU as units, the constant is one.

$$P = 16.7 \; days \; = \frac{16.7}{365} = \; 0.0457 \; years$$

$$a = 1.88 \cdot 10^6 km \; = \frac{1.88 \cdot 10^6}{1.5 \cdot 10^8} \; = \; 0.0126 \; AU$$

Therefore, the mass of Jupiter is

$$M_{Jupiter} = \frac{0.0126^3}{0.0457^2} = 9.58 \cdot 10^{-4} \; M_{Sun} = 9.58 \cdot 10^{-4} \cdot 1.99 \cdot 10^{30} \; = \; 1.91 \cdot 10^{27} \; kg.$$

Answer: $\mathbf{1.91 \cdot 10^{27} \; kg}$.