57. (a) We use the law of periods: $T^2 = (4\pi^2/GM)r^3$, where M is the mass of the Sun (1.99×10^{30} kg) and r is the radius of the orbit. The radius of the orbit is twice the radius of Earth's orbit: $r = 2r_e = 2(150 \times 10^9\text{ m}) = 300 \times 10^9$ m. Thus,

$$\begin{aligned} T &= \sqrt{\frac{4\pi^2 r^3}{GM}} \\ &= \sqrt{\frac{4\pi^2(300 \times 10^9\text{ m})^3}{(6.67 \times 10^{-11}\text{ m}^3/\text{s}^2\cdot\text{kg})(1.99 \times 10^{30}\text{ kg})}} = 8.96 \times 10^7\text{ s} . \end{aligned}$$

Dividing by (365 d/y)(24 h/d)(60 min/h)(60 s/min), we obtain $T = 2.8$ y.

(b) The kinetic energy of any asteroid or planet in a circular orbit of radius r is given by $K = GMm/2r$, where m is the mass of the asteroid or planet. We note that it is proportional to m and inversely proportional to r. The ratio of the kinetic energy of the asteroid to the kinetic energy of Earth is $K/K_e = (m/m_e)(r_e/r)$. We substitute $m = 2.0\times10^{-4}m_e$ and $r = 2r_e$ to obtain $K/K_e = 1.0\times10^{-4}$.