Chapter 8 Problem 51 [†]

Given
$v = 53\ km/s = 5.3 \times 10^4\ m/s$
$r = 1.50 \times 10^{11}\ m$
$M_s = 1.99 \times 10^{30}\ kg$

Solution
Find out if the comet is in a closed or open orbit.

If the orbit is closed, the total mechanical energy will be less than zero when the potential is taken to be zero with respect to an infinite distance from the sun. The total energy is

$$E = K + U = \tfrac{1}{2}mv^2 - G\frac{Mm}{r} = m\left(\tfrac{1}{2}v^2 - G\frac{M}{r}\right)$$

$$E = m\left(\tfrac{1}{2}(5.3 \times 10^4\ m/s)^2 - (6.67 \times 10^{-11}\ Nm^2/kg^2)\frac{1.99 \times 10^{30}\ kg}{1.50 \times 10^{11}\ m}\right)$$

$$E = m(5.20 \times 10^8\ J/kg)$$

The mass of the comet must be positive and thus the total energy is positive. The comet is in an open orbit. Once it goes around the sun it will head out of the solar system and never return to earth.

[†]Problem from Essential University Physics, Wolfson