PROBLEM SET 14 SOLUTIONS
Physics 2021

1. $P = 1/3\ P_{Jupiter} = 0.33\ (11.862\ yr) = 3.954\ yr$

$P^2 = a^3 = (3.954)^2 = 15.63$

$a = 2.50\ AU$

2a. $\mathcal{M} = \rho V = (2700\ kg/m^3)\ (4\pi / 3)(1300\ m / 2)^3 = 3.1 \times 10^{12}\ kg$

2b. $v_{escape} = sqrt[\ 2\ G\ \mathcal{M} / R\ ] = sqrt[2(6.673 \times 10^{-11}\ N\ m^2/kg^2)\ (3.1 \times 10^{12}\ kg) / (650\ m)]$

$= sqrt[\ 0.638\ m^2/s^2\ ] = 0.80\ m/s$

3. Use Kepler's Third Law

Aphelion (AU)	a (AU)	P (yr)	Lifetime (yr)
100	50	353 yr	35,300
1,000	500	11,180	1,118,000
10,000	5,000	353,000	35,300,000
100,000	50,000	11,180,000	1,118,000,000

4a. $\mathcal{M} = \rho V = (1000\ kg/m^3)\ (10{,}000\ m)^3 = 1 \times 10^{15}\ kg$

4b. $V_{tail} = 10^6 \times 10^6 \times 10^8 = 10^{20}\ km = 1 \times 10^{29}\ m^3$

$\mathcal{M}_{tail} = (0.01)\ \mathcal{M} = 1 \times 10^{13}\ kg$

$\rho = \mathcal{M} / V = 1 \times 10^{13}\ kg\ /\ 1 \times 10^{29}\ m^3 = 1 \times 10^{-16}\ kg/m^3$

4c. The concern is not justified because a comet tail's density is extremely minor.

5. $P^2 = a^3$

$P = sqrt\{\ (2.1)^3\ \} = 3.0\ yr$

$P = sqrt\{\ (3.3)^3\ \} = 6.0\ yr$

6. **Same as Jupiter**

$$P^2 = a^3$$

$$P = \text{sqrt}\{ (5.2)^3 \} = 11.8 \text{ yr}$$

7. $P^2 = a^3$

$$a = \text{cube-root}\{ (5.5 \times 10^6)^2 \} = 31{,}200 \text{ AU}$$