PROBLEM SET 12 SOLUTIONS
Physics 2021

1. **Mass of All Planets = 0.055 + 0.815 + 1.0 + 0.107**

+ 317.9 + 95.2 + 14.5 + 17.1 + 0.002 = 446.679 earth masses

Mass of Jupiter = 317.9 earth masses

Percentage = 317.9 / 446.679 = 71.2%

2. **Volume $\propto$ Radius^3 (or diameter if used in a ratio)**

Volume$_S$ / Volume$_E$ = (9.54 / 1.0)^3 = 868 X

3. **Compute the mass of Jupiter using Almathea's orbit.**

	Almathea
Period (days)	0.4982
Period (years)	1.364×10^{-3}
Distance (km)	181,365
Distance (AU)	1.209×10^{-3}
Mass (solar)	9.500×10^{-4}
Mass (kg)	1.90×10^{27}
Mass (earth)	318.1

4. **$R_{Jupiter}$ = 71,492 km = 7.15×10^5 km**

$C = 2 \pi R = 2 \pi (7.15 \times 10^5 \text{ km}) = 4.49 \times 10^5$ km

Rotation rate = $9^h\ 50^m\ 28^s = 3.54 \times 10^4$ s

$v = (4.49 \times 10^5 \text{ km}) / (3.54 \times 10^4 \text{ s}) = 12.7$ km/s

5. $\text{Diameter}_{\text{RedSpot}} = 2.5\ \text{Diameter}_{\text{Earth}} = 2.5 \times 12{,}750 = 32{,}000$ km

$C = 100{,}000$ km Period $= 5.5$ days $= 4.752 \times 10^5$ s

Velocity $= 100{,}000$ km / $(4.752 \times 10^5$ seconds$) = 0.21$ km/s $= 760$ km/hr

6. Saturn's orbital eccentricity varies its distance from the Sun and the time it takes to move in its orbit (via Kepler's Second Law).

7. Outer edge $a = 136{,}600$ km $= 9.11 \times 10^{-4}$ AU $\mathcal{M} = 2.86 \times 10^{-4}$ solar mass

Inner edge $a = 92{,}000$ km $= 6.13 \times 10^{-4}$ AU

Outer edge $P = 1.626 \times 10^{-3}$ yr $= 0.594$ day $= 14.25$ hours

Inner edge $P = 8.974 \times 10^{-4}$ yr $= 0.328$ day $= 7.87$ hours

The rotation of Saturn is 10.2 hours. The outer edge drifts eastward; the inner one goes westward.

8. $a = 1.335 \times 10^5$ km / 1.5×10^8 km/AU $= 8.9 \times 10^{-4}$ AU

$\mathcal{M} = 2.86 \times 10^{-4}$ solar mass

$P^2 = a^3 / \mathcal{M} = (8.9 \times 10^{-4})^3 / (2.86 \times 10^{-4}) = 2.466 \times 10^{-6}$

$P = 1.57 \times 10^{-3}$ yr $= 0.574$ days

Pan 0.573 days / 0.574 = 1 / 1

Tethys 1.888 / 0.574 = 3 / 1 (approximately)

Problem 4 is worth 1 point;
Problems 1, 2, and 5 are worth 2 points each.
Problem 3 is worth 3 points.