HW 2 ASTR 314

C) $L = m_{Jup} v_{Jup} r_{Jup}$ ← equation for angular momentum

$a = 7.779 \times 10^{11}$ m ← distance between Jupiter and Sun

$a = a_{Jup} + a_{sun}$

$a_{Jup} = a - a_{sun} = 7.779 \times 10^{11} - 741589636.5$

$= 7.77184 \times 10^{11}$ m ← distance Jupiter is from center of mass

Since circular orbit velocity is constant so $v = \frac{\text{circumference}}{\text{time to go around once}}$

$v_{Jup} = \frac{2\pi a_{Jup}}{P} = \frac{2\pi(7.77184 \times 10^{11})}{374{,}016{,}960} = 13056.07493 \frac{m}{s}$

11.86 yr but in seconds

$L = 1.898 \times 10^{27} \times 13056.07493 \times 7.77184 \times 10^{11}$ (m_{Jup}, r_{Jup})

$= \boxed{1.925896321 \times 10^{43} \text{ kg} \frac{m^2}{s}}$

Lot larger than sun's contribution to total angular momentum

D)

D) Sun

$I = \frac{2}{5} m r^2 = \frac{2}{5}(1.9891 \times 10^{30})(6.96 \times 10^8)^2 =$

$= 3.85412 \times 10^{47} \text{ kg} \cdot m^2$ $L = I\omega = \boxed{1.078 \times 10^{42} \text{ kg} \frac{m^2}{sec}}$

$\omega = \frac{2\pi}{26.86400} = 2.797 \times 10^{-6} \frac{\text{rad}}{\text{sec}}$

Jupiter $I = \frac{2}{5} m r^2 = \frac{2}{5}(1.898 \times 10^{27})(6.9 \times 10^7)^2 = 3.6145 \times 10^{42}$

$\omega = \frac{2\pi}{10.3600} = 1.745 \times 10^{-4} \frac{\text{rad}}{\text{sec}}$ $L = I\omega_{Jupiter} = \boxed{6.30858 \times 10^{38} \text{ kg} \frac{m^2}{sec}}$

e) The orbital angular momentum of Jupiter makes the largest contribution to the total angular momentum

HW2 ASTR 314

$m_s = 1.898 \times 10^{27}$ kg

$m_{sun} = 1.9891 \times 10^{30}$ kg

A) $L = \mu\sqrt{G M_{Tot} a(1-e^2)}$ (a = semi-major axis) $\mu = \frac{m_s m_{sun}}{m_s + m_{sun}} = 1.89619 \times 10^{27}$ kg

$L = 1.89619 \times 10^{27} \sqrt{(6.673 \times 10^{-11})(1.99 \times 10^{30})(7.779 \times 10^{11})(1 - 0.048^2)}$

$= \boxed{1.925 \times 10^{43} \text{ kg} \cdot \frac{m^2}{s}}$

5.2 AU $= 7.779 \times 10^{11}$ m

$11.86 \text{ years} \times \frac{365 \text{ days}}{\text{year}} \times \frac{86400 \text{ seconds}}{1 \text{ day}} = 374016960$ seconds

B) $L_{sun} = m_{sun} v_{sun} a_{sun}$

$v_{sun} = \frac{2\pi a_{sun}}{P_{sun}}$ (a_{sun})

$P^2 = \frac{4\pi^2}{G M_{Tot}} a^3$

$a = \left(\frac{G P^2 M_{Tot}}{4\pi^2}\right)^{1/3} = \left(\frac{(6.673 \times 10^{-11})(374016960)^2 (M_{Tot})}{4\pi^2}\right)^{1/3}$

distance between sun/Jupiter

$a = 7.779 \times 10^{11}$ m

$a = a_{Jup} + a_{sun}$

$a = 1048.997893\, r_{sun}$

distance sun is from center of mass

$r_{sun} = \frac{7.779 \times 10^{11}}{1048.997893} = 741589636.5$ m

$\frac{r_2}{r_1} = \frac{m_1}{m_2}$ ratio

$r_{Jup} = \frac{1.9891 \times 10^{30}}{1.898 \times 10^{27}}(r_{sun})$

$r_{Jup} = 1047.997893\, r_{sun}$

$v_{sun} = \frac{2\pi(741{,}589{,}636.5)}{374{,}016{,}960} = 12.458 \frac{m}{s}$ ← $\frac{2\pi a_{sun}}{P_{sun}}$

velocity is constant due to circular orbit

$L_{sun} = (1.9891 \times 10^{30} \text{ kg})_{m_{sun}} (12.458 \frac{m}{s})_{v_{sun}} (741{,}589{,}636.5 \text{ m})$

$= \boxed{1.83767 \times 10^{40} \text{ kg} \frac{m^2}{s}}$

distance sun is from center of mass