Chapter 11 Problem 48

$T = 33.5 \times 10^{-3}\ s$

$r = 10.0\ km$

$m = 2.8 \times 10^{30}\ kg$

Neutron Star

Treat as a solid sphere

$I = \frac{2}{5} MR^2$

a) What is the angular momentum of the pulsar?

If the period is T for one revolution, then the angle traveled in one revolution is 2π radians.

Then the angular velocity is $\omega = \frac{\theta}{T} = \frac{2\pi}{33.5 \times 10^{-3}\ s}$

$\omega = 187.6\ rad/s$

Moment of Inertia is

$I = \frac{2}{5}(2.8 \times 10^{30}\ kg)(10 \times 10^{3}\ m)^2$

$I = 1.12 \times 10^{38}\ kg\ m^2$

Angular momentum is then

$L = I \cdot \omega = (1.12 \times 10^{38}\ kg\ m^2)(187.6\ rad/s)$

$L = 2.10 \times 10^{40}\ kg\ m^2/s$

b) Angular velocity decreases at $\alpha = -10^{-14}\ rad/s^2$

∴ The torque is

$\tau = I \frac{d\vec{\omega}}{dt} = I\alpha = (1.12 \times 10^{38}\ kg\ m^2)(-10^{-4}\ \frac{rad}{s^2})$

$\tau = -1.12 \times 10^{34}\ N \cdot m$