One of the proposed *Discovery* missions is to Triton. Triton has a bulk density of 2061 kg/m$^3$ and a radius of 1353 km. It orbits synchronously with a 5.88 day period and an effectively zero eccentricity.

a) We might model Triton as a two-layer body having an inner silicate region of density 3.5 g/cc and a radius 1026 km, and an outer ice shell of density 0.95 g/cc. What is the dimensionless moment of inertia $c' = C/MR^2$?

b) Assuming that Triton is hydrostatic, determine the *secular* Love numbers $k_{2s}$ and $h_{2s}$.

c) Also determine $J_2$, $C_{22}$ and the equatorial flattening (in km).

d) Triton is retrograde, with an inclination of $i = 156.87^\circ$ and a ratio of mean motion to orbital precession rate $p = -4.27 \times 10^4$. The Cassini state constraint can be written

$$3 \left( J_2 + C_{22} \right) \cos \theta_0 + C_{22} \right) p \sin \theta_0 = 2 \ c' \sin(i - \theta_0)$$

where $\theta_0$ is the obliquity. What value does $\theta_0$ take to satisfy this equation? (You may have to solve it numerically, and it will have a *negative* value).

e) Let’s say we measure an obliquity of $-0.6^\circ$. What value of $c'$ would you deduce based on your assumed $J_2$ and $C_{22}$, and what would you conclude?

f) Calculate the expected period of free libration. You will need to know that $(B-A)/MR^2 = 4 \ C_{22}$.

g) In principle we could use an observation of forced libration amplitude to help determine $(B-A)$. Why is this technique unlikely to be useful at Triton?