EART 162 #8 4th June 08

a) $g = \frac{GM}{R^2} = 3.70\ ms^{-2}$ $\bar{\rho} = \frac{3M}{4\pi R^3} = 5420\ kgm^{-3}$ (2)

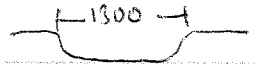
b) 

$f = \frac{R_c}{R}$ $M = \frac{4}{3}\pi R^3 \rho_m (1 + f^3 \frac{\Delta\rho}{\rho_m})$ $\Delta\rho = 2600\ kgm^{-3}$ (4)

$\Rightarrow f^3 = \left\{ \frac{3M}{4\pi R^3 \rho_m} - 1 \right\} \frac{\rho_m}{\Delta\rho}$ $\Rightarrow f = 0.92$ $\Rightarrow$ mantle thickness = 196 km

c) $\frac{C}{MR^2} = 0.4 \frac{\{1 + f^5 \frac{\Delta\rho}{\rho}\}}{\{1 + f^3 \frac{\Delta\rho}{\rho}\}} = 0.377$ (3).

d) Because we don't have a good gravity measurement (J_2) (1)

e) 

$\Delta g = 42 \times 3 \times 3 = 378$ mGal (2)

f) $e^{-kz} = 0.38$ $\Rightarrow \Delta g = 144$ mGal (2)

g) if $\Delta g = 0$ $C = 1$ if $\Delta g = 144$ mGal $C = 0$ $\Rightarrow C = 1 - \frac{\Delta g_{obs}}{\Delta g_{calc}} = 0.51$ (2).

h) $C = \frac{1}{1 + \frac{Dk^4}{\Delta\rho g}}$ $\Rightarrow D = \left\{ \left(\frac{1}{C}\right) - 1 \right\} \frac{\Delta\rho g}{k^4} = 3.3 \times 10^{24}$ Nm

$D = \frac{E T_e^3}{12(1-\sigma^2)}$ $\Rightarrow T_e = \left(\frac{12(1-\sigma^2)D}{E} \right)^{1/3} = 71.6$ km (4)

i) $F = k \frac{\Delta T}{d} = 25\ mW m^{-2}$ (2)

j) 
$M_{mantle} = 4.6 \times 10^{22}$ kg $F = \frac{M_{mantle} H}{4\pi R^2} \Rightarrow H = 4 \times 10^{-11}\ Wkg^{-1}$ (3)

k) $H = R \left(\frac{M}{m}\right)\left(\frac{R}{a}\right)^3 = 1$m strain $\sim 4 \times 10^{-7}$ strain rate $\sim 10^{-13}\ s^{-1}$

$\Rightarrow$ tidal heating likely negligible (3)

l) $Ra = \frac{\rho g k \Delta T d^3}{\kappa \eta}$ assume $\eta = 10^{21}$ Pas $k = 3 \times 10^{-5}\ K^{-1}$ $\Delta T = 1600$K

$\kappa = 10^{-6}$

$Ra \approx 4500$ $\Rightarrow$ very sluggish convection (4).

m) $\varepsilon = \alpha \Delta T = 3 \times 10^{-3}$ (2)

n) $\sigma = \frac{E\varepsilon}{(1-\sigma)} = 400$ MPa (1)

o) $P = \rho g z$ $\Rightarrow z = 32$ km (2).

p) Quite likely - stresses large enough to move faults at depths of several hrs of km (2). 39