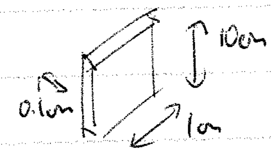
22 April 08.

EART 162 PS#3

2 1a) $\Delta g = 2\pi\rho G h = 118$ mGal

4 2 b) No. $e^{-kz} \sim e^{-\frac{6\times 100}{10}} \sim 0$ (attenuation)

2 a) $E = \sigma/\varepsilon \quad \sigma = F/A = 5/10^{-2}\times 10^{-3} = 5\times 10^{5}$ Pa



$\varepsilon = \Delta l / l = 0.5/10 = 0.05$

4 $\Rightarrow E = 5\times 10^{5}/0.05 = 10$ MPa.

2 b) $\varepsilon_1 = \sigma/E \quad \varepsilon_2 = -\nu\sigma/E = -\nu\varepsilon_1 \quad \varepsilon_2 = \frac{-0.05}{1}$

$\nu = -\varepsilon_2/\varepsilon_1 = 0.05/0.05 = 1$ (!! Not realistic, most materials $\nu < 0.5$)

8 2 c) The elastic band is starting to yield (plastic deformation)

3 a) $\bar{\rho} = \frac{M}{V} = 621$ kg m^{-3}

2 $g = \frac{GM}{r^2} = 10.5$ ms^{-2}

b) $P = c\rho^{5/3} \qquad dP = \rho g\, dz$

$\rho = \left(\frac{P}{c}\right)^{3/5} \Rightarrow dP = \left(\frac{P}{c}\right)^{3/5} g\, dz$

$\int P^{-3/5} dP = \int c^{-3/5} g\, dz \Rightarrow \frac{5}{2} P^{2/5} = c^{-3/5} g z + d$

when $z = 0$ $P = 0 \Rightarrow d = 0 \Rightarrow P^{2/5} = \frac{2}{5} c^{-3/5} g z$

5 $\Rightarrow P = c^{-3/2}\left(\tfrac{2}{5} g z\right)^{5/2}$

c) $g = 10.5$ $z = 60300$ km $c = 10^{6} \Rightarrow P = 1020$ GPa $= 1.02$ TPa

2 $\rho = \left(\frac{P}{c}\right)^{3/5} = 4030$ kg m^{-3} $= 10.2$ Mbar

d) assumed isothermal – increased temp will make our answer overestimate

assumed homogeneous – presence of rock/ice core " " " underestimate

6 assumed g constant – reduction of g with z " " " overestimate

e) our answer is an underestimate. This suggests that the presence of a rock/ice core is important (and is also expected on

17 2 cosmochemical grounds).

EART 162 PS#3 contd.

4 a) $\eta = A \exp(Q/RT)$

2 $\eta_m = A \exp(Q/RT_m) \Rightarrow A = \eta_m \exp(-Q/RT_m)$

2 b) $\eta = A \exp(Q/RT) = \eta_m \exp[(Q/R)(1/T - 1/T_m)]$

4 c) $\eta = \eta_m \exp\left[(Q/R)\left(\frac{T_m - T}{T_m T}\right)\right] \approx \eta_m \exp\left[(Q/R)\,\Delta T / T_m^2\right]$

d) RT_m^2/Q has units of temperature. This quantity is the change in temperature required to cause the viscosity to change by a

3 factor of e (≈ 3).

13 2 e) $RT_m^2/Q = 50.7$ K. 100K temperature change $\rightarrow \exp(1.97)$ $\Rightarrow$ viscosity changes by a factor of ≈ 7 (or 1/7).

4 + 8 + 17 + 13 = 42