GEOS 602 – Geophysical Fields
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Problem Set #2 Due Tue February 9

1. The earth formed by accretion of matter over a period of time, driven by gravitational attraction. We will solve a (very) simplified version of the problem to determine how hot the proto-Earth was when it reached its full size. We will assume point masses for everything, no radiation of heat energy, and no loss of mass through ejecta.

    a. Assume a particle moves inward toward the proto-Earth, which has radius a and uniform density ρ. Assuming no atmospheric or other drag forces, and assuming the particle was at rest initially, calculate its velocity on impact. (Hint: Assume that kinetic + potential energy = 0, so that at impact the kinetic energy = -U).

    b. Calculate the total energy of accretion, assuming that no heat is radiated, and no material is ejected by impacts.

    c. Calculate the increase in temperature caused by accretion, assuming $\Delta T = \frac{(energy\,/\,mass)}{(energy\,/mass \cdot {}^\circ C)}$, where $(energy\,/mass \cdot {}^\circ C) = 840$ J kg^{-1} °C^{-1}

2. Calculate the potential and gravitational field inside and outside a thin spherical shell of radius a, and uniform surface density σ (surface density σ in units of mass/length^2).

3. Calculate the potential and gravitational field everywhere for a thick-walled shell (inner radius a_1 and outer radius a_2). Sketch the potential and gravitational field as a function of radius.

4. Do problem 5-5 in Turcotte and Schubert.

5. Do problem 5-7 in Turcotte and Schubert.

6. Do problem 5-9 in Turcotte and Schubert.

7. Do Problem 5-11 in Turcotte and Schubert.