

**Problem Set 4**Due at *beginning* of class *Wednesday, 3 May 1995***Homework Problems:**

1. The temperature in the Earth's crust increases at a rate of  $20^\circ K$  per kilometer of depth.
  - a) How cold would the Earth become with the sun turned off?
  - b) Could geothermal sources provide a solution to the world's energy problem?

2. Consider the properties of iron at low temperature, but at the high pressure,

$$P \approx \frac{m_e^4 c^5}{\hbar^3} \approx 10^{25} \text{ dyne cm}^{-2}.$$

Such conditions are met in the cores of massive white dwarfs and in the crusts of neutron stars. Estimate:

- a) the mass density,
  - b) the elastic shear modulus at temperatures well below the melting temperature,
  - c) the melting temperature,
  - d) the debye temperature,
  - e) the electrical conductivity at the melting temperature.
3. A basketball is dropped onto a concrete pad from a high flying airplane.
  - a) How high will it bounce?
  - b) Would your answer be different if it were dropped from the top of Millikan library?

4. [modification of Eric Dickson's problem 6 from last week]

By 1618, tensions between the ruling Roman Catholics and the Protestants in Bohemia had risen to a fevered pitch, culminating in the ejection of the two (Catholic) imperial regents from an upper-floor window of the Prague castle. This event, known as the Defenestration\* of Prague, began the Thirty Years' War.

The two Catholics survived the fall without serious injury, and attributed their good fortune to the favor of the Lord. Skeptical Protestants pointed out that the Catholics had landed in a large pile of horse manure which had cushioned their fall.

- a) Assume for the moment that the pile of horse manure was infinitely deep. Use the fact that the Catholics were not injured to estimate an upper limit to the viscosity of the horse manure. [optional: if you have experience with horse manure, discuss the probable age and temperature of manure with this viscosity]
- b) Now assume that the viscosity is far below your limit in (a). Estimate the depth of manure needed to provide saving grace for the fallen Catholics.
- c) If the Catholics had instead fallen from heaven (let us say the height of Mt. Olympus, 3km) into the ocean, could they have survived? What if they had fallen into a rainforest jungle?

5. Estimate the natural frequencies of oscillation of Millikan library in the N-S and E-W directions.

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\* Latin *de*: from + *fenestra*: window