Physics 103b

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Order of Magnitude Physics

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Problem Set 3

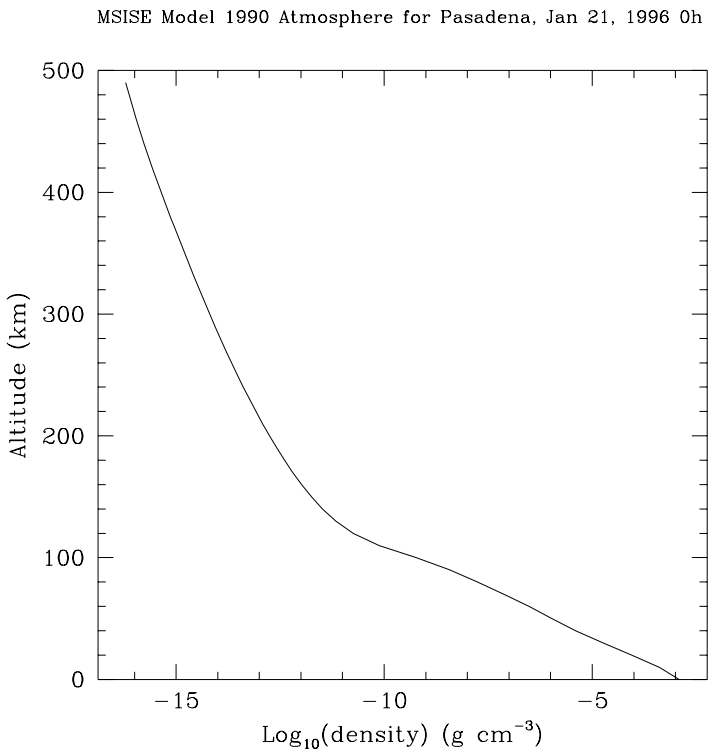
Due at *beginning* of class *28 January 1997*

1. Following a winter storm the interval between waves at Southern California beaches declined from $17 - 19$ s on Sunday, to $16 - 18$ s on Monday, and to $15 - 16$ s on Tuesday. Typical values are $10 - 11$ s.
   a) What was the maximum sustained wind speed during the storm?
   b) How distant was the storm from Southern California?
   c) How long ago did it take place?
   d) What are upper limits on the size and duration of the storm?

2. Seismic noise is dominated by forcing from ocean waves. Its power spectrum peaks near a period of 7 s, half the period of typical ocean waves. This frequency doubling is a nonlinear effect.
   a) Identify its origin by comparing the time dependence of the horizontally averaged height of a deep body of water perturbed by surface travelling waves to that perturbed by surface standing waves. Note: don't confuse the average height of the surface with the average height of the water.
   b) Estimate the amplitude of the bottom pressure variation in terms of the maximum height, ξ, of the waves.

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 any different if it were dropped from the top of Millikan library? A standard basketball has a radius of 12cm and a mass of 600g.

4. Of all the elements, only He, and to a lesser extent H_2 show interesting quantum effects in their liquid state. Give an order-of-magnitude calculation to explain why other liquids (including other noble gases besides He) don't show quantum effects, and are well described by classical (e.g. hard sphere) models. [Hint: some ingredients in your calculations will be binding energies, melting temperatures and the uncertainty principle]



5. Using the graph of the earth's atmospheric density as a function of altitude, estimate, for a meter-sized orbiting satellite,
   a) The altitude at which the mean-free path of air molecules is equal to the size of the satellite.
   b) The altitude from which a satellite initially placed in a circular orbit would crash in 10 years.
   c) The altitude at which the satellite could be considered to have re-entered the atmosphere (time to crash becomes less than an orbital period).

6. Make up a problem of your own.