Physics 103b

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Order of Magnitude Physics

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Problem Set 7

Due at *beginning* of class *25 February 1997*

1. Information Capacity Of A Continuous Channel
   a) How many real numbers are required to characterize a continuous signal of length T and bandwidth W?
   b) Estimate the number of significant bits each of these numbers carries if the signal is polluted by noise. Assume the signal to noise power ratio $S/N \gg 1$.
   c) What value of S/N is required for operation of a 3×10^4 baud modem over a commercial phone line with $W = 3 \times 10^3$ Hz?

2. More On Interplanetary Communication At Optical Frequencies

   Consider the communication system described in problem 5) of problem set 5. Would scattered sunlight be a significant noise source if the spacecraft were transmitting from in front of Saturn? In formulating your answer make sure to take into account that the space telescope resolves the disk of Saturn.

3. Evaporation
   a) Estimate the evaporation time per centimeter depth for water maintained at 15 degrees centigrade in vacuum. At this temperature the equilibrium vapor pressure is about 13 mm of Hg.
   b) Estimate the evaporation time per centimeter depth as a function of wind speed for water maintained at 15 degrees centigrade in air. Consider a puddle of 50 cm diameter.
   c) Compare your answers in a) and b) to the timescale over which puddles disappear in cloudy weather following a rain storm?

4. Estimate the mean free path of a photon of blue light at sea level on a clear day. Scale your answer to obtain the mean free path of a similar photon propagating along a glass fiber.

5. A ventilation system steadily blows fresh air at temperature 18 C (65 F) into a room. If there are enough people in the room to maintain the temperature at a steady state value of 24 C (75 F), by what fraction is the air leaving the room depleted in oxygen?

6. Make up a problem of your own.