Homework 5: Due Monday 11/19/2012 in class

Required Reading:
You should have completed Chapter 5.
Grad students: Please also read Dietrich & Perron's paper, "The search for a topographic signature of life" and answer the following:

Based on this paper, does life leave a unique imprint on a planet's surface morphology? If life were rare, but present now or previously in some regions of a planet (e.g., Mars), could we distinguish these regions from those that have always been sterile? What types of observations might be most informative?

Questions:
Please answer the following questions from your textbook:

Chapter 5: 5.5, 5.6, 5.9
Also, answer the following (adapted from Planetary Surface Processes by H. J. Melosh):

1) Swedish cratering rate
In addition to the 5 proven and 33 possible impact craters in the country of Sweden, Lilljequist & Henkel (1996) proposed the existence of a truly world-class crater, the Uppland structure, 320 km in diameter.

a.) Using Earth's estimated cratering rate of N_{cum} ($D > 22.6$ km) = 1.8 x 10^{-15} craters/km^2/yr, and a power law exponent $b = 1.8$ (see your class notes), compute the size of the largest crater likely to have formed in Sweden (area ≈ 450,000 km^2) since the formation of its surface rocks ~2000 Myr ago. How does this compare to the size of the putative Uppland structure?

b.) Calculate the probability that a crater as large as Uppland would have formed in the past 2000 Myr. Note that the largest *confirmed* crater in Sweden is the 55 km-diameter Siljan structure.

2) Winds in the outer solar system
Triton, Neptune's largest moon, has a ***very*** thin atmosphere (~15 μbar!) composed mainly of N_2 gas at a chilly 38 K. Suppose that loose "sand" grains of water ice (perhaps from impact ejecta) lie on Triton's surface.

a.) What grain size would be most easily entrained in saltation?

b.) How fast must the winds of Triton blow to entrain such grains? Compute both the threshold wind friction speed and the speed 1 meter above the surface, assuming a logarithmic wind profile with aerodynamic roughness z_0 equal to 1/30th of the grain size.

c.) Using equation 7.3 in your textbook, compare this to the speed of sound in Triton's atmosphere (note that $\gamma \approx 1.4$ for a diatomic gas such as N_2).

d.) What can you conclude about the likelihood of finding sand dunes on Triton? Do you expect New Horizons to find sand dunes on Pluto?