22.101 Applied Nuclear Physics

(Fall 2006)

Problem Set No. 4 **Due: October 11, 2006**

Problem 1

(a) It is well known that the cross section σ is a measure of the probability of having a reaction, yet σ has the dimension of an area. Give a physical definition of σ that shows clearly its connection to the probability of a reaction and at the same time explains why σ has the dimension that it does. Give a simple interpretation of the ratio: {reaction probability}/σ. Discuss whether your definition of σ allows σ to be calculated.

(b) Extend your consideration of σ as the scattering cross section to the angular differential scattering cross section $d\sigma/d\Omega$, and furthermore to the energy differential scattering cross section $d\sigma/dE$, and the double differential scattering cross section $d^2\sigma/d\Omega dE$. Give some thoughts to the physical interpretations of the three differential cross sections, and the relations they have with each other and with σ.

Problem 2

Verify the following results in the Lecture Notes (Lecture 7) by direct derivation.

(a) Equation (7.3)

(b) Equation (7.8).

(c) Equations (7.17) and (7.19).

Problem 3

Calculate the neutron scattering cross section of C^{12} for thermal neutrons. Assume a potential well with depth V_o = 36 Mev and range $r_o = 1.4xA^{1/3}$ F and consider only the s-wave contribution. Compare your result with the experimental value (use the Table of Nuclides (kaeri), http://atom.kaeri.re.kr/) and discuss any significance that you can observe. How does your result compare with the cross section of H^1? Explain the difference between neutron scattering by C^{12} and by H^1 in terms of the physics of neutron-nucleus interactions.