Problem Set 3
Due SES #8

[EL] = Lewis, Elmer L. *Fundamentals of Nuclear Reactor Physics*. Burlington, MA: Academic Press, 2008. ISBN: 9780123706317.

Suggested Problems: [EL] Chapter 4, Problems 4.9, 4.10, 4.11

Question 1: What is the probability that a neutron with an initial energy of 1 MeV, scattered elastically from hydrogen, will emerge from the scattering collision with an energy below 10 eV? Answer the same question if the collision is with a deuterium nucleus. Assume isotropic scattering in the center of mass system.

Question 2: From the data provided in Tables 1 and 2:

a. Calculate the average number of collisions needed to thermalize a neutron from 10 MeV to 1 eV in moderators 1,2 and 3 of Table 2.
b. Compute the moderating ratio or slowing down ratio for all three moderators.
c. Indicate which of these moderators is the best at slowing down neutrons
d. Indicate which of these moderators is the most effective moderator

Table 1

Isotopes	A	σ_s (barns)	σ_a (barns)
X	12	100	3
Y	6	500	2
Z	32	140	5

Table 2

Moderator	Chemical Formula	Σ_s (cm^{-1})	Σ_a (cm^{-1})
1	X	10.0	0.03
2	XY_2	110.0	0.07
3	Z_2	0.7	0.025

Question 3: Discuss the differences between potential scattering and resonance elastic scattering.

Question 4: Explain concisely what resonances are and why they are located at very high energies for light nuclei.

Question 5: Using the Breit-Wigner Narrow resonance approximation of eq.2-41, plot the resonance cross-section in function of energy for the following U-236 resonance:

$E_r = 5.49$ eV
$\Gamma_\gamma = 0.029$eV
$\Gamma_n = 0.0018$eV
$\sigma_0 = 1000$ barns

Question 6: Explain briefly the mechanism behind Doppler effect.

Question 7: Define all four factors of the 4-factor formula and estimate how these factors would vary with a substantial increase in temperature in a uranium oxide fuel.

22.05 Neutron Science and Reactor Physics
Fall 2009