Problem Set 7
Due SES #20

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

Suggested Problems: [EL] Chapter 7, Problems 7.5, 7.13

Question 1: Determine the critical radius of a sphere using:

a) 1-group theory
b) 2-group theory

Table 1.1: 1-group parameters

D (cm)	1
Σ_a (cm^{-1})	0.25
$\nu\Sigma_f$ (cm^{-1})	0.3125

Table 1.2: 2-group parameters

D_1 (cm)	2
Σ_{r1} (cm^{-1})	0.08
$\nu\Sigma_{f1}$ (cm^{-1})	0.02
D_2 (cm)	1
Σ_{a2} (cm^{-1})	0.25
$\nu\Sigma_{f2}$ (cm^{-1})	0.5
Σ_{s21}	0.058

Question 2: Write the 4 group steady-state diffusion equations with no external source. Assume that all fission neutrons are born in the fast group and that there is no-upscattering.

If we assume that the leakage in groups 2,3 and 4 is negligible compared to the collision terms in these groups, derive the corresponding modified 1 group equation.

Question 3: A bare spherical reactor is to be constructed of a homogeneous mixture of D_2O and U-235. The composition is such that for every uranium atom there are 2000 heavy water molecules (i.e. $N_{D2O} / N_{U\text{-}235} = 2000$). Calculate the critical radius of the reactor using one-speed diffusion theory using the following parameters:

$\eta_{U\text{-}235} = 2.06$
$D_{D2O} = 0.87$ cm
$\Sigma_{aD2O} = 3.3 \times 10^{-5}$ cm-1
$\sigma_{a,D2O} = 0.001$ barn
$\sigma_{a,U\text{-}235} = 678$ barn

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