Problem Set 3

22.211 Fall 2023

Due Date 3/8/2023

Question 1

Write a Monte Carlo code that calculates the crow-flight distance from a neutron born isotropically at position (0,0,0) with energy of 1MeV until it reaches an energy of 0.1 eV via elastic scattering isotropic in the COM.

a) For H-1, calculate the crow-flight distance (mean and std deviation) as a function of density (0.7 g/cm^3 to 1.0 g/cm^3).
b) For H-1 at 0.7 g/cm^3, calculate the crow-flight distance (mean and std deviation) as a function of boron concentration (0 ppm to 1000 ppm).
c) For C-12, calculate the crow-flight distance (mean and std deviation) as a function of equivalent boron impurities (0 ppm to 10 ppm).

*Note: The crow-flight distance is the distance between the starting point and ending point, and **not the total distance** travelled by the neutron during its random walk.*

Note 2: This code will require that you keep track of neutron direction, distance travelled and rotations after each scattering events. After each particle history, compute the distance between the end point and origin.

Question 2 (effective RI)

a) Compute numerical resonance integrals and group cross sections of U-238 capture for the groups listed in the tables below using a Monte Carlo slowing down code assuming elastic scattering in the COM with H-1 for dilutions of 10, 1000 and 1000000 for both 294K and 900K.
b) Repeat for C-12
c) Discuss the impact of dilution and temperature of resonance integrals and cross-sections.
d) Discuss the effectiveness of C-12 as a moderator in comparison to H-1.

U-238 Capture Resonance Integrals and Group cross sections as a function of background and temperature

Background	**(6-10) eV**		**(10-25) eV**		**(25-50) eV**	
10 – 294K	**RI**	**XS**	**RI**	**XS**	**RI**	**XS**
1000 – 294K	**RI**	**XS**	**RI**	**XS**	**RI**	**XS**
1M – 294K	**RI**	**XS**	**RI**	**XS**	**RI**	**XS**
10 – 900K	**RI**	**XS**	**RI**	**XS**	**RI**	**XS**
1000 – 900K	**RI**	**XS**	**RI**	**XS**	**RI**	**XS**
1M – 900K	**RI**	**XS**	**RI**	**XS**	**RI**	**XS**

Question 3: Estimate the total number of neutrons in a typical 1000 MWe pressurized water reactor and document your approach.