Homework 06 (21Nov22)

Name: `your name`

Rubric for each assignment:

Context	Points
Precision of the answer	80%
Answer Markdown readability	10%
Code readability	10%

Guidance:

- This is an individual homework.
- Upload your answers in the Blackboard submission portal as:

  lastname-firstname-homework-xx.pdf or **lastname-firstname-homework-xx.ipynb**

Table of Problems

Problem 1 (20 pts)

A 5-cm thick layer of purely absorbing material is found to absorb 99.9% of a neutron beam. The material has a nuclide number density of 4×10^{22} nuclei/cm^3. Calculate the following:

1.1)(5 pts) The macroscopic cross section.

Answer:

1.2)(5 pts) The mean free path. Explain the formula you used.

Answer:

1.3)(5 pts) The microscopic cross section.

Answer:

1.4)(5 pts) Is the cross section as big as a barn? Explain.

Answer:

Problem 2 (20 pts)

What is the minimum number of elastic scattering collisions required to slow a neutron down from 1 MeV to 1 eV in the materials below.

Formulae:

- Head-on energy loss ratio: $\alpha = \left(\frac{A-1}{A+1}\right)^2$
- Slowing down decrement: $\xi := \overline{\ln(E/E')} = \int \ln(E/E')\, p(E \to E')\, dE' = 1 + \frac{\alpha}{1-\alpha} \ln \alpha$

- Elastic scattered energy probability distribution function: $p(E \to E') = \begin{cases} \frac{1}{(1-\alpha)\,E} & \text{if} \quad \alpha E \le E' \le E \\ 0 & \text{otherwise} \end{cases}$

2.1)(5 pts) Hydrogen.

Answer:

2.2)(5 pts) Deuterium.

Answer:

2.3)(5 pts) ^{12}C.

Answer:

2.4)(5 pts) ^{238}U.

Answer:

Problem 3 (20 pts)

In contrast to Problem 2, assuming that any elastic collision in Problem 2 loses the average value, ξ, repeat the calculation of the number of elastic collisions for the same materials and compare with the results in Problem 2.

3.1)(5 pts) Hydrogen.

Answer:

3.2)(5 pts) Deuterium.

Answer:

3.3)(5 pts) ^{12}C.

Answer:

3.4)(5 pts) ^{238}U.

Answer:

Problem 4 (10 pts)

Explain the origin of resonance peaks in the scattering cross sections of heavy nuclides.

Answer:

Problem 5 (10 pts)

What are the significant neutron energy ranges in nuclear reactors? Provide the bounds and names of the regions.

Answer:

Problem 6 (10 pts)

Why all working nuclear reactors either use the thermal or fast neutron spectrum? What is the issue in between these spectra?

Answer:

Problem 7 (10 pts)

What are the desired properties of a neutron moderator material? List three quantities used to assess the effectiveness of a moderator material and define these quantities?

Answer: