Reactor Physics and Nuclear Power

1. Calculate the atom density of Hydrogen and Oxygen in water. (Given that, Mass of Hydrogen is 1.008 amu, Mass of Oxygen is 15.999 amu, Density of water is 1.0 g/cc)
2. Calculate the atom density of U-235 in a 3% enriched UO_2fuel (Use mass of U-235 as 235.044 amu, U-238 as 238.051 amu and O-16 as 15.999 amu, Density of UO_2 is 10.55 g/cc).
3. Calculate the binding energy of Hydrogen, Pb-209 and Th-232 nucleus (Mass of Proton is 1.00727 amu and Neutron is 1.00864, masses of Hydrogen = 1.0078 amu Pb-209 = 208.98 amu and Th-232 = 232.038 amu. Also use 1 amu = 931.5 MeV)
4. If the fission and capture cross section of U-235 is 580 barns and 100 barns, calculate the macroscopic absorption cross section for U-235 and nat. uranium. Also calculate the macroscopic fission cross section of U-235. Use all the relevant information from problem 2 and that density of natural uranium is 18.6 g/cc.
5. Calculate the value of eta factor for natural uranium as fuel. (for ^{235}U, microscopic fission and capture cross sections for thermal neutrons be taken as 580 barns and 100 barns, respectively. The absorption cross section for ^{238}U is given as 2.7 barns).
6. Calculate the mean free path of absorption of neutrons in light water given that σ_a(H) is 0.33 barns and σ_a(O) is $2x10^{-4}$ barns,
7. Calculate the power produced by 1 g of U-235 in a thermal reactor in a day if the operating flux level of 2.1 x 10^{14} n/cm^2/s . Assume that the absorption cross section for U-235 to be 680 barns. (Hint : Use the fact that to produce 1 W in U-235 one requires 3.2 x 10^{10} fissions/second)
8. Calculate the critical radius for a certain spherical reactor having the material properties as follows: Diffusion coefficient D=1.1 cm, Σ_a = 0.22 cm^{-1} and K_∞ =1.045.
9. Calculate the thermal flux and reaction rate for a PWR core loaded with 3.4 Te of U-235 and producing 3200 MWth. Assume that the fission cross section of U-235 from thermal neutron is 580 barns.
10. If the multiplication factor in a reactor is 1.0035, calculate in how many generations the neutron population will double. Also calculate the time required for the population to double
    a) When there are no delayed neutrons (assume that the neutron life time is 1 ms) and
    b) When there are delayed neutrons (assume the neutron life time is 0.1 seconds)

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