Assignment 4

1. A 2-MeV neutron travelling in water has a head-on collision with an O^{16} nucleus.
   (a) What are the energies of the neutron and nucleus after the collision? (b) Would you expect the water molecule involved in the collision to remain intact after the event?
2. A 1-MeV neutron strikes a C^{12} nucleus that is initially at rest. If the neutron is elastically scattered through an angle of 90^o, (a) what is the energy of the scattered neutron? (b) what is the energy of the recoiling nucleus? (c) at what angle does the recoiling nucleus appear?
3. Show that the average fractional energy loss in percent in elastic scattering for large A is given approximately by, $\frac{\overline{\Delta E}}{E} \cong \frac{200}{A}$
4. Calculate the average number of collisions required to reduce the energy of a neutron from 2 MeV to 0.025 eV in H^1 and C^{12} .
5. The mono-energetic neutron beams of intensities 2 x 10^{10} and 1 x 10^{10} neutrons/cm^2-s respectively, intersect an angle of 30^o. Calculate the neutron flux and current in the region where they intersect.
6. The neutron flux in a bare spherical reactor of radius 50 cm is given by 5 10^{13}(sin(0.0628r)/r) neutron/cm^2-s, where 'r' is measured in cm from the centre of the reactor. The diffusion coefficient for the system is 0.80 cm. (a) What is the maximum value of the flux in the reactor? (b) Calculate the neutron current density as a function of position in the reactor. (c) How many neutrons escape from the reactor per second?
7. Isotropic point sources each emitting S neutrons/sec are placed in infinite moderator at the four corners of a square of side 'a'. Compute the flux and current at the midpoint of any side of the square and at its centre.
8. An infinite bare slab of moderator of thickness '2a' contains uniformly distributed sources emitting S''' neutrons/cm^3-s.
   (a) show that the flux in the slab is given by $\frac{S'''}{\Sigma_a}\left(1-\frac{\cosh(x/L)}{\cosh((a+d)/L)}\right)$, where 'x' is measured from the centre of the slab and 'd' is the extrapolated length.
   (b) Verify the equation of continuity by computing per unit area of the slab the total number of neutrons (i) produced per sec within the slab; (ii) absorbed per second within slab; (iii) escaping per second from the slab [**Hint**: The solution to an inhomogeneous differential equation is the sum of the solutions to the homogeneous equation plus a particular solution. Try a constant for the particular solution]
9. An infinite planar source emitting S'' neutrons/cm^2-s is placed between infinite slabs of beryllium and graphite of thickness 'a' and 'b', respectively as shown in the figure. Derive an expression for the neutron flux in the system [Note: since the media are different the opposite sides of the source, this problem not symmetric and the source condition equation is not valid. The appropriate boundary conditions for this problem are: $\underset{x\to 0}{\mathrm{Lt}}\left(\phi(x>0)-\phi(x<0)\right)=0$ and $\underset{x\to 0}{\mathrm{Lt}}\left(\phi(x>0)-\phi(x<0)\right)=S''$. Note that condition 1 states that flux is continuous at the source, while condition 2 accounts for the neutrons emitted from the source.]