

Assignment-1

- 1) How many neutrons and protons are there in the nuclei of the following atoms.
(a) Li^7 , (b) Mg^{24} , (c) Xe^{135} , (d) Rn^{222} .
- 2) The fission of the nucleus of U^{235} releases approximately 200 MeV. How much energy (in kilowatt-hours and megawatt-days) is released when 1 g of U^{235} undergoes fission?
- 3) Compute the neutron-proton mass difference in MeV.
- 4 (a) Show that the energy released in the n^{th} generation of a fission chain reaction, initiated by one fission is given by $E_n = k^n E_R$: where k is the multiplication factor and E_R is the recoverable energy per fission. (The first neutron is considered as generation - 0)
(b) Show that the total energy released up to and including the n^{th} generation is given by

$$E_n = \frac{k^{n+1} - 1}{k - 1} E_R$$
- 5 (a) Show that the fraction F , of the energy released in a super critical chain reaction that originates in the final m generation of the chain is given approximately by $F = 1 - k^{-m}$, provided the total number of generations is large.
(b) Most of the energy from a nuclear explosion is released during the final moments of the detonation. Using the result of the previous problem, compute the number of fission generations required to release 99 percent of the total explosive yield. Use the nominal value $k = 2$.
(c) If the mean time between generation is in the order of 10^{-8} sec, over what period of time is energy released during a nuclear explosion? (6.844×10^{-8} s)
- 6 (a) Consider a nuclear reaction:

$$X_1 + X_2 \longrightarrow X_3 + X_4 + Q,$$
 where Q is the energy released in the reaction. Some tables tabulate the mass excess ' Δ ', defined as the $M-A$, where M and A are the rest mass of the neutral atom and the mass number of a given element expressed in energy units respectively. Derive a relation for the Q value in terms of $\Delta_{X_1}, \Delta_{X_2}, \Delta_{X_3}$ and Δ_{X_4}
(b) Given the values of Δ 's of ^3H , ^2D , ^4He and ^1n are 14.950, 13.136, 2.425 and 8.071 MeV respectively, compute the Q value for the reaction,

$$^3_1\text{H} + ^2_1\text{D} \longrightarrow ^4_2\text{He} + ^1_0\text{n}$$

(c) Compute the binding energy of the last neutron for $^{236}_{92}\text{U}$, given that the Δ values in MeV for $^{235}_{92}\text{U}$, $^{236}_{92}\text{U}$ and ^1_0n are 40.93, 42.46 and 8.071 respectively.
- 7) Assume that after a collision, the energy of a neutron having an energy E , is reduced to $[(1+\alpha)/2]E$, where, $\alpha = \{ (A-1) / (A+1) \}^2$. In the above expression A is the mass number of the moderator. 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} .