Indian Institute of Technology, Delhi
Centre for Energy Studies

ESL 734: Nuclear Energy

Semester II, 2015-2016

$n \lambda dt = dn$

Minor-I Examinations — Marks: 20

Duration: 60 minutes — 12 Feb. 2016

1.Find the number of Carbon atoms ($^{12}_{6}C$) in 1 cm^3 of graphite with density 1.65 gm/cc. **[2]**

2. Show that the kinetic energy of the α - particles emitted in an alpha decay is approximately equal to 4Q/A, where Q is the Q-value of the reaction and A is the mass number of parent nucleus. **[4]**

3. In a radioactive decay chain A→ B→ C, if the element C is stable than determine how the amount of C varies with time. Assume $N_A = N_{A0}$ and $N_B = 0$ at $t = 0$. Take λ_A and λ_B as decay constants for element A and B respectively. **[5]**

4. If a neutron is elastically scattered from a nucleus (Mass number A) at an angle θ, show that the neutron suffers maximum energy loss when is scattered directly backward. **[5]**

5. A nuclear reactor consuming fissile nuclei ($^{235}_{92}U$) is operating at a power 0.2 GW with a recoverable energy of 205 MeV. Estimate the burn-up rate of the fissile nuclei. **[2]**

6. Show that if Compton scattering is the dominant mode ofγray interaction, the mass – attenuation coefficient remains roughly the same for all elements. **[2]**

Given the following constants:

$n_{B0} e^{-\lambda_B t} + \frac{\lambda_A n_{A0}}{\lambda_B - \lambda_A}\left(e^{-\lambda_A t} - e^{-\lambda_B t}\right)$

Avagadro's number, N_A=0.6022 × 10^{24} /mol
Boltzmann constant, k_B= 1.38 × 10^{-23} J/°K
Electron charge, q=1.602 × 10^{-19} C
Electron rest mass, m_e=9.109 × 10^{-31} kg=0.00549 amu
Proton rest mass, m_p=1.672 × 10^{-27} kg=1.007276 amu
Neutron rest mass, m_n=1.675 × 10^{-27} kg=1.008665 amu
Speed of light, c=3 × 10^8 m/s
1 eV=1.602 × 10^{-19} J
Planck constant, h=6.6261 × 10^{-34} J-s
Atomic weight of $^{235}_{92}U$=235.044 amu

$N \frac{E}{A}$

$\sigma\, I\, N \cdot A\, n$

$N = \text{mole} \times N_A$