國立清華大學
ESS 201000 核工原理
(Principle of Nuclear Engineering)

Homework #4

1. Two hypothetical nuclei, ${}^{A}Z$ and ${}^{A+1}Z$, of atomic weights $M({}^{A}Z)$=241.0600 and $M({}^{A+1}Z)$=242.0621 have critical fission energies of 5.5 Me V and 6.5 Me V, respectively. Is the nuclide ${}^{A}Z$ fissile?

2. The fission-product ^{131}I has a half-life of 8.05 days and is produced in fission with a yield of 2.9%—that is, 0.029 atoms of ^{131}I are produced per fission. Calculate the equilibrium activity of this radionuclide in a reactor operating at 3,300 MW.

3. The yields of nuclear weapons are measured in kilotons (KT),where $1\ \mathrm{KT} = 2.6 \times 10^{25}$ Me V. With this in mind,
(a) How much ^{235}U is fissioned when a 100-KT bomb is exploded?
(b) What is the total fission-product activity due to this bomb 1 min, 1 hr, and 1 day after detonation?[*Note*: Assume a thermal energy release of 200 Me V per fission.]

4. The reactor on the nuclear ship *Savannah* operated at a power of 69 MW.
(a) How much ^{235}U was consumed on a 10,000-nautical-mile voyage at an average speed of 20 knots?

5. Calculate the mass attenuation coefficient of silica glass (SiO_2, ρ=2.21 g/cm^3) for 3-Me V γ-rays.

6. The mass attenuation coefficient of lead at 0.15 Me V is 1.84 cm^2/g. At this energy, the principal mode of interaction is by the photoelectric effect. What thickness of lead is required to reduce the intensity of a 0.15-Me V γ-ray beam by a factor of 1,000?

7. The absorption of radiation is often measured in units called *rads*, where 1 rad is equal to the absorption of 100 ergs per gram. What intensity of 1 Me V γ-rays incident on a thin slab of water is required to give an absorption rate of 1 rad per second?