University of Ottawa
Department of Mechanical and Engineering

GNG 4128 Introduction to Nuclear Engineering
Quiz #1
Date: Jan. 23 / 2018

Instructor: Nabel Sadek
Time Allowed: 45 minutes

Name :

Student ID:

1. The fuel of a research reactor consists of Uranium Dioxide (UO_2) having a density of 10.5 g/cm^3• If the uranium is enriched to 40% U-235 and 60% U-238, by weight. Calculate the number density of U-235 in the fuel. Given $N_a = 6.023 \times 10^{23}$ atoms/mole, and

Isotope	Atomic Weight M
U-238	238.0508
U-235	235.0439
O-16	15.9990

60%

2. What happens if the neutron to proton ratio of a nuclide is too high or too low? Please provide a short and concise answer.

(1)

$$M_U = \left(\frac{40}{100} * 235.0439\right) + \left(\frac{60}{100} * 238.0508\right) = 236.848 \quad \left[M = \sum_i \frac{M_i \cdot \gamma_i}{100}\right]$$ **40%**

$$M_{UO_2} = M_U + M_{O_2} = 236.848 + 2 * 15.9990 = 268.846$$

The uranium density in the fuel $\rho_U = 10.5 * \frac{236.848}{268.846} = 9.25 \frac{g}{cm^3}$

$$N_{U\text{-}235} = \frac{w_{U\text{-}235} * \rho_U * N_a}{M_{U\text{-}235}} = 0.4 * 9.25 * \frac{6.023 \times 10^{23}}{235.0439} = 9.48 \times 10^{21} \frac{atms}{cm^3}$$

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(2) A typical answer will demonstrate the following understanding

(a) If there are too many neutrons (n:p is high) or too few neutrons (n:p) is low in a nucleus, then nucleus is unstable and it undergoes radioactive decay to go back to stability

(b) Nuclei lacking neutrons (n:p low) undergoes β^+ decay. in this process one of the protons transforms into a neutron and a positron (e^+), and ~~and heat~~ neutrino(ν) are emitted $p^+ \longrightarrow n + e^+ + \nu$

(c) ~~Big~~ In contrast, neutron-rich nuclei undergo β^- decay. A neutron is transformed into a proton and an electron and antineutrino $\bar{\nu}$ are emitted $n \longrightarrow p^+ + e^- + \bar{\nu}$

(d) Higher ~~atomics~~ nuclei ($Z > 80$) undergo α decay ← {bounus}

Z is the atomic number (i.e. number of protons)