

## Homework 01 (09Sep24)

Name: your name

Guidance:

- Upload your answers in the Blackboard submission portal as:  
lastname-firstname-homework-xx.pdf or lastname-firstname-homework-xx.ipynb

### Table of Problems

- Problem 1 (20 pts) Atom density in enriched uranium.
- Problem 2 (20 pts) Co-60 decay.
- Problem 3 (20 pts) Sr-90 decay.
- Problem 4 (20 pts) Po-210 decay.
  - 4.1)(6 pts) Curies.
  - 4.2)(6 pts) Watts.
  - 4.3)(8 pts) 1 MW.
- Problem 5 (20 pts) Fission products.
  - 5.1)(5 pts) Time-dependent.
  - 5.2)(5 pts) Long-time limit.
  - 5.3)(5 pts) Maximum.
  - 5.4)(5 pts) Maximum rate.

### Problem 1 (20 pts)

Calculate the atom density of U-235 in uranium (a mixture of U-238 and U-235) enriched to 15% (a/o) in U-235 if the physical density of the uranium mixture is 19 g/cm<sup>3</sup>?

Answer:

### Problem 2 (20 pts)

What mass of Co-60,  $t_{1/2} = 5.26$  y, will have the same number of curies as 10 g of Sr-90,  $t_{1/2} = 28.8$  y?

Answer:

### Problem 3 (20 pts)

Suppose Co-60 and Sr-90 have the same activity at some point in time. Next, they are allowed to decay for 10 years. It is found that after 10 years 1.0 Ci of Co-60 remains. How many curies of Sr-90 remain?

Answer:

### Problem 4 (20 pts)

Po-210 decays to Pb-206 by emitting an alpha particle,  $t_{1/2} = 138$  d,  $E = 5.305$  MeV.

4.1)(6 pts) How many curies are there in 1 g of pure Po-210?

Answer:

4.2)(6 pts) How many watts of heat are produced by 1 g of Po-210?

Answer:

4.3)(8 pts) What mass of Pb-210 is required to produce 1 kW of thermal energy from its radioactive decay?

Answer:

### Problem 5 (20 pts)

Consider the fission product chain  $A \xrightarrow{\beta} B \xrightarrow{\beta} C$  with decay constants  $\lambda_A$  and  $\lambda_B$  for  $A$  and  $B$  respectively. A reactor is started up at  $t = 0$  with some initial number density of fission product A, say  $n_{A_0}$ , and produces A at a constant source rate  $S_A$  thereafter. Assuming that B and C are not produced directly from fission and are not initially present in the reactor:

**5.1)**(5 pts) Find  $n_A(t)$  and  $n_B(t)$ .

Answer:

**5.2)**(5 pts) What are  $n_A(\infty)$  and  $n_B(\infty)$ ?

Answer:

**5.3)**(5 pts) Find the maximum of  $n_B(t)$ .

Answer:

**5.4)**(5 pts) Find the maximum of  $n'_B(t)$ .

Answer: