

QUESTION 4

You are a health physicist assigned to a research reactor. The reactor is equipped with a number of sample irradiation locations, including a pneumatic sample delivery system ("rabbit"). The reactor operators are performing extended activation runs with the reactor and would like to measure thermal neutron flux levels in the rabbit sample location using gold foil activation analysis. After inserting the sample into the reactor, the pneumatic system develops problems that do not allow retrieval of the sample. Six hours after insertion of the sample into the reactor, the rabbit problems are repaired and the sample is retrieved. The next morning (11 hours after being removed from the reactor), the sample is counted in a Na I (TI) well detector with a multi-channel analyzer.

GIVEN

Rabbit transit time from reactor to rabbit portal = 2 s
 Inner diameter of rabbit tube = 4 cm

Target foil (thin) is ^{197}Au with a mass of 25 mg
 The thermal activation cross-section for $^{197}\text{Au}(n, \gamma)^{198}\text{Au}$ is 98.8 barns

^{198}Au β^- $E_{\text{max}} = 961 \text{ keV}$ abundance = 98.65%
 γ 412 keV, abundance = 95.5%
 half-life = 2.695 d

Ignore self-shielding in gold foil
 Measured net photopeak counts = 827,410 in 1 minute
 Na I (TI) detector efficiency at 412 keV = 27.3%

POINTS

- 20 A. Using the measured values for the sample, what is the ^{198}Au activity, in Bq, when it was removed from the reactor? **Show all work.**
- 20 B. For this part only, assume the sample activity upon exiting the reactor is 3.5 mCi. Estimate the gamma dose rate, in mR/h, at 10 cm. **Show all work.**

- 10 C. If the gold foil target contains 1×10^{24} ^{197}Au atoms and the incident thermal neutron flux is 1×10^{11} n/cm²-s, what is the saturation activity?
1. 9.88×10^{36} Bq
 2. 9.88×10^{12} Bq
 3. 10^{35} Bq
 4. 10^{11} Bq
 5. 98.8 Bq