QUESTION 4

You are the Health Physicist on the staff of a custom isotope production facility. A customer has inquired about the production of Na-24 sources. You are required to calculate information regarding the production, build-up, decay, and shielding of the proposed product.

GIVEN

^{24}Na Data:
$T_{1/2}$ = 14.96 hours
$E(\gamma_1)$ = 1.4 MeV; $Y(\gamma_1)$ = 1.0
$E(\gamma_2)$ = 2.8 MeV; $Y(\gamma_2)$ = 1.0

Thermal neutron capture cross section, σ_c, for ^{23}Na (n,γ) ^{24}Na = 0.534 barns

Fraction of Target, by weight, which is ^{23}Na = 0.20
Air mass energy absorption coefficient = 0.03 cm^2/g
Lead mass attenuation coefficient = 4.6×10^{-2} cm^2/g
Density of lead = 11.3 g/cm^3
Assume there is no initial ^{24}Na activity at the start of any irradiation

POINTS

15 A What is the thermal neutron flux, in neutrons per cm^2 per second, required to produce 3.7×10^{10} Bq of ^{24}Na at saturation in a 5 gram target? **Show all work.**

15 B What is the estimated unshielded absorbed dose rate in rad/hr on the surface of a shipping drum of 30 cm radius containing the target (3.7×10^{10} Bq of ^{24}Na) in the center of the drum? Assume a point source. Neglect air attenuation. **Show all work.**

20 C Assume 35 rem/hr on contact with the surface of the unshielded shipping container. Will the addition of 10 cm of lead shielding allow shipment of this container with a Radioactive II transport shipping label? **Show all work.**