Háskóli Íslands
Raunvísindadeild
Eðlisfræði

Haust 2015

Kjarna- og öreindafræði

Dæmablað 1

Skilafrestur 2. September 2015 kl. 15:00

1. **A gold foil** (10)

   A gold foil 0.02 cm thick is irradiated by a beam of thermal neutrons with a flux of 10^{12} neutrons/cm^2/s. The nuclide ^{198}Au with a half-life of 2.7 days is produced by the reaction ^{197}Au(n, γ)^{198}Au. The density of gold is 19.3 g/cm^3 and the cross section for the above reaction is 97.8 $\times 10^{-24}$ cm^2. ^{197}Au is 100 % naturally abundant.

   (a) If the foil is irradiated for 5 minutes, what is the ^{198}Au activity of the foil in decays/cm^2/s?

   (b) What is the maximum amount of ^{198}Au/cm^2 that can be produced in the foil?

   (c) How long must the foil be irradiated if it is to have 2/3 of its maximum activity?

2. **Decay chain** (20)

   A parent isotope has a half-life $T_{1/2} = 104$ yr $= 3.15 \times 10^{11}$ s. It decays through a series of radioactive daughters to a final stable isotope. Among the daughters the greatest half-life is 20 yr. Others are less than a year. At $t = 0$ one has 10^{20} parent nuclei but no daughters.

   (a) At $t = 0$ what is the activity (decays/sec) of the parent isotope ?

   (b) How long does it take for the population of the 20 yr isotope to reach approximately 97 % of its equilibrium value ?

   (c) At $t = 104$ yr how many nuclei of the 20 yr isotope are present ? Assume that none of the decays leading to the 20 yr isotope is branched.

(d) The 20 yr isotope has two competing decay modes: α, 99.5 %; β, 0.5 %. At $t =$ 104 yr, what is the activity of the isotope which results from the β-decay ?

(e) Among the radioactive daughters, could any reach their equilibrium populations much more quickly (or much more slowly) than the 20 yr isotope ?