Some Nuclear Chemistry Problems

1. Tritium (^3H) decays by beta emission with a half-life of 12.26 years. A sample of tritiated compound has an initial activity of 0.833 Bq. Calculate the number N_i of tritium nuclei in the sample initially, the decay constant k, and the activity after 2.50 years.

2. Over geological time, an atom of ^{238}U decays to a stable ^{206}Pb atoms by the emission of eight alpha emissions, each of which leads to the formation of one helium atom. A geochemist analyzes a rock and finds that it contains 9.0×10^{-5} mL of helium (at STP) per gram and 2.0×10^{-7} g of ^{238}U per gram. Estimate the age of the mineral, given that the half life of ^{238}U is 4.47×10^9 years.

3. The half lives of ^{235}U and ^{238}U are 7.04×10^8 and 4.47×10^9 years respectively, and the present abundance ratio is $^{238}U/^{235}U = 137.7$. It is thought that their abundance ratio was 1 at some time **before** our earth and solar system were formed about 4.5×10^9 years ago. Estimate how long ago the supernova occurred that supposedly produced all the uranium isotopes in equal abundance, including the two longest lived isotopes, ^{238}U and ^{235}U.

4. The beta decay of ^{40}K that is a natural part of the body makes all human beings slightly radioactive. An adult weighing 70.0 kg contains about 170 g of potassium. The relative abundance of ^{40}K is 0.0118%, its half-life is 1.28×10^9 years, and its beta particles have an average kinetic energy of 0.55 MeV. (There are 1.602×10^{-13} J/MeV)

    a. Calculate the total activity of ^{40}K in this person.
    b. Determine (in rad per year) the annual radiation absorbed dose arising from this internal ^{40}K.