Radiation Biology, Protection and Applications

(PHYS-450)

EXERCISES

Week 10

Problem 1:

A radionuclide ${}^{62}_{29}Cu$ emits β^+ radiation with a half-life $T_{1/2}$ =9.76 min. Determine the particle composition of the daughter's nuclide atom coming from this decay and determine a decay constant λ.

Problem 2:

A uranium nucleus ${}^{238}_{92}U$ is gradually changing to other nuclei (the decay series). This uranium series consist of eight alpha decays and six beta decays. What is the final product of this decay series?

Problem 3:

By simultaneously conserving energy and momentum, find the alpha-particle energy emitted in the decay of a nucleus with mass number 210 if the Q-value of the decay is 5.50 MeV.

Problem 4:

During bombardment of carbon nucleus ${}^{12}_{6}C$ by deuterons ${}^{2}_{1}H$ a nuclear reaction in which the emergence of a radioactive nucleus of nitrogen and emission of neutron take place.(a) Write down this nuclear reaction by using the symbols of chemical elements. (b) The nitrogen nucleus is further transformed while a positron is emitted. Which nucleus is formed from this transformation?

Problem 5:

The half-life $T_{1/2}$ is defined as the time at which half of the nuclei from the original amount N_0 will decay. Does that mean that over $2T_{1/2}$ all nuclei N_0 will decay?

Problem 6:

The RaA element arises from $^{238}_{92}U$ by emitting five successive alpha and two beta particles. Identify the RaA element.

Problem 7:

An alpha emitter contains 10^{12} radioactive nuclei with a half-life $T_{1/2}$ =3 min. How many nuclei decay in 1 s, in 1 min., in 3 min. and in 6 min.?

Problem 8:

A radioactive isotope with a half-life $T_{1/2}$ emits one particle in each nucleus decay. There are N_0 nuclei at the beginning. How many particles were emitted in time $3T_{1/2}$?

Problem 9:

A thermal neutron beam with a kinetic energy $E_{thermal}$ = 0.025 eV is brought out from a nuclear reactor. Calculate what fraction from a total number of neutrons N_0 will decay on the length of one meter. The neutron half-life is 10.37 min.

Problem 10:

A solution with a radioisotope ^{24}Na of activity A_0 = 2 kBq was injected into the blood of man. Volume activity a_v of the blood was measured 5 hours after the injection and it was determined to be 265 kBq/m^3. Determine a volume of the man's blood in liters. The half-life of ^{24}Na is 15 hours.

Problem 11:

What is the lowest wavelength limit of the X-rays emitted by a tube operating at a potential of 195 kV?

Problem 12:

Calculate the specific activity of pure tritium (^{3}H) with a half-life of 12.26 years.

Problem 13:

What is the highest energy to which doubly ionized helium atoms (alpha particles) can be accelerated in a direct current accelerator with 3 MV maximum voltage?