

Series N°1 Part 2 (Chemistry 1)

Exercise 01:

In a nuclear center, each uranium nucleus undergoes fission under the impact of a slow neutron. One of the possible processes leads to the formation of a cesium nucleus, a zirconium nucleus, neutrons, electrons and photons.

- 1- Write this fission reaction.
- 2- Calculate: a)- the mass loss that accompanies this fission reaction,
b)- the energy released, in joules and in MeV, (the mass of the electron will be neglected).

Data: $m({}^1_0n) = 1,0087 \text{ uma}$; $m({}^{235}_{92}\text{U}) = 235,0439 \text{ uma}$; $m({}^{137}_{55}\text{Cs}) = 136,9098 \text{ uma}$; $m({}^{97}_{40}\text{Zr}) = 96,9139 \text{ uma}$;
 $m({}^0_{-1}\text{e}) = 5,486 \cdot 10^{-4} \text{ uma}$.

Exercise 02 :

To determine the age of archaeological finds, we use a method known as carbon-14 dating.

- 1- This carbon isotope is constantly formed when atmospheric nitrogen (${}^{14}_7\text{N}$) is bombarded by cosmic neutrons.
 - Write the nuclear reaction that forms ${}^{14}_6\text{C}^*$.
- 2- Carbon 14 oxidizes to ${}^{14}\text{CO}_2$ and participates in the cycle of living matter; its concentration remains constant. After the organism's death, the proportion of carbon 14 decreases as this isotope is radioactive (β^-).
 - Write the nuclear decay reaction of ${}^{14}_6\text{C}^*$.
- 3- The activity of a sample of organic matter on an archaeological piece is $a = 1180 \text{ dps}$ (disintegration per second); the activity of the same quantity of organic matter is $a_0 = 1980 \text{ dps}$.
 - Determine the age of this archaeological piece.

Data: period ${}^{14}_6\text{C}^*$: $T = 5590 \text{ years}$.

Exercise 03:

A laboratory receives a sample of 1 mg of radioactive cadmium ${}^{107}_{48}\text{Cd}$, with half-life $T = 6 \text{ h } 42 \text{ min}$. It decays to ${}^{107}_{47}\text{Ag}$ with emission of a charged particle.

- 1 - Write the decay equation, knowing that cadmium decay is accompanied by the emission of radiation.
 - What type of radioactivity is involved?
2. Explain the radiation emitted and define the radioactive constant.
- 3 - Give its expression and calculate it.
4. Calculate the number N_0 of nuclei present when the sample is received.
- 5 - Give the expression for the activity at date t of a radioactive sample containing $N(t)$ nuclei.
 - Calculate the activity of this sample at date $t=0$.
 - Calculate the time after which the activity will have decreased by three quarters.

Exercise 04:

1. Consider a radioactive source consisting of one milligram of radium with a half-life of around 1,600 years. Calculate the mass of radium remaining after 1, 100, 1600 years.
2. The nuclide ${}^{14}_6\text{C}$ is radioactive β^- . Write the equation for its decay. Given: $T = 5500 \text{ years}$
A sample containing this single radioactive nuclide has an activity corresponding to 16 electrons emitted per second. After how long will this activity be reduced to 4 electrons emitted per second?
3. Tritium ${}^3_1\text{H}$ decays with a radioactive constant: $\lambda = 1.789 \cdot 10^{-9} \text{ s}^{-1}$.
 - a) What is its half-life?
 - b) Consider a mass of tritium giving 2,106 disintegrations per second. What is the value of this mass?