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Exercises Series N°2

Exercise 1

Complete the nuclear reactions :

$^{58}_{26}Fe + 2\ ^{1}_{0}n \rightarrow\ ^{60}_{27}Co + ...$

$^{30}_{15}P \rightarrow\ ^{....}_{} + \ ^{0}_{+1}e$

$^{235}_{92}U + \ ^{1}_{0}n \rightarrow\ ^{142}_{56}Ba + \ ^{....}_{} + 2\ ^{1}_{0}n$

$^{35}_{17}Cl + \ ^{1}_{0}n \rightarrow\ ^{35}_{16}S + \ ...$

$^{55}_{25}Mn\ (\ldots, n)\ ^{55}_{26}Fe$ $\qquad$ $^{25}_{12}Mg\ (\alpha, p)...$

Exercise 2

The radioactive radon $^{222}_{86}Rn$ emits α particles with a period T = 3,76 days.

1) Write the nuclear decay reaction.

2) Calculate the initial mass m_0 of the sample, given that its initial activity is $A_0 = 4{,}7.\ 10^3 Ci$.

3) Calculate the activity of the sample at time $t = 20\ days$.

4) Determine the time t at which its activity would have decreased by 35%.

Data : $N_A = 6{,}022.10^{23}$, 1 Ci = $3{,}7.10^{10}$ dps

Exercise 3

Bismuth $^{212}_{83}Bi$ is radioactive and emits α particules.

1) Write the nuclear decay reaction.

2) Calculate the initial mass m_0 of Bi, knowing that after $t = 15min$, $N_d = 4{,}484.\ 10^{19}\ nuclei$ have disintegrated, and the periode of Bi is T = 5 days.

3) If initially taking $m_0 = 4{,}2\ Kg$ of the element, what would be the mass of this sample after 22days ?

Exercise 4

Let there be an element X that decays into an element Y and a negaton β^-. Given that the atomic number of Y is 28 and the nucleus of X contains 33 neutrons:

1) Write the nuclear decay reaction.

2) Knowing that we initially have 0,012 kg of element X and that after 15 days we have obtained 9,0345. 10^{22} β^- particles, determine the half-life of element X.

3) Determine the activity in curies of element X after 30 days.

Exercise 5

In a nuclear power plant, each uranium nucleus undergoes fission when struck by 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 accompanying this fission reaction.

b. The energy released, in joules and in MeV, during the fission of one gram of uranium (neglecting the mass of the electron).

Data : $^{235}_{92}U$ = 235,0439 amu, $^{137}_{55}Cs$ = 136,9098 amu, $^{97}_{40}Zr$ = 96, 9139 amu, $^{1}_{0}n$ = 1,0087 amu.

Exercise 6

1) Calculate the energy released by the following nuclear fusion reaction:

$^{3}_{1}H + \ ^{2}_{1}H \rightarrow\ ^{4}_{2}He + \ ^{1}_{0}n$

2) Calculate the energy released during the formation of one mole of helium nuclei.

3) What quantity of coal is required to produce the same amount of energy as calculated in question (2)? The heat of combustion of coal is given as 8000 cal/g.

Data : $^{3}_{1}H$ = 3,01604 amu, $^{2}_{1}H$ = 2,0140 amu, $^{4}_{2}He$ = 4,00260 amu, $^{1}_{0}n$ = 1,00866 amu