University center Mila **academic year 2025/2026**

Institute of sciences and technology **module: Structure of matter**

First year Ing/ ST.

Series N^0 03

Exercise 1:

Complete the following reactions, giving the type of reaction in each case.

1) $^{131}_{53}I \longrightarrow {}^{131}_{52}Te + \ldots\ldots$

2) $^{124}_{53}I \longrightarrow \ldots\ldots + \beta^-$

3) $^{3}_{1}H + {}^{2}_{1}H \longrightarrow {}^{1}_{0}n + \ldots\ldots$

4) $^{14}_{7}N + {}^{4}_{2}He \longrightarrow {}^{16}_{8}O + \ldots\ldots$

5) $^{215}_{84}Po \longrightarrow {}^{211}_{82}Pb + \ldots\ldots$

6) $^{1}_{0}n + {}^{235}_{92}U \longrightarrow \ldots\ldots + {}^{139}_{53}I + 3\ {}^{1}_{0}n$

7) $^{9}_{4}Be\ (\beta^+, \alpha)$

Exercise 2:

Consider the following nuclear reaction:

$$2\ {}^{1}_{1}\mathrm{H} + 2\ {}^{1}_{0}\mathrm{n} \longrightarrow {}^{4}_{2}\mathrm{He}$$

1) Calculate the loss of mass Δm.
2) Calculate the energy of cohesion of the nucleons in MeV.
3) Calculate the cohesion energy of one nucleon in joules and eV.
4) Calculate the cohesion energy of one mole of nucleons in joules and Kcal.

Given $^{4}_{2}\mathrm{He} = 4.0026$ uma, $^{1}_{1}\mathrm{H} = 1.0073$ uma, $^{1}_{0}\mathrm{n} = 1.00866$ uma

Exercise 3:

We have the following reaction:

$$^{14}_{7}N + {}^{4}_{2}He \rightarrow {}^{17}_{8}O + {}^{1}_{1}H$$

The reaction absorbs energy equal 0.8Mev.

-Calculate the mass of Helium atom in a.m.u

Given mass in a.m.u: $^{7}_{14}N = 14{,}00754; {}^{1}_{1}H = 1{,}007883;\ {}^{16}_{8}O = 17{,}0045$

Exercise 4:

A) Write the following nuclear reactions

$$^{130}_{52}Te(d,2n)^{130}_{53}I \ , \ ^{40}_{18}Ar(\alpha,P)^{43}_{19}K \ , \ ^{55}_{25}Mn(n,\gamma)^{56}_{25}Mn \ , \ ^{15}_{8}O(\beta^{+})^{15}_{7}N \ , ^{14}_{6}C(\beta^{-})^{14}_{7}N$$

B) Detail the nuclear reaction $^{55}_{25}Mn\ (\beta^{-})^{56}_{26}Fe$

1) It was found that in 7.5 hours, 1 mole of ^{56}Mn gives 49 g of ^{56}Fe.Calculate the period T of manganese

2) Calculate the mass of a sample of manganese. Its activity is 2 x 10^6 Ci

3) Calculate the energy resulting from disintegration a nucleus of Mn, and then for 1 mole.

Given ^{56}Mn = 55,93948 a.m.u, ^{56}Fe =55,93493 a.m.u

Exercise 5:

Thorium $^{232}_{90}Th$ disintegrates into lead nucleus $^{208}_{82}Pb$, after a series of successive reactions, Radioactive particles are released.

-Determine the number and nature of radiation transitions and the resulting miniscule particles in each case.

Exercise 6:

The bismuth nucleus $^{210}_{83}Bi$ disintegrates through β^- radioactivity.

1- Write the nuclear reaction equation that occurs and show how the electron accompanying the radiation is produced.

2- A sample of bismuth has a number of nuclei at moment **t** equal to $\mathbf{N_{(t)}}$, Express the number of disintegrated nuclei $N_d(t)$ as a function of time t, the initial number of nuclei N_0, and the radioactive decay constant λ.

3- The curve was plotted where A is the radioactivity of the sample at moment t.

-Express Ln A in terms of λ and A_0.

-Deduce the value λ and A_0 from the curve.

- Calculate the number of primary nuclei N_0

-Calculate the time required to remain $\frac{1}{1000}$ from the number of primary nuclei.