University of Batna 2 **2025-2026**
Faculty of Technology
Department of Science and Technology LMD
Module: Chemistry 1

Continued from Tutorial Series Nº 5

Exercise 1:

1.Complete the equations for the following nuclear reactions and specify the name of each transformation:

1. * $^{19}_{9}F + ^{1}_{1}H \longrightarrow ^{16}_{8}O + ...$ * $^{9}_{4}Be + ^{1}_{1}H \longrightarrow .... + ^{2}_{1}H$
2. * $^{59}_{27}Co + ... \longrightarrow ^{60}_{27}Co + ^{1}_{1}H$ * $.... + ^{1}_{1}H \longrightarrow ^{13}_{7}N + ^{1}_{0}n$
3. * $^{26}_{12}Mg + ^{1}_{0}\mathrm{n} \longrightarrow ^{23}_{10}Ne + ...$ * $^{63}_{29}Cu + ... \longrightarrow ^{63}_{30}Zn + ^{1}_{0}n$
4. * $^{27}_{13}Al + ^{4}_{2}He \longrightarrow .... + ^{1}_{0}n$ * $^{0}_{+1}\beta .... + \longrightarrow ^{30}_{15}P$

2. What are the following nuclear equations?

$^{23}_{11}Na\ (\alpha, p)...,\ ^{39}_{19}K\ (d, p)...\ ,\ ^{14}_{7}N\ (\alpha, p)...\ ,\ ^{55}_{25}Mn\ (d, 2n)...$

Exercise 2:

Given the nuclear reaction represented by the following equation:

$$^{235}_{92}\mathrm{U} + ^{1}_{0}\mathrm{n} \longrightarrow ^{134}_{51}\mathrm{Sb} + ^{A}_{Z}\mathrm{X} + ^{4}_{2}\mathrm{He} + 3^{1}_{0}\mathrm{n}$$

1. Complete the above equation by specifying the atomic number and the mass number of element X, as well as the type of this nuclear reaction.
2. Calculate the energy released during this reaction, then determine the energy released by:
   a) 1 mole of uranium b) 1 single nucleon of uranium c) 1 gram of the products
3. Given that the combustion of 1 mole of methane releases an energy equivalent to 213 kcal, calculate the volume of methane that needs to be burned (under standard temperature and pressure conditions) to produce the same energy as that released by the reaction of 1 mole of uranium.
4. Determine which nucleus is more stable between X and He.

Given:

1 MeV= 10^{6} eV	1eV=1.6 .10^{-19} J	n = 1.008665	p = 1.007278 (u.m.a)
$^{235}_{92}$U=235.0439	$^{134}_{51}$Sb= 133.8969	X=94.9125	$^{4}_{2}$He= 4.0026 (u.m.a)

Exercise 3:

The decay constant of radioactive sodium, Na* is λ=0.046 h^{-1}.

1. Derive the expression for the number of radioactive nuclei at time ttt (Nt) in terms of time, the decay constant λ, and the initial number of nuclei N_0.
2. Calculate the half-life T in hours.
3. Calculate the time required for the decay of: a) 1% of the initial nuclei b) 99% of the initial nuclei.
4. Injecting 10 ml of a solution with an initial concentration of radioactive sodium of 10^{-3} mol/L into a person's blood, a sample of 10 ml of blood taken 5 hours later contains 1.6×10−8 moles of Na*. Assuming the injected dose has uniformly distributed throughout the blood, calculate the blood volume.

Exercise 4: Actinium decays spontaneously to produce a stable bismuth nuclide, along with α and β particles, according to the following equation: : $^{225}_{89}Ac \longrightarrow \; ^{209}_{83}Bi + x\,\alpha + y\,\beta$

1. Calculate x and y, then deduce the nature of the β particle.
2. One month later (30 days), the ratio of final to initial activity of actinium is 1/8. Calculate the half-life t and the decay constant λ.
3. Assume an initial actinium mass of m_0=16 g. Calculate:
    - a) the masses of actinium and bismuth after one month,
    - b) the volume resulting from the neutralization of helium charges collected under normal conditions,
    - c) the activity of actinium in disintegrations per second (dps) and curies (Ci).

Exercise 5: A sample containing radioactive cesium $^{136}_{55}Cs$, has an activity of 3 microcuries at time t. Eight days later, its activity is 2 microcuries.

1. Determine the decay constant of $^{136}_{55}Cs$ and calculate its half-life.
2. Given t=50 days, calculate the initial radioactivity of the sample.
3. The sample is cesium chloride. Calculate the mass of $^{136}_{55}Cs$ that corresponds to the initial radioactivity calculated in question 2.