Chapter 20 Nuclear Chemistry Math Summary

Particles Involved in Nuclear Reactions, either as Nucleons, Emitted particles or Particles that React with a Nucleus and Induce a Decay

(Memorize these for Test)

-the first three, alpha, beta, and positrons are the crucial ones for balancing radioactive nuclear decay reactions

$^{4}_{2}He$ α-particle (alpha)

$^{0}_{-1}e$ ß-particle (beta), electron

$^{0}_{+1}e$ positron

$^{0}_{0}\gamma$ gamma

$^{1}_{0}n$ neutron

$^{1}_{1}H$ proton

Radioactive Decay Math

$t = (t_{1/2}/0.693) \ln (m_o/m_t)$ When solving for time, given half life and quantities of material

$\ln (m_o/m_t) = (0.693/t_{1/2}) \cdot t$ When solving for the amount of material left after a given time, given the half life

Handling "ln y = x" on calculator, when you know "x" but want to solve for "y": enter "x", then hit your "e^x" button.

Mass Defect/Binding Energy Math

Proton mass: 1.00783

Neutron mass: 1.00867

$E = \Delta mc^2$

- The binding energy will depend on the Δm difference between the summed weight of the protons and neutrons minus the actual mass of the nucleus.
- Δm in terms of kilograms (you'll normally need to convert from grams to kg)
- The energy answer from the formula comes out in terms of Joules, not kJ;you'll routinely need to convert from J to kJ to fit the answers.

Fill in the Holes, Name the Processes

① $^{234}Pu \longrightarrow {}^{4}_{2}He + \square$

② $^{14}C \longrightarrow {}^{14}N + \square$

③ $^{230}U \longrightarrow {}^{226}Th + \square$

④ $^{99}_{43}Tc^{*} \longrightarrow {}^{99}_{43}Tc + \square$

⑤ $^{0}_{-1}e + {}^{81}_{37}Rb \longrightarrow \square$

⑥ $^{210}Pb \longrightarrow {}^{0}_{+1}e + \square$

⑦ $^{238}_{92}U + {}^{1}_{0}n \longrightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + \square$ = neutron bombardment

⑧ $^{35}_{17}Cl + {}^{1}_{1}H \longrightarrow {}^{32}_{16}S + \square$ Proton bombardment

⑨ $^{239}_{92}U + {}^{4}_{2}He \longrightarrow {}^{1}_{0}n + \square$ Alpha bombardment

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Predict how the following would decay, by α, β, or positron emission, or by electron capture. Then draw the nuclide produced.

① ^{40}Cl

② ^{134}Ba

③ $^{237}_{93}Np$

④ What is the binding energy in kJ/mol for $^{16}_{8}O$?

Given $^{16}_{8}O$ 15.978
$^{1}_{1}p$ 1.00783
$^{1}_{0}n$ 1.00867

⑤ For the above, what is the binding energy in kJ/mol <u>nucleons</u>?

2012

① ^{99}Tc $t_{1/2} = 6.0$ hours. What percentage of a dose of ^{99}Tc (used for a brain imaging scan) is left after 24 h?

② ^{131}I $t_{1/2} = 8.0$ days. How long to decay to 10% of original?

③ ^{14}C $t_{1/2} = 5730$ years. "Live" carbon has activity of 15.3 A shirt is claimed to be Jesus's, but is found to have carbon activity of 14.0. How old is the shirt, and can the claim be true?

④ ^{90}Sr $t_{1/2} = 28.8$ y If 42 g of ^{90}Sr is buried, how much is left after 120 years?