

CH18

I. Atomic symbols: A_ZX

- a. X: letter symbol (use z to search X on the periodic table)
 Z: atomic # = # of proton
 A: mass # = # of proton + # of neutron = # of nucleon
 atomic symbol for proton (1_1p), neutron (1_0n), and electron (${}^0_{-1}e$)
- b. Isotope: atoms with the same # of p (same z) but different # of neutron
 atomic weight = weighted average of atomic mass

II. Radioactive decay: ${}^A_ZX = {}^B_US + {}^C_VT, A=B+C, Z=U+V$

- a. Type of particles: Alpha (α) = ${}^4_2\text{He}$ Beta (β) = ${}^0_{-1}e$ Gamma (γ) = 0_0r positron = ${}^0_{+1}e$
- b. atoms with even # of proton and neutron are more stable
 magic # of p: 2, 8, 28, 82, 2, 50, 126 → super stable
- c. atom is not stable if the difference of mass # and atomic mass is >2
 if the z > 83
- d. type of decay will be determined by the N/Z ratio

Z	Threshold	> threshold, β decay → ${}^0_{-1}e$ at the product side
1:20	1	< threshold, positron emission → ${}^0_{+1}e$ at the product side electron capture → ${}^0_{-1}e$ at the reactant side
20:40	1.25	
40:83	1.5	
>83	1.6	< threshold, α decay → ${}^4_2\text{He}$ at the product side

e. Decay kinetics: $\ln\left(\frac{A_t}{A_0}\right) = -kt$ $k \cdot t_{1/2} = 0.693$

the rock contains A and B, B is the decay product of A, $\frac{A_t}{A_0} = \frac{A}{A+B}$ (note A is # of atoms, NOT the mass of atoms)

III. Thermodynamic stability

- a. mass defect: difference in mass between actual and hypothetical formation of a nucleus
- b. binding energy: $\Delta E = \Delta mc^2$
 1 amu = $1.66 \cdot 10^{-27}$ Kg = 931.5 MeV/c²

IV. Particle accelerator : uses an electric field to accelerate charged particle (typically ${}^4_2\text{He}$) to bombard the atom.
 The notation ${}^A_ZX({}^4_2\text{He}, {}^1_0n)$ means $X + {}^4_2\text{He} \rightarrow Y + {}^1_0n$

Nuclear power station:

- a. fission: splits a larger atom into smaller ones (most electric power is generated using fission)
 fusion: joins 2 or more lighter atoms into a larger one
- b. Breeder reactors convert the non-fissionable nuclide, ${}^{238}\text{U}$ to a fissionable product.
- c. The control rods in the nuclear fission reactors are composed of a substance that absorbs neutrons.

CH18

18.1-II

- ^{17}N is expected to be stable.[F]
 ^{74}As is expected to be stable[T]
 ^{24}Al is expected to be stable[F]
 ^{209}Bi is expected to be stable[T]
- Y-95 is radioactive. Which mode of decay would be expected for this nucleus? [**Beta decay**]
How would ^{141}Eu be expected to decay? [**positron or electron capture**]
Which mode of decay would be expected for a nucleus of At-212 [**Alpha decay**]
V-47 can undergo electron capture. What is the product nucleus? Enter your answer using the same format, i.e, symbol-mass number [**Ti-47**]
- ^{244}Cf is produced (as well as 2 neutrons) when a nucleus reacts with an alpha particle. What is the reactant nucleus? (^{242}Cm)
- Cesium-137 undergoes beta decay and has a half-life of 30 years. How many beta particles are emitted by a 14.0g sample of Cesium-137 in three minutes? (**8.1e15**)

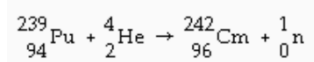
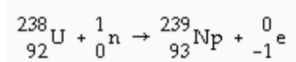
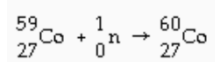
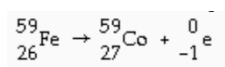
5. A rock contains 0.275 mg of lead-206 for each milligram of uranium-238. The half-life for the decay of uranium-238 to lead-206 is 4.5×10^9 yr. The rock was formed _____ yr ago. (**1.79×10^9**)

18.III

6. An atom of ^{122}In has a mass of 121.910280 amu. Calculate the binding energy in MeV per atom, MeV per nucleon, MeV per mole, kJ per atom, kJ per nucleon, kJ per mole. Use the masses: mass of ^1H atom = 1.007825 amu; mass of a neutron = 1.008665 amu; $c = 2.99792 \times 10^8$ m/s; $c = 2.99792 \times 10^8$ m/s; $1 \text{ amu} = 1.66 \times 10^{-27} \text{ Kg} = 931.5 \text{ MeV}/c^2$. Give your answer to 4 significant figures and DO NOT use E notation. [**1029.9 MeV/atom**]

7. Which of the following statement(s) is/are correct?
- Breeder reactors convert the non-fissionable nuclide, ^{238}U to a fissionable product.**
 - The control rods in nuclear fission reactors are composed of a substance that emits neutrons.
 - Electric power is widely generated using nuclear fusion reactors.

8. Which one of the following requires a particle accelerator to occur



none of these