GPH 390
Assignment No. (2)
Due on: Tuesday, 13October, 2015

Natural Radioactivity Problems

Type 1: Balancing Natural Nuclear Reactions.
It is important to remember that in such reactions there is only one nuclear species, on the left-hand side of the reaction, as there is no bombarding particle.
You must know:

1. Every nuclear species is written in the form where ${}^{A}_{Z}X$
Z = Number of protons in the nucleus (Atomic Number) and
A = Total number of particles in the nucleus (Mass Number).
2. $\alpha = {}^{4}_{2}He$ $\beta = {}^{0}_{-1}e$
3. Conservation of charge: In all nuclear reactions the sum of the atomic number(s) before = the sum of the atomic number(s) after.
4. Conservation of nucleons: In all nuclear reactions the sum of the mass number(s) before = the sum of the mass number(s) after.

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problem 1

${}^{214}_{84}Po \rightarrow X + \alpha$. Find X.

problem 2

${}^{198}_{79}Au \rightarrow Y + \beta$. Find Y.

Type 2: Number of α and β particles emitted in successive decays.
You must know: When an **α** particle is emitted the mass number **A** of the parent nucleus decreases by **4** and its atomic number **Z** decreases by **2.**

When a **β** particle is emitted the mass number **A** of the parent nucleus is **unchanged** but its atomic number **Z** increases by **1**.

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problem 3

How many α particles and β particles are emitted when $^{238}_{92}U$ decays to $^{206}_{82}Pb$.

Type 3: **Half-Life (HL) Problems**

You must know:

(i) The half-life of a radioactive isotope is the time taken for half of the nuclei in a sample of the radioactive isotope to decay.

(ii) The fraction of undecayed nuclei **left** after n half-lives is $\frac{1}{2^n}$.

(iii) The relationship between decay constant, λ, and half-life, $t_{\frac{1}{2}}$, is given by:

$$t_{\frac{1}{2}} = \frac{0 \cdot 693}{\lambda}$$

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problem 4

The half-life of a certain radioisotope is 3.8 days. What fraction is left after 19 days?

problem 5

A radioactive material has a half-life of 40 days. How long does it take seven-eighths of the material to decay.

problem 6

The mass of a certain sample is found to decrease by 60% in 10 days. Find its half-life.

problem 7

Calculate (a) the decay constant of $^{64}_{29}Cu$ and (b) the activity of 5 μg of it if it has a half-life of 13 hours.

(Avogadro's No. = $6 \times 10^{23}\ mol^{-1}$)