

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_ZX

Z = Number of protons in the nucleus (Atomic Number) and

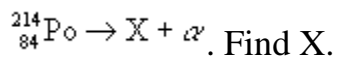
A = Total number of particles in the nucleus (Mass Number).

2. $\alpha = {}^4_2\text{He}$ $\beta = {}^0_{-1}\text{e}$

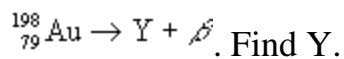
3. Conservation of charge: In all nuclear reactions the sum of the atomic number(s) before = the sum of the atomic number(s) after.

4. Conservation of nucleons: In all nuclear reactions the sum of the mass number(s) before = the sum of the mass number(s) after.

problem 1



problem 2



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.

problem 3

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

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, $t_{1/2}$, is given by:

$$t_{1/2} = \frac{0.693}{\lambda}$$

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

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