Balancing nuclear reactions

Notes on General Chemistry

http://quantum.bu.edu/notes/General Chemistry/BalancingNuclearReactions.pdf
Last updated Thursday, October 18, 2007 11:59:59-05:00

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One way to identify the missing component of a nuclear reaction is to use the requirement that the total atomic number Z, mass number A (the sum of the protons and nuetrons, and so also called the nucleon number) and total charge Q must balance between reactants and products.

To see how this works, let's consider the reaction (ACS Chemistry, page 175)

$$^{249}\mathrm{Cf} + {}^{18}\mathrm{O} \to ? + 4\,n.$$

The first thing to do is to write each component of the reaction in the form ${}^{\text{mass number}}_{\text{atomic number}}\mathrm{X}^{\text{charge}}$,

$${}^{249}_{98}\mathrm{Cf}^{98+} + {}^{18}_{8}\mathrm{O}^{8+} \to {}^{b}_{a}\mathrm{X}^{c} + 4\,{}^{1}_{0}\mathrm{n}^{0},$$

where for now the unknown component is labelled X.

Next, we consider in turn the balance of atomic number (number of protons), mass number (number of protons plus neutrons), and total charge.

The atomic number balance means

$$98 + 8 \to a + 4 \times 0$$

and so the number of protons in the unknown species is $a = 98 + 8 - 0 = 106$. From the atomic number we can immediate identify that the unknown nucleus is that of transuranium element with $Z = 106$, known as seaborgium, Sg.

The mass number balance means

$$249 + 18 \to b + 4 \times 1$$

and so the mass number of the unknown species is $b = 249 + 18 - 4 = 263$. This means the Sg nucleus contains 106 protons and $263 - 106 = 157$ neutrons

The charge balance means

$$98 + 8 \to c + 4 \times 0$$

and so the charge of the unknown species is $c = 98 + 8 - 0 = 106$.

With this information we can identify the unknown reaction component to be ${}^{263}_{106}\mathrm{Sg}^{106+}$.