Instructor: Josephine P. Blaha (2003 Science Teacher Workshop participant)
School District: Holmdel
Lesson Title: Writing Balanced Nuclear Equations
Grades: 10,11,12
Subject: Chemistry
Overview:
I teach a low level Chemistry class in which the students have low Math skills. The students often have difficulty visualizing chemical reactions. In this lesson, I try to get the students to construct small nuclides, and physically take them apart (simulating nuclear decay, or fusion, or fission) and put together the products that ensue; from this, they will be able to predict the products of a nuclear reaction and write the corresponding balanced nuclear equation. The students will be using round stickers of various colors, one color for protons, one for neutrons, and will be using them on a sheet of transparency film.

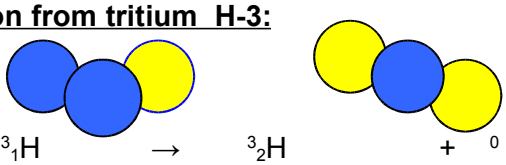
A limitation of this technique is that one can only use small nuclides, as such nuclides as U-238 will get rather cumbersome and will only confuse the students. This technique can also be used to simulate regular chemical equations.
Objectives: The students will be able to predict the products obtained from nuclear decay, fusion, or fission by using stickers as manipulatives.
Materials and Resources:

- Stickers, round, and two or three colors; it would be helpful to mark the protons with a + and the neutrons with a 0.
- Blank overhead transparencies
- Printed exercise sheets (see below).

Background: Prior to this activity, the students will have been introduced to the subject of various radioactive emissions, in particular, α, β^-, β^+, γ radiations and what happens to the nuclear particles when these are emitted, or when they are fused into a nuclide. They will also have been introduced to the various types of nuclear reactions and have started to try to write balanced nuclear reactions.
Make sure that the students understand that if an α particle is emitted, two protons and two neutrons are removed from the nucleus (and vice versa if a nuclide fuses with the α particle. Likewise, if a beta particle is emitted, a neutron is converted to a proton from the emitting nuclide; and if a positron is emitted, a proton is converted to a neutron in the emitting nuclide.
Procedure: Print and hand out a nuclear reaction, maybe two to a page and have the students place the transparencies over each page. Have them construct the nuclides on the transparency right above the formulas, and have them physically take these apart

and see what products are obtained, by counting the resulting protons and neutrons. On the next pages are sample reactions the students can use.

β^- emission from tritium H-3:



$^{3}_{1}H \rightarrow {}^{3}_{2}H + {}^{0}_{-1}e$

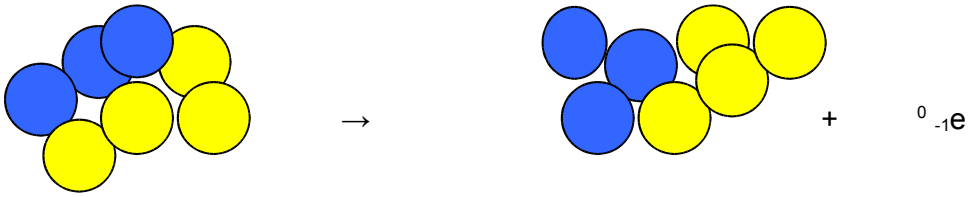
1 proton
2 neutrons

2 protons
1 neutron

- yellow sticker is a proton, **+** charge

- blue sticker is a neutron, 0 charge

β^+ positron emission from Be-7



$^{7}_{4}Be \rightarrow {}^{7}_{3}Li + {}^{0}_{-1}e$

4 protons
3 neutrons

3 protons
4 neutrons

Fusion of N-14 with an alpha particle:

$^{14}_{7}N + {}^{4}_{2}He \rightarrow (?) + {}^{0}_{-1}e \rightarrow (?) + {}^{1}_{1}H$

(Students should be able to predict the product, $^{18}_{9}F$ which is unstable and decays further to $^{17}_{8}O$.)

Challenge:

A fusion reaction occurs in the sun which involves the combination of two He-3 nuclei to form two H-1 nuclei and one other nucleus. Write the balanced nuclear equation for this. Be sure to include all reactants and products. You may use your stickers to model this reaction.

Ans : $^{3}_{2}He + {}^{3}_{2}He \rightarrow {}^{4}_{2}H + {}^{4}_{2}H + {}^{4}_{2}He$