

**Exercise 10: Nuclear chemistry**

From the University of California's Lawrence Berkeley Lab website (6/7/99):  
<http://enews.lbl.gov/Science-Articles/Archive/elements-116-118.html>

"Discovery of two new "superheavy" elements has been announced by scientists at the U.S. Department of Energy's Lawrence Berkeley National Laboratory. Element 118 and its immediate decay product, element 116, were discovered at Berkeley Lab's 88-Inch Cyclotron by bombarding targets of lead with an intense beam of high-energy krypton ions....The isotope of element 118 with mass number 293 identified at Berkeley Lab contains 118 protons and \_\_\_\_\_ neutrons in its nucleus."

1. Fill in the blank above.
2. Assume the element symbol for element 118 is "X". Write the isotope symbol for the X isotope mentioned above.

More from that site:

"Elements 118 and 116 were discovered by accelerating a beam of krypton-86 ions to an energy of 449 million electron volts and directing the beam into targets of lead-208. This yielded heavy compound nuclei at low excitation energies."

3. Write the **nuclear equation** for the generation of element 118 that the sentence above suggests. Add neutrons as necessary to either the product or reactant side. Make sure the mass number and the atomic number are balanced.

As a footnote: "On July 27, 2001, the results reported [above] were retracted through a correspondence with *Physical Review Letters*." This shows the scientific method in action, as the authors of the original report reviewed their own work carefully, and, with the help of other researchers, were able to disprove their own results.

A less peaceful use: Breeder reactors generate the radioactive element plutonium from uranium. Plutonium is a key component in nuclear weapons technology.

From [http://www.nukeworker.com/study/nuclear\\_energy/ne3-power\\_reactors.shtml](http://www.nukeworker.com/study/nuclear_energy/ne3-power_reactors.shtml)

“The key feature of a breeder reactor is that it produces more fuel than it consumes. It does this by promoting the absorption of excess neutrons in a fertile material. Several breeder reactor systems are technically feasible. The breeder system that has received the greatest worldwide attention uses uranium-238 as the fertile material. When uranium-238 absorbs neutrons in the reactor, it is transmuted to a new fissionable material, plutonium, through a nuclear process called  $\beta$  (beta) decay. The sequence of nuclear reactions is:

Equation (3):

In beta decay a nuclear neutron decays into a proton and a beta particle (a high-energy electron).

When plutonium-239 itself absorbs a neutron, fission can occur, and on the average about 2.8 neutrons are released. In an operating reactor, one of these neutrons is needed to cause the next fission and keep the chain reaction going. On the average about 0.5 neutron is uselessly lost by absorption in the reactor structure or coolant. The remaining 1.3 neutrons can be absorbed in uranium-238 to produce more plutonium via the reactions in equation (3).”

4. Fill in equation (3). There are actually three reactions: First, a neutron collides and fuses with a uranium-238 nucleus. Next, that new nucleus undergoes a beta decay. Finally, *that* product undergoes another beta decay, which results in a plutonium nucleus.

*Calculate your own radiation dosage!*

5. Go to the Environmental Protection Agency site for calculating your own radiation dosage at  
<http://www.epa.gov/radiation/understand/calculate.html>

What is your annual radiation dose (in millirem)?