War & Peace Cluster, Summit Program
Physics Assignment 4

Fission reactions

1. Given

$$n + {}^{235}U \rightarrow {}^{141}Cs + X + 2n$$

   a. What nucleus is represented by the X? (Hint: both atomic number and mass number has to be conserved.)
   b. What is the (combined) kinetic energy of the neutrons? (Mass of a neutron = 1.00894 amu, mass of ^{235}U = 235.0439 amu, mass of ^{141}Cs = 140.92 amu, mass of X = 92.922 amu. Assume that the incident neutron has negligible kinetic energy.)

Nuclear reactors

2. What was the first ***commercial*** reactor, and in which year did it start producing electricity? Note: we are looking for the first reactor designed to produce electricity. The is an earlier one (in the Soviet Union) which was designed for military purposes, but which was used to provide electricity as a by product. There are other experimental reactors (for example in Idaho) some of which did produce electricity but not on a commercial scale. Which was the first ***commercial*** reactor in the US, and its date?

Nuclear waste

There are two main drawbacks to nuclear power, the proper disposal of nuclear waste, and the possibility of a catastrophic accident. A later assignment deals with the latter, this assignment with the former. In both cases the questions will require some Internet research, although the answers are readily available, and you should be able to find them easily. Note: check more than one independent source. There is a wide range of numbers out there, and many are very wide of the mark.

3. Since that time what is the ***total*** radioactive waste (in tons) which has been produced from nuclear fuels in the US? (The world wide figure is about three times larger.) Concentrate on the fuel waste, that is the fission products, and leave out low level waste such as contaminated clothing. Also, include just the waste produced by the nuclear power industry, and ignore the waste from the production and decommissioning of nuclear weapons. The latter is much higher.

4. If we are required to store all of it in one place, how much space (volume) would it occupy? (Density of uranium in the form of "yellowcake" is 9,000 kg/m^3, and 1 ton is approximately 1000 kg. **Density = mass/volume**, and the mass is the answer to question 3, converted to kg.)

5. Try to put this in context by relating to something that you can visualize. For example, if the waste were stored on a football field, calculate how deep would it be given your answer to question 4, and the relationship

volume = area * depth

(note: you can find this answer on line, but many web sites have it wrong, or at least do not substantiate their answer. Try to answer based on your answer to the previous question)