War & Peace Cluster, Summit Program
Physics Assignment 4

Nuclear reactors

1. 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.

   World: Calder Hall, 1956

2. Which was the first ***commercial*** reactor in the US, and its date?

   US: Shippingport, 1957

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.

   Depending on your source, somewhere between 60,000 and 70,000 tons total over the almost 6 decades that we have been using nuclear power.

   (Note that a recent TV program quoted the waste from US coal power in the US as 130 ***million*** tons ***per year***.)

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. It might help to refer back to the in class assignment on September 6 when answering this question.)
   a. Taking the larger volume from above, the mass is 70,000 tons = 70,000,000 kg
   b. Volume = mass / density = 70,000,000 kg / 9,000 kg/m^3 = 7780 m^3

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, and show your working. The answer you get should be about the same as that given in the documentary *Pandora's Promise*.)

a. A football field is approximately 100 m x 50 m = 5000 m^2.
b. If the waste is distributed on the field uniformly then its depth would be
    i. volume = area * depth
    ii. 7780 = 5000 * depth
    iii. depth = 7780 / 5000 = 1.56 m (about 5 feet)