War & Peace Cluster, Summit Program, Physics section
Assignment 5

Notes:

Please write your answers on a separate sheet.
There is not enough room between the questions.

In all assignments you should keep in mind the GE goals, and in particular the goal referring to communication. It requires that a complete answer to a question requires not only the final result, but also the justification for that result. Mathematics is just another language, and showing the details of a calculation is nothing more than supporting your final conclusion.

Questions:

Review questions

1. What causes radioactivity? Why are some isotopes radioactive whilst others are stable? (Be careful about the answers that you will find on line. Most of them are useless, even downright wrong. Ask yourself, could my answer help to to decide if a particular isotope is radioactive, given access to data about the nucleus of that isotope.)
2. Why is the mass of a nucleus less than the mass of the same number of free protons and neutrons?
3. What do you think makes radiation so dangerous? (Not what are the consequences, but what is about radioactive nuclei that causes them to be dangerous in the first place? The answer lies in the lecture material from this semester, and only requires one word.)

Parents and daughters You should be able to answer these questions yourselves, but once you have done so by all means go ahead and check your answers on line.

4. For all of the isotopes below determine
    i. the daughter nucleus
    ii. the loss of mass
    iii. the energy that is produced

You will need an online source such as EnvironmentalChemistry.com to find the data for this question and for the next two questions. Please see the web site for a link to their database. Also, remember that the destruction of 1 u (atomic mass unit) of mass creates 931.4 MeV of energy.

a) ^{239}U which is a β^- emitter.
b) ^{82}As which is a β^- emitter.
c) ^{182}Hg which is an α emitter.

5. You are told that the isotope ^{53}V is radioactive, but you are not told what the daughter is. There are two possibilities. It could be an α emitter

$$^{53}V \rightarrow {}^{49}Sc + {}^{4}He$$

or it could be a β^- emitter.

$$^{53}V \rightarrow {}^{53}Cr + e^-$$

Without looking up the answer, but basing you answer on the masses of the different isotopes, which of the above possibilities is the correct one, if either?

6. You are told that the isotope ^{213}Bi is radioactive, but you are not told what the daughter is. There are two possibilities. It could be an α emitter

$$^{213}Bi \rightarrow {}^{209}Tl + {}^{4}He$$

or it could be a β^- emitter

$$^{213}Bi \rightarrow {}^{213}Po + e^-$$

Without looking up the answer, but basing you answer on the masses of the different isotopes, which of the above possibilities is correct?