Chem 155 Homework #6 Due at the start of class on Weds. Feb 17
Reading: Chapter 15

Chapter 14 Problems:
14.38
14.68
Chapter 15 Problems:
15.4
15.8
15.14
15.23
15.24
15.28
15.68

Additional Problems:
1) Pb-Pb dating is a well-established technique for calculating the age of very old minerals and is one (of many) pieces of evidence that have been used to date the earth and the solar system. The Pb/Pb technique is based on the fact that ^{238}U and ^{235}U both undergo a series of decays (beginning with an alpha emission) to produce ^{206}Pb (from ^{238}U) and ^{207}Pb (from ^{235}U). If a sample is found that contains no non-radiogenic ^{204}Pb (or, more commonly, by taking the ratios of the radiogenic isotopes to those of the non-radiogenic isotopes), the fraction of the ^{206}Pb and ^{207}Pb present in the sample formed from the decay of ^{238}U and ^{235}U can be determined. By measuring the ratio of the two radiogenic lead isotopes, and using the known modern day ratio of $^{238}U/^{235}U$ isotopes, the age of the sample (time since it became a closed system) can be determined. Since isotopic ratios can be measured very accurately, the age of rocks and meteorites with ages of billions of years can be measured with impressive results.

A recent paper in Science (G. Brennecka et al. v237, p449-451, Jan 22. 2010) performed a detailed analysis of the several meteorite samples and concluded that variations in the initial $^{238}U/^{235}U$ ratios may lead to additional uncertainties in this dating technique that need to be refined for accurate geological ages.

1a) There is a typographical error in equation 1 in the paper. What should the correct formula be for a sample that had no initial (non-radiogenic) ^{204}Pb (i.e. all Pb isotopes came from U decay)?

1b) Using the standard dating curve, what would the age of a meteorite be that has a ratio of $^{206}Pb/^{207}Pb$ of 1.5647 and no detectable ^{204}Pb (You'll need to look up the half-lives of λ_{235} and λ_{238})?

1c) What age would the corrected age of the meteorite be if, instead of 1/137.88, the ratio of $^{238}U/^{235}U$ was actually 137.40 (the outer limit suggested in the paper). Would most people worry about this "error"?

2) a) What is the energy in J of a 635 nm photon. **b)** How many photons per second are emitted by a 1 mW laser pointer with a 635 nm wavelength? **c)** What color is this laser pointer?

3) Calculate the potential energy in J, of an electron and a proton separated by 1 Angstrom. What is this value in eV?

4) If an electron has 100 eV of kinetic energy how fast is it moving in m/s? What is its momentum?

5) Suppose that a 100W source radiates 600 nm light uniformly in all directions. Assuming that the human eye can detect this light if only 20 photons per second enter a dark-adapted eye with a 7-mm diameter pupil. How far from the source can the light be detected under these conditions? Why do you think can't we see this far in the "real world"?

6) In the Bohr model of the atom, electrons are constantly accelerating, yet they are traveling at constant speed. Explain how something can be accelerating but not changing speed. What behavior does classical electromagnetism predict for accelerating charges?