1) Half life and lifetime are two closely related quantities, but they are not the same. One is the time it takes (on average) for half of a radioactive sample to decay, and the other is the average amount of time each atom takes to decay. Perform the following simple demonstration: take a number of coins (10 is a convenient number, but feel free to use more if you have them). Toss them repeatedly. After each toss, take out the coins that come up showing tails, and record them as having lasted 1, 2, or however many tosses. Keep tossing until all the coins are gone. By recording how many tosses the coins last, you are finding experimentally the lifetime of a coin in a “coin-toss decay” experiment. You need only average over the lifetime of all the coins. Repeat the coin tossing exercise until you are sure you know what the correct answer is. Your answer will average to the correct number very slowly, as one over the square root of the total number of coin tosses you do. You have to do four times as many coin tosses to cut your error in half. This is the same kind of error that occurs in political polls. Obviously, the half life for coin tosses is one throw. What is your result for the average lifetime? Note: the relation between lifetime and half life is slightly different for discrete processes like coin tossing and continuous processes like radioactive decay, but the principles are the same.

2) A charcoal sample is found in the ruins of an ancient city, and shows a C-14 activity of 190 decays/minute. A modern sample of the same mass shows an activity of 376 decays/minute. Given that C-14 has a half-life of 5730 years, approximately how old is the sample? Explain your reasoning.

3) Calculate the binding energy per nucleon (in MeV) of $^{239}$Pu (Z=94). The rest energy of the Plutonium nucleus is 222677 MeV, compared to 938.28 MeV for the proton, and 939.57 MeV for the neutron. Repeat your calculation for $^{56}$Fe (Z=26), which has a rest energy of 52103 MeV. The difference in binding energy is an indication of the very different nuclear properties of plutonium and iron.