

Physics 325 Assignment 3
Due Tuesday 2/3/09

1. C&G 4.6

2. a) Starting with equation 4.8, derive equation 4.9, which gives an estimate of the Z value of the nucleus with the lowest rest mass for a given A (the most stable isobar for that A).

b) Find Z_{\min} for $A=99$. Check with the Chart of the Nuclides to see whether that nucleus is, in fact, stable. If not, how far off is the estimate?

3. a) The isotope ^{222}Rn undergoes alpha decay. This is the longest-lived isotope of radon (which is naturally occurring on Earth as part of the decay chain of other isotopes; as a radioactive gas, radon can cause lung cancer; it's also been detected on the moon). Write out the ^{222}Rn decay process, showing the parent and daughter nucleus and the other decay product(s).

b) The isotope ^{18}F undergoes β^+ decay. It is often used in positron emission tomography (to image areas of glucose metabolism, using fluorodeoxyglucose molecules). Write out the decay process of ^{18}F .

c) The isotope used for carbon dating, ^{14}C , undergoes β^- decay. Write out its decay process.

d) Which one of ^{222}Rn , ^{18}F , or ^{14}C can also decay by electron capture? Write out that decay process.

4. The fusion reaction $p + ^{11}\text{B} \rightarrow 3(^4\text{He})$ is one of the few reactions being considered for fusion power that doesn't produce any neutrons. Using Table 4.2, find the energy release in this reaction. (Note: there is no binding energy associated with the free proton in the initial state. The three ^4He nuclei produced are not bound to each other in any way; you can think of the final state as $^4\text{He} + ^4\text{He} + ^4\text{He}$.)

5. For each of the following, give the expected shell-model spin and parity assignments for the ground states. Then look up the actual spin and parity in the Chart of the Nuclides and comment on how well the shell model does.

^7Li

^{11}B

^{15}C

^{17}F

^{31}P

^{141}Pr

^{141}Ce