

Physics 325 Assignment 2
Due Tuesday 1/27/09

1. a) C&G 2.6; in addition to reproducing the arguments in the back of the book, you should explicitly check that energy can be conserved in the otherwise permitted decays by finding the total energy in the initial state (you can assume the kinetic energy is very small) and making sure that's enough energy to create the particles in the final state.
b) Can the decay $(\mu^+ e^-) \rightarrow e^+ + e^- + e^+ + e^- + \nu_e + \bar{\nu}_\mu$ occur? Explain your reasoning.
c) Which interaction causes each of the listed muonium decays that can occur?

2. As shown on p. 17, all neutrinos produced by the weak interaction are "left-handed," with their spin anti-parallel to their direction of motion. Make an argument (similar to the one we made in class for beta decay) that shows how the preference by the weak interaction for left-handed rather than right-handed neutrinos violates parity.

3. a) Classify each of the following decays as strong, electromagnetic, or weak, and explain your reasoning briefly.

The quark content of the particles in this problem is:

$$\rho^0 = u\bar{u} + d\bar{d}; \pi^+ = u\bar{d}; \pi^- = d\bar{u}; \Delta^- = ddd; \Lambda^0 = uds; \Sigma^0 = uds$$

- i) $\rho^0 \rightarrow \pi^+ + \pi^-$
ii) $\Delta^- \rightarrow n + \pi^-$
iii) $\Lambda^0 \rightarrow p + \pi^-$
iv) $\Sigma^0 \rightarrow \Lambda^0 + \gamma$
v) $\pi^+ \rightarrow \mu^+ + \nu_\mu$

b) Which of these particles would you expect to have the longest half-life? The shortest? Explain your reasoning briefly.

4. C&G 4.1

5. What is the approximate radius of the ${}^6\text{Li}$ nucleus? What about ${}^{226}\text{Mt}$?

6. a) Calculate the binding energy of the ${}^4\text{He}$ nucleus. Check your answer against the value given in Table 4.2. Atomic masses are given in many places, including most Modern Physics textbooks.

b) For this nucleus, is it OK to neglect the electron binding energy to the number of significant figures in the table? (You may use the Thomas-Fermi model discussed in the text to estimate the electron binding energy.)