M99Q.2—Excited States of Helium

Problem

This question is about the excited states of the ^{4}He atom where one electron has been excited to an $n = 2$ state. (The ^{4}He nucleus has spin zero.)

a) How many different such $n = 2$ atomic energy levels are there? (Include all fine-structure effects.) Give the quantum numbers and degeneracy of each level.

b) Which $n = 2$ state has the highest energy? the lowest energy? Give a short explanation of the physics behind your answers, based on symmetries and/or qualitative considerations; no precise calculation is necessary here.

c) For each $n = 2$ state, what is the strongest decay process, and to what atomic state does it decay? Which state has the shortest lifetime, and why? Which state do you think has the longest lifetime, and why?