PHYS2332-Modern Physics II
Winter 2020, Assignment #5

Due on Thursday March 19, 2020.

Question 1 Problem 8 chapter 11

Question 2 Problem 18 chapter 11

Question 3 Consider Helium-3, aka ${}^{3}_{2}He$ (2 protons plus 1 neutron).

A) Show that in its **electronic ground state**, the **total spin** (electronic and nuclear spin) can take on value, $S = \frac{1}{2}, \frac{3}{2}$.

B) In actual fact the **total spin** is $S = \frac{1}{2}$, and it is a fermion that can behave like a Fermi-Dirac degenerate gas at low temperature. Consider now ${}^{3}_{2}He$ in at very low temperature where it is in the liquid state with mass density, $0.081 g \cdot cm^{-3}$. Calculate the Fermi Energy, ε_F, and Fermi temperature, T_F, of ${}^{3}_{2}He$. **HINT:** 1) For electron in metals we used the mass of an electron to calculate the ε_F, but here it is ${}^{3}_{2}He$ that is the fermion; 2) the Fermi temperature is **less** than 10K.

Question 4 Problem 18 chapter 12

Question 5 Problem 26 chapter 12.

Question 6 Problem 42 chapter 12.

Question 7 Problem 68, chapter 12.

Question 8 ${}^{222}_{86}Rn$ is produced by the decay of Radium (Ra). **A)** Use appendix 8 to show how Ra decays to ${}^{222}_{86}Rn$, and calculate the disintegration energy. **B)** If there is one mole of ${}^{222}_{86}Rn$ in your basement, use data from appendix 8 to calculate the amount of ${}^{222}_{86}Rn$ that will remain after one hour. **C)** Use appendix 8 to find (at least 5) the isotopes produced by the decay of ${}^{222}_{86}Rn$. Can you find a stable isotope?