

1. (6 pts) (a) Explain how Cooper pairs form, even though the two electrons have the same charge and ought to repel each other. (b) Explain, in terms of the energy gap and Cooper pairs, why a large enough magnetic field can kill superconductivity. (c) Explain why type II superconductors can remain superconducting at higher magnetic fields than type I superconductors can.
2. (5 pts) (a) Explain why Josephson oscillations occur. (b) If I put one volt across a Josephson junction, what wavelength of light should come out of my junction?
3. (6 pts) Write down the nuclide symbol for a nuclide with the following numbers of protons and neutrons: (a) 2 protons and 2 neutrons, (b) 7 protons and 8 neutrons, (c) 18 protons and 22 neutrons. For example, the nuclide symbol for 6 protons and 8 neutrons is ${}^1_6\text{C}$.
4. (3 pts) Explain why stable light nuclei tend to have about equal numbers of protons and neutrons, and why heavier nuclei tend to have more neutrons than protons.
5. (4 pts) Use the data in the appendix of your book to find the binding energy per nucleon for Iron-56 (${}^{56}_{26}\text{Fe}$).
6. (6 pts) A given nuclear decay process cannot spontaneously occur if the stuff we are left with after the decay has more mass than what we started with. In this case, we say that the nuclide is stable against the particular decay process in question. For example, alpha decay (the ejection of an alpha particle, which is just a ${}^4\text{He}$ nucleus) cannot occur if the mass of an alpha particle + the mass of the daughter nucleus is greater than the parent nucleus. Consider a ${}^{218}_{84}\text{Po}$ nucleus ejecting an alpha particle to become ${}^{214}_{82}\text{Pb}$. Can this decay occur, or is ${}^{218}_{84}\text{Po}$ stable against alpha decay?

Extra problems I recommend you work (not to be turned in)

- Find an element which is not stable against alpha decay.
- (a) What voltage would you have to put across a Josephson junction to make it oscillate at 10 Hz? (b) Why can't I trust the equation in the book (10.28) for extremely low oscillation frequencies? (Hint, what would the oscillation frequency be for $V = 0$?)