

Physics 2 “home exam”, part 1. (based on chapter 20)

Note: short answers are OK!

- 1) Quantum numbers for atoms: Explain what n , l , m_l and m_s are. How does this relate to chemistry labels such as “2p”?
- 2) Describe what is meant by “degeneracy” and the Pauli exclusion principle. For example, why does the 1s orbital have a maximum occupancy of 2 electrons? Why does the “ $n=2$ ” (i.e. 2s and 2p) level allow up to 8 electrons? If they’re all at the same energy level, how is this not contradicting the Pauli exclusion principle?
- 3) Look at figure 20.22 (Zeeman effect). Explain what you see, i.e. why does the $l=0$ level not split in a magnetic field? Why does the $l=1$ level split when a field is applied, but that the splitting goes away when there is no field.
- 4) Look at figure 20.32 (energy levels in atoms): Why are the 3s, 3p and 3d electrons at the same energy in Hydrogen, but not in Sodium?
- 5) Try problem 20.7 and discuss your findings.

Physics 2 “home exam”, part 2. (based on chapter 21)

Note: short answers are OK!!

- 6) Bonding: Describe the different kinds of bonding which can exist in a solid. Which bonding types are strongest? Why? What is the underlying mechanism?
- 7) Classical model for electrical conduction: Choose a metal (maybe copper? Or an alkali metal like sodium?). Estimate the average velocity of electrons participating in conduction. Estimate the average scattering length and time between scattering (i.e. look through pages 563 - 565). Don't just give the numbers, but show the approximations used (i.e. show your working)
- 8) QM model for electrical conduction: What is the meaning of “Fermi level”, and why is it important when understanding the properties of metals? Using the quantum mechanical approach, recalculate the example in the previous question: How do your answers for velocity, time and length change?
- 9) Band theory of solids: Why do solid materials have allowed energy “bands” and forbidden gaps? Why are some solid materials very good conductors (i.e. metallic) and others are insulating or semiconducting? Answer in terms of the electron filling of an isolated atom and the separation.
- 10) Advanced topic: Choose a relevant topic to explore a bit further and write about. Here are some suggested topics: i) intrinsic and extrinsic semiconductors, ii) p-n junctions and diode behavior iii) how does a transistor work? iv) metal to insulator transitions because of applied pressure v) metal to insulator transitions because of pairing of atoms vi) superconductivity.