Study Guide for Exam Three

For Exam three, you will need
• a non-programmable, non-graphing calculator (You will NOT be allowed to share or borrow a calculator or use a cell phone for a calculator during the exam.)
• a #2 pencil

Exam 3- Protocol: (same as Exam 1 and 2)
• Read each question and the directions carefully. The directions may change from problem to problem.
• If you don’t know how to do a problem, skip it and move on. Careful of the time. Some of the multiple choice questions will be worth only a few points but could take a while. Try to do the big point problems that you know how to do first.
• Be sure any work you do is clear and easy to follow. I am not a mind reader.
• Follow all of the rules of significant figures and label all answers with the appropriate units.

Exam 3 will primarily cover the sections of chapters 9, 10, and 12 (for chapters 9 and 12 focus on the content covered in lecture, then fill in the gaps with the textbook, we jumped around a bit during these chapters) that I specified on the course schedule page, any problems assigned from those chapters (including worksheets) and anything covered in lecture. For this exam, your lecture notes should be a primary source of information for a lot of the solid state and semiconductor/LED content. The exam will consist of multiple choice questions, some true-false questions, some short answer questions, and some problems. etc. Don’t ask me too many specific questions because I haven’t written the exam yet!

What should you know from Chapters 1-5? (The same as the other exams – see other study guides for more information.)

What should you know from Chapter 9?
• The three types of bonding (ionic, covalent, and metallic), a brief definition of each, and what type of atoms (metal, nonmetal, metalloid) participate in that type of bonding.
• Lattice energy – definition, what it is, how it can be affected (charge of ion, size of ion)?
• Born-Haber cycle – can you identify all of the pieces if they were given in a diagram like Figure 9.6 or in a Hess’s Law problem like problem 9.30? Could you translate the words to balanced equations and vice versa (like the problems on worksheet 7)?
• Difference between bonding pair (shared pair) or lone pair (unshared pair) of electrons in a covalent bond
• Types of bonds and how to determine the bond order
• Using the periodic table and what you know about atomic size and electronegativity, can you predict which bonds would be longer or stronger?
What should you know from Chapter 10?

- How to count up valence electrons for molecules and ions
- How to draw a Lewis structure (including those with multiple bonds)
- What are resonance structures? When does a molecule have resonance structures?
- How to calculate bond order for these resonance structures.
- What is formal charge and how to calculate it for any atom in any molecule?
- Exceptions to the octet rule
- Valence-Shell Electron-Pair Repulsion Theory (VSEPR): know the electron-group arrangements, the molecular geometries for all those on the table on the handout from class
- What is molecular polarity? How do you determine it? What is a dipole moment? Can you decide if a molecule is polar or nonpolar?

What should you know from Chapter 12?

- Crystalline versus amorphous solids. What are the key differences?
- Types of crystalline solids discussed in class and at that detail
- What is a unit cell? Lattice point? Can you identify a unit cell given an extended 2-D or 3-D structure?
- The three different types of unit cells in the cubic system: simple cubic (sc), body-centered cubic (bcc), and face-centered cubic (fcc). Which pack squarely? Which pack hexagonally?
- What is a coordination number?
- For each unit cell type, you should know the packing efficiency, the edge length of the unit cell, the volume of the unit cell, and the coordination number of an atom in that unit cell type.
- What is a z-diagram? How to draw them. How to read them.
- How do you count atoms in a unit cell? Corners, edges, faces, and centers all contribute how much to a unit cell?
- Density calculation problems and the many variations that are possible. You also need to know the conversion between pm to cm.
- What are ionic solids? How do they form? How do you determine the stoichiometry of an ionic solid? What is its empirical formula?
- For metallic bonding, can you draw the picture when 2 atomic orbitals come together and form two new molecular orbitals? What does that picture look like when you do that for an Avogadro’s number of atoms?
- What is a valence band? Conduction band? What are they really made up of?
- What does the band structure (picture or diagram) look like for a metal/conductor? Semiconductor? Insulator? What are the relevant band gap sizes in each?
- What is an intrinsic semiconductor? Extrinsic semiconductor? Compound semiconductor?
- How to improve conductivity of semiconductor using doping. What is doping? The two types of doped semiconductors (n-type and p-type). What elements are
used for either type and why? What will the band structure look like after doping and why?

- Why as you move down a group in Group IV does the band gap decrease? Can you argue why using atomic size and electronegativity? When is the size argument best? When is the electronegativity argument best?
- Why different compound semiconductors with the same edge length have dramatically different band gaps although they all have a combined 8 valence electrons?
- How do you move electrons across a band gap and the corresponding calculations using light energy, thermal energy, and electrical energy?
- How do electrons return to the valence band after absorbing energy (radiatively and non-radiatively) and which is favored when?
- How does a LED or p-n junction work?
- Temperature effects on conductors, semiconductors, and insulators. What happens on the atomic level when you heat them up or cool them down that explains the change in conductivity/resistance or change in the size of the band gap?
- Why does the light intensity change when you heat or cool a semiconductor? What is happening on the atomic level to do this?
- What is a superconductor? How does it repel a magnet? What is the Meissner effect?
- How do you change the band gap of a compound semiconductor (no doping allowed!)?

What should you know from the labs?

- The different types of unit cells, how to determine the edge length, coordination number, number of atoms in a unit cell, and the stoichiometry of an ionic solid. How to draw a z-diagram.
- What happened to the conductor under room temperature conditions? Low temperature conditions and why (explain what is happening on the atomic level)?
- What happened to the LED (semiconductor) under room temperature conditions? Low temperature conditions and higher temperature conditions and why (explain what is happening on the atomic level)?
- What happened to the superconductor? The magnet?

You should also be familiar with the material from Exam 1 and 2. It can show up on this exam as well. However, if any material from Exam 1 or 2 shows up on this exam, you can count on it being a significant topic and something you probably know since you have done many problems of that type. I won’t bring back minor details from Exam 1 and 2 to test you on Exam 3. You have a good idea based on the quizzes what I may ask from the Exam 1 and 2 material. HOWEVER, to explain the behavior and the changes of band gaps we have used periodic trends (in particular atomic size and electronegativity) to explain these concepts. These trends should be fresh in your mind. The calculations for light, energy, wavelength, and frequency should also be fresh in your mind.
The main thing is to keep practicing problems and work on the problems and worksheets. You have good practice there. If you need help, send me an email or post your question in the Discussion Board. Good luck with the studying!