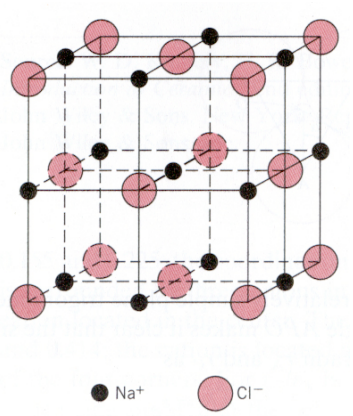
SCI 1410: materials science & solid state chemistry

EXAM TWO.



INTRODUCTION

Instructions: I'll assess these exam questions and count the scores toward your quantitative and qualitative analysis competency grade. You may work on this as much as you like, and start whenever you like. You're allowed to chat about the analyses with your teammates, if that's helpful to your understanding, but you must write up your exam document on your own. Submit this to me via email (stolk@olin.edu) no later than **11:59 pm on Wednesday, February 04.**

ATOMS, IONS, & MOLECULES

For this question, you are going to examine the composition, structure, and bonding of a component of your product.

1. Pick a component of your object to examine. Try to pick a component that is interesting from the perspective of your project, e.g., the bristles of a paintbrush, blade of a ceramic knife, etc. Make this exam work for your project goals!

2. Let's start with the chemical composition of the component:

   - Which **elements** are present in the material? Just give a list of what's there, and in what amounts.
   - Did you determine the elemental composition of the material through lab experimentation? If so, what instrument(s) or techniques(s) did you use? If not, would equipment would you use to measure your material composition in the Olin mat sci lab? The *Mat Sci Equipment Rundown* document (on the Resources page of the web site) might be helpful here.
   - How would you classify the material – metal, ceramic, polymer, composite, semiconductor?

3. It's time to move on to structure. Let's now consider the 3D arrangements of atoms, ions, or molecules in your product component.

   - Is your material crystalline, amorphous, or semicrystalline? How do you know? Did you use laboratory experimentation to determine this? If so, which instrument(s) or technique(s) did you use? If not, what could you do to determine if the material is crystalline, amorphous, or semicrystalline?
   - Create a sketch that illustrates how the atoms, ions, or molecules are arranged in the material. Label the atoms, ions, or groups of molecules in your sketch.
   - Does your material have a repeating structure at the atomic or molecular level, e.g., a unit cell for a metal, or a mer unit for a polymer?
   - Does your material have a larger scale structure, e.g., organized polymer chains or metal grains?

4. Now consider the interactions among the atoms, ions, or molecules in the material.

   - What types of bonding are present in your material? Be sure to include **all** of the different types of bonds, especially if you're dealing with a polymeric material.
   - Are these bonds considered "strong" or "weak," or is there a combination of strong and weak bonds?
   - Estimate the bond energies of the various bonds in the material (emphasis on the word "estimate" here; you may not be able to find exact bond energy values for your material).

5. Let's see if we can connect concepts of composition, bonding, and structure to measurable properties of your material.

   - Use the CES EduPack software, Callister's textbook appendices, or another reliable reference source to find data on the density of your material in g/cm^3 (be sure to cite your sources). How does this density value relate to the composition, bonding, and structure? Discuss the relationships.
   - Now look up a Young's modulus value for your material, and report this value in GPa. Explain the value based on what you've learned about atomic bonding, i.e., how does atomic or molecular bonding relate to the elastic properties of the material?
   - Are the mechanical properties of your material isotropic or anisotropic? Explain your answer based on what you know about the structure and bonding of your material.

6. Create a graphic for your final project poster that illustrates your material's atomic- or molecular-scale composition, structure and bonding. Do some work now for your final deliverable!