MATRL 218/CHEM277: Assignment 1

Ram Seshadri (seshadri@mrl.ucsb.edu)

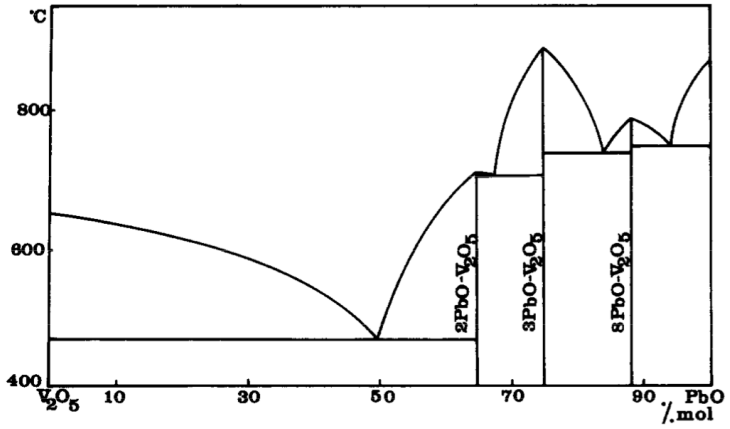
Due date: January 18th 2011

1. Why is the crystallization of hard spheres, with no attractive interaction between them, considered to be entropy stabilized? How does the volume fraction of the spheres needed for crystallization compare to cubic close-packing (fcc)? See the reference by Lekkerkerer in your notes.

2. When significant pressure is applied to an extended solid such as Si, amorphous Si forms. Does Si exhibit directional or non-directional bonding, and how does this result suggest that?

3. What is the difference between a glass and an amorphous solid?

4. Many liquids can be rapidly quenched to give a glass. Why can't this be indicated in a phase diagram? It has been observed that certain features in phase diagrams are found associated some glass forming alloys. What are these features, and briefly why do they aid glass formation? Hint: PbO-V_2O_5 phase diagram:



5. What is the Kauzmann paradox ? Why does the entropy of a liquid decrease when it becomes a glass, even though the effective structures of liquids and glasses (snapshots) are similar?

6. What is Vaseline glass (hint: Google)? What is the main constituent besides SiO_2? Do you suspect that the alloying element is a glass former or glass modifier? Discuss in the context of Zachariason's definitions, drawing reference to the coordination of the cation in its native oxide crystal structure (CaF_2 structure) or other knowledge about fluorescence of that cation.

7. Explain structural frustration in the context of forming crystalline versus glassy structures – pentagons are frustrated from forming crystalline packings in 2D, but not on curved surfaces, like around a sphere. Explain with a sketch.