MATRL 218/CHEM277: Assignment 1

Ram Seshadri (seshadri@mrl.ucsb.edu)

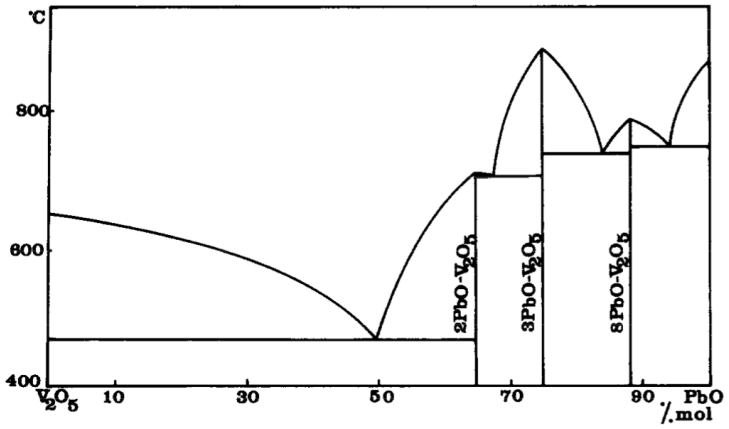
Due date: January 13th 2016 (in class, or under my door). Keep everything brief.

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 linked to the course website.

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. Are all amorphous solids considered glasses. How are glasses characterized?

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, suggesting similar configirational entropies?

6. 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. Try and explain with a sketch.

7. Look at this talk by Davis Norris: http://nanoparticles.org/pdf/12-Norris.pdf and explain why when olloidal spheres are close-packed, *fcc* packings may be preferred over *hcp*.