

Assignment 1: Due Tuesday Jan 19th

1. Many liquids can be rapidly quenched to give a glass. Why can't this be indicated in a phase diagram?
2. Explain structural frustration in the context of forming crystalline versus glassy structures – pentagons are frustrated in 2D from forming crystalline packings, but not in curved 2D, like the surface of a sphere. Explain with a sketch.
3. The entropy of a liquid *decreases* when it becomes a glass, even though the effective structural "snapshots" of liquids and glasses are similar. Why is this? Look up the wiki (or any other source) on the Kauzmann paradox, and sketch the plot of entropy versus temperature for the liquid to crystal transition. Indicate where a glass might form if crystallization is avoided.
4. Solids are sometimes characterized by their possessing a shear modulus (they resist shear). When a liquid transforms to a glass, what measurement do you think would characterize the change?
5. Look at the literature on silicate glasses and distinguish glass formers from glass modifiers; PbO is added to glass to increase the refractive index (lead "crystal": carries a warning in the State of California). Is PbO a glass former or a glass modifier?
6. Why is the crystallization of hard spheres, with no attractive interaction between them, considered to be entropy stabilized? See the reference by Lekkerkerker [doi on website]
7. See this paper by David Norris *Adv. Mater.* **16** (2004) p 1393 and explain how the flow of the carrier liquid can affect the crystal structure formed by hard colloidal spheres.