MATRL 218/CHEM 227: Assignment 1

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Due date: January 20th 2005

1. Water and silicon share a common feature in that when they melt, their densities increase (at least at 1 bar pressure). Provide a simple structural reason. What do you think silica would do? What about FCC Cu?

2. 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.

3. Many liquids can be rapidly quenched to give a glass. Why can’t this be indicated in a phase diagram?

4. Certain zeolites (open SiO$_2$ frameworks) amorphize on being subject to pressure. Suggest an explanation.

5. It is not possible to tile a flat surface with only pentagons. What if the surface were curved (such as a sphere)? Can you close-pack disks on the surface of a sphere? What about the surface of a saddle (see figure)

6. We have discussed two classes of glass structures — crn and rcp. Give examples of glasses which correspond to these.

7. SiO$_2$ is a glass former whereas PbO is a glass modifier. What do these terms mean structurally? Why is PbO added to Na$_2$O/SiO$_2$ glass? to make “crystal”? (The State California now requires such lead crystal to carry a warning).

8. Why is the crystallization of hard spheres, with no attractive interaction between them, considered to be entropy stabilized?

9. Calculate the geometric Madelung potential on a cation that forms a part of a 1D chain, if it’s nearest neighbors are anions at a distance of 1, second nearest neighbors are cations at a distance 2, third nearest neighbors are anions at a distance 4 and so on. Assume magnitudes of the charges = 1.