

Homework #9A

November 3, 2009 (to be tested November 10)

Averill. Ch. 12: 28-36, 83, 84, 86, 87; Ch. 14: 51, 53, 54, 58, 59, 61, 65, 67, 70, 71, 87

Shackelford: Practice Problem 5.2, Sample Problem 5.2

1. Calculate the vacancy fraction in copper (Cu) at (i) 20°C and (ii) the melting point, 1085°C. Measurements have determined the values of the enthalpy of vacancy formation, ΔH_v , to be 1.03 eV and the entropic prefactor, A, to be 1.1
2. In iridium(Ir), the vacancy fraction, n_v/N , is 3.091×10^{-5} at 1234°C and 5.26×10^{-3} at the melting point. Calculate the enthalpy of vacancy formation, ΔH_v .
3. A formation energy of 2.0 eV is required to create a vacancy in a particular metal. At 800°C there is one vacancy for every 10,000 atoms.
 - (a) At what temperature will there be one vacancy for every 1,000 atoms?
 - (b) Repeat the calculation, but this time with an activation energy of 1.0 eV. Note the big change in the temperature interval necessary to obtain the same change in vacancy concentration as was the case with an activation energy of 2.0 eV.
4. Identify 3 types of crystal defects in solids (one point, one linear and one planar) and suggest for each of these one material property that is adversely affected by its presence and one that is improved. Also state what to look for in a crystal that possesses each of these defects.
5. Identify the directions of slip for indium on the (111) plane.
6.
 - a. In the context of amorphous inorganic compounds, name two network formers, two network modifiers, and one intermediate.
 - b. Sketch the variation of molar volume with temperature for pure silica. Show glass formation at two different cooling rates. As well, show crystallization. On each cooling curve, label the melting point or the glass transition temperature.
 - c. What are two key factors that determine whether a material will solidify as a glass or a crystal?
7. Account for the fact that Al does not form a stable glass while elemental Se does.

8. Describe two analytical techniques that allow you to distinguish an amorphous solid from a crystalline solid.
9.
 - a. Draw the network structure of a borate glass.
 - b. Explain how the addition of Na_2O to B_2O_3 decreases viscosity of the glass melt.
 - c. To raise the glass transition temperature of the borate glass, do you increase or decrease the cooling rate? Explain.
 - d. Describe one surface treatment method by which you can strengthen a borate glass
 - e. Explain why borate glass is transparent to visible light.