

Winter 2018 Chem 1B Discussion
Chapter 12(13) – Phase Diagrams and Types of Solids

Goals

- Understand the fundamental difference between liquids, crystals and amorphous solids
- Learn about different types of organization of atoms in crystals
- Understand the concept of a physical equilibrium.
- Interpret one-component phase diagrams.

Key Concepts

- Phase diagram, phase boundary, triple point
- Boiling and melting temperatures; effect of pressure on boiling and melting
- Critical pressure and critical temperature
- Long-range and short-range order in materials
- Crystalline and amorphous solids
- Molecular solids
- Atomic covalent network solids, metallic solids, and atomic nonbonding solids
- Ionic solids
- X-ray diffraction
- Unit cell, packing order, types of crystal lattices, body-centered cubic structure, face-centered cubic structure, coordination number

Problems

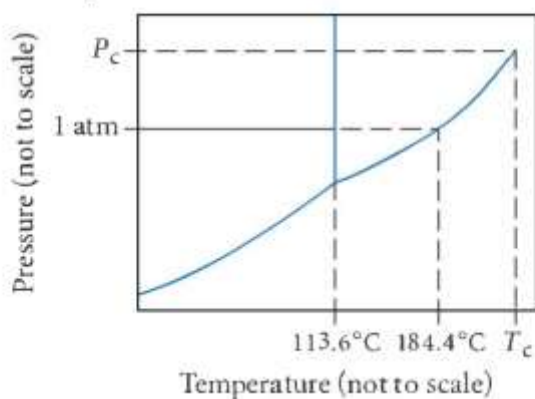
- *Question 13.2*
- *Question 13.5*
- *Question 13.10*
- *Question 13.11*
- *Question 13.14*
- *Question 13.17*
- *Problem 13.20*
- *Problem 13.22*
- *Problem 13.26*
- *Problem 13.29*
- *Problem 13.37*
- *Problem 13.45*
- *Problem 13.66*

2. Draw a generic phase diagram and label its important features.

5. What is Bragg's law, and how is it used in X-ray crystallography?

10. What are the three basic types of solids and the composite units of each? What types of forces hold each type of solid together?

11. In an ionic compound, how are the relative sizes of the cation and anion related to the coordination number of the crystal structure?
14. List the three basic subtypes of atomic solids. What kinds of forces hold each of these subtypes together?
20. Consider the phase diagram for iodine shown here.
 - a. What is the normal boiling point for iodine?
 - b. What is the melting point for iodine at 1 atm?
 - c. What state is present at room temperature and normal atmospheric pressure?
 - d. What state is present at 186 °C and 1.0 atm?



22. Argon has a normal boiling point of 87.2 K and a melting point (at 1 atm) of 84.1 K. Its critical temperature is 150.8 K, and its critical pressure is 48.3 atm. It has a triple point at 83.7 K and 0.68 atm. Sketch the phase diagram for argon. Which has the greater density, solid argon or liquid argon?
26. An X-ray beam of unknown wavelength is diffracted from a NaCl surface. If the interplanar distance in the crystal is 286 pm and the angle of maximum reflection is found to be 7.23° , what is the wavelength of the X-ray beam? (Assume $n = 1$.)
29. Platinum crystallizes with the face-centered cubic unit cell. The radius of a platinum atom is 139 pm. Calculate the edge length of the unit cell and the density of platinum in g/cm^3 .
37. Identify each solid as molecular, ionic, or atomic.
 - a. $\text{Ar}(s)$
 - b. $\text{H}_2\text{O}(s)$
 - c. $\text{K}_2\text{O}(s)$
 - d. $\text{Fe}(s)$

45. An oxide of titanium crystallizes with the unit cell shown here (titanium = gray; oxygen = red). What is the formula of the oxide?



66. The density of a substance is greater in its solid state than in its liquid state. If the triple point in the phase diagram of the substance is below 1.0 atm, which must be at a lower temperature, the triple point or the normal melting point?