CHAPTER 4

Equilibrium Phase Diagrams and the Iron-Carbon System

Review Questions

1. A phase is a portion of a substance possessing a well-defined structure, uniform composition, and distinct boundaries or interfaces.

2. In a glass of soda with ice, the soda is continuous and the ice is discontinuous. Helium in a balloon is a gaseous phase, and coffee with cream is a single-phase solution.

3. An equilibrium phase diagram is a graphical mapping of the natural tendencies of a material system (assuming that equilibrium has been attained) as a function of such variables as pressure, temperature, and composition.

4. The three primary variables considered in equilibrium phase diagrams are: temperature, pressure and composition.

5. A pressure-temperature phase diagram is not that useful for many engineering applications because most processes are conducted at atmospheric pressure. Most variations occur in temperature and composition.

6. A cooling curve is a temperature versus time plot of the cooling history when a fixed-composition material is heated and subsequently cooled by removing heat at a uniformly
slow rate.

7. Transitions in a material's structure are indicated by characteristic points on the cooling

curve. These characteristic points may take the form of an isothermal hold, abrupt change in slope, or localized aberration to the continuity of the curve.

8. Solubility limits denote the conditions at which a solution becomes completely saturated, i.e. any additional solute must go into a second phase. Solubility limits are generally determined through use of inspection techniques such as X-ray analysis (detects where a new crystal structure or lattice spacing appears) or microscopy (detects the presence of the second phase), that can be used to identify the composition where the transition from one to two-phase occurs.

9. In general, as the temperature of a system is increased, the maximum amount of a substance that can be held in solution also increases.

10. Complete solubility implies complete solubility in both liquid and solid states. The two types of atoms have to be able to exist in the same crystalline structure. Atom "size" and valence electron structure have to be similar.
Partial solubility results when there is a saturation limit for one type of material in another and this saturation limit depends on temperature. So, as temperature is lowered and solubility decreases a two phase material forms from the initially one phase material.

Insolubility means that the materials are so different in nature (atomic size, valence electron structure, etc.) that they are totally insoluble in each other.

11. Upon crossing the liquidus line during cooling, the first solid begins to form in the material. Upon crossing the solidus line, solidification is complete, i.e. there is no longer
any liquid present. Upon crossing a solvus line, a single phase material begins to

precipitate a second phase, since the solubility limit is now being exceeded.