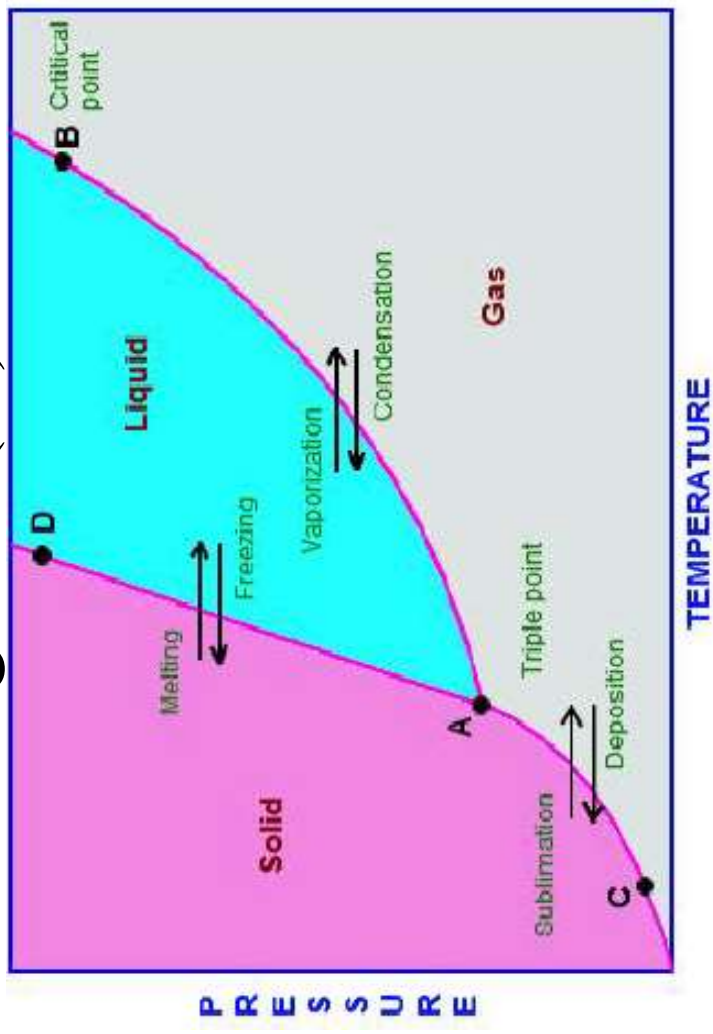




Phase diagrams



- It is the graphical representations of what phases are present in a materials system at various temperatures, pressures and compositions
- It is also known as equilibrium diagrams (or) constitutional diagrams





Phase



- Phase can be defined as a physically distinct and chemically homogeneous portion of a system that has a particular chemical composition and structure
- **Examples:** Water in liquid or vapor state is single phase. Ice floating on water is an example two phase system.

Single Phase

- Three forms of water – ice, water , water vapour

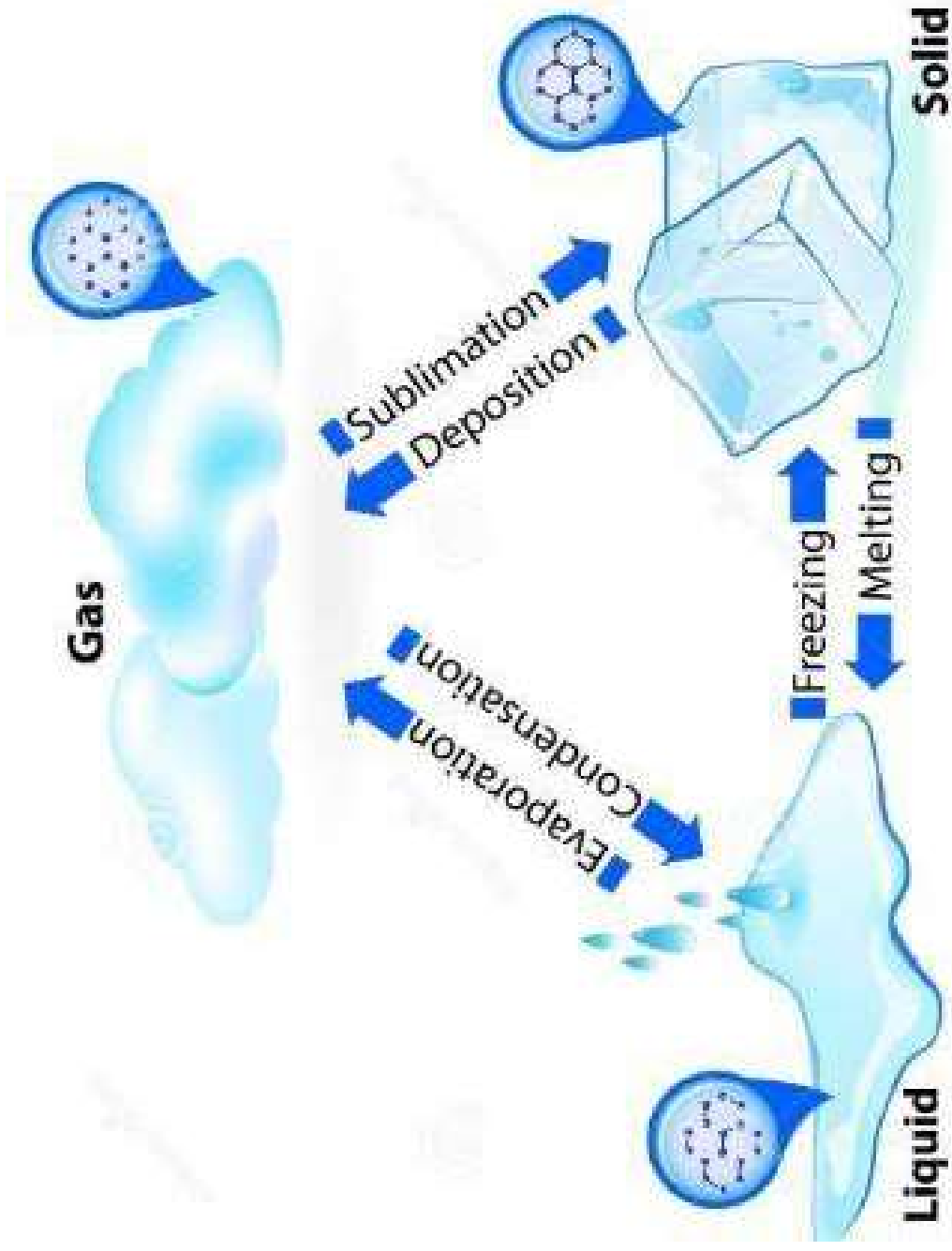
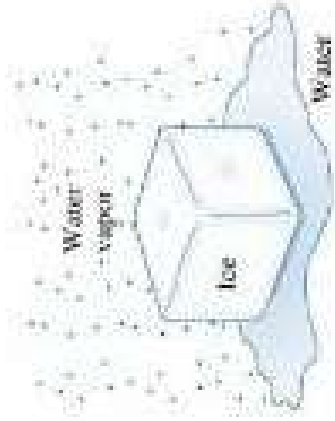
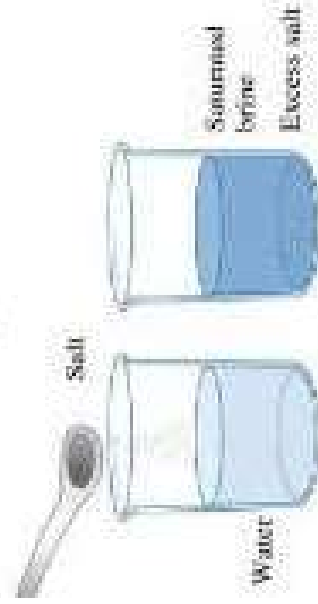


Illustration of phases and solubility

(a) The three forms of water – gas, liquid, and solid – are each a phase.



(a)



(b)

(c) Salt and water have limited solubility.

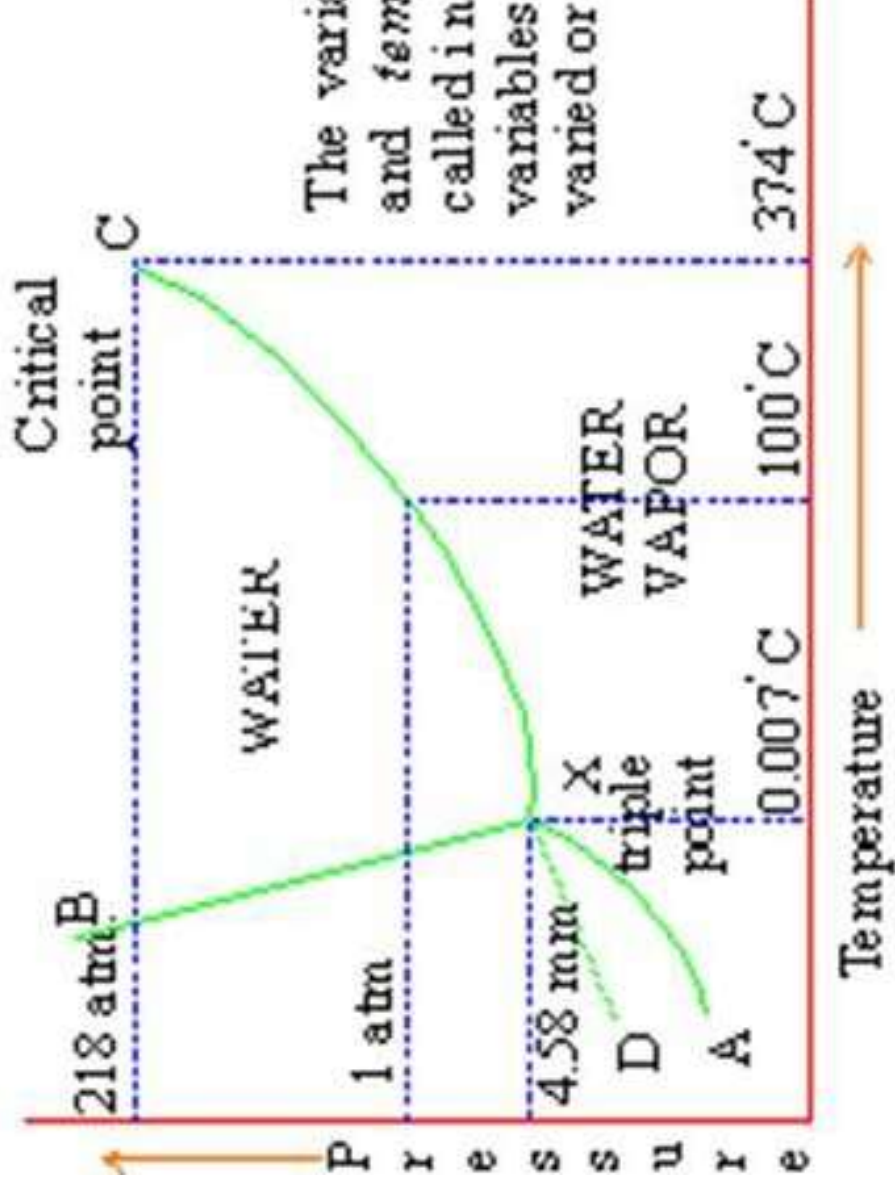
(d) Oil and water have virtually no solubility.



(d)



Phase diagram of a pure substance (one component phase diagram)



The variables *pressure* and *temperature* are called *independent* variables and can be varied or held constant.

Phase diagram of water (not to scale)



Gibb's phase rule



- The number of phases present in any alloy depends upon the number of elements of which is alloy is composed

$$F = C - P + 2$$

Where,

F= Degrees of freedom of system or number of variables (temp, pressure, or composition etc) that may be changed independently without altering the equilibrium

C= No. of components

P= Number phases present in the system

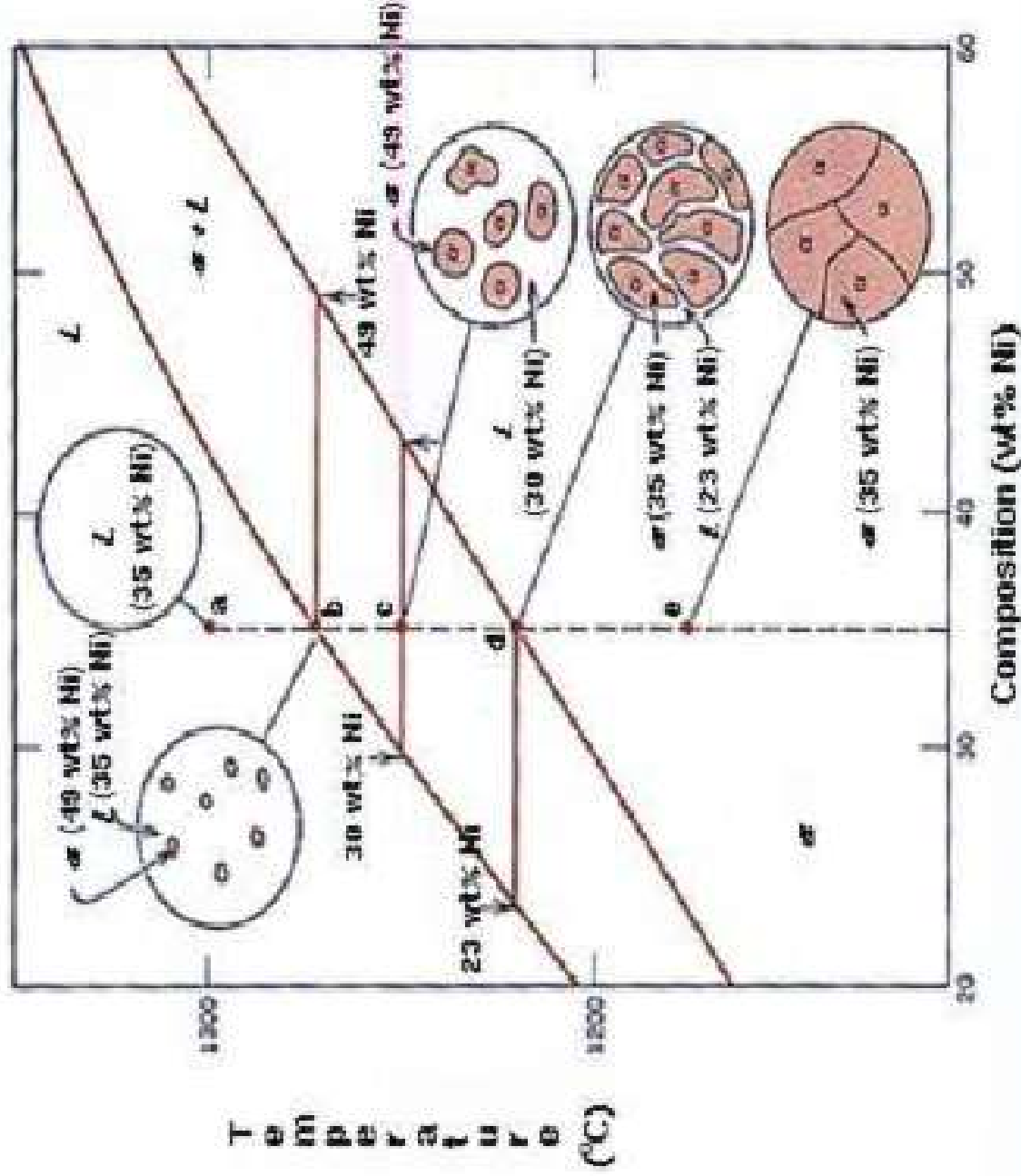


Isomorphous binary Phase diagrams



- **Example:**
 - Copper-Nickel (Cu-Ni) System
 - Antimony- Bismuth (Sb- Bi) System
 - Gold – Silver (Au-Ag) System
 - Chromium – Molybdenum (Cr- Mo) System

Isomorphous binary Phase diagrams





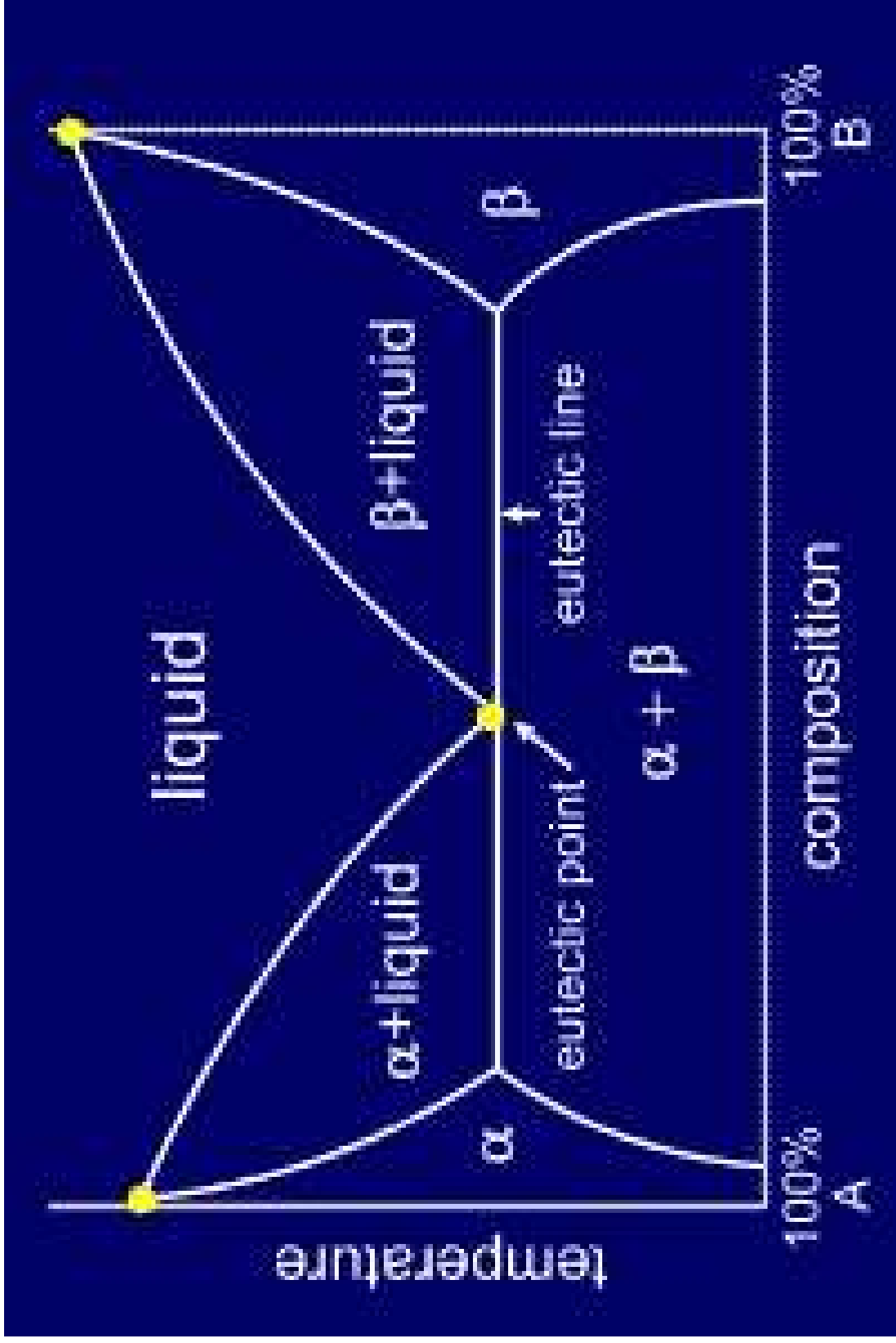
Phase diagram for partial solid solubility



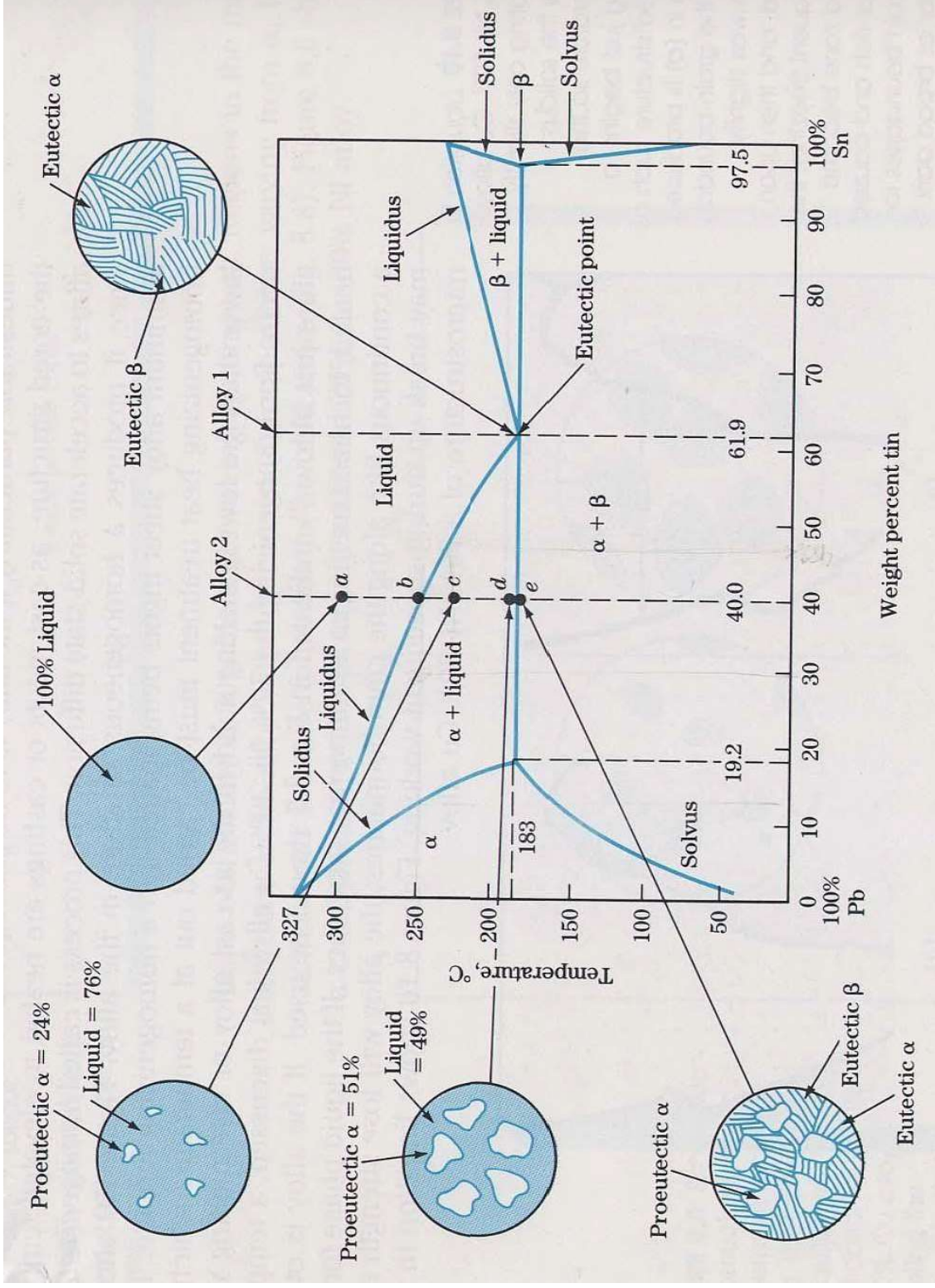
- Each element is soluble in the other element up to certain limit or saturation point. The value of this limit is a function of temperature
- If the two metals A and B are not completely soluble through all ranges in composition, then second phase will form at grain boundaries.
- Examples:
 - Copper- Silver (Cu-Ag) System
 - Lead- tin (Pb-Sn) System
 - Aluminium – Copper (Al-Cu) System



Phase diagram for partial solid solubility



Phase diagram for partial solid solubility – Lead(Pb)-Tin(Sn)





Phase diagram for partial solid solubility



■ Six phase regions/fields are found in the diagram

■ α solid solution phase

■ β solid solution phase

■ α solid + liquid phase

■ β solid + liquid phase

■ $\alpha + \beta$ Solid Solution phase

■ Liquid phase

[Eutectic - Greek work – Easily melted]