FUNDAMENTALS OF METAL ALLOYS, EQUILIBRIUM DIAGRAMS

Chapter 4-Part 1

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4.2 What is a Phase?

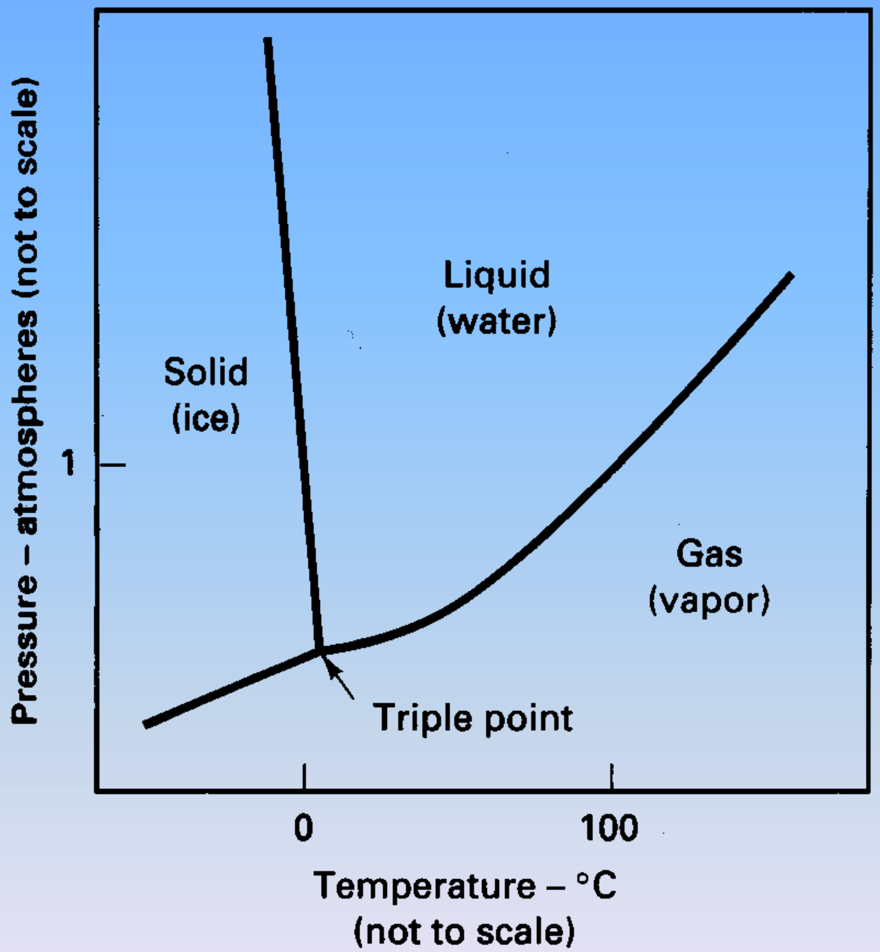
- Phase is a form of material having characteristic structure and properties.
- More precisely: form of material with identifiable composition (chemistry), definable structure, and distinctive boundaries (interfaces) which separate it from other phases.

4.2 Phases

- Phase can be continuous (air in the room) or discontinuous (salt grains in the shaker).
- Gas, liquid or solid.
- Pure substance or solution (uniform structure throughout).

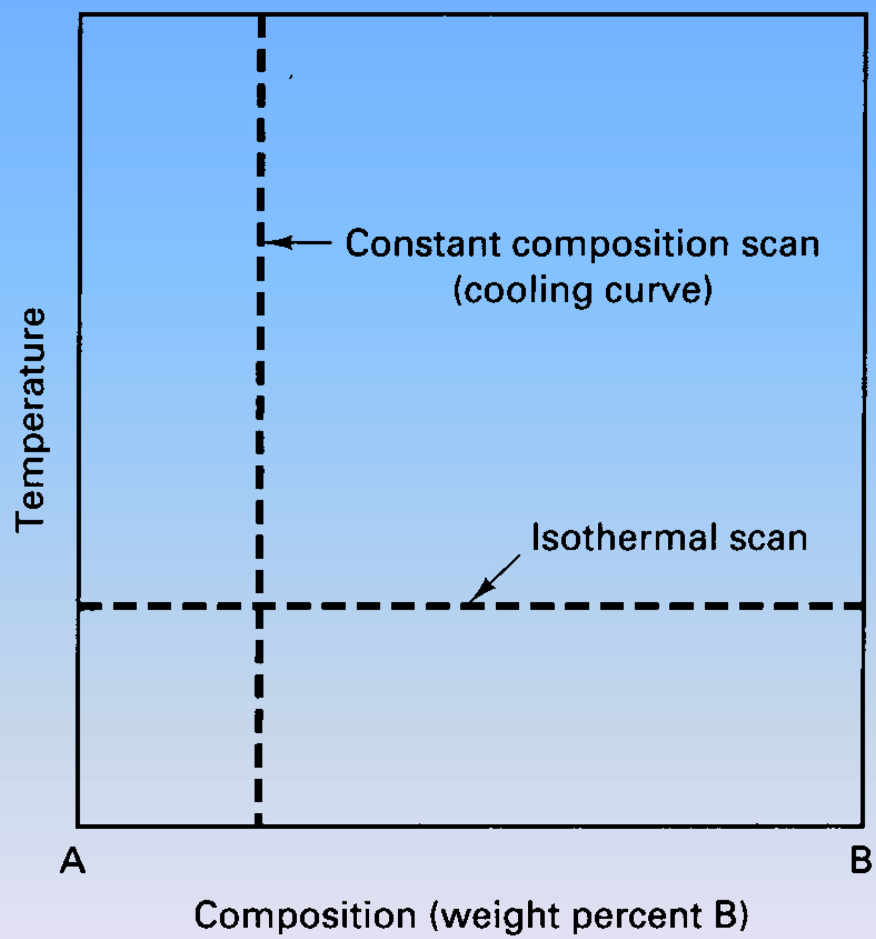
4.3 Equilibrium Phase Diagrams

- Graphic mapping of the natural tendencies of a material or a material system (equilibrium for all possible conditions).
- Primary variables: temperature, pressure and composition.
- P-T diagram (the simplest).



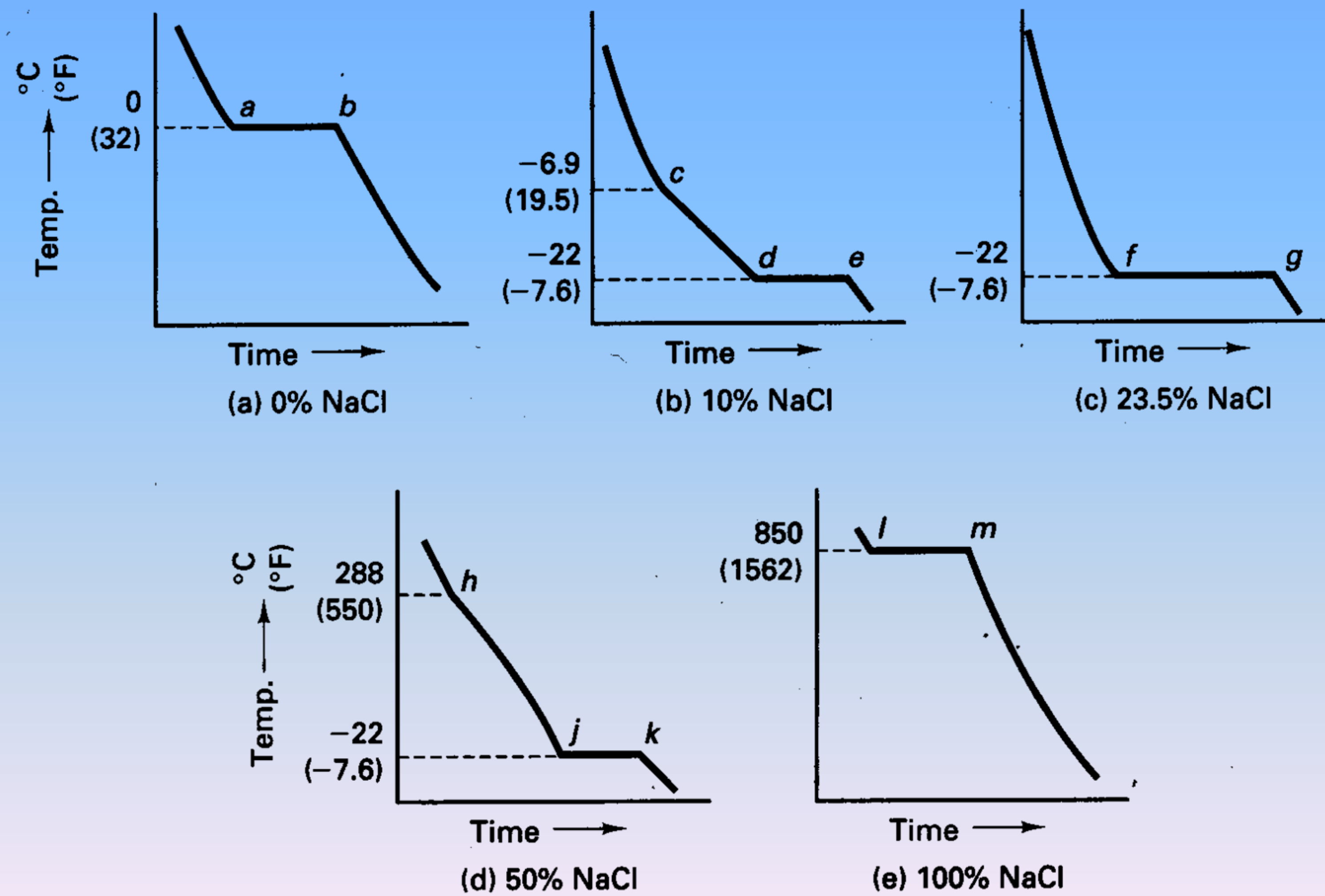
4.3 Temperature-Composition Diagrams

- Engineering processes conducted at atmospheric pressure (P/T variations).
- The most common: temperature-composition phase diagrams.



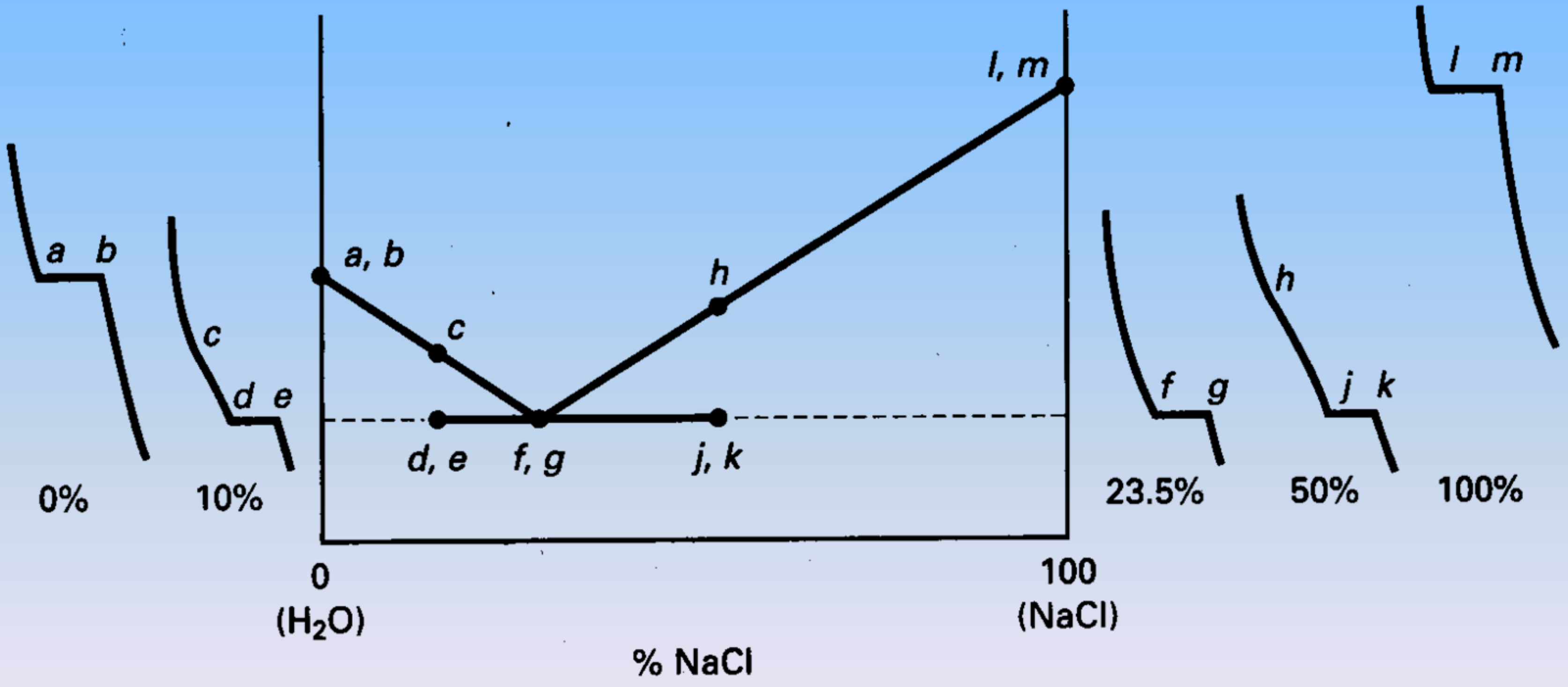
4.3 Cooling Curves

- Cooling curves for NaCl-H20 combinations:



4.3 Cooling Curves

- Partial equilibrium diagram of NaCl-H20 system

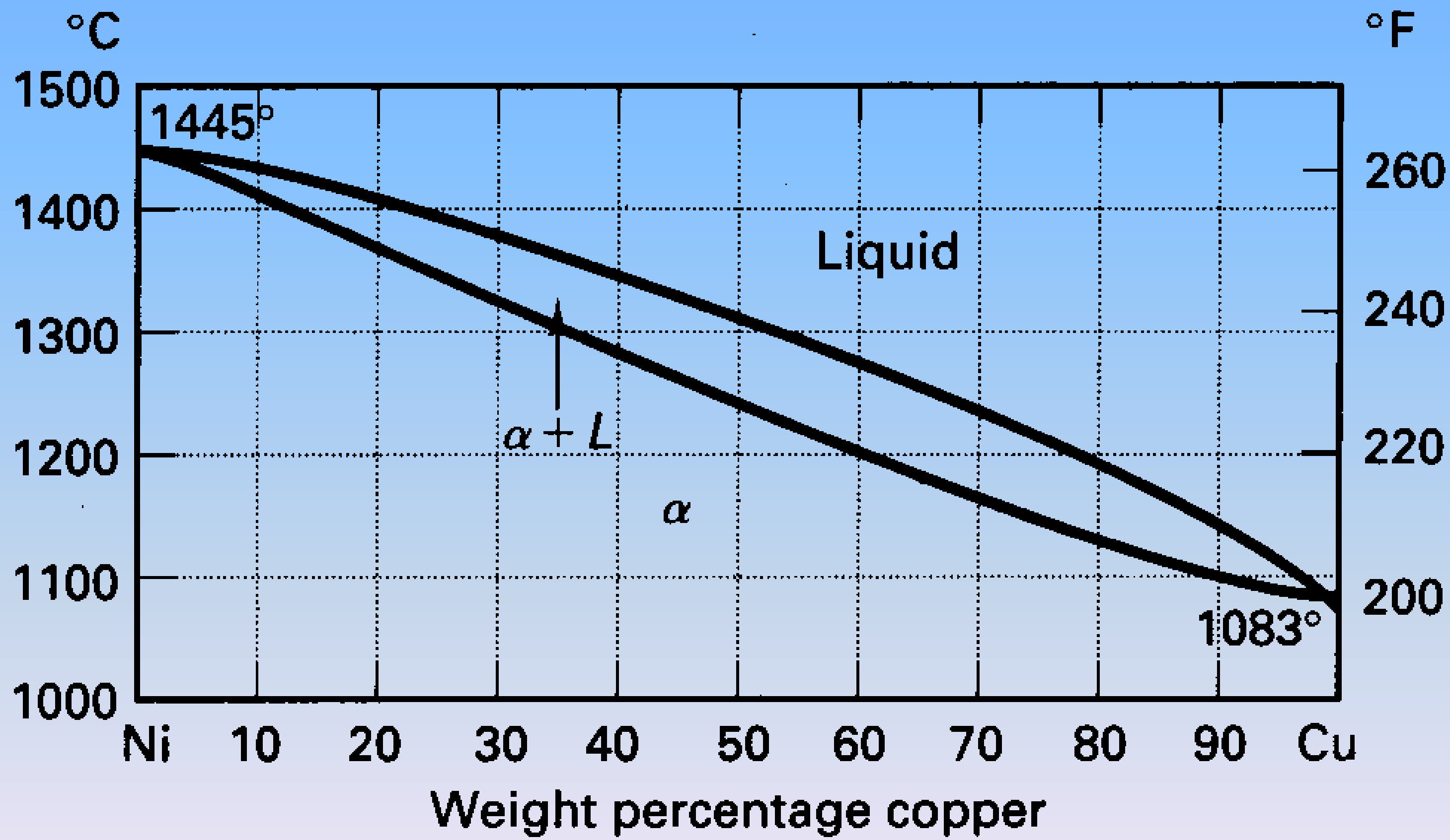


4.3 Solubility

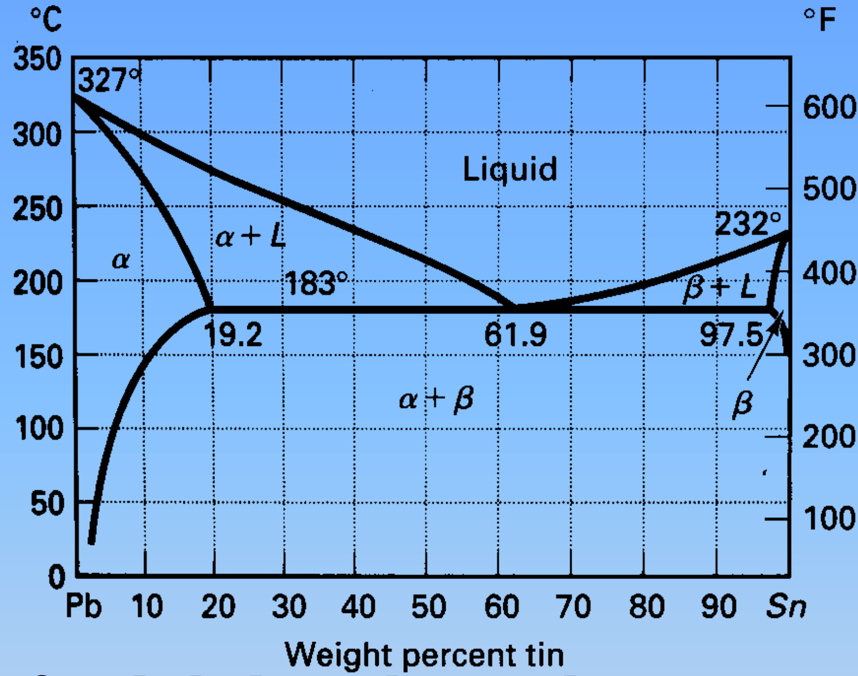
- Solubility limits.
- Degree of solubility determines properties.
- I-Two metals completely soluble in each other.
- II- Two metals soluble in liquid state and insoluble in solid state.
- III-Two metals soluble in liquid state and partially soluble in solid state.

4.3 Complete Solubility

- Copper-Nickel equilibrium diagram



4.3 Partial Solid Solubility

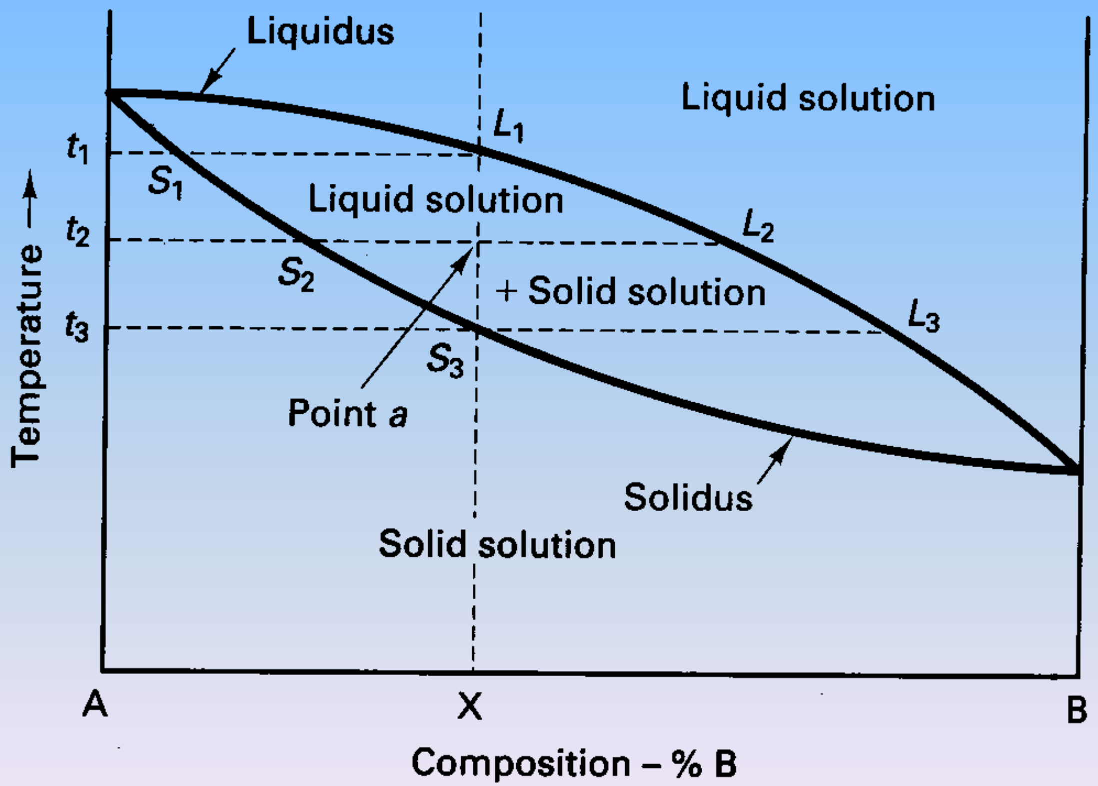


- Degree of solubility depends on temperature
- At max. solubility, 183°C: lead holds up to 19.2 wt% tin in a single phase solution, and tin holds up to 2.5wt% lead and still be a single phase.

4.3 Utilization of Diagrams

$$Liquid\ phase\ amount = \frac{a - S_2}{L_2 - S_2} \times 100\% = \%\ by\ mas$$

$$Solid\ phase\ amount = \frac{L_2 - a}{L_2 - S_2} \times 100\% = \%\ by\ mass$$



4.3 Example problem

$Given\ data:$

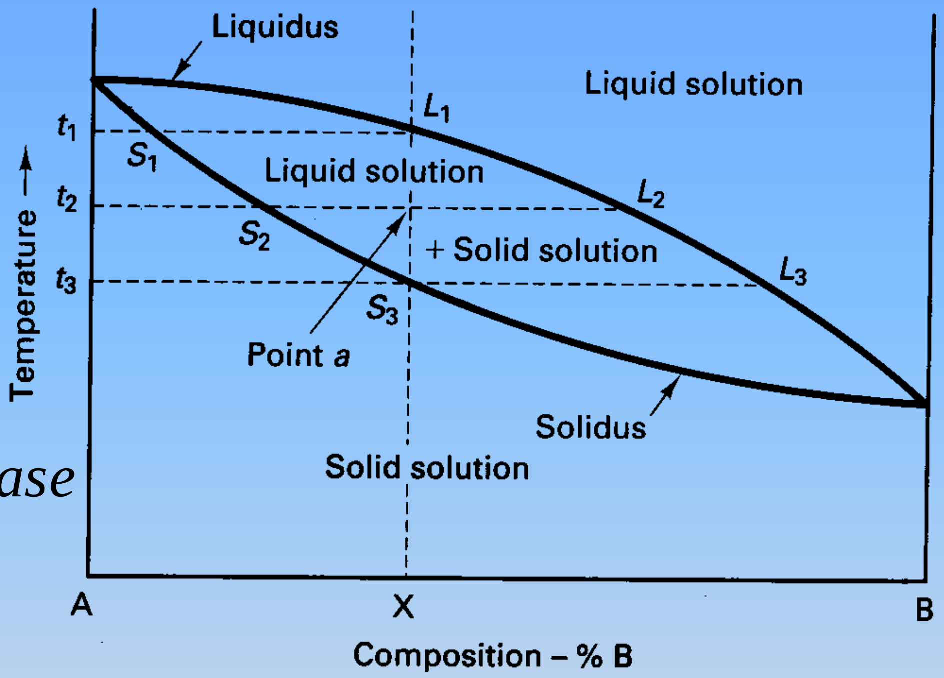
$X = 36\%\ of\ B$

$a = 36\%\ of\ B$

$L_2 = 72\%\ of\ B$

$S_2 = 18\%\ of\ B$

$Compute\ liquid\ phase\ and\ solid\ phase\ \%\ amounts\ by\ mass.$



$$Liquid\ phase\ amount = \frac{36-18}{72-18} \times 100\% = 33.33\ \%\ by\ mass$$

$$Solid\ phase\ amount = \frac{72-36}{72-18} \times 100\% = 66.67\ \%\ by\ mass$$

4.3 Utilization of Diagrams

- The phases present.
- Composition of each phase (single phase region or two phase region).
- In two phase region a tie-line should be constructed.
- The amount of each phase present: lever-law calculation using a tie-line.

4.3 Three Phase Reactions