
Phase Diagrams

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- ❖ The internal structure of a material plays an important part on its mechanical properties.
 - ❖ There is a strong correlation between micro structure and mechanical properties.

Definitions

- ❖ Component
 - ❖ A component is the pure metals and or compounds of which an alloy is composed.
- ❖ Brass is copper and Zinc mixed together to form an alloy

Brass

- ❖ Copper is the solute, it is the least common and fills in substitutional or interstitial positions.
- ❖ Zinc is the solvent. The Zinc forms the major lattice points.

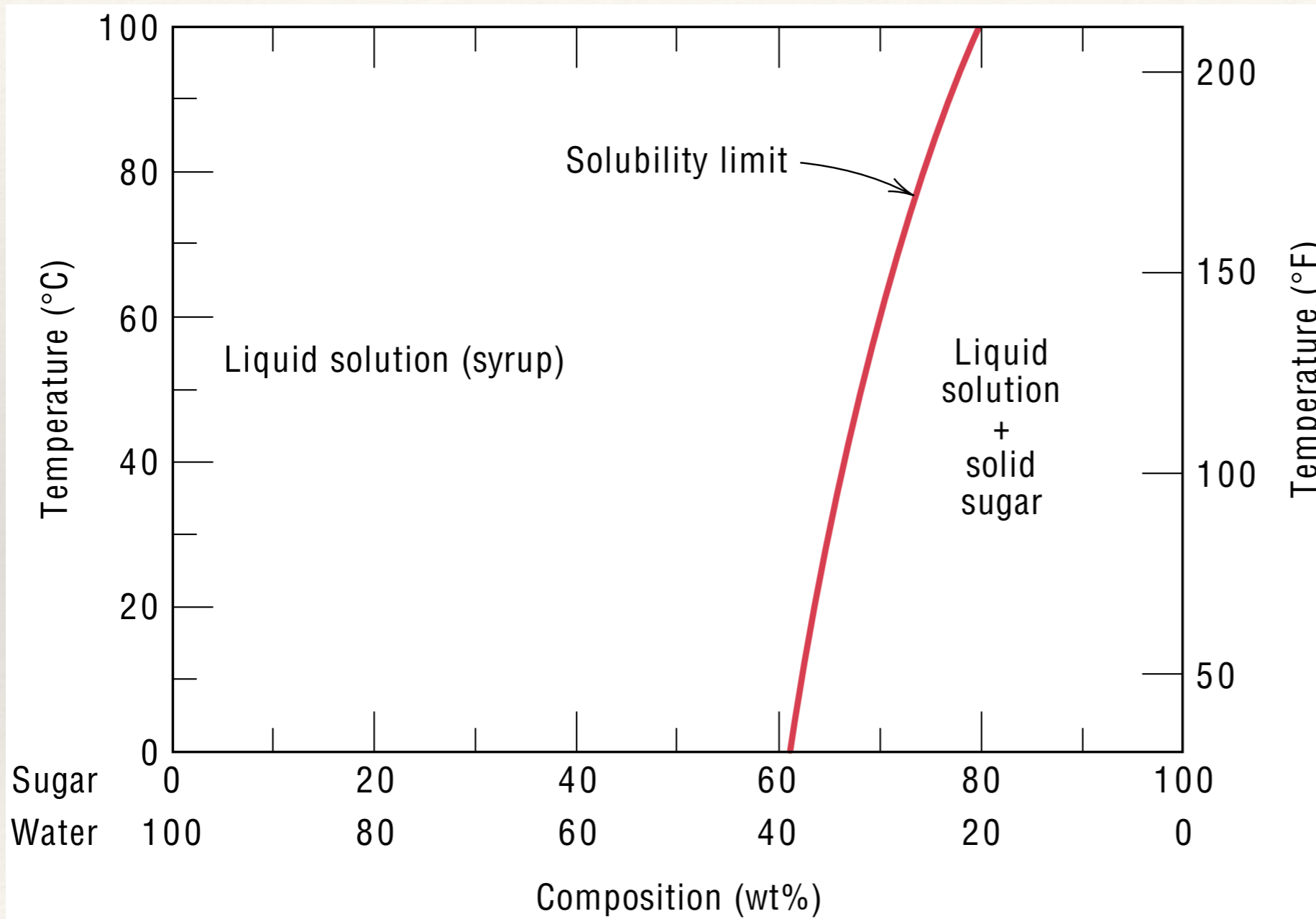
Solid Solution

- ❖ Consists of atoms of a least two different types.
- ❖ Made up of Solute (atoms) and solvent (atoms).

Solubility

- ❖ For most systems at a specific temperature there is a maximum number of solute atoms that fit (or dissolve) in to the solvent this is the solubility.

Example of Solubility



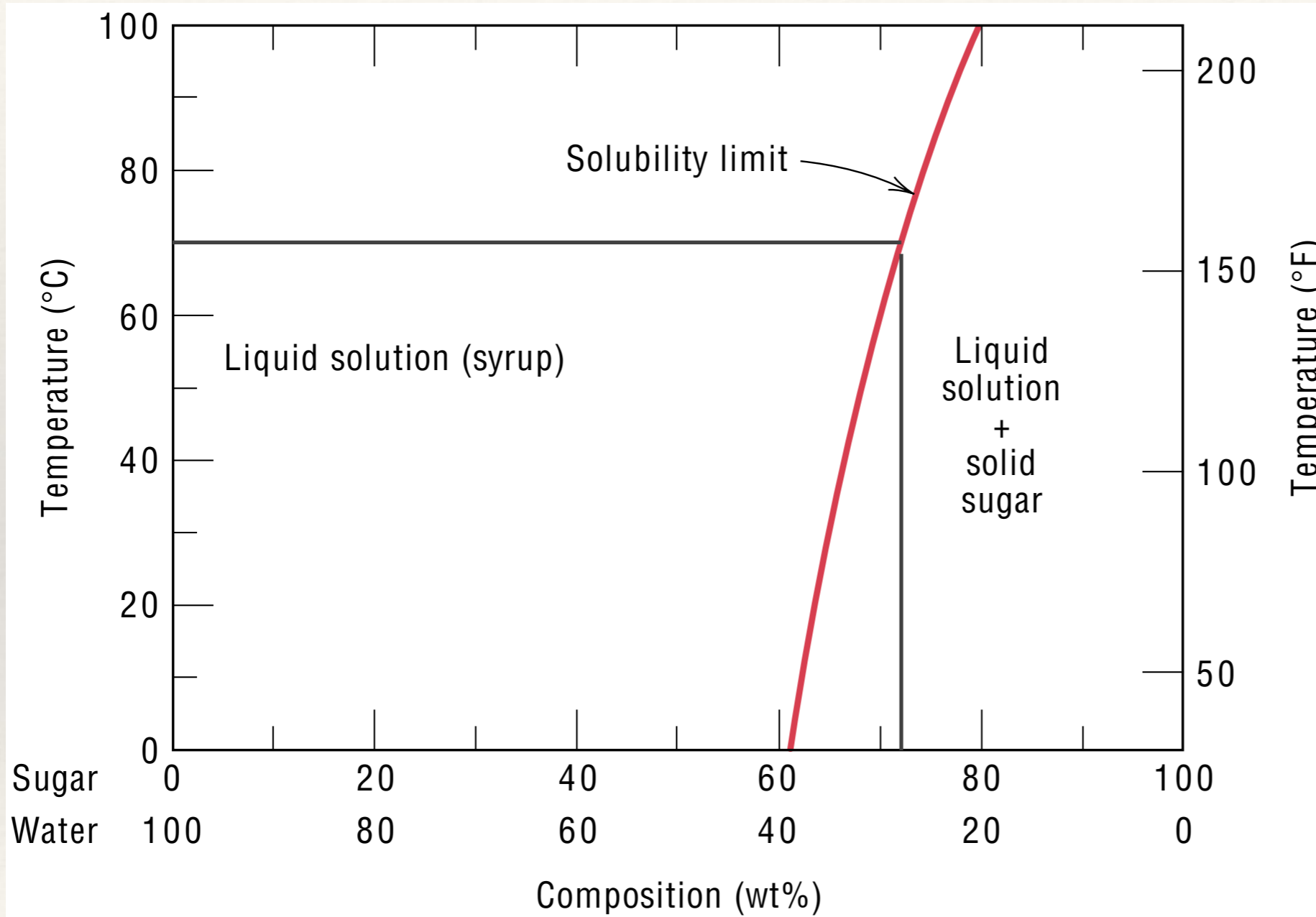
Two regions

1.) Liquid

2.) Liquid + solid

The amount of sugar which dissolves depends on concentration and temperature

The solubility limit is shown



We can see that we can change the temperature or the composition of the system to alter the properties of the system.

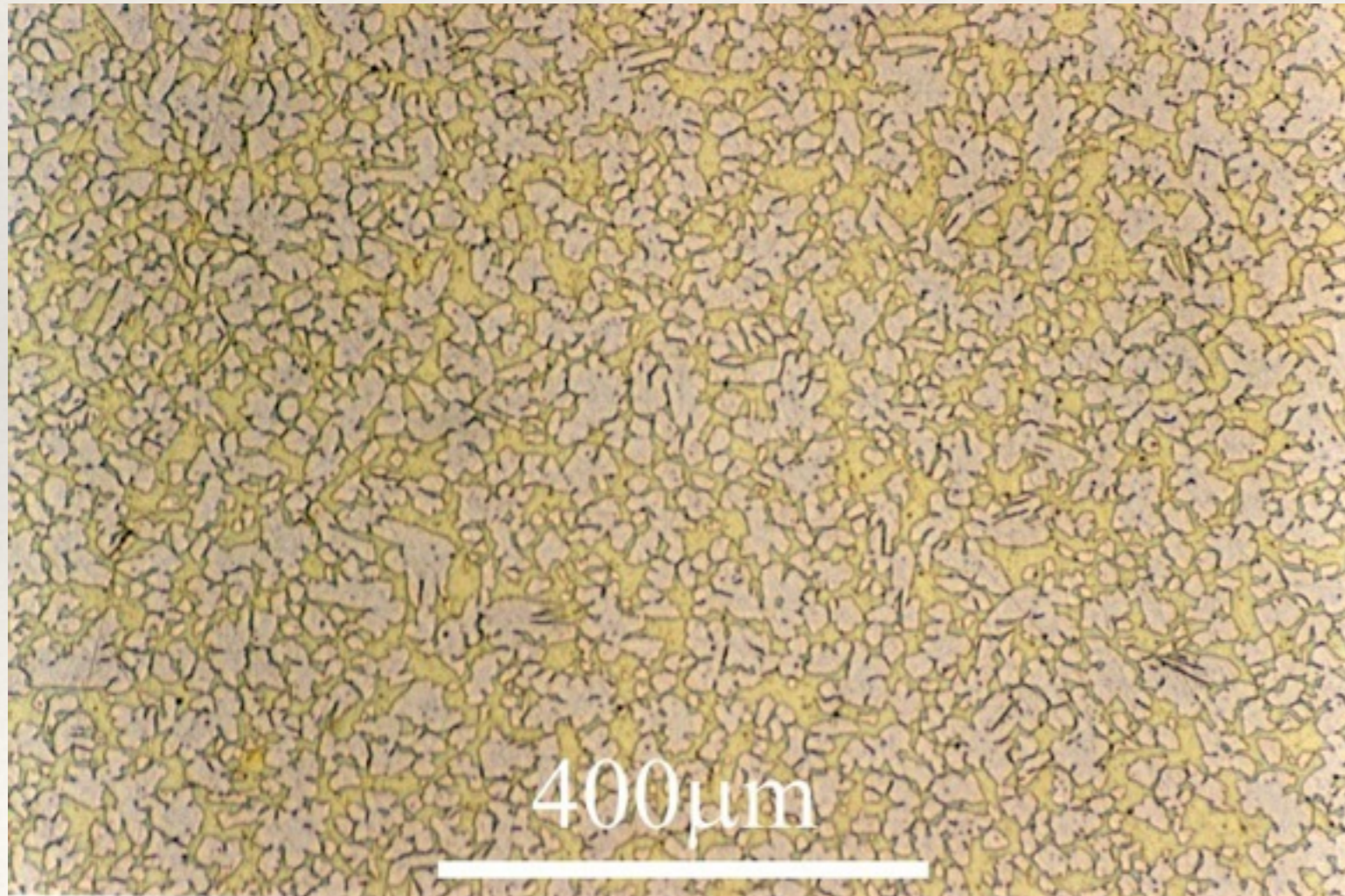
Definitions

- ❖ Phases
 - ❖ A phase is defined as a homogeneous portion of a system that has uniform physical and chemical characteristics
- ❖ Every pure material is a phase, also considered phases are the solid, liquid and gasses of the material.
- ❖ In our previous example, Liquid is one phase and the solid sugar another.

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- ❖ If more than one phase is present in a given system it will have its own distinct properties.
 - ❖ Phases don't need to have both different chemical and physical characteristics (just one)

Microstructure

- ❖ Simply the observed structures, studied using either optical or electron microscopy



Brass

Phase equilibrium

- ❖ Exists in systems with more than one phase and is characterised by time consistency between phases.
- ❖ In our sugar example at 20 degrees centigrade, with 65% sugar, some will be solid, some in solution. The amount moving from one state to the other is equal to the amount moving in the opposite direction.
- ❖ Upon heating however, the system will not be in equilibrium until the two directions once again are equal.

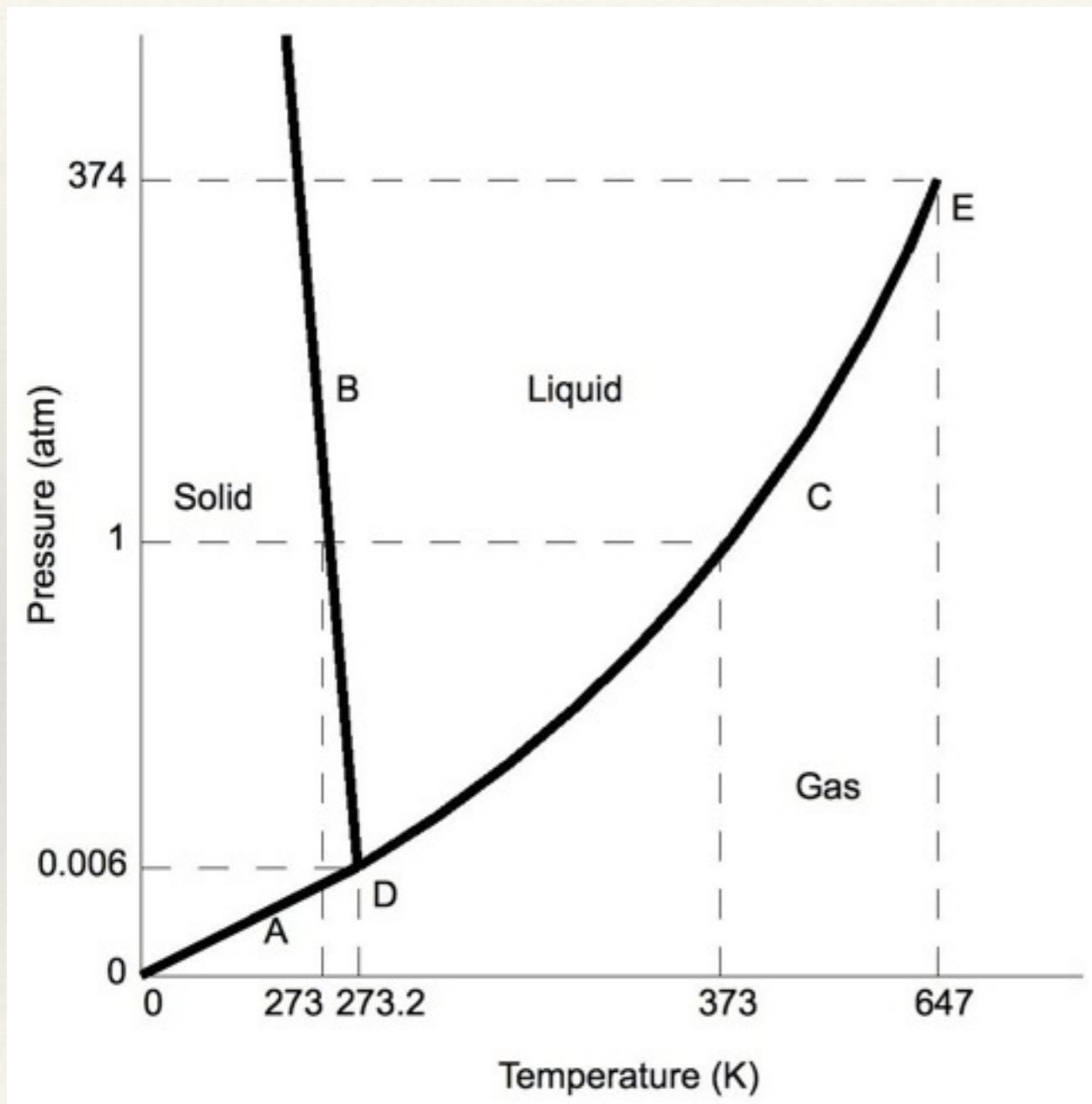
Metastable states

- ❖ Very slow movements from one state to the other are said to be metastable.

Phase diagrams

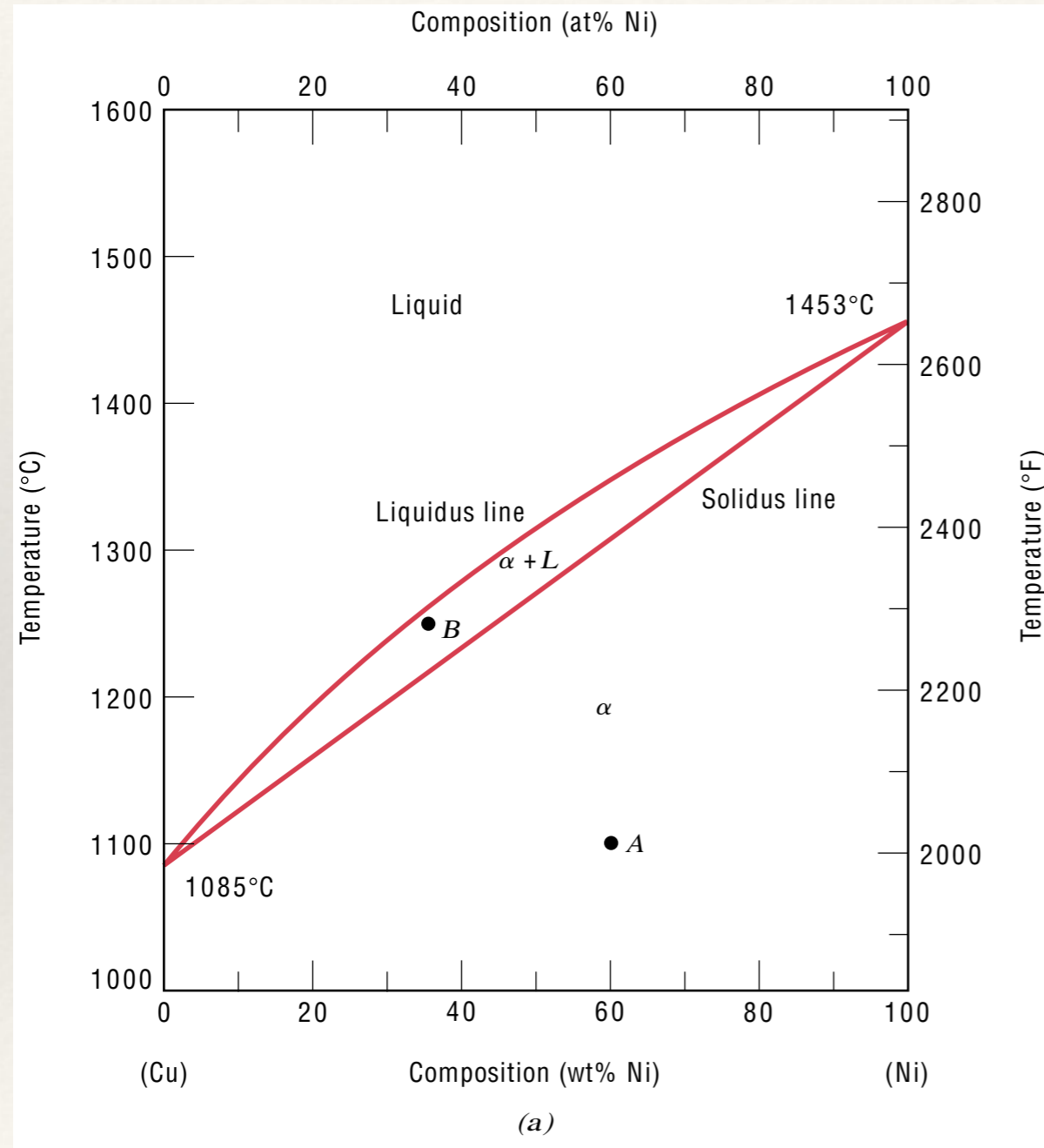
- ❖ Much of the information about the phase structure of a system is conveniently described in what's called a phase diagram
- ❖ Defined by three parameters which affect phase structure
 - ❖ Temperature, Pressure and composition

One component phase diagrams (Unary)



Single component
So we can change
Temp and Pressure

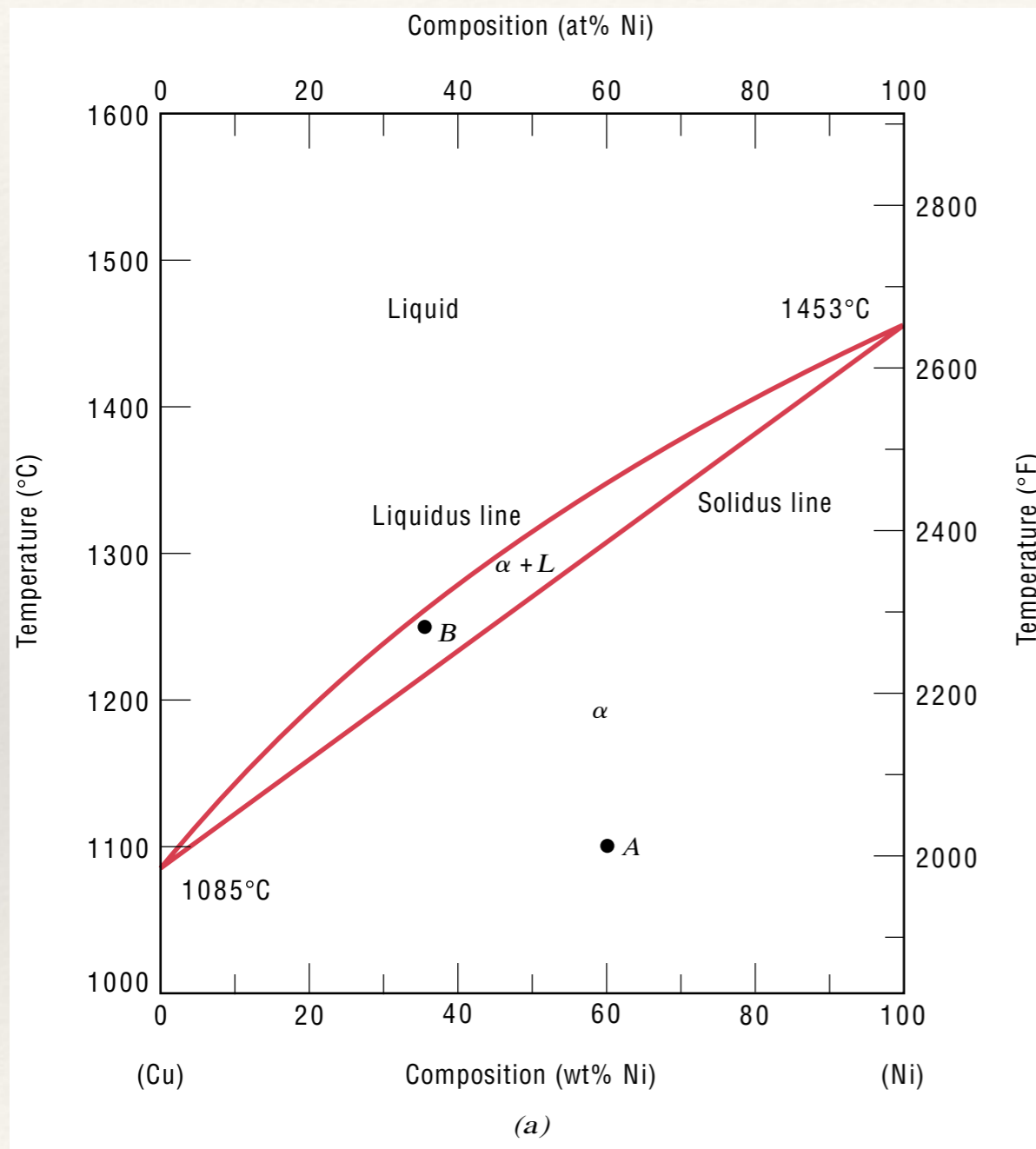
Binary Isomorphous systems



Nickel Copper alloy

In binary systems we can

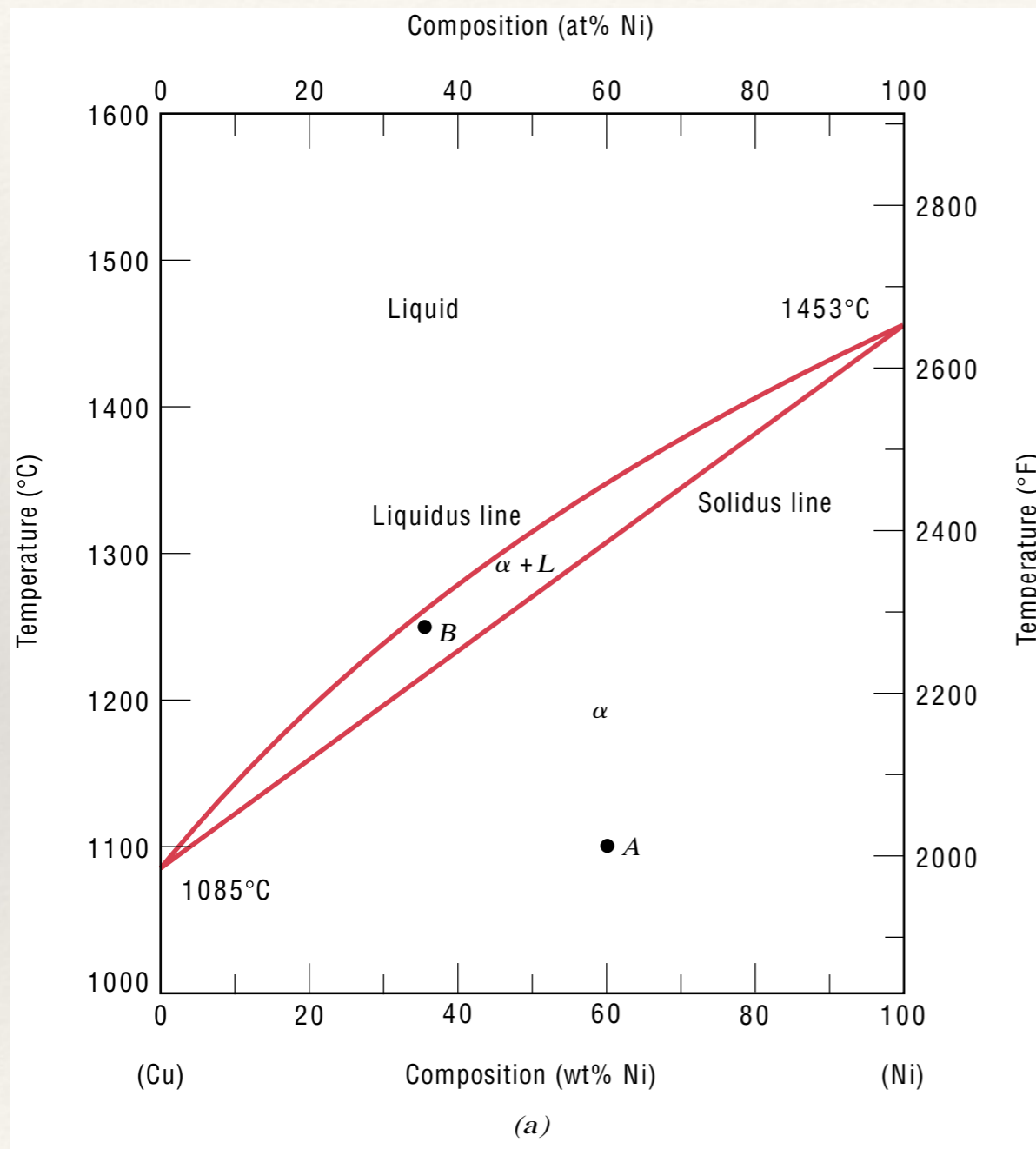
Measurements



The phases present
The composition of the phases
The percentage fraction of those phases

Liquid Phase
Solid (alpha) phase
Mixed (range of conditions where liquid and solid are in equilibrium)

Phases Present

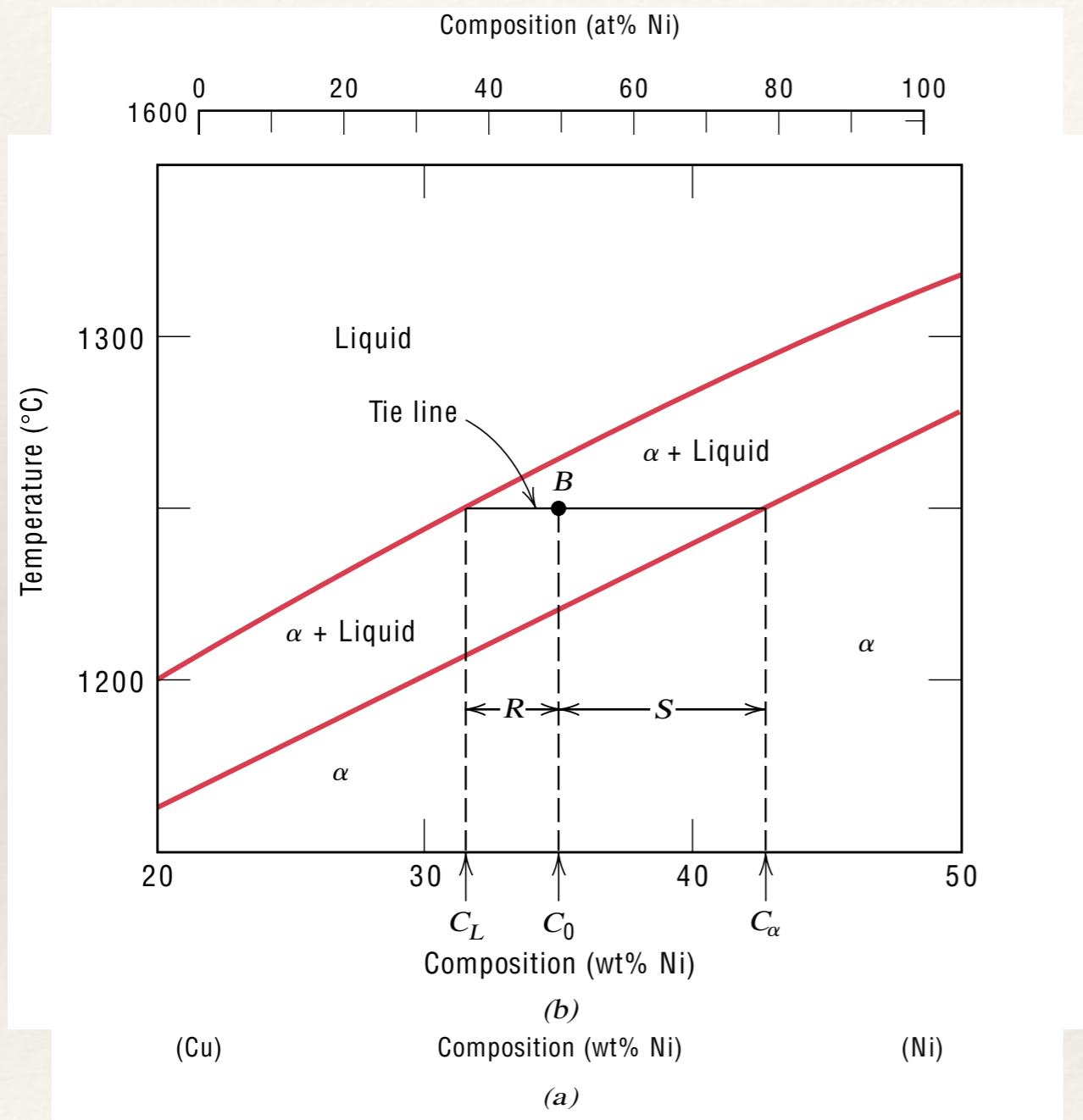


Examples

60% Ni at 1100 degrees centigrade
A

35% Ni at 1250 degrees centigrade
B

Determination of the Phase compositions



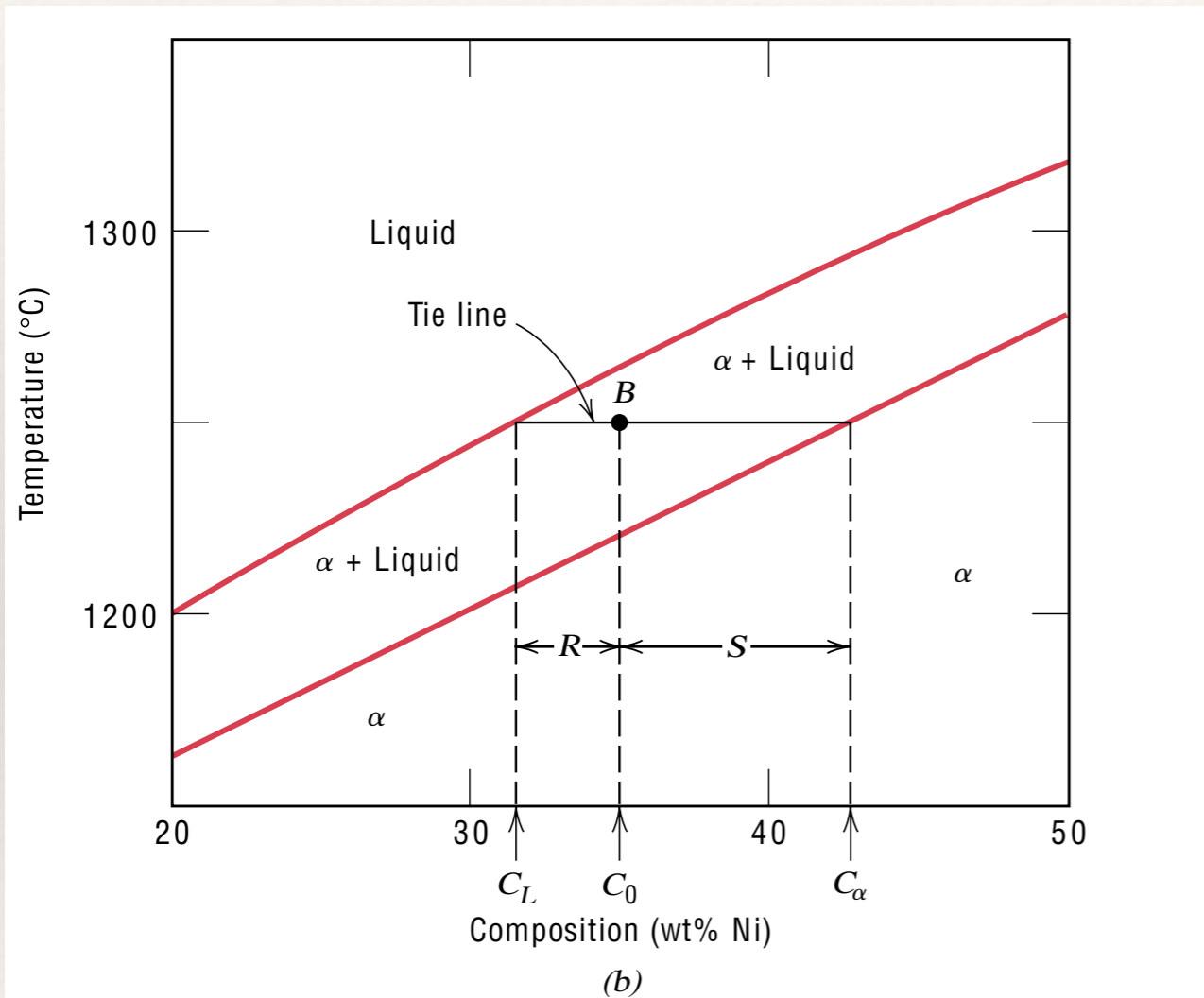
Examples

60% at 1100 C
has phase (alpha)

Examples

35% at 1250 C
has phase (alpha+Liquid)

Determination of phase amounts



Question: *A copper-nickel alloy of composition 70 wt% Ni-30 wt% Cu is slowly heated from a temperature of 1300C.*

- (a) At what temperature does the first liquid phase form?*
- (b) What is the composition of this liquid phase?*
- (c) At what temperature does complete melting of the alloy occur?*
- (d) What is the composition of the last solid remaining prior to complete melting?*