

# Phase Diagrams

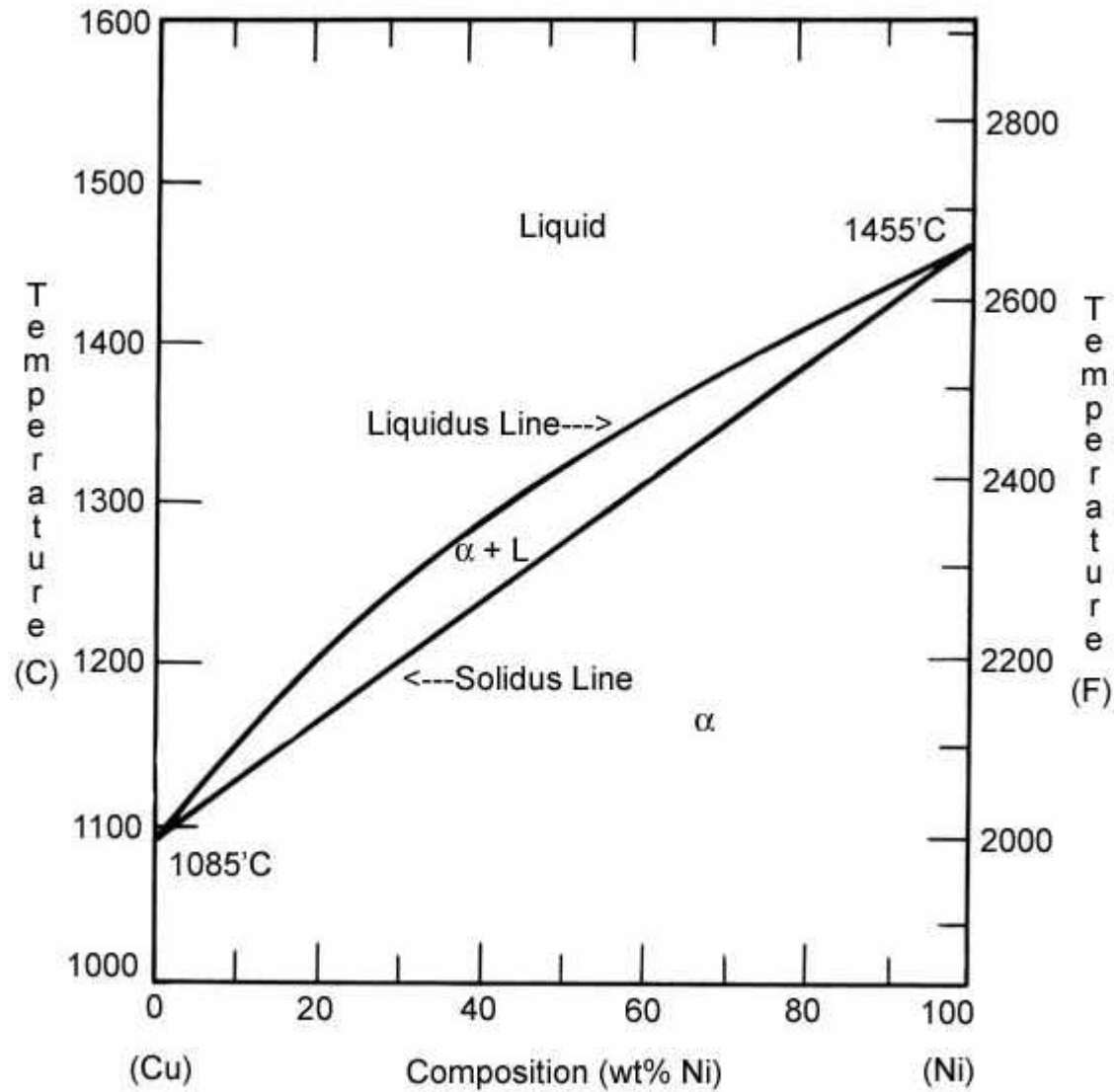
## Issues to cover

- ❑ What are Phase Diagrams and what information can we get from them?
- ❑ Solid Solution and its strengthening mechanics.
- ❑ What is the Lever Law and how to use it.
- ❑ Eutectics and Binary Eutectic systems.

# Phase Diagrams

- Phase Diagrams are a road map for the Materials Engineer.
- Phase diagrams help in determining properties of different alloying systems.
- A Phase is a portion of a system that is homogeneous with uniform chemical compositions and physical properties.
- Phase diagrams are your friends.

# Solid Solutions



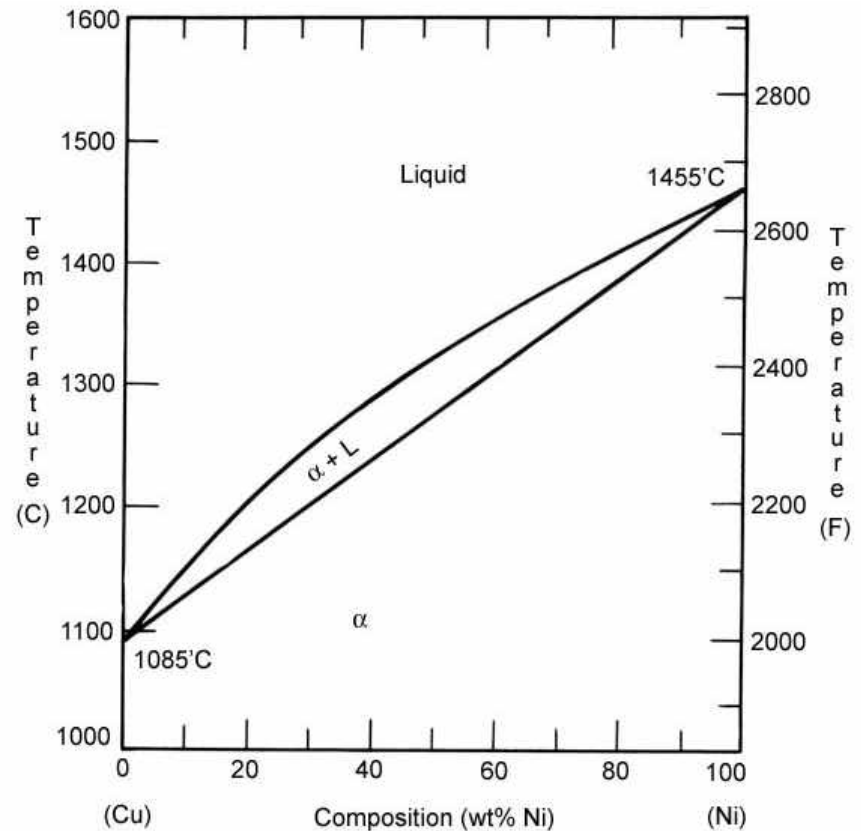
# Lever Law

- In order to determine the amount of a phase present at a given temperature and composition we must use the Lever Law.
- Tie Line is the line drawn connecting one phase to the other through the two phased region.
- The Arms are the portions of the Tie Line extending from the overall alloy composition to each phase.

$$\text{Percent of Phase} = \frac{\text{opposite arm}}{\text{Tie Line}} \times 100$$

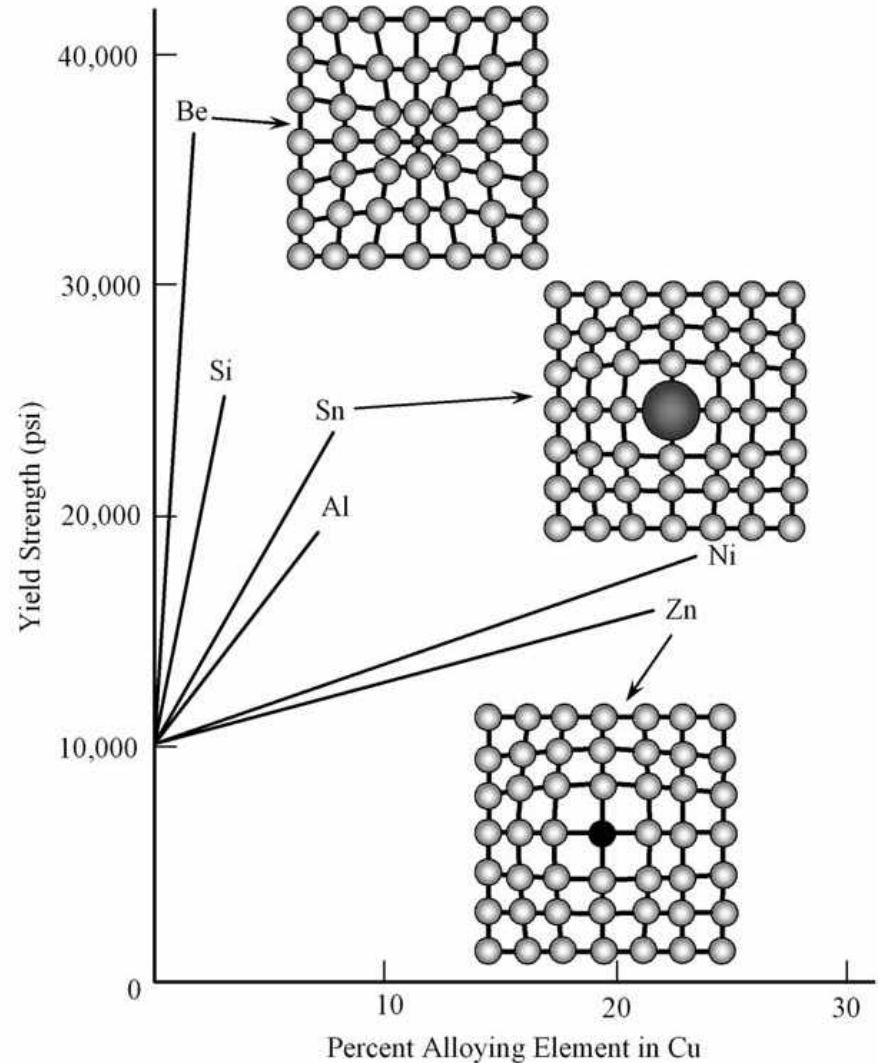
# Example

For a 50 gram sample of a 60% Ni alloy at 1325°C what are the compositions of the phases present and what is the amount of each?

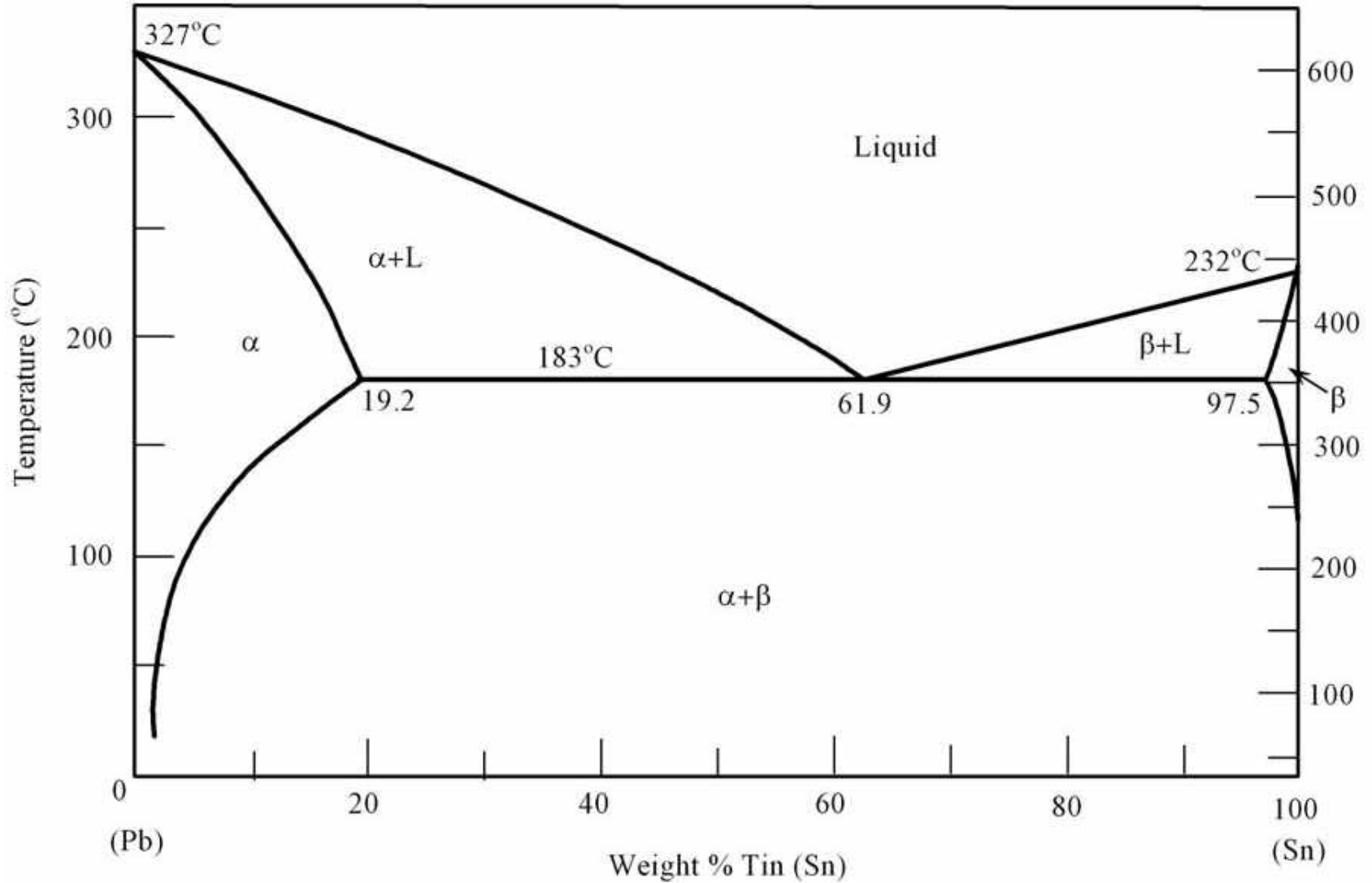


# Solid Solution Strengthening

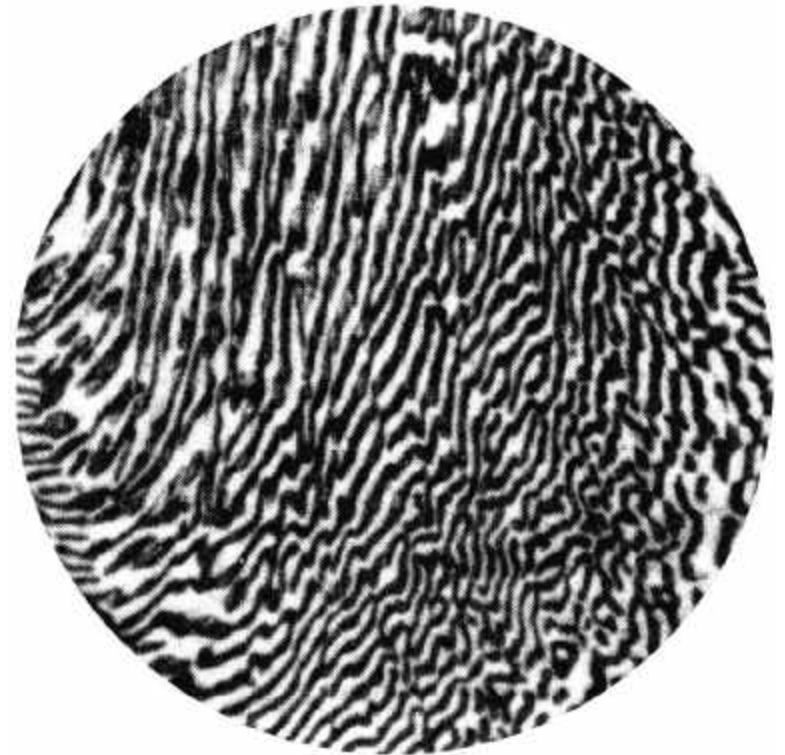
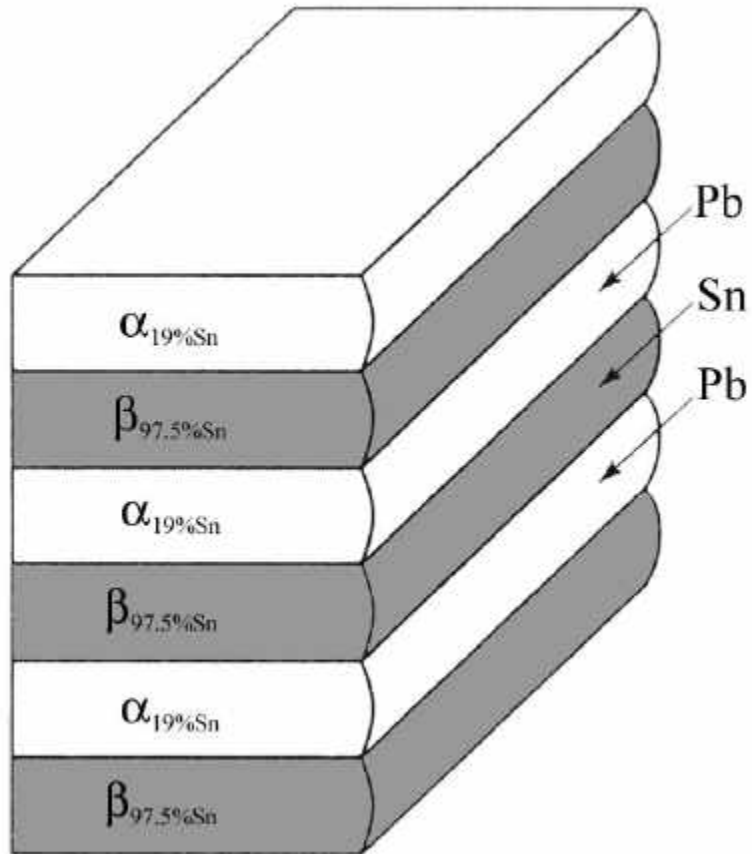
- The yield strength, tensile strength, and hardness of the alloy are higher
- The ductility of the alloy is usually lower
- The electrical conductivity of the alloy is much lower
- The resistance to creep, or loss of strength at higher temperatures is improved



# Binary Eutectic Systems

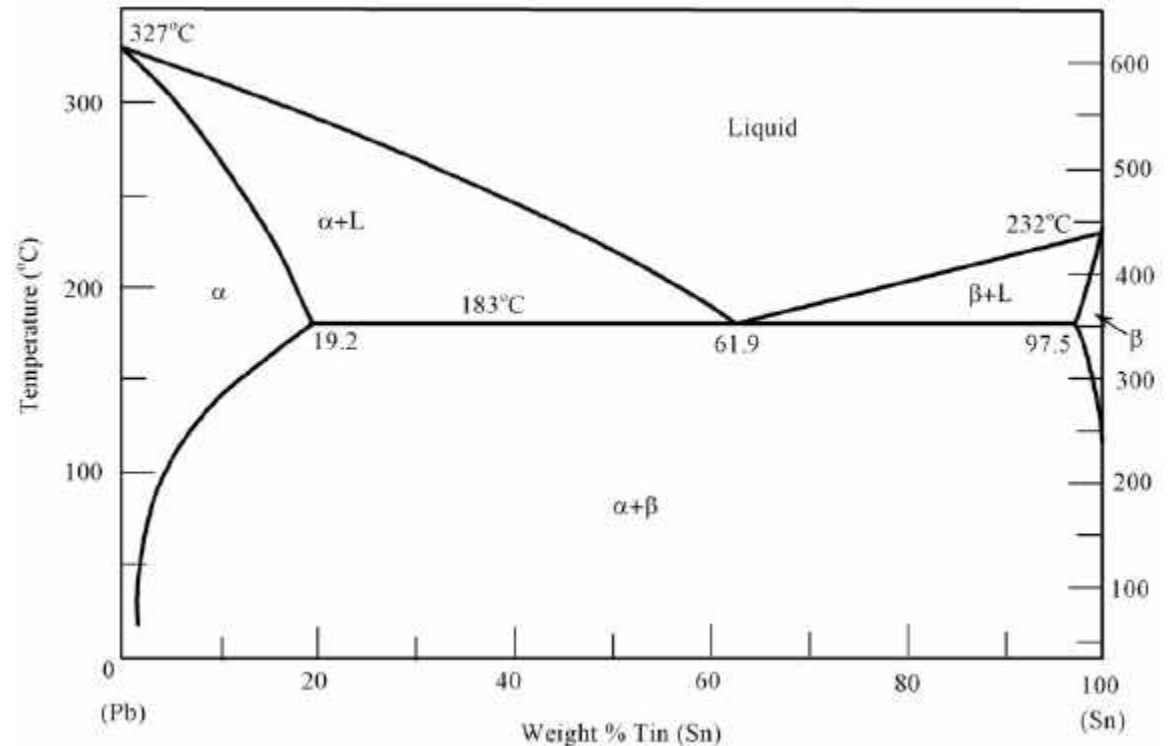


# Eutectic Alloys

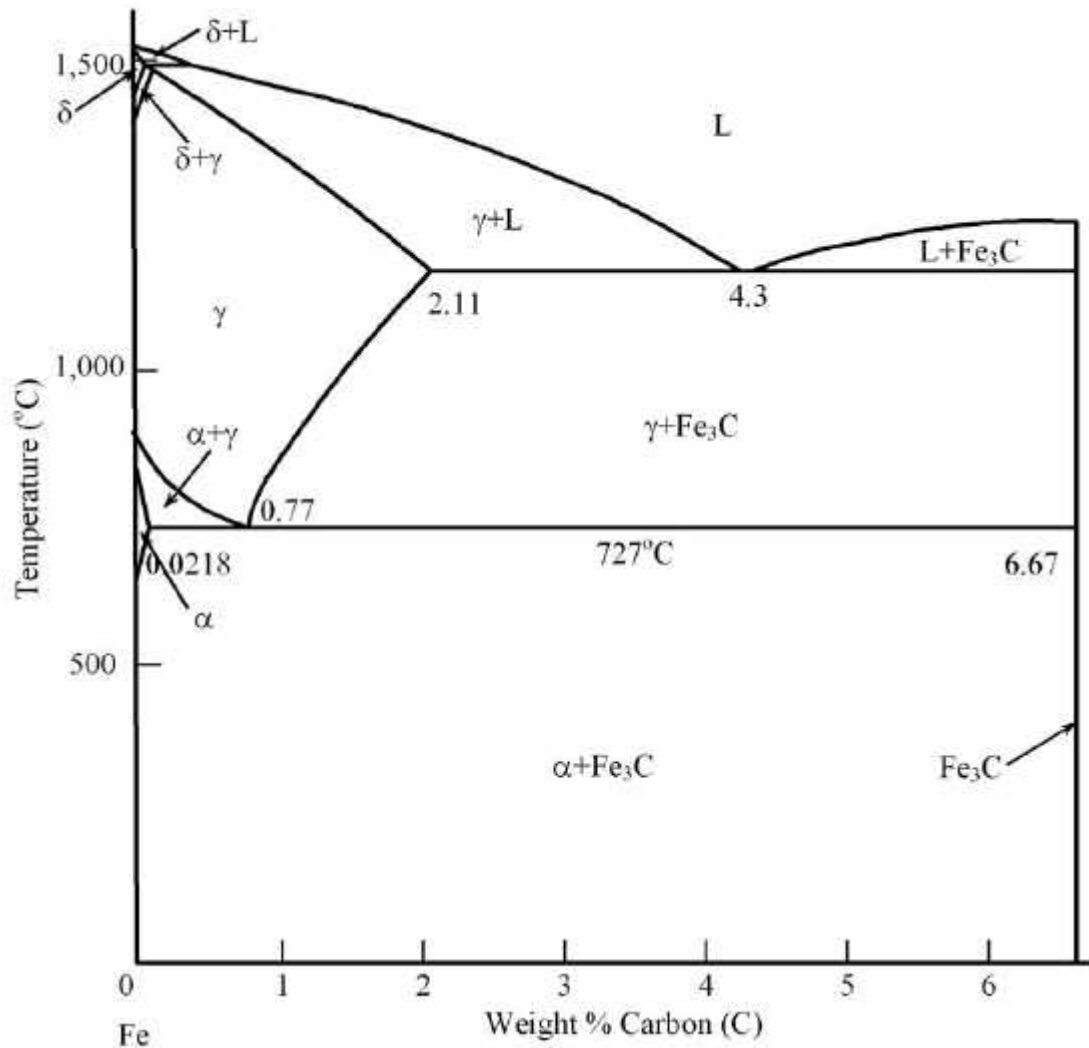


# Example

For a 40% Sn alloy at 200°C what phases are present, what is their composition, and what is the amount of each?



# Eutectoid System (Steel)



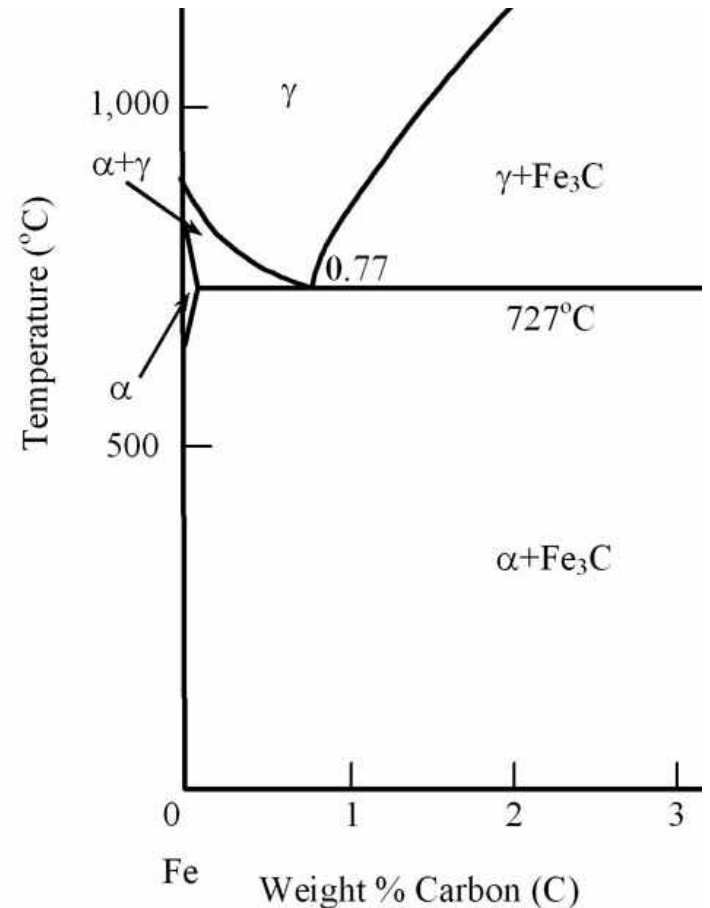
$\gamma$  = Austenite

$\alpha$  = Ferrite

$\text{Fe}_3\text{C}$  = Cementite

# Example

For a 0.3% C Steel at 800°C what phases are present, what is their composition, and what is the amount of each?



# Summary

- Phase Diagrams tell us what phases are present in a given alloy at a given temperature.
- Solid Solution is uniform mixing of elements.
- The Lever Law allows the calculation of the amounts of each phase.
- Eutectic is a layered structure that forms when an alloy is cooled from a single phase liquid into a two phase solid.
- The Iron-C phase diagram has specific names for each of the phases (eg. Ferrite, Pearlite, Austenite,...)