Quiz 3 Phase Diagrams

You Should Be Able to:

- Define a phase is and explain how the amount, nature, size, shape, distribution, and orientation of the phases affects the material properties.
- Given an equilibrium phase diagram,
  - identify the liquidus, solidus, or solvus lines, and state what they represent.
  - identify the eutectic or eutectoid point, composition, or temperature, and state what they represent.
  - find the number of phases present, name those phases, find their chemical compositions (phase analyses), and find in what proportions (amounts) the phases occur.
  - predict whether age hardening is possible for a given alloy.
- For **Iron-Carbon** alloys you should:
  - Label regions in Fe-Fe_3C equilibrium phase diagram
  - State the composition, structure, and properties of austenite, ferrite, cementite, and pearlite and explain how each is formed.
  - Sketch and label the equilibrium structure for hypo- and hyper-eutectoid steels and be able to determine the approximate weight percent pearlite present in a given alloy from a microphotograph

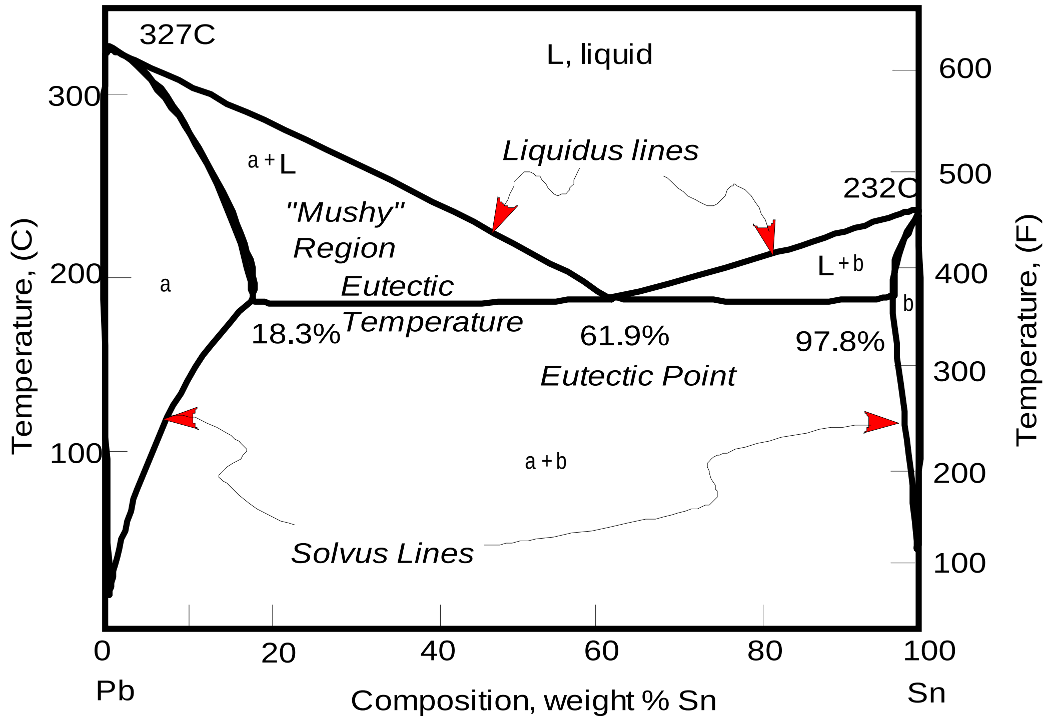
Vocabulary

Austenite	Liquidus Line
Cementite	Microconstituent
Equilibrium	Pearlite
Eutectic reaction	Phase
Eutectic structure	Phase Diagram
Eutectoid reaction	Primary Phase
Hypereutectoid	Proeutectoid
Hypoeutectoid	Solidus Line
Intermetallic Compound	Solvus Line
Lever Rule	Tie Line

Equilibrium Phase Diagrams
(Binary or Two Element)

Useful Information from a Phase diagram

- The phases present for any alloy at any temperature
- Chemical composition of each phase
- Relative amounts (weights of each phase)
- Melting/Solidification temperatures



Finding Chemical Composition

To find the chemical compositions of the phases, you first have to know

- the alloy you are using (defines location on the x-axis
- the temperature of interest (defines location on the y axis

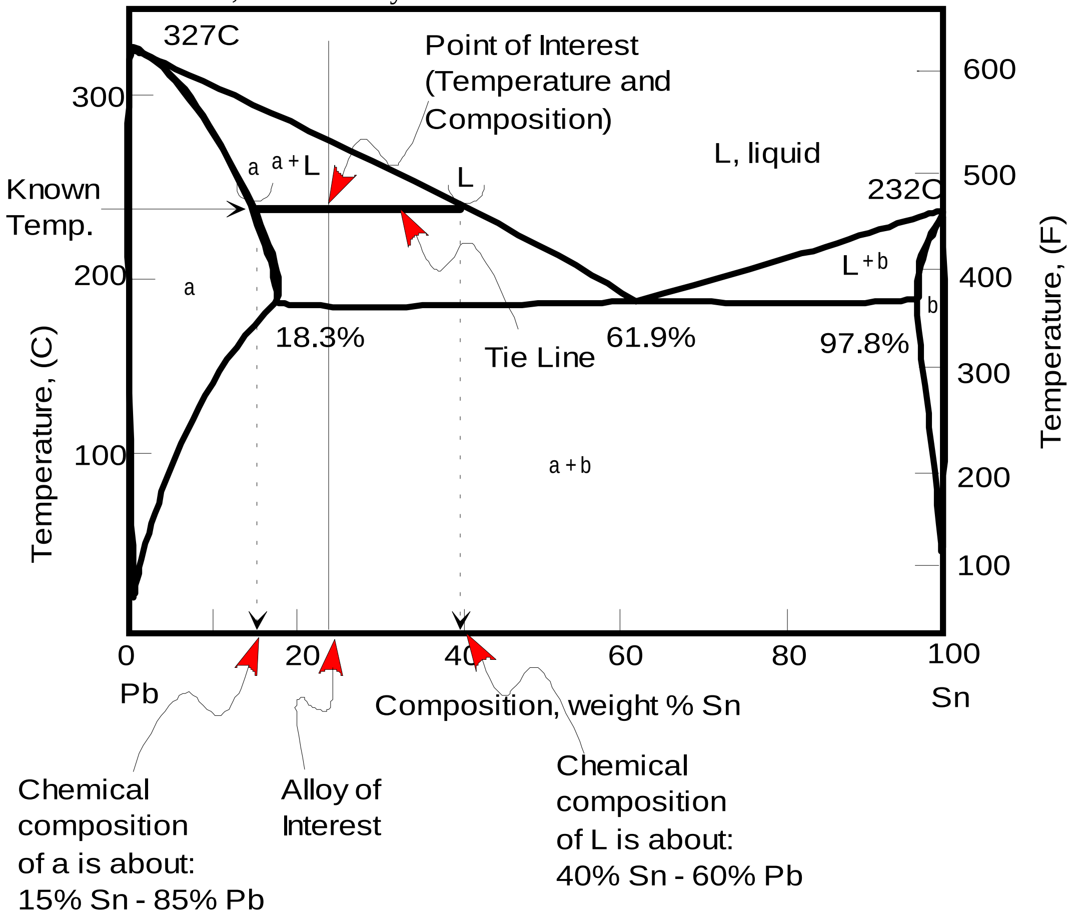
If the intersection of the alloy line and the temperature line (point of interest) fall in a **single phase region**, there is only one phase present. The composition of the phase is the composition of the alloy.

If the point of interest falls in a **two phase region**, you will need to find the composition for each phase. To do this:

- draw a horizontal point thru the point of interest until it intersects with the boundaries of the closest single phase regions
- draw vertical lines to the x-axis and read the composition for each phase

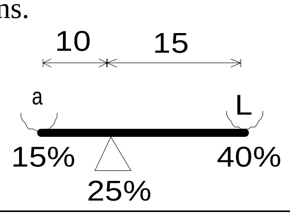
Finding Composition of the Phases present in a Two Phase Region

Consider a 25% Sn, 75% Pb alloy at 230C



Continuing with the same alloy at the same temperature

Finding Relative Amounts (proportions of the phases)

To find the **weight percent of a phase**, use the tie line as a <u>lever</u> with fulcrum at the point of interest and lever ends at the phase compositions. 	$\%\alpha = \frac{\text{opposite leg}}{\text{total length}} = \frac{15}{25}(100\%) = 60\%$ $\%L = \frac{\text{opposite leg}}{\text{total length}} = \frac{10}{25}(100\%) = 40\%$

Iron Carbon Phase Diagram (partial)

Phase	Carbon	Name	Structure	Temp
Ferrite	<0.02%	α-iron	BCC	
Austenite	<2.2%	γ-iron	FCC	>727°C
Cementite	6.7%	Fe_3C	Intermetallic	
Structure				
Pearlite	0.76%		layered α,Fe_3C	<727°C

Terms

Eutectoid point - 3 phases (ferrite, austenite, cementite) in equilibrium at one temperature. All phases are solid, therefore this is a solid-solid transformation.

Eutectoid composition - 0.76% carbon (approximately a 1080 steel)

Eutectoid Structure - Pearlite

Proeutectoid - phase that forms at temps above the eutectoid temperature (727°C). For *hypoeutectoid steels* (steels with less than 0.76% C), ferrite is the proeutectoid phase. For hyper eutectoid steels (steels with more than 0.76% C, cementite is the proeutectoid phase.

Hypoeutectoid is an iron carbon ally