TWO COMPONENT SYSTEM

Binary Component System

Two component system is one in which it is possible to express the composition of each phase in terms of two substances.

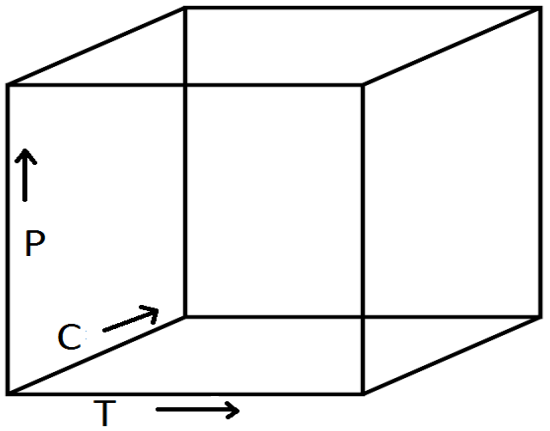
Number of Phases (P) = 1

Number of Components(C) = 2

Degree of Freedom (F) = C + 2 – P

= 2 + 2 – 1 = 3

So to define the system completely three variables temperature, pressure and composition are required.



Types of Binary Component System

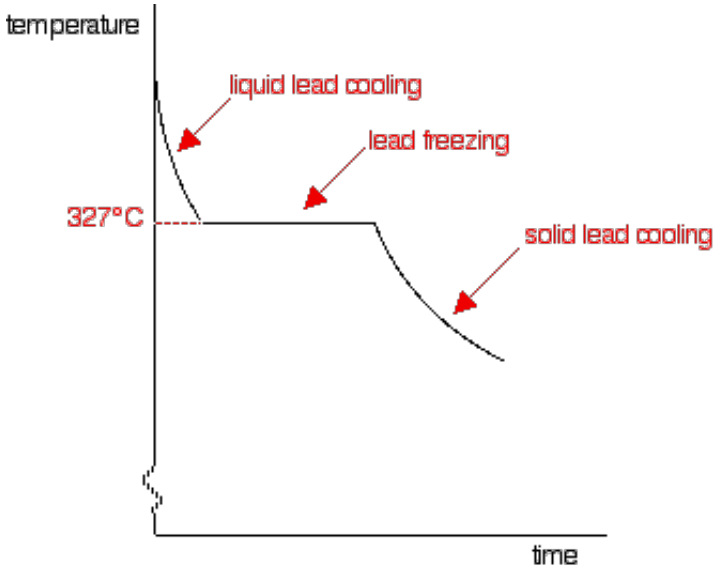
Two component system is of three types involving solid-liquid equilibria.

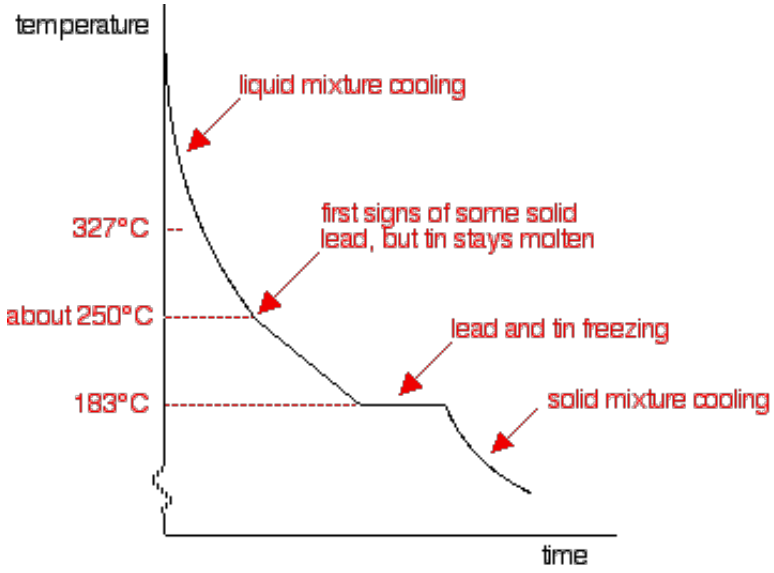
Type-I: Two component do not react with each other but mix with each other in molten state or in solution.
For Example: Lead-Silver System, KI-H_2O System

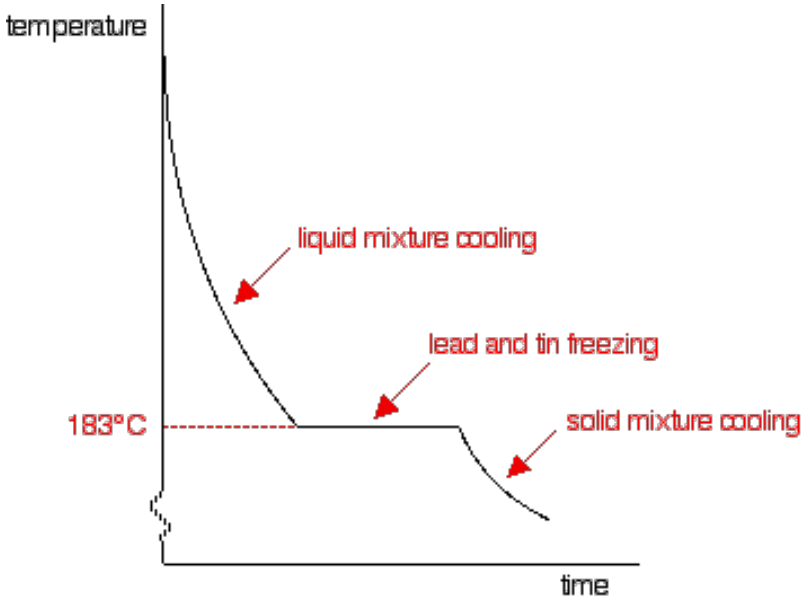
Type-II: Two pure component react to form a compound which is stable up to its melting point. At melting point it melts to gives a liquid of the same composition as that of solid compound. The compound formed is then said to have congruent melting point.
For Example: $FeCl_3$-H_2O System

Type-III: Two pure component react to form a compound which is unstable up to its melting point. On heating it starts decomposing before melting point to give a new solid and a solution with composition different from that of solid phase. The compound is said to have incongruent melting point.

For Example: Na_2SO_4-H_2O System


temperature
liquid lead cooling
lead freezing
327°C
solid lead cooling
time

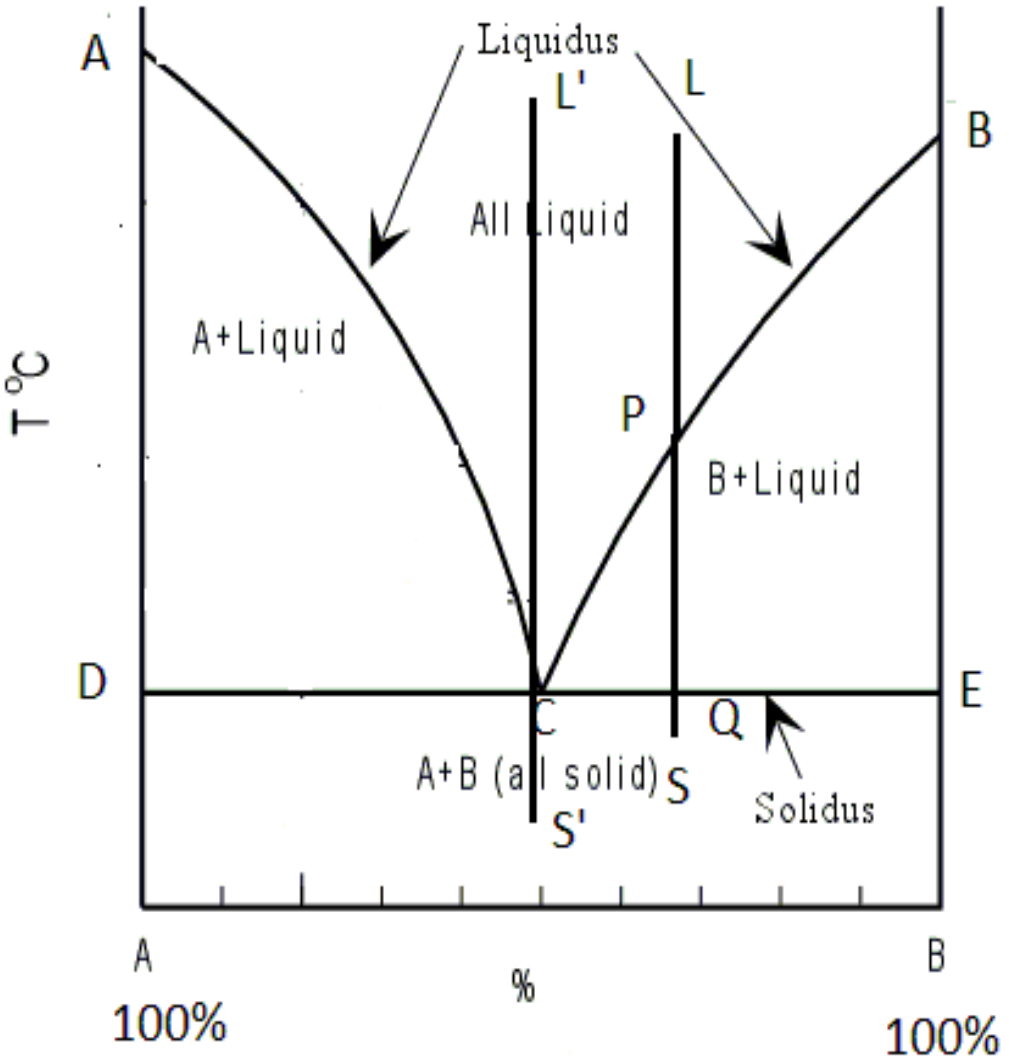

temperature
liquid mixture cooling
327°C
first signs of some solid lead, but tin stays molten
about 250°C
lead and tin freezing
183°C
solid mixture cooling
time


temperature
liquid mixture cooling
lead and tin freezing
183°C
solid mixture cooling
time

General Features of Phase Diagram of Two Component System

Consider a system of composition represented by line LS. “L” represent system above melting point & “S” represent system in solidified state.

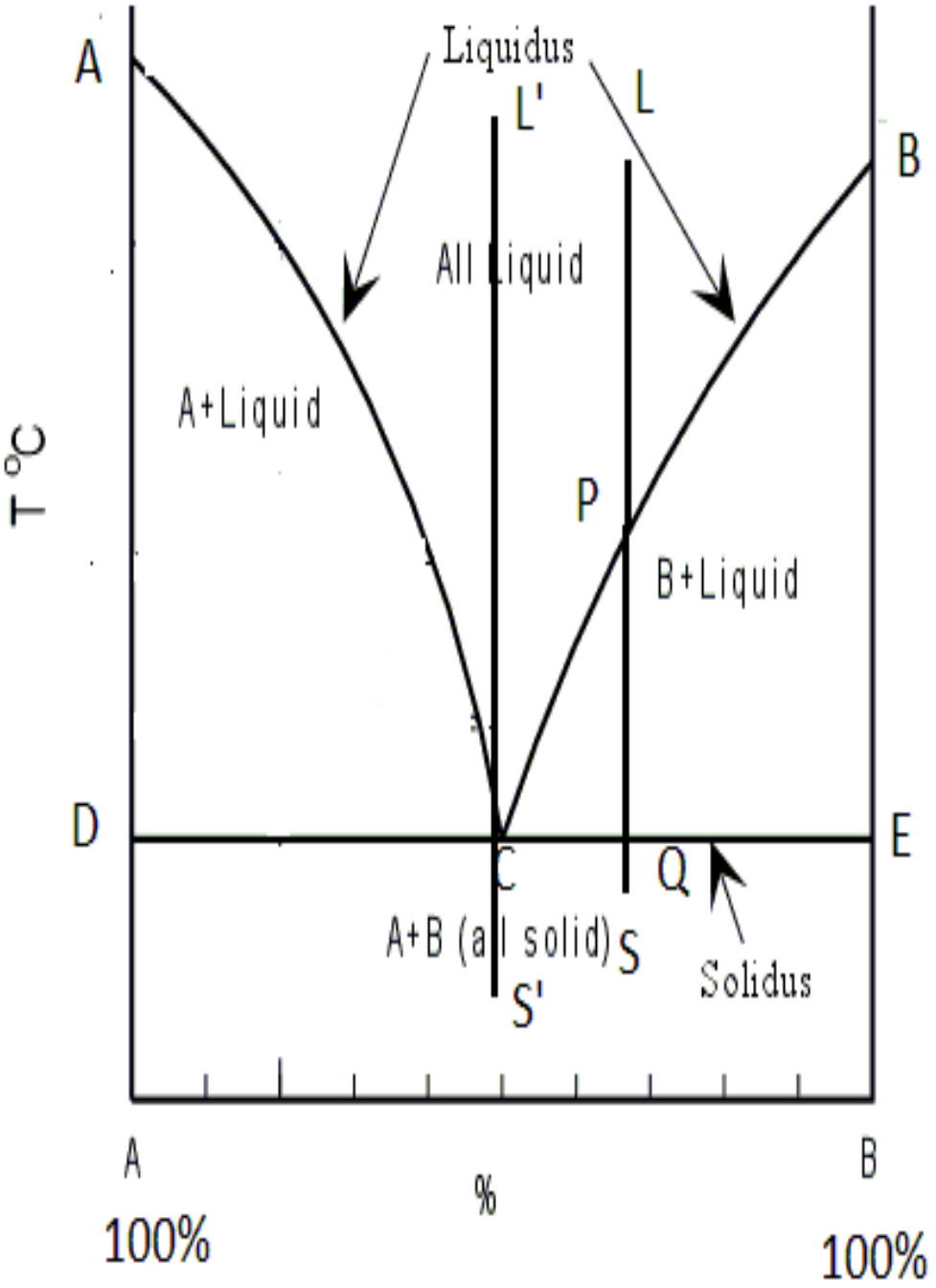
If “L” is cooled then no solid will separate till point “P” on the freezing point curve BC is reached. At this temperature solid B will separate out.



The solidification result in the evolution of heat called heat of solidification, which slow downs the cooling up to point Q.

During cooling from P to Q, the composition of liquid phase changes from P to C along the curve PC.

On reaching the eutectic point “C”, the second solid A will separate out and temperature will remain constant till all the liquid has been solidified.



Eutectic Mixture

Solid solution of such two component system which has lowest melting point of all the possible mixtures of the components is known as **Eutectic mixture** and the corresponding freezing point temperature is known as **Eutectic point**.

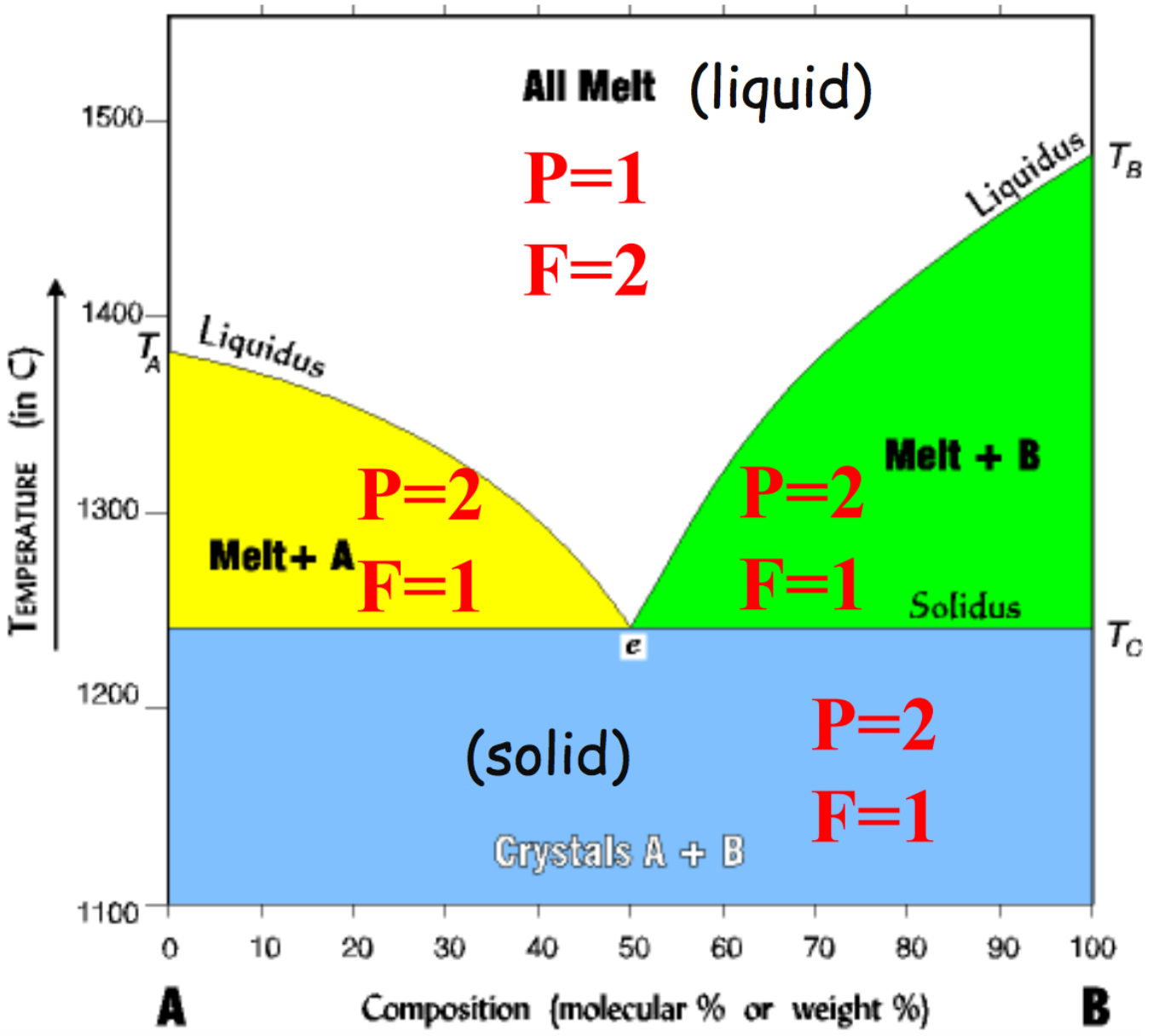
For Example: Cu – Ag, Pb-Ag, Bi - Cd

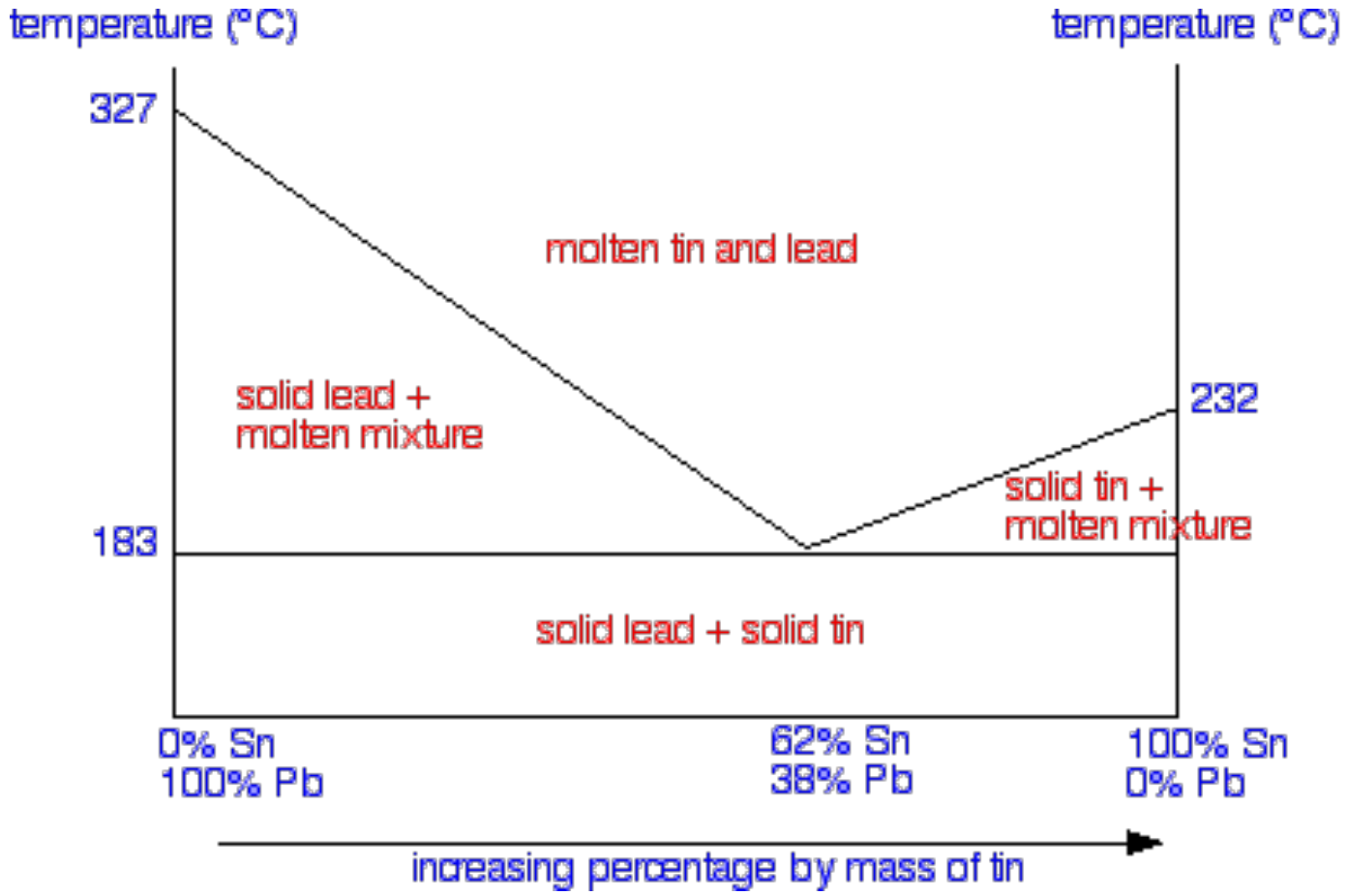
Application of Eutectic Mixture

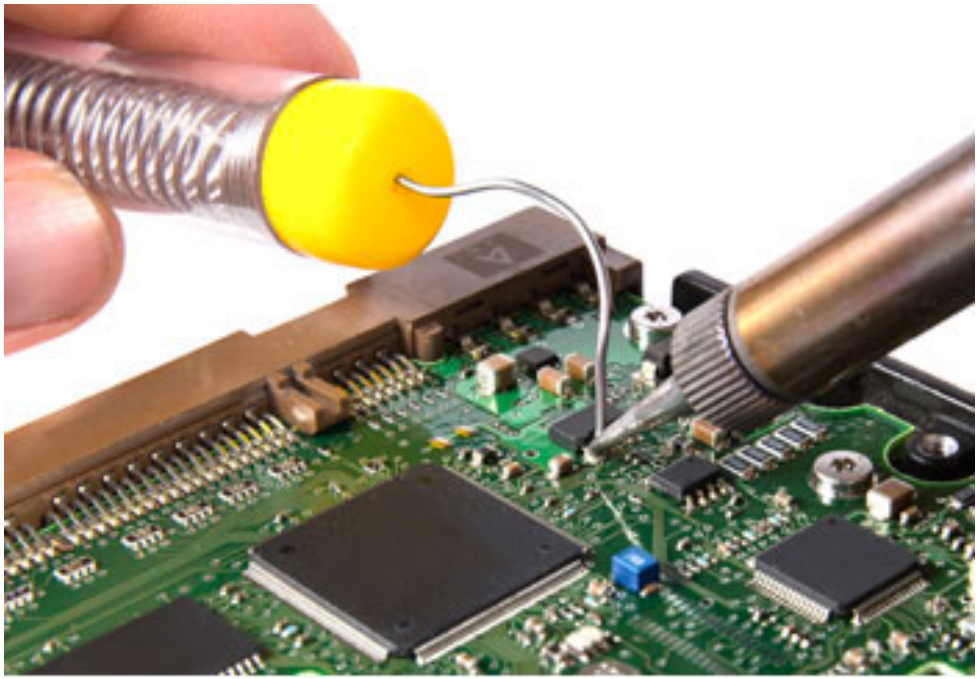
Alloys which are known to form eutectic mixture are used as ‘Fail Safe’ devices in boilers & domestic water geysers, as plug in automobiles.

Eutectic mixtures has low melting point, so they are used for joining two metal pieces together. For example Lead-Tin solders.

Eutectic mixtures of Sodium & Potassium are liquid at room temperature and are used as coolant in nuclear reactors.

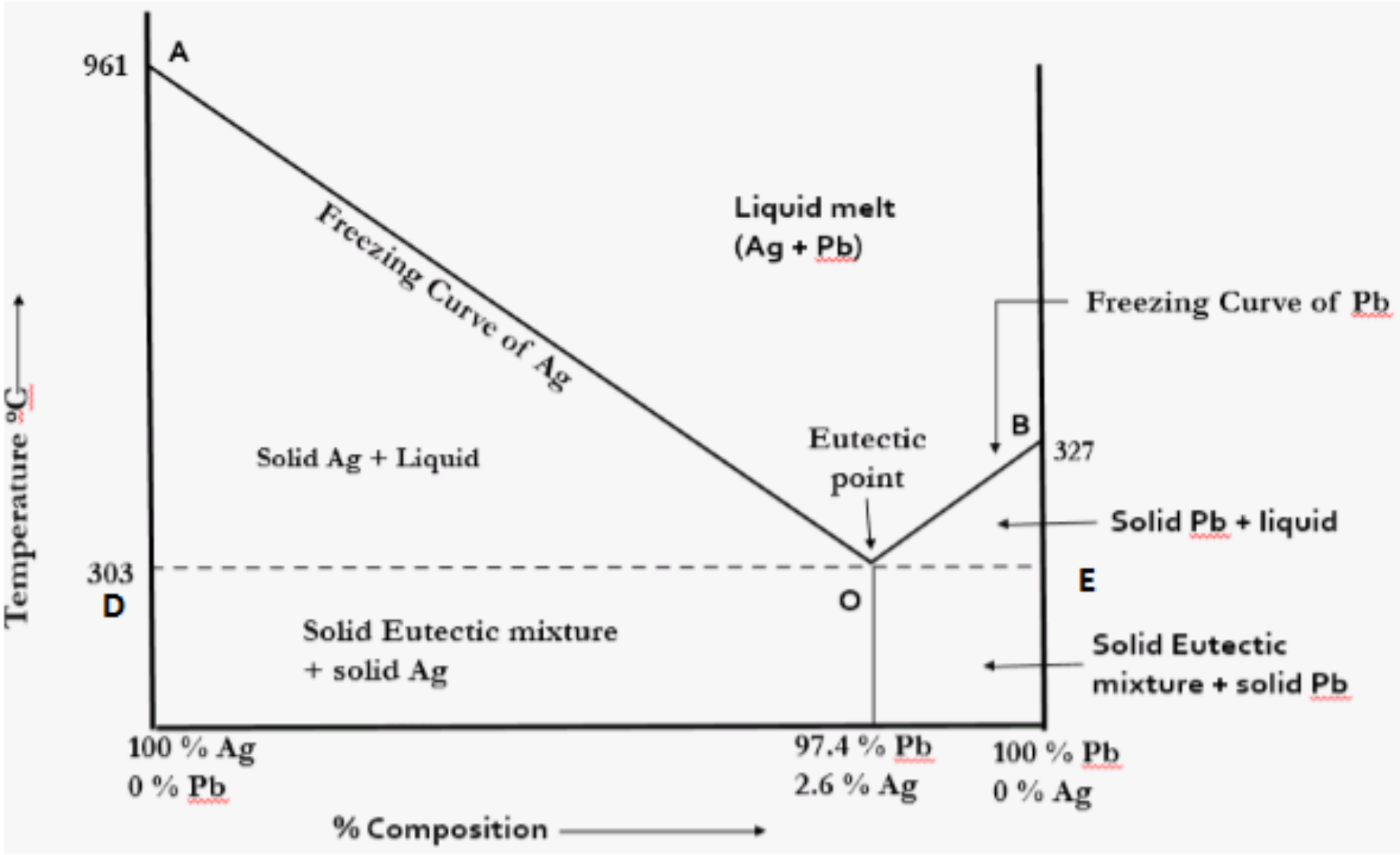

All Melt (liquid)
P=1
F=2
Liquidus
T_B
Liquidus
T_A
Melt + B
P=2
F=1
Melt+ A
P=2
F=1
Solidus
e
T_C
(solid)
P=2
F=1
Crystals A + B
1500
1400
1300
1200
1100
Temperature (in C)
0
10
20
30
40
50
60
70
80
90
100
A
Composition (molecular % or weight %)
B


temperature (°C)
temperature (°C)
327
molten tin and lead
solid lead +
molten mixture
232
solid tin +
molten mixture
183
solid lead + solid tin
0% Sn
100% Pb
62% Sn
38% Pb
100% Sn
0% Pb
increasing percentage by mass of tin



- Binary Component System – Lead-Silver System

Binary Component System-Lead-Silver



Phase Diagram of Lead – Silver System