
GPS Map
Camera Lite
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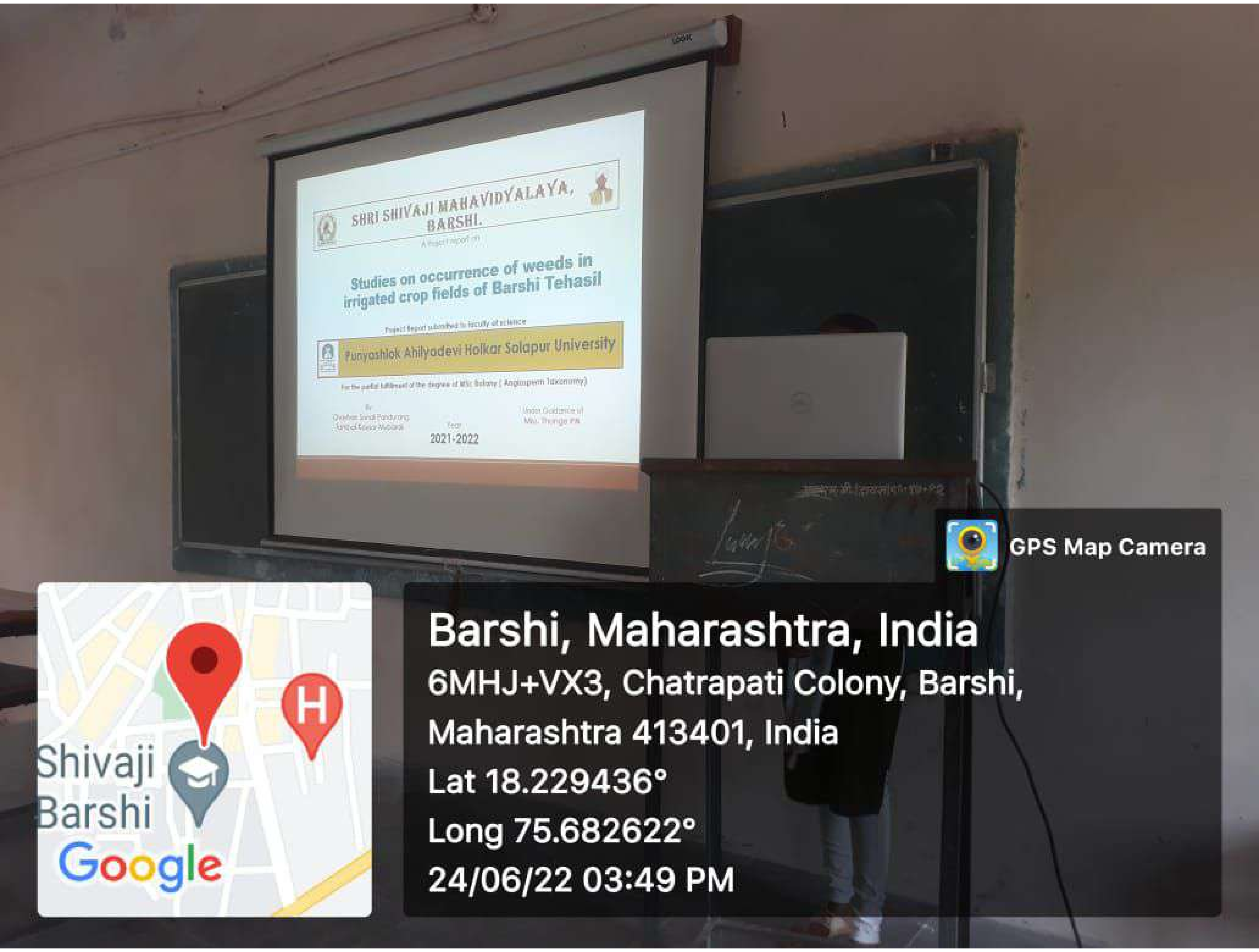
GMT 08:21:14 AM
Altitude 446.5 meters
Monday, 28-03-2022


SHRI SHIVAJI MAHAVIDYALAYA, BARSHI.
Studies on occurrence of weeds in irrigated crop fields of Barshi Tehasil
Punyashlok Ahilyadevi Holkar Solapur University
2021-2022
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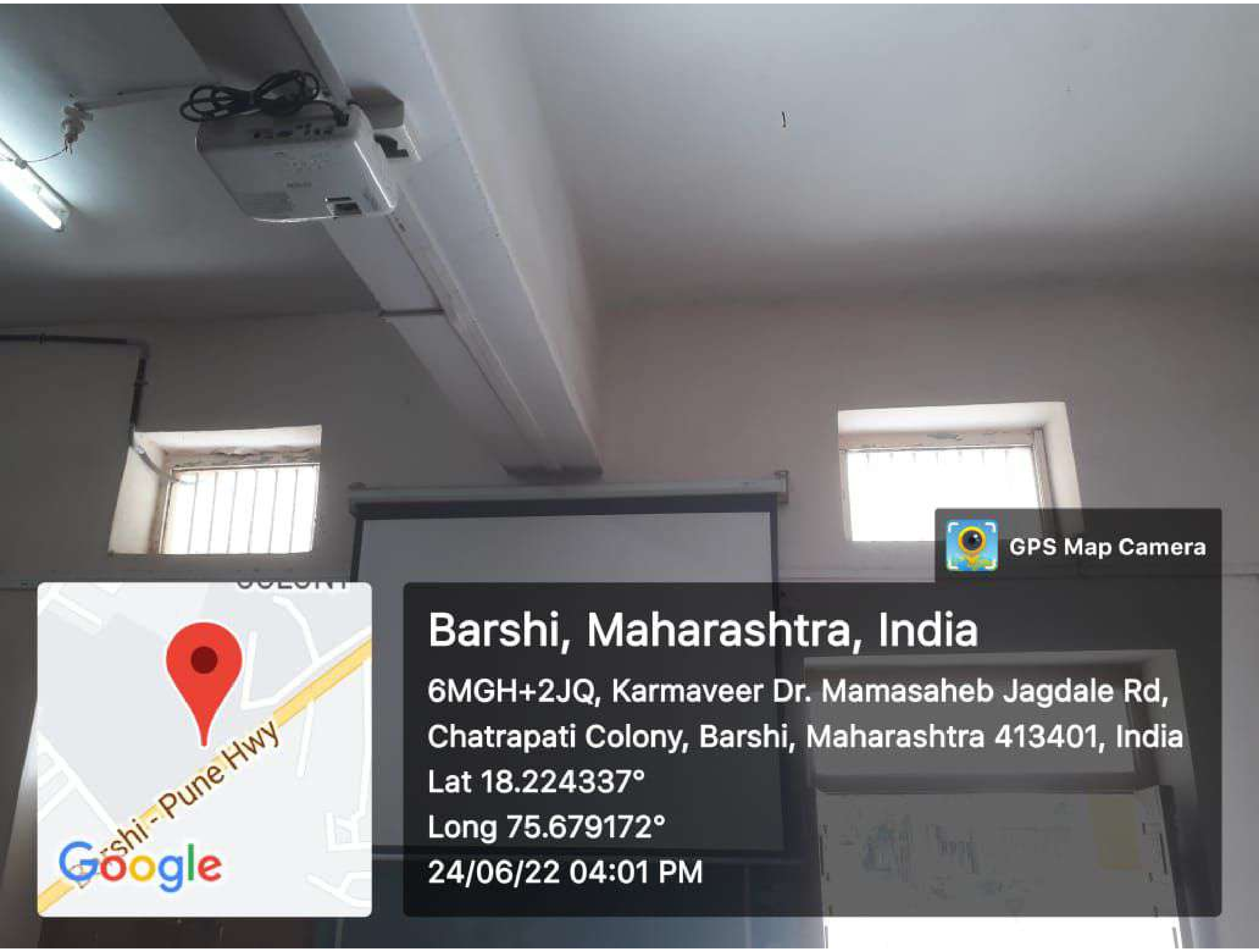
HDMI



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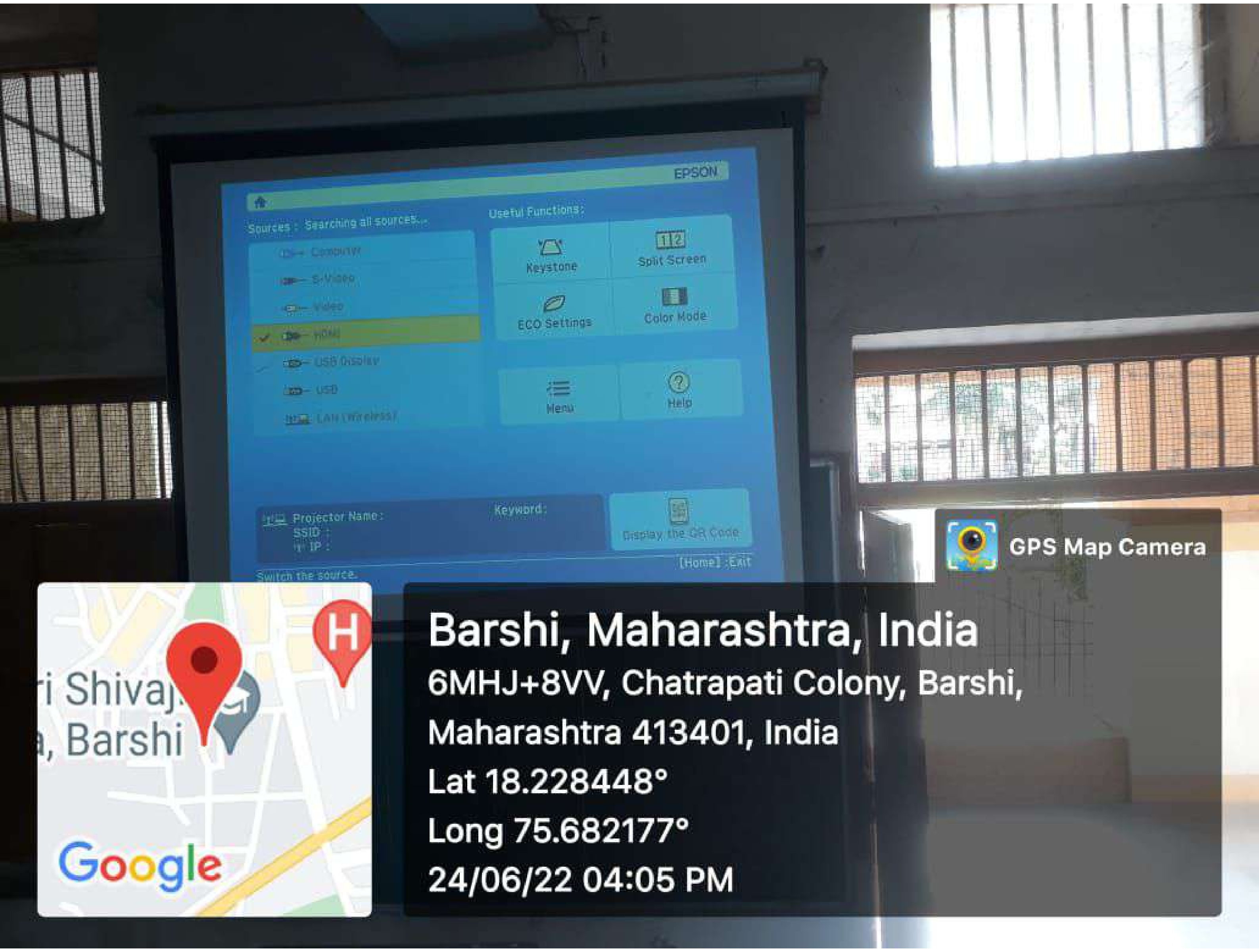
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GPS Map Camera
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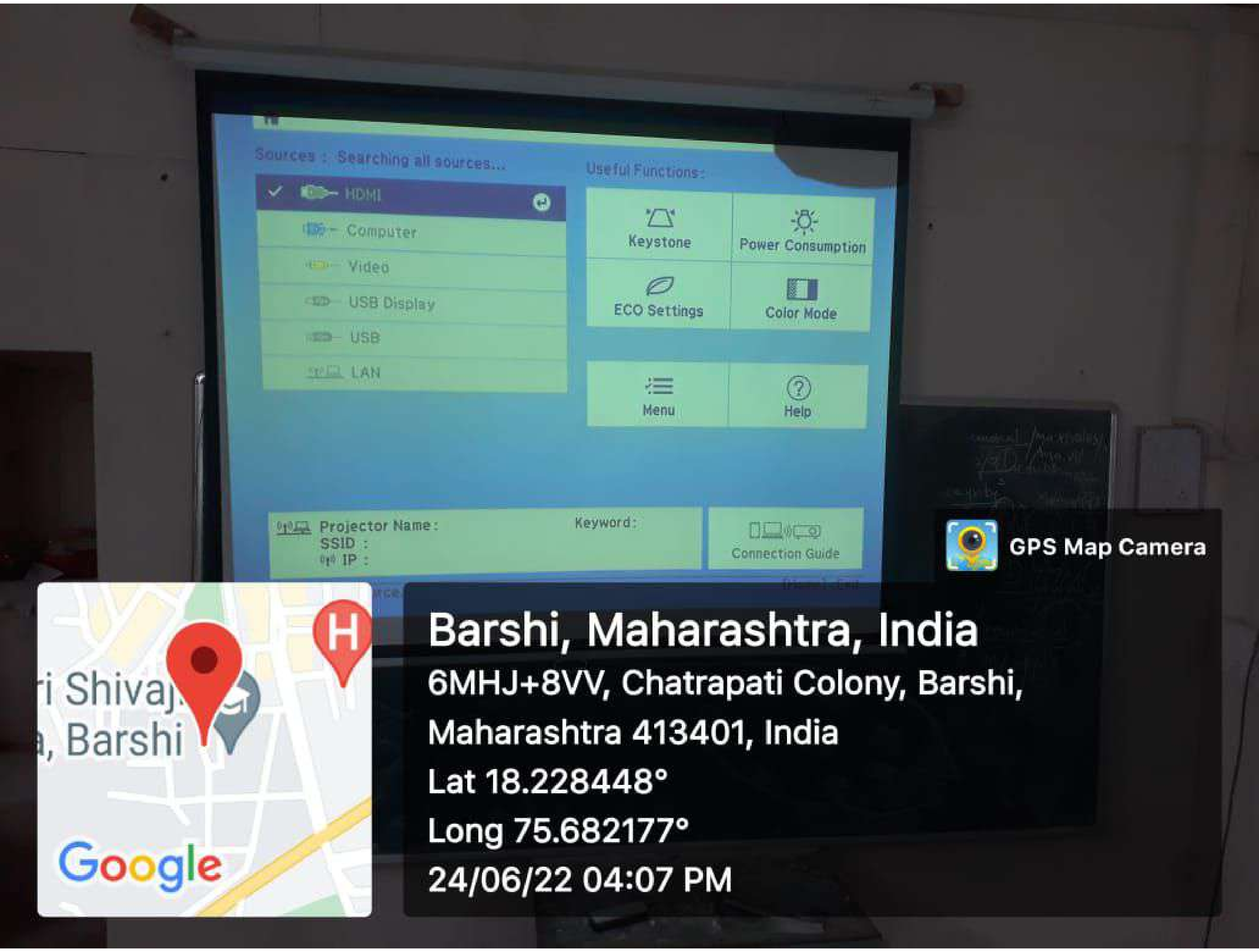
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Connection Guide
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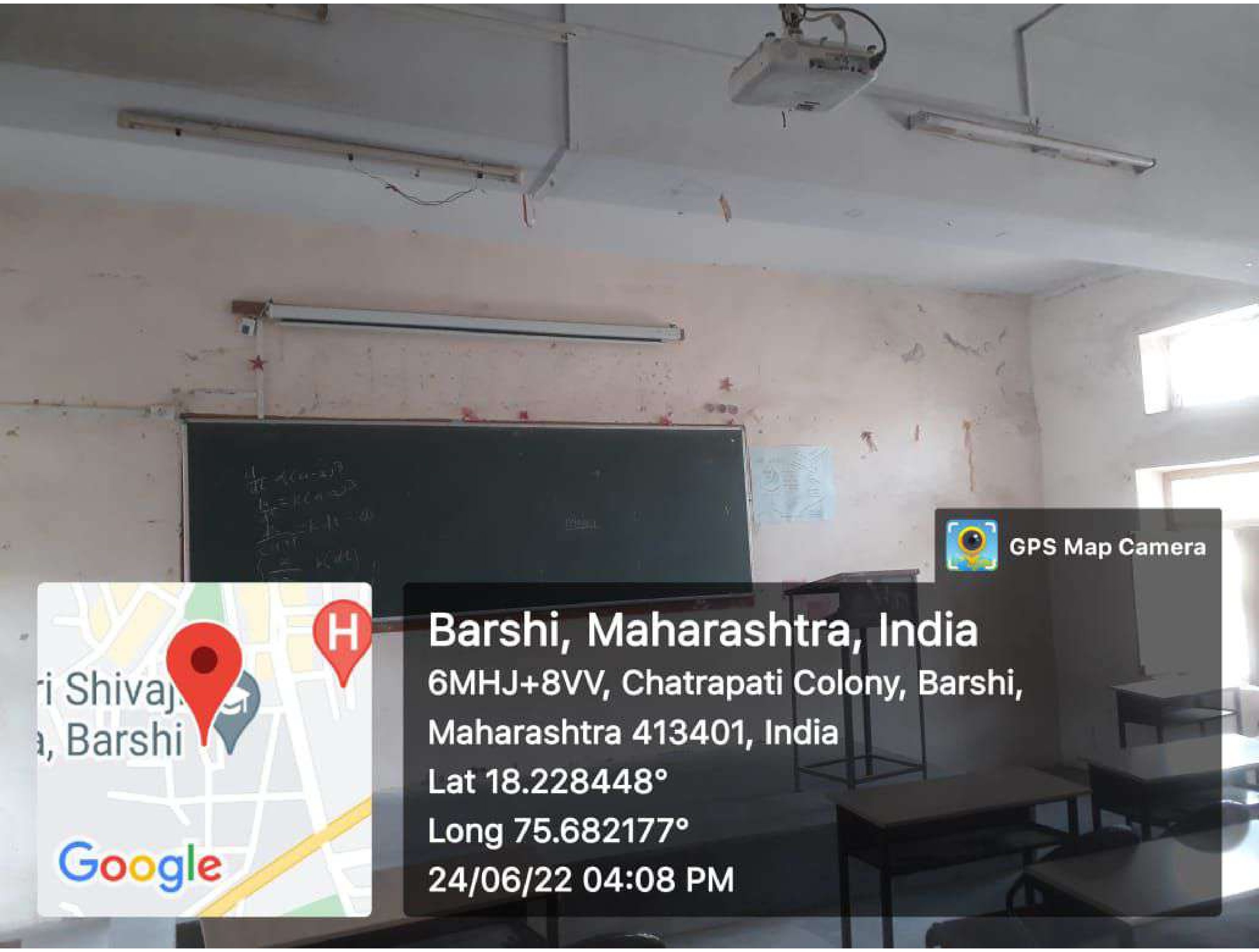
GPS Map Camera
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i Shivaj
, Barshi

B.Sc. III, semester V

Phase Equilibria

By

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Member- College Development Committee,

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System: Part of the universe under study.
Homogeneous system: It has only one phase throughout.
Heterogeneous system: It has more than one phases.
Phase(P): It is homogenous part of the system which is physically distinct and separated from other parts of the system by definite bounding surface. Eg. Freezing of ice. **3**
Component(C): It is the minimum number of chemical constituents which are essential to express the composition of every phase present in the system directly or in the form of a chemical equation. Eg. Freezing of ice. **1**
Variance or degrees of freedom (F): It is the minimum number of variables which must be fixed or stated in order to describe the system at equilibrium completely. Eg. Freezing of ice. **0**

Phase Rule:
Phase rule was deduced by Willard Gibbs in 1876. It is applicable to all heterogenous systems and helps to know the effect of temperature , pressure and concentration on the system.
It can be stated as the sum of the number of phases and degrees of freedom of any system exceeds the number of components by 2.

$$P+F=C+2 \quad \text{OR}$$

$$F=C-P+2 \qquad \ldots\ldots(1)$$

Phase

Example	Phases	P
Air	V (Gases)	1
Water + acetone	L	1
Water + benzene	L+L	2
$CaCO_3$ (S) = CaO(S)+CO_2(G)	S+S+ V	3
Water	Ice + water + vapour	3

Component

Example:	Compositions	C
Water system	Ice: XH_2O Water: YH_2O Vapours : ZH_2O	1
Sulphur	Rhombic: S Monoclinic: S Liquid: S Vapour: S	1
Salt and water	L : salt and H_2O	2
$CaCO_3 = CaO + CO_2$	phase components $CaCO_3$ (solid) $= CaCO_3 + 0CaO$ $= CaCO_3 + 0CO_2$ $= CaO + CO_2$ CaO(Solid) $= 0CaCO_3 + CaO$ $= CaCO_3 - CO_2$ $= CaO + 0CO_2$ CO_2(Gas) $= CaCO_3 - CaO$ $= 0CaCO_3 + CO_2$ $= 0CaO + CO_2$	2

Degree of Freedom

Example:	Facts	F	Variance of system
Given mass of pure gas	PV=RT	2 (from P,V,T)	Bivariant
Solution of salt	Solubility α Temp.	1 (C or T)	Univariant
Pure liquid	Vapour Pressure α Temp.	1 (T or P)	Univariant
water with three phases	Triple point	0	nonvariant

Phase Diagram:

The conditions of equilibrium of a system can be conveniently studied by means of Gibb's phase rule using a diagram or graph known as **Phase Diagram**.

If P is plotted against T: **P-T diagram** : Useful for single component systems.

If T is plotted against C: **T-C diagram**: Useful for two component systems.:

True and metastable equilibrium:

True equilibrium: In any system when the same state is obtained by approach from either direction, it is called a state of true equilibrium. Ex. Ice (S) ↔water (L)

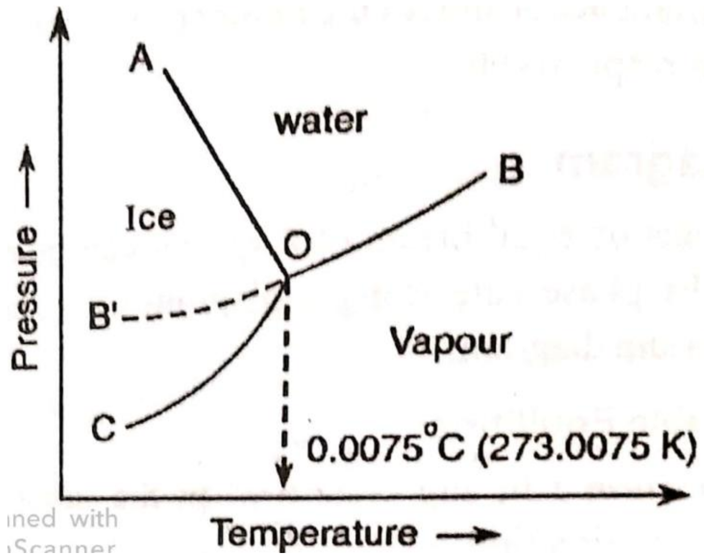
T, P

Metastable equilibrium: State of metastable equilibrium in any system can be obtained only by careful approach from only one direction is called a state of true equilibrium.

Ex. Supercooled water (H_2O at -4°C) ↔ ice

- Not possible to obtain liquid water at -4°C by melting ice.
- Possible to obtain liquid water at -4°C by careful cooling of water.
- by slight disturbance, shock, stirring it immediately converted into ice.

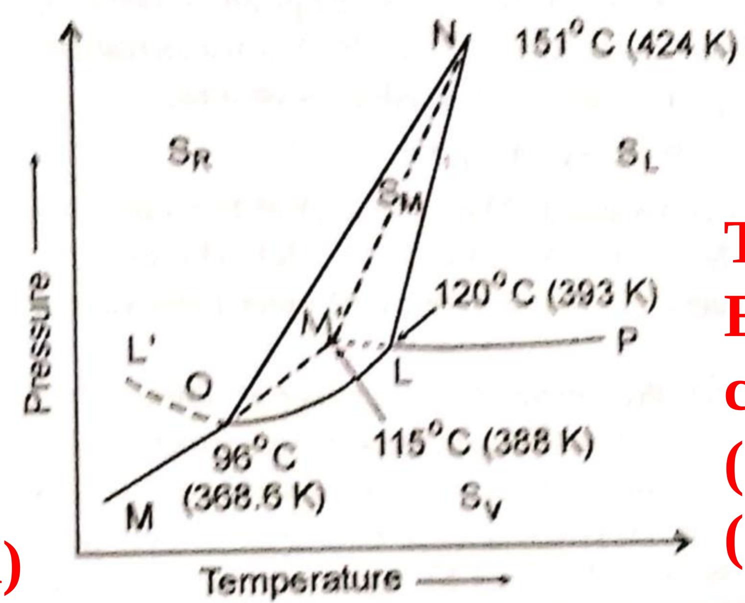
One component system: water system



Salient feature	Name	Phases	P=	F=C-P+2	Variance
Curve OC	sublimation curve of water	Ice + vapour	2	1	monovariant
Curve OA	FP curve of water/MP curve of ice	Water+ ice	2	1	monovariant
Curve OB	B.P curve of water	vapours+water	2	1	monovariant
Curve OB’	Metastable curve of supercooled water	Vapours + supercooled water	2	1	monovariant
Point: O	triple point	Ice+water+vapours	3	0	Invariant or Nonvariant
Area BOC	Single phase	vapours	1	2	Bivariant
Area AOB	Single phase	water	1	2	Bivariant
Area AOC	Single phase	ice	1	2	Bivariant

Salient feature	Name	Phases	P=	F=C-P+2	Variance F
Curve MO	Sublimation curve of S_R	S_R and S_V	2	1	monovariant
Curve OL	Sublimation curve of S_M	S_M and S_V	2	1	monovariant
Curve LP	B.P.Curve of S_L	S_L and S_V	2	1	monovariant
Curve ON	Transition curve of S_R to S_M	S_R and S_M	2	1	monovariant
Curve LN	M.P.Curve of S_M	S_M and S_L	2	1	monovariant
Curve OM'	Metastable curve	Superheated S_R and S_V	2	1	monovariant
Curve LM'	Metastable curve	Supercooled S_L and S_V	2	1	monovariant
Curve NM'	Metastable curve	Superheated S_R and supercooled S_L	2	1	monovariant
point O	Triple point	S_R,S_M,S_V	3	0	nonvariant
point L	Triple point	S_M,S_L,S_V	3	0	nonvariant
point N	Triple point	S_R,S_L,S_M	3	0	nonvariant
point M'	Triple point	S_R,S_L,S_V	3	0	nonvariant
Area MON	Single phase area	S_R	1	2	Bivariant
Area MOLP	Single phase area	S_V	1	2	Bivariant
Area OLN	Single phase area	S_M	1	2	Bivariant
Area PLN	Single phase area	S_L	1	2	bivariant

Sulphur system:



Crystalline form

Allotropy(element),

Polymorphism

(substance) or (compound)

Transition point,

Enantiotropy,

conversion,

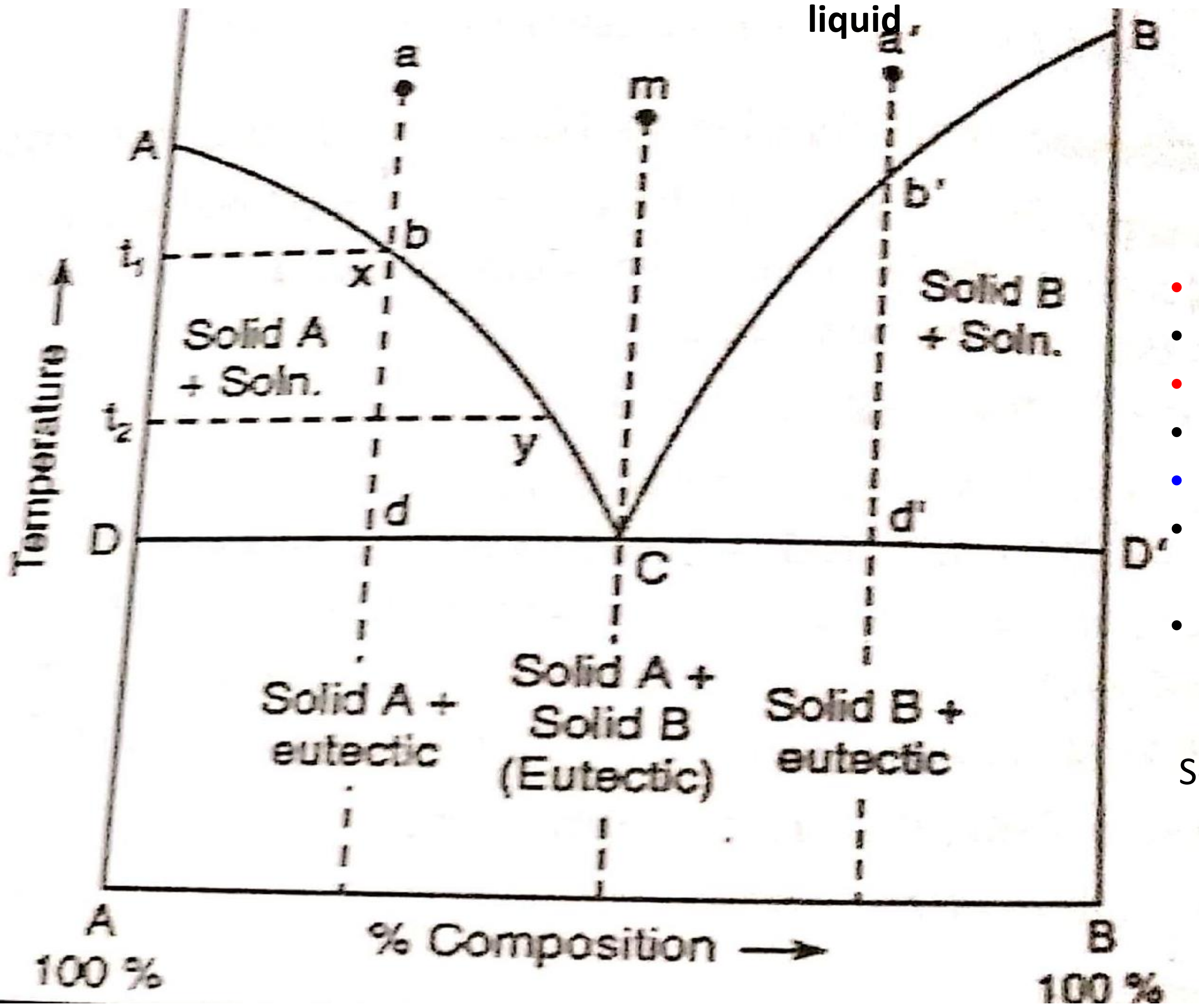
(substance) or

(compound)

Two component system (condensed system):

- Phase rule is F=C-P+2
- Suppose C=2, P=1 then F=2-1+2 =3
- T, P, C are required to be stated or fixed
- Three coordinate axes at right angle to each other gives three dimensional figure.
- Generally for simplicity or convenience, we draw plane diagram with 2 variables and third variable is supposed as constant.
- PT diagram, TC diagram, CP diagram
- In solid liquid equilibria, vapor phase is neglected and P is kept constant. P is negligible
- The system in which only solid & liquid phases are considered is called as condensed system.
- One variable is fixed or constant.
- So degree of freedom reduces by 1
- Reduced phase rule is F'=C-P+1

Two component system: Type I: Simple Eutectic system:



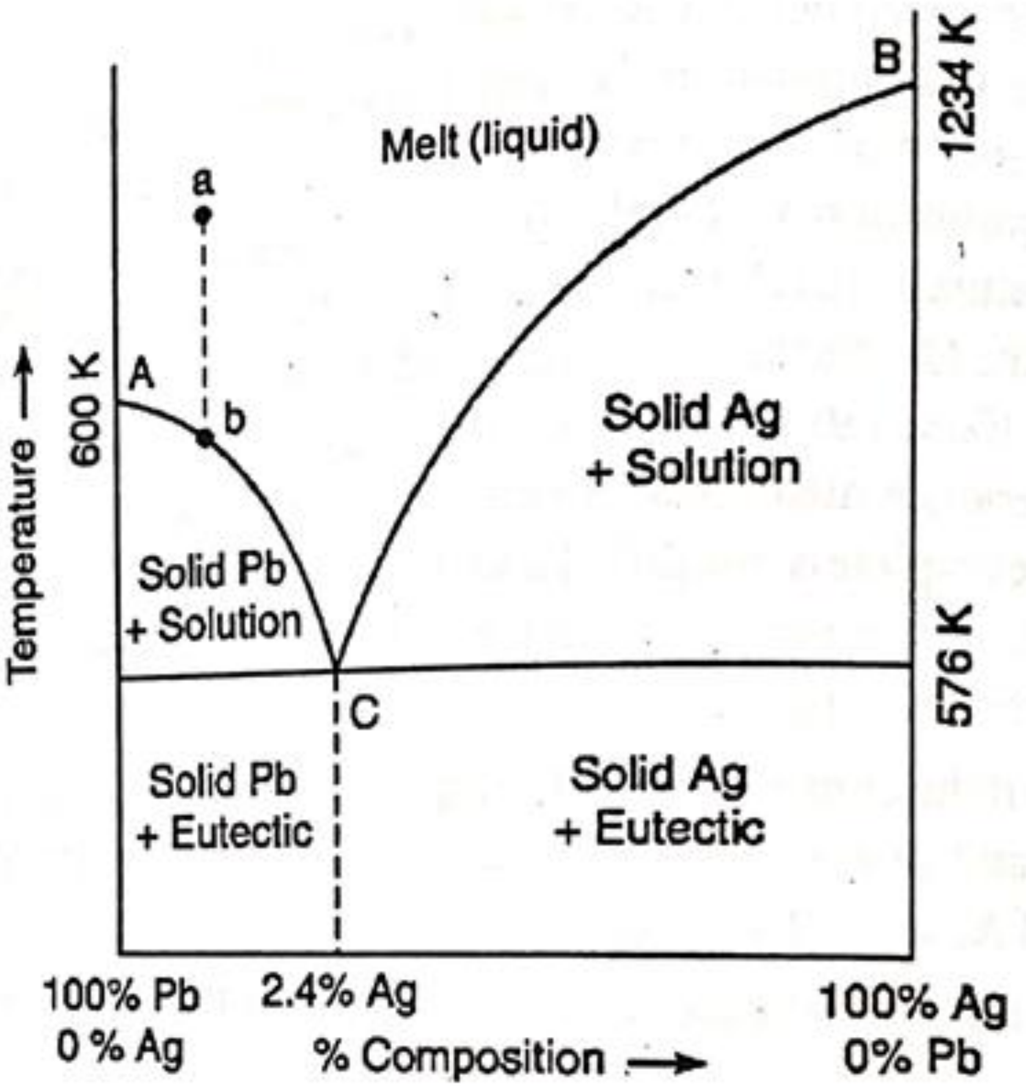
- Curve AC or CA
- a to b to d
- Curve BC or CB
- a' to b' to d'
- Point C
- Eutectic temp & composition
- Special case m
  liq comp = eutectic composition

Solidus & liquidus

Point A and B are freezing points or melting points of pure A and B respectively

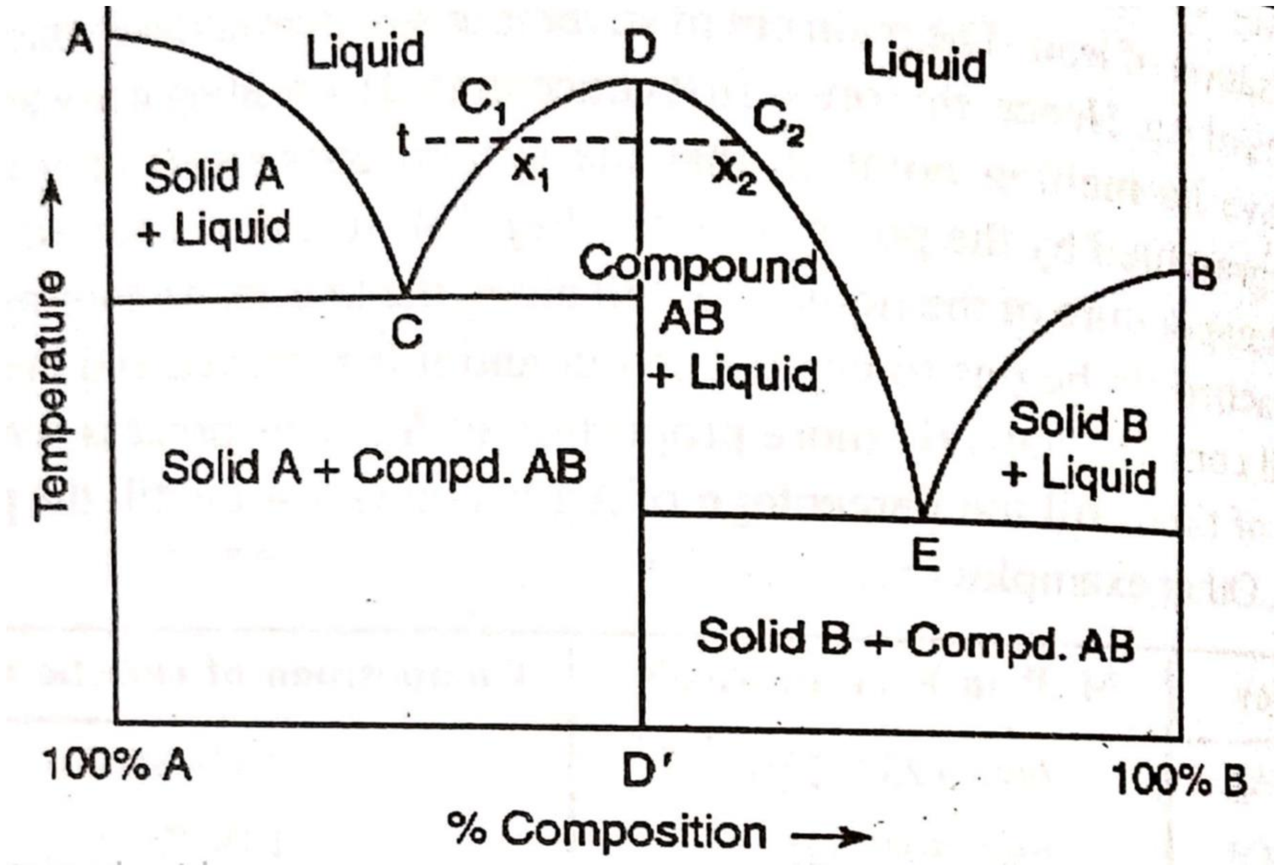
Salient feature	Name	Phases	P=	F'=C-P+1	Variance
Point: C	Eutectic point	Solid A + Solid B +soln	3	0	nonvariant
Curve AC	FP curve of A	Solid A + soln	2	1	monovariant
	liquidus : gives information about the composition of liquid phase				
Curve BC	F.P curve of B	Solid B+ soln	2	1	monovariant
	liquidus : gives information about the composition of liquid phase				
Solidus AD	i.e 100% A				
Solidus BD'	gives information about the composition of solid phase. i. e !00% B				
Solidus DD'	gives information about the composition of solid phase. i. e % of A and B				
Area above AOB	Solution of A and B with diff composition P=1, hence F'=2, bivariant				
Area Below DD'	Solid solution mixture of A and B with different composition , P=1, hence F'=2, bivariant				
Area within AOD	Solid A + soln, P=2, hence F'=1, monovariant				
Area within BOD'	Solid B + soln, P=2, hence F'=1, monovariant				

Pb-Ag System

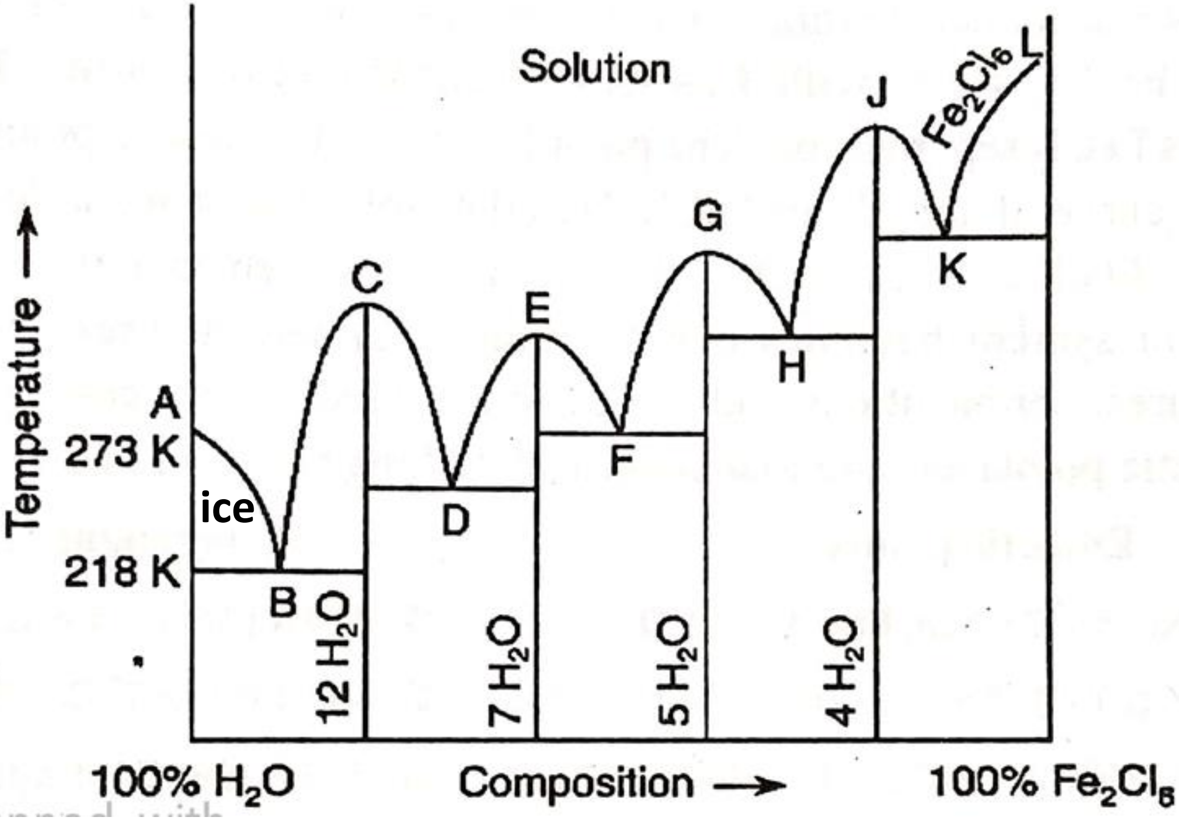


- Curve AC
- Curve BC
- Point C
- Desilverisation of lead

Two component system: Type II:
Formation of a compound with congruent MP:
Reduced phase rule: F'=C-P+1



- Congruent MP
- Compound AB
- Curve AC, BE, CDE
- equilibriums
- point D,
- point C,E
- x1, x2 composition
- retroflex solubilities
- curve DC, DE
- line DD'
- horizontal lines passing through C & E are solidus



Water-ferric chloride system

Curves AB, BCD, DEF, FGH, HJK, KL

Eutectic points

B : 218 K(– 55°C) - ice, $Fe_2Cl_6 \cdot 12H_2O$

D : 299 K (26°C) - $Fe_2Cl_6 \cdot 12H_2O$, $Fe_2Cl_6 \cdot 7H_2O$

F : 303 K (30°C) - $Fe_2Cl_6 \cdot 7H_2O$, $Fe_2Cl_6 \cdot 5H_2O$

H : 328 K (55°C) - $Fe_2Cl_6 \cdot 5H_2O$, $Fe_2Cl_6 \cdot 4H_2O$

K : 339 K (66°C) - $Fe_2Cl_6 \cdot 4H_2O$, Fe_2Cl_6

Congruent M. P.

C : 310 K (37° C) -$Fe_2Cl_6 \cdot 12H_2O$

E : 305.5 K (32.5° C) - $Fe_2Cl_6 \cdot 7H_2O$

G : 329 K (56° C) - $Fe_2Cl_6 \cdot 5H_2O$

J : 346.5 K (73.5° C) - $Fe_2Cl_6 \cdot 4H_2O$

Explanation of P, C, F for some systems

(i) **Ice ⇌ Water ⇌ Vapour :** It is one component system (*i.e.* H_2O) and there are three phases *i.e.* C = 1, P = 3, hence by applying the phase rule we get,

$$F = C - P + 2 = 1 - 3 + 2 = 0$$

i.e. degree of freedom is zero and system is non-variant.

(ii) **NaCl solid with saturated solution, ice and vapour :** It is two component system (NaCl and H_2O) and there are four phases *i.e.* solid NaCl, ice, solution and vapour. Thus, C = 2, P = 4, hence applying phase rule we get,

$$F = C - P + 2 = 2 - 4 + 2 = 0$$

i.e. degree of freedom is zero and system is invariant.

(iii) **Unsaturated solution of KI and vapour :** It is two component system (KI and H_2O) and there are two phases *i.e.*, solution and vapour. Thus, C = 2, P = 2, hence applying the phase rule we get,

$$F = C - P + 2 = 2 - 2 + 2 = 2$$

i.e. degree of freedom is two and system is bivariant.

(iv) $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$: It is two component system as composition of any phase can be explained with the help of two components by using a chemical equation. There are three phases (two solids and one gas phase).

i.e. $C = 2, P = 3$, hence applying the phase rule we get,

$$F = C - P + 2 = 2 - 3 + 2 = 1$$

i.e. degree of freedom is one and system is univariant.

(v) $S_L \rightleftharpoons S_V$: It is one component system (*i.e.*, sulphur) and there are two phases, S_L and S_V, hence applying the phase rule,

$$F = C - P + 2 = 1 - 2 + 2 = 1$$ and system is univariant.

(vi) Solution of cane sugar in a beaker at room temperature : Here there are two components *i.e.*, cane sugar and water (solvent) and phases are two *i.e.*, solution and vapour. Hence, applying the phase rule we get,

$$F = C - P + 2 = 2 - 2 + 2 = 2$$ and system is bivariant.

(vii) $S_R \rightleftharpoons S_M \rightleftharpoons S_V$: This is the one component system as S_R, S_M and S_V are different forms of the same chemical individual, sulphur. There are three phases (two solids S_R and S_M and one gas phase) *i.e.*, the degree of freedom is zero as,

$$F = C - P + 2 = 1 - 3 + 2 = 0 \text{ and system is non-variant.}$$

(viii) $NH_4Cl_{(s)} \rightleftharpoons NH_{3(g)} + HCl_{(g)}$: Here the number of components is one because each phase can be explained with the help of only one chemical component NH_4Cl. There are two phases *i.e.*, solid NH_4Cl and homogeneous gaseous mixture of $NH_{3(g)}$ and $HCl_{(g)}$ *i.e.*, $C = 1, P = 2$ and hence by applying the phase rule we get,

$$F = C - P + 2 = 1 - 2 + 2 = 1$$

i.e., the degree of freedom is one and system is univariant.

(ix) A mixture of benzene and water at room temperature : It is two component system *i.e.*, benzene and water with the help of which composition of every phase can be explained. There are three phases *i.e.*, two liquids (as benzene and water are immiscible) and one vapour phase. Thus, $C = 2$, $P = 3$ and hence applying the phase rule we get,

$$F = C - P + 2 = 2 - 3 + 2 = 1$$

i.e., the degree of freedom is one and system is univariant.

THANK YOU