

Lab(2) physical pharmacy

# the Phase Rule and Different Components

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- phase rule : is a relationship for determining the least number of variables required to define the state of the system.
- -phase :-is homogeneous physically distinct portion of the system which is separated from other parts of the system by bounding surfaces
- (e.g. **water** & its **vapor** is **one component two phase system**)



- × Number of component :is the smallest number of constituents by which the phase of equilibrium system can be expressed as a chemical formula or equation.

# Two component systems containing liquid phase

- -as we know ethyl **alcohol & water** are **miscible** in all proportions , while **water & mercury** are completely **immiscible** regardless the amount of each.
- Between these two extremes lie a whole range of system which **exhibit a partial miscibility ( or immiscibility)** such as **water & phenol** , as their miscibility affected by two factors **conc. & temp.**



# Two Component Systems Containing Liquid Phases:



ethyl alcohol and water



phenol and water



water and mercury

## Phenol and water system:



miscible

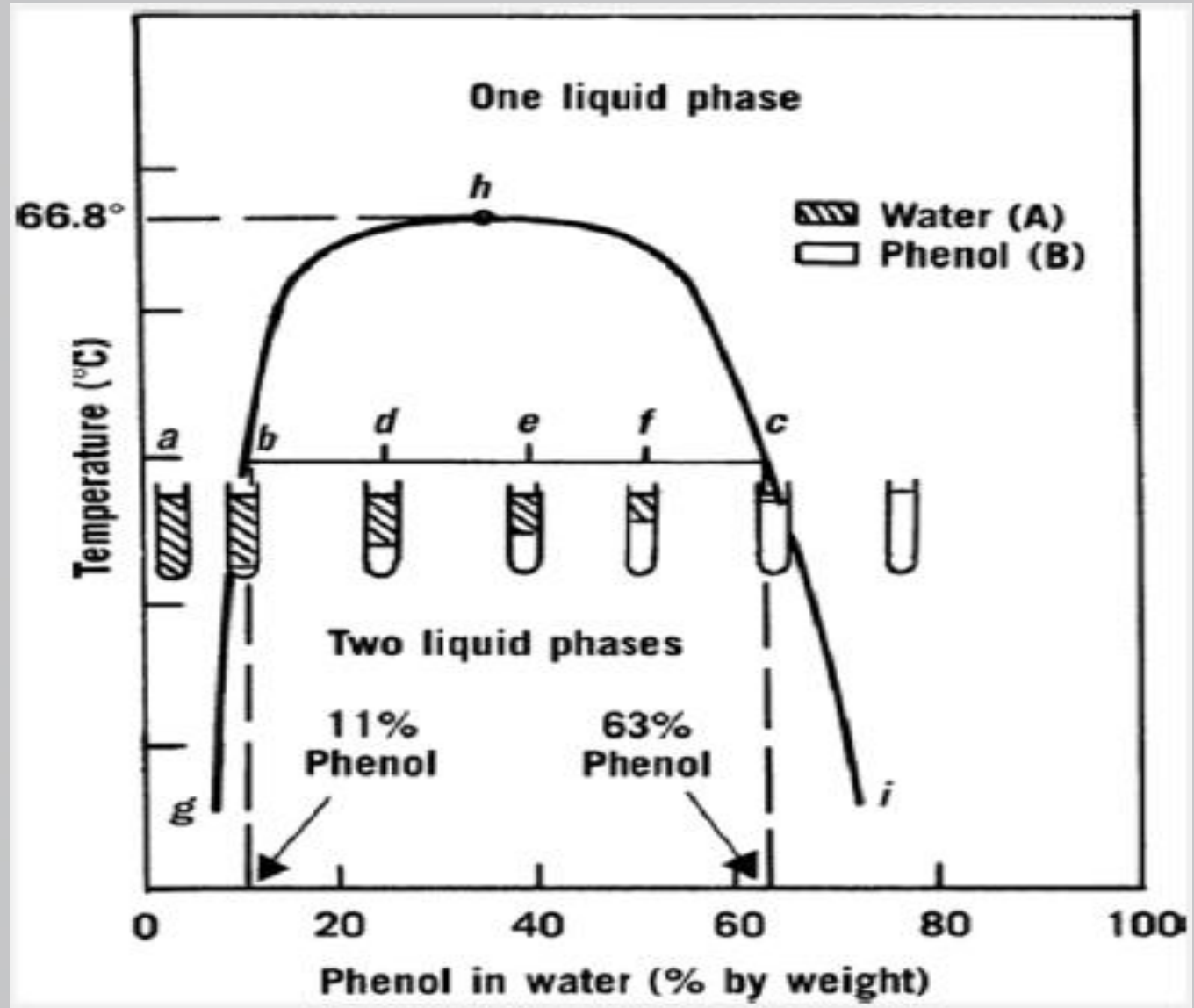


Partially miscible

Two factors affecting miscibility

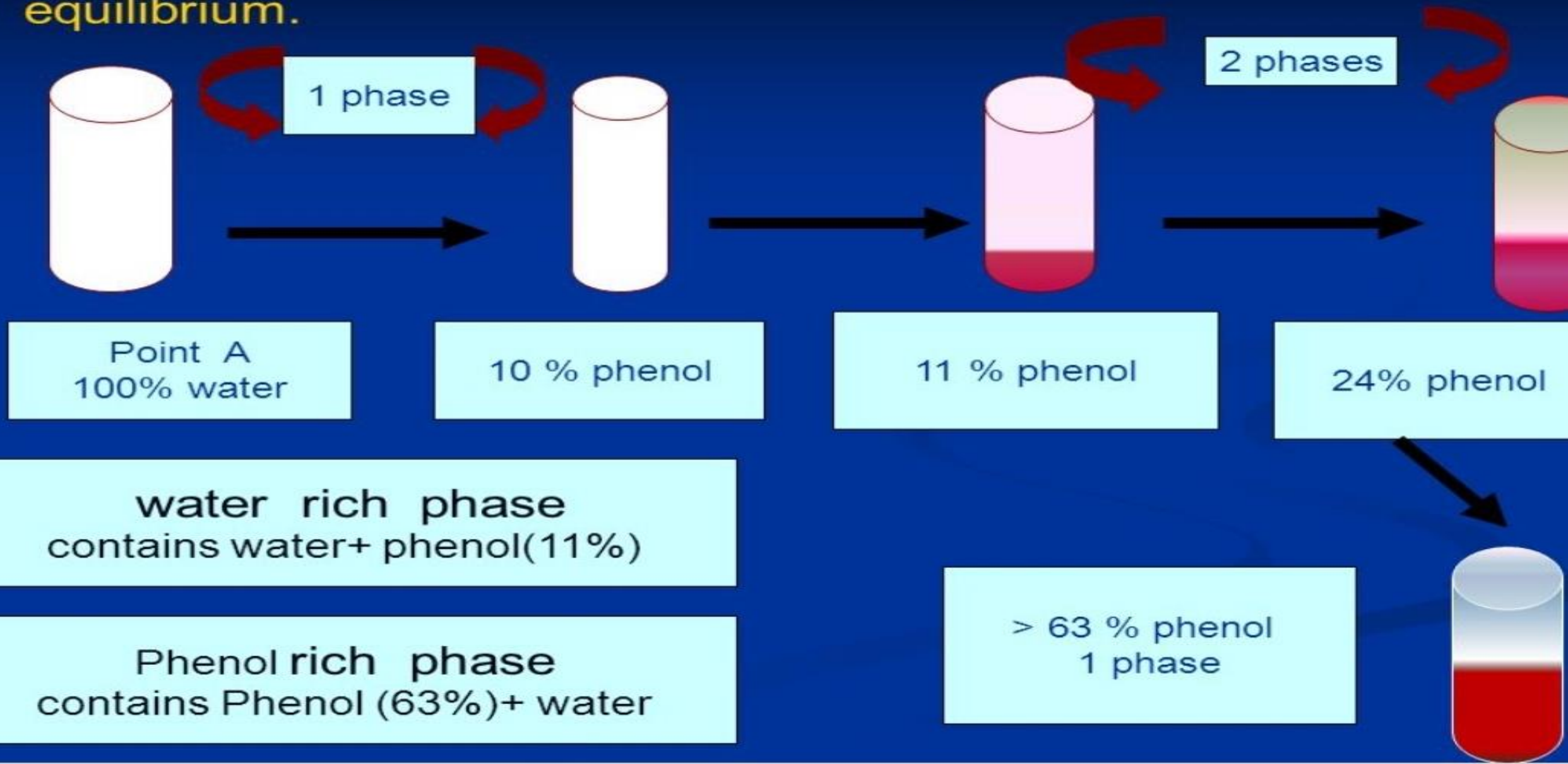
- 1- **Concentration of phenol in water.**
- 2- **Temperature.**

To see the effect of temp. & conc. ,we draw graph paper of temp. versus conc.





The curve *g b h c i* shows limits of temperature and concentration within which two liquid phases exist in equilibrium.



**binodal curve** :- is the curve that separates two phase area from one phase area .

**-tie line** :- is the line drawn across the region of two phases (conjugate phases ) as each temp. has its own tie line.

**-upper consolute temp. or critical solu. Temp.** :- is the maximum temp. at which two phase region exists .

**Water & phenol system it is 66.8 as all combinations above this temp. is completely miscible & give one phase system.**

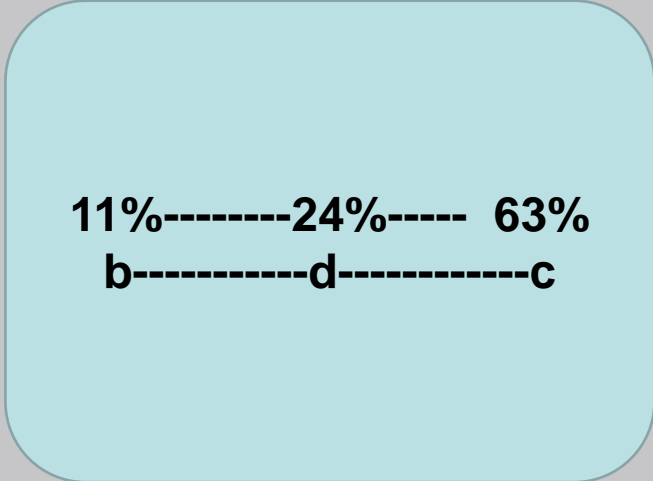
**-mass ratio**:-is the relative amount by wt. of conjugate phase ,it depends on the position in tie line & temp.



**properties of the tie –line in two component systems:-**

- 1-it is parallel to the base line
- 2-all systems prepared along the tie line at equilibrium separated into two conjugate phases of constant composition.

For instance, consider a system containing 24% by weight of phenol and 76% by weight of water (point d in the diagram). At equilibrium two liquid phases have been presented in the tube. The upper one, A, has a composition of 11% phenol in water (point b on the diagram), whereas the lower layer, B, contains 63% phenol (point c on the diagram). The relative weights of the two phases can be calculated by the equation



$$\frac{\text{Weight of phase A}}{\text{weight of phase B}} = \frac{\text{Length dc}}{\text{Length bd}}$$

$$\frac{63-24}{24-11} = \frac{39}{11} = \frac{3}{1}$$



## advantages of binodal curve :-

Binodal curve or phase diagram is used to formulate systems containing more than component in single liq. phase product

Q: At 25 C a tie line 7%-----70% (w/w)% phenol in water, find the mass ratio and the composition of each phase of 40% w/w phenol by water at this temperature, note that the **total weight is 10 gm**?

7%-----40%-----70%

b-----d-----c

$$\frac{\text{Wt of A}}{\text{Wt of B}} = \frac{\text{length dc}}{\text{length bd}} \rightarrow \frac{70-40}{40-7} = \frac{30}{33} = \frac{10}{11} \quad (\text{mass ratio})$$

10+11=21 (total parts)

10      21

x      10 (total wt.)      x = 4.76 gm wt of phase A (water rich layer)

10-4.76 = 5.24 gm wt of phase B (phenol rich layer)

If we want to know the amount of phenol and water in each phase (composition)

**For phase A (water rich layer)**

7      100

X      4.76      x = 0.33 gm of phenol in A

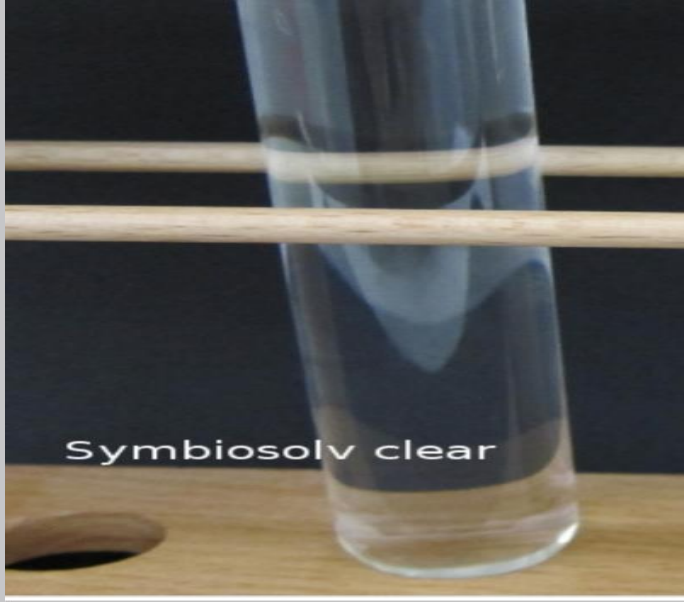
4.76-0.33 = 4.42 gm of water in A

**For phase B (phenol rich layer)**

70      100

X      5.24      X = 3.6 gm of phenol in B

5.24- 3.6 = 1.57 gm of water in B



## Procedure:

**Prepare the following percent W/W phenol/water(10 gm total) 2%,7%,9%,11% ,24%,40%,55 %,63%,70%,75%.**

**Put test tube in a fixed temperature in water bath (25 C<sup>0</sup>) or (left test tube at room temp.) and keep it for 10 minutes at that temp.**

**Take the test tubes out and before their temp has changed record which one has 2 phases and which has one phase.**

**Repeat the work at higher temp using the following temp.40C<sup>0</sup>, 50C<sup>0</sup>, 70C<sup>0</sup>.**

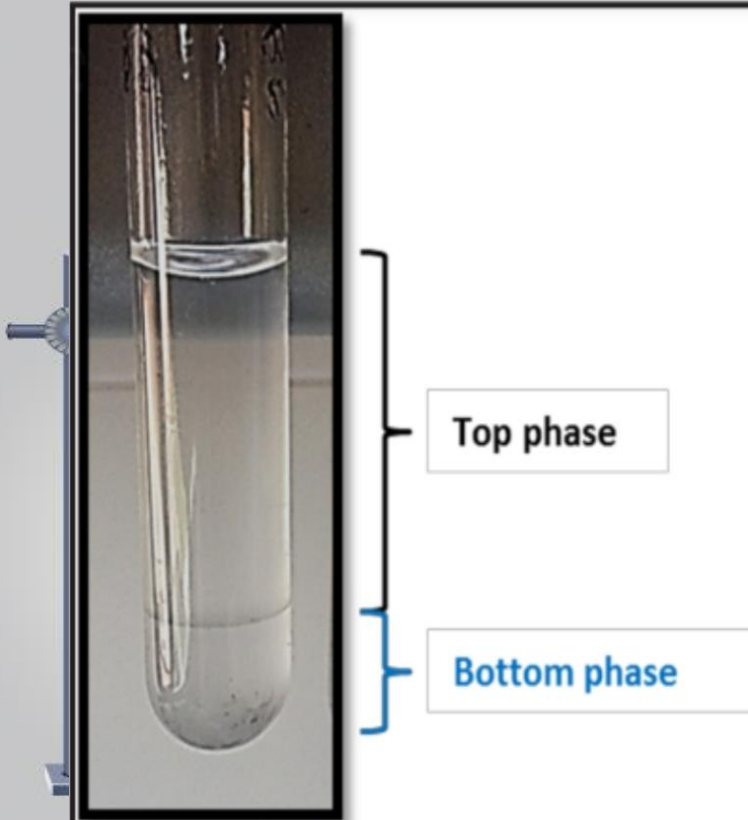
**Draw a curve temp verses concentrations showing your 2 phases area and one phase area in the curve.**

**Draw tie line for each temp.**

**Take 40% W/W for example to find the mass ratio and the composition of each phase at different temp.**

**Mention the upper consolute temp**

2 gm 100 gm  
X 10gm  
X=0.2 gm of  
phenol  
10-0.2=9.8gm  
water



*The results of two components (phenol +water)*

Temp	2%	7%	9%	11%	24%	40%	55%	63%	70%	75%
25C°										
40C°										
50C°										
70C°										





**THANK YOU  
FOR  
LISTENING**

