وزارة التعليم العالي والبحث العلمي
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مختبر الصيدلة الفيزياويه I / المرحلة الثانية

Two component systems containing liquid phases

Lab2

General Definitions

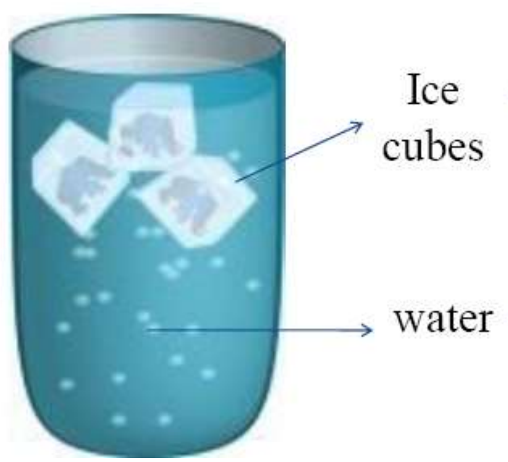
Component : is a substance in a system with a defined chemical structure.

Phase : is a homogenous, physically distinct and mechanically separable portion of the material with a given chemical composition and structure. It is separated from other portions in the system by a boundary.

A single-phase system is called **homogeneous system**

A two or more phase systems are called **mixtures** or **heterogeneous** systems.

A phase may contain one or more components



Ice + water system is One component (Two Phase system)

Ice+ water + vapor system is 1 component and 3 phase system

Solubility vs. Miscibility

- ✓ Solids are soluble in liquids
- ✓ Liquids are miscible in liquids

Types of miscibility

- Miscible (e.g. Ethanol and water)
- Non Miscible (e.g. Mercury and water)
- Partially Miscible (e.g. Phenol and water)

phase diagram of two partially miscible liquids (phenol and water)

1. Experimental set up

Objective

To determine the solubility of 2 partially miscible liquids (phenol and water) and construct phase diagram of such system

Procedure

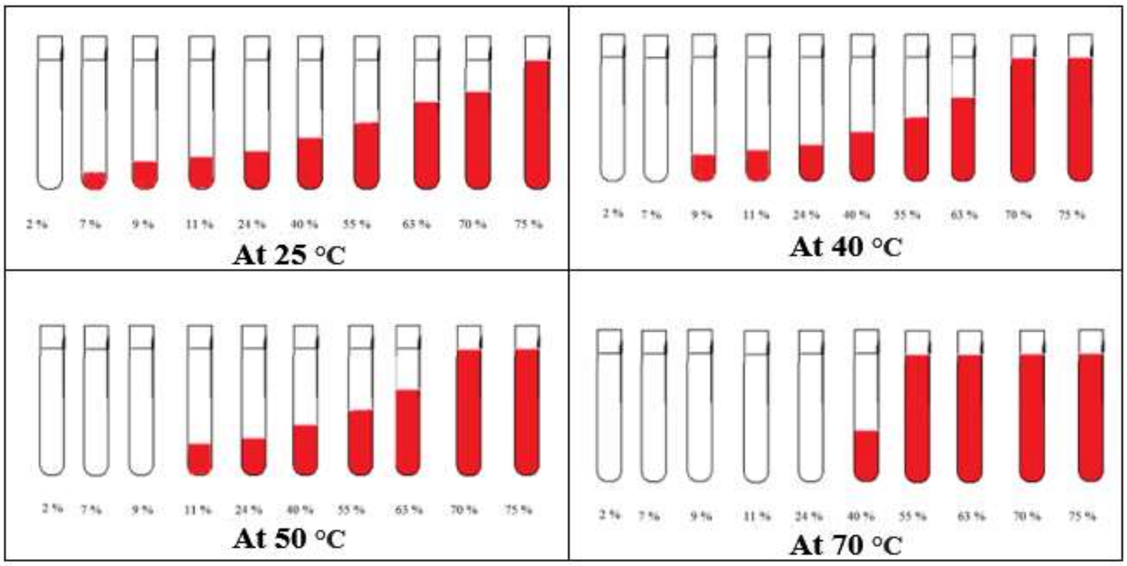
- Prepare a number of **different concentrations** of phenol and water.
- Put test tube in a fixed temperature in water bath (25 ^{0}C) for 10 minutes. During heating , seal the test tubes with rubber stoppers and heat. Remove the stopper from time to time to release excess pressure and shake the mixtures
- Observe test tubes and record at which concentration there is a **one phase** system and at which concentration there is a **two phase** system.
- Repeat your observation at different increasing temperatures of 40°C, 50°C, and 70°C.

Test tube no.	phenol in water (%w/w)	Phenol weight (gm)	Water weight (gm)
1	2	0.2	9.8
2	7	0.7	9.3
3	9	0.9	9.1
4	11	1.1	8.9
5	24	2.4	7.6
6	40	4.0	6.0
7	55	5.5	4.5
8	63	6.3	3.7
9	70	7.0	3.0
10	75	7.5	2.5

2. Tabularization of Results

Temperature (°C)	Concentration (w/w)									
	2 %	7 %	9 %	11 %	24 %	40 %	55 %	63 %	70 %	73 %
25										
40										
50										
70										

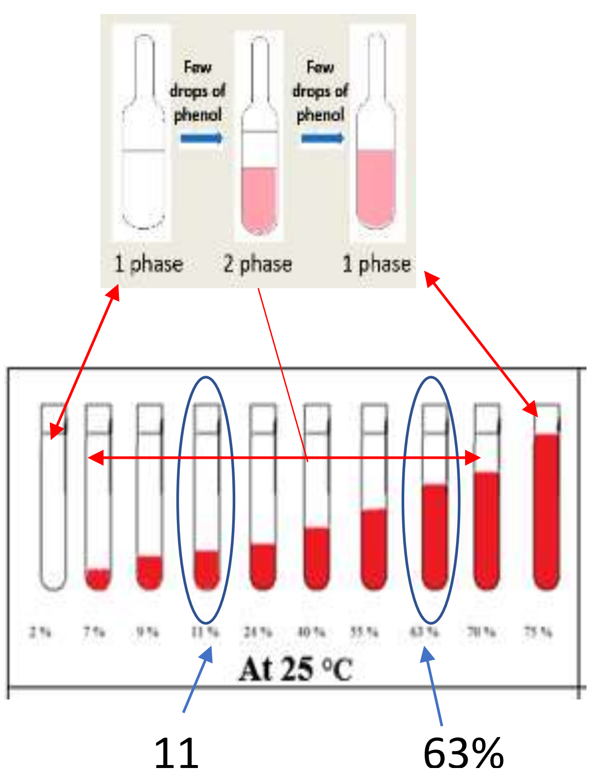
Number of phases obtained for varying (% w/w) concentrations of phenol in water at different temperatures



Factors affecting miscibility of phenol in water

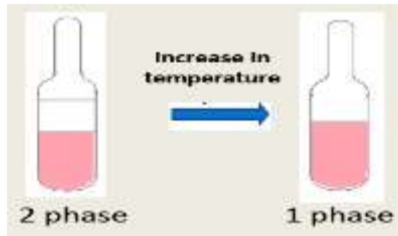
1-Concentration

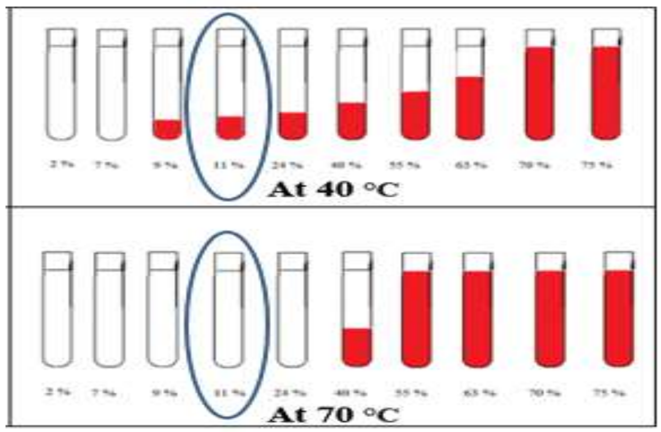
The proportion of **phenol-rich layer** relative to the water-rich layer **increases** as the concentration of phenol added increases



2-Temperature

Normally the mutual miscibility of liquid components increases with increasing temperature





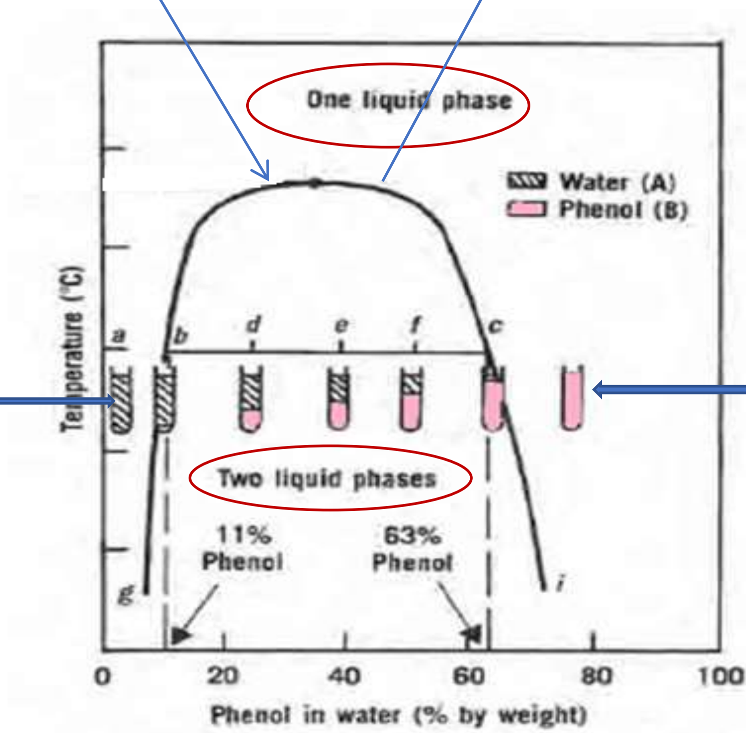
3. Constructing of phenol/water phase diagram

Phase diagram (also called binodal curve; equilibrium or solubility diagrams) . Is a graphical representation summarizing the relationship Binodal curve separate the two phase area from the one phase area. temperature, concentration…) at equilibrium

- **Binodal curve separate the two phase area from the one phase area.**

Any point on the boundaries of binodal curve represent a system of 2 phases existing in dynamic equilibrium

At low (< 11%) of phenol, water and phenol mix completely ,forming a single liquid phase



At high (> 63%) of phenol, water and phenol mix completely, forming a single liquid phase

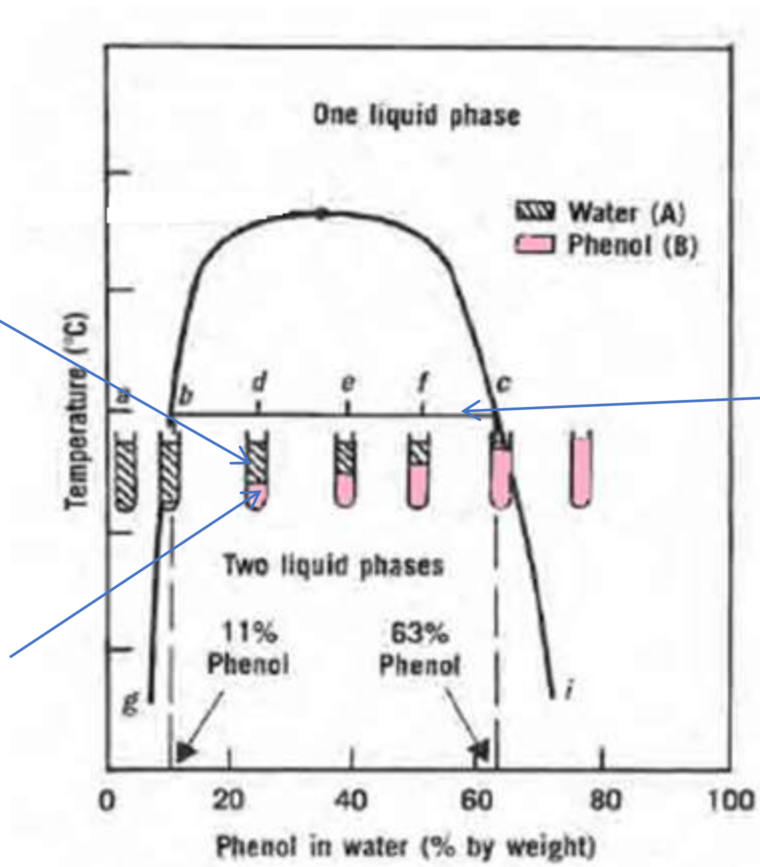
Binodal curve separate the two phase area from the one phase area.

Tie line determination

- At **intermediate** compositions, mixtures of phenol and water separate into **two liquid phases** coexisting together and known as **“conjugated solutions”.**
- As we proceed across the diagram from point **b** to point **c**, the amount of the phenol-rich phase (B) continually increases and at the same time the amount of the water-rich phase (A) decreases

Water rich phase (A)

Phenol rich phase (B)



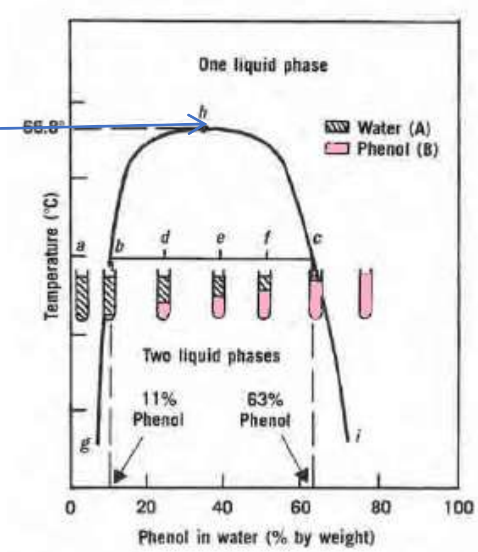
The line connecting the coexisting liquids is known as “**the tie line**”.

It is drawn across the region containing **2 phase system of constant composition.**

Tie line is always parallel to the base line in 2 component

Determination of critical solution temperature of phenol/ water system

- Point "h" in the figure is **the critical point** and the corresponding temperature on the y-axis is known as "**critical solution temperature (CST)"** or "**upper consolute temperature"**



- For phenol/water system, the CST is 66.8 ^{0}C
- CST is defined as the maximum or highest temperature **at which phase separation occurs .**
- Above the CST, phenol and water are completely miscible , and give one phase liquid systems in any ratio.

Advantages of Constructing a Phase Diagram

For a given system at a given temperature and composition, we can use phase diagram to determine

1. The number of phases that are present
2. Determine the critical solution temperature
3. Determine the tie line and from it determine the relative fractions of the phases (and full compositions of the phases)