Al-Mustaqbal University College

Department of Pharmacy

Second Stage

Physical Pharmacy Laboratory

First Semester – Fourth Experiment

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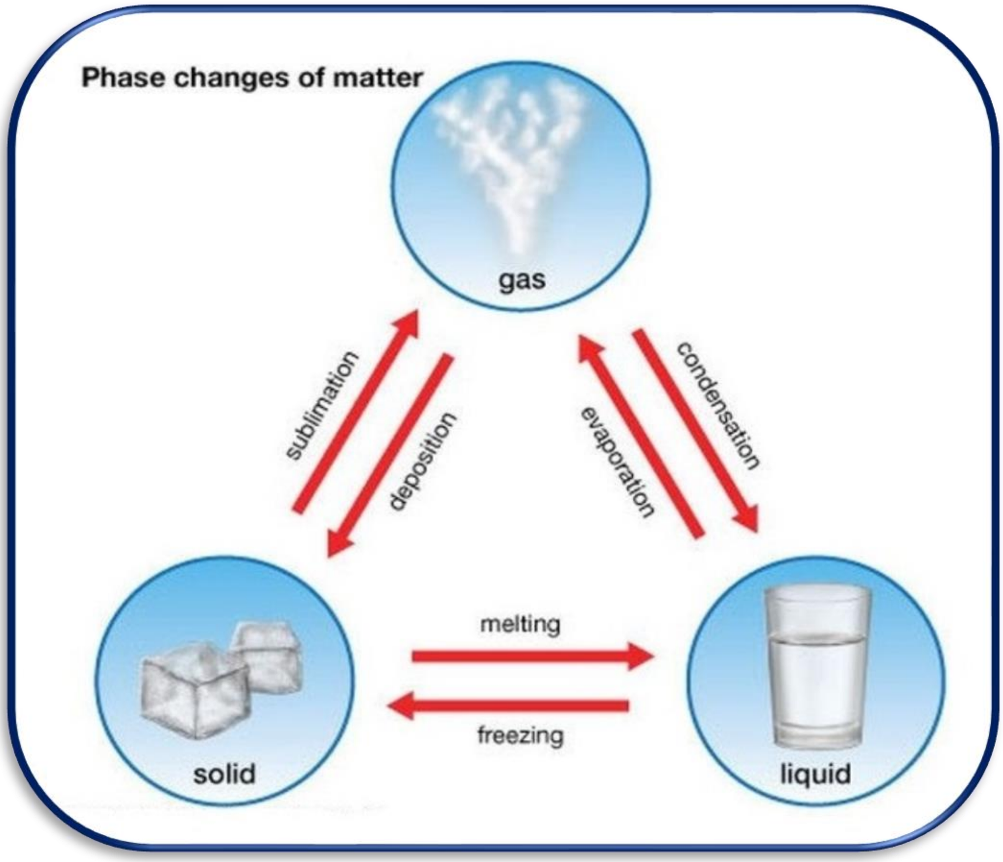
Two components system containing liquid phases

The **three primary phases (solid, liquid, and gaseous)** of matter are often defined individually under different conditions, but in most systems, we usually encounter phases in coexistence.

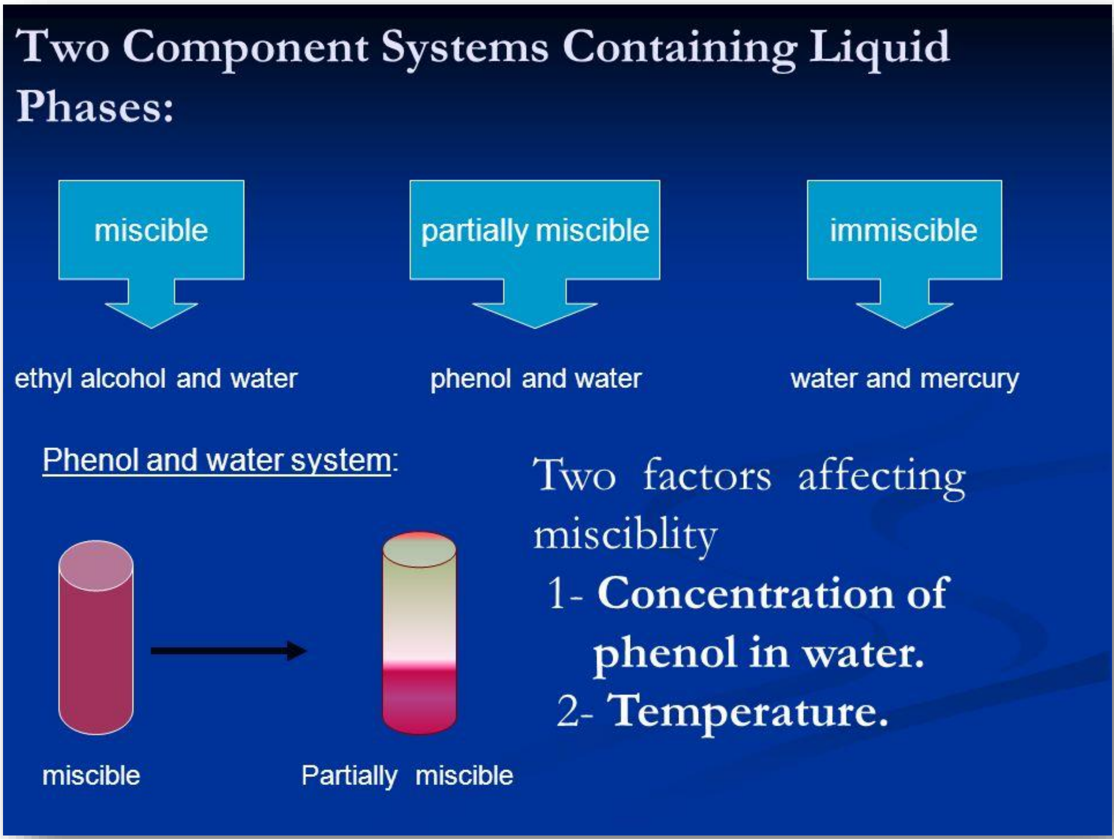
For example, a glass of ice water on a hot summer day comprises three coexisting phases: ice (solid), water (liquid), and vapor (gaseous).

The amount of ice in the drink depends heavily on several variables including the amount of ice placed in the glass, the temperature of the water in which it was placed, and the temperature of the surrounding air.



When two liquids are mixed together, one of the following cases may arise:

1. **The two liquids are completely miscible** in all proportions yielding one homogeneous liquid phase, for example alcohol and water.
2. **The two liquids are partially miscible** yielding either one or two liquid phases, depending on the conditions, for example phenol and water.
3. **The two liquids are practically immiscible** yielding always two distinct phases under ordinary condition, for example mercury and water.



When equilibrium exists between a number of phases under external controlling conditions such as temperature, pressure, and concentration, according to the following equation:

$$F = C - P + 2$$

Where **F:** number of degrees of freedom.

C: number of components in the system.

P: number of phases in equilibrium.

Above equation called the ***phase rule*** which relates the phases, components and degrees of freedom of the system. The different terms used in the equation may be defined as follows:

Phase: is defined as any homogeneous and physically distinct part of a system which is separated from other parts of the system by defining bounding surfaces. Number of components are a smallest number of chemical constituents to define the system.

The number of degrees of freedom: is the number of variable factors, such as temperature, pressure and concentration, which need to be fixed in order to completely define the conditions of a system in equilibrium.

When 2 partially miscible liquids are mixed and shaken together, we get 2 solutions of different compositions. For example, on shaking phenol and water, we get 2 layers: **the upper layer** is a solution of **water in phenol**, and the **lower layer** is a solution of **phenol in water**. At a fixed temperature, the composition of each solution is fixed, and both the solutions are in equilibrium.

Above a specific temperature, such solutions are completely miscible in all proportions. Such a temperature is known as the ***Critical Solution Temperature (CST)***.

Glassware and Equipment

1. Hot Plate
2. Hard Glass Test tubes.
3. Thermometer.
4. Stirrer.
5. Beakers.
6. Volumetric flask.
7. Pipette.

Chemicals

1. Phenol.
2. Distilled Water.

Procedure

1. In eight test tube prepare 80 %, 70 %, 60 %, 50 %, 40%, 30 %, 20 % and 10 % of phenol.
2. Heat the solution tube in a beaker containing water on the hot plate or in the water bath to increase the temperature through heating.
3. At a certain temperature, the mixture becomes clear. Note this temperature (T_1 °C).

4. Remove the tube from the hot plate, and allow the solution to cool down slowly. Note the temperature at which the turbidity re-appears (T_2 °C).
5. Repeat Steps 2 to 4 for each phenol concentration.

Calculations

1. List results in table:

Phenol %	T_1 °C	T_2 °C	Average T °C $\frac{T_1 + T_2}{2}$
80 %			
70 %			
60 %			
50 %			
40 %			
30 %			
20 %			
10 %			

2. Draw between component percentage (phenol%) with temperature to calculate CST.