University of Al-Ameed
College of Pharmacy

2nd stage , 1st Semester

Practical Physical Pharmacy

Tie line of Two component systems/Lab3

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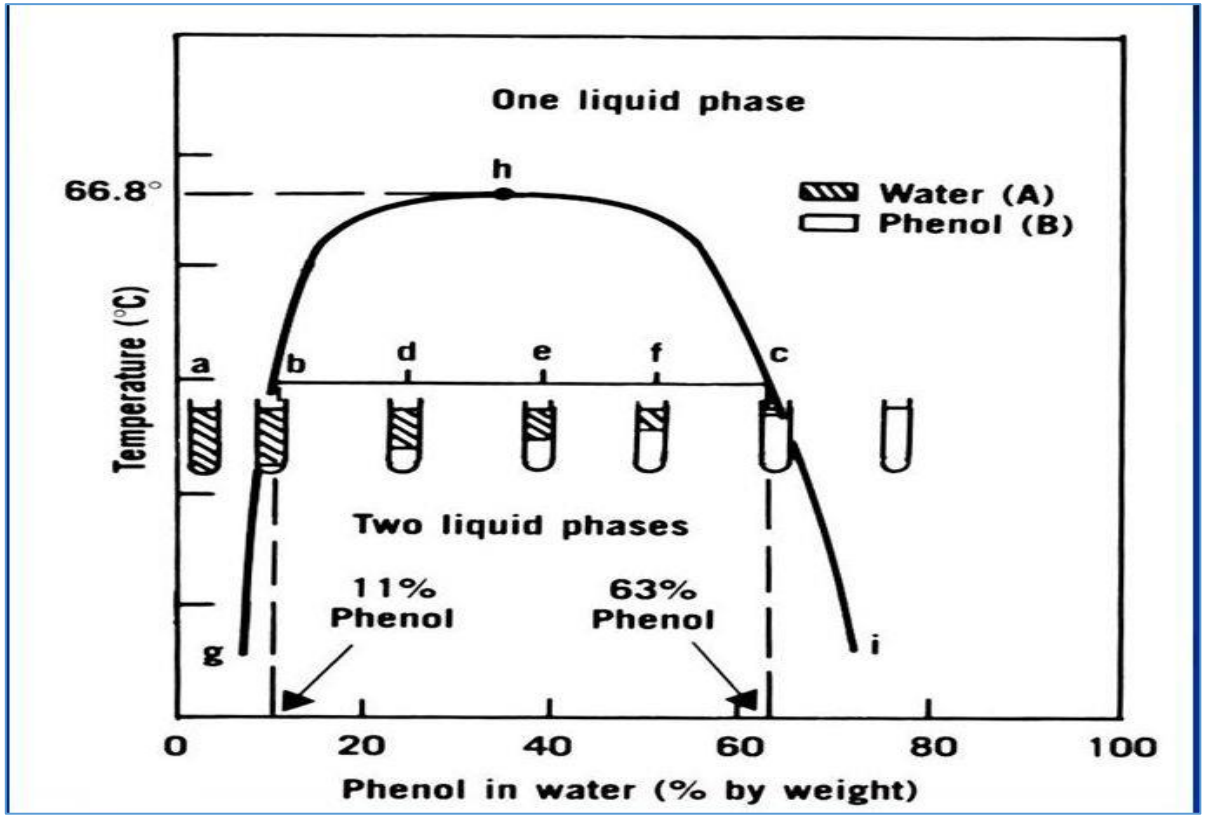
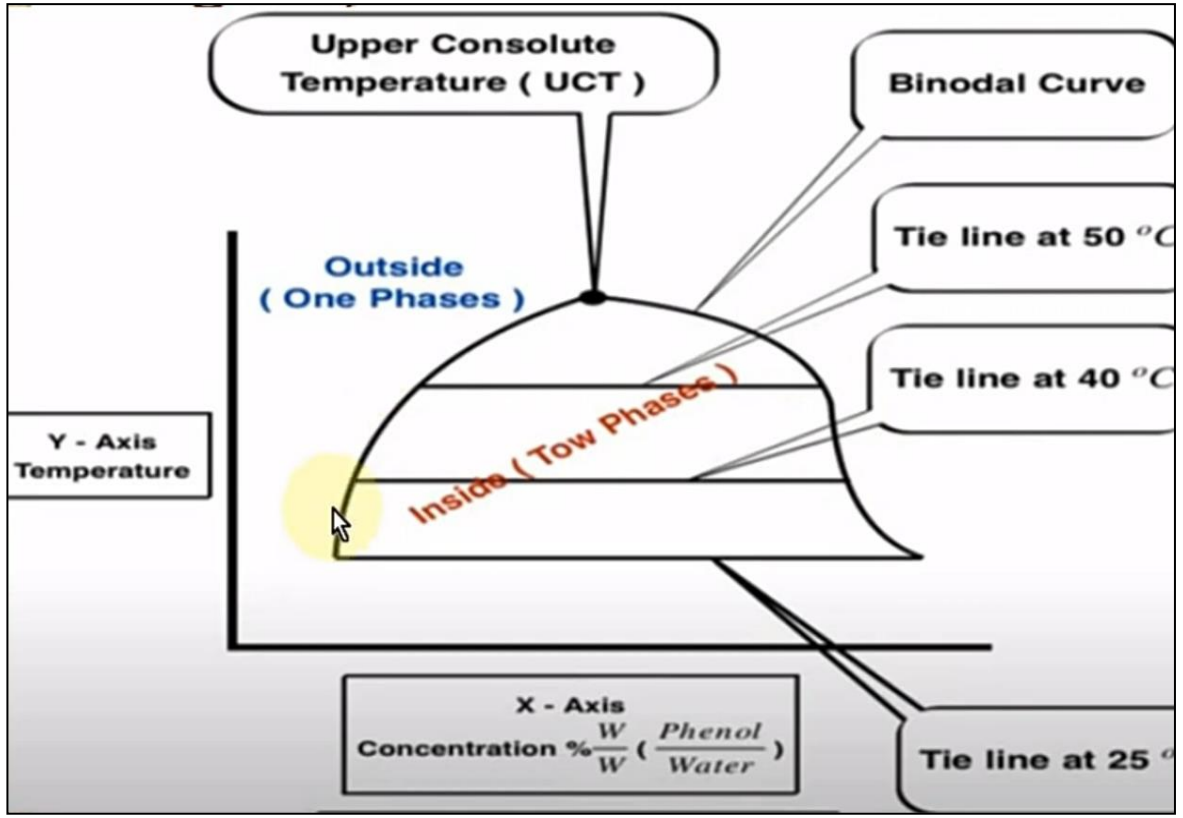
Tie line: is a line drawn across the phase diagram, any concentration laying on tie line are two phases at equilibrium and will have constant compositions at certain temperature as each temperature has its own tie line.



Phase diagram of phenol and water system



Binodal curve diagram (phase diagram)

- **Binodal curve:** is a curve that separate two phases area from one phase area, and any system inside the binodal curve is two phases system, while thus outside as one phase system.

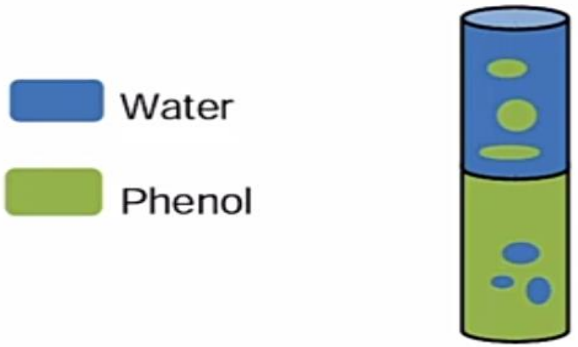
- **Upper Consolute Temperature (UCT):** is the temperature above which a miscible liquid (one phase) exists. Also it called critical solution temperature. For example water and phenol system, it is 66.8 °C as all combinations above this temperature is completely miscible and give one phase system.

- **Conjugated phases:** is two phases that existing in equilibrium at certain temperature and has a constant composition.

Properties of the Tie line in two component systems:

1. It is **parallel** to the **base**
2. All systems prepared along the Tie line at equilibrium will **separate into phases of constant composition**. These phases are termed conjugated phases.
3. **Cut the binodal curve at two points**, the first represents the concentration of phenol in aqueous layer and the second represents the concentration of phenol in phenolic layer.
4. The phase diagram enables us to **calculate the composition of each phase** in addition to the weight of the phases. Thus, it become a simple matter to calculate the distribution of phenol (or water) throughout the system as a whole.

CALCULATIONS



- Using the tie line, we can calculate :

1. Weight of aq. Layer
2. Weight of phenolic layer
3. Weight of phenol in aq. Layer
4. Weight of phenol in phenolic layer

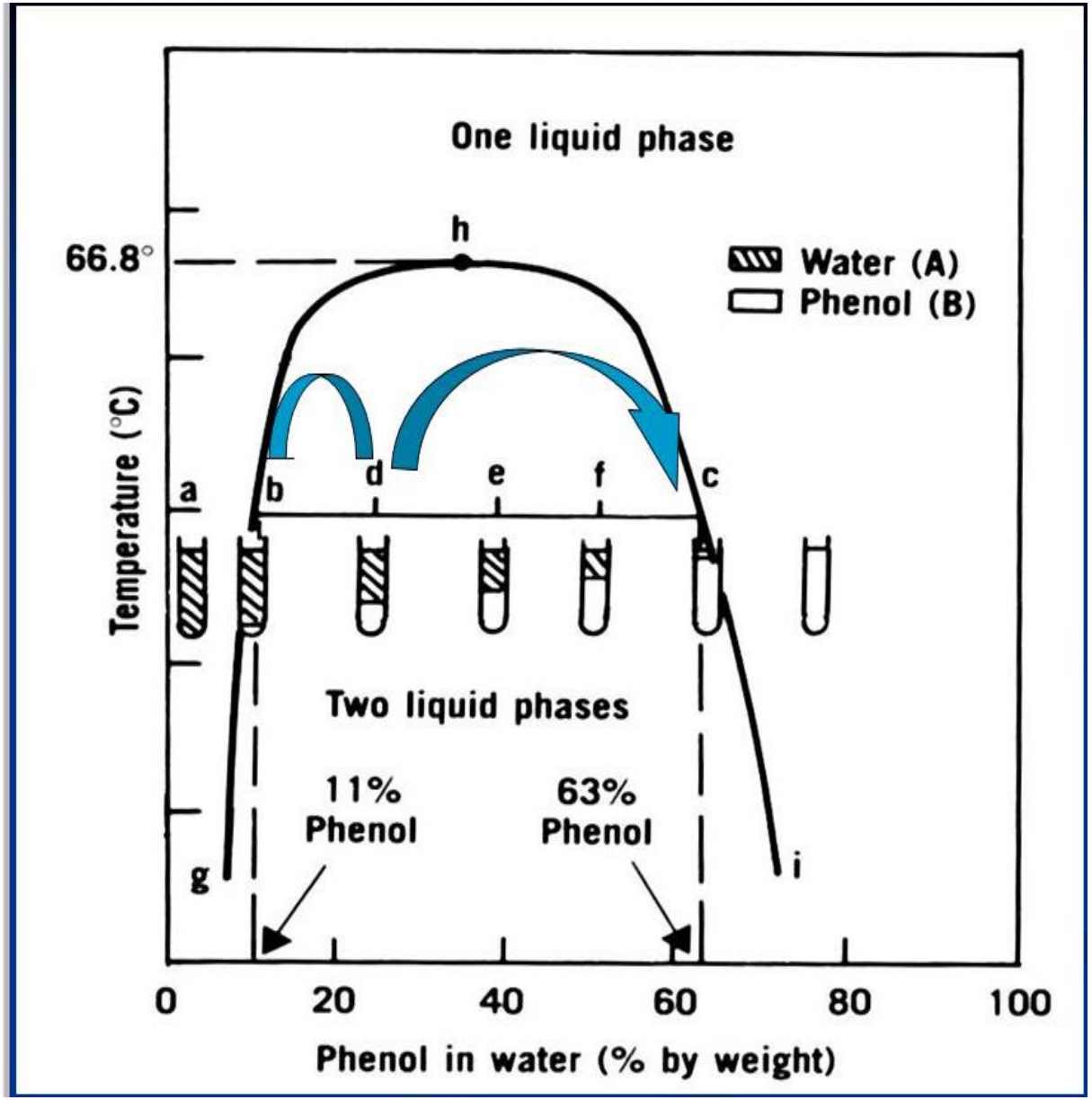
On the Tie line :

If the conc. Of phenol represent the point d then

$$\frac{wt.\ of\ aq.\ layer}{wt.of\ phenolic\ layer} = \frac{length\ dc}{length\ bd} = \frac{c-d}{d-b}$$

b= % of phenol in aq. Layer

c= % of phenol in phenolic layer



PROBLEMS

- A mixture of phenol and water at 20°C has a total composition of 50% w/w phenol. The tie line at this temperature cuts the bi nodal at points equivalent to 8.4% and 72.2% w/w phenol.

  What is the weight of the aqueous layer and of the phenol layer in 500 g of the mixture and how many grams of phenol are present in each of the two layers?

Solution

$$\frac{wt.of\ aq.layer}{wt.of\ phenolic\ layer} = \frac{72.2-50}{50-8.4} = \frac{22.2}{41.6}$$

Wt. % of aq. Layer $= \frac{22.2}{41.6+22.2} x\ 100 = 34.8\%$

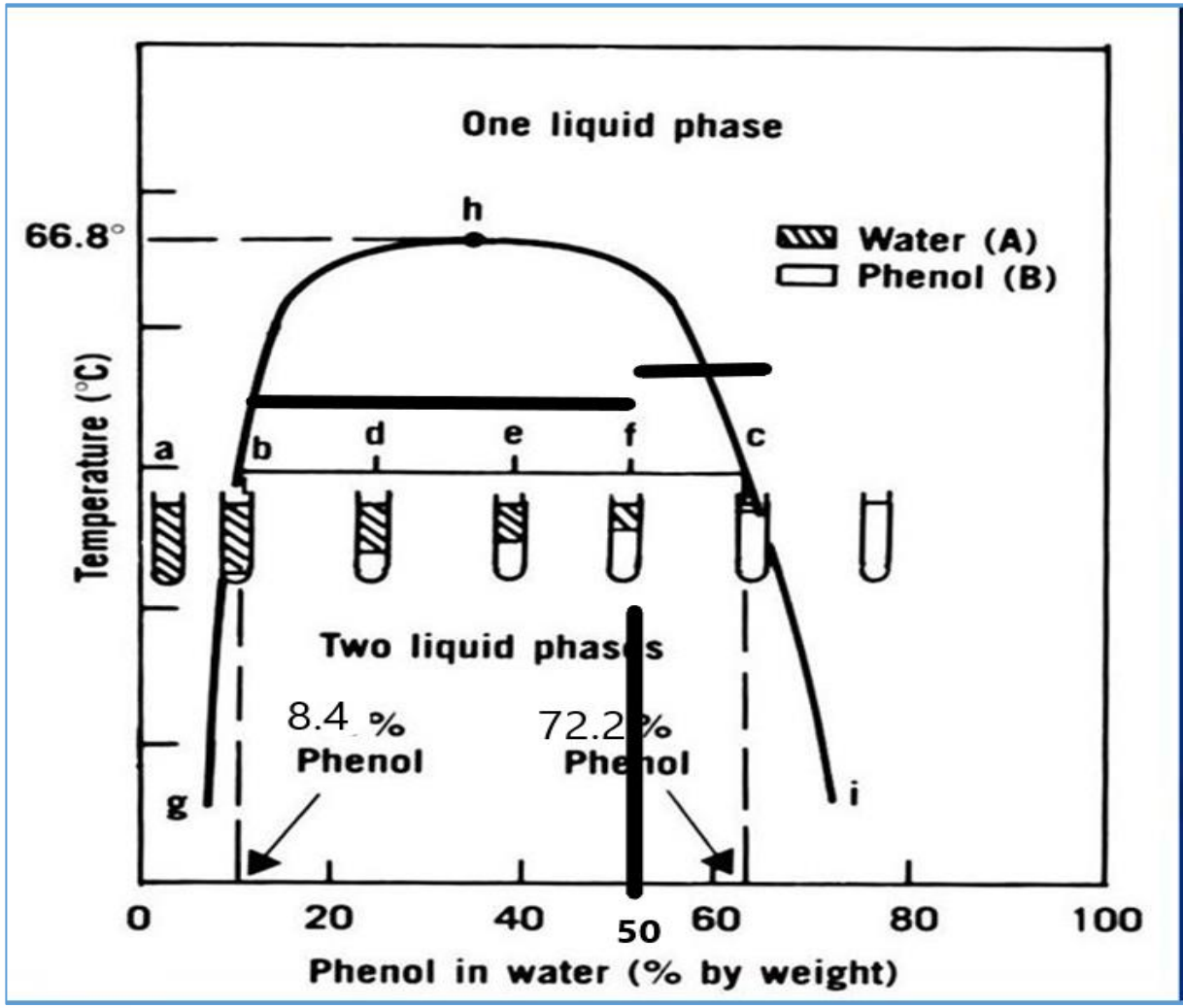
Wt. % of phenolic Layer $= \frac{41.6}{41.6+22.2} x\ 100 = 65.2\%$

Wt. of aq. Layer $= \frac{34.8}{100}\ x\ 500 = 174\ g$

Wt. of phenolic Layer $= \frac{65.2}{100}\ x\ 500 = 326\ g$

Wt. of phenol in aq. Layer $= \frac{8.4}{100} x\ 174 = 15\ g$

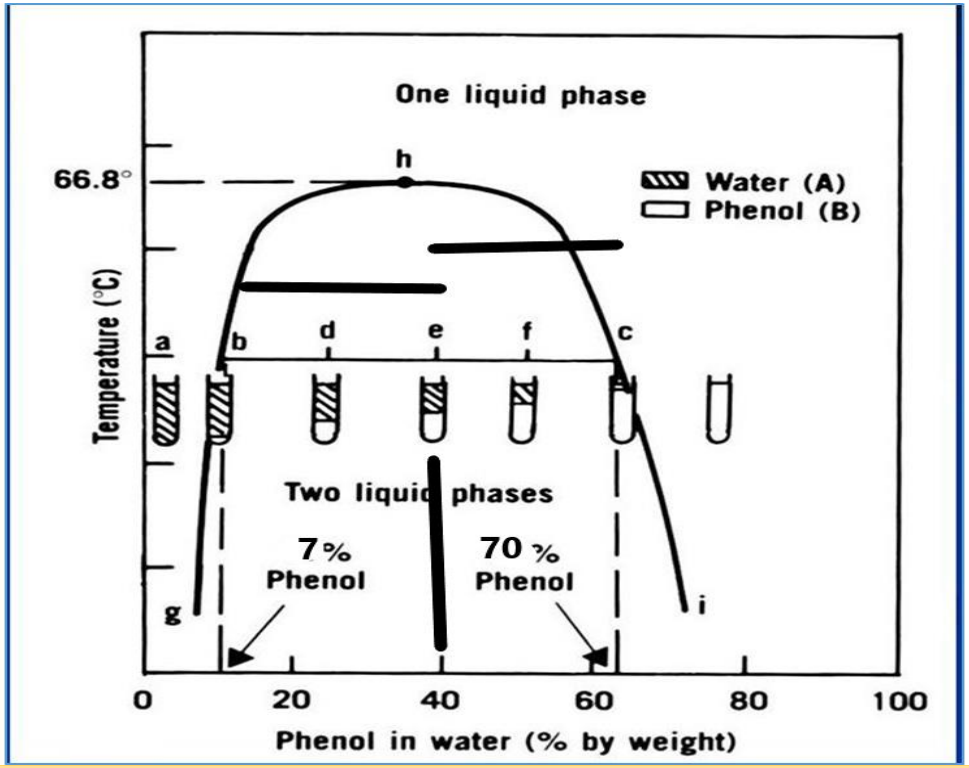
Wt. of phenol in phenolic Layer $= \frac{72.2}{100} x\ 326 = 235\ g$



Example:

Q: At 25 C a tie line 7% …… 70%, the mixture has a total composition of 40% w/w phenol by water at this temperature, note that the total weight is 10gm, Calculate the following:

1. Weight of phenol at 40% w/w phenol
2. Mass ratio of each phase
3. Weight of phenol in aqueous layer
4. Weight of phenol in phenolic layer



Solution:

1. **Weight of phenol = $\frac{40 \times 10}{100}$ = 4g**
2. $\frac{weight\ of\ aqueous\ layer}{weight\ of\ phenolic\ layer} = \frac{70-40}{40-7} = \frac{30}{33}$

   $\%\ of\ aqueous\ layer = \frac{30}{30+33} \times 100 = 47.6\%$

   $\%\ of\ phenolic\ layer = \frac{33}{30+33} \times 100 = 52.4\%$

   Weight of aqueous layer = $\frac{47.6}{100} \times 10 = 4.8g$

   Weight of phenolic layer = $\frac{52.4}{100} \times 10 = 5.2g$
3. **Weight of phenol in aqueous layer = $\frac{7}{100}$ × 4.8= 0.4g**
4. **Weight of phenol in phenolic layer = $\frac{70}{100}$ × 5.2= 3.6g**

Experiment

Title:

Tie line of two component system

Aim:

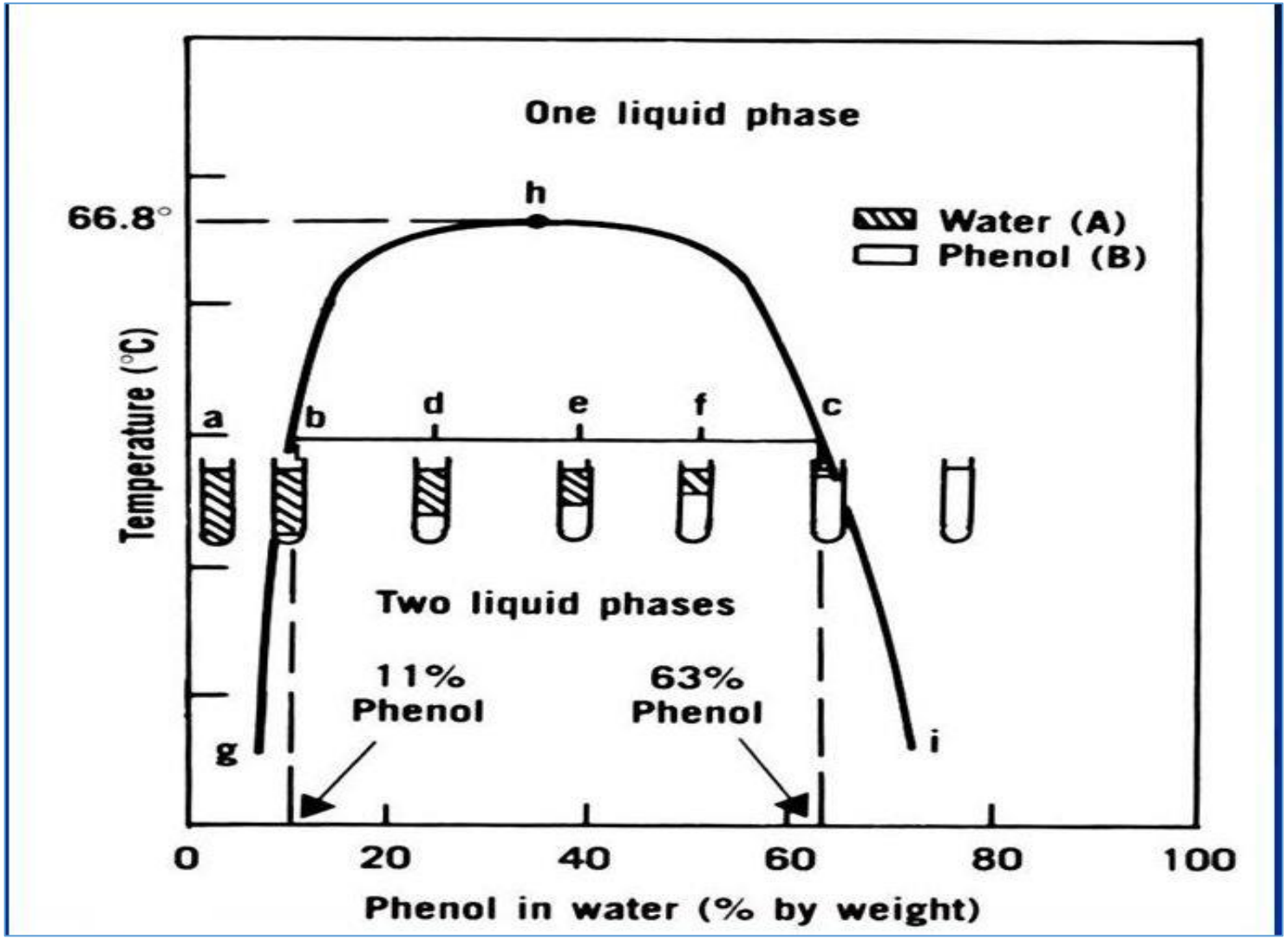
- To calculate the weight of each phase of the two component system. And calculate the weight of phenol in each phase.

Calculations

Calculations:

- Draw a curve temp. verses conc.
- 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 weight of each phase and component at different temp.
- Mention the upper consulate temperature.

Results:


One liquid phase
66.8°
h
Water (A)
Phenol (B)
Temperature (°C)
a
b
d
e
f
c
Two liquid phases
11%
Phenol
63%
Phenol
g
i
0
20
40
60
80
100
Phenol in water (% by weight)

Thank You