LAB NO. 4:

The tie – line for three component system

Done By:

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Ternary systems with one pair of partially miscible liquids:-

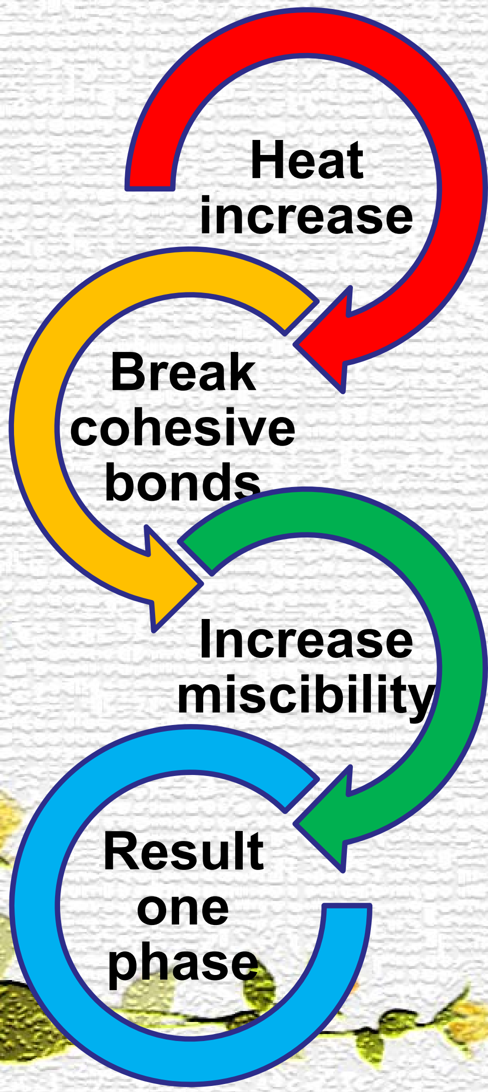
- **Water & benzene** are miscible only to a slight extremes so a mixture of the two usually **produces 2 phase system** the *lower* layer consist of **water saturated with benzene** while the *lighter* phase (upper) consist of **benzene saturated with water** .

Ternary systems with one pair of partially miscible liquids:-

- **On the other hand,** alcohol is completely miscible with both benzene & water .it is expected ,therefore, that the addition of sufficient alcohol to 2 phase of water & benzene will **produce single phase system** in which all the three component are miscible.
- **It might helpful to consider alcohol as acting in manner comparable to that of Temperature in binary system of phenol & water .**

- As **heat** used to break the **cohesive** forces between molecules → **miscibility increase** until one phase result ,
- the addition of alcohol to benzene-water mixture achieves the same but by different means namely **solvent effect** instead **of temperature effect** . In this case alcohol **serves as intermediate polar solvent** that shifts the **electric equilibrium of the dramatically opposed** highly polar water & non-polar benzene solution to **provide solvation .**

2 component system



3 component system

Alcohol addition to:

- water
- benzene

Solubilize the mixture

- One phase

Note:

Adhesive: means force between Alike molecules

Cohesive: means force between Like molecules

The tie line with the binodal are ***not necessarily parallel*** to one another or to the base line as in binary systems ,in fact the direction of the tie line are related to the shape of binodal curve ,which in turn depends on the solubility of the third component (i.e. alcohol) in the other two components .

only when the added component acts *equally* on the other two component to bring them into solution
Will the binodal perfectly symmetrical & the tie line run parallel to the base line .

Properties of the tie line of three component system :-

1- any system prepared a long the tie line both give rise two phase having a constant composition.

2- the relative amount by weight of the two conjugate phases will depends on the position of the original system along the tie line.

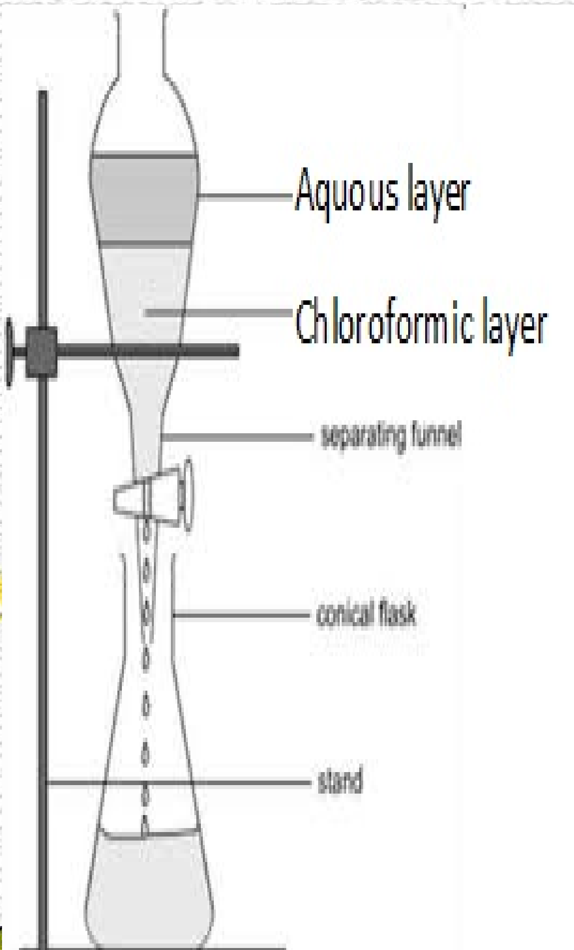
Materials and equipment:-

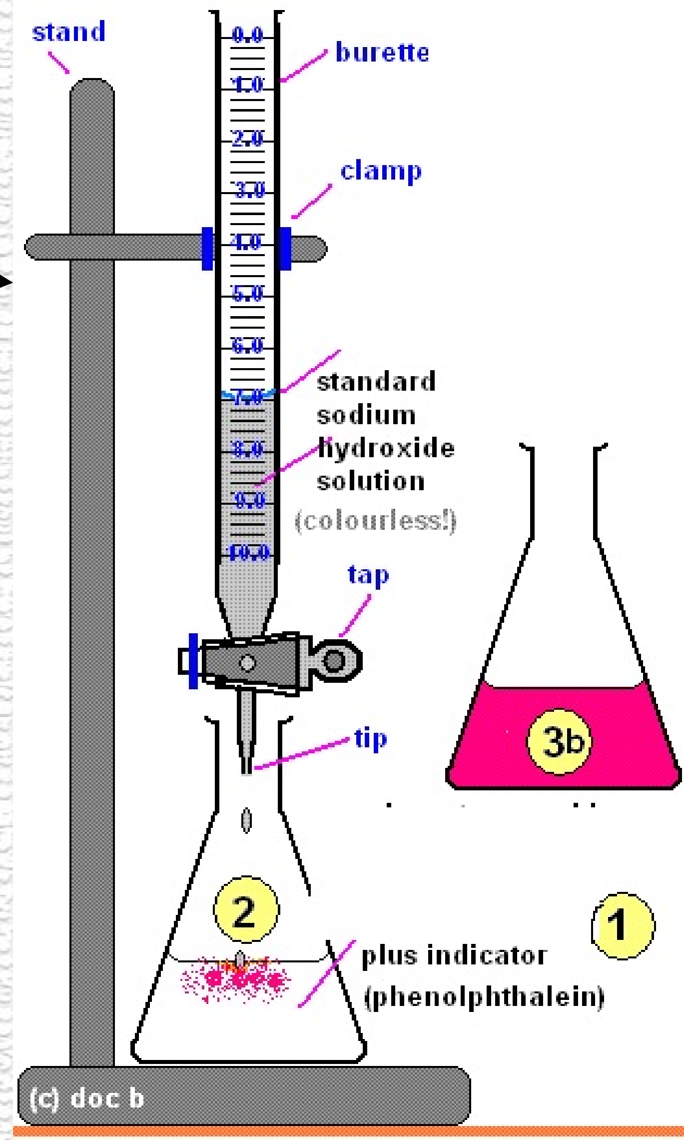
- 1- $H_2O, HAC, CHCl_3$, 1N NaOH solution, phenolphthalein indicator.
- 2- Burette, separatory funnel, conical flask, balance.

Procedure:-

- In a small separatory funnel prepare 50 gm of a mixture having composition giving rise to a two phase system (e.g. 4gm HAC+16 gm CHCl3 +30gm H2O).
- Separate each layer in two conical flasks.
- Weigh 10 gm for each layer.
- Titrate each layer with standard 1N NaOH solution using phenolphthalein as indicator. The end point from colorless to pink.
- Obtain tie line, calculate the percent W/W of HAC in each layer and locate the values on the miscibility curve. The straight line joining these points should pass through compositions of the two phase system.

Mixture prepared
(4 ml of HAC) +(16\1.4 =11.4 ml CHCL3) +(30 ml H2O)





Calculation:-

- HAC + NaOH → NaAC + H2O
- 1 M.wt. of HAC= 1 M.wt. of NaOH
- 1 eq.wt of HAC = 1eq.wt of NaOH
- 60 = 1000 ml 1N NaOH
- 60/1000 = 1 ml 1N NaOH
- So, each 1 ml of 1N NaOH is equivalent to 0.06 gm, this is the chemical factor (it is the no. of gms of substance which is equivalent to 1 ml of standard solution).
- E.P 1 x0.06 =gm HAC in 10 gm aqueous layer (upper layer).
- E.P 2 x 0.06 =gm HAC in 10 gm CHCl3 layer (lower layer).
- Change these values to percent

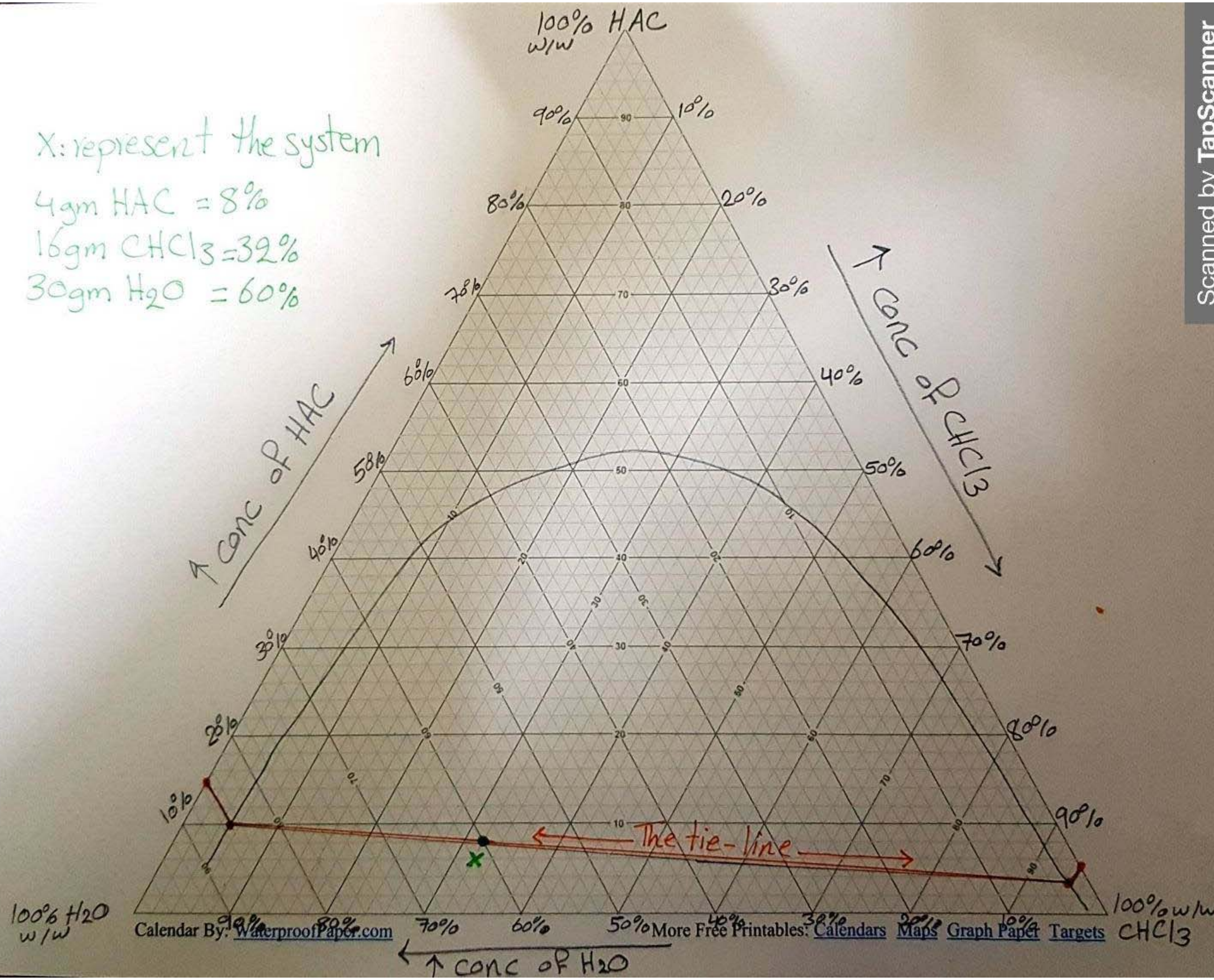
No. of grams of HAC= E.P(mL of NaOH added)× Ch.F

- Upper layer (between HAC and H2O)
- wt. of HAC total vol.
- No. of grams 10 mL of HAC
- X 100 mL
- X= ? % w/w of HAC
- 100% - X% = ?% w/w of water

- Lower layer (between HAC and CHCl3)
- wt. of HAC total vol.
- No. of grams 10 mL of HAC
- X 100 mL
- X= ? % w/w of HAC
- 100% - X% = ?% w/w of CHCl3

- Upper layer
- We assume NaOH= 25 mL× 0.06
- 1.5 gm 10mL
- X 100%
- X= 15% acetic acid
- 100%- 15%= 85% water

- Lower layer
- We assume NaOH= 8.5 mL× 0.06
- 0.51 gm 10mL
- X 100%
- X= 5% acetic acid
- 100%- 5%= 95% CHCl3


X: represent the system
4gm HAC = 8%
16gm CHCl3 = 32%
30gm H2O = 60%
100% HAC w/w
90%
10%
80%
20%
70%
30%
60%
40%
50%
50%
40%
60%
30%
70%
20%
80%
10%
90%
↑ conc of HAC
↑ conc of CHCl3
The tie-line
100% H2O w/w
100% w/w CHCl3
90%
80%
70%
60%
50%
40%
30%
20%
10%
↑ conc of H2O
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Note:-

- For the upper layer represent mostly water with little chloroform.
- This layer represents aqueous layer.
- For the lower layer represent mostly chloroform with little water.
- This layer represents chloroformic layer.

Sp. gr for $CHCl_3$= 1.4

Sp. gr for HAC= 1.009

Thank You for Your Listening

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