University of Al-Ameed
College of Pharmacy

2nd stage , 1st Semester

Practical Physical Pharmacy

Three components system containing liquid phases/Lab4

Asst.Prof.Dr. Abdullah Maad

Introduction

Phase Rule:

- For three component system, phase rule equation becomes **F= 3 – P +2.**
- If we consider a minimum number of phases (P=1), then to represent three component system **F= 3 – 1 +2= 4**, the number of Degrees of Freedom (F) of the system is 4. i.e. 4 variables: pressure, temperature, and concentration of two components will be required.
- Graphical representation with 4 variables is not possible, so 2 variables pressure and temperature are kept constant.

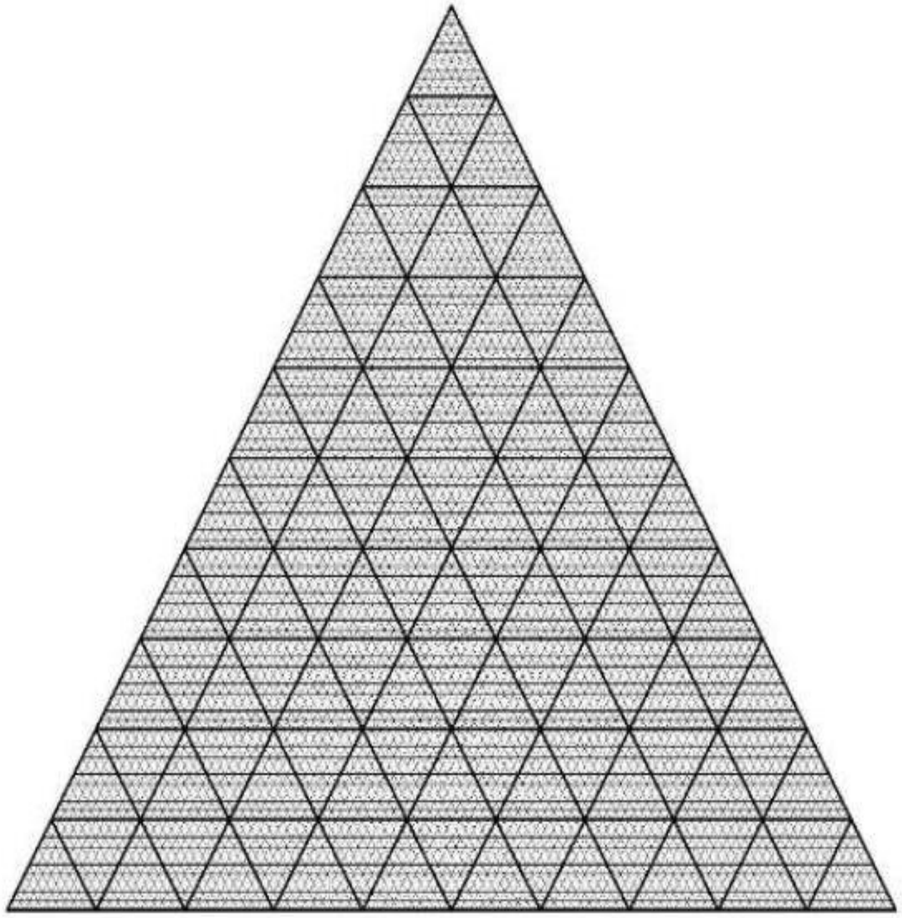
Three components system with one pair of partially miscible liquids

- **The classical example of three components system** is Acetic acid, Chloroform, and Water.
- **Water & chloroform** are miscible only to a slight extreme so a mixture of the two usually produces **2 phases system**, the **lower phase consists of** chloroform saturated with water while the **upper phase consists of** water saturated with chloroform…?.
- On the other hand, **acetic acid** is completely miscible with both chloroform & water. It is expected ,therefore, that the addition of sufficient acetic acid to 2 phases of water & chloroform will produce single phase system in which all the three component are miscible…. Why?
- Mention the different uses of acetic acid?

- It might helpful to consider acetic acid as acting in manner comparable to that of temperature in two components system of phenol & water.
- As heat used to break the cohesive forces between molecules the miscibility increase until one phase result, the addition of acetic acid to chloroform-water mixture achieves the same but by different means namely solvent effect instead of temperature effect .
- In this case acetic acid serves as intermediate polar solvent that shifts the electric equilibrium of the dramatically opposed highly polar water & non-polar chloroform solution to provide solvation .

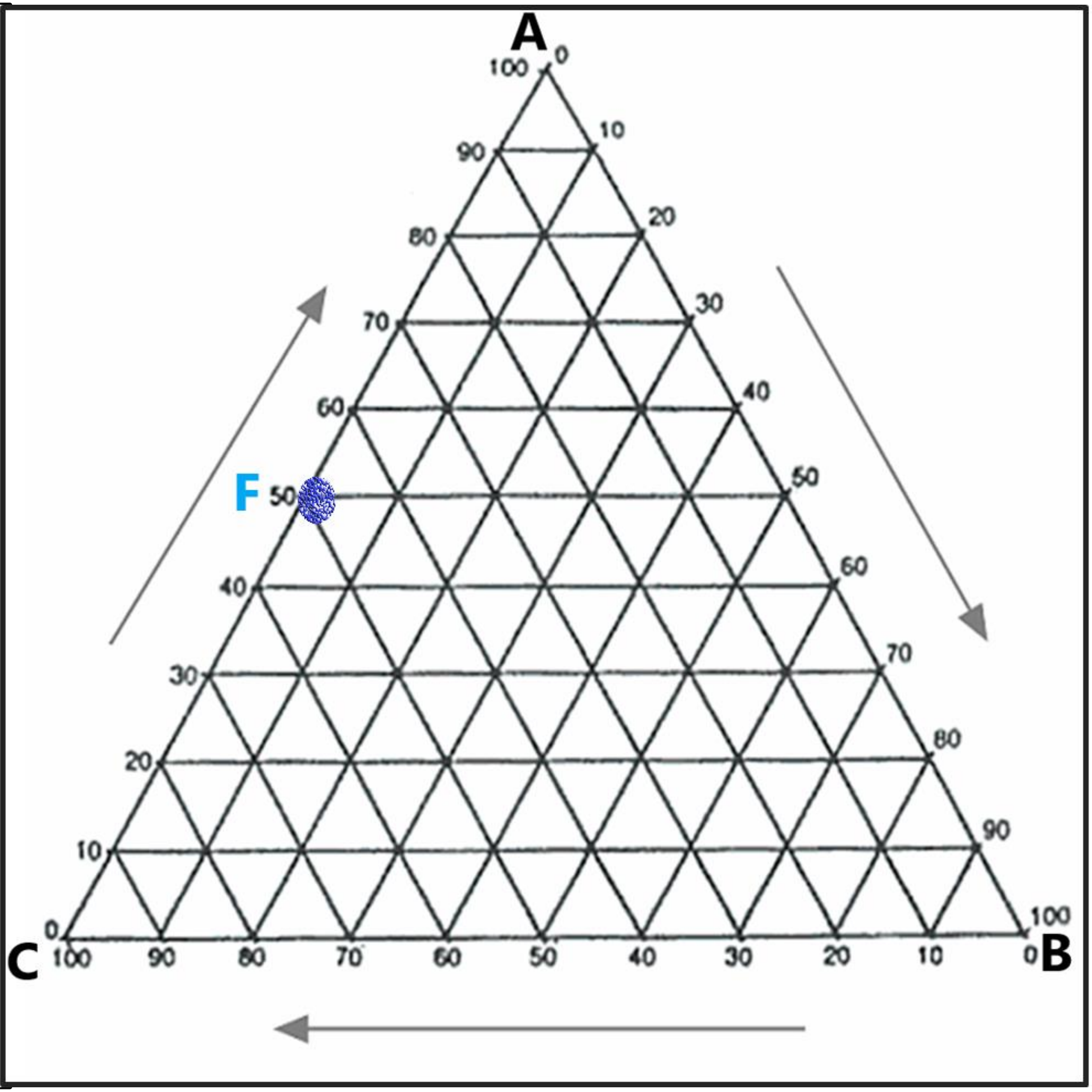
Triangular diagram

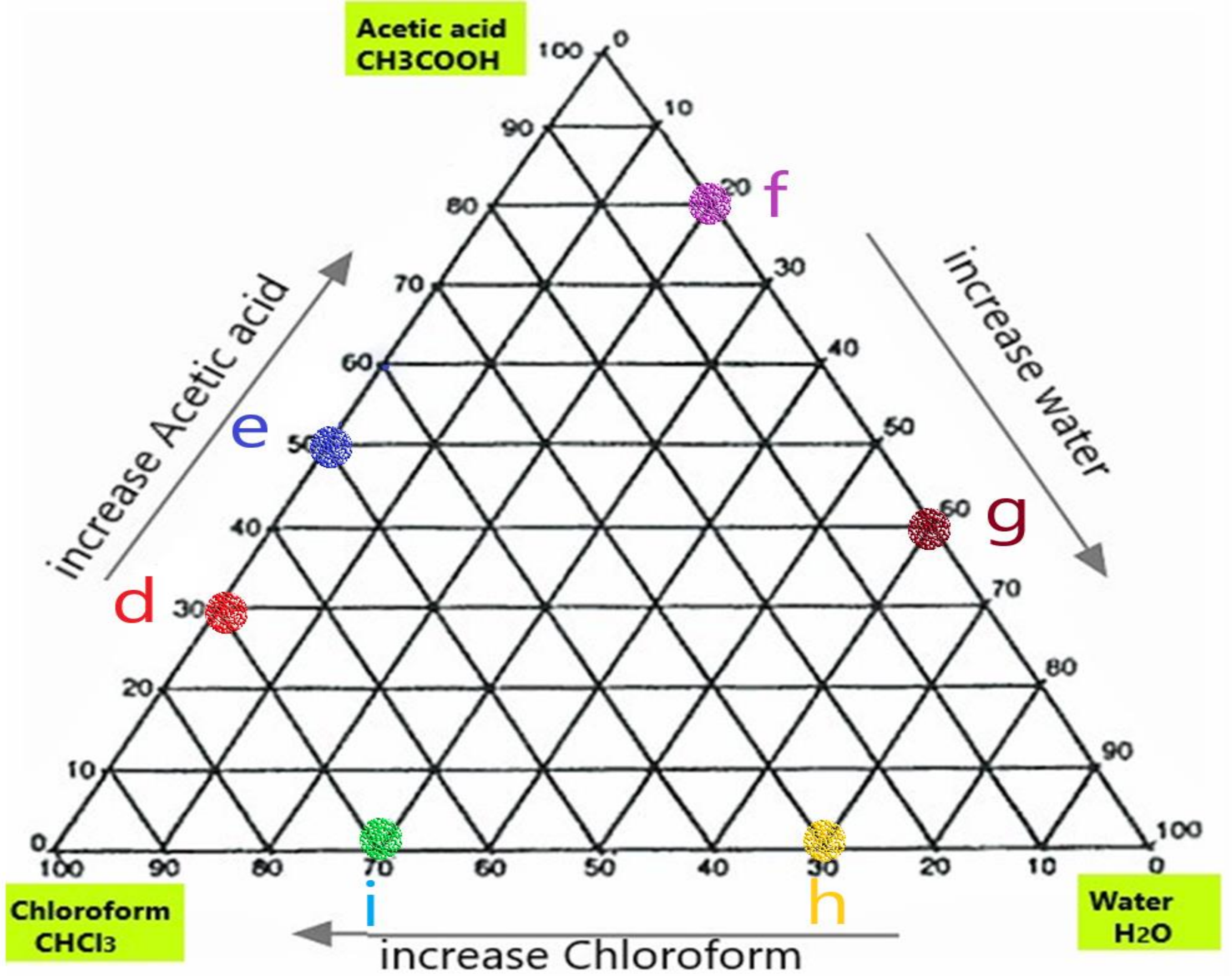
Triangular diagrams are used to illustrate the phase equilibrium of three component system. In this method , variation of compositions of three components at constant pressure and temperature are expressed by means of equilateral triangle.

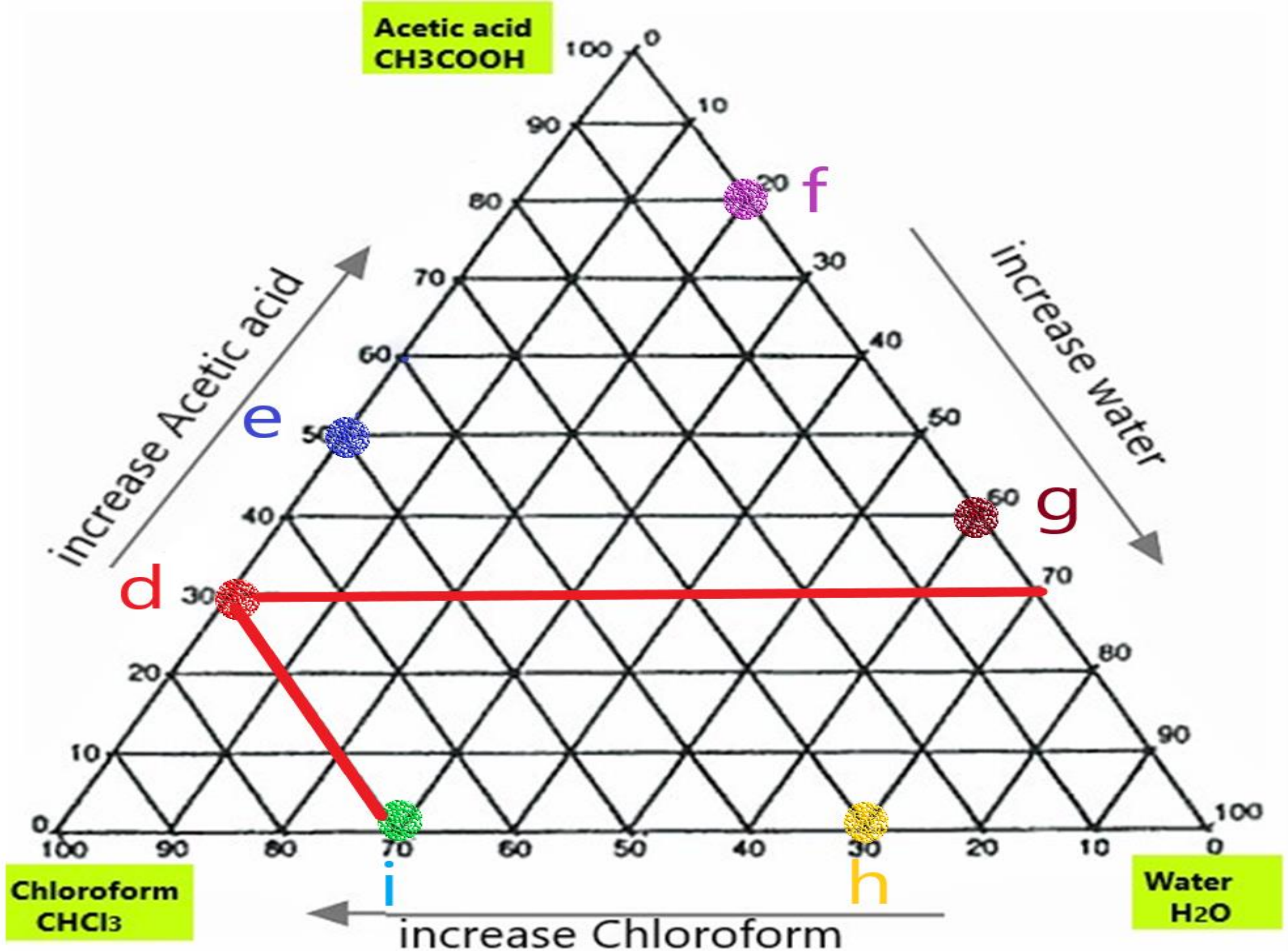


- **The rules relating to this diagram are:**

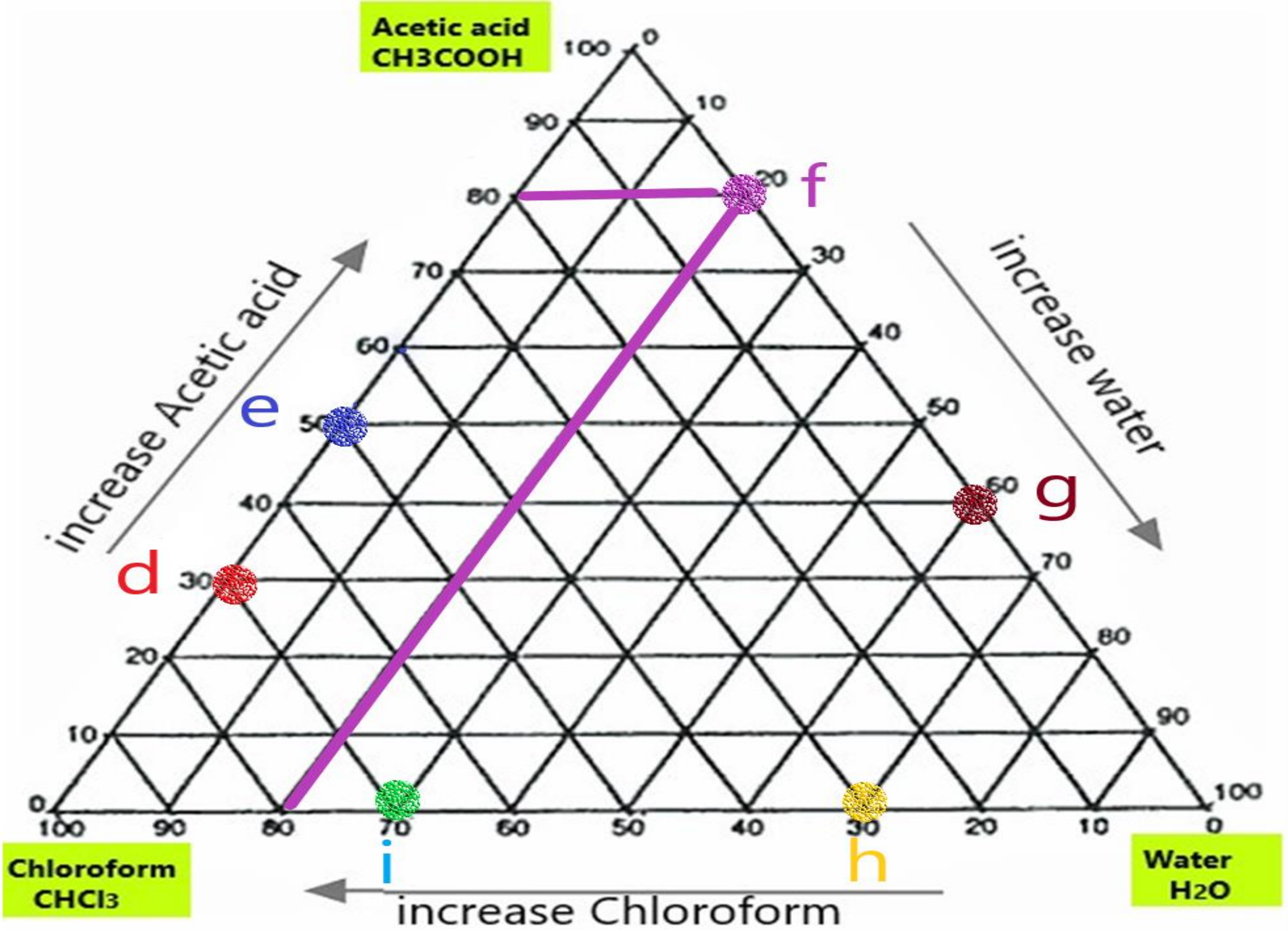
1. Each of the corners of triangle represent 100 % by weight of one component (A, B & C) as a result, the same apex will represents 0% of the other two components.
2. Each side of the triangle is divided into 10 equal parts and proceed in one direction (either clockwise or counter clockwise).
3. The three lines joining the corner points represent two component mixture of the three possible combinations of A, B & C. For example, the point (**F**) midway between A and C on the line AC, represent a system containing 50% of A and hence 50% of C also, 0 % of B.




Acetic acid
CH3COOH
Chloroform
CHCl3
Water
H2O
increase Acetic acid
increase water
increase Chloroform
100
0
10
90
20
80
30
70
40
60
50
d
e
f
g
h
i



Acetic acid
CH3COOH
increase Acetic acid
increase water
increase Chloroform
Chloroform
CHCl3
Water
H2O
d
e
f
g
h
i



Acetic acid
CH3COOH
increase Acetic acid
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increase Chloroform
Chloroform
CHCl3
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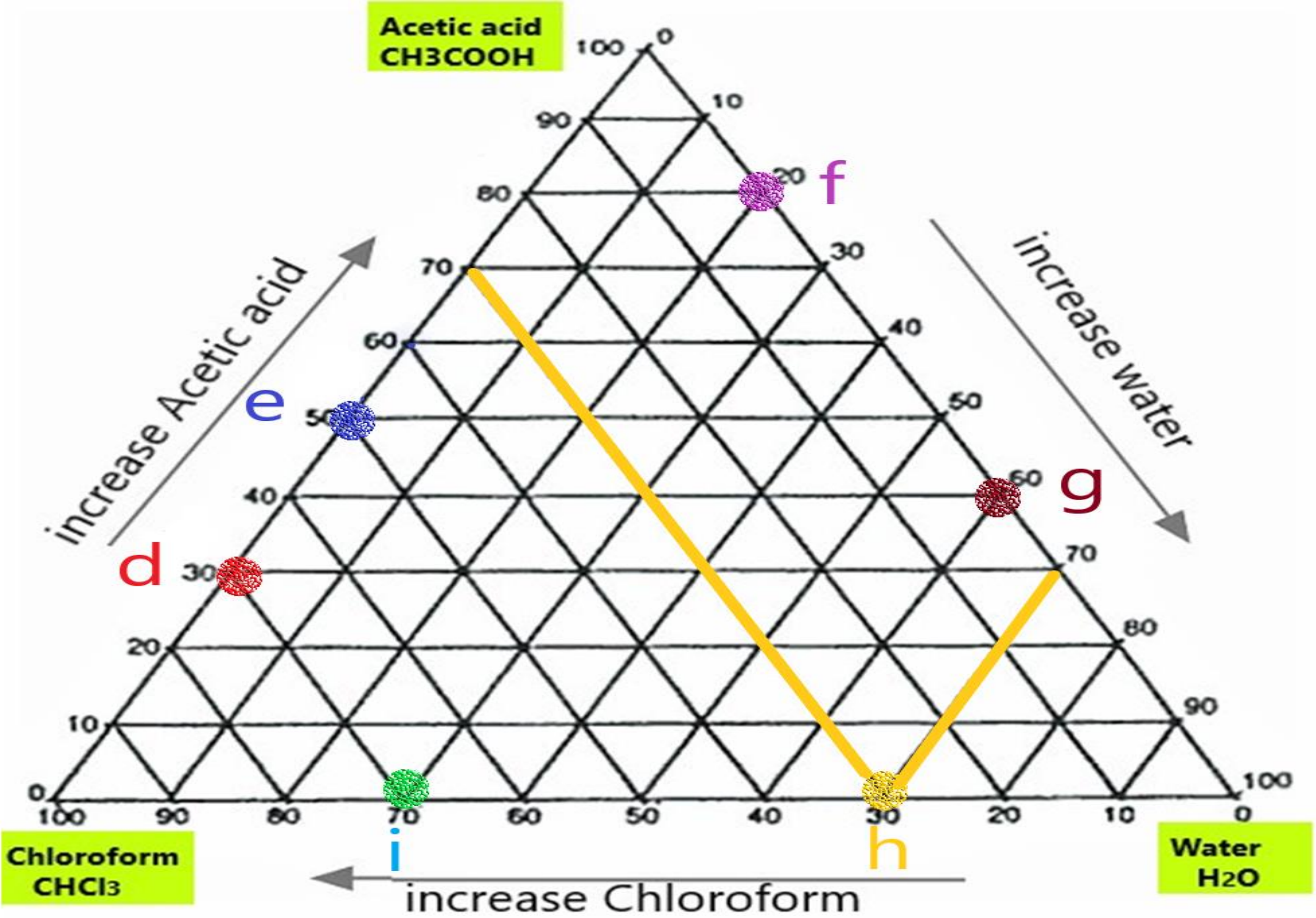
H2O
d
e
f
g
h
i
100
90
80
70
60
50
40
30
20
10
0


Acetic acid
CH3COOH
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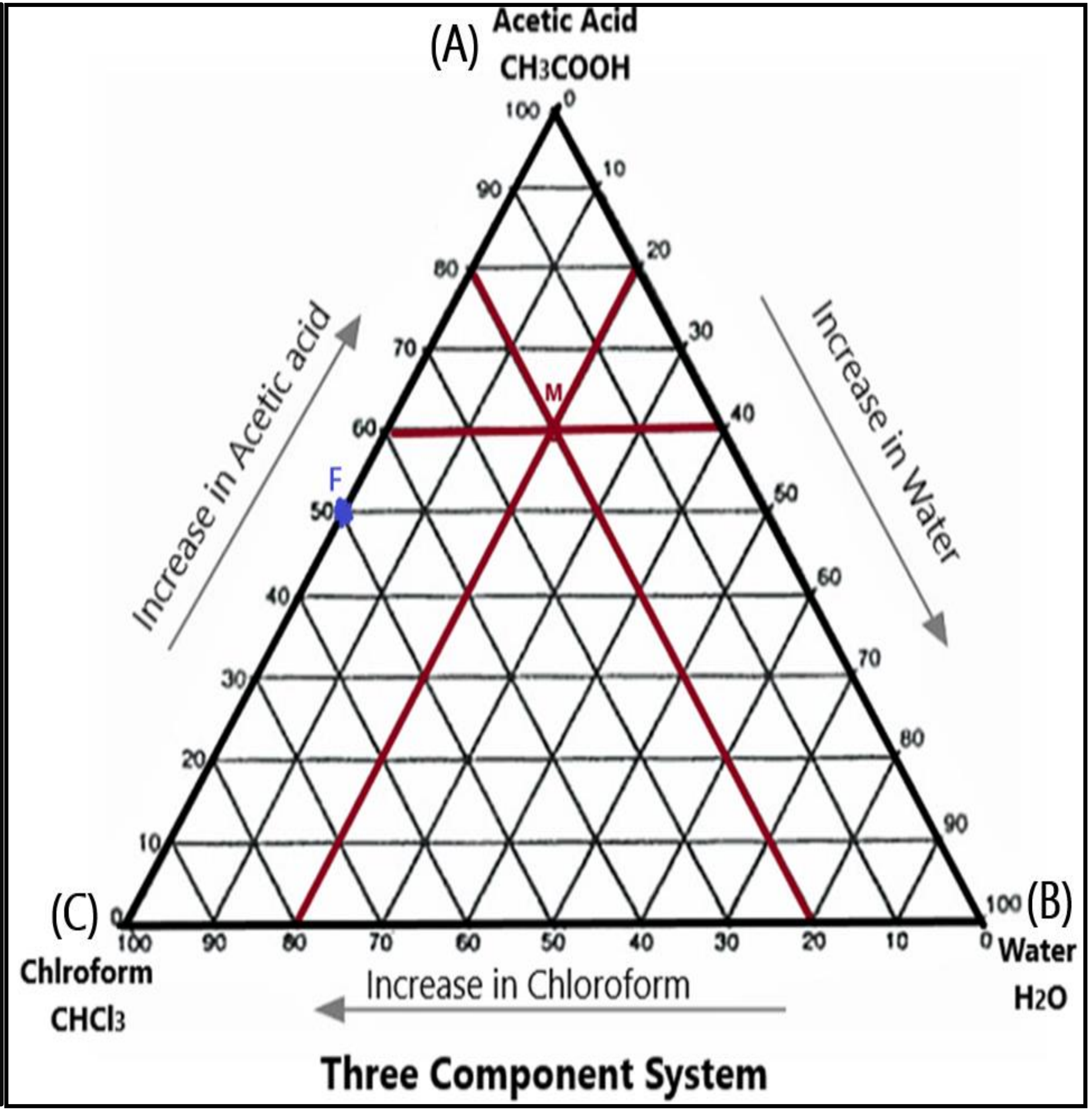
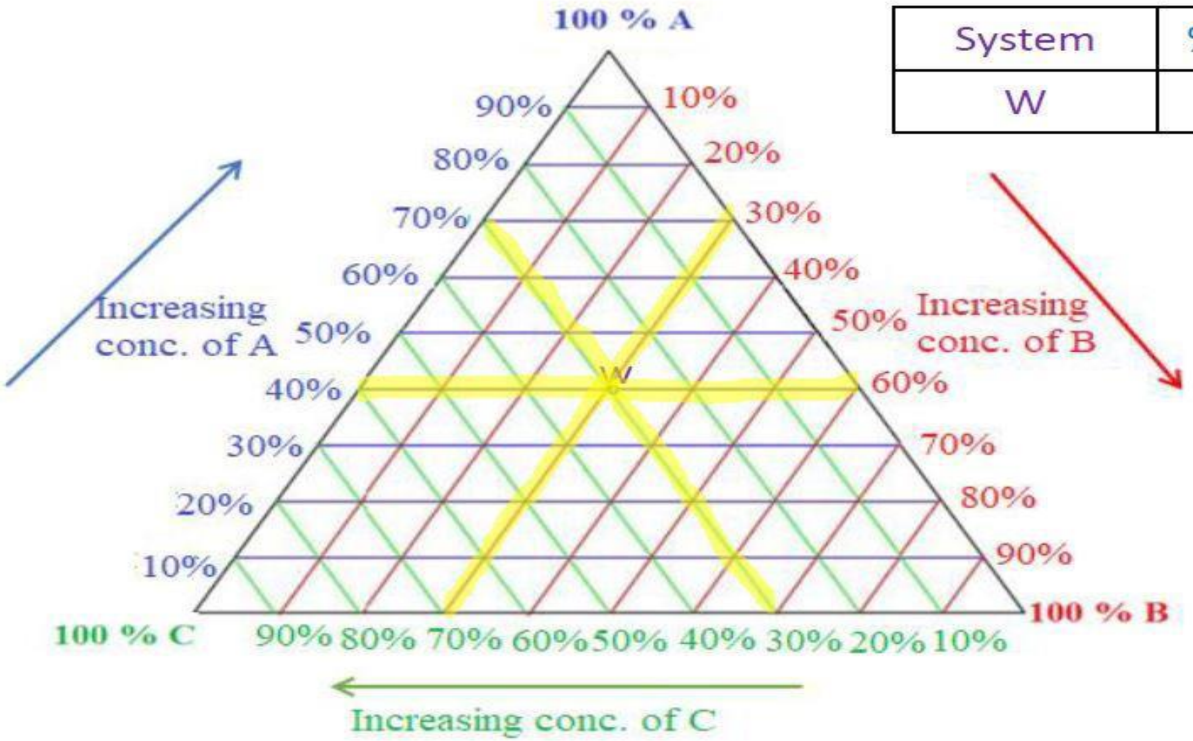
increase Acetic acid
increase water
increase Chloroform
d
e
f
g
h
i

4. The area within the triangle represents all possible combinations of A, B & C to give three component system. For example, the point (**M**) lies on the line parallel to BC that is equivalent to 60% A, and lies on the line parallel to AC that is equivalent to 20% B, and lies on the line parallel to the line AB that is equivalent to 20% C.



Examples

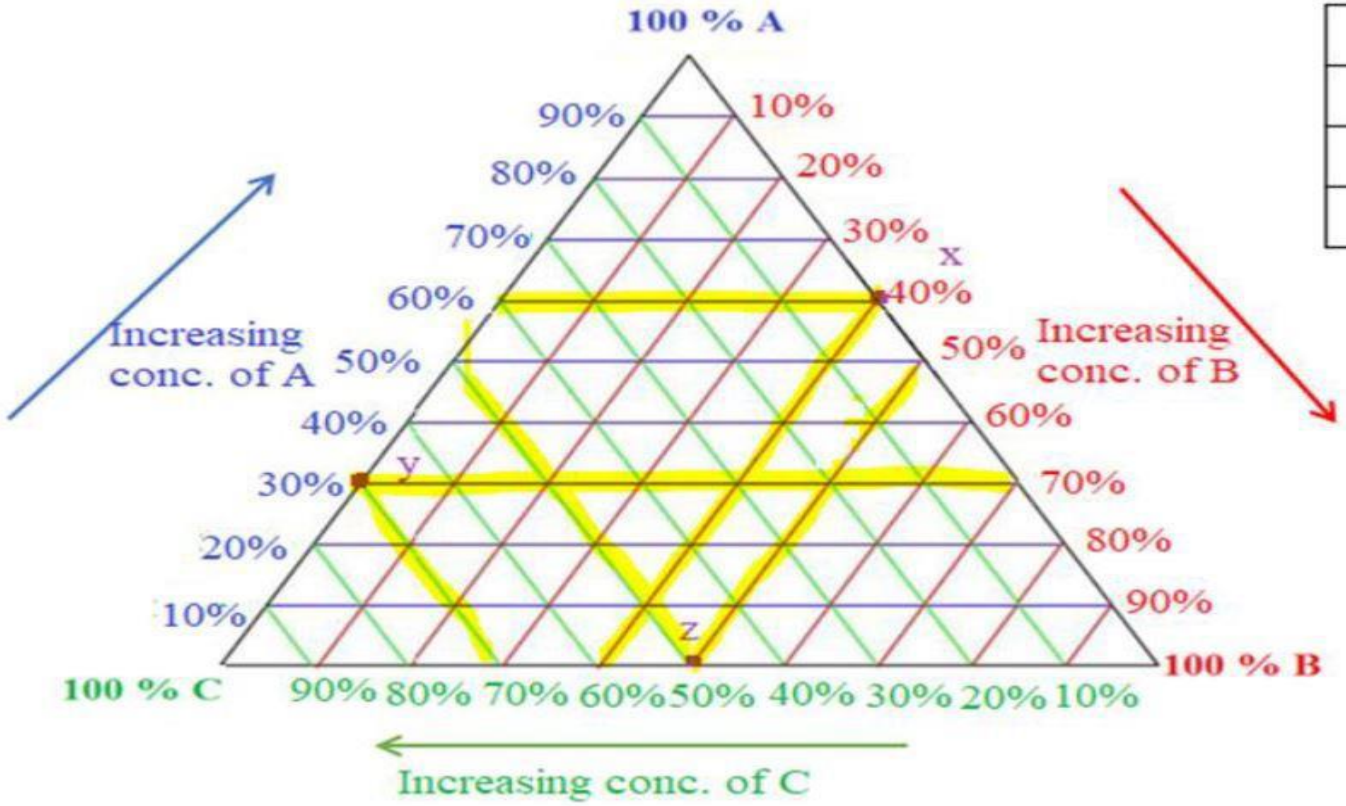
What is the compositions of system represented by point w?



System	% A (w/w)	% B (w/w)	% C (w/w)
W	40	30	30

Examples

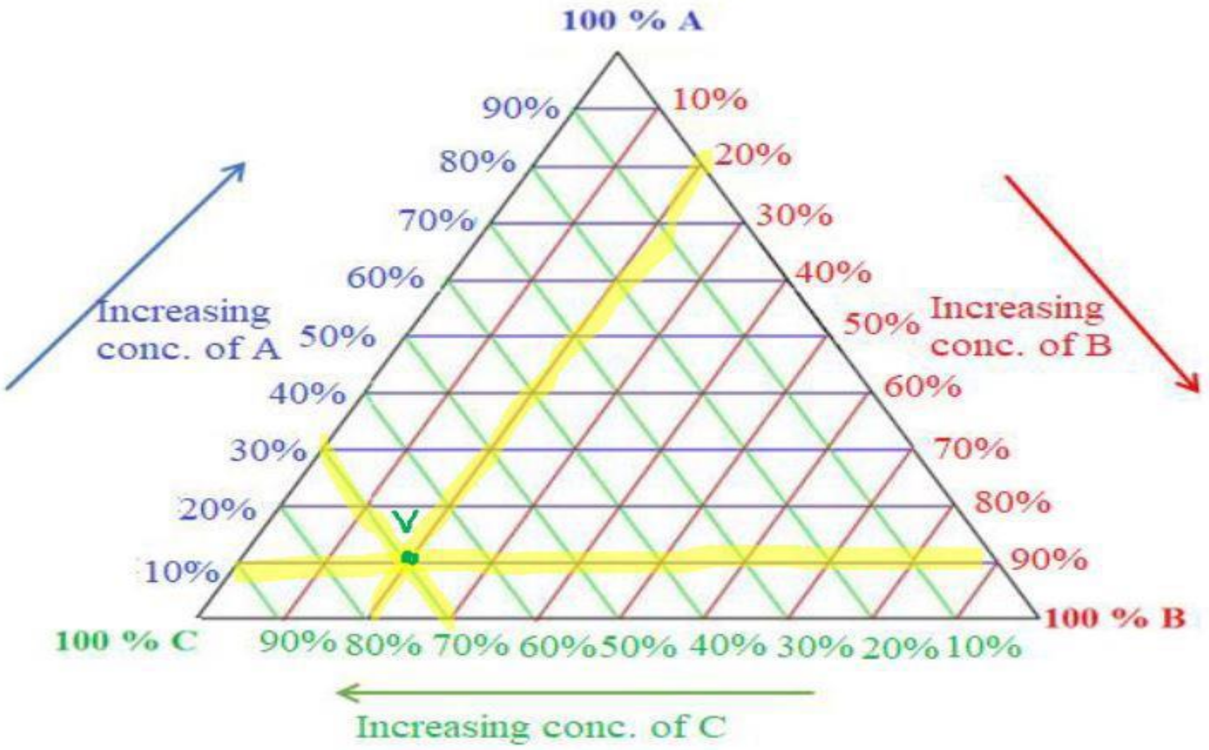
What are the compositions of systems represented by points x, y and z ?



System	% A (w/w)	% B (w/w)	% C (w/w)
X	60	40	0
Y	30	0	70
Z	0	50	50

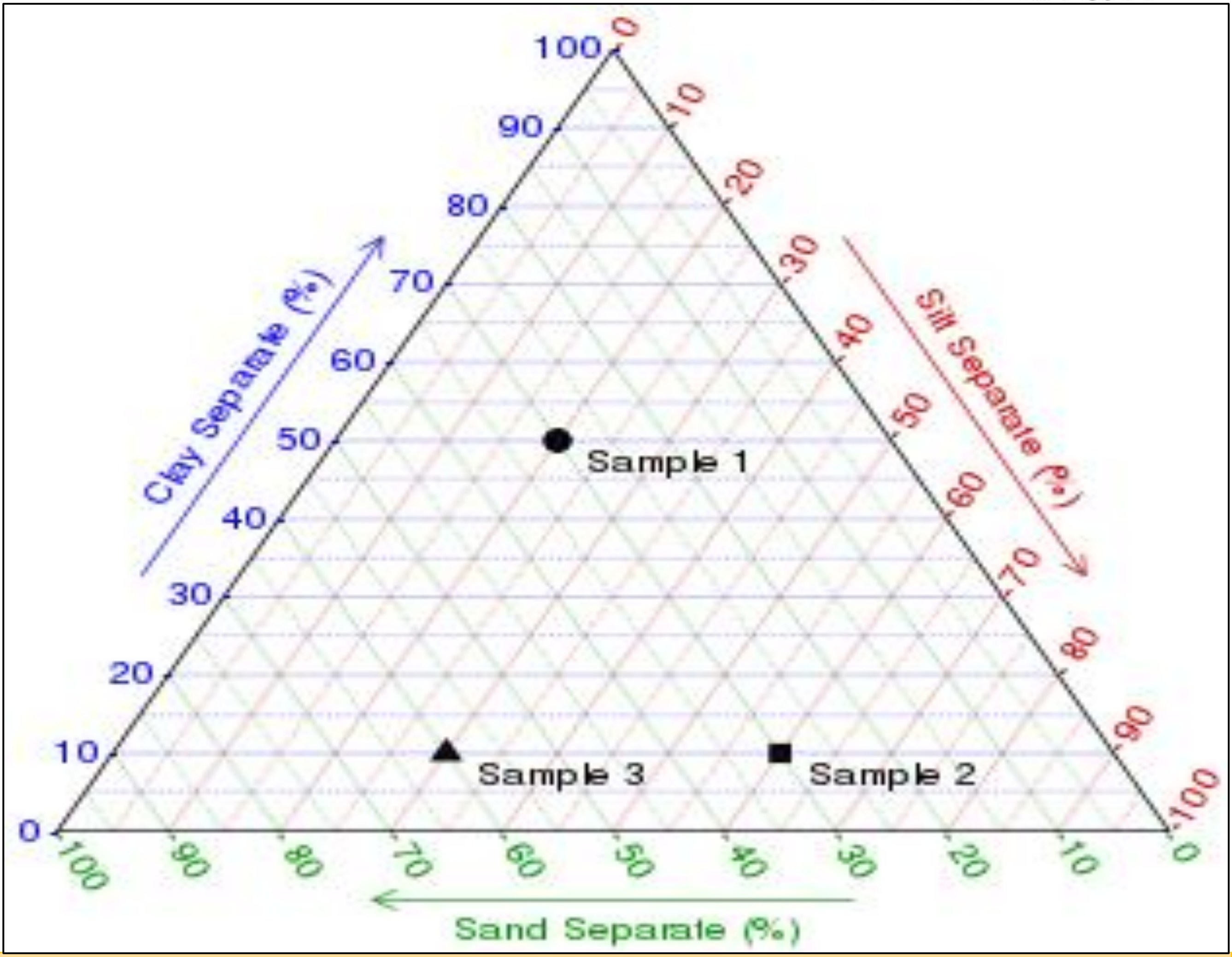
Examples

Where will be the position of system v having a composition of 10% (w/w) A, 20 % (w/w) B, 70 % (w/w) C ?

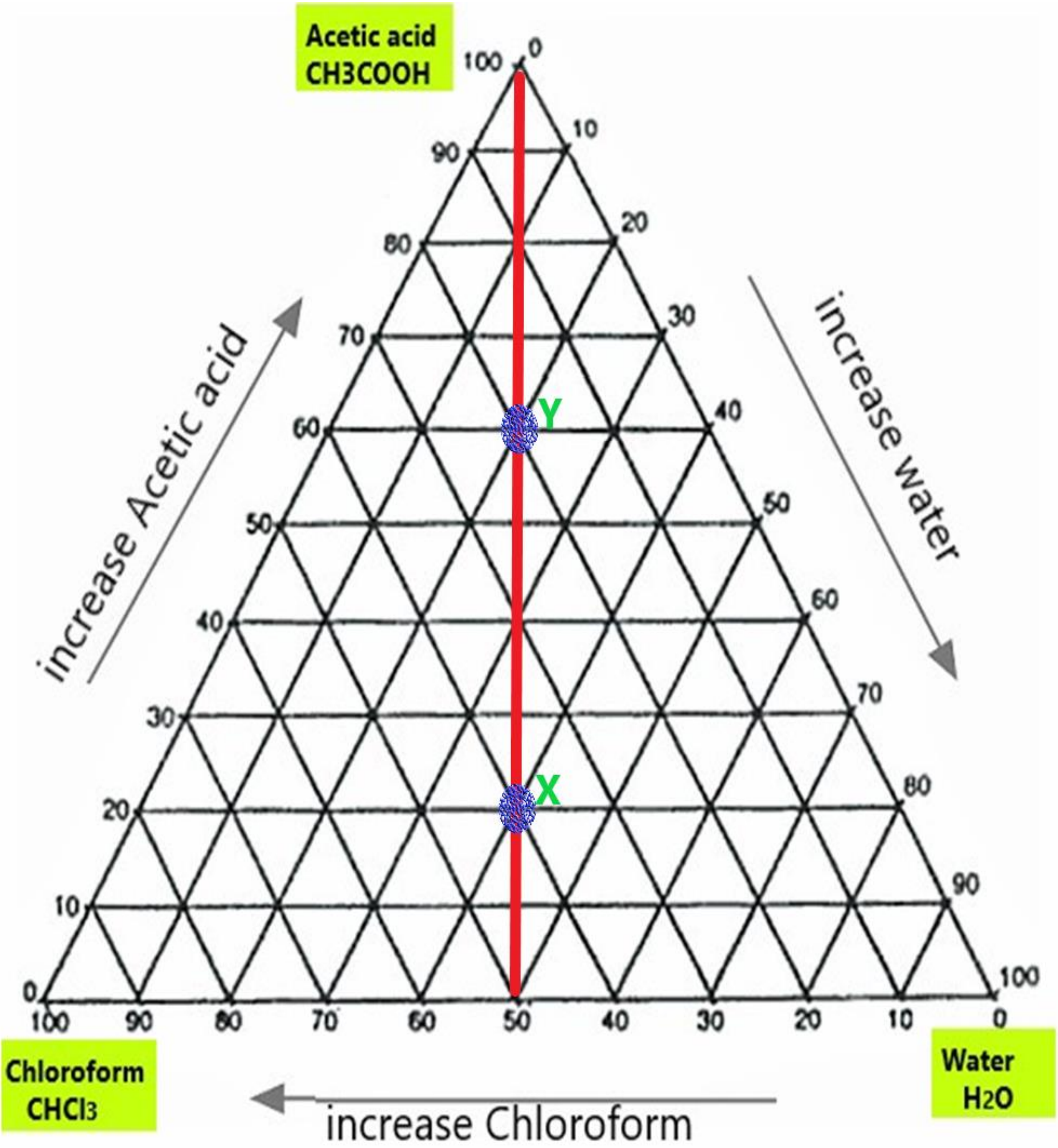


Exercise

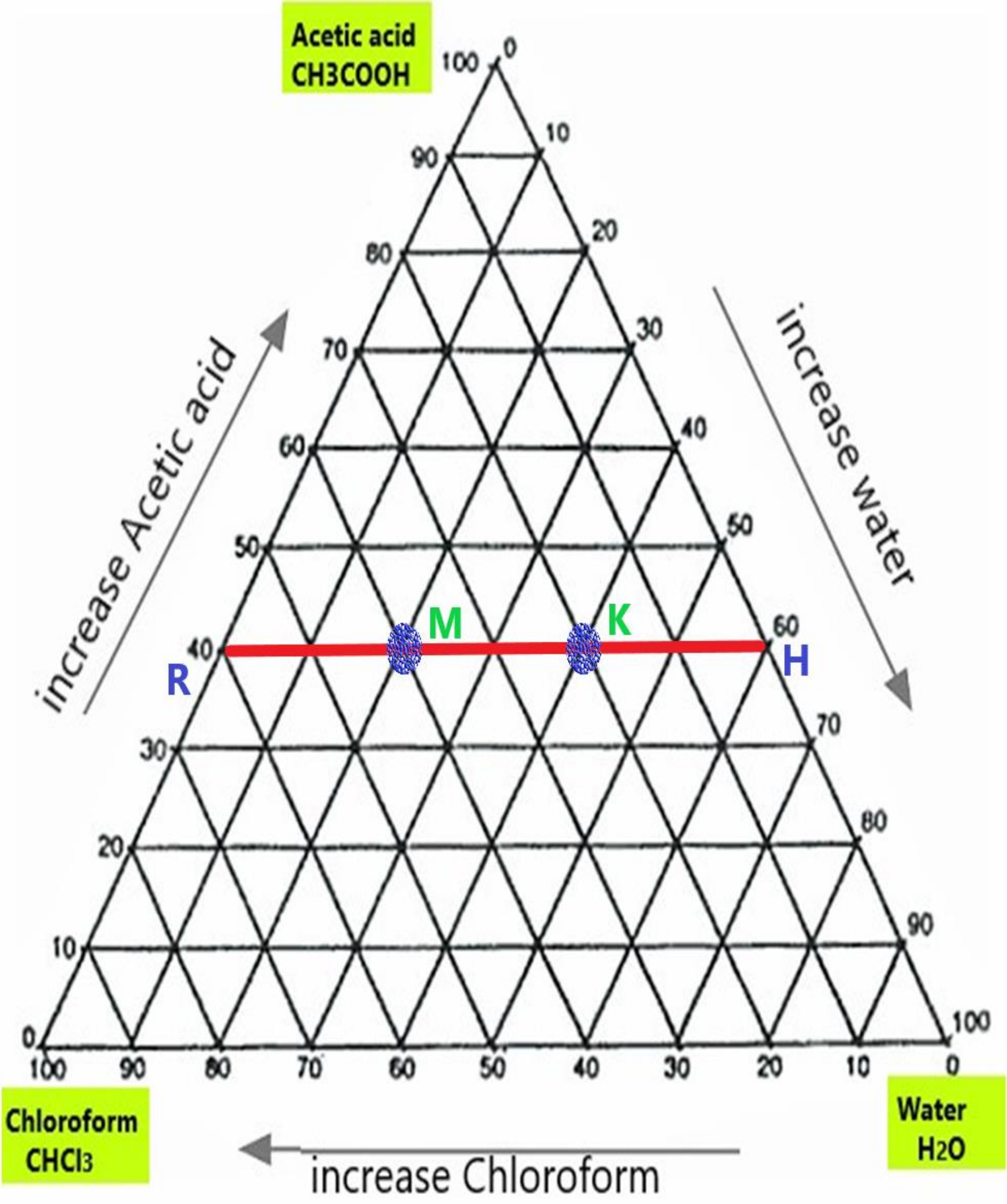
What are the compositions of systems represented by points: **sample 1, sample 2, and sample 3**?



5. If a line is drawn through any apex to a point on the opposite side ,then all systems represented by points on such line have constant ratio of two components. For example, the point Y, lies on the line drawn through the apex of Acetic acid, represents 60% of Acetic acid, and constant ratio of water & Chloroform (water= 20%, and Chloroform= 20%). Also the point X, represents 20% of Acetic acid, 40% of water and 40% of Chloroform.



6. Any line drawn parallel to one side of the triangle represents ternary systems in which the proportion (or % by wt.) of one component is constant. In this instance, all systems prepared along **HR** will contain 40% of Acetic acid and varying concentrations of water and Chloroform. For example, the point M contain 40% of Acetic acid, 20% of water and 40% of Chloroform. The point K contain 40% of Acetic acid, 40% of water and 20% of Chloroform.



Experiment

- **Title:**

  Three components system containing liquid phases

- **Aim :**
  - To study the effect of conc. of Acetic acid on the miscibility of chloroform in water.
  - To calculate the weight of each component of the three component system.
- **Materials and equipment:**
  - Chloroform, acetic acid, and water.
  - Conical flasks, burettes, and balances.

Procedure:

1. Prepare 10 g of the following combination of $CHCl_3$ & water: 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, and 90% w/w $CHCl_3$: water in a small clean & dry flask which form two phase.

2. To these mixtures slowly add acetic acid from a burette until a turbidity just disappears.

3. Check the weight of acetic acid (which is equal to its volume).

   Wt = Sp.gr × Volume, (Sp.gr of HAC =1.009)

4. Obtain a miscibility curve by calculating the percent w/w of each component in the miscible mixture and plot this triangular diagram.

5. Tabulated the amount of HAC ,$CHCl_3$ and H_2O.

Steps:

To prepare 10 g of the $CHCl_3$ and water mixtures with varying percentages follow these steps:

1. **Label Flasks:**
   - Label 10 small, clean, and dry flasks for each percentage of chloroform: 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, and 90%.
2. **Prepare the $CHCl_3$: Water Mixtures:**
   - Weigh each flask to ensure you are preparing 10 g of total mixture. Use the following steps for each percentage:
     - For 5%: Weigh 0.5 g of chloroform and 9.5 g of water
     - For 10%: Weigh 1 g of chloroform and 9 g of water
     - Continue similarly for the other concentrations.
     - Carefully transfer the appropriate amount of chloroform and water into each flask.

3. **Formation of Two Phases:**
    - After adding the chloroform and water to the flask, you will notice that two distinct phases form due to the immiscibility of $CHCl_3$ and water.

4. **Addition of Acetic Acid:**
    - Weigh each flask to ensure you are preparing 10 g of total mixture. Use the following steps for each percentage:
        - ➢ Set up the burette filled with acetic acid.
        - ➢ Start with the flask containing the 5% $CHCl_3$ mixture. Slowly add acetic acid from the burette, drop by drop, while gently stirring the mixture.
        - ➢ Continue adding acetic acid until the turbidity (cloudiness) in the flask just disappears, indicating that the chloroform and water phases are no longer distinct.

Calculations

For example Group no. 1

If the amount of HAC consumed for a turbidity just disappears = 0.5ml

Total weight of the system = wt of $CHCl_3$ + wt of H_2O + wt of HAC

= 0.5g + 9.5g + 0.5g

= 10.5g

FOR $CHCl_3$: $\frac{0.5}{10.5} \times 100 =$ 4.76 %w/w

FOR H_2O : $\frac{9.5}{10.5} \times 100 =$ 90.5 %w/w

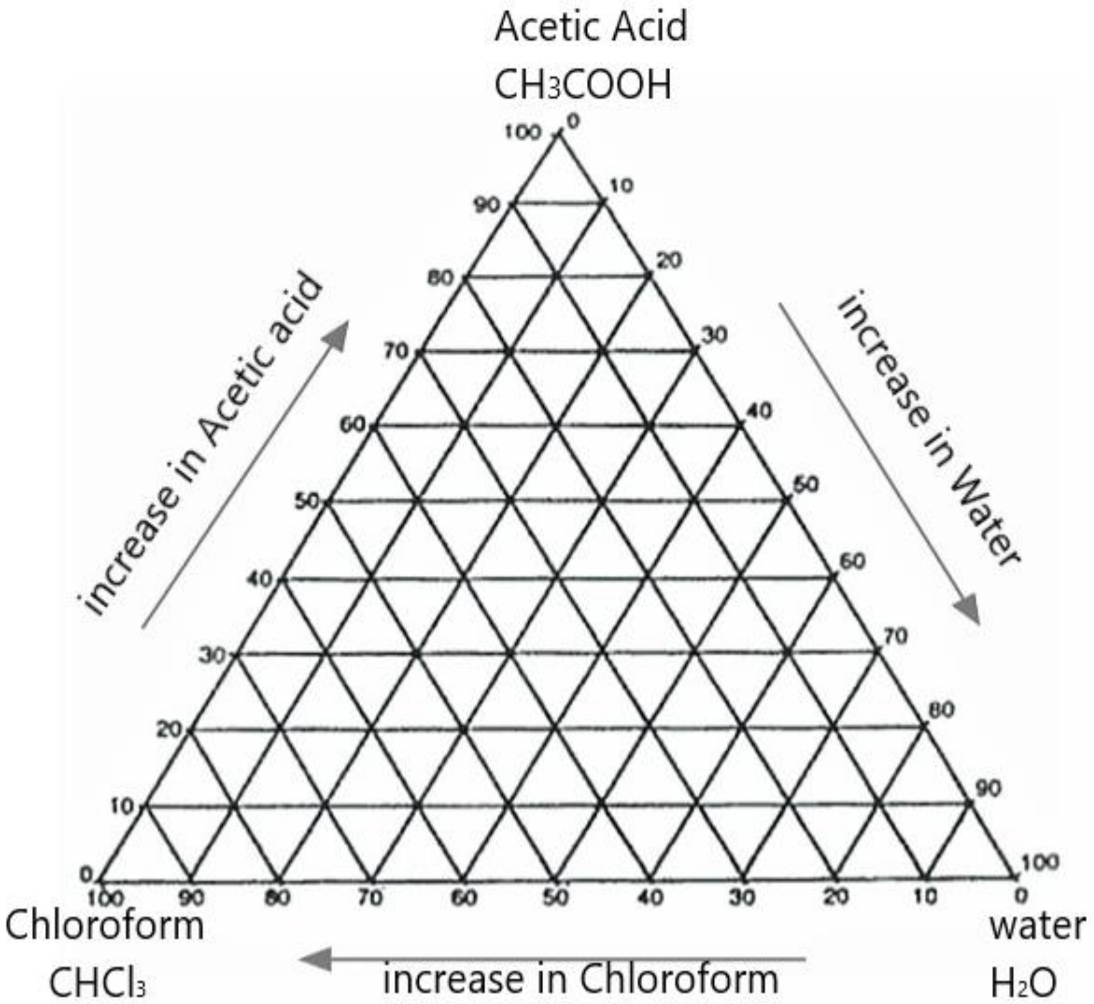
FOR HAC : $\frac{0.5}{10.5} \times 100 =$ 4.76 %w/w

Results

Results:

Concentration %	Weight of each component (g)			Weight percentage of each component (% w/w)		
	Acetic Acid	Chloroform	Water	Acetic Acid	Chloroform	Water

Results



Acetic Acid
CH3COOH
increase in Acetic acid
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Chloroform
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water
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increase in Chloroform
100
90
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70
60
50
40
30
20
10
0

Thank You