Experiment No.: 5

To prepare standard buffer solutions using ammonium hydroxide and ammonium chloride, and to measure the pH of the given unknown solution using universal indicator.

Apparatus required:

(1) Pipette, (2) Burette, (3) Conical flask, (4) Beaker, (5) Test tubes (6) Stand

Chemicals required:

1. Standard HCl solution
2. Ammonium chloride
3. Ammonium hydroxide
4. Methyl orange indicator
5. Universal indicator

Theory :

The buffer solution has a constant pH, and resists change in pH even on addition of small amounts of acid or base. The pH of a buffer consisting of a weak base and its salt can be calculated by using the Henderson equation

$$pOH = pK_b + \log_{10} \frac{[salt]}{[base]} \quad \ldots\ldots\ldots\ldots (1)$$

Where, $pK_b = -\log K_b$ of weak base

[salt] = molar concentration of the salt

[base] = molar concentration of the weak base

$$pOH + pH = 14 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In the indicator method, a series of the standard buffer solutions are prepared and the universal indicator is added to each of them. Then

the same amount of the universal indicator is added to the equal volumes of the unknown solution. pH is determined by matching the color against the standard solutions. Solutions having the same pH have the same color.

Procedure :

1. Prepare 100 ml of ammonium hydroxide solution of approximately 0.4 M strength in a beaker. Standardize it against a standard 0.4 M HCl solution using methyl orange as the indicator. From this ammonium hydroxide, prepare 100 ml of exactly 0.2M ammonium hydroxide by taking the required volume of alkali from the burette and making up to the mark by the addition of water.

2. 100 ml. of exactly 0.2 M ammonium chloride is supplied.

3. Prepare a series of standard buffer solutions by mixing different volumes of 0.2 M ammonium hydroxide and 0.2M ammonium chloride as given in the following Table and calculate the value of each by using the Henderson equation (1) given above.

4. Mark test tubes as 1, 2, 3, ...9 and put them in a test tube stand serially.

5. Put 5 drops of the universal indicator in each of them.

6. Now take 10 ml of the given unknown solution in another test tube and add 5 drops of the universal indicator in it.

Determine the pH of the unknown solution by matching the color against the standards.

Observation Table :

pK_b of ammonium hydroxide = 4.74

Test tube No.	Vol. of 0.2 M NH_4Cl sol^n (ml)	Vol. of 0.2 M NH_4OH sol^n (ml)	$pOH = pK_b + \log \frac{[salt]}{[base]}$	pH = 14 − pOH	pH of the unknown solution
1	9	1			
2	8	2			
3	7	3			
4	6	4			
5	5	5			
6	4	6			
7	3	7			
8	2	8			
9	1	9			

Calculation :

For buffer no. 1

pOH = 4.74 + log 1/9 = 4.74 + (- 0.95) = 3.78

pH = 14 - 3.78

= 10.22

For buffer no. 2,

pOH = 4.74 + log 2/8 =

For buffer no. 3

pOH = 4.74 + log 3/7 =

and so on.

Results :