**LABORATORY REPORT**

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| DETERMINATION OF THE ACID-DISSOCIATION CONSTANT |
| |  |  | | --- | --- | | Name: | Victor Kwansa | | Index Number: | 2841708 | | Class: | P.1.2.3 | | Demonstrator: | Mr. Adolf Oti-Boakye | | Date: | 10th March, 2009 | |
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| **AIMS/OBJECTIVES:** |
| 1. Learn how to use the spectrophotometer to measure the absorbance of a given solution. 2. Determine the acid dissociation constant of phenol red. 3. Determine the pH of the solutions. 4. Be able to accurately measure and mix solutions.   **INTRODUCTION/THEORY:**  An (acid-base) indicator refers to a highly weak organic acid or base which contains a highly delocalized planar pi-bonding system and indicates by colour change, the point at which equivalent amounts of the acid has reacted with equivalent amount of the base in a solution. Indicators exhibit different colour changes in acid and base solutions. Thus the indicator turns one colour in an acid and turns another colour in a base. The higher the pH, the stronger the basicity and the more colour change observed when the indicator is added and vice versa.  The concentration of an indicator is negligible compared to the concentration of the solution to which it is added. Indicators are also usually present as minor species in the solution .Therefore the colour change is often determined by the dominant equilibrium. Hence in a sufficiently acidic solution, the equilibrium will shift to the left, producing colour ‘x’, whiles in a sufficiently basic solution the equilibrium shifts to the right to give colour ‘y’.  Indicators are weak acids or bases, therefore they dissociate partially in aqueous solution.  From the equation above the acid dissociation constant, Ka is given by  Ka = [H+][ln-]  [Hln]  Rearranging and taking logs gives:  pH = pka + log [ln-]  [Hln]  As the two forms the indicator has different colours, with the help of the spectrophotometer, absorbance measurement can be used to determine the pka of the indicator from the equation  pH = pka + log (A-AHln)  (Aln-A)  Where “A’’ is the absorbance at a wavelength of 550nm  AHln is the minimum absorbance  Aln is the maximum absorbance |
| **CHEMICALS & EQUIPMENT:**   1. 0.067moldm-3 KH2PO4 2. 0.067moldm-3 NaHPO4 3. 0.1 moldm-3 HCl 4. 0.025 moldm-3 NaB4O3 .10H2O 5. 0.025 moldm-3 NaHCO3 6. 0.025 moldm-3 Na2CO3 7. Spectrophotometer 8. Distilled water 9. Phenol red indicator 10. Beaker 11. Measuring cylinder |
| **PROCEEDURE:**   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **pH** | **Buffer /cm3** | **440λ** | **470λ** | **490λ** | **520λ** | **550λ** | **580λ** | **590λ** | **680λ** | | 6.0 | KH2PO4/Na2HOP4 | 0.08 | 0.08 | 0.04 | 0.04 | 0.04 | 0.01 | 0.05 | 0.03 | | 6.4 | KH2PO4/Na2HOP4 | 0.10 | 0.07 | 0.03 | 0.02 | 0.06 | 0.06 | 0.06 | 0.04 | | 6.8 | KH2PO4/Na2HOP4 | 0.11 | 0.05 | 0.03 | 0.03 | 0.08 | 0.05 | 0.04 | 0.04 | | 7.2 | KH2PO4/Na2HOP4 | 0.06 | 0.03 | 0.04 | 0.04 | 0.04 | 0.05 | 0.04 | 0.02 | | 7.6 | KH2PO4/Na2HOP4 | 0.05 | 0.03 | 0.02 | 0.07 | 0.08 | 0.05 | 0.13 | 0.03 | | 8.0 | KH2PO4/Na2HOP4 | 0.10 | 0.07 | 0.04 | 0.08 | 0.10 | 0.08 | 0.08 | 0.05 | | 8.4 | HCl/Borax/DIH2O | 0.10 | 0.07 | 0.03 | 0.09 | 0.08 | 0.08 | 0.03 | 0.04 | | 8.8 | HCl/Borax/DIH2O | 0.09 | 0.06 | 0.08 | 0.08 | 0.12 | 0.11 | 0.03 | 0.03 | | 9.0 | HCl/Borax/DIH2O | 0.02 | 0.03 | 0.07 | 0.09 | 0.13 | 0.10 | 0.05 | 0.02 | | 10.0 | HCl/Borax/DIH2O | 0.01 | 0.03 | 0.07 | 0.09 | 0.12 | 0.09 | 0.05 | 0.02 | |
| **CALCULATIONS:**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **pH** | **Wavelength (λ)** | **Absorbance A** | **A- AHln** | **Aln -A** | **log** | | 6.0 | 550 | 0.03 | 0.03 | 0.08 | -0.426 | | 6.4 | 550 | -0.06 | -0.02 | -0.03 | -0.176 | | 6.8 | 550 | -0.03 | 0.01 | -0.05 |  | | 7.2 | 550 | 0.39 | 0.56 | -0.05 |  | | 7.6 | 550 | 0.29 | 0.15 | -0.09 |  | | 8.0 | 550 | 0.24 | 0.02 | 0.15 | -0.875 | | 8.4 | 550 | 0.15 | 0.13 | 0.02 | 0.813 | | 8.8 | 550 | 0.21 | 0.14 | -0.02 |  | | 9.0 | 550 | 0.25 | 0.16 | -0.04 |  | | 10.0 | 550 | 0.21 | 0.18 | -0.07 |  | |
| pKa + log y= mx+c  Using the method of least squares in which  ............. (1)  ………. (11)  The gradient m is calculated from  m= ……….. (I)  and the intercept, c= ……… (11)  where n= number of terms   |  |  | | --- | --- | | **x=log** | **y=pH** | | -0.426 | 6.0 | | -0.176 | 6.4 | |  | 6.8 | |  | 7.2 | |  | 7.6 | | -0.875 | 8.0 | | 0.813 | 8.4 | |  | 8.8 | |  | 9.0 | |  | 10.0 |   From the graph, the equation of the graph is *y=1.937x +* *5.80*  Therefore the slope of the graph is 1.937.  The pKa = the y- intercept = 5.80  The Ka = 10 -5.80= 1.58 x 10-6  **DISCUSSION:**  From the result gathered from the experiment, it can be seen that, the absorbance of the buffers increased with increasing pH.  Again, in acidic medium, a buffer solution with pH below 7, the colour of the unionized form of the phenol red is dominant. As the intensity increases, the yellow colour also intensifies as the corresponding pH moves to the acidic medium. This indicates that phenol red changes to yellow in the acidic medium.  Whilst, in the basic medium, the pink colour, that is the basic form of the phenol red becomes dominant. The pink intensified with an increase in pH. The purple colour obtained at higher pH when pink intensifies. |
| **ERROR ANALYSIS:**   1. The expected pH of the mixture of the solutions could have been altered since some of the remaining water droplets in the beaker could have diluted the solutions slightly. 2. Certain estimations were made in reading the pH values and wavelength values from the pH meter and the spectrophotometer respectively. 3. Inconsistent amount of drops of the indicator which were added to the solutions could have affected the reading of values. I.e. the amount of indicator drops which were added ranged from two to three drops. 4. The expected volumes of solutions were slightly exceeded due to the lack of accurate measuring apparatus to be used in accurately measuring the solutions. |
| **PRECAUTIONS:**   1. The initial wavelength on the spectrophotometer was ensured to remain at the zero mark to ensure that all wavelength readings were accurate. 2. The glassware that was used in the experiment was thoroughly washed clean to prevent impurities. 3. All solutions were carefully prepared to prevent burns to the hand. Also safety goggles and laboratory coats were worn as a preventive measure from laboratory accidents. |
| **CONCLUSION:**  The absorbance of a solution is directly proportional to its pH. The colour of phenol red indicator is yellow in a sufficiently acidic solution and red in a sufficiently basic solution.  The pKa of phenol red indicator can be determined graphically and by calculation.  The working range of phenol red is within the range 4.8-8.0.  It can be concluded that the absorbance of a given solution is directly proportional to its pH. |
| **REFRENCES:**   1. Brown, L. B., (?), Chemistry: The central science, 7th edition, Pages 597-598. 2. Olmsted and Williams, Chemistry; The molecular science, Pages 803-805. 3. [www.wikipedia.com/dissociation](http://www.wikipedia.com/dissociation). 4. [www.answers.com/topic/indicator](http://www.answers.com/topic/indicator) . |