Semester-I

2H 1C

17CHU112 STATES OF MATTER AND IONIC EQUILIBRIUM PRACTICAL

Instruction Hours/week:L: 0 T:0 P:2 Marks: Internal: 40 External: 60 Total:100

Scope

This course is an introduction to chemistry lab that illustrates principles of chemistry and laboratory techniques. The course presents the practical knowledge of the states of matter and ionic equlibria. It deals with the measurement of the properties of different states of matter and PH of buffer solutions.

Objectives

1. To provide the knowledge to measure the surface tension and viscosity of different liquids and to characterise a solid.
2. To provide knowledge on the preparations of buffer solutions and to measure the PH.

Methodology

Surface tension & viscosity measurements, XRD data, PH meter and buffer solutions.

1. **Surface tension measurements**

   a. Determination of the surface tension of a liquid.

   b. Study the variation of surface tension with different concentration of detergent solutions.

2. **Viscosity measurement.**

   a. Determination of co-efficient of viscosity of an unknown aqueous solution.

   b. Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar of PVA.

   b. Study the variation of viscosity with different concentration of sugar solutions.

3. **Solid State:**

   a. Indexing of a given powder diffraction pattern of a cubic crystalline system.

4. **pH metry**:

a. Study the effect of addition of HCl/NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.

b. Preparation of buffer solutions of different pH values (i). Sodium acetate-acetic acid (ii). Ammonium chloride-ammonium hydroxide

c. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base. Determination of dissociation constant of a weak acid.

Suggested Readings:

Text Books:

1. Khosla, B. D., Garg, V. C. & Gulati, A. (2011). *Senior Practical Physical Chemistry*. New Delhi : R. Chand & Co.

Reference Books:

1. Garland, C. W., Nibler, J. W. & Shoemaker, D. P. (2003). *Experiments in Physical Chemistry*. 8th Ed. New York : McGraw-Hill.

States Of Matter And Ionic Equilibrium Practical

Ex. No.1. Surface Tension by drop weight method

Aim

To determine the surface tension of water/ liquid by drop weight method

Apparatus required

A glass funnel with vertical stand, burette, beaker.

Formulae

From Rayleigh's formulae the surface tension of water is given by $T = mg/3.8r$ N/m Where 'm' is the mass of one drop of water, 'r' is the radius of the glass tube and 'g' is the acceleration due to gravity.

Procedure

1. The funnel/burette are thoroughly cleaned and fixed in a burette stand.
2. The experimental liquid is poured inside the funnel from above and the temperature of the liquid is noted.
3. A beaker of known weight(W1) is placed first below the burette. The flow is regulated in such a manner that drops are formed and allowed to break away at the rate of about one per minute or even at a slower rate.
4. About 30 drops are allowed to be collected in the beaker at a time.
5. The liquid thus collected in the beaker is weighed again (W2). The difference in weight (W2-W1) is noted.
6. From the known number of drops collected the average mass of a single drop is calculated.
7. The weight of single drop and the radius of the tube were substituted in the above formulae to obtain the surface tension.

Result

1. Mass of the empty glass beaker =
2. Surface tension of the liquid =

Table 1

Determination of mass of liquid drops and their numbers

Mass of empty beaker(W1) gm	Number of drops (N)	Mass of the beaker with the liquid(W2)gm	Mass of liquid M (W2-W1) gm	Mass (m) of each liquid drop (M/N)	Awerage mass of each liquid drop $x10^{-3}$Kg

$r= 0.0405 \times 10^{-2}$ m

Ex.No.2 VISCOSITY OF A LIQUID BY STOKES METHOD

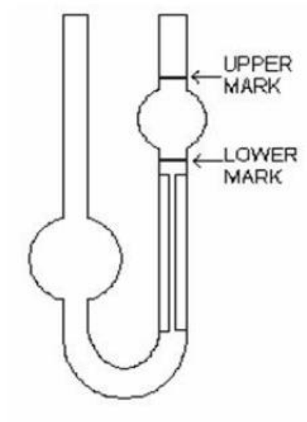
Aim
To determine the coefficient of viscosity of a liquid by Stokes method
Formulae
Co-efficient of viscosity of a given liquid = $\eta = 2/9\ g(\rho - \sigma)\ r^2/v$ NSm^{-2}
Where
r = radius of sphere (10^{-3}m)
g = acceleration due to gravity m/s^2
ρ = density of the material of the sphere Kg/m^2
σ = density of the liquid
v = terminal velocity m/s
Procedure
Castor oil is taken in a tall glass cylindrical jar of about 50 cm in height and 5 to 10 cm in dia. Two lines A and B are marked on the jar, one mark a few cm below the surface of the liquid and the other a few cm above the bottom. A metal ball or a glass ball of radius 'a' is gently dropped centrally in to the liquid in the jar. When the ball just crosses the first mark a stop watch is started and when the ball crosses the second mark, the watch is stopped. The time taken to travel the distance 'h' between the mark is noted as 't'. Now the velocity of the ball $v = h/t$.
By Stokes law
$6\pi\eta v = 4/3\ \pi r^3\ (\rho - \sigma)\ g$
Where 'ρ' is the density of the ball, 'σ' the density of the liquid and 'g' the acceleration due to gravity.
Therefore
$\eta = 2/9\ g(\rho - \sigma)\ r^2/v$ NSm^{-2}
r^2t is a constant for balls of the same material. The experiment is repeated using balls of different radii and the values are tabulated.

To determine the density of the liquid
The weight of empty specific gravity bottle = w1
The weight of empty specific gravity bottle and 10 spheres = W2
Weight of 10 spheres + water = W3
Weight of water bottle = W4
Weight of liquid specific gravity bottle = W5

P = W2-W1/ (W4-W1) – (W3-W2)
σ = (W5-W1)/(W4 – W1)

Ex.No.3. Determination of viscosity with Ostwald viscometer

The Ostwald viscometer The Ostwald viscometer fulfils these conditions: a U-tube with two reservoir bulbs separated by a capillary as shown in Fig. 2.



The liquid is added to the viscometer, pulled into the upper reservoir by suction, and then allowed todrain by gravity back into the lower reservoir. The time that it takes for the liquid to pass between twoetched marks, one above and one bellow the upper reservoir, is measured. If the level of the liquid having density r is initially at *h*1 and finally at *h*2 the mean hydrostatic pressure during the outflow is:

$$p = \frac{h_1 + h_2}{2} \rho g$$

where *g* is the gravitational acceleration of free fall. For absolute measurement we have to know all parameters of the viscometer (*V*, *r*, *l*, *h*1, *h*2) but we can calibrate the equipment using a reference liquid having well known density r0. The relative viscosity is:

$$\eta_{rel} = \frac{\eta}{\eta_0} = \frac{\rho t}{\rho_0 t_0}$$

where r is the density, *t* is the time of outflow of the sample, r0 is the density, *t*0 is the time of theoutflow of the reference liquid (water). Knowing h0 the viscosity of the sample can be calculated.We have to measure the density of the sample. At the laboratory course we use pycnometer for thedetermination of the density. We measure the weight of the empty pycnometer (*m*p) the filledpycnometer with reference liquid (water)(*m*p+w) having well known density (rw) and filled pycnometerwith the sample (*m*p+s). The density of the sample (rs) can be calculated as follows:

$$\rho_s = \frac{m_{p+s} - m_p}{m_{p+w} - m_p} \rho_w$$

Equipments:

Ostwald viscometer, pycnometer, 20 cm3 pipette, capillary funnel, thermostat, analytical balance

Steps:

1. Set up the temperature given by the supervisor of the measurement.

2. Measure 20 cm3 distilled water to the lower reservoir and put the viscometer to the thermostat

(even the *h*1 level should be under the level of the water in the thermostat)!

3. Measure the weight of the empty, dry pycnometer!

4. Fill the pycnometer with 2x distilled water and put the pycnometer to the thermostat!

5. If the temperature is stable measure the time of the outflow 6-8 times! There should be no

systematic change in the times!

6. Remove the distilled water from the viscometer and fill it with the Poly Vinyl Alcohol (PVA) solution! Put the viscometer to the thermostat again!

7. Fill the pycnometer to the ring mark IN the thermostat! Measure the weight of the pycnometer

filled with 2x distilled water!

8. Clean the pycnometer, fill it with the PVA solution and put to the thermostat again!

9. Measure the outflow times for the sample 6-8 times! There should be no systematic change in the

times!

10. Fill the pycnometer to the ring mark In the thermostat Measure the weight of the pycnometer

filled with the sample!

11. Clean the equipments!

Result:

The Viscosity of given PVA solution is……….

Ex.No.4. ACID-BASE TITRATION USING A pH METER

Introduction

In an acid-base titration, the important information to obtain is the **equivalence point**. If there are a given number of moles of acid in the titration flask, the equivalence point is reached when that same number of moles of base have been added from the buret. The molarity of the base can then be calculated since the number of moles of base added is the same as the number of moles of acid in the flask, and the volume of the base added is also known. Similarly, if the number of moles of acid in the titration flask is unknown, it can be calculated for the equivalence point if the molarity of the base and the volume of base added are known.

Often the pH of the solution will change dramatically at the equivalence point. An acid-base indicator works by changing color over a given pH range. If an indicator which changes color near the equivalence point is chosen, there is also a dramatic change in the color of the indicator at the equivalence point because the pH changes so rapidly.

In a potentiometric acid-base titration, an indicator is not necessary. A pH meter is used to measure the pH as base is added in small increments (called aliquots) to an acid solution. A graph is then made with pH along the vertical axis and volume of base added along the horizontal axis. From this graph the equivalence point can be determined and the molarity of the base calculated.

Aim

To determine the normality of the given basic solution using PH meter.

OBJECTIVES

1. To perform a potentiometric titration of an acidic solution of known normality

2. To graph the volume of base added vs the pH and to determine the equivalence point.

3. To calculate the normality of the basic solution.

MATERIALS

pH meter with standard buffers of pH 4.0, pH 7.0, and pH 10.0
50 mL burette
burette clamp stand
100 mL beaker
HCl solution of known normality
NaOH Solution of unknown normality

Procedure

1. Obtain about 100 mL of 0.1 N HCl in a clean, dry beaker. This beaker should be labeled.
2. Rinse your burette with distilled water. Then use a small amount of the 0.lN HCl solution to rinse the burette. The rinsing solution should be discarded into the sink.
3. Fill the burette to some point with HCl.

4. Obtain about 100 mL of NaOH solution in another clean, dry beaker. This beaker should also be labeled.
5. Rinse and fill the other burette with NaOH as indicated in step 2
6. Standardize the pH meter using buffer solutions with known PH.
7. Place a 100 mL beaker under the burette containing the 0.1 N HCl and let out approximately 20 mL into the beaker. Record the mL of HCl added to the beaker.
8. Set the beaker and position the burette containing the NaOH solution just above the beaker.
9. Set up your data table to include mL of NaOH added and the pH of the solution.
10. Add 1 ml of NaOH from the burette at a time, stir well with the help of a glass rod and note down the PH. Continue adding NaOH in 1.0 mL increments until you have obtained a pH reading greater than 12.
11. Remove the pH electrode from the solution, rinse it with distilled water, and store it as directed by your teacher.
12. The solutions may be discarded down the sink. Rinse the burets with distilled water and place it in the store as directed by your teacher.

Calculations

Make a graph of the pH vs mL of NaOH added. The pH should be on the vertical axis and the mL of NaOH should be on the horizontal axis.

There should be a region on your graph where the slope is very steep. Determine the midpoint of this region. This is the equivalence point. Record the mL of NaOH added at the equivalence point as determined from the graph.

Use the relationship: $N_A V_A = N_B V_B$ to determine the normality of the base

Table

S.No	**Volume of the acid**	**Burette reading Initial**	**Burette reading Initial**	**Volume of NaOH added**	**pH of the solution**

Result

The normality of the given basic solution :

Ex.No. 5. EFFECT OF ADDITION OF HCl/NaOH ON PH OF A SOLUTION

Aim

To study the effect of addition of HCl and NaOH on pH to the solutions of acetic acid, sodium acetate and their mixtures.

Introduction

Often the pH of the solution will change dramatically by the addition of a strong acid(HCl) or a base(NaOH). A pH meter is used to measure the pH as the acid (HCl)/base(NaOH) is added in small increments (called aliquots) to an acid/basic solution. A graph is then made with pH along the vertical axis and volume of base added along the horizontal axis. The addition of an acid or a base to a buffer solution the pH will not change appreciably.

Materials

pH meter with standard buffers of pH 4.0, pH 7.0, and pH 10.0
50 mL burette
burette clamp stand
100 mL beaker
Acetic acid and sodium acetate solutions
HCl solution of known normality
NaOH Solution of unknown normality

Procedure

1. Obtain about 100 mL of 0.1N HCl in a clean, dry beaker. This beaker should be labeled.
2. Rinse your burette with distilled water. Then use a small amount of the 0.lN HCl solution to rinse the burette. The rinsing solution should be discarded into the sink.
3. Fill the burette to some point with HCl.
4. Obtain about 100 mL of NaOH solution in another clean, dry beaker. This beaker should also be labeled.
5. Rinse and fill the other burette with NaOH as indicated in step 2
6. Standardize the pH meter using buffer solutions with known PH.

Beaker 1

7. Take 20 ml of acetic acid in a 100 ml beaker. Measure the pH.
8. Set the beaker and position the burette containing the NaOH solution just above the beaker with acetic acid solution.

9. Set up your data table to include mL of NaOH added and the pH of the solution.
10. Add 1 ml of NaOH from the burette at a time, stir well with the help of a glass rod and note down the PH. Continue adding NaOH in 1.0 mL increments until you have obtained a pH reading greater than 12.

Table

S.No	**Volume of the acetic acid**	**Burette reading Initial**	**Burette reading Initial**	**Volume of NaOH added**	**pH of the solution**

A graph is then made with pH along the vertical axis and volume of base added along the horizontal axis.

Beaker 2

11. Take 20 ml of acetic acid in a 100 ml beaker. Measure the pH.
12. Set the beaker and position the burette containing the HCl solution just above the beaker with acetic acid solution.
13. Set up your data table to include mL of HCl added and the pH of the solution.
14. Add 1 ml of HCl from the burette at a time, stir well with the help of a glass rod and note down the PH. Continue adding HCl in 1.0 mL increments until you have obtained a pH reading below pH 2.
    A graph is then made with pH along the vertical axis and volume of acid added along the horizontal axis.

Beaker 3

15. Take 10 ml of acetic acid and 10 ml of sodium acetate and 10 ml of acetic acid in a 100 ml beaker. Measure the pH.
16. Repeat the steps 8 to 10 and 12 to 14.

Table

S.No	**Volume of**	**Burette reading**	**Burette**	**Volume of**	**pH of**

	the mixture of acetic acid & sodium acetate	Initial	reading Initial	NaOH added	the solution

Table

S.No	Volume of the mixture of acetic acid & sodium acetate	Burette reading Initial	Burette reading Initial	Volume of HCl added	pH of the solution

A graph is then made with pH along the vertical axis and volume of acid/base added along the horizontal axis.

Result:

1. By the addition of HCl acid to acetic acid the pH ---------------------------
2. By the addition of NaOH to acid acid the pH ------------------------------
3. By the addition of HCl acid to a mixture of acetic acid and sodium acetate pH -----
4. By the addition of NaOH to a mixture of acetic acid and sodium acetate pH -----

Test tube	1	2	3	4	5	6	7	8	9

Ex.No.6. PREPERATION OF BUFFER SOLUTIONS

Aim

To prepare an acidic buffer solution of different pH values using acetic acid and sodium acetate

Introduction

Buffer solutions are those solutions which resist the change in their pH by the addition of an acid or a base. In this experiment, a series of buffer solutions are prepared by mixing different volumes of equimolar solutions of acetic acid and sodium acetate. Acetic acid is slightly dissociated while sodium acetate being a salt is completely dissociated. Thus the mixture contains CH_3COOH, CH_3COO^- and Na^+ ions. The pH of the buffer solution is calculated using Hendersen equation.

Procedure

1. Prepare 100 ml of 0.4N NaOH solution and 0.4N acetic acid solution
2. Prepare 100 ml of 0.2 N sodium acetate solution(by mixing 50 ml of 0.4N NaOH solution and 50 ml of 0.4N acetic acid solution)
3. Prepare 100 ml 0.2N acetic acid solution (by mixing 50 ml of distilled water with 50 ml of 0.4N acetic acid solution)
4. Prepare the following buffer solutions
5. Standardize the pH meter using buffer solutions with known PH.
6. Note down the PH of the above test solutions using the PH meter.

Vol. of sodium acetate solution	9	8	7	6	5	4	3	2	1
Vol. of acetic acid solution	1	2	3	4	5	6	7	8	9
pH	5.70	5.35	5.12	4.93	4.75	4.56	4.38	4.15	3.79

Results:

The PH of the above prepared buffer solutions from acetic acid and sodium acetate are..