Volumetric analysis – Selected tasks

Practical Lesson on Medical Chemistry and Biochemistry

General Medicine

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Task 1: Construction of titration curves

Reagents

1. Solution c(NaOH) = 0.1 mol/l 
2. Solution c(HCl) = 0.1 mol/l 
3. Solution c(CH_3COOH) = 0.1 mol/l

Procedure

20.0 ml of relevant acid is pipetted into a pure plastic container and its pH is measured by means of pH-meter. Sodium hydroxide is added step by step as directed by the table below. The pH of the solution is measured after each addition of sodium hydroxide and good mixing. Do not wash the pH electrode between the measurements, but avoid leaving the electrode for a long time outside the solution – **remember that the electrode must not get dry!**

Note: Each student couple measures values of pH for one type of acid, either strong or weak, but students will include both types of titration curves to their reports. The couples of students are supposed to give the results to each other.

	20ml **HCl** c=0.1mol/l			20ml **CH_3COOH** c=0.1mol/l		
	NaOH c=0.1mol/l		pH	NaOH c=0.1mol/l		pH
	Addition in ml	Σ ml		Addition in ml	Σ ml	
1	0	0		0	0	
2	3	3		1	1	
3	3	6		2	3	
4	3	9		3	6	
5	3	12		4	10	
6	3	15		5	15	
7	3	18		3	18	
8	1	19		1	19	
9	1	20		1	20	
10	1	21		1	21	
11	1	22		1	22	
12	3	25		3	25	
13	5	30		5	30	
14	10	40		10	40	

Objectives

1. The obtained values are recorded to a graph: on x-axis plot the quantity of added hydroxide in ml, and on y-axis the measured values of pH. Draw both titration curves to the same graph; they can be distinguished by colour. Compare and explain the different courses of titration curves.
2. Calculate a theoretical value of pH for c(HCl) = 0.1 mol/l (activity coefficient f=0.796).
3. Calculate a theoretical value of pH for $c(CH_3COOH)$ = 0.1 mol/l (K_a=1.75×10^{-5}).
4. Find and indicate in your graph the pK_a of acetic acid and compare this value with the one provided above.
5. Determine pH of the equivalence point for both titration curves.

Task 2: Determination of molar and mass concentration of sulphuric acid solution by acid-base titration

Principle

$$H_2SO_4 + 2\ NaOH \rightarrow Na_2SO_4 + 2\ H_2O$$

Reagents

1. Solution of sulphuric acid of unknown concentration 

2. Titration reagent c(NaOH) = 0.1 mol/l, factor = 1.00 

3. Phenolphthalein 2 g/l in ethanol 

Procedure

Exactly 5.0 ml of H_2SO_4 solution of unknown concentration is measured to a pure titration flask and diluted with about 10-20 ml of distilled water. A few drops of indicator are added and solution is titrated with the titration reagent NaOH from burette. Titration is completed when a permanent tint of indicator, clearly different from the colourless state of the original solution, is achieved. Titration is repeated three times. The molar and mass concentration of sulphuric acid is calculated from the average of values of the second and third titrations.

Objectives

1. Write the equation in ionic form – the base of titration determination.
2. Give reasons for the used indicator.
3. Calculate molar and mass concentration of sulphuric acid in tested sample.

Task 3: Determination of molar and mass concentration of NaCl solution by argentometry

Principle

$$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$$

Reagents

1. Solution of NaCl of unknown concentration.
2. Titration reagent c($AgNO_3$) = 0.01 mol/l, factor = 1.00.

3. Solution of c(K_2CrO_4) = 50 g/l.

Procedure

Exactly 5.0 ml of NaCl solution is measured to a pure titration flask, about 10 ml of distilled water is added, together with 2-4 drops of K_2CrO_4 indicator. Solution is titrated with $AgNO_3$ solution from burette to a permanent reddish brown tint of precipitate (the original colour of precipitate is white). The titration is repeated three times. The molar and mass concentration of NaCl solution is calculated from average of values of the second and third titrations.

Objectives

1. Write the ionic equation of titration determination and also the ionic equation of the reaction with indicator behind the point of equivalence.
2. Give reasons for the used indicator and explain why AgCl precipitates first, despite the fact that its solubility product (K_s=1.6×10^{-10}) is greater than the solubility product of Ag_2CrO_4 (K_s=4×10^{-12}).
3. Calculate molar and mass concentration of chloride anion Cl^- in the tested sample of NaCl.
4. Calculate molar and mass concentration of the tested solution if the sample were $CaCl_2$ instead of NaCl, for the same volume and consumption of titration reagent.