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Lab 7 Partner: Linh Nguyen

Hypochlorite Ion in Bleach

10/29/2019

Prelab Assignment

$IO_3^- + 8I^- + 6H^+ \rightleftharpoons 3I_3^- + 3H_2O$

$0.1358g\left(\frac{1mol}{214.00g}\right) = 6.34579\times10^{-4} = n_{KIO_3} = n_{IO_3^-}$

$IO_3^- : 3I_3^- \Rightarrow 1:3$ ratio

$n_{I_3^-} = 1.903737\times10^{-3}$ mol (a)

$2g\left(\frac{1mol}{166.0028g}\right) = 0.01205mol\ KI = 0.01205mol\ I^-$

$8I^- : 3I_3^- \Rightarrow 8:3$ ratio

$n_{I_3^-} = 4.51875\times10^{-3}$ mol (b)

$0.002L(6M) = 0.012mol = n_{HCl} = n_{H^+}$

$6H^+ : 3I_3^- \Rightarrow 6:3$ ratio.

$n_{I_3^-} = 6\times10^{-3}$ mol (c)

Since $n_{I_3^-}$ (a) < (b) < (c), IO_3^- is the limiting reagent.

$2S_2O_3^{2-} + I_3^- \rightleftharpoons S_4O_6^{2-} + 3I^-$

2 : 1 ratio

$n_{S_2O_3^{2-}} = 2(1.903737\times10^{-3}mol) = 3.807474\times10^{-3}$

$[S_2O_3^{2-}] = \frac{3.807474\times10^{-3}mol}{0.03194L} = 0.12\ M$.

$\frac{M_1V_1}{M_2V_2} = \frac{2}{1}$

$\frac{0.12M(21.33mL)}{M_2(25.00mL)}$

$M_2 = 0.05\ M = [I_3^-]$

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Objective

The purpose of this experiment is to determine the concentration of hypochlorite ions in bleach by titration of thiosulfate solution into the bleach solution.

Introduction:

The experiment is divided into two parts, where the first part involves the determination of concentration of thiosulfate solution, to be used in the second part, to then determine the concentration of hypochlorite ions in bleach, via titrations. Starch is used as an indicator, which will change from blue to black colored complex with iodine. For iodimetry (where standard iodine solution is used as titrant for oxidizable titrant), the end point corresponds to a sudden color change to blue. Meanwhile for iodometry ~~the~~ (where excess iodine is used to reduce a chemical species while simultaneously forming iodine), the end point corresponds to a sudden loss of blue color in the solution.

Procedure:

A) Preparation of Standard Sodium Thiosulfate solution

1. Prepare a 0.1M thiosulfate solution (dissolve ~12g of sodium thiosulfate pentahydrate & ~0.05g of sodium carbonate in ~250 mL of water). Mix very well to dissolve. Transfer the solution to a clean 500 mL volumetric flask. Dilute to the mark & mix well. (serve as stock thiosulfate solution).

2. Fill a 50 mL burette with thiosulfate solution. Record the initial volume.

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Part A

Erlenmeyer flasks #	1	2	3
Mass of KI (solid) (g)	1.8801	2.1689	2.1266
Beakers #	1	2	3
Mass of KIO_3 solid (g)	0.1421	0.1249	0.1376
Initial buret reading (mL)	0.29	0.23	0.82
Final buret reading (mL)	42.35	36.65	42.18
Titrated volume (mL)	42.06	36.42	41.36

Sodium Thiosulfate standardization			
Erlenmeyer flask #	1	2	3
Mass of KI solid (g)	1.8801	2.1689	2.1266
Mass of KIO_3 solid (g)	0.1421	0.1249	0.1376
Initial buret reading (mL)	0.29	0.23	0.82
Final buret reading (mL)	42.35	36.65	42.18
Titrated volume (mL)	42.06	36.42	41.36
Molecular weight of KIO_3 (g/mol)	214.001		
Mole of IO_3^- ions (mol)	6.640E-04	5.836E-04	6.430E-04
Mole of I_3^- ions (mol)	1.992E-03	1.751E-03	1.929E-03
Mol of $S_2O_3^{2-}$ ions (mol)	3.984E-03	3.502E-03	3.858E-03
Molarity of $Na_2S_2O_3$ solution (M)	0.09472	0.09615	0.09328
Average molarity (M)	0.09472		
Standard deviation in molarity (M)	0.00144		
RSD (%)	1.5		

3. Weigh ~ 2g of reagent-grade KI solid into each of 3 numbered 125 mL Erlenmeyer flasks. Add ~ 25mL of water & ~2 mL of 6 M HCl to each flask. Swirl the solution to dissolve the KI.

4. Number 3 small beakers (with the same numbers used for Erlenmeyer flasks.

5. Into each beaker, weigh between 0.12 & 0.15g of KIO_3. Record the mass of KIO_3 in each numbered container/beaker.

6. Add KIO_3 in one of the numbered containers to the solution in the identically numbered Erlenmeyer flask. Swirl the solution to dissolve the ~~potassium~~ KIO_3. Brown color of I_3^- should be apparent in the solution.

7. After recording the initial volume, titrate the solution in the Erlenmeyer flask with the thiosulfate solution in the burette until the ~~ti~~ I_3^- color has become noticeably less intense. Add ~2mL of starch indicator & continue the titration until the dark-blue color of starch-triiodide complex disappears. Record end-point volume to the nearest 0.01mL.

8. Individually repeat steps 6 & 7 with the remaining 2 KIO_3 samples. Generate iodine/triiodide just before titrating with thiosulfate to minimize loss of triiodide reactant & error from the loss.

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Part B

Erlenmeyer Flasks #	1	2	3
Mass of KI (g)	1.5865	1.9429	1.7282
Initial buret reading (mL)	42.18	14.93	18.95
Final buret reading (mL)	45.90	18.95	23.49
Titrated volume (mL)	3.72	4.02	4.54

Determination of Hypochlorite in Bleach			
Erlenmeyer flask	1	2	3
Mass of KI solid (g)	1.5865	1.9429	1.7282
Initial buret reading (mL)	42.18	14.93	18.95
Final buret reading (mL)	45.90	18.95	23.49
Titrated volume (mL)	3.72	4.02	4.54
Average molarity $Na_2S_2O_3$ solution (M)	0.09472		
Volume of NaOCl (mL)	2.00		
Mole of $S_2O_3^{2-}$ ions (mol)	3.523E-04	3.808E-04	4.300E-04
Mole of I_3^- ions (mol)	1.762E-04	1.904E-04	2.150E-04
Mole of OCl^- (mol)	1.762E-04	1.904E-04	2.150E-04
Molarity of NaOCl (M)	0.08809	0.09519	0.1075
Average molarity NaOCl (M)	0.09693		
Standard deviation molarity NaOCl (M)	0.00982		
RSD (%)	10.1		

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B) Iodometric Determination of Hypochlorite

1. Add ~ 50 mL of DI water & between 1.5 & 2.0g of KI to each of 3 250mL Erlenmeyer flasks. Stir the solutions until the ~~pot~~ KI in each flask is dissolved.

2. Add ~ 10mL of 3M H_2SO_4 to each flask.

3. Use a pipet to deliver 2.00mL of liquid bleach into one of the flasks, & stir by swirling the solution. Fill a 50mL buret with standard sodium thiosulfate solution, record the initial volume, & use the thiosulfate solution to titrate the I_3^- formed during the reaction of bleach with iodide. When ~~the~~ I_3^- color starts to fade, add 2mL of starch solution & continue the titration to the endpoint. Record the end-point volume to the nearest 0.01mL.

4. Individually repeat step 3 with the solutions in each of the other 2 Erlenmeyer flasks. Generate iodine just before the titration with thiosulfate.

5. Dispose of the titration solutions, thiosulfate standard & other solutions as indicated. Clean & dry the lab work area.

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Analysis & Results

The calculations for the determination of molarity of thiosulfate solution and the liquid bleach are done in Excel, as tabulated in the table ~~shown~~ attached in this book. The formula used were as stated in the summary report.

Conclusion

In order to determine the concentration of liquid bleach, the thiosulfate solution has to be prepared. The average molarity of thiosulfate solution is found to be 0.09472M with a standard deviation of 0.00144M. By using this thiosulfate solution, it is titrated into the ~~liquid~~ bleach solution and the molarity of the bleach is found to be 0.09693M with a standard deviation of 0.00982M.