

Objective

- Explore the properties of acids and bases
- Understand and perform titrations

Background

pH

In chemistry, one of the most important properties of a solution is the pH. This quantity gives insight into the concentration of hydronium ions in a solution. The pH of a solution can be defined as the negative logarithm of the concentration of hydronium ions. Values of pH typically range from 0 to 14 in water. A pH of 7 is considered neutral, any pH below 7 is considered acidic, and any pH above 7 is considered basic.

As is typical in our chemistry lab, we must standardize our methods and equipment to ensure accurate results. First, we will standardize our titrant (NaOH). The NaOH solution was prepared using very hygroscopic solid pellets. Upon contact with the air, these pellets absorbed moisture. The added mass from the moisture causes error in the weighing of the pellets and as a result, the concentration provided to us is only an approximation. To determine the true concentration of our NaOH, we will use a primary standard. A primary standard is a chemical that is used to standardize various solutions. In general, a primary standard must have high purity, low reactivity, and a high molecular mass. All three of these properties contribute to an accurate amount of moles for analytical calculations. The primary standard to be used in today's lab is potassium hydrogen phthalate (KHP).

The second standardization we will perform is on the pH meters for today's lab. Two buffer solutions have been prepared or purchased that have a highly accurate value for pH. Using these, we will set the pH meters to read the pH of the buffer when in that solution. You should remember to rinse the tip (probe) with water between samples and dry it. Probes should not be left out of water for more than an hour as the meter will have to be recalibrated at that time. Calibration of the meters is covered in the procedure.

The purpose of this lab is to determine concentrations. For this, we will use acid-base neutralization chemistry. The equivalence point, or the point at which the moles of acid and base in the solution are equal, will be detected. In the standardization of NaOH, an indicator will be used. An indicator undergoes a physiochemical change to signal a specific change. For this experiment, phenolphthalein will turn pink to indicate the solution transitioning from acidic to basic. In the determinate of the concentration of HCl, the equivalence point will be determined graphically.

Materials

- KHP
- Phenolphthalein indicator
- NaOH (aq)
- HCl(aq)
- Buret
- Buret clamp
- Erlenmeyer flasks
- pH meter
- pH buffers (4 and 10)

Safety goggles are required!

Sodium hydroxide is a corrosive strong base.

Hydrochloric acid is a corrosive strong acid.

Procedure

pH

Standardizing the NaOH Solution

1. In a 125mL Erlenmeyer flask, weigh approximately 0.5g of dry KHP. Record this mass.
2. Add to the Erlenmeyer flask approximately 20mL of deionized water.
3. Add to the Erlenmeyer flask 2-3 drops of phenolphthalein indicator.
4. Fill burette with sodium hydroxide solution to slightly above the top line using a funnel. Do not overfill the funnel due to risk of overflow from the burette.
5. Dispense excess volume into a waste beaker until the level of solution is at the top mark on the burette. This step eliminates an air bubble in the stopcock that could lead to inaccurate volumes.
6. Dispense sodium hydroxide drop-wise in the Erlenmeyer flask while continuously swirling the flask. Look for signs of the pink ind. When the indicator has turned a faint pink and is persistent with continuous swirling, the titration is complete. Write down the final volume on the burette.
7. While continuously swirling, dispense sodium hydroxide drop-wise in the Erlenmeyer flask. Look for signs of the pink indicator. When the indicator has turned a faint pink and is persistent with continuous swirling. The titration is complete. Write down the final volume on the burette.
8. Repeat steps 1-7 twice more.
9. Find the average molarity of sodium hydroxide from your titrations.

Determination of an Unknown Concentration of Hydrochloric Acid

10. Obtain and calibrate a pH meter. To calibrate, you will use two prepared buffer solutions, pH 4 and 10. Place pH probe in the pH 4 standard. Adjust the calibration until the pH

readout matches the prepared buffer pH. Rinse off the probe. Repeat this with the pH 10 standard. Calibration is dependent on the type of meter so you should be helped by the TA with this if needed.

11. Obtain 20mL of unknown acid in a 125mL Erlenmeyer flask.
12. Perform a titration by adding sodium hydroxide solution drop-wise. This time, however, monitor the pH of the solution using the pH probe. Take a data point (volume NaOH added, pH) ever few drops. Be sure to continue taking data points after the pH has reached 7.
13. Repeat steps 10-11 twice more.

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Pre-Lab Questions

Prepare for lab by completing and understanding the answers to these questions. Refer to the Background or another resource, such as your textbook, if necessary.

1. Draw a flowchart illustrating how you will obtain the concentration of the HCl.
2. List the properties that a primary standard must possess.
3. Draw a titration curve graph. Please label the axes, sketch the general shape of the curve, and label the equivalence point.
4. Calculate the pH of a 0.0012M solution of HCl in water. Show all work.
5. Calculate the pH of a .0012M solution of NaOH in water. Hint: There is a relationship between pH and pOH. Show all work.

Name _____ Section _____
Date _____ Instructor _____

Standardizing the NaOH Solution

Average concentration of NaOH (M) _____

Trial 1	Trial 2	Trial 3
1	2	3
2	3	4
3	4	5
4	5	6
5	6	7
6	7	8
7	8	9
8	9	10
9	10	11
10	11	12
11	12	13
12	13	14
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14	15	16
15	16	17
16	17	18
17	18	19
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89	90	91
90	91	92
91	92	93
92	93	94
93	94	95
94	95	96
95	96	97
96	97	98
97	98	99
98	99	100

[illegible]

Post-Lab Questions

1. Describe, in detail, the effect on the determined concentration of HCl if during the standardization your solution turned a dark pink instead of faint pink.
2. In a titration, it took 37.9mL of .17M NaOH to neutralize a 5mL sample of HCl. What is the concentration of the hydrochloric acid? Show all work.

3. Assuming that the experiment was performed perfectly at every step of the procedure, identify possible sources of error in this experiment and discuss their impact.

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