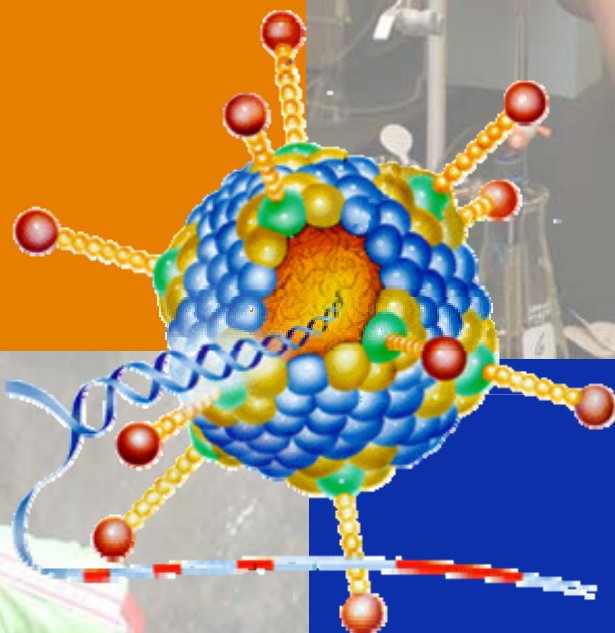


Changes in Conductivity and pH

Lab Book



The waterCAMPWS
Center for Advanced Materials
for Purification of Water with Systems



Overview

Controlling the amount of acid or base, referred to as pH, of our water is a very important task for civil engineers. For example, water with a pH of 5.0 or below will be corrosive and destroy pipes in your home. Water with a high pH of 8.0 or more will form a scale and start to clog pipes and form scale on sinks and tubs. Materials, such as activated granular charcoal is used to control water's pH as well as remove harmful substances from the water. This lab demonstrates the change in the pH curve when granular activated carbon is added during the acid base titration.

Materials and Equipment

Materials required for this lesson are (for each group of students):

- Reagents: 0.002 M CuCl_2
 - 0.1 M HCl
 - 0.1 M NaOH
- granular activated carbon or AC (presoaked in distilled water)
- 100 mL graduated cylinder
- 400 mL beaker
- Titration setup
- magnetic mixers and magnetic stir bars
- pH probe
- Hand pipettes or burettes
- Scale



Procedure

You will perform two titrations. A 0.002M solution of copper chloride (CuCl_2) will be provided. Three mL of 0.1M hydrochloric acid (HCl) will be added to the solution. You will then titrate the acidic solution using sodium hydroxide (NaOH) and record the pH after each addition. In the second titration, each group should add approximately 2.0 grams of activated carbon to the solution before beginning the titration. Be sure to record all observations (e.g. color changes). After completing the lab, plot graphs of pH vs. volume of NaOH added. You will also need to determine the concentration of NaOH. Calculate answers on the space provided.

First Titration:

- Start with approximately 200 mL 0.002M copper chloride solution.
- Place magnetic stir bar in solution and turn mixer on (slowly).
- Add 3 mL of 0.1M HCl to solution.
- Record initial pH.
- Begin titrating with NaOH.
- Record pH after each **0.3mL** NaOH addition. If the pH meter does not stabilize, wait 2 minutes and record that reading.
- Continue titrating to pH 11.
- Create a graph of pH vs. added NaOH.

Second Titration:

- Start with approximately 100 mL 0.002M copper chloride solution
- Place magnetic stir bar in solution and turn mixer on (slowly).
- Add 1.5mL of 0.1M HCl to solution.
- Add 2.00 grams granular activated carbon (GAC)
- Record initial pH.
- Begin titrating with NaOH.
- Record pH each **0.2mL** NaOH addition. Be sure to wait for reading to stabilize.
- Continue titrating to pH 11.
- Create a graph of pH vs. added NaOH.

Results

Please show all work on paper for calculations done. Be sure to include correct labels for your answers.

Titration Data for First Titration:

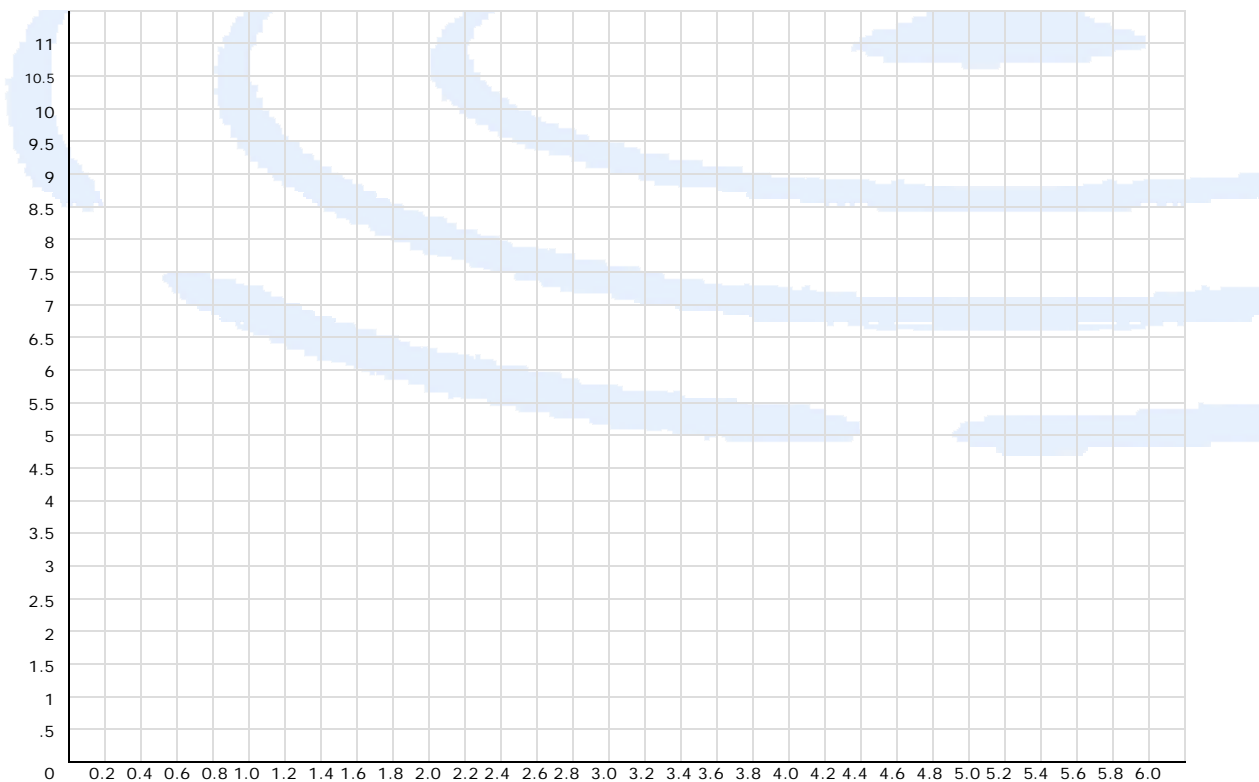
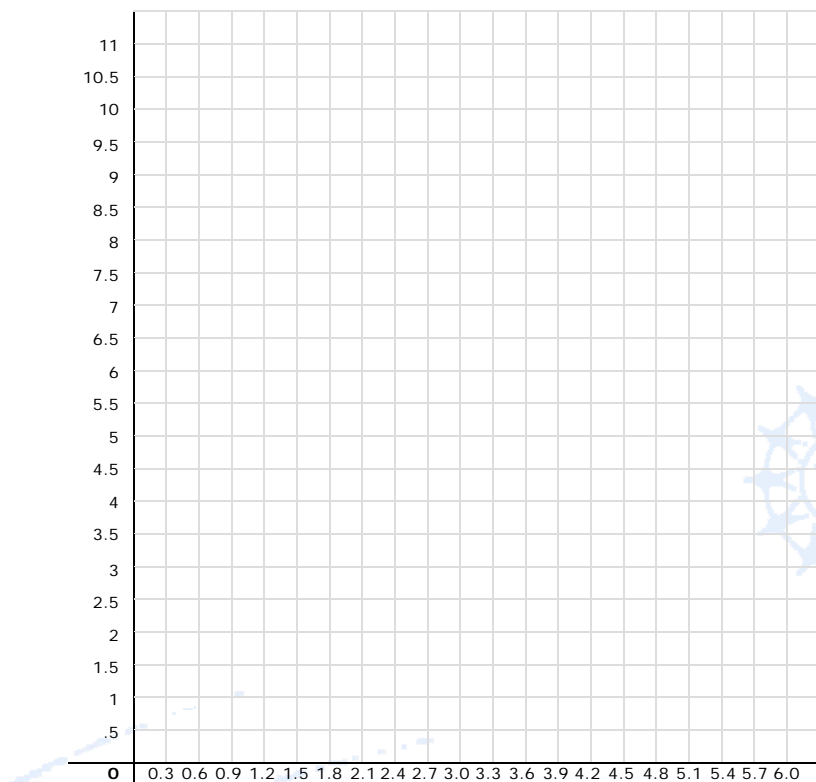
NaOH added in 0.3 mL increments	pH	NaOH added in 0.3 mL increments	pH
0		3.9	
0.3		4.2	
0.6		4.5	
0.9		4.8	
1.2		5.1	
1.5		5.4	
1.8		5.7	
2.1		6.0	
2.4			
2.7			
3.0			
3.3			
3.6			

Titration data for Second Titration

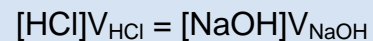
NaOH added in 0.2 mL increments	pH	NaOH added in 0.2 mL increments	pH
0		3.2	
0.2		3.4	
0.4		3.6	
0.6		3.8	
0.8		4.0	
1.0		4.2	
1.2		4.4	
1.4		4.6	
1.6		4.8	
1.8		5.0	
2.0		5.2	
2.2		5.4	
2.4		5.6	
2.6		5.8	
2.8		6.0	
3.0			

Analysis

Graph the change in pH as NaOH is added for the two titrations. Label the graph and the axes.



1. Calculate the amount of NaOH needed to reach the equivalence point. Remember that both the concentration of HCl (0.1 M) and the amount added are known. Be sure to use the values from the titration completed without the use of AC (activated charcoal) to determine the concentration of AC.



2. As the pH of a substance becomes less acidic or closer neutral, does the equilibrium constant increase or decrease? Explain your answer.

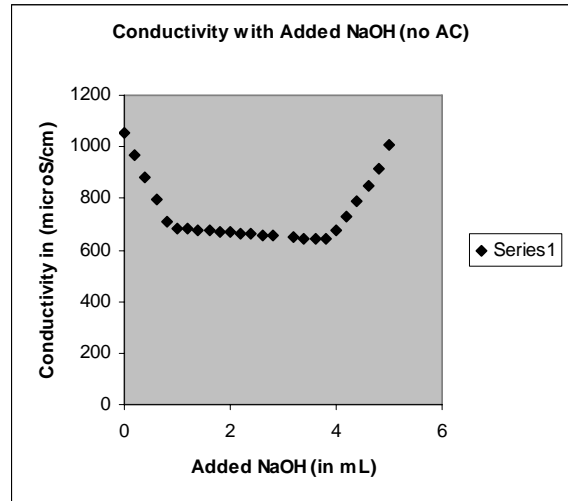
3. Activated carbon can absorb both positive and negative ions. Because it is used as a filter for water, what must this tell you about:

- a. the charges of particles that are found in water

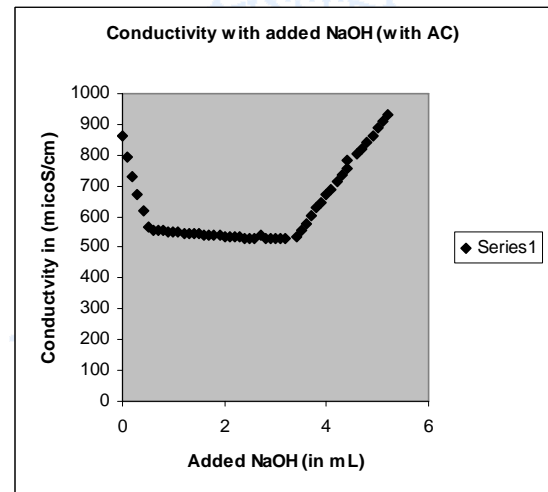
- b. seasonal pH of water

4. The chart to the right shows the conductivity of the solution as NaOH is added. Conductivity decreases steadily as H^+ ions (from HCl) form bonds with OH^- ions. The conductivity decreases once more (this time the drop is more subtle), then increases. Note the volume of NaOH added at these points and locate the points with the same volumes on your pH curves.

a. What do you notice when comparing the changes in slope on the two graphs?



b. Formulate a list of possible explanations for these changes. In other words, why does the conductivity decrease/increase?



5. The conductivity vs. volume of added NaOH graph for the titration using activated carbon produces a similar curve, but the amount of NaOH needed to reach the same points is not the same. After comparing the points on the two graphs, why is less NaOH needed for the second titration?

6. Now calculate the amount of copper absorbed by the activated carbon. You will need to calculate:
- the concentration of NaOH

- the molar mass of CuCl_2

- the difference in the amount of NaOH used to reach the second equivalence point in the first and second titrations.

7. If you were asked to write a blurb about conductivity and pH for a local newspaper that has a "Science for the Rest of Us" column on Sunday, what would you write about this lab? What relationship does this lab have to the everyday life of a person who doesn't remember much about their high school science?