Best Practices for Teaching Chemistry Video Series Professional Development

The Flinn Scientific Teaching Chemistry eLearning Video Series is a proven teacher training professional development program guaranteed to help chemistry teachers from across the country improve their chemistry teaching skills. 126 chemistry content areas with more than 500 individual learning episodes are available for viewing over the Internet. Every major topic of the high school chemistry curriculum is covered. Our presenters have proven experience in teaching students and training teachers.

- All of our video episodes are arranged into 126 different products that cover all of the chemistry topic areas. Each one of these products includes between 4 and 6 video episodes that cover a different lab or demonstration for that topic. All of these episodes are presented by a team of more than 20 master teachers from across the United States, all with numerous years of classroom and teacher training experience. Please refer to the eLearning Web site http://elearning.flinnsci.com for a list of all these presenters and their training credentials.

- Every video episode comes with a set of detailed and clearly written ChemFax™ instructions that are printable in PDF format. An example "Buffering of Lakes" is included following this cover letter.

- A form documenting participation in the Teaching Chemistry eLearning Video Series will be available to all teachers who purchase and watch the product in its entirety. The form will be filled out by Flinn Scientific and will note the amount of hours earned and all topics that were covered. This form will be available on the eLearning Web site for all participants to print. A post-activity assessment form will also be available for teachers to print and fill out once the video is completed. An example of both of these forms is also included in this PDF.

The Flinn Scientific Teaching Chemistry eLearning Video Series has captured awesome pedagogical content knowledge of 20 master teachers with proven expertise in teaching students and training teachers. Our presenters have 550 years of combined classroom experience and teachers of all levels of experience can benefit and learn from the valuable information shared through these videos.

Each video package has a viewing time of approximately 45 minutes and includes several pages of in-depth handouts to read and review. One clock hour of professional development credit can be awarded for each video package that is viewed.

If you have any further questions please contact Flinn Scientific at
elearning@flinnsci.com — 800-452-1261

P.O. Box 219 • Batavia, IL 60510
(800) 452-1261 • Fax (866) 452-1436
www.flinnsci.com • E-mail: flinn@flinnsci.com

eLearning

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"Your Safer Source for Science Supplies"

Publication No. 91314

Buffering of Lakes

Buffers and Environmental Chemistry

Introduction

Acid rainfall causes deleterious effects to our environment. It can be especially harmful to the ecosystems of lakes and streams. Help students discover natural defenses that allow lakes and streams to maintain pH.

Concepts

- Acid rain
- Buffers
- Acid–base indicators
- Water quality

Materials

Marble chips (calcium carbonate, $CaCO_3$), 150 g
Sulfuric acid, H_2SO_4, 0.1 M, 3–5 mL
Universal indicator solution, 3 mL
Water, distilled or deionized
Beaker, 250-mL
Beaker, 400-mL
Glass demonstration tube, 2 cm × 60 cm
Cotton balls, 3
Graduated cylinder, 10-mL
Pipets, Beral-type, or eyedroppers, 3
Rubber stopper (2-hole) to fit tube, size 2
Stirring rod
Support stand and buret clamp

Safety Precautions

Dilute sulfuric acid solution is corrosive to eyes, skin and other tissue—avoid contact of all chemicals with eyes and skin. Wear chemical splash goggles, a chemical-resistant apron, and chemical-resistant gloves. Please consult current Material Safety Data Sheets for additional safety, handling and disposal information.

Preparation

Part A. Constructing the Column

1. Place three cotton balls loosely bunched into one end of the long glass demonstration tube. Stopper this end of the demonstration tube with a two-hole rubber stopper.
2. Fill the glass demonstration tube about three-quarters full with 150 g of marble chips.
3. Using a single buret clamp, attach the demonstration tube vertically to a support stand so that the stoppered end of the tube is at the bottom and the open end is at the top.
4. Place a 250-mL beaker under the stoppered end of the tube. Rinse the column of marble chips with tap water until the water leaving the column is clear (not cloudy), then rinse the column a second time with distilled or deionized water.
5. Discard the rinse water in the 250-mL beaker and clean the beaker before replacing it back under the column.

Part B. Preparing the "Acid Rainfall" Solution

6. In a 400-mL beaker, combine 250 mL of deionized water and 3 mL of universal indicator.
7. Using a Beral-type pipet, add 1–2 drops of 0.1 M sulfuric acid to the indicator solution until it turns red (pH ≤4).

Procedure

1. Slowly pour the "acid rainfall" solution into the demonstration column filled with marble chips.
2. Observe the rainbow spectrum of color changes as the acid rain solution slowly filters through the column. Record observations in the Buffering Lakes and Streams Worksheet.
3. Record the color of the filtrate after all of the acid rain solution has passed through the column.
4. Using a Beral-type pipet, slowly add more acid rain solution to the filtrate in the beaker. Stir the filtrate with a stirring rod or using a magnetic stirrer. Observe the indicator color of the "naturally buffered lake" created in the beaker.
5. Use a Universal Indicator Color Chart to correlate the relationship of the buffer color and the pH of "acid rainfall" solution.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The buffered filtrate and dilute acidic rainfall solution may be rinsed down the drain with an excess of water according to Flinn Suggested Disposal Method #26b. The column filled with marble chips may be rinsed with distilled or deionized water and stored for reuse in future demonstrations.

Tips

- The *Buffering of Lakes and Streams—Environmental Science Demonstration Kit* (Catalog No. FB1911) is available from Flinn Scientific and contains enough chemicals to perform the demonstration seven times: 300 g marble chips (reusable), glass demonstration tube, 35 mL 0.1 M sulfuric acid, 30 mL universal indicator, 21 Beral pipets, one 2-hole rubber stopper (size 2), and cotton balls.
- As an extension of this activity, fill parallel demonstration tubes with marble, granite, and sand and compare the effectiveness of different "soil types" in neutralizing acid rain. Test local soil samples to determine their buffering capacity as well.
- Bromcresol green may be used as an alternative acid–base indicator for this demonstration. Bromcresol green is yellow when the pH is <3.8, blue when the pH >5.4, and green in the intermediate or transition range between these two values. The color changes for bromcresol green occur at the lower pH limit for natural or normal rainfall. (Rain is naturally slightly acidic, pH about 5.5, due to the presence of dissolved carbon dioxide from the atmosphere.)

Discussion

The acidity of different bodies of water in a specific area can vary greatly. An increase in acidity is generally a result of pollution in the form of acid rain or snow. Acid rain is precipitation that has absorbed and reacted with compounds (mainly sulfur oxides and nitrogen oxides) in the atmosphere. The term acid rain is used to describe precipitation with a pH below 5.4. Why does the pH vary in different bodies of water that are in the same geographical area and have been exposed to the same amount of acid rain?

Waters that are able to maintain a generally neutral pH do so largely because of the chemical makeup of the surrounding soil. Soils that are composed of carbonates, such as marble chips (limestone), are able to neutralize acidic solutions. Conversely, soils that are composed mainly of silicates, such as granite, have little or no acid-neutralizing capabilities. When acidic rainfall flows over soils rich in carbonates, bicarbonate ions are formed and the rainwater runoff becomes more basic before entering the nearby body of water. The majority of lakes, rivers, and streams in the United States have pH values between 6.5 and 8.2. As the pH of water drops below this range, several negative events may occur. Physiological processes of many aquatic organisms can be disrupted or disabled. Toxic metals are also chemically released readily in waters that have a low pH. The toxicity of the water may even reach a level where fish and other organisms can no longer survive.

Acid rainfall reacts with limestone (calcium carbonate, $CaCO_3$) to produce bicarbonate ions (HCO_3^-), see Equation 1. This reaction decreases the hydrogen ion concentration in the acidic rainfall and increases the pH, as evidenced by the spectrum of color changes for the universal indicator solution from red to orange to green as it travels though the column in this demonstration.

$$H^+(aq) + CaCO_3(s) \rightarrow HCO_3^-(aq) + Ca^{2+}(aq) \qquad \textit{Equation 1}$$

The formation of bicarbonate ions creates a natural buffer system where the "lake water" in the filtrate can resist the acidifying effect of additional acid rainfall (Equation 2). This reaction is evident from the resistance of the filtrate to change color when more acid rain is added to it (step 4 in the *Procedure*).

$$HCO_3^-(aq) + H^+ \rightarrow H_2CO_3(aq) \qquad \textit{Equation 2}$$

The existence of limestone in lake beds enables the lake to initially resist changes in pH when acid rain falls on the water. Moreover, the lake will continue to resist pH changes due to the formation of the buffer system.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12

Evidence, models, and explanation
Constancy, change, and measurement
Evolution and equilibrium

Content Standards: Grades 5–8

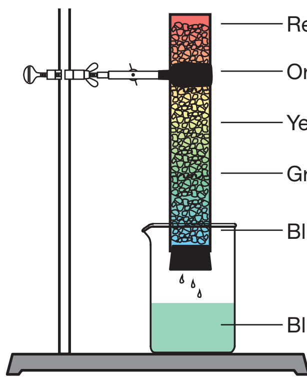
Content Standard C: Life Science, population and ecosystems,
Content Standard D: Earth Science, structure of the Earth system
Content Standard F: Science in Personal and Social Perspectives; resources and environments;

Content Standards: Grades 9–12

Content Standard F: Science in Personal and Social Perspectives, environmental quality, natural and human-induced hazards, science and technology in local, national, and global challenges

Answers to Worksheet Questions

Observations



Answers to Post-Lab Questions

1. Compare the initial color of the rainfall solution and the color of the filtrate. Is the pH of the filtrate higher or lower than the acid rain solution? Is it more acidic or more basic?

   The filtrate solution is more basic and has a higher pH than the "acid rain" solution.

2. As the "acid rainfall" solution containing universal indicator passes through the demonstration tube, it changes color indicating a change in pH. Write out the balanced chemical equation for the "acid rainfall" solution reacting with the marble chips.

   $H^+(aq) + CaCO_3(s) \rightarrow HCO_3^-(aq) + Ca^{2+}(aq)$

3. The formation of bicarbonate ions creates a natural buffer system in lakes and streams. Write out a balanced chemical equation for this reaction and give the physical evidence supporting the presence of a buffer system.

   $HCO_3^-(aq) + H^+ \rightleftarrows H_2CO_3(aq)$

   There is a buffer system present in the filtrate because when drops of "acid rain" are added the filtrate remains blue-green in color.

4. A soil sample collected from a local stream was found to have high sand content. Is the water found in this stream likely to be more basic or acidic and why?

   The water sample collected from this stream is likely to be more acidic. Soils composed of silicates such as sand and granite have little acid-neutralizing capabilities. In order for the water in the stream to be neutralized the soil would have to contain carbonates.

References

This activity was adapted from *Chemistry in the Environment, Flinn ChemTopic™ Labs,* Volume 22; Cesa, I., Editor; Flinn Scientific Inc.: Batavia, IL (2006).

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Buffering of Lakes* activity, presented by Kathleen Dombrink, is available in *Buffers* and in *Environmental Chemistry,* part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Buffering of Lakes* are available from Flinn Scientific, Inc.

Materials required to perform this activity are available in the *Buffering of Lakes and Streams—Environmental Science Demonstration Kit* available from Flinn Scientific. Materials may also be purchased separately.

Catalog No.	Description
FB1911	Buffering of Lakes and Streams—Environmental Science Demonstration Kit
U0009	Universal Indicator Solution, 35 mL
AP1718	Beral Pipet, Thin-Stem, Pkg/20
AP2312	Rubber Stoppers, 1 lb, Size #2, Black, Two-Hole
GP9146	Glass Demonstration Tube
M0032	Marble Chips, 500 g
S0419	Sulfuric Acid Solution
FB0680	Cotton Balls, Pkg/20

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

Name: ______________________________

Buffering of Lakes Worksheet

Observations

Using colored pencils, draw the colors of the universal indicator as it passes through the demonstration tube as well as the color of the collected filtrate.

Post-Lab Questions

1. Compare the initial color of the rainfall solution and the color of the filtrate. Is the pH of the filtrate higher or lower than the acid rain solution? Is it more acidic or more basic?

2. As the "acid rainfall" solution containing universal indicator passes through the demonstration tube, it changes color indicating a change in pH. Write out the balanced chemical equation for the "acid rainfall" solution reacting with the marble chips.

3. The formation of bicarbonate ions creates a natural buffer system in lakes and streams. Write out a balanced chemical equation of this reaction and give the physical evidence supporting the presence of a buffer system.

4. A soil sample collected from a local stream was found to have high sand content. Is the water found in this stream likely to be more basic or acidic and why?

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Documentation of Professional Development

Number of Development Hours: 1

Name of Development Provider: Flinn Scientific, Inc

Educator's Information: Joe Schoolteacher
Community High School
770 N. Raddant Rd.
Batavia, IL 60510

Title of Development Activity: **Content Area:** Acids and Bases

Product Title: Buffers

Description of Development Activity: In-depth online instruction of how to use the following activities to teach specific Chemistry topics. Detailed handouts and assessment included.

Content Description: Vinegar, aspirin, Vitamin C, baking soda and ammonia—many common substances are acids and bases. Investigate the properties, principles and applications of acid–base chemistry.

Product Description: Buffers provide an essential acid–base balance in consumer products, foods, lakes, streams and even living cells. What are buffers made of and how do they work?

Episode 1 Running Time 13:47 **Bet on Buffers** — At the very least, don't ever bet against them. Not when it comes to pH! Discover why buffers have a remarkable capacity to resist changes in pH.

Episode 2 Running Time 8:26 **Buffering of Lakes** — An "acid rainfall" is poured through a column of marble chips to illustrate the formation of a buffer in lakes or streams with a limestone bed.

Episode 3 Running Time 12:56 **Buffer Balancing Acts** — The ability of a phosphate buffer and Alka-Seltzer® to resist pH changes highlights the physiological role of buffers within cells and in consumer products.

Date: 3/24/09

Location: www.flinnsci.com

Presenters: Penney Sconzo, Kathleen Dombrink, Irene Cesa

Kevin T. McNulty — VP Marketing and Sales

FLINN SCIENTIFIC, INC

Professional Development Post-Activity Assessment

(Please fill out and keep with your records)

1. Give a general summary of the activities that were presented.

2. How and where would these activities be utilized in your classroom?

3. What pre- and post-activities could be added to enhance the students' learning experience?

4. How would the concepts learned improve and strengthen your current curriculum?

5. How could this material be modified to align with your school mission, goals or current teaching strategies?

6. What method type was learned that would best fit your current students and why? (For example, inquiry-based laboratory, teacher demonstration, direct student laboratory, etc.)

(800) 452-1261 • Fax: (866) 452-1436 • P.O. Box 219 • Batavia, IL 60510 • E-mail: flinn@flinnsci.com • www.flinnsci.com