Name_____

Project 4.2.3 Soil Buffers

Purpose

Soils have chemical properties affecting all organisms that depend upon it. In *Activity 3.2.3 Acids and Bases*, you learned how substances have differing pH levels. The pH in soils varies as well. Chemicals, fertilizers, and environmental factors, such as acid rain, all affect the pH of the soil. If a soil is acidic, adding a base to the soil should cause the acidity level to move toward neutral. If a soil is basic, adding an acid to the soil should help neutralize the base.

The ability of a soil to maintain a stable pH is called buffering capacity. Organic matter, soil minerals, and fertilizers are substances acting as buffers in the soil, preventing the pH from changing. Buffers cling to hydrogen ions preventing the ions from influencing the pH of the soil. Sand, silt, and clay particles in a soil affect the buffering capacity of soil just as they affect the texture of the soil.

What is the relationship between soil texture and buffering capacity of soil?

Materials

Per pair of students:
- LabQuest2
- Vernier pH sensor
- Buffer solution
- 2 250ml beaker
- 2 50ml beaker
- Permanent marker
- Laboratory tape
- 3 plastic spoons

- Distilled water
- Rinse bottle
- HCL dropper
- NaOH dropper
- Stir rod
- 3 soil samples
- 4 9-oz plastic cups

Per student:
- Disposable gloves
- Safety glasses
- Lab apron
- Pencil

- *Agriscience Notebook*
- *Lab Report Template*
- *Lab Report Evaluation Rubric*

Procedure

Work with your partner to examine the buffering capacity of water. Then design an experiment testing the buffer capacity of different soil textures.

Part One – Water Titration

CAUTION: *Handle the hydrochloric acid with care. Painful burns may occur with skin contact. Sodium hydroxide solution is caustic. Handle with care and avoid spilling it on skin or clothing.*

1. Obtain a 250ml beaker with 100ml of buffer solution.

2. Using tape and a permanent marker label the 250ml beaker *buffer solution*.

3. Label the second 250ml beaker *rinse beaker*.

4. Set up the LabQuest2 for data collection.

- Attach the pH sensor to Channel 1.
- On the *Meter* screen, tap **Mode**. Change the data-collection mode to **Events with Entry**.

5. Enter the *Entry Label* as **drops** and leave the Units field blank.

6. Use a permanent marker pen and tape to label a 50ml beaker *acidic*.

1. Place 20ml of distilled water in the beaker.

2. Rinse the pH sensor thoroughly with distilled water over the rinse beaker.

3. Place the sensor into the 50ml beaker of distilled water.

4. Start data collection. Monitor the pH readings displayed to the right of the graph. When the readings are stable, tap **Keep.**

5. Using the numerical keyboard displayed on the screen, Enter **0** as the number of drops you have added. Select **OK** to store the first data set for this experiment.

6. Rinse the pH sensor thoroughly with distilled water and place the sensor into the beaker of buffer solution.

7. Add 5 drops of HCl (acid) to the beaker. Stir the solution thoroughly with a stirring rod after adding the acid.

8. Place the pH sensor in the solution.

9. When the LabQuest2 readings are stable, tap **Keep**. Enter the total number of drops of HCl added to the water in the beaker and select "OK".

10. Rinse the pH sensor thoroughly with distilled water and place the sensor into the beaker of buffer solution.

11. Repeat Steps 13 – 16 adding 5 drops of HCl each time until you have added a total of 30 drops.

12. Stop data collection by tapping on the red square on the screen.

13. To examine the data on the displayed graph, select any data point. As you select each data point, the pH and drop number values are displayed to the right of the graph. Tap each point and record the pH values in Table 1.

Table 1. *Data*

Material Tested	Add	pH, after adding this many drops							
	Acid or base	0	5	10	15	20	25	30	ΔpH
Distilled Water	acid								
	base								

14. Label the second 50ml beaker *basic*. Place 20ml of distilled water in the beaker.

15. Repeat Steps 10 – 19, substituting NaOH (base) for HCl.

Part Two – Soil Test

Perform an experiment to determine which soil texture is the most resistant to pH change.

Question
Record the following question on *Project 4.2.3 Lab Plan*.
- Which soil texture has a high buffering capacity?

Develop a Hypothesis
On *Project 4.2.3 Lab Plan*, write a one or two sentence prediction on the student worksheet explaining which soil texture, sand, silt or clay, you believe will be most resistant to change in pH.

Procedure

1. Use marker and masking tape to label one cup "sand", a second "silt", and a third "clay".

2. Place four spoonfuls of sand into your cup labeled sand. Keep the spoon used to transfer the soil to the cup inside the cup for mixing later.

3. Repeat this process for silt and clay.

4. For each sample measure 100ml of distilled water and add the water to each cup.

5. Stir each sample with a stir rod for two minutes.

6. As the samples settle, develop your own procedure for testing the buffering capabilities of each soil solution. **Note: Samples should settle for 2 – 3 minutes before measuring pH with pH sensor.**

7. Record your procedure and materials on the lab plan.

8. Develop a data table for organizing your data. Record the data table on the lab plan.

Data Collection

Have your teacher approve your materials, procedure, and data table. Then begin your experiment and record your data in your data table.

Data Analysis and Conclusion

Use the *Lab Report Template* to complete a typed final report. Complete the data analysis portion of the lab report by explaining your results.

Complete the conclusion on the lab report by answering the following questions.
- Did you prove or disprove your hypothesis?
- What can you infer about the relationship between soil texture and buffering of soil?
- What are possible sources of error?
- What other questions do you have about soil pH and buffering?

Review your lab report using the *Lab Report Evaluation Rubric*. Fix any errors and complete any incomplete areas. Turn in your lab report for teacher assessment.

Conclusion

1. What is the relationship between soil mineral size and the buffering capacity of soil?

2. What types of soils will be more susceptible to change in pH? Why?

Name_____

Table 1. *Prediction*

Table 2. *Materials*

Table 3. *Procedures*

Table 4. *Data Table*

Teacher Approval Signature:	**Date:**