SeaGlide_TEAM	pH	Lesson # 3 (60 minutes)

Description:

For this lesson, you will assume the role of a environmental chemist, which is a scientist who studies how chemicals, usually contaminants, move through the environment. Part of your job entails going into forests or wooded areas to sample and to test water from different areas to measure their pH readings. In this lesson, you will be working in a lab with samples of water brought into the lab. You will have to test the different samples of water and prepare a report based on your findings and your interpretations of what the values mean. In order to do this, you must have a good understanding of how a pH sensor works. You must also be able to use the Vernier apparatus to carry out your experiments.

Students will be able to:

- Understand the necessity for sensors
- Properly utilize sensors to collect data
- Find trends found in the data and interpret what these trends mean
- Figure out reasons for any usual data found. It could be because of environmental reasons or human interference in natural processes
- Observe how the readings affect a SeaGlide and the wildlife in the area
- Determine ways to improve conditions if they are bad, or find methods to preserve and maintain current conditions if they are good

Students will understand:

In this lesson, students will experiment on a real, existing water body. They will record several data, and students will be questioned based on their findings. Successfully completing this exercise will ensure that students learn all of the learning goals. Using sensors to test and gather data is an essential part of any and all scientific procedures. Studying output data reveals if a system is functioning the way it is supposed to, or if there are issues that need fixing. In the case of a natural entity, collected data show trends that are observed and studied to determine the state of that entity. For example, using a relative humidity sensor in a rainforest can show if the plants are healthy and photosynthesizing adequately etc.

Key Definitions & Concepts: [1]

- **Sensor:** a device which detects or measures a physical property and records, indicates, or otherwise responds to it
- **Vernier Computer Interface:** a Vernier device that connects a Vernier sensor to a computer to display the results
- **Vernier pH Probe:** a device that measures pH
- **pH:** the power of hydrogen, meaning, the amount of H^+ ions in a solution. Determines if the solution is acidic or basic
- **Logger Pro:** a data collection and analysis software for Windows and Mac. This is the platform on which the collected data is displayed, and the interface provides users with several options to analyze the presented data

Standards: [Copied from: 2]

4.1.10.B: Explain the consequences of interrupting natural cycles.

4.1.10.E: Analyze how humans influence the pattern of natural changes (e.g. primary / secondary succession and desertification) in ecosystems over time.

K-ESS3-3: Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

Background Information

Prior Knowledge:

- Students must have knowledge of pH and the three divisions: acidic, neutral and alkaline
- Students must know what the pH scale indicates and how to read it
- Students must have a good idea of which substances are acidic and which are basic, and how to distinguish between them
- Students must know how to use Vernier equipment

Science Practices: [Copied from: 3]

- Asking questions and defining problems
- Developing and using models
- Carrying and Planning Out Investigations
- Analyzing and interpreting data
- Obtaining, Evaluating and Communicating Information

Core Ideas: [Copied from: 4]

- Earth Material and Systems
- Roles of Water in Earth's Surface Processes
- Natural Resources
- Human Impact on Earth Systems

Cross Cutting Concepts: [Copied from: 5]

- Patterns
- Cause and effect
- Scale, Proportion and Quantity
- Systems and system models

Possible Preconceptions/Misconceptions:

Students often wonder what the unit for pH is. pH is measured by taking the negative logarithmic function of the concentration of Hydrogen ions in a solution. So, the derived value does not have a unit, and is always represented as a number within the range of 0 to 14 inclusively.

Lesson Plan - 5E(+) Model

Engage: [6]

Students will be working with a pH sensor during this lesson. To understand the need to measure and collect pH, students must understand what pH is and the importance of it. The instructor will hand out *The pH Scale* worksheet, and the students will need about 5 minutes to complete it with a partner. This worksheet will help the students understand the pH variations between different substances what this signifies and how it affects systems. The worksheet consists of foundational questions that will help

build the students' concept of pH. The instructor should facilitate an open class discussion to review students' responses and address any misconceptions as necessary. This section should take no longer than 10 minutes to complete.

Explore: [1]

Part I: Introduction

The instructor will give a brief overview of the *pH* Vernier Experiment. The instructor will distribute materials, go over safety guidelines, and answer any questions that students may have prior to experimentation. The instructor should allot 5 minutes for this.

Part II: *Benchmark Lesson*: Experiment

Students will work on the *pH* Vernier Experiment in this section. Students can be allowed to work in pairs if the class size is too large; however, students should be able to carry out the experiment individually. The purpose of this activity is to give students first hand experience in collecting data using a pH probe and using their readings to answer conceptual questions. Students are expected to follow the procedure listed in the *pH* test in the Vernier book to complete the lesson. There will be three samples of water for each group, and all of these should come from the same source. The instructor should provided these samples to the students, and during the experiment, should circulate around the classroom to assist the students with any issues they face or with any questions they might have. This activity should take about 20 minutes to complete.

Part III: *Investigation Lesson:* Analysis

After the *pH* Vernier Experiment, students will be required to answer questions that pertain to the experiment and the application of the lesson goals. Working individually, students will need to invoke critical and higher-level thinking to answer these questions on the *Analysis Questions* worksheet. The content of these questions range from simple experimental details (including the learning objectives) to more complex topics (such as experimental errors within the activity). Students will also be extending the lesson topic to their SeaGlide and understanding how pH of the water affects its function.

Explain:

Throughout the exploration of this lesson, students will engage in discussions and activities that seek to discover their understanding of the topic at-hand as it relates to pH determination. Instructors should informally ask questions to promote thoughtful discussion that is designed to aid in addressing any questions or concerns that some students may have. Students are expected to formalize their answers throughout the entirety of the lesson via the worksheets and the activities.

Elaborate:

In this lesson, students are asked to measure the pH of water samples. Low pH means that the water is acidic, whereas higher pH indicates that the medium is alkaline. These conditions would not affect the sailing of a SeaGlide; however, it would certainly affect the body of the device. Depending on how the SeaGlide is constructed, it might react with acidic water, resulting in a corroding hull. This is to say that, the lower the pH, the greater the chance of corroding the plastic that comprises the body of a SeaGlide. If corrosion occurs due to exposure within acidic environments, then the internal structures

(including the electrical components) have a greater potential of being damaged beyond repair. Students must know where they will operate their SeaGlides before they start construction to circumvent the probability of corrosion from acidity.

Evaluate:

Throughout this lesson, there are both formal and informal evaluations. The informal evaluations occur throughout the exploration portions via leading and open-ended questioning, as well as through the open class discussions. The informal evaluations will allow for the teacher to gauge surface-level understanding of the students. By surveying the students during completion of the worksheets and activities, teachers will be able to hear and to address any misconceptions or misunderstandings as necessary. The formal evaluations of this lesson are the *pH* Vernier Experiment, and the *Analysis Questions* worksheet.

Enrich:

This lesson can be extended to an aquatic ecology course because of the *pH* Vernier Experiment activity. In aquatic ecology, field work involving pH sampling and aquatic environmental factor data collection is heavily emphasized and required for coursework. This lesson and its associated activity can be further extended by including other data collection methods, such as the following: plant life collection, predator-prey interactions, microenvironment analysis, and how these topics are affected by changing pH.

All associated documents are attached below

Reference *Annotated Bibliography* on the very last page of this packet

NOTE:

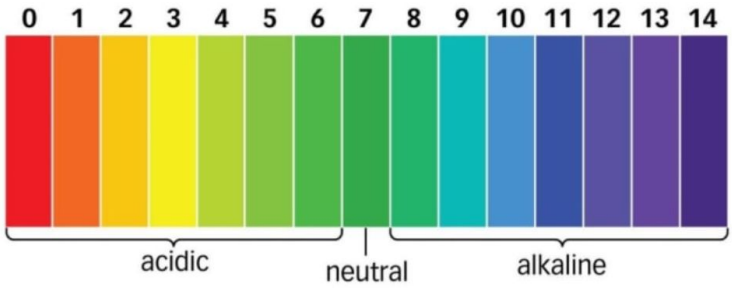
This lesson incorporates the use of the *Water Quality with Vernier by Robyn L. Johnson, Dan D. Holmquist, and Kelly Redding, Second Edition*. The SeaGlide Curriculum Team created an engagement to preface this experiment and added an additional analysis to conclude this lesson. The engagement activity is designed to pique students' interest in completing the experiment. The purpose of the analysis is to promote critical thinking techniques as students relate this lesson to SeaGlide by completing the *Analysis Questions* worksheet.

Additionally, the experiment (Experiment 2: pH) used during the exploration can be found in the Water Quality with vernier lab manual, starting on page 2-1.

Name:_____ Date:_____

The pH Scale [6]

1. The image below shows a pH scale. The scale illustrates if a substance is acidic or alkaline.



   a. If sodium hydroxide is rated 13.5 and calcium oxide is rated 10.2, which of the two compounds is more alkaline? Defend your response.

   b. Hydrochloric acid, deemed one of the strongest acids in the world, is rated 1.3 on the pH scale. If sulfuric acid is 0.57 on the scale, is it a stronger acid than hydrochloric acid? Explain your reasoning.

   c. What do you think happens when an acid and an alkali are mixed together?

   d. Based on your answer above, explain why rubbing alcohol is a great first aid treatment for acid burns.

Name:_____ Date:_____

Analysis Questions

1. What was the objective of this activity? Refer back to the data you were collecting and how you were collecting it.

2. While calibrating your senser, why is it necessary to rinse the tip with distilled water, and then place it in a pH 7 buffer?

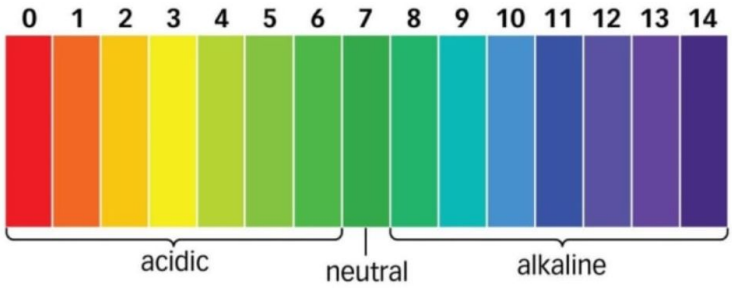
3. No experiment is 100% correct or without fault. Describe at least one source of error that is present in this experiment.

4. Your SeaGlide is made of plastic. The lake you are planning on sailing the SeaGlide in is known to be very acidic due to a recent dumping of industrial waste. Would you make any modifications to your device before you used it?

Name:_____ANSWER KEY_____ Date:_____

The pH Scale [6]

1. The image below shows a pH scale. The scale illustrates if a substance is acidic or alkaline.



   a. If sodium hydroxide is rated 13.5 and calcium oxide is rated 10.2, which of the two compounds is more alkaline? Defend your response.

      Sodium Hydroxide is more alkaline. This is because, the closer to 14 a compound is on the pH scale, the more alkaline it is.

   b. Hydrochloric acid, deemed one of the strongest acids in the world, is rated 1.3 on the pH scale. If sulfuric acid is 0.57 on the scale, is it a stronger acid than hydrochloric acid? Explain your reasoning.

      Sulfuric acid is the stronger acid in this case because it has a lower pH. In the case of acids, the closer to 0 a compound is, the more acidic it is.

   c. What do you think happens when an acid and an alkali are mixed together?

      The two compounds will mix together to form water. This is called neutralization.

   d. Based on your answer above, explain why rubbing alcohol is a great first aid treatment for acid burns.

      In case of acid burns, even if they are washed with water, there could be residual acid on the skin. Using alcohol is between skin alcohol is an alkali and would neutralize the acid.

Name:_____ANSWER KEY_____ Date:_____

Analysis Questions

1. What was the objective of this activity? Refer back to the data you were collecting and how you were collecting it.

   The objective of this activity was to determine the pH of samples of water, using Vernier equipment, and lab manual.

2. While calibrating your senser, why is it necessary to rinse the tip with distilled water, and then place it in a pH 7 buffer?

   Dipping it in distilled water removes any contaminants. Placing it in the pH 7 buffer would re-calibrate it, since 7 is the neutral pH point.

3. No experiment is 100% correct or without fault. Describe at least one source of error that is present in this experiment.

   The container used to collect the sampled water might be contaminated, meaning not clean. So, the pH reading that you get might not be the actual pH of the source.

4. Your SeaGlide is made of plastic. The lake you are planning on sailing the SeaGlide in is known to be very acidic due to a recent dumping of industrial waste. Would you make any modifications to your device before you used it?

   Acidic waters would corrode the plastic and damage the body (and potentially the inner structures) of the SeaGlide. You could use a acid resistance substance to coat the body of your SeaGlide, so that it is unaffected by the water.

Annotated Bibliography

[1] Johnson, R. L., Redding, K., & Holmquist, D. D. (2007). *Water Quality with Vernier: Water Quality Tests Using Vernier Sensors*. Vernier Software & Technology.

This book was used for excerption within the Temperature lesson plan. The reference aided in the completion of the Explore. Test 2 in the book, the pH test, was excepted for the students. Pages 2-1 through 2-5 contain information, required material, procedure and a data collection sheet for the students. The following two pages were designed for the instructors, so that they are able to troubleshoot the students' questions and misconceptions. The Venier book is an excellent resource to learn sensor technology. It contains detailed experiments to test different water conditions, and determine if the findings fall within the normal range.

[2] Nsta. (n.d.). Access the Next Generation Science Standards by Topic. Retrieved January 18, 2019, from https://ngss.nsta.org/AccessStandardsByTopic.aspx

This website was used in each lesson in the Sensor Technology & Programming module to select proper national set standards for science subjects that each lesson is centered around.

[3] Nsta. (n.d.). Science and Engineering Practices. Retrieved January 18, 2019, from https://ngss.nsta.org/PracticesFull.aspx

This website used in every lesson in the Sensor Technology & Programming module to find Standards for Science and Engineering Practices that are applicable in each lesson.

[4] Nsta. (n.d.). Disciplinary Core Ideas. Retrieved from https://ngss.nsta.org/DisciplinaryCoreIdeasTop.aspx

This website was used in each lesson in the Sensor Technology & Programming module to select appropriate disciplinary core ideas set forth by the NSTA that are at the center of each lesson.

[5] Nsta. (n.d.). Crosscutting Concepts. Retrieved from https://ngss.nsta.org/CrosscuttingConceptsFull.aspx

This website was used in each lesson in the Sensor Technology & Programming module to selecting appropriate crosscutting concepts set forth by the NSTA that apply to each science lesson.

[6] PH Scale Defined - What is pH? (n.d.). Retrieved April 12, 2019, from https://www.jansanconsulting.com/ph-scale.html

This website was used for excerption within the pH lesson plan. The reference aided in the completion of the Engage. Only the pH scale image was excerpted from the source. It was used to ask analytical and conceptual questions to the students. This helped in preparing them for the rest of the lesson where they have to carry out pH tests and interpret their data.