What does science have to do with *wastewater treatment plants?*

GET REAL SCIENCE!

Company Background
With approximately 300 facilities across North America, South America and Europe, Georgia-Pacific is one of the world's leading manufacturers and marketers of bath tissue, paper towels and napkins, tableware, paper-based packaging, office papers, cellulose, specialty fibers, nonwoven fabrics, building products and related chemicals. In Northeastern Wisconsin, its Green Bay facilities make nationally known products (Quilted Northern®, Angel Soft® and Compact® bath tissue; enMotion® and SofPul® paper towels; and Vanity Fair® and Mardi Gras® napkins) and packaging is produced in Sheboygan and Oshkosh. Each year, GP's Ecosourceä facility in Green Bay recycles nearly 100,000 tons of wastepaper - equal to 1.7 million trees - and saves 5 million cubic feet of landfill space. In addition, its Neenah-based research and development laboratory, iNNOVATION institute®, constantly develops creative and innovative products, and tests them in Green Bay using the latest technology available. For more information, visit: gp.com.

Get Real Science Video Link: What does science have to do with wastewater treatment plants? or YouTube: https://youtu.be/F6PGWcZkAe4

Teacher Note
This lesson is written to accompany the above video. It is recommended that you watch the entire video in advance. This will help you to anticipate student misconceptions and questions and prepare ways to support their sense making.

Lesson Summary
In this lesson, students will learn about the tests conducted on water that is sent back to the Fox River. Students will investigate the science behind the pH scale using a hands-on simulation and lab experiment that involves testing various solutions in their school. They will create a claim, evidence, reasoning to share this information with people that might be interested. Students can alternatively use the following simulation to take place of the pH testing lab: http://i2c-clix.tiss.edu/phet/en/simulation/ph-scale-basics.html

Standards Alignment
Next Generation Science Standards Performance Expectations

MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

HS-HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence	LS2.C: Ecosystem Dynamics, Functioning and Resilience	Stability and Change Cause & Effect

Materials

Safety goggles pH paper pipettes (5 per group) plastic cups (5 per group)
Various solutions computers different colored beads (10 of one and 10 of another for each group)
Can also use squares of paper, bingo chips, etc. instead of beads.

Procedure

1) Show students the Get Real Science video: [What does science have to do with wastewater treatment plants?]

2) Break 1 - Ask your students to think about the question: "What do the scientists at Georgia Pacific do to keep the good bacteria happy and healthy?"
    a) Ask students to record a few ideas on their own in their science notebooks or on scrap paper.
    b) Have students share their ideas with a partner to look for similarities and differences in their answers.
    c) Discuss as a large group. Display all student ideas on chart paper or whiteboard.

3) Break 2: Nitrate, oxygen and pH levels
    a) Have students get into groups of 4 and hand out a whiteboard to each group. Have students create a T-chart:
        i) Students should write down the three levels that are tested before sending into the Fox River on the left side of their chart (nitrogen, dissolved oxygen and pH).
        ii) On the right side of the chart, students should brainstorm and predict what would happen if these levels were too low or too high. You can use sentence starters to help your students such as "if dissolved oxygen was too low, then _____."
        iii) Have each group share what they think would happen if the nitrate levels were not within range when sending the water back into the Fox River. Jot down all responses on chart paper. Complete step for dissolved oxygen and pH levels.
        iv) Discuss with students that the nitrates are essentially resources/food for the aquatic life. Not enough = not enough food. Too much = algae blooms. The dissolved oxygen provides oxygen to the aquatic life. Not enough = cannot breathe. Too much = harmful to aquatic life, increased bacteria growth. pH high = basic solution, harmful to aquatic life. pH low = acidic solution, harmful to aquatic life.

b) Create another T-chart on a new piece of chart paper. List “acid” in one column and “base” in the other. Have the class brainstorm solutions they know of that might be an acid or base. Write down all ideas on chart paper.
c) Ask students if they know what makes something acidic or basic. Write ideas on chart paper. Tell students they will be investigating acids and bases closer today.
d) Assign roles to each group member.
   (1) Leader - this student is the only person who can ask the teacher questions
   (2) Reader - this student reads the lab procedure. Hand out one “pH Lab Procedure” to the reader of each group
   (3) Runner - this student will select the materials and return them when finished
   (4) Timekeeper - this student will make sure the group is working efficiently
e) Hand out “pH lab” sheet to students.
f) Review lab safety information as a group.
g) The reader should read the following article to the group: Scientists say: pH. You can also print this article and hand out to all students to annotate.
h) Students should complete pre-lab question 1.
i) Students will complete the hands-on activity simulating acids and bases. Each group will need 10 beads of one color and 10 beads of another color.
j) Move from group to group to make sure they correctly answer the Pre-lab questions.
k) Check student’s solutions they will be testing and approve before they start the lab. Have students conduct the lab.

4) Claim, Evidence, Reasoning
   a) Students will complete a claim, evidence, reasoning regarding their results. They will think of a creative way to communicate these results.
   b) Have students present their claim, evidence and reasoning to the class.

5) Conclusion questions
   a) Have students complete conclusion questions as a group.

Name _____ Date _____

Get Real Science

pH Lab Procedure

A very important part of science is being able to read and follow a procedure. If you are the reader, it is your responsibility to read this lab procedure to your group. It might help to cross off a step once you read it. Anything **bold and underlined** is something that the group needs to write down on their own lab sheet.

Procedure

Pre-Lab

1. Your teacher will assign each group member one of the roles below. **Record the roles on the "Stains Lab" worksheet.**
    a. Leader - this student is the only person who can ask the teacher questions
    b. Reader - this student reads the lab procedure
    c. Runner - this student will select the materials and return them when finished
    d. Timekeeper - this student will make sure the group is working efficiently
2. Your teacher will review the lab safety information with you. **Initial in the space below the lab safety to indicate you have read the lab safety.**
3. The reader should read the following article to the group: Scientists say: pH.
4. **Answer pre-lab question 1**.
5. The lab runner should get 10 beads of one color and 10 beads of another color. They should also get one plastic cup. One of these beads will represent the "H+ ions" and the other will be the "OH-" ions.
6. The leader should put all the beads into the cup, place their hand over the cup and shake. Pour out some of the beads. Count how many of each color you have and as a group decide if this is showing an acid, base, or neutral solution. Review your answer from pre-lab question 1 to help you.
7. Take turns so each group member completes step 6.
8. Return the cup to the leader. Have them complete step 6 again. Add the appropriate amount of beads to create a neutral solution. Take turns so each group member completes this step.
9. Return the cup to the leader. Have them complete step 6 again until they "shake" an acidic solution. **Draw this solution in the appropriate cup in pre-lab question 2. Color in the "key" according to the colors of the beads.** Have the leader complete this step for a basic and neutral solution. Complete the remaining diagrams.

Part I: Investigation

1. As a group, brainstorm different solutions that you could test that are available to you. (Ex: tap water, soda, etc.).
2. Complete the data table on your lab with the following categories: solution, predicted pH, actual pH, acid/base/neutral. List the solutions you will be testing below the "solution" column. Get approval from your teacher before proceeding.
3. Review the pH scale from the article with your group. Make predictions about the solutions you will be testing by writing the pH number in the column "predicted pH."
4. Put on your safety goggles. Have the runner from your group obtain 5 pH testing strips, 5 plastic cups and 5 pipets.
5. Obtain a sample of your first solution in the plastic cup. Using the pipet, place two drops of the solution on a pH test strip. Compare to the pH scale on the test strip container. **Record this number in "actual pH" column.**
6. Identify whether this solution is an acid/base/neutral and **record in the last column.**
7. Complete steps 5 and 6 for the remaining solutions.

Part II: Claim, Evidence, Reasoning

1. Now that you've gathered your evidence, it's time to share your information with others! You will be sending this information to someone who might be interested in these results. Ex: If you're Aunt May drinks a lot of diet coke and you found that it was acidic, write to tell her about it. If the school tap water is neutral, who might want to know this good news? You can create a letter, social media post, video or newspaper article. **Complete the claim, evidence, reasoning section on your lab sheet.**
2. Complete the conclusion questions.

Name _____ Date _____

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pH Lab

Roles:

Leader _____ Reader _____

Runner _____ Timekeeper _____

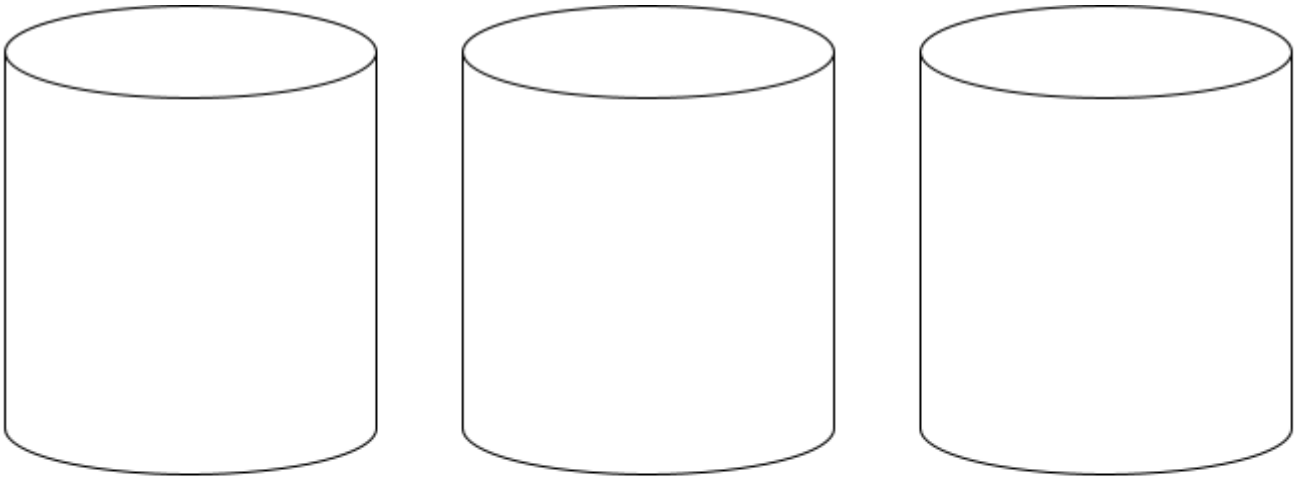
Lab Safety

a. Do not consume anything in the lab
b. Goggles must be worn at all times

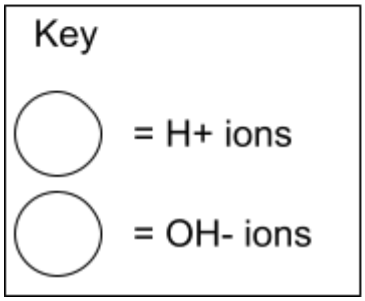
Student initials: _____

Pre-Lab Investigation

1. Complete the following to help you with new terminology from the article:
   a. **<u>pH scale:</u>** measures how _____ or _____ a solution is.
   b. In the article, it refers to the term "ion." An "ion" is a charged particle. Ions can either be positively charged or negatively charged. The ions we will be looking closely at are **H+** and **OH-** Fill in the following with either **acidic, basic,** or **neutral**.
      i. A solution with more OH- ions than H+ ions is a(n) _____ solution.
      ii. A solution with more H+ ions than OH- ions is a(n) _____ solution.
      iii. A solution with the same amount of H+ ions and OH- ions is a(n) _____ solution.
2. Create a diagram of each "solution" you created in the lab. Color and label your diagrams.



Acid Neutral Base



Data Table:

Solution	Predicted pH	Actual pH	Acid/Base/Neutral

Part II: Claim, Evidence, Reasoning

1. Write your **claim** in the space below about the results you want to communicate. Ex: You should not drink a lot of Gatorade.

2. Support your claim with **evidence** from your lab investigation. Ex: We recently completed a pH lab and tested the pH of Gatorade. We found that the pH of Gatorade is 3.

3. Connect your claim and evidence with **reasoning**. If you're telling this person not to drink Gatorade because the pH is 3, explain to them what that means. Is it acidic, basic or neutral? Explain the pH scale to them. Research what drinking an acidic beverage can do to your body. Cite your sources. Ex: A pH of 3 means that the Gatorade is very acidic. Drinking acidic beverages can damage your teeth.

4. Now that you have your claim, evidence, reasoning statement complete, find a creative way to share the news. Create a letter, social media post, video or newspaper article. Who would want to know this information? In our example we used Gatorade. A good target audience for this sports drink would be athletes.

Conclusion questions:

1. The environmental scientist at Georgia Pacific tests the pH of the water they send back into the Fox River. Why is this important? Read the following article: https://www.sciencenews.org/blog/wild-things/pink-salmon-threatened-freshwater-acidification. Using your knowledge of the pH scale and evidence from this article, explain why this is an important step in the wastewater treatment process.

2. Read the following article on ocean acidification. https://www.snexplores.org/article/shell-shocked-emerging-impacts-ocean-acidification
    a. List three effects that ocean acidification causes.

    b. Using the information from the article, predict what could happen to the Fox River if the wastewater treatment process released acidic water into the river. How could this affect you?

3. Review the pH scale examples in the Scientists say: pH article. Which of these substances are sometimes poured down the drain? How does this affect our water?