Acids and Bases

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| FRAMEWORK |
| 1. Scientific and Engineering Practices  * 1. Asking questions and defining problems * 4. Analyzing and Interpreting Data | |
| 1. Cross-Cutting Concepts  * 3. Scale, proportion, and quantity | |
| 1. Disciplinary Core Ideas  * EES 3: Earth and Human Activity | |

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| SKILLS/OBJECTIVES |
| * Learn the definition of the terms acidic, basic, and neutral * Make hypothesis about the pH of different liquids * Test the pH of different liquids * Comprehend the arrangement of the pH scale and the placement of solutions on this scale | |

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| MATERIALS |
| * Red Cabbage Juice * Disposable glass test tubes * Plastic pippettors * Tape   o Velcro  o Poster Board Scale   * Index Cards * Liquids of varying pH (Ex. Lemon juice, bleach, vinegar, soap, milk, soda, water, baking soda solution.)   \*Note: you will want to dilute some of the solutions such as the soap (to make it easier to dispense with the pipettor) and the bleach (to make it less concentrated). | |
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| NOTES |
| * Make sure the students know they should not eat or drink anything in this activity, nor should not touch their faces at anytime (to avoid ingesting liquids or getting their in their eyes). Have students wash their hands promptly after clean up. * If you have a small group of children (5-7) you can all work together however if you have a larger group (20-25) you can break into groups of 5-7 and work on the activity separately so that everybody feels engaged. | |

**BACKGROUND**

* Discuss acidity, basicity and pH
  + Who knows what an acid or base is?
  + Has anyone heard of the pH scale?
  + Can you name some common acids or bases?
* Key Points
  + All liquids are acidic, basic or neutral. Acidic liquids are on the low end of the pH scale (0 to 6) while basic liquids are on the high end of the pH scale (8 to 12). Neutral liquids have a pH of 7.
  + Acids and bases on the far ends of the scale are called strong and can be very dangerous. They can eat through your skin, and even through metal. (If a blackboard is available, draw the pH scale).
* What we are going to do:
  + We will be using an **indicator** made from red cabbage to determine is solutions are acids or bases. An indicator changes to one color when a base is added and to a different color when an acid is added. If a liquid is an acid the indicator will turn red. If it is a base it will change to blue or yellow/green. Lastly, if the liquid id neutral it will be purple.
  + Demonstrate how a basic solution (such as baking soda) changes the color of the indicator paper, and how an acidic solution (such as lemon juice) changes the color of the paper.

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| Activity # 1 | **pH scale** |
| Materials | Poster board scale  markers  Cards representing substances  tape |

* What is the pH of the schools tap water? Is it acidic or basic?
* Explain pH by stating that substances below 7 are acidic, and mention characteristics associated with **acids** (i.e. “sour”). Also discuss that substances with a pH of more than seven are **basic** or alkaline, and are described with qualities such as “soap‐like” or “slippery”. Make sure to emphasize these characteristics and use pictures, since the numbers may seem abstract to the children. Explain that 7 (water) is neutral and that it doesn’t have either basic or acidic qualities.

1. Now have the students try to place index cards with names of common items on the correct spot on the acids/bases/neutral poster board.
2. Correct the placement of the cards, explain why each substance has a certain pH values.
3. **Acids Bases Neutrals**
4. 2.0 - Lemon Juice 7.4 - Human Blood Water  
   2.2 – Vinegar 9—Baking Soda
5. 6.6 – Milk 13- clorox
6. 3.3 Apples Detergent
7. 4.5 Bananas
8. 2.3 - Cranberry Juice
9. 2.5- Soda

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| Activity #2 | **Testing the pH** |
| Materials | * Red Cabbage Juice * Disposable glass test tubes * Plastic pippettors * Test Tube racks * Vinegar * Milk * Detergent (soap) * Soda * Water * Oil * Baking Soda Solution |
| Worksheet | Yes |

1. Give students a **worksheet** and have them predict whether they think a liquid is an acid or base and what color change (if any) they believe will occur.
2. Give each group of students (3-6 in each group) six test tubes, each filled about 1/3 of the way with indicator solution
3. Provide the solutions of varying pHs (in the materials list) in plastic cups with pipettors.
4. Allow the students to experiment by adding the different liquids to a test tube.
   1. **Add a few drops of one of the liquids to the test tube with the red cabbage indicator (count how many drops it takes to see a color change and record in the worksheet).**
      1. What happens to the color? Based on this color, is the solution acidic or basic?
   2. **Do the same thing with another one of the liquids. Add a few drops to a few test tube with indicator and observe what happens.**
5. Allow the students to continue to explore with mixing the liquids and the indicator.
   1. Can you change a basic solution to an acidic one? Can you change an acidic solution to a basic one?
      1. If you add a basic liquid to an acidic one, it might turn purple (neutral) and then blue or yellow/green. Have students add a base to an acidic solution with indicator already mixed into it and observe what happens. Do the same with basic solutions.
   2. Can you tell which solutions might be strong acids/bases and which are weak?
      1. Depending on the amount of drops it takes to change the indicator, we can tell which liquids are most acidic and basic.
6. Have all of the students come back together and fill in the pH scale with the tested liquids. Ask the kids for their observations:
   1. Ex. What color did the indicator turn when you added lemon juice? What does this tell you about lemon juice? Is it more or less acidic than milk?

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| Activity # 3 | **pH of a substance** |
| Materials | Foam cups  Universal Indicator  pH scales for universal indicator  Baking Soda Lemon Juice Apple juice  Orange Tums dissolved in water  Egg Whites  Liquid laundry detergent Distilled Water Pipets |
| Worksheet | N |

Ask students: How can we find out the pH of a substance?  
Explain that there are special chemicals called “pH indicators” that change different colors based on pH value when mixed with a sample. Tell them that the laminated color chart is similar to the colors the substances produce with the indicator.  
Tell the students that you mixed up all your chemicals and you need their help to identify them (should be in foam cups so they cant see the liquid). Explain that they will use a universal indicator to discover all the different “mystery chemicals” which are samples of the items described and depicted on the poster.

* Show how the universal indicator works by testing the pH of one of the

“mystery chemicals” . **Dip pH paper indicator in cup and observe color change.**

* Split the students into groups of three and have them come up with a name for their group. Tell them this is a scientist competition and we are going to determine which group has the mad scientists by predicting which liquid is a base or acid according to the color on the indicator.
  1. Dip paper into cup and **tape it** to the cup for the groups to see.
  2. Have each group say their prediction as they use the printed color pH scale.

1. Why do none of these samples have a pH of 1 or 14?

-Because these extreme pH values would be harmful to ingest, the human

body can only be exposed to certain pH values without damage being done...ect...

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| Activity # 4 | **pH of water** |
| Materials | Tap Water  Cup  pH indicator paper |

* What is the pH of the schools tap water? Is it acidic or basic?

1. **Have students test the pH of tap water**
2. **Mix chemicals into the tap water and test pH**

Why does different substances have different pHs?  
Why does no drinks have a pH of 1 or 14?  
Next time you are drinking a juice think about if its an acid or base.

**CONCLUSIONS**

* After completing the pH scale together as a group, ask students if the results match their hypotheses about the pH of different liquids.
  + What are some other liquids you think would be acidic? (maybe ask about some of the ones that you didn’t chose) What are some that you think would be basic?
* Discuss how the pH of certain liquids is very important.
  + For example, fish can only live in water that has a certain pH: if it is too acidic or basic they will die. When we pollute the water with certain chemicals, it can change this pH, which can be detrimental to the fish.
  + Also the blood in our bodies needs to maintain a certain pH so that we stay healthy.

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_**

**Hypothesis & Observations Worksheet**

**Acids and Bases**

What color will the cabbage juice turn?

If a liquid is an acid the indicator will turn red.

If it is a base it will change to blue or yellow/green.

If the liquid id neutral it will be purple.

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| Liquid | milk | vinegar | soap | soda | water | Baking soda solution | Oil |
| Hypothesis  Acid or Base? |  |  |  |  |  |  |  |
| Observations |  |  |  |  |  |  |  |
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