This 5E model for instruction helps students gain an understanding of the concept of acids and bases and how we interact with them in our everyday lives.

Student Science Performance

Grade level: 9-12 Physical Science	**Title:** Acids and Bases I Use Everyday
Topic: Acids and Bases	

Performance Expectations for GSE:

SPS6. Obtain, evaluate, and communicate information to explain the properties of solutions.

d. Obtain and communicate information to explain the relationship between the structure and properties (e.g., pH, and color change in the presence of an indicator) of acids and bases. (*Clarification statement:* Limited to only the structure of simple acids and bases (e.g., HCl and NaOH) that demonstrates the presence of an H+ or OH-.)

e. Plan and carry out investigations to detect patterns in order to classify common household substances as acidic, basic or neutral.

Performance Expectations for Instruction:

- Plan and carry out an investigation to determine the interaction between various substances and an acid/base indicator.
- Analyze and interpret the data from the investigation to determine patterns in the results of the investigation.
- Develop and use a model to explain the changes in the indicator caused by the substances.
- Use your model to predict the behavior of other substances and to classify these unknown materials as either acid or base.

Additional notes on student supports

Materials:

- Cabbage juice- prepared in large quantities depending on class size (This can be prepared in advance and the concentrate can be frozen. See the video.
- Substances of varying pH (bleach, vinegar, sour candy, water, lemon juice, grapefruit juice, soda, coffee, distilled water, baking soda, shampoo, and hand soap, etc,)
- Medicine cups or other small containers (Many pharmacies will donate these to teachers or they can be obtained cheaply online.)
- Access to internet resources
- pH paper (enough for 2-3 per group)
- Litmus paper (enough for 2-3 per group)
- pH meter (if possible, one per class, minimum)

Engaging Learners	Phenomenon: When red cabbage juice is mixed with different substances the color of the juice will change. Teacher Notes: 1. Demonstrate how mixing a substance with a specific pH (such as an acid or a base) with the cabbage juice causes a color change. Do this with other substances in separate containers. 2. Students observe and ask questions about the phenomena. 3. When you use the terms acid and base, begin to help students connect this to the alkalinity or acidity of a substance being related to the amount of the OH- or the H+ present in the solution. This should be connected back to the discussion of ions in the structure and function of matter unit.

	***Communicating*:** Start this discussion with a table full of common household substances. *Safety alert: Never allow students to mix solutions such as ammonia and bleach. Caution them to test each substance separately in separate cups.* Go over what each item is with the students and make sure they know the use of the item in the home if it is not obvious. In pairs have the students sort the items into categories. They can choose the categories but limit them to no more than four total groups. After about ten minutes, have a few groups present their ideas. At this point pick a few of the substances and show how each one reacts with the cabbage juice. Pick an acid, base (alkaline) and a neutral substance. Ask them if the phenomena they just observed makes them change how they group the substances. Have each group either keep their groups the same or change them based on the reaction to the cabbage juice.
Exploring	***Obtaining:*** Students will now conduct an investigation using red cabbage juice as a pH indicator and various household substances as samples to test. *Teacher Notes: The students will now test all the substances on the data table using the cabbage juice. Use enough substances to represent the range of pH normally seen in the household. Be careful not to include substances that could be harmful if not handled correctly. Some examples of substances to use are: Lemon juice, grapefruit juice, soda, coffee, distilled water, baking soda, shampoo and hand soap. Household bleach is a base but will stain clothes so be careful if you use it.* *Students should test only one substance at a time - mixing substances will not produce valid data for pH.* *Teacher hint: Provide small amounts of the substances (medicine cups work well) and cabbage juice for each lab group at each station.* This video may be helpful in explaining the investigation and how to prepare the red cabbage juice. Other helpful links and resources can be found online.
	***Evaluating**:* Students should classify the substances based on their reaction with the cabbage juice by color of the indicator. The goal is to recognize patterns in the substances that cause similar reactions, such as adding other properties to the data collection like the texture or feel of the substance (e.g. slippery, soapy). Post a color chart in pH order for the cabbage juice reactions. Students can use this as a guide to put the substances in order. If they are familiar with the concept of pH some students will start to see the pattern. All students need to see that patterns emerge as they put the substances in the correct color order. For example, the cleaning products are close together and the foods tend to be together.
	Communicating: At this point introduce the students to the concept of pH and how it is used to classify substances. Be sure to connect this understanding to the understanding of the concentration of OH- and H+ in solution and connect this to the previous units' discussion of ions. There are many resources to use to help students understand pH: 1. pH Scale 2. Basically Acidic Ink

	3. Red Cabbage Chemistry
Explaining	***Obtaining:*** Students will develop questions about why the cabbage juice turns colors. They should investigate these questions by: 1. Follow-up investigations a. These follow-up investigations may include mixing substances to see the reactions of the indicator. (Be careful to include only substances that will not cause a health concern if mixed together.) b. Students can also try other substances to aid in determining a pattern in the results. 2. Obtain information through internet searches or teacher provided materials about the concept of pH. The chemical difference between and acid and a base needs to be understood. This is at a level where students know that acids have a high concentration of H+ ions and bases a high concentration of OH- ions.
	Evaluating: Based on the follow-up investigation and the other materials students need to work towards the explanation that the indicator changes color based on acidity or alkalinity of the substance. The presence of H+ in an acid and OH- ions in a base need to be understood as a difference between acids and bases.
	Communicating: Based on all the investigations and information students should communicate a model for the reaction of the cabbage juice with acids and bases. Students should have the following understandings: 1. Indicators change color based on the acidity or alkalinity of the sample. 2. Acids have a high concentration of H+ ions and bases a high concentration of OH- ions. 3. Patterns should also be observed such as food being mainly acidic and cleaning products being basic. Bases tend to be slippery and acids taste sour. *Teacher note: Caution students to never taste or touch any substances in a lab setting without permission.*
Elaborating	***Obtaining:*** Students may have found in obtaining information that there are other pH indicators that are typically used in experimentation. Have students investigate the pH of substances used in the cabbage juice study using: 1. Litmus paper 2. pH paper 3. pH Meter (if available)
	Evaluating: Investigations using other pH indicators will help illustrate the uses and limitations of each in the identification and classification of acids and bases.
	Communicating: Using the understanding of acids and bases and how indicators are used to identify the pH of a substance, students will propose the best method to determine pH in various scenarios. Some examples may include: 1. Testing the pH of water in a swimming pool 2. Testing the pH of a substance to determine if it is harmful to humans. 3. Quality control in a factory to make sure the pH of a product stays in a range.

Evaluation	***Assessment of Student Learning*** Students will write an explanation of the following questions: 1. Is bleach an acid or a base? How do you know? Justify with information from your investigations. 2. Is vinegar an acid or a base? How do you know? Justify with information from your investigations. The teacher will be looking with the following things in the explanations: ● Students will accurately predict the pH of a common household substance ● Students will accurately determine the reaction of red and blue litmus paper to acids and bases. ● Students will explain the basic properties of acids and bases including H+ versus OH- ions and other physical properties.
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	● Planning and carrying out investigations ● Analyzing and interpreting data ● Constructing explanations ● Obtaining, evaluating and communicating information
Crosscutting Concepts	● Patterns ● Cause and Effect ● Systems and System Models
Disciplinary Core Ideas	From A Framework for K-12 Science Education: PS1.B: Many substances react chemically with other substances to form new substances with different properties. PS1.B: The reactivity of hydrogen ions gives rise to many biological and geophysical phenomena.

Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.

General supports for the following categories:

Reading:	Writing:	Math:
1. Provide reading support by reading aloud or doing partner reads 2. Have the teacher model what they are thinking when reading the text 3. Annotate the text with students so that they may refer to it as they work through the lab	1. The teacher can provide a sentence starter for the students. 2. The teacher can give students an audience to write to (i.e. Write a letter to your sibling explaining this topic). 3. The teacher can provide constructive feedback during the writing process to help students understand the expectations.	1. Provide calculators as needed. 2. Provide graph paper as needed.

Supports for this specific lesson if needed:

Performance expectations for instruction:

1. The teacher should provide information to students in various formats to reach as many students as possible.
2. The students should be given adequate time to complete each part of the lesson.
3. The students should be allowed to express their knowledge in various formats.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.

Engage:

1. The teacher should give the students a data sheet to record observations, data and research.
2. The teacher should use intentional and flexible grouping.
3. The students may need additional time to discuss and condense their ideas prior to proceeding.
4. Students may need additional time to revise their groupings of the household materials.

Exploring:

1. The teacher should provide the data table to students. This is a place for students to record their data, observations and research.
2. The teacher should remind students of the directions as needed.

3. The teacher should provide explicit instruction about lab safety. The teacher should explicitly remind students not to mix chemicals unless told that it is ok. In this instance it is safe to mix cabbage juice with other materials but nothing else is to be mixed.
4. Explicitly tell students not to eat or drink anything in the lab.
5. The teacher should provide a formative assessment at this point. The teacher could give the students an opportunity to draw or write an explanation of pH. This will give the teacher an opportunity to decide who is ready to move forward and who needs more assistance.

Explaining:

1. The students can continue recording on their data sheet from the other activity.
2. The teacher should lead a discussion of why the cabbage juice is changing colors when mixed with other substances.
3. The teacher should provide a formative assessment at this point. The teacher could give the students an opportunity to draw or write an explanation of pH. This will give the teacher an opportunity to see which students need re-teaching, reviewing and enriching.
4. The teacher may need to help students define acidity and alkalinity.
5. Students may need additional time to design and communicate their model.
6. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. Models could include drawings, writings or verbally explaining.

Elaborating:

1. The teacher may need to use guiding questions if the students have not been able to locate the other pH indicators.
2. The teacher should provide a data sheet for using the other pH indicators. The students can then compare the data between the cabbage juice and the other indicators.
3. The teacher should give the scenarios one at a time to not overwhelm students as they work.

Evaluating:

1. The teacher should allow multiple formats for the students to express their models. These formats could include drawing, writing or designing a play.
2. Students may need additional time to complete their explanation.

Return to Instructional Segment

Acids and Bases Data Log

Student Names

_____

_____

_____

Fill in the table below-

Household item	Color before adding indicator (cabbage juice)	Color after adding indicator (cabbage juice)	Acid or Base?
Lemon Juice			

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