



## COLOR CLUES

### **BENCHMARK and TASK**

**SC.A.1.2.5** The student knows that materials made by chemically combining two or more substances may have properties that differ from the original materials.

- The student observes the original materials and compares their properties to the properties of the new material produced in a chemical reaction.

### **KEY QUESTION**

How can you determine if common household items are acids or bases?

### **BACKGROUND INFORMATION**

Chemicals are grouped together because of common properties. Acids are a group of chemicals that have a sour taste, can neutralize bases, and turn purple cabbage juice red. Foods like lemons, oranges, and tomatoes contain acids. Bases are chemical opposites of acids; they feel slippery or soapy, can neutralize acids, and turn purple cabbage juice green or blue. Foods that contain bases have a bitter taste. (Baking soda dissolved in water is one example.) Acids and bases can neutralize each other, resulting in a **solution** that is neither acidic nor basic and will not change the color of purple cabbage juice.

Purple cabbage juice will turn a wide range of colors, from yellow-green for strong bases to bright red or pink for acids. Cabbage juice is an acid-base indicator. Litmus paper is also an acid-base indicator.

### **MATERIALS**

#### **Per group**

½ cup of cabbage juice (see Teaching Tips)

9 droppers

*Color Clue Data Table*

egg cartons or ice cube trays (White egg cartons or ice cube trays work best. Sometimes plastic ice cube trays can be found at a dollar store. Another option is to purchase chemical plates from a science supply company.)

crayons

safety goggles (1 pair per student)

solutions to be tested:

medicine cup of vinegar (equal parts vinegar and water)

medicine cup of baking soda (1 tsp. dissolved in water)

medicine cup of rubbing alcohol (full strength)  
medicine cup of aspirin (1 aspirin dissolved in water)  
medicine cup of salt water (1/2 tsp. in water)  
medicine cup of ammonia (1-2 drops of ammonia dissolved in water)  
medicine cup of lemon juice (full strength)  
medicine cup of water (plain tap water)  
medicine cup of shampoo (1 tsp. dissolved in water)

### **TEACHING TIPS**

1. Cabbage juice can be made by the teacher before the activity or you can have students make the cabbage juice themselves. The best way to prepare cabbage juice before the activity is to use a large non-aluminum pan. Place about 1 gallon of water in the pan along with a purple cabbage that you have cut into large pieces. Bring the water to a boil and turn off the heat. Let the cabbage just sit in the water over night. Pour off the cabbage juice into a large container and throw away the cabbage pieces. The cabbage juice will keep in the refrigerator for several weeks or can be frozen for months.  
Optional method: Students can prepare the juice at the beginning of the activity. Have them place torn pieces of purple cabbage leaves into a zipper-type plastic bag. Add  $\frac{3}{4}$  cup of very warm water and close the bag securely. Students should gently squeeze the bag of cabbage and water until it turns dark blue (about 3 minutes).
2. Caution students not to taste any of the items during the lab.
3. Make sure to only use 1 or 2 drops of ammonia to prepare the ammonia solution.
4. Safety goggles should be worn when working with chemicals.
5. You may want to prepare students before they encounter the strong odor of cabbage juice.
6. Labeling both cups of solutions to be tested and the egg carton sections 1-9 to match the data sheet will help students keep track of which solution is being used during the testing.

### **ENGAGE**

1. Ask:  
*When someone sneezes, what might that indicate?*  
*When you walk into your house and smell chocolate chip cookies, what does that indicate?*  
*When you have your temperature taken and it is 101 degrees, what does that indicate?*
2. Discuss the fact that we are surrounded by clues to what is happening in the world around us. These are called “indicators”. Ask students if they can think of other indicators (e.g., crying, thunder, frost, telephone rings).
3. Tell students that many items in our homes are either acids or bases. Sometimes we can tell by tasting that a substance is acidic. However, since tasting isn’t always a safe way to tell, sometimes we need to use an indicator. The indicator we are going to use in this activity is cabbage juice.

### **EXPLORE**

1. Distribute materials to the groups. In the egg carton, have students put  $\frac{1}{2}$  medicine dropper of cabbage juice in each of the 9 compartments. (If chemical plates are purchased, they will be smaller than egg cartons so students will only need about 3-4 drops of cabbage juice in each of the chemical plate wells.)

2. Ask students to add a few drops of the first household test solution to the first compartment and gently jiggle the egg carton to mix the cabbage juice and solution.
3. Tell students to select the crayon that most closely matches the color of the mixture and record on the *Color Clue* data sheet. Students may need to blend two colors together to get the correct shade to match.
4. Tell students to continue testing the household solutions in order, using a new dropper each time to avoid contamination of the solutions being tested.

### **EXPLAIN**

1. Ask:
 

*Which solutions were the most acidic? How can you tell?* (Acidic solutions tend to be pinker.)

*Which solutions were the most basic? How can you tell?* (Basic solutions tend to be greener.)

*Which solutions do you think are neutral - neither an acid nor a base? How can you tell?* (Purple indicator is unchanged.)
2. Display the following chart. Ask students to order the solutions from strongest acid to strongest base according to the chart.

Acid-Base Color Chart	
Strong Acid	Pink
Weak Acid	Lavender
Neutral	Purple
Weak Base	Blue
Strong Base	Green

### **EXTEND/APPLY**

1. Ask students if they can think of a way to neutralize one of the acidic solutions. Discuss their ideas and test them, if possible. (Adding a base to an acid can neutralize the acid.)
2. Ask students if they can think of a way to neutralize one of the base solutions. Try their ideas, if possible. (Adding an acid to a base can neutralize the base.)
3. Acid rain is a serious problem in many urban areas. Fumes from cars and industry rise into the air and dissolve in the droplets of water that form clouds. In the droplets these substances form an acid and fall to earth as acid rain. Acid rain may have a pH value as low as 2.8. Use a weak solution of vinegar/water to water a plant for one month. Chart the condition of the plant.
4. It is important to maintain the correct pH balance in a swimming pool. In order to do this, pool water needs to be tested periodically. Ask students if any of them have experienced testing swimming pool water at home. If so, ask them to find out what is used to adjust the pH of their pools if they are too acidic. (Some form of soda ash is added to neutralize the water.)

### **EXTENSIONS**

1. Let students test solutions again with new indicator paper:
  - Dissolve 1 tsp. turmeric (spice) in  $\frac{1}{4}$  cup rubbing alcohol.

- Dip coffee filters in the solution, let the excess solution drip off, and then spread the filters on foil to dry. (Turmeric stains hands, clothes, and counter tops, so handle carefully.)
  - Cut dried filters into 1 x 2 inch strips.
  - Give indicator strips to students. Explain that they will change to bright red in basic solutions. Let them test several solutions. Ask students to think about how they could use the strips to indicate the presence of acids. (Dip the strip in a base first, turning it red. Dip it in acid afterwards. The acid will neutralize the base, returning the strip to its original color.)
2. Purchase some litmus paper from a science supply catalog and let students test the same solutions that were used with the cabbage juice. Have them compare their results with the results from the cabbage juice activity.

### ASSESSMENT

Maria added cabbage juice to 3 different liquids. Here is her data table:

Liquid Number	Color of the Liquid After Adding Purple Cabbage Juice
1	Pink
2	Green
3	Purple

What do you know about the three liquids just from looking at Maria's data table?



## COLOR CLUES

<b>Solutions</b>	<b>Color</b>
<b>1. Vinegar in water</b>	
<b>2. Baking Soda in Water</b>	
<b>3. Rubbing Alcohol</b>	
<b>4. Aspirin in Water</b>	
<b>5. Salt in Water</b>	
<b>6. Ammonia in Water</b>	
<b>7. Lemon Juice</b>	
<b>8. Water</b>	
<b>9. Shampoo in Water</b>	