LESSON 2: RAINBOW pH

Students will learn about acids, bases, and pH levels by exploring how they react with everyday items to produce different colors.

OBJECTIVES

- ☑ What is pH level?
- ☑ How do acids and bases interact to cause chemical reactions in cabbage?
- ☑ What is the evidence that a chemical reaction has occurred?

SUPPLIES

- 15 small clear, plastic cups
- 15 plastic spoons
- 1 bottle of grape juice (or beet juice)
- 4 lemons
- 1 knife
- 1 cutting board
- 1 container of cream of tartar
- 1 bottle of baby shampoo (clear and fragrance-free is best)
- 1 container of baking soda
- 1 bottle of milk of magnesia
- 12 pieces of paper and 12 pencils

HOOK

3-5 min

What color can grapes be? What is your favorite?

Red grapes has a red hue because of anthocyanin, a type of natural pigment. When anthocyanin mixes with warm water, it is quickly extracted and turns water a purple color.

STUDY

5-10 min

Acids and bases are two kinds of chemicals. Nearly every liquid is either an acid or a base, depending on its ions. Acids have mainly hydrogen ions. Bases have mainly hydroxide ions. To measure how acidic or basic something is, scientists use the pH scale. The pH scale ranges from 0 to 14. The range 0 to 7 is for acids (0 being the most acidic) and from 8 to 14 is for bases (with 14 being the most basic). A 7 on the scale is considered neutral.

Tell the students that today they are going to study chemical reactions with acids and bases, using red grape juice. Show the students the 5 liquids being used in the experiment today.

HYPOTHESIS

3-5 min

Have the students copy down or create a chart like the scientist worksheet. Have them predict whether each liquid is an acid or a base. Then, have them predict what color the grape juice will turn when it is mixed with that liquid.

LESSON 2

CHEMICAL REACTION

A chemical reaction is where different substances (reactants) are changed into a new substance (product)

SIGNS

- change of color
- change of temperature
- change of smell
- production of gas
- production of a solid
- emission of light

TIP

It may help to draw a model scale on the board for students (like right), showing them the range and labelling it from acidic to basic.

KEYWORDS

- pH level
- Acid
- Base
- Ion
- Hydrogen

EXPERIMENT

20-25 min

Before starting the experiment, remind the students that these materials are all household materials, but can be dangerous if not used correctly. Ensure that they do not touch the liquids where possible and mix carefully.

1. Split students into 3 groups.
2. Start by giving each group 5 cups. Have them fill each cup with a small amount of one liquid - lemon juice, cream of tartar, baby shampoo, baking soda, and milk of magnesia.
3. Then, add the grape juice to fill the cup halfway and stir with a spoon. (Note: Use a different spoon for each different cup so you do not mix the liquids.) As they mix the solution, make a note on their chart of what happens to each different liquid.

OBSERVATION

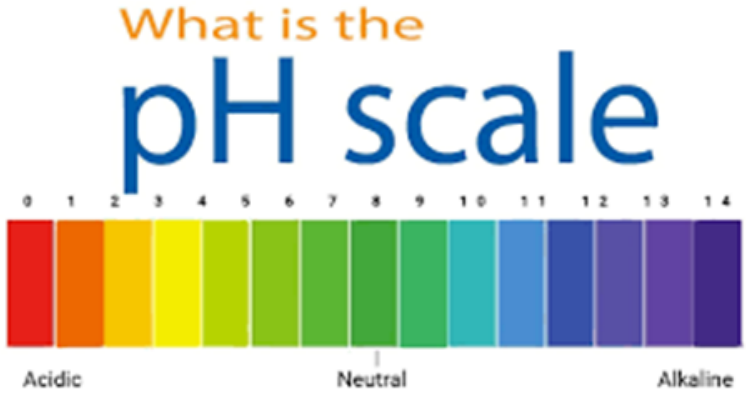
5-10 min

Ask students to discuss:

- What happened when the purple juice was added?
- What colors did the liquids turn?

Students should note that when the juice was added, the cups of water turned a different color.

- pink-red (lemon juice)
- lilac (cream of tartar)
- purple (baby shampoo)
- blue (bicarbonate of soda)
- green (milk of magnesia)



LESSON 2

EXTENSION 5-10 min

If there is extra time, ask students how they think they could change the colored water back to a purple color.

Allow students to experiment with their mixtures and the resources in attempts to change it back. Ask them to use their knowledge of acids and bases to help them.

Students should find that to turn an acidic solution back to a purple color (neutral) they need to add a base to it. To turn a basic solution back to neutral they will have to add an acid to it.

Students may also begin to discover strong acids and strong bases (lemon juice and milk of magnesia) vs weak acids and weak bases (cream of tartar and baking soda). For example, if they add a strong base to a weak acid, the solution will turn basic rather than neutral.

CONCLUSION 5-10 min

Ask students to share their findings.

- Which liquid do you think is the most basic?
- Which do you think is the most acidic?
- Can you order them from most acidic to basic?
- Why do you think the liquids changed colors?

The lemon juice was the most acidic while the milk of magnesia was the most basic. Students should notice that when lined up in order, they form a rainbow from pink to purple to blue to green. Students should note that a chemical reaction occurred here (because the change of color) but may not know exactly what happened.

EXPLANATION 5-10 min

Anthocyanin is an acid-base indicator. This means that when it mixes with an acid or a base, it changes color to indicate the pH level. Today, most pH indicators are man-made, but anthocyanin is a natural occurring pH indicator.

When it mixes with an acid (less than 7 on the pH scale), anthocyanin turns red. When it mixes with a base (8 or higher), anthocyanin turns blue or green. When it mixes with a neutral liquid (7), it stays purple.

As we learned in the 'Study' section, acids and bases are classified according to their hydrogen or hydroxide ions. Basic solutions accept hydrogen ions while acidic solutions donate hydrogen ions. Anthocyanin responds to the levels of hydrogen ions in a liquid.

A chemical reaction occurs when the levels of the hydrogen ions in the solution changes, altering the structure and thus changing the color of the liquid. When anthocyanin mixes with the different liquids, it causes them to donate or accept ions, thus changing the structure and the color to indicate the pH level.

CLEAN UP & DISMISSAL 3-5 min

Students must then clean their workspace. Dispose of the liquids carefully. Make sure to leave the classroom the way you found it.

LESSON 2

SCIENTIST'S WORKSHEET

Tip: Can draw or write the following down on whiteboard!

	Hypothesis - Acid or Base?	Hypothesis - What do you think will happen?	Observation - What does happen?
Lemon Juice			
Baby Shampoo			
Baking Soda			
Cream of Tartar			
Milk of Magnesia