



ACIDS AND BASES

Ask any young person about science and they will usually conjure up a picture of someone surrounded by beakers doing chemistry. Chemistry can be a great motivator, but the thought of doing any in an after school setting can be scary. This month's STEM Gem demonstrates how to perform a series of simple color changing reactions using nothing more complicated than cups and nothing more dangerous than a cabbage.

WHAT IS AN ACID

An acid is a type of chemical that tastes sour and dissolves metals. The word acid comes from the Latin word "acere", which means sour. When we taste sour foods, our taste buds identify an acid. Acids can be strong or weak. Weak acids are in things we eat and drink, such as citrus fruits, sour candy, and vinegar. Strong acids, such as the sulfuric acid in car batteries, are corrosive enough to cause burns and dissolve metals. Acids become less acidic when they are mixed with bases.

WHAT IS A BASE

A base is a type of chemical that tastes bitter, feels slippery, and dissolves fats and oils. Bases can be strong or weak. Weak bases include soaps and cleaners, such as hand soap and dishwashing soap. Strong bases, such as the sodium hydroxide in drain cleaners, are corrosive enough to cause burns. Bases become less basic when they are mixed with acids.

WHAT IS A CHEMICAL INDICATOR

A chemical indicator is a dye that changes color in the presence of an acid or a base. Red cabbage contains this kind of dye and the juice from a red cabbage can be used to determine if a clear liquid is an acid or a base. Below is a chart that shows the color that the juice from a red cabbage will turn when in the presence of an acid or a base.

ACIDS		NEUTRAL	BASES	
STRONG	WEAK	↓	STRONG	WEAK

SCIENCE talk

ACID

A class of chemicals that is corrosive to metals and tastes sour.

BASE

A class of chemicals that feels slippery, tastes bitter, and dissolves fats and oils.

CHEMICAL INDICATOR

A dye, usually plant-based, that changes color in the presence of either an acid or a base.

NEUTRAL

A chemical that is neither an acid nor a base; distilled water is a neutral.

engage

- ?** **What is chemistry?** *Young people's choice. The study of the structure, properties, and reactions of chemical elements and the compounds they form.*
- ?** **What do you think of when you hear the word acid?** *Young people's choice. Young people may mention sour things, dissolving metal, or acid indigestion.*
- ?** **Are all acids dangerous substances?** *Strong acids can be dangerous, but a lot of weak acids can be found in foods, such as lemons, orange juice, and soda.*
- ?** **What is the opposite of an acid?** *A base is a substance that feels soapy and dissolves fats and oils.*
- ?** **What are some of the rules we should have when working with chemicals?** *Explain the following chemistry safety rules. Ensure young people do not eat or drink any chemicals at any time. Ensure young people do not touch or smell any chemicals at any time. Ensure that young people listen carefully and follow all directions. Young people should use both hands for stirring and pouring, keeping mixing cups flat on the table. Young people should not reach across each other for materials, but ask to have things passed to them. Young people should wash their hands before and after the experiment. Keep paper towels nearby to clean up spills.*



what YOU WILL NEED

- ! A red cabbage
- ! A knife
- ! Blender
- ! Strainer
- ! An empty bottle or container for cabbage juice
- ! Lemon juice
- ! Bottle of Sprite® soda
- ! Bottle of white vinegar
- ! Bottle of Fruit-Fresh® Produce Protector or cream of tartar
- ! Box of baking soda
- ! Bottle of ammonia or clear Windex®
- ! Bottle of water
- ! Bottle of liquid laundry detergent
- ! 1 small cup per test group for cabbage juice
- ! 7 small portion cups (1-oz) or a paint pallet for test sample sets for each group
- ! Tape
- ! Pens
- ! Straws to use as droppers and stirrers
- ! Roll of paper towels
- ! 1 sheet of paper per group
- ! Goggles or safety glasses, if available

& before YOU BEGIN



Traditionally, red cabbage had to be boiled to turn it into a chemical indicator. Unfortunately, this process added a unique and lasting aroma to a kitchen. Luckily for you, I discovered an equally effective method. **Cut the cabbage into chunks and use a blender to mix with water.** When only small pieces remain, strain the resulting purple juice into a bottle or another container.

Dilute one-part ammonia with five-parts water.

Pour about two ounces of cabbage juice into a cup for each of your research teams.

Create a sample set of the following chemicals for each research team: previously diluted ammonia, baking soda, Fruit-Fresh® Produce Protector, liquid laundry detergent, lemon juice, Sprite® soda, vinegar, and water. Place approximately one teaspoon of each chemical into a portion cup or the well of a paint pallet. Use tape and a pen to label each chemical.

Create a chart with four columns. Label the first column “Sample” and list each sample chemical within that column. Then label one column “Hypothesis”, one column “Color” and one column “Result”. Print a copy of the chart for each research team to record their results.

Sample	Hypothesis	Color	Result
Ammonia			
Baking Soda			
Fruit Fresh®			
Laundry Detergent			
Lemon Juice			
Sprite®			
Vinegar			
Water			



EXPLORE & EXPERIMENT

- 1** **Divide the group** into small research teams.
- 2** **Explain that everything in the world is either an acid, a base or neutral.** Hand out the samples and results charts prepared earlier. Have teams carefully observe each sample without touching them. Have teams discuss the different properties of the samples. What does each sample look like? Is it a liquid or a solid? Does it have a color? Does it look thin or thick?
- 3** **Have teams collectively hypothesize if each sample is an acid, base, or neutral.** Instruct teams to record their hypotheses in the appropriate column on the chart.
- 4** **Provide cabbage juice and a straw to each team** and explain that cabbage juice contains a dye that changes color when it mixes with acids and bases. For acids, cabbage juice will change color from pink to red, depending on the strength of the acid. For bases, cabbage juice will change from blue to yellow to green, depending on the strength of the base.
- 5** **Demonstrate how to use a straw as a dropper.** Place one end of the straw into the cabbage juice and place a thumb over the opposite end of the straw to pick up the juice. Remove the straw from the cabbage juice and slowly release the thumb to drop the juice into one of the samples. Depending on the size of the sample, additional drops of cabbage juice may be needed to produce a change in color. Demonstrate how to stir each sample by holding the sample flat on the table with one hand and using the other hand to stir the sample with the straw.
- 6** **Have teams place drops of cabbage juice into each sample using the demonstrated method.** Have team members observe any color changes and record the results on their charts. Make sure that young people rotate the tasks of dropping, stirring and recording results among each team member.
- 7** **Gather all teams together to discuss the results after they are finished testing each sample.** Explain what an acid and base are. Ask teams if any of the results were surprising and invite them to explain.



make THE CONNECTION

BUY SOME LEMONS AND A SELECTION OF SOUR CANDY. Explain to young people that when you have a snack and you like it, you tell others you like how the snack tastes! Taste is a sense, just like seeing, feeling, smelling, and hearing. Explain that eyes are used for seeing, fingers are used for feeling, noses are used for smelling, ears are used for hearing, and tongues are used for tasting. Invite young people to stick their tongues out and look at a person sitting near them. Ask them: What do you see on your partner's tongue? Do you see little tiny dots? Explain that the little dots on a person's tongue are called taste buds and they are what allow a person to taste things. A tongue is pretty big, but taste buds are mostly located around the edges of the tongue. Taste buds can identify five different flavors. Have young people discuss the five flavors they can taste. The five flavors are sweet, savory (umami), salty, bitter, and sour. Sugar tastes sweet. Ask the following questions: What are examples of foods that activate a different flavor? What kinds of foods taste sour? Explain that food tastes sour when taste buds detect the presence of an acid. Usually when we taste sour, the food we are eating contains citric acid. Citric acid can be found in lemons, limes, lemonade, oranges, soda and sour candy. The more citric acid something has, the sourer it will taste. Tell young people they cannot taste any of the samples from the indicator experiment because they are not food. However, invite them to taste lemon slices and sour candy. Ask them to describe which tastes sourer and has more citric acid – the candy or the lemon wedge.



EXTEND & EVALUATE

Have young people design and draw a color poster that illustrates the colors that the dye in cabbage juice turns when in contact with substances ranging from a strong acid to a strong base.

Have young people discuss other common liquids they can test with the cabbage juice. Collect the suggestions and obtain the samples for the group to test.