

Lesson 2

Color change

TEACHER GUIDE

Lesson summary

Students meet marine chemist Sera Tuikabe, who is studying ocean acidification in the water surrounding the Republic of the Fiji Islands. Students combine different amounts of acids and bases to explore the range of color changes of universal indicator solution. Then students make as many different-colored solutions as they can.



Key concepts

- A change in color is a clue that a chemical reaction may have occurred.
- Universal indicator solution is green when it has a pH around 7.
- Acidic solutions have a pH less than 7.
- Basic solutions have a pH greater than 7.
- Adding a base to an acidic solution makes the solution less acidic.
- Adding an acid to a basic solution makes the solution less basic.
- Carbon dioxide gas reacts with water to form carbonic acid.

Safety

Be sure you and the students wear properly fitting goggles. Read and follow all safety warnings on the labels of the citric acid and sodium carbonate containers. Have students wash their hands after the activity. Bromthymol blue and universal indicators are both alcohol-based and flammable.



Proper disposal

At the end of the lesson, have students pour their used solutions in a waste container. Dispose of this waste down the drain or according to local regulations. The leftover citric acid and sodium carbonate powders can be disposed of with the classroom trash. Wipe up spills with paper towels and dispose of them with the classroom trash.

Introduction

1. Introduce students to a scientist and her work.

Distribute the student activity sheets for Lesson 2. In this lesson, students meet marine chemist Sera Tuikabe. She explains that carbon dioxide gas can dissolve in water and chemically change the water, making it more acidic. The harmful effects of acidic water on marine life are especially noticeable in corals, clams, starfish, and other creatures that have shells.



Teacher demonstration

2. Bubble carbon dioxide gas from two different chemical reactions through a color-changing indicator solution.

Tell students that you will produce carbon dioxide gas in two different ways. Then you will add the gas to a special solution called *bromthymol blue indicator* to see if the gas reacts with the solution. If a chemical reaction does occur, this blue solution will change color. A color change is a clue that a chemical reaction may have occurred.

You will need

- Goggles
- Bromthymol blue indicator
- Sodium bicarbonate
- Vinegar (bring this from home or use from school)
- Water
- Small metric measuring cup
- Small plastic spoon
- Plastic disposable water bottle, 8 ounces (collect from a student)
- Balloon
- 3 clear plastic cups
- 2 straws



Spoon

Preparation instructions

- Place 20 mL of water into two clean, unused, clear plastic cups.
- Add about 15–20 drops of bromthymol blue indicator to each cup and swirl so that the solutions are blue. Place a clean straw in each cup.
- Put about 30 mL of vinegar into the bottom of a small disposable plastic water bottle.
- With the help of an assistant, place about 2 small spoonfuls of sodium bicarbonate into a deflated balloon.



Procedure

1. Place the balloon over the top of the bottle.
2. Lift the balloon so that the baking soda drops into the vinegar and gently swirl the bottle.

Expected results

The balloon will stand up over the top of the bottle. The balloon will not fully inflate, but it will contain enough carbon dioxide gas for the next part of the demonstration.

Procedure

- Twist the balloon so that you can remove it from the bottle without allowing the gas to escape.
- Carefully remove the balloon and place the end of a straw into the opening while pinching the opening so that not too much gas escapes.
- Place the other end of the straw into one of your cups of bromthymol blue indicator solution and gently squeeze the balloon to bubble the gas into the solution.

**Expected results**

The solution should change from blue to yellow.

Tell students that the carbon dioxide gas reacted with the water in the solution and formed an acid called *carbonic acid*. This acidic solution reacted with the indicator and caused the color to change.

Ask students

- **Next, I am going to gently blow my own breath into bromthymol blue indicator solution. Do you expect a color change? Why or why not?**

Students may know that we exhale carbon dioxide gas. Because carbon dioxide produced from the vinegar and baking soda reaction changed the color of the indicator solution, carbon dioxide from another source should do the same.

Procedure

- Place a straw in the cup of bromthymol blue indicator solution that you have not yet used.
- Push the straw to the bottom of the cup and gently blow until the solution turns greenish-yellow.

**Expected results**

The indicator solution will turn a greenish yellow and may even turn completely yellow after about a minute of blowing through the solution.

Remind students that a change in color is a clue that a chemical reaction may have occurred. In a chemical reaction the reactants that we start with change to become different chemicals, or products. In this reaction, carbon dioxide gas reacts with water to make the product carbonic acid, which causes the color change. Tell students that oceanographer Sera Tuikabe uses the color changes from different indicators to help her measure the health of the water surrounding coral reefs.

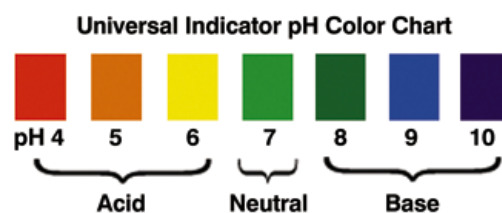
Teacher demonstration

3. Do a demonstration to introduce students to their chemistry challenge.

Tell students that they will use a type of indicator called *universal indicator*. This indicator solution starts out green, but changes color as it reacts with different substances. Its color changes can help you tell whether the solution is *acidic*, *neutral*, or *basic*. And if you are familiar with the range of color changes, you can not only tell whether a solution is acidic or not, you can tell how acidic it is.

You will need

- Goggles
- Universal indicator
- Citric acid
- Sodium carbonate
- Water
- Universal indicator pH color chart
- Small metric measuring cup
- 2 small plastic scoops
- 3 small clear plastic cups



Preparation instructions

- Add about 1 small scoop of citric acid to one plastic cup and 1 small scoop of sodium carbonate to another. Tell students that you have added a substance to each cup but do not tell them what is in each cup.
- In a clean, clear plastic cup, combine 60 mL water and 2.5 mL universal indicator solution.
- Line the three cups up as shown.



Procedure

1. While holding the cups up so that students can see, slowly add about $\frac{1}{3}$ of the universal indicator to the cup with the citric acid.
2. Then slowly add about the same amount to the cup with the sodium carbonate. Try to leave about one third of the indicator solution in its cup.

Expected results

The citric acid turns the indicator from green to reddish. The sodium carbonate turns the indicator from green to purple.



Distribute one universal indicator pH color chart to each group.

Ask students

■ What do you know about the powders in each cup?

By looking at their pH color chart, students will know that the cup in which the solution turned reddish contained the acid and the solution that turned purple contained the base.

Procedure

3. Tell students to watch as you slowly pour the acidic (pink) universal indicator into the basic (purple) universal indicator solution.

Expected results

The basic solution changes color and goes toward neutral on the pH scale.

Tell students that acids and bases are like chemical opposites: If you add an acid to a basic solution, the solution becomes less basic. If you add a base to an acidic solution, the solution becomes less acidic.

Student activity**4. Have students make at least 6 different colors by adding drops of acid and base to universal indicator solution.**

Depending on students' experience using droppers, you may need to have students practice using them. Be sure to demonstrate the difference between "drops" and "squirts" and, if necessary, give students a chance to practice releasing single drops of water. In this activity, students will add a certain number of drops of each of the required solutions to each well.

Activity summary

Students will begin by preparing their acid and base solutions and adding universal indicator solution to 12 different wells on a spot plate. Then they will combine drops of citric acid and sodium carbonate (a base) in each well to make as many different colors as they can. This activity is described in detail on the student activity sheet.

Preparation instructions

- Reuse the portion cup labeled *citric acid* from the previous activity. Then label one clean, unused, clear plastic cup and one dropper *citric acid solution* for each group.
- Label one portion cup sodium carbonate. Then label one clean, unused, clear plastic cup and one dropper *sodium carbonate solution* for each group.
- Place about $\frac{1}{4}$ teaspoon of citric acid and sodium carbonate in their labeled portion cups. Each group will make their own citric acid and sodium carbonate solutions in the clear plastic cups.

Expected results

The wells in the first row will be shades of green, blue, and purple. The wells in the second row will be shades of yellow, orange, and pink. And the wells in the third row will be varying shades of the colors in the first and second row.



Teacher demonstration

5. Do a demonstration to review the two clues of chemical change introduced in the first two lessons.

You will need

- Goggles
- Bromthymol blue indicator
- Sodium bicarbonate
- Citric acid
- Water
- Small metric measuring cup
- 2 small scoops
- 2 clear plastic cups



Procedure

1. Place 10 mL of water in a clear plastic cup.
2. Add 1 scoop of sodium bicarbonate (baking soda) and swirl to dissolve.
3. Add 10 drops of bromthymol blue indicator to the baking soda solution.
4. Place 10 mL of water in a separate clear plastic cup.
5. Add 2 scoops of citric acid to the water and swirl to dissolve.



Ask students to predict

- What do you think will happen if you pour the citric acid solution into the sodium bicarbonate solution?

Procedure

6. Pour the citric acid solution into the sodium bicarbonate solution.

Expected results

The blue color will turn yellowish and there will be some bubbling.

Ask students

- **What two clues of chemical change did you observe?**
A color change and production of a gas

Application

Have students read the real life application on the student activity sheet. Explain that people with diabetes can use a color-changing chemical reaction to help them keep track of the glucose levels in their bodies. A small strip of paper with different chemicals on it reacts with a person's urine; the darker the color, the more glucose in the urine. This amount of glucose is a reflection of the level of glucose in a person's blood.

