Orange Juice and Strawberry Float

Acid–Base Indicators

Introduction

It's big, it's colorful, it's messy, and it's chemistry! Watch as the "orange juice" in a beaker changes into a foamy "strawberry float." What a great way to introduce the properties of acid–base indicators to your students!

Concepts

- Acids and bases
- Acid–base indicators

Materials

Alconox® soap, 50 g

Methyl orange, 0.2% solution, 100 mL

Hydrochloric acid, HCl, 3 *M*, 270–280 mL

Sodium bicarbonate, $NaHCO_3$, 50 g

Water, tap

Beakers, 2-L and 600-mL

Demonstration tray, dishpan or aquarium

Stirring rod, long

Safety Precautions

Hydrochloric acid is moderately toxic by ingestion and inhalation; it is corrosive to all body tissues, especially to the eyes. Methyl orange solution is slightly toxic by ingestion. Alconox® and sodium bicarbonate are skin irritants. Avoid contact of all chemicals with eyes and skin. This demonstration rapidly generates a foamy mixture which may spray in all directions. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water after performing this demonstration. *Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.*

Procedure

1. Place a large demonstration tray or dishpan on the demonstration table.
2. Add approximately 300 mL of tap water to a 2-L beaker.
3. Add 50 g sodium bicarbonate and 50 g Alconox® to the 2-L beaker. Stir the solution with the long stirring rod. All of the solid may not dissolve.
4. Add 100 mL of 0.2% solution methyl orange indicator to the beaker containing the sodium bicarbonate and Alconox®. Stir. The resulting solution should look somewhat like orange juice; however, the orange solution is thicker and darker in color than actual orange juice.
5. Pour approximately 270–280 mL of 3 *M* hydrochloric acid into a 600-mL beaker.
6. Place the beaker containing the sodium bicarbonate mixture in the center of the large demonstration tray or dishpan.
7. Quickly but carefully add the 270–280 mL of HCl, all in one pour, to the large, 2-L beaker. Stand back as the mixture will immediately erupt out of the beaker.
8. Note the color change of the mixture. The solution will look like a strawberry float, but after some time, parts of the solution will turn yellow.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The resulting mixture should be diluted with water, neutralized, and flushed down the drain with plenty of water according to Flinn Suggested Disposal Method #24b.

Tips

- Prepare 0.2% methyl orange solution by dissolving 0.2 g of the solid indicator in 100 mL of water.
- This demonstration is very messy and produces over 13 liters of soap bubbles that may still contain small amounts of hydrochloric acid. Please practice this demonstration before performing it in front of your students. All persons watching the demonstration should be wearing chemical splash goggles. All amounts can be cut in half for a safer and less messy (although less dramatic) alternative.
- This demonstration can also be performed in a 1-L or 3-L beaker. It is advised *not* to use an Erlenmeyer flask or a graduated cylinder as excessive splattering will erupt out of the narrow mouth.
- It is possible to substitute 75 g or 25 g of Alconox® (rather than 50 g) for more or less foam, respectively. Liquid dish detergent also works (about three healthy squirts) but gives a lower quality foam. A less foamy reaction will occur using 25 g of sodium bicarbonate (rather than 50 g) and 1 *M* hydrochloric acid (rather than 3 *M*) with the same amount of soap (50 g).

Discussion

The sodium bicarbonate reacts with the hydrochloric acid in a neutralization reaction to produce sodium chloride, water and carbon dioxide gas according to the following equation:

$$NaHCO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$$

Methyl orange is an acid–base indicator that is red at pH values less than 3.0, yellow-orange at pH > 4.4, and intermediate peach colors in the pH range 3.0–4.4. The initial basic solution has a deep yellow-orange color. The color intensity of the initial solution is due to the high indicator concentration. Upon adding the acid, the pH drops and a strawberry red color is observed. One of the products of this neutralization reaction is carbon dioxide gas, which is rapidly produced and becomes trapped in the soap bubbles. Over 13 liters of CO_2 gas are produced in the reaction, resulting in an abundance of soap bubbles.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Answers to Worksheet Discussion Questions

1. Describe what happened in this demonstration. Make sure to mention all the chemicals used.

   Hydrochloric acid was added to a large beaker containing a mixture of sodium bicarbonate, soap, and methyl orange, an acid–base indicator. The solution, which was originally the color of orange juice, turned red and a great deal of foaming was produced.

2. Write a chemical equation for the reaction that occurred when hydrochloric acid was added to the mixture inside the large beaker.

   $NaHCO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$

3. What product of this reaction and what chemical present in the original mixture were responsible for the foaming? Explain.

The carbon dioxide gas (CO_2) produced by the reaction between the hydrochloric acid and sodium bicarbonate, along with the soap, were responsible for the foaming. The CO_2 became trapped in the soap bubbles from the detergent, causing an abundance of foamy bubbles.

4. What chemical was responsible for the color change? Explain.

The methyl orange indicator was responsible for the color change. Methyl orange is red in an acid and yellow-orange in a base, and thus when the hydrochloric acid was added, the color of the solution changed to a strawberry red.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Orange Juice and Strawberry Float* activity, presented by Irene Cesa, is available in *Acid–Base Indicators* and in *Classroom Fun*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Orange Juice and Strawberry Float* are available from Flinn Scientific, Inc.

Materials required to perform this activity are available in the *Orange Juice to Strawberry Float—Chemical Demonstration Kit* available from Flinn Scientific. Materials may also be purchased separately.

Catalog No.	Description
AP4778	Orange Juice to Strawberry Float—Chemical Demonstration Kit
A0126	Alconox, 4 lb
H0034	Hydrochloric Acid, 3 M, 500 mL
M0076	Methyl Orange, 25 g
S0042	Sodium Bicarbonate, 500 g
AP5429	Demonstration Tray

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

Orange Juice and Strawberry Float Worksheet

Discussion Questions

1. Describe what happened in this demonstration. Make sure to mention all the chemicals used.

2. Write a chemical equation for the reaction that occurred when hydrochloric acid was added to the mixture inside the large beaker.

3. What product of this reaction and what chemical present in the original mixture were responsible for the foaming? Explain.

4. What chemical was responsible for the color change? Explain.