

# The Rainbow Reaction



## Introduction

A saturated sodium carbonate solution is introduced to a test tube containing a mixture of 0.10 M hydrochloric acid solution and universal indicator. In a few seconds a rainbow of colors forms.

## Concepts

- pH indicators
- Acids–bases

## Materials (enough for 20 hands-on experiments)

Hydrochloric acid, 0.10 M, HCl, 1 L

Graduated Beral pipet

Sodium carbonate solution, saturated, Na<sub>2</sub>CO<sub>3</sub>, 1 L

Test tube, 25 × 200 mm

Universal indicator solution, 25 mL

Test tube rack

## Safety Precautions

*Hydrochloric acid is corrosive to eyes and skin. Toxic by ingestion or inhalation. Avoid direct contact. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Use and dispense concentrated acid in an operating fume hood. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.*

## Procedure

1. The hydrochloric acid solution is prepared by diluting 8.3 mL of concentrated hydrochloric acid in about 500 mL of distilled water, add 25 mL of universal indicator, and then bring to a final volume of 1.0 L. Remember to add acid to water and to wear protective equipment. See Safety Precautions below.
2. Prepare the sodium carbonate solution by dissolving 130 g of sodium carbonate in 1.0 L of water.
3. Fill a 25 × 200 mm test tube almost full with the 0.10 M hydrochloric acid/universal indicator solution. Leave about 1–2 cm of space at the top of the test tube.
4. Fill a graduated Beral pipet with the saturated sodium carbonate solution.
5. Tilt the test tube slightly and squirt about one-third of the saturated sodium carbonate solution down the side of the test tube. Do not attempt to layer the solutions.
6. Hold the test tube vertically or place it in a test tube rack, and observe.

## Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. All solutions may be disposed of according to Flinn Suggested Disposal Method #26a.

## Tip

- This activity can be used in a unit related to acids and bases, pH, neutralization or indicators. It also can be used to illustrate how slowly ions diffuse in an undisturbed liquid.

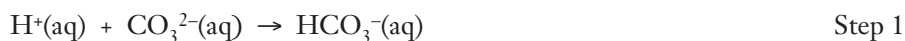
## Discussion

Because the density of the sodium carbonate solution is greater than hydrochloric acid solution, the sodium carbonate solution will settle to the bottom. As the sodium carbonate settles to the bottom, a neutralization reaction takes place between the sodium carbonate and the hydrochloric acid. At different depths, the concentration of the hydrogen (H<sup>+</sup>) ions vary, producing layers of varying pH. The universal indicator responds accordingly, forming the rainbow effect. Since molecular motion is relatively slow, this effect will remain for several weeks if left undisturbed.

## The Rainbow Reaction *continued*

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The reactions between sodium carbonate and hydrochloric acid occurs in three steps, as follows.



## Connecting to the National Standards

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

**Unifying Concepts and Processes: Grades K–12**

Evidence, models, and explanation

Evolution and equilibrium

**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 of atoms, structure and properties of matter, chemical reactions

## References

Moore, Howard and Elizabeth, *The Journal of Chemical Education*, **1993**, *60*, (5), May, pp 406–407.

Summerlin, L. R.; Ealy J. L., Jr. *Chemical Demonstrations: A Sourcebook for Teachers*; American Chemical Society: Washington, DC, 1985; Vol. 1, p 38.

## Materials for *The Rainbow Reaction* are available from Flinn Scientific, Inc.

Catalog No.	Description
H0014	Hydrochloric acid, 0.1 M, 500 mL
S0052	Sodium carbonate, 500 g
U0001	Universal indicator solution, 100 mL

Consult the [Flinn Scientific website](#) for current prices.