Determination of the Volume of CO_2 in Pop Rocks®

Purpose

To determine the amount of CO_2 in Pop Rocks® candy using the molar volume of a gas and solubility of a gas in water.

Learning Objectives

- Using the Ideal Gas Law.
- Calculation of gas solubility in water.
- Determination of mass of a gas.

Introduction

Pop Rocks were developed in 1956 by General Foods research scientist William A. Mitchell and introduced to the market in 1975.

Pop Rocks is a hard candy made from sugar, lactose (milk sugar) corn syrup and flavoring. The ingredients are heated together and boiled in a pressure cooker, then agitated and mixed with carbon dioxide gas at about 600 PSI. The mixture is then rapidly cooled to 25°C resulting in the carbon dioxide gas forming tiny, 600 PSI bubbles in the candy. When the pressure is released, the candy shatters into the form as it is packaged, but the pieces still contain trapped bubbles of carbon dioxide. These bubbles can be observed with a magnifying lens or dissection microscope. The tiny air pockets of carbonation (CO_2) are released when melted in your mouth and has a mild "crackling" sensation and "popping" noise. The original flavors were Orange, Cherry and Grape.

In this experiment, a sample of the Pop Rocks® will be dissolved in water and the amount of carbon dioxide trapped in the candy will be determined. While most of the carbon dioxide escapes into the air, sufficient carbon dioxide is soluble in water that the amount of dissolved carbon dioxide must also be determined.

Chemicals and Equipment

A package of Pop Rocks® candy
150-mL beaker
Watch glass
Glass stirring rod
Thermometer, 110°C or similar
Scissors
Magnifying lens or Dissection Microscope
Distilled or deionized water

Safety Precautions

There are no safety hazards in this experiment.

Disposal

The materials used in this experiment can safely be disposed of down the drain. Any paper towels or paper waste can be disposed of in the trash.

Experimental Procedure

1. Determine the mass of the 150-mL beaker.

2. Measure 100 mL of distilled or deionized water into the beaker. Determine the mass of the beaker and water.

3. Obtain a package of Pop Rocks® candy. Cut open the package and removed two or three pieces of the candy, place them on a watch glass, and put them aside. These will be examined using a magnifying lens or a dissection microscope.

4. Determine the mass of the remaining Pop Rocks® candy.

5. Add the Pop Rocks® candy to the beaker of water. Record your observations. Calculate the total mass of the beaker, water, and candy. Stir gently to dissolve the candy. (It may take up to 30 minutes for the candy to dissolve. Note: Be careful not to spill or splash any liquid as the mass of any lost liquid will affect your results.) During this time, examine the pieces of candy on the watch glass with a magnifying lens or a dissection microscope. Record your observations. Using a dropper, add one drop of water to the pieces of candy while observing them. Record your observations.

6. Measure the temperature of the solution of Pop Rocks® in the beaker, then determine the mass of the beaker and its contents.

7. Determine the total mass of CO_2 that escaped from the solution. Use the ideal gas law equation to determine the volume of the CO_2 that escaped from the solution. Also, calculate the mass and volume of CO_2 dissolved in the solution in the beaker.

8. If a barometer is available, determine the atmospheric pressure.

Data Analysis

1. Calculate the total volume of gas released from the Pop Rocks® candy.

2. Calculate the volume of gas contained in 1.00 g of Pop Rocks® candy.

3. What other gases may be dissolved in the water in the beaker? How will these affect your results? (You may need to access additional information from a chemistry handbook or on the Internet.)

4. What effect would splashing a small amount of water from the beaker have on your results?

5. The data for this experiment is measured at one atmosphere pressure. How would your results vary if you corrected them for the actual atmospheric pressure?

6. Read the information regarding the urban legends surrounding Pop Rocks®. How much CO_2 is contained in a typical can of a soft drink? Are you in any danger from eating this candy? (You will need to access additional information on the Internet.)

References

May, Bryan, Determine the volume of CO_2 in a package of Pop Rocks® candy, CHEM13news, February 2009, No. 363.

Kremzner, Leon, and Mitchell, William A., Gasified Confection and Method of Making the Same, U.S. Patent 3,012,893, Patented Dec. 12, 1961.

Pages at the web site *http://www.poprockscandy.com*

Urban legends at *http://www.snopes.com/horros/freakishpoprocks.asp*

The Urban Legend

Pop Rocks® had been thoroughly tested and found innocuous, but the exploding candy still startled residents in Seattle. The Food and Drug Administration arranged a telephone hotline to assure anxious parents that the popping candy would not cause children to choke. The most common story was that mixing the candy with carbonated drinks would cause the stomach to explode. Coke is the favorite legend, but others say milk, root beer, Pepsi, Dr. Pepper, Zima or Mountain Dew.

Another story involved, Mikey, a child actor from Life cereal commercials who hates everything, except Life cereal and Pop Rocks. According to the story, he gorges himself with the candy and washes it down with a soda. The chemical reaction in his stomach causes an eruption and he explodes. (According to the Pop Rocks web site, the actor who played Mikey is alive and prefers to remain anonymous. He currently works as an attorney in the New York City area.)

General Foods was battling "exploded kid" rumors as early as 1979, a mere four years after the product went to market. They took out full-page ads in 45 major publications, wrote some 50,000 letters to school principals around the country, and sent the confection's inventor on the road to explain to all that Pop Rocks generate less gas than half a can of soda and ingesting them could induce nothing worse in the human body than a hearty, non-life-threatening belch. Despite all these measures, the rumors of the urban legend abound even to this day.

Around 1983, enough pressure become too much and Pop Rocks were taken off the market. What's less known is that Kraft bought the rights to the product from General Foods in 1985 and then marketed it as "Action Candy" through a company named Carbonated Candy.

Pop Rocks are currently marketed under their original name by Zeta Espacial S.A. and is distributed by Pop Rocks, Inc.

Solubility of Carbon Dioxide in water at various temperatures

Expressed as aqueous solubility of CO_2 at 101.3 kPa (1 atm) **partial pressure**

Temperature	grams CO_2 per 100 ml H_2O		Temperature	grams CO_2 per 100 ml H_2O
0 °C	0.3346		16 °C	0.1903
1 °C	0.3213		17 °C	0.1845
2 °C	0.3091		18 °C	0.1789
3 °C	0.2978		19 °C	0.1737
4 °C	0.2871		20 °C	0.1688
5 °C	0.2774		21 °C	0.1640
6 °C	0.2681		22 °C	0.1590
7 °C	0.2589		23 °C	0.1540
8 °C	0.2492		24 °C	0.1493
9 °C	0.2403		25 °C	0.1449
10 °C	0.2318		26 °C	0.1406
11 °C	0.2239		27 °C	0.1366
12 °C	0.2165		28 °C	0.1327
13 °C	0.2098		29 °C	0.1292
14 °C	0.2032		30 °C	0.1257
15 °C	0.1970			

Density of Water (g/mL) at Various Temperatures (°C)

	0.0	0.3	0.5	0.7
0	0.999841	0.999860	0.999872	0.999884
1	0.999900	0.999914	0.999923	0.999930
2	0.999941	0.999950	0.999955	0.999960
3	0.999965	0.999969	0.999971	0.999972
4	0.999973	0.999972	0.999972	0.999969
5	0.999965	0.999959	0.999955	0.999950
6	0.999941	0.999931	0.999924	0.999916
7	0.999902	0.999888	0.999877	0.999866
8	0.999849	0.999830	0.999817	0.999803
9	0.999781	0.999758	0.999742	0.999726
10	0.999700	0.999673	0.999654	0.999635
11	0.999605	0.999574	0.999553	0.999531
12	0.999498	0.999463	0.999439	0.999415
13	0.999377	0.999339	0.999312	0.999285
14	0.999244	0.999202	0.999173	0.999144
15	0.999099	0.999054	0.999023	0.998991
16	0.998943	0.998893	0.998860	0.998826
17	0.998774	0.998722	0.998686	0.998650
18	0.998595	0.998539	0.998501	0.998463
19	0.998405	0.998345	0.998305	0.998265
20	0.998203	0.998141	0.998099	0.998056
21	0.997992	0.997926	0.997882	0.997837
22	0.997770	0.997701	0.997655	0.997608
23	0.997538	0.997466	0.997418	0.997369
24	0.997296	0.997221	0.997171	0.997120
25	0.997044	0.996967	0.996914	0.996862
26	0.996783	0.996703	0.996649	0.996594
27	0.996512	0.996429	0.996373	0.996317
28	0.996232	0.996147	0.996089	0.996031
29	0.995944	0.995855	0.995796	0.995736
30	0.995646	0.995555	0.995494	0.995433

Reference: Handbook of Chemistry and Physics, 62nd ed.