PART 2

LABORATORY EXPERIMENTS

OVERVIEW TO PART 2

PART 2. LABORATORY EXPERIMENTS

Part 2 consists of six full lab period experiments that can be used with the three gases that were mastered in Part 1, carbon dioxide, hydrogen and oxygen. These experiments are suited for use by high school chemistry students as well as university-level chemistry students.

The experiments are ranked in approximate order of difficulty. "Mystery Gas" is a good example of an inquiry-based learning lab. Students design and use a strategy to determine the identities of three gas samples. "Percent Composition" relates the volume of carbon dioxide produced from the acid decomposition of calcium carbonate to the composition of an antacid tablet. The "Carbonated Beverages" lab is a set of experiments that explores some of the properties of carbonated beverages and relates these observations to those made my Joseph Priestley in the 1770s. The "Molar Mass" lab works well for any gas, not just the three we have studied so far. Results are generally within a few percent of the actual value — much improved from the popular "molar mass of butane lab" that appears in many books.

The last two experiments, "Limiting Reagent" and "Barometric Pressure", along with "Percent Composition" all require the entire class to work together to determine a set of data that everyone will use to complete the experiment.

CHAPTER 6

MYSTERY GAS

THREE GASES HAVE BEEN STUDIED in detail so far. This laboratory experiment tests students' abilities to identify the three gases based on their differences. Students must design an experiment to make the correct identification.

By way of review, the following list summarizes 3 – 4 experiments that were performed by the students on each gas.

Experiments performed on carbon dioxide:

Experiment 1. Traditional limewater test for carbon dioxide.
Experiment 2. Acidity of carbon dioxide
Experiment 3. Carbon dioxide extinguishes fires
Experiment 4. Carbon dioxide and aqueous sodium hydroxide react.

Experiments performed on hydrogen:

Experiment 1. Traditional test for hydrogen.
Experiment 2. Hydrogen bubbles are flammable
Experiment 3. Reduction of CuO(s) with hydrogen

Experiments performed on oxygen:

Experiment 1. Traditional test for oxygen
Experiment 2. Oxygen supports combustion
Experiment 3. Dynamite soap

Students should design a series of experiments to correctly identify samples of each of these gases from the list given above.

MYSTERY GAS

INFORMATION FOR THE TEACHER

Suitability

This laboratory activity is suited for high school chemistry students.

Background skills required

Students should be able to:

- perform the student experiments given in Chapters 1 – 3.
- design an experimental procedure

Time required

Students should be able to perform this experiment in a single 45 minute laboratory period.

Equipment

Microscale Gas Kit
Piezoelectric lighter or match

Chemicals

To make a gas bag full of CO_2: Use 3 g $NaHCO_3$ and 50 mL of vinegar
To make a gas bag full of H_2: Use 1 g magnesium and 50 mL 1.2 M HCl(aq)
To make a gas bag full of O_2: Use 0.5 potassium iodide and 60 mL 3% H_2O_2(aq)
limewater
universal indicator solution
concentrate ammonium hydroxide solution (only the NH_3 fumes are needed)
magnesium ribbon
phenolphthalein solution
3% dish soap solution

Before students arrive

Prepare gas bags filled with carbon dioxide, hydrogen, and oxygen as described in Chapter 5.

Instructions

Each group of students will receive 3 syringes marked “A” “B” & “C”. Each of the three syringes will contain a gas: CO_2(g), H_2(g), and O_2(g). The students themselves will not know what gas is in what syringe by simply looking at the syringes. Vary the

order from group to group. The students will be asked to perform test on each of the syringes using the information and data collected from prior Microscale Gas Experiments done for $CO_2(g)$, $H_2(g)$, and $O_2(g)$.

Website

This chapter is available at our gas website:

http://mattson.creighton.edu/Microscale_Gas_Chemistry.html

Instructions for your students

Content for this chapter first appeared as “Microscale Gas Chemistry, Part 25. Mystery Gas”, Mattson, B.; and Pottebaum, D.; ***Chem13 News***, **318**, February, 2004, 10 - 11.

MYSTERY GAS

INSTRUCTIONS FOR STUDENTS

General Safety Precautions

Always wear safety glasses. Gases in syringes may be under pressure and could spray liquid chemicals. Follow the instructions and only use the quantities suggested.

Toxicity

Carbon dioxide, hydrogen and oxygen are all relatively non-toxic. The first two are asphyxiants if inhaled in quantities much larger than we will encounter today. Even pure oxygen can be toxic if inhaled in large quantities. Do not intentionally inhale any samples of gas in these experiments.

Your assignment

You and your lab partner will be given three syringes filled with three different gases, carbon dioxide, hydrogen and oxygen. Your assignment is to correctly identify the contents of each syringe using the experimental procedures previously conducted.

Design an experiment

Design a method to identify each gas from the three possibilities, carbon dioxide, hydrogen and oxygen. You may use any of the following experiments that you have already performed.

Experiments performed on carbon dioxide:

Experiment 1. Traditional limewater test for carbon dioxide.
Experiment 2. Acidity of carbon dioxide
Experiment 3. Carbon dioxide extinguishes fires
Experiment 4. Carbon dioxide and aqueous sodium hydroxide react.

Experiments performed on hydrogen:

Experiment 1. Traditional test for hydrogen.
Experiment 2. Hydrogen bubbles are flammable
Experiment 3. Reduction of CuO(s) with hydrogen

Experiments performed on oxygen:

Experiment 1. Traditional test for oxygen
Experiment 2. Oxygen supports combustion
Experiment 3. Dynamite Soap

Conduct the experiment

Locate the necessary chemicals and equipment needed to perform the proposed experiments. Record all results in your laboratory notebook.

Clean-up and storage

At the end of the experiments, clean all syringe parts (including the plunger seal), caps and tubing with soap and water. Rinse all parts with distilled water. Be careful with the small parts because they can easily be lost down the drain. Important: Store plunger out of barrel.

Questions

1. What experiments allowed you to conclusively identify each gas?
2. What would happen if you performed the experiment given for one particular gas on a different gas? For example, what would happen if you performed the limewater test on oxygen?
3. Identify a gas that causes hot copper to darken and does not form acidic solutions with water.
4. Why is “Dynamite Soap” not as useful as other experiments for the identification of gases?
5. If you had to pick only one experiment to try to identify each gas, which one would you pick for each gas?

SUMMARY OF MATERIALS AND CHEMICALS NEEDED FOR CHAPTER 6. MYSTERY GAS EXPERIMENT.

Equipment required

Item	For 5 pairs	For 10 pairs
Microscale Gas Chemistry Kit (Chapter 1)	5	10
wooden splint	5	10
Bunsen burner, small	5	10
glass Pasteur pipet	5	10
ring stand and clamp	5	10
glass rod	5	10
test tube, (25 x 200 mm)	5	10

Materials required

Item	For 5 pairs	For 10 pairs
short candle affixed to coin	5	10
white 6-oz cup	5	10
matches or lighter	5	10
tape	10 cm	20 cm
copper wool - kitchen scrubbing pad	*	*
3% dish soap solution*	50 mL	100 mL

* one pad will be enough for everyone

** 3% v/v dish soap solution (3 mL dish soap + 97 mL (or g) distilled water)

Chemicals required

Item	For 5 pairs	For 10 pairs
sodium bicarbonate, $NaHCO_3$	3 g	3 g
vinegar	50 mL	50 mL
magnesium	1 g	1 g
hydrochloric acid, 1.2 M HCl(aq)	50 mL	50 mL
potassium iodide	0.5	0.5
hydrogen peroxide, 3% H_2O_2 (aq)*	60 mL	60 mL
limewater (Appendix D)	10 mL	20 mL
universal indicator solution	50 mL	100 mL
concentrated ammonium hydroxide solution	**	**
sodium hydroxide, 6 M NaOH	50 mL	100 mL

3% H_2O_2(aq) will also work, but not quite as well

**only the NH_3 fumes will be used

