CAC, IB Chemistry
Experiment: Reaction of Magnesium and HCl: Determination of R

Adapted from: Chemistry, Exp.Foundations, 4th Ed. Laboratory Manual, by Merrill, Parry & Bassow.

Clothing

This experiment requires proper safety attire, including close-toed shoes, long pants, and goggles. If you are not properly attired, you will have to come back to perform the experiment during your free time.

Learning/Review Goals

- Write and balance chemical equations.
- Use balanced equation stoichiometry in combination with gas data to find, experimentally, the ideal gas constant

"Notebook" requirements

Before coming to lab, you must have these parts of your Google Doc prepared:

- Title
- Partner
- Purpose
- Balanced chemical reaction
- Data table including a space for every piece of data that you will collect

After Lab, in notebook:

- Analysis, all calculations must be completed using an equation editor (including uncertainty)
- Evaluation/Discussion: look at the questions from the previous lab (Molar Mass of a Volatile Liquid) and consider those questions in paragraph form your evaluation. Make sure to be specific about how any systematic errors would affect your final value of R. Also include any improvements to the experiment that you suggest.

Part A. Data Collection

1. Obtain a piece of magnesium ribbon approximately 3 cm long. Gently "scrub" off any oxidized portion with some steel wool. Mass the ribbon on the analytical balance. Show your recorded mass to your teacher to obtain her initials before you proceed!
2. Fold the magnesium ribbon so that it can be encased in a small spiral cage made of fine copper wire (shown at the right). Let enough copper wire serve as a handle so that the cage can rest at the 50 mL mark of the gas measuring tube.
3. Set up a ring stand and utility clamp in a position to hold a 50 mL gas measuring tube. Place a 400 mL beaker about two-thirds full of tap water near the ring stand.
4. Tilt the gas measuring tube slightly and carefully fill it with with 3M hydrochloric acid (HCl) to about the 15 mL mark.
5. With the tube still tilted, *slowly* fill it with distilled water from a beaker. While pouring, rinse any acid that may be on the side of the tube. The final liquid in the top of the tube should contain very little acid, so try to avoid stirring up the acid layer. The tube should be *brimming full* of water.
6. Use the handle to insert the copper cage into the tube until is is positioned at about the 50 mL mark. Thread the wire through the hole in the stopper and bend it around to keep it in place. Secure the

stopper in place at the end of the tube. The stopper hole(s) should be full of water and you should have no air bubbles in your tube.

7. Cover the hole(s) in the stopper with your finger and invert the tube into the 400 mL beaker of water. Clamp the tube in place and watch the reaction occur.
8. After the reaction stops, wait about 5 minutes to allow the tube and contents to come to room temperature. (Although you may not be able to feel it with your hand, this is a slightly exothermic reaction, and this waiting period is important.) Dislodge any bubbles by gently tapping on the side of the tube.
9. Again, cover the hole in the stopper with your finger and transfer the tube to a large cylinder of room temperature water (provided in the lab).
10. Raise or lower the tube in the water until the level of liquid inside the tube is the same as the level of water outside the tube. At this position, measure and record the volume of gas in the tube. Raise your hand to have your instructor check and initial your measurement. (See Figure 2)
11. Remove the gas measuring tube from the cylinder, and

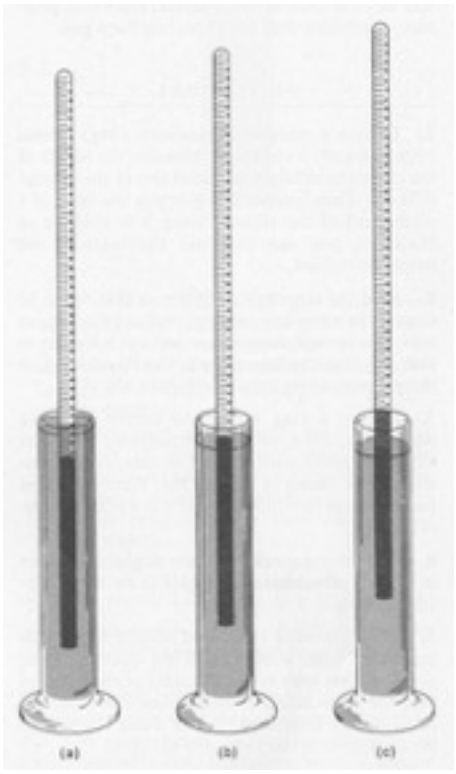

Figure 2: Measuring the volume of gas at room pressure.
a) $P_{room}<P_{gas}$
b) $P_{room}=P_{gas}$
c) $P_{room}>P_{gas}$

dispose of its contents down the sink with lots of water. Rinse your tube with tap water and replace it and your stopper on the prep bench. Pour the water from your 400 mL beaker down the sink.

12. Record the room temperature and the atmospheric pressure.

Analysis, label each step clearly with a <u>title</u>, not with the number of the step. (Include uncertainty for each calculation)

1. The hydrogen gas (H_2) in this experiment was collected over water, such that the gas in the collection tube was both H_2 gas and water vapor. When you equalize the level of liquid in the two containers, the total pressure in the collection tube equals the atmospheric pressure.Use the chart posted on Moodle to find the vapor pressure of water (P_{H2O}) at your experimental temperature. Use this value and your measured P_{ATM} to compute the P_{H2}.

$$P_{atm} = P_{H2} + P_{H2O}$$

2. Use stoichiometry to compute the number of moles of hydrogen gas in the tube.
3. Compute the value of R, of the ideal gas constant in J/(mol K), or (kPa dm^3)/(mol K). Show each step and include absolute uncertainty on your final value.
4. Compute the class average and its experimental uncertainty.
5. Compute the percent difference between your experimental value for R and the accepted value of R. You will comment on this difference in your discussion.