GASES

INTRODUCTION

Carbon dioxide, CO_2, is produced when an antacid tablet is added to an acidic solution, for example:

$$\mathbf{NaHCO_3(s) + HCl(aq) \rightarrow CO_2(g) + NaCl(aq) + H_2O(l)}$$

In this procedure, the carbon dioxide gas generated by the reaction is trapped and the volume of gas is measured by downward displacement of water in a graduated tube.

When performing calculations you will use the ideal gas law:

$$\mathbf{PV = nRT}$$

where R = 62.364 L Torr mol^{-1} K^{-1} or 0.08206 L atm mol^{-1} K^{-1}, P is the pressure of the gas, V is the volume of the gas, n is the number of moles of the gas, and T is the temperature of the gas in kelvin.

In this experiment, you will also use Dalton's law of partial pressures, which states that the sum of the partial pressures of all the different gases in a mixture is equal to the total pressure of the mixture:

$$\mathbf{P_{Total} = P_{Gas1} + P_{Gas2} + \ldots}$$

In this experiment, the total pressure of the gas in the reaction apparatus (above the liquid) is the sum of the partial pressure of CO_2 and the partial pressure (vapor pressure) of water:

$$P_{Total} = P_{CO_2} + P_{H_2O}$$

The vapor pressure of H_2O at various temperatures is listed in the table on Page 6 of this handout.

PROCEDURE

You will need to check out from Lab Services the equipment shown in Figure 1 on page 7 and set it up.

1. Measure the mass of an entire Alka-Seltzer tablet and record the value.

2. Break an Alka-Seltzer tablet in half and wrap one half tightly in aluminum foil.

3. Practice breaking the other half into pieces that are between 0.1 and 0.2 g. When you can do that easily, put all **the little pieces** into 250 mL beaker containing 125 mL of 0.2 M HCl. Stir until bubbling ceases. This is your "apparatus" fluid.

4. Pour the "apparatus" fluid into the leveling bulb. Alternately raise and lower the bulb until all the air has been expelled from the connecting tubing and no more bubbles rise in the graduated buret tube.

5. Pour 5.0 mL of 6 M HCl into a 125 mL Erlenmeyer flask. Stopper the flask.

PLAN THE NEXT FEW STEPS CAREFULLY AND DO THEM QUICKLY. THE ANTACID IS MOISTURE SENSITIVE.

6. Take the foil-wrapped half of your tablet over to the balance and break off one piece that is between 0.100 and 0.200 g and record the exact mass. Using this size piece will allow you to generate a **measurable** amount of gas. Tightly rewrap the remaining chunk for repeat experiments.

ONE LAB PARTNER SHOULD GO ON TO THE NEXT PARAGRAPH WHILE THE OTHER MAKES A LOOP FROM A 20 CM LENGTH OF THREAD AND SLIPS THE WEIGHED PIECE OF TABLET SNUGLY INTO IT.

7. Open the flask and raise the leveling bulb until the liquid level in the buret is between 0 and 2 mL. Clamp the leveling bulb in this fixed position. Carefully suspend the tablet by a thread until it hangs approximately 2 cm above the surface of the acid in the flask and insert the stopper tightly. The thread should be pinched in place between stopper and neck of the flask.

8. Lower the leveling bulb about 10 cm below its original position.

IF YOUR SYSTEM IS GAS TIGHT, THE LIQUID LEVEL IN THE BURET WILL DROP BUT REMAIN ABOVE THE LEVEL IN THE BULB. IF THE SYSTEM IS NOT GAS TIGHT, CHECK FOR LEAKS AND/OR GET HELP FROM YOUR INSTRUCTOR.

9. Now raise the bulb until the two liquid levels match. The buret reading should be between 1 and 5 mL. **If the level is below the 5 mL mark, your system has a leak. Start again at step 7.** If the buret reading is in the correct range, record it to the nearest 0.1 mL and go on to the final steps. Restore the leveling bulb to its previous position in STEP 7.

10. Tilt the flask so that the acid contacts the suspended piece of antacid tablet. Be sure that the tablet slips out of the loop and drops into the acid. As gas is released, the liquid level in the buret will fall, a downward displacement. Lower the bulb to keep pace with it. This precaution minimizes errors caused by leaks.

11. Swirl the conical flask gently until the liquid level in the buret stabilizes. Bring the level of the fluid in the bulb to the same level as in the buret. When the two levels are the same the pressure of the gas is the same as the atmospheric pressure in the laboratory. Read and record the volume of gas in the buret.

12. FINAL CHECK

Raise the bulb to the position in Step 11. The liquid in the buret should not rise continuously. If it does, the results are not valid.

13. Repeat the experiment using the same "apparatus" fluid but with a clean flask, fresh acid, and another piece of tablet.

WHEN YOU HAVE FINISHED THE EXPERIMENT, FLUSH THE ENTIRE SYSTEM WITH DI WATER, AND RETURN IT TO LAB SERVICES.

Correction Factors

When gases are collected in aqueous systems, water vapor is always present. Thus, the pressure due to water must be subtracted (Dalton's Law) from the total pressure. The vapor pressure of H_2O at various temperatures is listed in the table on Page 6 of this handout.

Bubbling the CO_2 through the "apparatus" fluid that is already saturated with the gas captures most of the CO_2 from the tablet. However, some CO_2 dissolves in the 5.0 mL of acid in the generator flask. Based on this, assume that 4.00 mL of gas dissolves in the acid.

Alka-Seltzer is a product of the Bayer Corporation of Elkhart IN, 46515.

DATA AND ANALYSIS SHEET: GASES

Name: _____

Date _____ Lab Partner _____

Mass of whole tablet: _____

Laboratory Temperature: _____

Standard Atmospheric Pressure: _____

Total Pressure of gases in buret (Barometric Pressure): _____

	Run #1	**Run #2**
Vapor Pressure of H_2O (from Appendix):	_____	_____
Pressure of CO_2 :	_____	_____
Volume of CO_2 collected (add 4.00 mL for correction factor):	_____	_____
Exact mass of tablet used:	_____	_____
Calculations (Show work) Moles of CO_2 collected:	_____	_____
Moles of $NaHCO_3$ reacted:	_____	_____

Name: _____

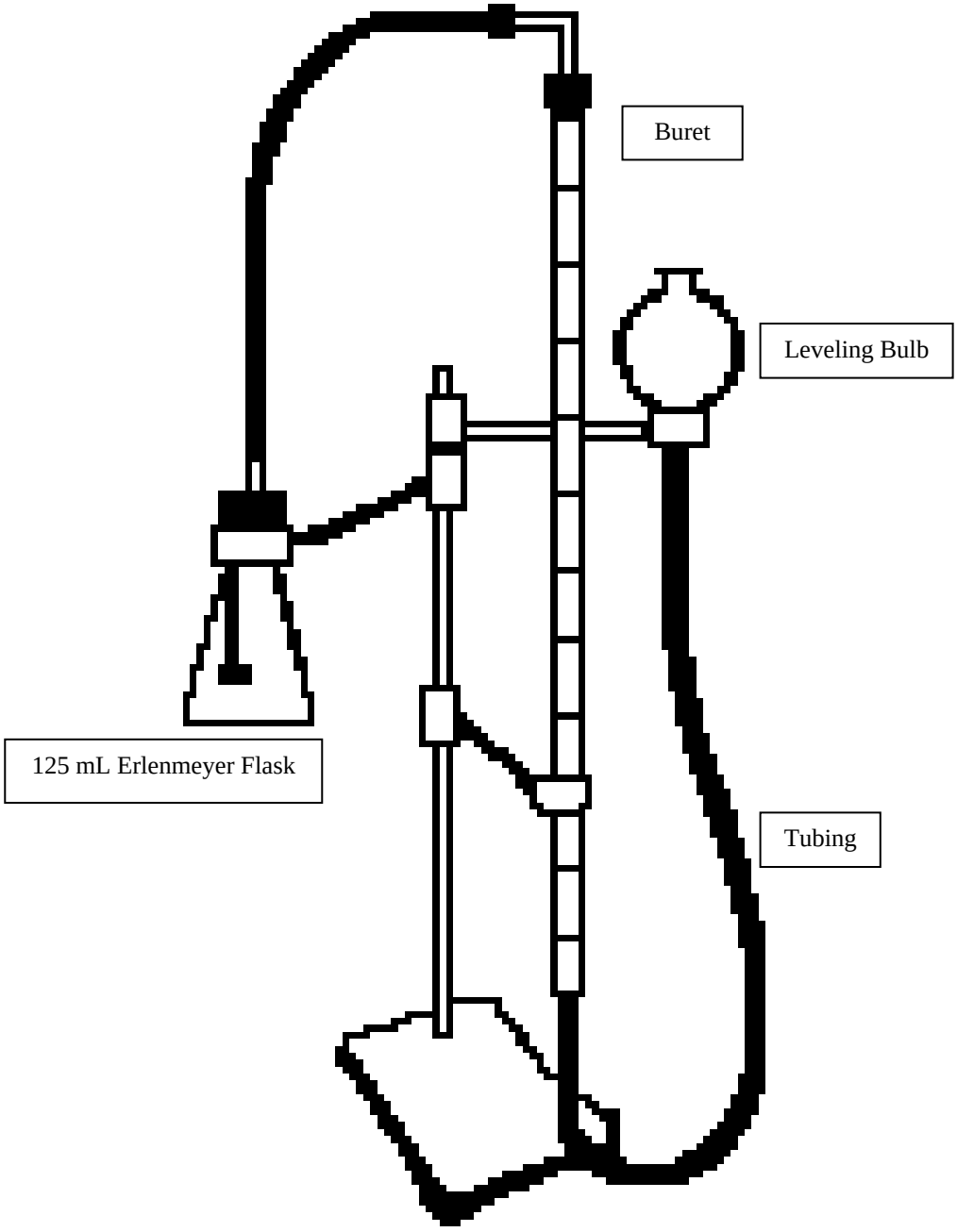
Mass of $NaHCO_3$ reacted: _____ _____

Percentage of tablet sample that is $NaHCO_3$: _____ _____

Percentage of a whole tablet that is $NaHCO_3$: _____ _____

Average percentage of a whole tablet that is $NaHCO_3$. _____

Vapor Pressure of Water	
Temperature (Celsius)	**Pressure (torr)**
0	4.58
5	6.54
10	9.21
12	10.52
14	11.99
16	13.63
17	14.53
18	15.48
19	16.48
20	17.54
21	18.65
22	19.83
23	21.07
24	22.38
25	23.76
26	25.21
27	26.74
28	28.35
29	30.04
30	31.82
35	42.2
40	55.3
45	71.9
50	92.5
55	118.0
60	149.4
65	185.5
70	233.7
80	355.1
90	525.8


Buret
Leveling Bulb
125 mL Erlenmeyer Flask
Tubing