Name _____ Period _____

Lab 8 – Stoichiometry of an Ideal Gas 50 Points

Introduction

In this lab you will be performing a gas producing reaction between sodium bicarbonate [$NaHCO_3(s)$] and acetic acid [$HC_2H_3O_2(aq)$] in an aqueous solution producing CO_2 gas

$$NaHCO_3(s) + HC_2H_3O_2(aq) \rightarrow NaC_2H_3O_2(aq) + CO_2(g) + H_2O(l)$$

By using stoichiometry you will calculate the amount of sodium bicarbonate needed to completely react with 100mL of a 1.00M $HC_2H_3O_2(aq)$ solution (0.100mol $HC_2H_3O_2(aq)$). The product of the lab, carbon dioxide gas, will be collected in a balloon, and measured using a flexible ruler. The volume of a balloon is then calculated with the circumference to find the total volume of $CO_2(g)$.

The experimental volume of $CO_2(g)$ is then compared to the theoretical volume based on stoichiometry to determine the accuracy and precision of the lab.

Procedure

1. Weigh the mass of an empty balloon using the laboratory balance. Add $NaHCO_3(s)$ to the balloon, subtracting the mass of the balloon until you obtain the mass calculated in pre-lab question 1;
2. Measure out 100.0mL of 1.00mol/L $HC_2H_3O_2(aq)$ and add to a 125mL Erlenmeyer flask. Fill the flask to the top with deionized water, and allow the acid and water to mix;
3. Place balloon lip over the lip of the flask while not allowing the sodium bicarbonate to fall into the balloon;
4. Hold the lip of the balloon and allow the acid to flow into the balloon to wash out the sodium bicarbonate. Allow the acid to flow back into the beaker, completely draining the acid from the balloon. Allow the reaction to proceed while holding the balloon;
5. Once the reaction completes, carefully remove the balloon lip from the flask, and tie a knot in the balloon. Measure the circumference of the balloon, and record on data table;
6. Clean out all laboratory glassware and return supplies to the stock table. Carefully put a hole in the balloon, and throw the balloon in the large trash can.

Pre-Lab Calculations

Balanced Reaction: $NaHCO_3(s) + HC_2H_3O_2(aq) \rightarrow NaC_2H_3O_2(aq) + CO_2(g) + H_2O(l)$

Calculate the mol $HC_2H_3O_2$ (*acetic acid, vinegar*)

Starting Values (*Measurements*)	Molarity Equation	Solve for mol $HC_2H_3O_2$	Mol $HC_2H_3O_2$
Molarity = 1.00mol/L	Molarity = mol / L	mol $HC_2H_3O_2$ $1.00\frac{mol}{L} \times 0.125L$	0.125mol mol $HC_2H_3O_2$
$V_{solution}$ = 0.100L (*100mL*)	mol = Molarity · L		

Calculate Mass (*g*) of $NaHCO_3$ to perform reaction

Convert ____mol $HC_2H_3O_2$ to mol $NaHCO_3$	
$0.125\ mol\ HC_2H_3O_2$	$\frac{1\ mol\ NaHCO_3}{1\ mol\ HC_2H_3O_2}$
mol $NaHCO_3$	$0.125\ mol\ NaHCO_3$

Convert _____ mol $NaHCO_3$ to mass $NaHCO_3$ Molar Mass $NaHCO_3$ = 84.01g/mol	
$0.125\ mol\ NaHCO_3$	$\frac{84.01g\ NaHCO_3}{1\ mol\ NaHCO_3}$
mass $NaHCO_3$	$10.50g\ NaHCO_3$

Calculate Mol (*mol*) of $CO_2(g)$ from $HC_2H_3O_2$

Convert ____mol $HC_2H_3O_2$ to mol CO_2	
$0.125\ mol\ HC_2H_3O_2$	$\frac{1\ mol\ CO_2}{1\ mol\ HC_2H_3O_2}$
mol CO_2	$0.125\ mol\ CO_2$

Convert _____ mol CO_2 to mass CO_2 Molar Mass CO_2 = 44.01g/mol	
$0.125\ mol\ CO_2$	$\frac{44.01\ g\ CO_2}{1\ mol\ CO_2}$
mass CO_2	$5.50\ g\ CO_2$

Lab Data Set

Laboratory Measurement	mol $CO_2(g)$ (*Calc Above*)	Pressure Room (P_{room})	Temperature Room (T_{room})	Ideal Gas Constant (R)
	$0.125\ mol$	$1.07\ atm$	$296.2\ K$	$0.0821\ \frac{L\ atm}{mol\ K}$
Laboratory Measurement	Circumference of Balloon (*cm*)	Volume of Flask (*mL*)	Radius of Balloon (*cm, calculated*)	Volume of Balloon (*cm, calculated*)
Experimental Data Value	$61.5\ cm$* exper. data	$125\ mL$	$9.79\ cm$*	$3930.40\ mL$* $3.93\ L$

1 L = 1000 mL

Post-Lab Calculations

Experimental Radius and Volume of Balloon

Radius
Circumference

$r_{balloon} = \frac{c}{2\pi} = \frac{61.5\ cm}{2 \cdot \pi}$*	$V_{balloon} = \frac{4}{3}\pi r^3 = \frac{4}{3} \cdot \pi \cdot (9.79\ cm)^3$*
$r_{balloon} = 9.79\ cm$	$V_{balloon} = 3930.40\ cm^3\ (mL)$

Experimental mol and mass of $CO_2(g)$ $n = \frac{PV}{RT}$ $3.93 = L$

P = ~~1.00~~ 1.07 atm, V = ____L, exp. n = ____mol CO_2, T = ~~298.15K~~ 296.2K	mass CO_2 = ____g CO_2 Molar Mass CO_2 = 44.01g/mol

mol CO_2 =	$\frac{1.07\ atm \cdot 3.93\ L}{0.0821\ \frac{L\ atm}{mol \cdot K} \cdot 296.2\ K}$
mol CO_2 =	$0.17\ mol\ CO_2$

mass CO_2 =	$0.17\ mol\ CO_2 \cdot \frac{44.01\ g\ CO_2}{1\ mol\ CO_2}$
mass CO_2 =	$7.48\ g\ CO_2$