EXPERIMENT 18

Sample Formal Report

The following is a sample formal report of the Chemistry 120 experiment “Measurement of the Gas Constant and Molar Volume of Oxygen.”

The light bulb gives you a basic description of what is expected in each section of the laboratory report.

The exclamation point shows instructor grading notes.

This sample formal report is only mean to be a guide for writing laboratory reports for Chemistry 141. **It is by no means comprehensive.** Your instructor will give you more detailed information about what you are expected to do for each laboratory write-up throughout the semester.

Title Page: This will identify you, who you worked with when appropriate, your class, and when the experiment was completed and turned in.

Gas Constant and Molar Volume Experiment

Grading Rubric		
Lab Grade from Data Sheet		/100
Formal Report		38/50
Title Page	2/2	
Objective	3/5	
Introduction	11/15	
Procedure	2/3	
Results and Calculations	2/5	
Discussion	13/15	
Conclusion	5/5	
Total		/150

Measurement of the Gas Constant and the Molar Volume of Oxygen

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Chemistry 120

Section 6653

Instructor: D. Vance

April 28, 2010, experiment completed

May 12, 2010 report turned in

Objective:

Why are you doing this experiment?

The purpose of this is experiment is to determine the value of the universal gas constant, R, and the molar volume, V_m, of a gas through experimentation.

Be more specific than, "through experimentation." for example, "through the decomposition of potassium chlorate."

After the experimental value has been calculated, the percent error will be determined from the universal gas constant, R.

What about the percent error of the molar volume?

The percentage of potassium chlorate, absent the manganese dioxide catalyst, will also be determined.

Introduction:

This section tells a little bit about the theory of the experiment and how it will be done.

This experiment is working with the ideal gas law, which is a summation of Boyle's Law, where pressure is inversely proportional to volume, Charles's Law, where the volume is directly proportional to temperature and Avogadros' Law, where volume is directly proportional to moles.

Show the equations for Boyle's ($P\ \alpha\ V$), Charles' ($P\ \alpha\ T(K)$) and Avogadro's law ($V\ \alpha\ n$).

The ideal gas law is

$PV = nRT$ eq. 1

⚠ *Use an equation editor for equations.*

where P= the pressure of the gas, in atmospheres, V= the volume of the gas, in liters, n= the moles of the gas, T= the temperature of the gas, in Kelvin, and R = the gas constant. The standard accepted value of R is 0.08206 $\frac{L\ atm}{mol\ K}$.

In order to calculate the number of moles, n is replaced with mass (m) divided by molecular mass (M), because moles are not easily measurable directly. Replacing m/M for n produces the equation:

$PV= \frac{mRT}{M}$ eq. 2

To find the experimental value of R, rearrange eq. 2 to solve for R:

$R= \frac{PVM}{mT}$ eq. 3

Using the ideal gas law, the molar volume can also be found:

$V_m= \frac{V}{n} = \frac{RT}{P}$ eq. 4

The standard accepted value of $V_m= \frac{22.414\ L}{mol}$.

⚠ *How will this experiment apply the kinetic molecular theory of gases?*

To experimentally determine these values, potassium chlorate is decomposed in the presence of the catalyst manganese dioxide. The chemical reaction for the decomposition of the potassium chlorate is:

$2\ KClO_{3\ (s)} \xrightarrow{MnO2} 2\ KCl_{\ (s)} + 3\ O_{2\ (g)}$ rxn. 1

> ⚠ It may be better to use an equation editor here so that all of the subscripts are shown properly.
>
> $2\ KClO_{3\ (s)} \xrightarrow{MnO_2} 2\ KCl_{(s)} + \ 3\ O_{2\,(g)}$ rxn 1

A recovery system is set up to capture the oxygen gas produced by the reaction.

> ⚠ Logic of experiment? After the oxygen gas is captured how is that information used in the experiment?
>
> What about Dalton's Law of partial pressures to determine the pressure of the dry oxygen gas?
>
> $P_{total} = P_{oxygen} + P_{water}$ eq. ?
>
> The value for P_{oxygen} will be plugged into eq. 3 to determine the value of R.

To find the percent error, once an experimental value for R is found the percent error equation will be used:

$$\frac{\text{experimental value of R- accepted value of R}}{\text{Accepted value of R}} * 100(\%) = \text{percent error} \qquad \text{eq. 5}$$

> ⚠ The bottom "Accepted value of R" the A should be lower case "accepted value of R".

The percent of potassium chlorate will also be determined using molar mass and molar ratios.

> Equation for percentage of potassium chlorate in sample?
>
> $$\% \, KClO_3 = \frac{m_{KClO_3}}{m_{mixture}} \times 100 \qquad \text{eq.?}$$
>
> How do you find the mass of potassium chlorate?

Procedure:

> *Reference the procedure used and note any deviations from the published procedure. Your reference will be slightly different from the one shown, but follow a similar format. Your instructor will give you more information.*

The procedure was followed from the handout:

– Dirbas, J., Holleran, J., Willard, C. (2007). Experiment 9: Chemistry 120: Measurement of the Gas Constant and the Molar Volume of Oxygen. In Che*mistry 120 Laboratory Manual* (pp. 9.1-9.9). Grossmont College, El Cajon, California.

No changes were made from the handout. Standard laboratory safety precautions, such as wearing safety goggles and working in fume hoods were observed. Waste was disposed of properly according to instructor's directions, water was disposed of down the sink, solid waste was diluted and also poured down the sink.

> It is not necessary to talk about safety precautions and waste disposal here because you already did that in your running log in your laboratory notebook.

Results and Calculation:

Tabulate data and any calculated values. Show sample calculations (typed or handwritten). For non-numerical labs, summarize the data generated.

Results Table 1

	Experimental Value	Literature Value	Percentage Error
Ideal Gas Constant, R ($\frac{L\ atm}{mol\ K}$)	.08315 $\frac{L\ atm}{mol\ K}$	0.08206 $\frac{L\ atm}{mol\ K}$	1.27%
Molar Volume, V_m ($\frac{L}{mol}$)	22.7 $\frac{L}{mol}$	22.414 $\frac{L}{mol}$	1.28%
Percentage $KClO_3$	92.4%	99%	n/a

Results Calculations:

(eq.3) Ideal Gas Constant, R

$$R = \frac{0.638\ L\ O_2 * 0.96194\ atm}{0.02490\ mol\ O_2 * 296.0\ K} = 0.08315\ \frac{L\ atm}{mol\ K}$$

Remember to watch your significant figures! R should only have 3 significant figures based on the volume.

Watch your math! The calculated R value should be 0.0833 $\frac{L\ atm}{mol\ K}$.

(eq.4) Molar Volume, V_m ($\frac{L}{mol}$)

$$V_m = \frac{0.08315\ \frac{L\ atm}{mol\ K} * 273\ K}{1.00\ atm} = 22.7\ L/mol$$

At Standard Temperature and Pressure T = 0 °C or 273.15 K and P = 1 atm, so these values should not limit your significant figures to 3. But, your R would.

(eq.5) Percent Error:

$$\frac{22.7 - 22.414}{22.414} * 100 = 1.28\%$$

Remember to watch your units and significant figures! The percent error calculation for molar volume is missing the units of L/mol on each molar volume and should only have one significant figure or 1%.

Additional data appears in attached spread sheet and data sheet.

What page?

Discussion:

This is where you get to explain your major results.

The value of R was found to be 0.08315 $\frac{L\ atm}{mol\ K}$ which is within 1.27% of the accepted constant of R of 0.0821 $\frac{L\ atm}{mol\ K}$. The molar volume was similarly close, 22.7 $\frac{L}{mol}$, within 1.28% of the accepted constant of 22.4 $\frac{L}{mol}$. Both the calculated value of R and the molar volume were slightly higher than the accepted constant which points to a possible lack of equalization of the system either before the experiment was started or when the reaction was completed. Also, the percentage of potassium chlorate that was calculated experimentally was only 92.4% when it should have been 99%, which points to a possible lack of complete reaction of all of the potassium chlorate due to incomplete heating. This incomplete reaction would lead to a lower mass of oxygen gas being produced which in turn would lead to a higher value of R. The value of R was then used to calculate the molar volume, using standard temperature and pressure, so the molar volume is directly tied to the value of R.

> What did the sample look like before, during and after the decomposition reaction was completed?

Conclusion:

> *This is where you give the final major results. It should be a mirror of your objective, but contain numerical results if they were generated.*

The value of the universal gas law constant, R, was found to be 0.08315 $\frac{L\ atm}{mol\ K}$ with a percentage error of 1.27 percent. The molar volume of a gas was found to be 22.7 $\frac{L}{mol}$ with a percentage error of 1.28 percent. The percentage of potassium chlorate used was determined to be 92.4 percent.

> Good.