Chem115 Fall 2023 - Ilana Berlin/Lab12: Gas Laws: The Atomic Weight of a Metal/LabReport12

Jason Cody - Nov 27, 2023, 10:37 AM CST

Assignment #24 - LabReport12

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Description	Gas Laws
I worked in a group with	
The work for this assignment is in	My notebook

Grade **9 / 10**

Graded on Nov 27, 2023, 10:37 AM CST

Jason Cody - Oct 01, 2021, 10:38 AM CDT

ReportTemplate.docx (15.5 kB)

Jason Cody - Nov 04, 2020, 1:22 PM CST

Date and Title

Ilana Berlin - Nov 20, 2023, 12:00 PM CST

Determining Atomic Weight of Metal Using Gas Laws.

Jason Cody - Nov 04, 2020, 1:22 PM CST

Purpose

Jason Cody - Nov 27, 2023, 10:24 AM CST

A metal (magnesium or zinc) will react with hydrochloric acid to form metal (II) chloride and hydrogen gas ($M(s) + 2HCl(aq) \rightarrow MCl_2(aq) + H_2(g)$) By determine the pressure of the H_2 produced, gas laws, and the original weight of the metal (g) we can determine the molecular weight of the metal. The calculated molecular weight will be compared to the molecular weight from the periodic table to determine percent error. Precision will also be evaluated (CV).

Jason Cody - Nov 04, 2020, 1:22 PM CST

Reference

Ilana Berlin - Nov 20, 2023, 12:20 PM CST

Kateley, L. J., *Introduction to Chemistry in the Laboratory, 20th Ed.*, Lake Forest College, **2021**, Experiment 12 Appendix B,H.

Jason Cody - Nov 04, 2020, 1:22 PM CST

Data and Observations

Jason Cody - Nov 27, 2023, 10:33 AM CST

Factor	Trial One	Trial Two
Weight of Mg (g)	0.0300	0.0369
Temp of H_2 (°C)	23.0	23.0
Temp of H_2 (°K)	296.0	296.0
Volume of H_2 (mL)	36.71	45.25
Volume of H_2 (L)	0.03971	0.04525
Pressure of barometer (mmHg/torr)	749.5	749.5
Correction for Hg expansion (mmHg/torr)	2.69	2.69
atmospheric pressure (mmHg/torr)	746.8	746.8
Height of water in buret (mmH_2O)	191.5	186.8
Height of water in buret (mmHg/torr)	14.1	13.7
Pressure of gasses in buret (mmHg/torr)	732.7	733.1
vapor pressure of water at room temp (mmHg/torr)	19.8	19.8
Pressure of H_2 in buret (mmHg/torr)	712.9	713.3
Pressure of H_2 in buret (atm)	0.938	0.939
Moles of H_2(mol)	1.42×10^{-3}	1.75×10^{-3}
Calculated MW of metal (g/mol)	21.1	21.1

MW of metal from periodic table (g/mol)	24.3	24.3

Figure 1 Data for determining molecular weight. Very consistent, but quite low!

Two pieces of Mg ribbon were cleaned with emery paper to get rid of dirt and increase surface area of the metal. The ribbons were shiny gray thin sheets of metal. The ribbons were weighed on analytical balances. They weighed 0.300g and 0.0369g. The Mg ribbons were rapped in 20cm of a #22 copper wire leaving a tail of about 8cm. The copper wire is used to help prevent the Mg from escaping the buret.

Approximately 5mL of a 12M HCl solution was added to a 50mL Kinmax buret. The rest of the buret was filled with room temperature deionized water. The tail of the copper wire cage was threaded through the buret cap. The cap of the buret was insterted and the buret was inverted to allow the dense HCl solution to sink towards the Mg. The top of the buret was places in a tub of room temperature tap water that was 24.8°C. The Mg reacted with the HCl and started releasing H_2 gas to the top of the buret. While the first buret reacted the second was set up using the same conditions. By the end of the reaction the tub of water had dropped to 23.0°C. ? curious--the dilution of the acid is exothermic, so I'd expect it to warm, not cool.

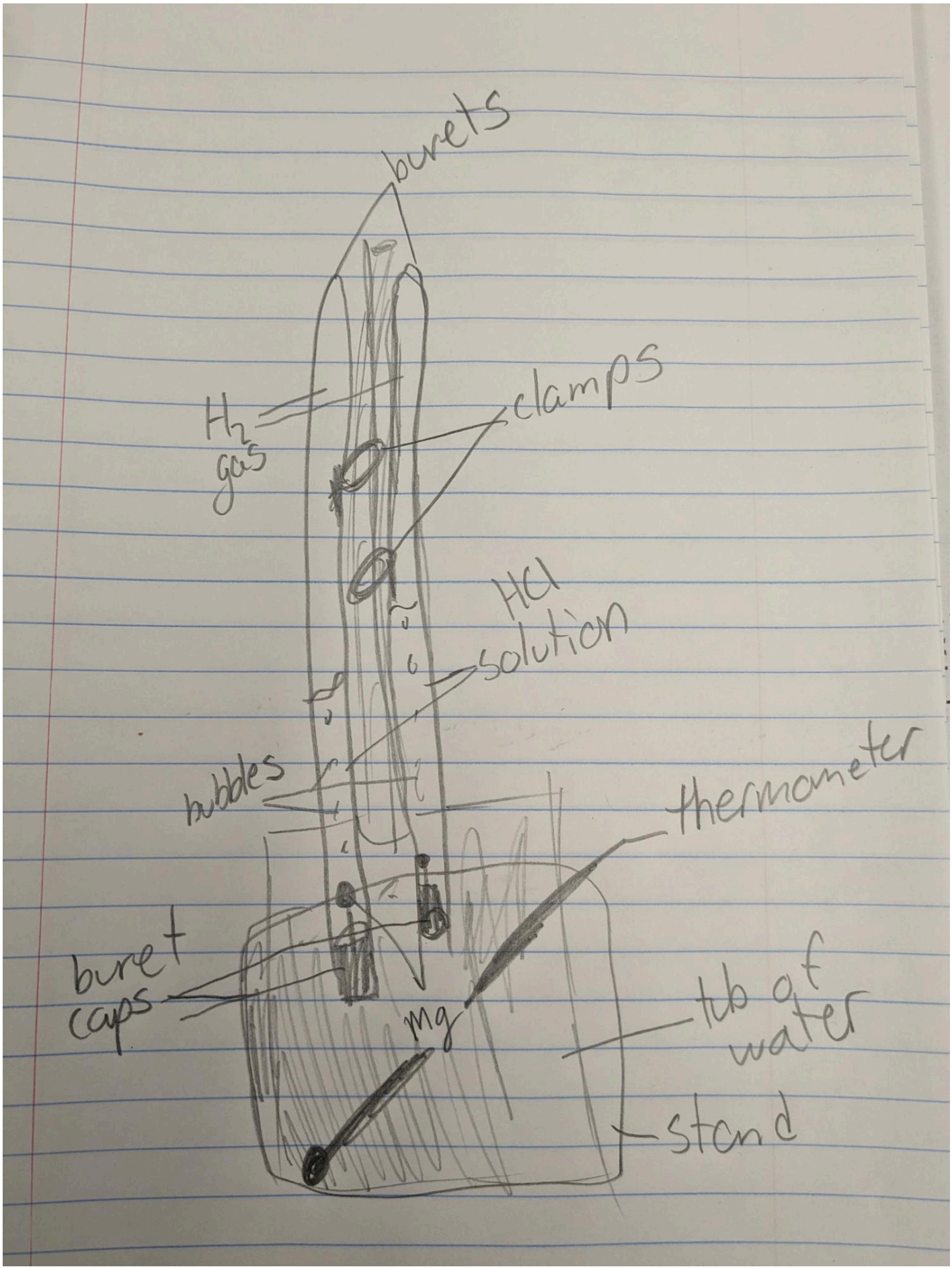

Figure 2 Set-up of burets.

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Calculations

Jason Cody - Nov 27, 2023, 10:34 AM CST

Very clear and I get the same MW as you with your inputs.

23.0°C+273.0=296°K

749.5-2.69=746.8mmHg

Trial One

PV=nRT

(0.938atm)(0.0367L)=n(0.0821atm·L/mol·°K)(296°K)

0.0344=24.30n

n=.00142mol= $1.42x10^{-3}$mol

0.0300g/$1.42x10^{-3}$mol =21.1g/mol

|24.3-21.2|/24.3x100= 13.2%

Trial Two

PV=nRT

(0.939atm)(0.0452L)=n(0.0821atm·L/mol·°K)(296°K)

0.0424=24.30n

n=0.00175mol=$1.75x10^{-3}$

0.0369g/$1.75x10^{-3}$mol=21.1g/mol

|24.3-21.2|/24.3x100=13.2%

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Conclusions

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This reaction was a single replacement redox reaction with HCl as the oxidizing agent and Mg as the reducing agent. Using the class data set of calculated molar masses with two trials each from TH, AN, BS, EM, MD, and myself (24.2, 24.4, 25.1, 24.4, 23.0, 27.9, 24.9, 24.6, 24.7, 24.6, 21.1, 21.1) we get a mean MW of 24.1g/mol, a median of 24.6g/mol, and a range of 27.9-21.1g/mol. We also get a σ_{n-1} of 1.82 and a CV of 7.55%. OK. Thanks for sharing your data here!

Using the periodic table MW as an actual values I get a percent error of 13.2% for both trials. OK Using the mean molecular weight we get a percent error of 0.82%. OK, yes, the mean should always end up closer to the true value (if the error is random) My trials were on the low range of the class range at 21.1g/mol. My trials were outside of the standard deviation of the group since they were below 22.3g/mol. My trials were lower than the group median of 24.6 g/mol and the mean on 24.1g/mol. The closest MW to mine was BS's 23.0g/mol. OK, but you could use numbers to support your argument here (13.2% > 7.55%)

All measurements were possible sources of error. The temperature of the H_2 was the most doubtful since it was measured indirectly through the water escaping the buret. OK Volume height? of water was also doubtful since it was measured by holding a ruler up to the buret. It is also possible that small amounts of Mg escaped the reaction despite the wire cage. The volume of the H_2 gas is the most reliable since it was measured using the buret. OK, mass on the analytical balance? The mmHg of the atmosphere was also accurate because it was actually measured in mmHg. OK