Instructions for a Formal Written Lab Report

- The written lab report will count as two weekly assignments. This means it has twice the weight of an ELR or other assignment.
- The laboratory report is written based upon the findings recorded in your lab notebook.
- The written laboratory report is due one week from the lab session at the BEGINNING of the following lab session.
- **All pre and post laboratory questions are due as part of the written report**.
- A penalty of 10% off the report grade will be assessed for each day the report is late.
- **The report must be typed and stapled.**
- YOUR NAME AND THE EXPERIMENT NAME SHOULD BE ON EVERY PAGE OF THE REPORT!
- Do not use first person.
- The report should be in past tense, as you are reporting what has already been done.
- **You must cite any sources of information used to prepare your report including the lab manual and specific handouts in the course pack.**

REPORT FORMAT

The following guidelines and the sample lab report seen on the web should be consulted before writing your report.

1. **Introduction:** Give a brief discussion of the purpose of the experiment. For example, “The purpose of this experiment was to determine the atomic mass of zinc using an electrochemical method.” Discuss the principle and theory as the basis for the experiment. Briefly describe the chemical reactions and physical changes that took place in the experiment. State the key mathematical and chemical equations used to analyze the experimental data and calculate results that you report.
2. **Procedure**: Provide a brief summary of the procedure you followed to acquire the data. References can be made to the laboratory manual. If significant modifications were made from the originally published manual procedure, indicate the changes.
3. **Tabulated Experimental Data:** Your laboratory data must be presented in a neat tabular form with each column clearly labeled. You should maintain significant figures throughout the report and assign correct units to all tables of data.
4. **Sample Calculations:** One complete set of representative calculations using your data necessary to arrive at your final result must be included.
5. **Tabulated Results of Calculations:** This section must show the results of your calculations in table form. These results may be included with Part 3, but a clear table of experimental results must appear as part of the report.
6. **Discussion of Results:** Interpret your results in terms of the stated purpose. Explain in your own words whether or not your experimental results verified the theory or principle discussed in your introduction section. Explain why the results do or do not match the theory, principle or law. You should make comparison to known values when available. Any references or handbooks used for obtaining known values should be properly cited.
7. **Conclusions:** Give a brief statement in your own words to summarize the experiment. If the results were unexpected, cite possible sources of error. The

conclusion should be scientific and practical, not a personal reaction to the lab. You should restate your results.

8. **Pre-Lab and Post-Lab Questions:** show all of your work for all questions.

Sample Lab Report for CHEM 1211 & 1212

Refer to Experiment # 12 in Hunt & Block, second edition

The first page is the cover page for the report.

Title:
Experiment #12 Determination of the Atomic Mass of Zinc
(p 117, Hunt and Block)

YOUR NAME:____

YOUR EQUIPMENT BOX NUMBER:____________________________

PARTNER(S) NAME:______________________________________

DATE PERFORMED:______________________________________

DATE DUE:____

DATE SUBMITTED:_______________________________________

I. Introduction:

The purpose of this experiment was to determine the atomic mass of zinc. Zinc metal was oxidized to zinc ions with an electric current. See Figure 12.1 in Hunt and Block, second edition. When an electric potential is applied from the power supply through the electrochemical cell, zinc metal is oxidized at the anode forming Zn^{+2} ions. Simultaneously, hydrogen ions are reduced at the cathode to generate hydrogen gas. The overall reaction is:

$Zn(s) + 2\ HC_2H_3O_2(aq) \rightarrow H_2(g) + Zn_2+(aq) + 2\ C_2H_3O^-(aq)$ (1)

The hydrogen gas was collected and measured in a eudiometer tube. The mass of zinc converted to Zn^{2+} ions was found by weighing a small piece of zinc before and after the electrolysis. From the balanced equation above, one can we see that the number of moles of zinc oxidized is equal to the number of moles of hydrogen collected. From the volume of hydrogen gas one can find the moles of hydrogen gas collected. Dalton's Law of Partial Pressures, equation (2), and the Ideal Gas Law, equation (3) can be used to calculate the moles of gas:

$P_{total} = P_{H2} + P_{water} + P_h = P_{atm}$ (2)

$PV = nRT$ (3)

where, P_{H2} and P_{water} are vapor pressures of the hydrogen gas and water vapor inside the eudiometer tube, and P_h is the pressure due to the water column in the tube. A sum of the three pressures inside the tube, P_{total}, must be equal to the atmospheric pressure. Then the moles of H2 collected is calculated using equation (4) below:

$n(H_2) = P_{H2}\ V_{H2}/(RT) = (P_{atm} – P_{water} - P_h)\ V/(RT)$ (4)

The mass of zinc metal oxidized divided by the number of moles of H_2 at STP is equal to the atomic mass of zinc. Thus the atomic mass of zinc can be found using the following equations (5):

Atomic mass (Zn) = mass (Zn oxidized)/moles (Zn oxidized) or,

Atomic mass (Zn) = mass (Zn oxidized)/$n(H_2)$. (5)

II. Procedure:

Directions given in the laboratory manual (p 118-119) were followed. The mass of zinc was recorded to four decimal places and the volume of H_2 gas was measured to 2 decimal places (4 significant figures). This is done to maximize the number of significant figures in the data.

III. Tabulated Experimental Data:

Mass of zinc at start	0.5175 g
Mass of zinc after reaction	0.4462 g
Mass of zinc reacted	0.0713 g

Volume of hydrogen collected	29.10 mL
h 246 mm H_2O	(1.80 Torr)
Room temperature 22.0 ºC	(295.1 K)
Vapor pressure of water	19.8 Torr
Barometric pressure	740.0 Torr
Partial pressure of dry hydrogen	718.4 Torr
Moles of hydrogen collected	1.136 x 10-^{3}
Moles of zinc reacted	1.136×10^{-3}

IV. Sample Calculations:

YOU MUST SHOW ACTUAL DATA IN THE CALCULATIONS NOT JUST FORMULAS !

NOTE: YOU MAY HAND-WRITE ONLY THE EQUATIONS IN THIS SECTION

The mass of zinc lost was 0.0713 g. The volume of hydrogen collected over water was 29.10 mL. The pressure of hydrogen in the eudiometer tube is found from Dalton's Law of Partial Pressure.

$P_{total} = P_{H2} + P_{water} + P_h = P_{atm}$

Solve for the pressure of hydrogen gas:

$P_{H2} = P_{atm} - P_{water}$ - Ph

P_{atm} = 740.0 Torr (Barometric pressure)

Pwater = the vapor pressure of water at 22.0C (19.8 Torr)

h = 246 mm water, converting to cm of water 246mm x 1cm/10mm = 24.6 cm.
To convert cm of water to cm of Hg or, Ph in Torr, 246 mm water x 1 cm Hg/13.6 mm water = 1.80 Torr.

$P_{H2} = P_{atm} - P_{water}$ - Ph

= 740.0 - 19.8 - 1.8 Torr = 718.4 Torr
The Ideal Gas Law was used to solve for the number of moles of hydrogen.

n = PV/RT

The units of the gas constant, R, and the experimental data must be consistent. If one uses R=0.08206(L-atm)/(mol-K), then the pressure in Torr, (mm Hg), must be converted to atmospheres.

Thus, P = 718.4 Torr/(760Torr/atm) = 0.9452 atm.

Converting the mL of gas to liters we have, (29.10 mL) (1 L/1000mL) = 0.02910 L.

The moles of H_2 can now be calculated from the Ideal Gas Law,

n(H2) = (.09452 atm) (0.02910 L)/(0.08206L-atm/mol-K)(295.13K) = 1.136×10^{-3} mol H_2.

The atomic mass of zinc = mass (Zn oxidized)/n(H2).

Atomic mass (Zn) = 0.0713 g/1.136×10^{-3} mol = 62.8g/mol.

Calculation of Errors:

The known value for the atomic mass of zinc is 65.37 g/mol. The experimental value was 62.8g/mol. The absolute error is the difference between the known value and the measured value;

65.4g/mol - 62.8g/mol = 2.6g/mol.

The relative percent error is:

(Known - Experimental)/(Known) x 100% =

(65.4 - 62.8)/(65.4) x 100% = 4.0% error.

V. Tabulated Results of Calculations:

Partial pressure of H_2O	702.1 Torr
Moles of H_2 collected	1.136x 10_{-3} mol
Moles of zinc reduced.	1.136 x 10^{-3} mol
Atomic mass of zinc (from experimental data)	62.8g/mol
Atomic mass of zinc (from periodic table)	65.4g/mol (rounded from 65.37)
Absolute error	2.6 g/mol
Relative error	4.0%

VI. Discussion of Results and Conclusion:

During the experiment, the process of electrolysis generated hydrogen gas. By collecting the gas and applying the Ideal Gas Law, the number of moles of hydrogen for this sample was calculated to be 1.136 X 10^{-3}. The stoichiometry of the chemical equation indicates that this is same value for the number of moles of Zn reduced. The atomic mass of zinc was determined to be 62.8 g/mol. This experimental value can be compared to 65.4 g/mol, the value from the periodic table. There relative error in this experiment was 4.0%. The most significant source of error is in measuring the volume of hydrogen gas. If the accuracy of a eudiometer tube is ±0.2 mL, for this experiment the uncertainty is: (0.2/29.10)*100% = 0.67%

Other sources of error include the following:

The uncertainty in the mass of zinc, (±0.0003/0.0713)*100% = 0.42%.

The uncertainty in the temperature, (±0.5K/303.2K)*100% = 0.16%.

The uncertainty in the barometric pressure, (±1Torr/740Torr)*100% = 0.14%.

The uncertainty in h, (±2mm water/(13.6*740mm)*100% = 0.02%.

The approximate uncertainty in the water vapor pressure is, ±2/740*100% = 0.27%.

The sum of the random errors is: 0.67%+0.42%+0.17%+0.14%+0.02%+0.27% = 1.68%.

A more rigorous estimation of the random experimental error is equal to the sum of the square root of the experimental errors squared. That is:

[(0.67%)2+(0.42%)2+(0.17%)2+(0.14%)2+(0.02%)2+(0.27%)2]½ = 0.87%.

Seventy seven percent of the estimated experimental error, (0.67/0.87/100% =77%), comes from the uncertainty in measuring the volume of hydrogen. This validates the statement that the major contributing factor to the experimental error is in the measurement of the volume of H_2 gas.

The actual relative error is 2.4 (4.0%/1.69% = 2.4) times greater than the estimated experimental error. It should be said that many of the experimental uncertainties used to calculate the overall experimental error actually are not known exactly. It is possible that the actual experimental errors are larger than those used in our estimated. If that is true, the value for the atomic mass of zinc could be within the range of experimental error for this experiment. It might be that the experimenter did not use the apparatus to the limits of accuracy.

VII. Conclusion

This experiment found the atomic mass of zinc to be 62.8g/mol. This is a 4.0% experimental error. This electrochemical method of determining atomic weight of a metallic element should be very reliable because the estimated error is only 0.87%. Refined technique and apparatus might result in a smaller experimental error.

Spelling, grammar, and writing style are important. Proof read the laboratory report and use the spelling checker in your word processor program!

PRE-LAB AND POST-LAB QUESTIONS ARE DUE WITH YOUR LAB REPORT

(Original by Dale Manos, 1995; Converted to an HTML file by M. H. Kim, 11/11/97)