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Demonstrator's Name: Tom Burns

PLEASE NOTE: If ANY of the above information is UNCLEAR or not provided, your grade will NOT be recorded!!

Lab Day (T/W/Th/F): Friday, September 16th

Lab Week (even/odd): odd

Lab time (10:00, 2:30, 6:30): 2:30

Laboratory Report Form

Experiment 1.

Determination of the Composition of an Alloy

Checklist:

- **Raw Data Sheet written in pen, signed by TA and attached**
- **Report Form typed and attached**

Student's Initials __C.N.P.____

Data Tables

Table 1. Pure Metal

Data	Trial 1	Trial 2
Identity of Metal	Zinc	Zinc
Mass of metal (g)	42.3 mg	48.1 mg
Uncalibrated volume of eudiometer (mL)	n/a	n/a
Volume of hydrogen gas (mL)	16.8 mL	20.4 mL
Height of water column (cm)	30.7 cm	27.1 cm
Density of water (kg/m^3)	1000 (kg/m^3)	1000 (kg/m^3)
Acceleration due to gravity (m/s^2)	n/a	n/a
Pressure of water column (Pa)	3000 Pa	2660Pa
Water Temperature (°C)	23.9 °C	23.9 °C
Water Vapour pressure (Pa)		
Atmospheric Pressure (Torr)	760 Torr	760 Torr
Pressure of Hydrogen	95000 Pa	95700 Pa
Room Temperature	22.4 °C	22.4 °C
Ideal Gas Constant, R	8.314 J / mol	8.314 J / mol
Actual Moles of Hydrogen (mol)	7.0 x 10^-4 mol	8.59 x 10^-4 mol
Theoretical moles of Hydrogen (mol)	3.8 x 10^-4	3.12 x 10^-4
Percent Yield (%)	108%	274%

Observations (Part 1):

Table 2. Alloy

Data	Trial 1	Trial 2
Unknown Number		
Mass of alloy (g)	42.2 mg	44.8 mg
Uncalibrated volume of eudiometer (mL)	n/a	n/a
Volume of hydrogen gas (mL)	25.4 mL	27.5 mL
Height of water column (cm)	25.6 cm	23.5 cm
Density of water (kg/m^3)		
Acceleration due to gravity (m/s^2)	9.8 (m/s^2)	9.8 (m/s^2)
Pressure of water column (Pa)	2510 Pa	2303 Pa
Water Temperature (°C)	23.8 °C	18.3 °C
Water Vapour pressure (kPa)	101. 3 kPa	101.3kPa
Atmospheric Pressure (Torr)	760 Torr	760 Torr
Pressure of Hydrogen	95810 Pa	96107 Pa
Room Temperature	22.4 °C	22.4 °C
Ideal Gas Constant, R	8.314 J / mol	8.314 J / mol
Moles of Hydrogen (mol)	1.0844 x 10^-3 mol	9.985 x 10^-4
Mass of Zinc (g)	0.04087 g	0.00432 g
Mass of Aluminum (g)	0.00133 g	0.0405 g
Percent Zinc (%)	3.15 %	9.6 %
Percent Aluminum (%)	96.85%	90.4%
Average Percent	%Zn = 6.4% %Al = 93.6%	%Zn = 6.4% %Al = 93.6%

Observations (Part 2):

Sample Calculation : Pure Metal

1. Uncalibrated Volume of the Eudiometer:

   n/a. Both eudiometers were calibrated.

2. Volume of Hydrogen gas:

   Trial 1: 16.8mL = 0.0168 L

   Trial 2: 20.4mL = 0.0204 L

3. Pressure exerted by the water column:

   P trial 1 = dgh
   = (1000Kg/m^3) (9.8m/s^2) (0.307m)
   = (3008.6 Kg/m s^2) (1Kpa/1000N/m^2)
   = 3.0 Kpa

   P trial 2 = dgh
   = (1000Kg/m^3) (9.8m/s^2) (0.271 m)
   = (2655.8Kg/m s^2) (1Kpa/1000N/m^2)
   = 2.66 Kpa

4. Pressure of hydrogen gas:

   P Hydrogen, 1 = P atm – P water column – P water vapor
   = 101.3 Kpa – 3.0 Kpa – 2.98 Kpa
   = 95 Kpa

   P Hydrogen, 2 = P atm – P water column – P water vapor
   = 101.3 Kpa – 2.66 Kpa – 2.98 Kpa
   = 95.66 = 95.7 Kpa

5. Moles of hydrogen gas (experimental):

Trial 1: n = PV/RT

= (95 Kpa) (0.0168 L) / (8.314 J/mol K) (273.15 K)

= 7.0 x 10^-4

Trial 2: n = PV/RT

= (95.7 Kpa) (0.0204 L) / (8.314 J/mol K) (273.15 K)

= 8.59 x 10 ^-4

6. Moles of hydrogen gas (theoretical)

Trial 1:

Zn (s) + 2HCl(aq) → ZnCl2 – (aq) + H2 (g) ^

0.0254 g Zn X 1mol/65.38g X 1mol/1mol

= 3.8 x 10^-4

Trial 2:

Zn (s) + 2HCl(aq) → ZnCl2 – (aq) + H2 (g) ^

0.0204 g Zn X 1mol/65.3800g X 1mol/1mol

= 3.12 x 10^-4

7. Percentage Purity of metal (percentage yield of hydrogen):

Trial 1:

% yield: (7.0 x 10^-4 / 6.47 x 10^-4) x 100% = 108%

Trial 2:

% yield: (8.54 x 10^-4 / 3.12 x 10^-4) x 100% =273.7% = 274%

8. Average Percent Purity:

%Zn = (108% + 274%) / 2 = 191%

Sample Calculation: Alloy

1. Pressure of water column and hydrogen gas:

   Trial 1:

   $P = dgh$
   $= (1000 Kg/m^3)(9.8\ m/s^2)(0.256m)$
   $= 2508.8\ Pa \times 1Kpa/1000\ N/m^2$
   $= 2.51\ Kpa$

   $P_{H2} = P_{atm} - P_{H2O\ v} - P_{H2O,\ l}$
   $= 101.3\ Kpa - 2.98\ Kpa - 2.51\ Kpa$
   $= 95.81\ Kpa$

   Trial 2:

   $P = dgh$
   $= (1000 Kg/m^3)(9.8\ m/s^2)(0.235m)$
   $= 2303\ Pa \times 1Kpa/1000\ N/m^2$
   $= 2.303\ Kpa$

   $P_{H2} = P_{atm} - P_{H2O\ v} - P_{H2O,\ l}$
   $= 101.3\ Kpa - 2.98\ Kpa - 2.303\ Kpa$
   $= 96.107\ Kpa$

2. Moles of hydrogen gas:

   Trial 1:
   $n = PV/RT$
   $= (95.81\ Kpa)\ (0.0275L) / (8.314\ J/mol\ K)\ (293.15\ K)$
   $= 1.0844 \times 10^{-3}$

   Trial 2:
   $n = PV/RT$
   $= (96.107\ Kpa)\ (0.0254L) / (8.314\ J/mol\ K)\ (293.15\ K)$
   $= 9.985 \times 10^{-4}$

3. Masses of Zinc and Aluminum in the alloy:

nH_2 = (mAll / MM Zn) – (m Al/ MM Zn + 3/2 mAl/MM Al)

7.0 x 10 ^-4mol = (0.0422g / 65.39 g/mol) – (m Al / 65.39g/mol) + (3/2) (m Al / 26.98 g/mol)

7.0 x 10 ^-4mol - 0.000645 mol = – (m Al/ 65.39 g/mol) + (3mAl / 53.96 g/mol)

5.5 x 10^-5mol = – (m Al/ 65.39 g/mol) (53.96 g/mol) + (3mAl / 53.96 g/mol) (65.39 g/mol)

5.5 x 10^-5 mol = - 53.96 mAl + 196.17 mAl / 3528.4444 g/mol

(5.5 x 10^-5mol) (3528.4444g/mol) = -(53.96g) (mAl) + (196.17g)(mAl)

0.19 g = 142.21g mAl

0.19g / 142.21g = mAl

1.33 x 10^-3 g = mAl

mZn = mAll – mAl

= 0.0422g – 0.00133

= 0.04087 g

4. Percent composition of the alloy:

%Al = (0.0405g / 0.0448g) x 100%
= 90.4 %

%Zn = 100 – 90.4
= 9.6%

5. Average Percent composition of the alloy (average of zinc values and average of aluminum values):

% Zn = (9.6 % + 3.15%) / 2
= 6.4%

% Al = (96.85% + 90.4%) / 2
= 93.6%

Discussion:

1. Having a calibrated eudiometer is a very important part of the laboratory. In order to have the correct results, it is necessary to have reliable equipment. In this case, if the eudiometer is not calibrated, the final volume of gas measured will not be accurate.

2. The reason why the mass of the metal should be measured is because it is necessary to ensure that the metal is the limiting reactant. By doing this, we will be ensuring that the metal will be fully dissolved as there will be an excess of HCl and not of the metal.

3. If an air bubble is produced multiple problems could be seen. First, it will take space in the eudiometer which will lead to the wrong result. This is because the air bubble will be measured as if it was part of the gas produced. In the same order of ideas, when the eudiometer is inverted, the air bubble will most likely cause the metal to go up the eudiometer. If this happens, the metal will possibly not be dissolved and stick to the walls of the eudiometer, and once again this will give a wrong final result.

4. If the metal gets stick on the walls of the eudiometer the reaction will not be successful, thus the experiment has to be done again. This is because it will not react with the HCl to its full potential which will not produce the complete amount of gas that would have otherwise been produced as the HCl will not be touching the metal.

5. What does it mean if your percent yield (percent purity of the metal) is a) greater than 100% b) 100% c) less than 100%?

   Percentage yield is the percentage of theoretical amount that is actually acquired.

   A) if the percent yield is greater than 100%, it means that the actual amount was bigger than the theoretical. This situation could possibly be seen as it is likely that extra substances in or on the substance (in this case the metal) and affects the overall mass.
   B) If the percent yield is a 100%, this means that the theoretical and the actual mass were equal. However, such event is uncommon as it is hard to accomplish a lab under perfect conditions.
   C) The most common event is when the % yield is under 100% because lab conditions are not always ideal. Thus, multiple factors may affect the results decreasing the % yield (i.e. = not diluting all the solute).

6. An alloy is a combination of two or more different metals. Alloys are commonly used due to their mix of properties. These properties come from the mixed metals which formed new and better properties such as resistance to corrosion.

7. How do you expect an alloy to react with acid compared to a pure metal?

   As it has been mentioned before, an alloy is a combination of multiple metals. Therefore, it is expected that an alloy will take longer to react with an acid than a single metal would. In the same order of ideas, alloys are characterized for having certain unique physical properties. Thus, alloys have stronger bonds which also makes them take longer to dissolve in the solution.

8. Do you expect multiple trials with an alloy to produce similar results? Should you?
   As long as the same alloy is being used for the trials, and the lab conditions are similar, it is expected of the results to be similar. On the other hand, as lab conditions do not remain the same throughout multiple trials, this statement can occasionally be wrong.

9. Does the mass of metal or the mass of alloy used affect your result? Should it?
   Yes, the mass of a metal or an alloy used affects the result in a way in which greater the mass of metal used, the longer the reaction will take.

10. If your results are not what you expected, is it due to a flaw in the theory? A flaw in the procedure? A flaw in your experimental work? Factors outside your control?
    After conducting the experiment, my results are not what I expected as the values seem to be too high. Thus, it is evident that some errors might have occurred. First, when it comes to the percent yield, trial 1 = 274% and trial 2 = 108%. The reason for this could be that another substance must have reacted, or that the metal did not react properly. When analyzing this flaw, it could be said that some molecules might have fallen in when the metal got sanded. Also, it is possible that sweat from my fingers when I touched the metal when getting it ready to be mixed with the acid.

11. Think of a way in which this experiment relates to your work in the lecture course.
    This experiment fully relates to what we have learned during the lectures. It is a prime example of the topics seen such as the importance of understanding how to use and rearrange equations as well. In the same order of ideas, putting in practice what we have learned during the lecture allow us to experience, analyze and understand better the properties of gasses, how they react with acid and how to put in practice the formulas we have been teach.

12. Think of a way in which this experiment connects to or has applications in the world around you.
    Since science is a primordial topic in the world around us, it is important to understand the elements that we can possibly find. More specifically, alloys' abundance in the world around us is considerably high thus understanding its properties might be essential. On the other hand, metals are not as powerful as alloys. Therefore, knowing the composition of alloys and understanding how to manipulate them and combine the proper equations and percentages can be extremely essential. This is due to the fact that combining metals in between them or with other substances creates new substances with new physical and chemical properties. Thus, it is important to understand the risks and advantages of using such substances.

Conclusion:

When observing the results, it is evident that when the atmospheric conditions remain constant, it is expected for the unknown alloy and the metal to have similar results. However it is very easy to see experimental error. On the other hand, disregarding the errors that could have occurred, the alloy's average volume of the Hydrogen collected is 7.85 mL greater than the metal's.

Principles

hydrochloric acid, HCl (aq)

- mole ratios
- Dalton's law of partial pressures

- mole ratios
- Dalton's law of partial pressures
- stoichiometry
- reactions of acids and metals

	Zinc 1	Zinc 2	Unknown Alloy 1	Unknown Alloy 2
Mass	42.3 mg	48.1 mg	42.2 mg	44.8 mg
12M HCl	20.1 ml	20.4 ml	10.4 ml	10.0 ml
Initial T°	22.4°C	"	"	"
Initial P	101.3 kPa	"	"	"
Final T°	23.9°C = 297.05 K	24.3°C	23.8°C	18.3°C
height from H_2O surface	30.7 cm = 0.307 m	27.1 cm 0.271 m	25.6 cm	23.5 cm
Volume of gas produced	16.8 ml → 0.0168 L	20.4 ml → 0.0204	25.4 ml	27.5 ml
uncalibrated	n/a	"	"	"