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CH201
Lab 7

Lab 7: Moles and Empirical Formula

Data:

Part A:

Data Table 1.

Item	Mass (g)
Cooled Crucible	15.772
Crucible + hydrate before heating	16.872
Crucible + anhydrous after heating	16.642
Filter Paper	0.630
Watch Glass	18.234
1 st heating of watch glass, filter paper, and dried copper	19.283
2 nd heating of watch glass, filter paper, and dried copper	19.273

Part B:

Data Table 2.

Item	Formula	Mass (g)	Length (cm)
Cube	Cu	144.28	2.50
Aluminum Can	Al	14.22	
Glass Slide	SiO ₂	4.65	
Chalk	CaCO ₃	4.54	
Epsom Salt	MgSO ₄ •7H ₂ O	4.89	
Water	H ₂ O	10.58	

Calculations:

Part A:

Copper Chloride Hydrate Mass: $16.872\text{ g} - 15.772\text{ g} = 1.100\text{ g}$

Water Lost Mass: $16.872\text{ g} - 16.642\text{ g} = 0.230\text{ g}$

Anhydrous Copper Chloride Mass: $16.642\text{ g} - 15.772\text{ g} = 0.870\text{ g}$

Copper Mass: $19.273\text{ g} - (18.234\text{ g} + 0.630\text{ g}) = 0.409\text{ g}$

Chloride Mass: $0.87\text{ g} - 0.409\text{ g} = 0.461\text{ g}$

Moles Water: $0.23\text{ g} / 18.015\text{ g/mol} = 0.0128\text{ mol}$

Moles Copper: $0.409\text{ g} / 63.546\text{ g/mol} = 0.00644\text{ mol}$

Moles Chloride: $0.461\text{ g} / 35.446\text{ g/mol} = 0.0130\text{ mol}$

Mole Ratios:

Copper/Copper = $0.00644\text{ mol} / 0.00644\text{ mol} = 1$

Chloride/Copper = $0.0130\text{ mol} / 0.00644\text{ mol} = 2.02 \rightarrow 2$

Water/Copper = $0.0128\text{ mol} / 0.00644\text{ mol} = 1.99 \rightarrow 2$

Part B:

Molar Mass Cu = 63.55 g/mol

Molar Mass Al = 26.98 g/mol

Molar Mass SiO_2 = 60.09 g/mol

Molar Mass CaCO_3 = 100.09 g/mol

Molar Mass $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ = 246.48 g/mol

Copper Cube:

Moles Copper: $144.28\text{ g} / 63.55\text{ g/mol} = 2.2705\text{ mol}$

Atoms of Copper b: $2.2795\text{ mol} * 6.022 \times 10^{23}\text{ atoms/mol} = 1.37 \times 10^{24}\text{ atoms Cu}$

Atoms of Copper c: $= 8.96\text{ g/cm}^3 * (2.50\text{ cm})^3 = 140\text{ g} \rightarrow 140\text{ g} / 63.55\text{ g/mol} = 2.20\text{ mol} \rightarrow$
 $2.20\text{ mol} * 6.022 \times 10^{23}\text{ atoms/mol} = 1.33 \times 10^{24}\text{ atoms Cu}$

Aluminum Can:

Moles Aluminum: $14.22\text{ g} / 26.98\text{ g/mol} = 0.5270\text{ mol}$

Atoms of Aluminum: $0.5270\text{ mol} * 6.022 \times 10^{23}\text{ atoms/mol} = 3.17 \times 10^{23}\text{ atoms Al}$

Microscope Slide:

Moles SiO_2 : $4.65\text{ g} / 60.09\text{ g/mol} = 0.077\text{ mol SiO}_2$

Moles O: $0.774\text{ mol} * 2 = 0.155\text{ mol O}$

Moles Si: $0.774\text{ mol} * 1 = 0.774\text{ mol Si}$

Chalk:

Moles CaCO_3 : $4.45\text{ g} / 100.09\text{ g/mol} = 0.045\text{ mol CaCO}_3$

Moles O: $.0445\text{ mol} * 3 = 0.133\text{ mol O}$

Moles CO_3 : $0.0445\text{ mol} * 1 = 0.0445\text{ CO}_3$

Epsom Salt:

Moles $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$: $4.89 \text{ g} / 246.48 \text{ g/mol} = 0.020 \text{ mol MgSO}_4 \cdot 7\text{H}_2\text{O}$

Moles MgSO_4 : $0.02 \text{ mol} \cdot 1 = 0.02 \text{ mol MgSO}_4$

Mass of H_2O : $0.0198 \text{ mol H}_2\text{O} \cdot 7 \cdot 18.016 \text{ g/mol} = 2.497 \text{ g H}_2\text{O}$

Water:

Moles of 10 mL H_2O : $(10 \text{ mL H}_2\text{O} / 0.9167 \text{ g/mL}) / 18.006 \text{ g/mol} = 0.61 \text{ mol H}_2\text{O}$

Moles of O: $0.61 \text{ mol} \cdot 1 = 0.61 \text{ mol O}$

Moles of H: $0.61 \text{ mol} \cdot 2 = 1.22 \text{ mol H}$

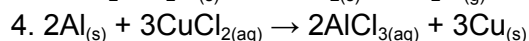
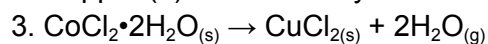
Results:

Part A:

Results Table 1. Moles of Copper, Chlorine, H_2O

	Mass (g)	Moles (mol)
Copper Chloride Hydrate	1.10	
$\text{H}_2\text{O}_{(\text{g})}$ Removed	0.230	0.0128
Anhydrous Copper Chloride	0.870	
Copper	0.409	0.00644
Chloride	0.461	0.0130
Formula of the Copper Chloride Hydrate	$\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$	

2. Copper (II) Chloride Dihydrate



Part B:

Results Table 2. Direct Measurements of Matter

Item	Molar Mass (g/mol)	Moles of Item	Calculation b. Answer & unit	Calculation c. Answer & Unit
Cube	63.546	2.2705	1.367×10^{24} atoms Cu	9.23 g/cm^3
Aluminum Can	26.981	0.5270	3.174×10^{23} atoms Al	
Glass Slide	60.09	0.0774	0.155 mol O	0.774 mol Si
Chalk	100.09	0.0445	0.133 mol O	0.0445 mol CO_3
Epsom Salt	246.482	0.0198	0.0198 mol MgSO_4	2.497 g H_2O
Water	18.006	0.61	0.61 mol O	1.22 mol H

Discussion and Conclusion:

The purpose of this lab was to use the theoretical understanding of the law of multiple proportions and the law of definite proportions to find the empirical formula of some copper chloride hydrate compound. This was accomplished in Part A by evaporating the water from the copper chloride hydrate to make anhydrous copper chloride. Next, the anhydrous copper chloride was mixed with water and an aluminum wire placed in the solution. In this reaction, aluminum reduces copper chloride to form aluminum chloride in aqueous solution and copper as a solid metal. The copper was then separated from the aluminum wire. Each stage was massed. Through the laws of definite proportions and the masses of each stage of the reaction the empirical formula was determined through molar ratios. This experiment can be generalized to find the empirical formula of other compounds.

The empirical formula of the Copper Chloride Hydrate was determined to be $\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$. It was necessary to heat the sample multiple times because there are hydrate compounds that were bound up in the sample. This method correctly identified the empirical formula of the compound. In Part B, the moles and number of atoms are reasonable when comparing the g/mol of each element or compound to the mass measured.