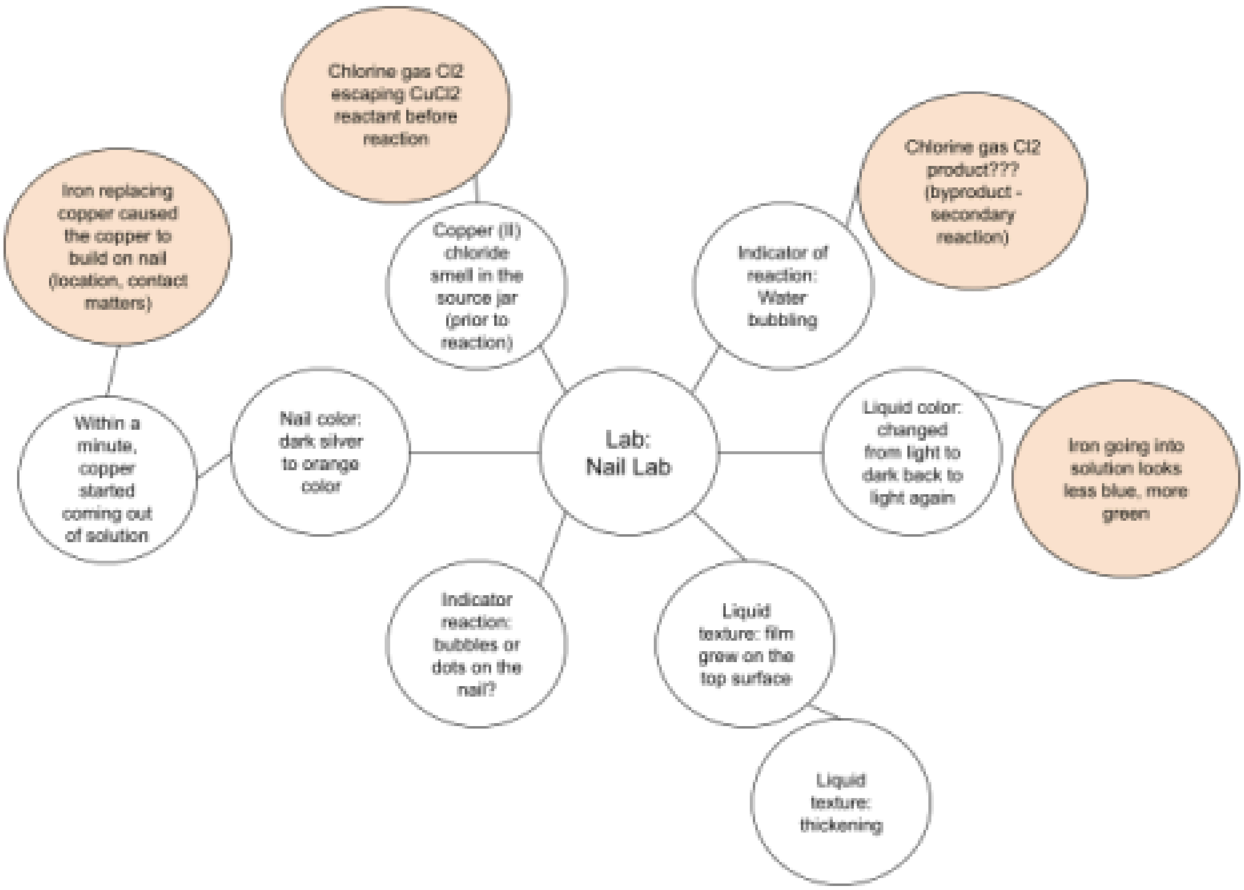
Student Name:
Course:Chemistry 130

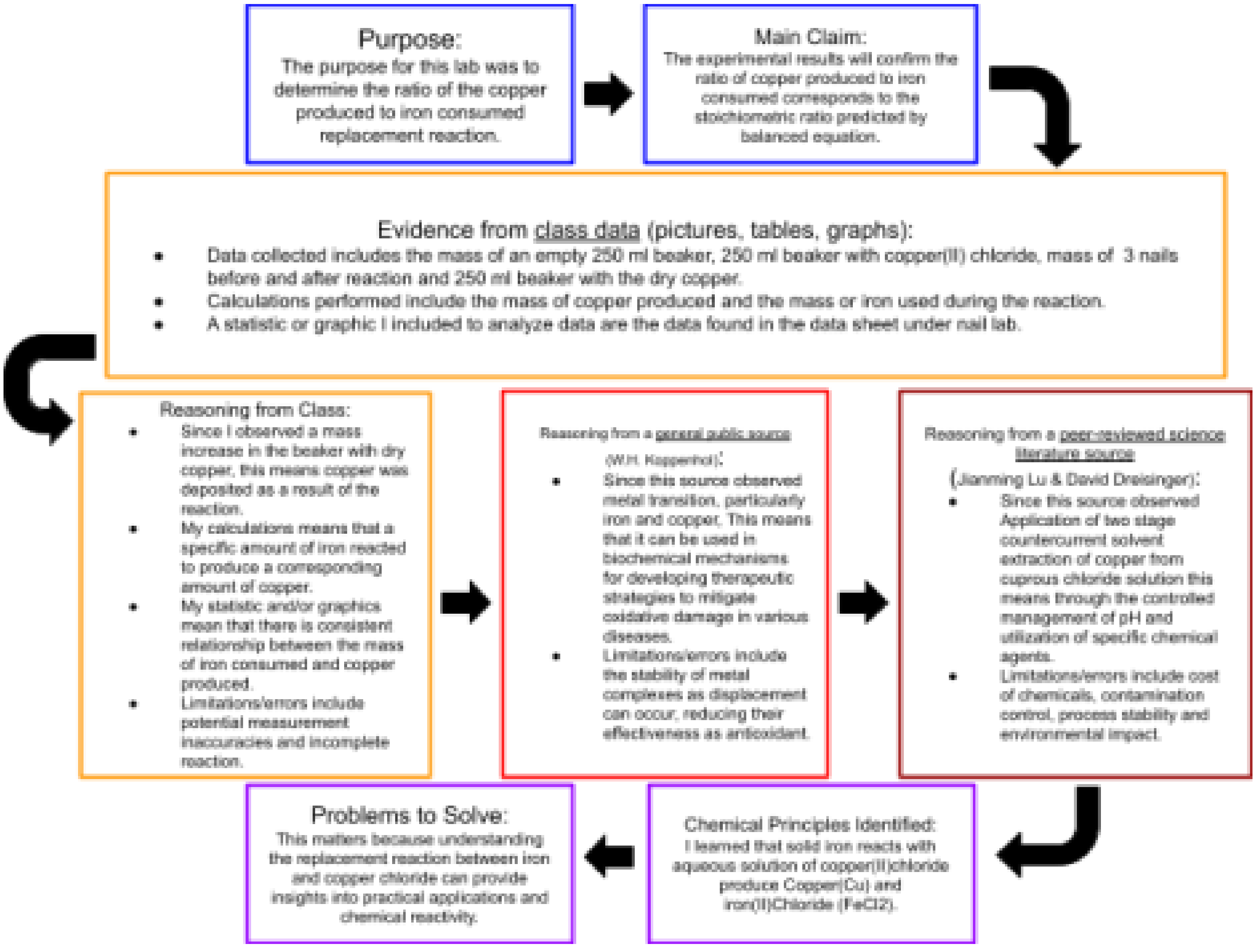
Bubble Map



Pick one bubble to focus on for this lab write-up

Main Claim: Iron replacing copper caused by the copper to build up on nails (location, contact matters).
Develop an <u>outline</u> for your Lab Write-up:

Flow Map Outline



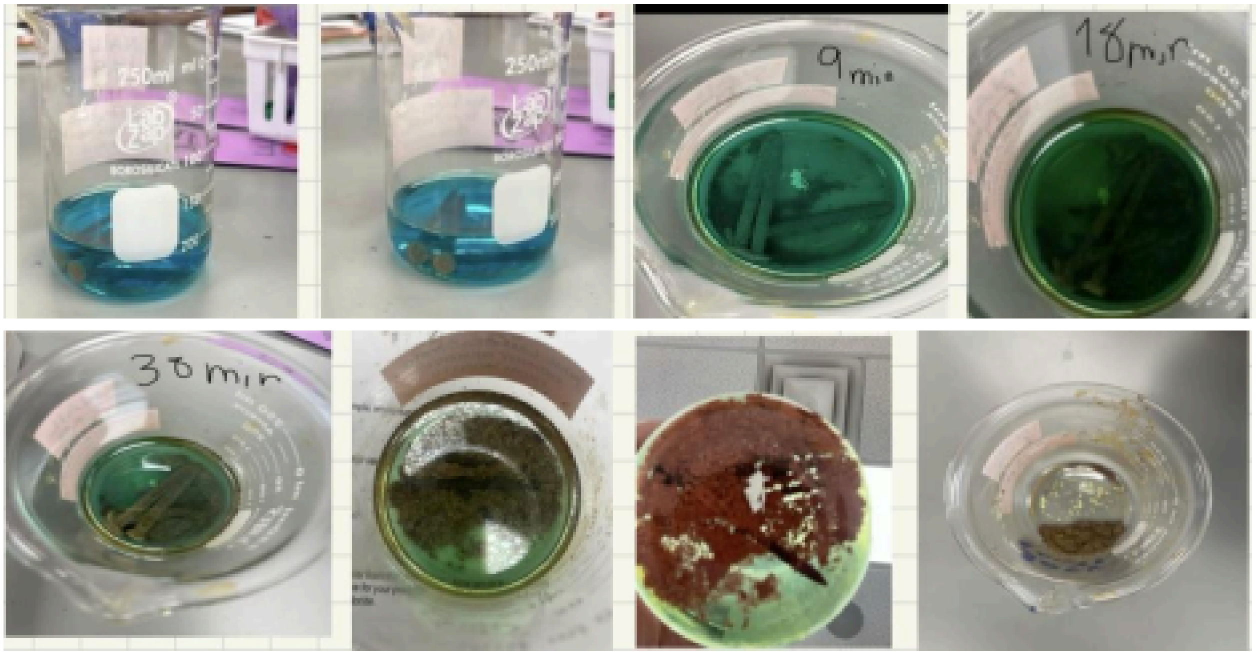
Lab Write-Up

Introduction

The purpose of this lab is to determine the stoichiometry of the replacement reaction between copper(II)chloride (CuCl2) and iron (Fe). This reaction illustrates how a more reactive metal iron (Fe) displaces a less reactive metal copper (Cu) from its compound.

Results

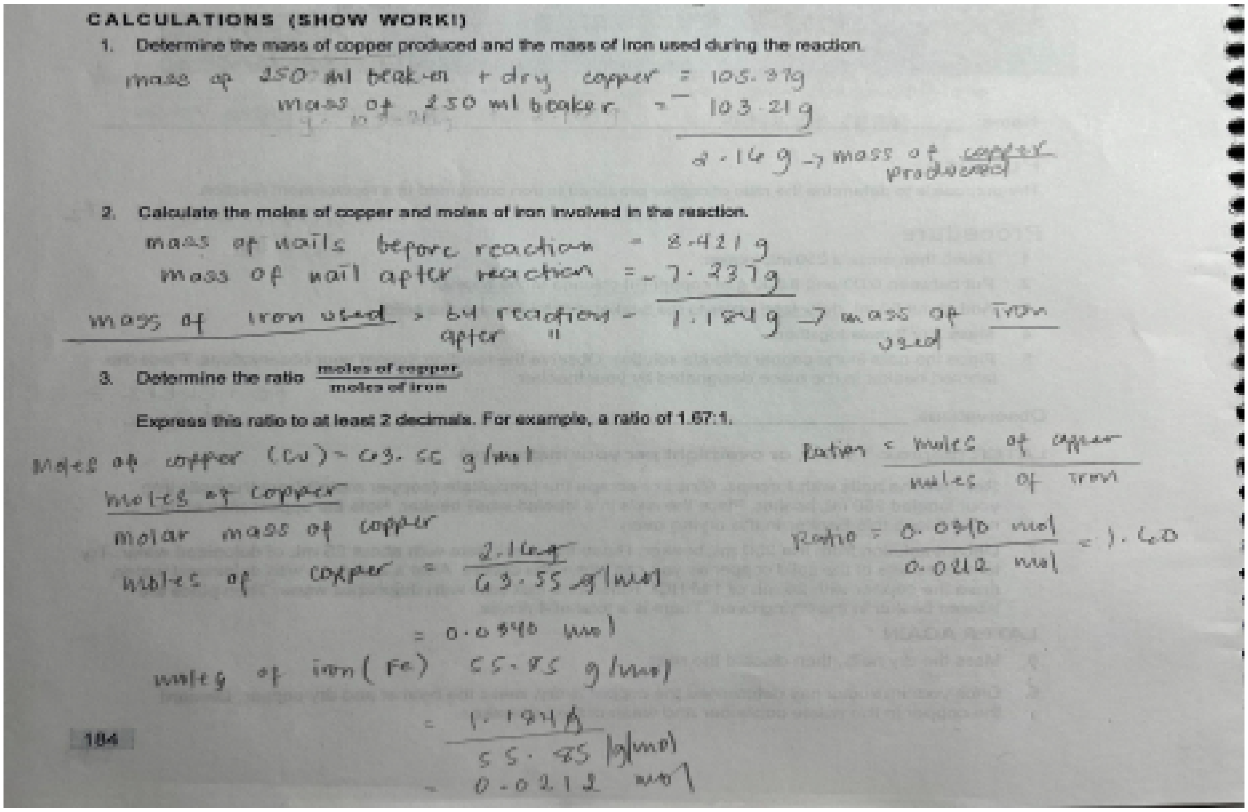
During the experiment, when the solid iron (Fe) was introduced to an aqueous solution of copper(II)chloride (CuCul2), a single displacement reaction occurred. The iron displaces copper from the copper(II)chloride solution, leading to the formation of solid copper (Cu) and iron(II) chloride (FeCl2) in a solution. I observed a color change; the blue color of copper(II)chloride solution faded as copper was displaced and precipitated as a solid. Solid copper (Cu) appears at the bottom of the reaction beaker and adheres to the surface of the iron. The solution now contains iron(II) chloride, which is light yellow-green.



The data that we collected during the lab.

	units	Group 6
Mass of beaker	(g)	103.211
Mass of beaker + copper(II) chloride	(g)	110.335
Mass of 1-2 nails	(g)	8.421
Observations of reaction		Rusting, change of color
Mass of remaining nails	(g)	7.237
Mass of beaker + precipitate (Dried)	(g)	105.37
Mass of copper produced (solid precipitate)	(g)	2.159
Mass of iron used	(g)	1.184
Moles of precipitate produced	mol	0.034
Moles of iron used	(mol)	0.0212
Cu:Fe mole ratio	(mol)	1.60:1
Rounded (whole numbers) Cu:Fe mole ratio	Cu mol / Fe mo	1

Solution



CALCULATIONS (SHOW WORK!)

1. Determine the mass of copper produced and the mass of iron used during the reaction.

mass of 250 ml beaker + dry copper = 105.37g
mass of 250 ml beaker = 103.21g
2.16 g → mass of copper produced

2. Calculate the moles of copper and moles of iron involved in the reaction.

mass of nails before reaction = 8.421 g
mass of nail after reaction = 7.237g
mass of iron used by reactions before - after = 1.184 g → mass of iron used

3. Determine the ratio $\frac{\text{moles of copper}}{\text{moles of iron}}$

Express this ratio to at least 2 decimals. For example, a ratio of 1.67:1.

Moles of copper (Cu) - 63.55 g/mol
moles of copper = mass of copper / molar mass of copper
moles of copper = 2.16g / 63.55 g/mol = 0.0340 mol

moles of iron (Fe) 55.85 g/mol = 1.184g / 55.85 g/mol = 0.0212 mol

Ratio = moles of copper / moles of iron

Ratio = 0.0340 mol / 0.0212 mol = 1.60

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Discussion

The chemical equation for this lab write-up is Fe(s) + CuCl2→Cu(s) + FeCl2(aq). This is a classic single displacement reaction when one element displaces another. The reactant iron (Fe) is a more reactive metal than copper. CuCl2 is an ionic compound consisting of (Cu2+) and chloride ions (Cl-). The products of these reactions are Copper (Cu), which is a less reactive metal that is displaced from the copper(II) chloride, and Iron(II) (FeCl2), an ionic compound that is formed when the iron is displaced copper from the copper(II)chloride. A visual change occurred during the formation of brownish copper metal on the surface of the iron, along with the solution changing its color.

I have learned that from the general public source by ***Koppenol, W.H. New Comprehensive Biochemistry. Chemistry of Iron and Copper in radical reaction*** that metal transitions, particularly in elements such as iron and copper, is very significant in biochemical contexts because these metals play vital roles in various biological processes, including redox reactions that are central to cellular metabolism. For instance, the therapeutic strategies: Antioxidant role, is to develop therapies that will utilize metal complexes that could potentially help mitigate oxidative damage that is associated with various diseases related to neuro and cardiovascular. The metal complexes can act as an antioxidant by stabilizing free radicals. However, one of the limitations that get stuck in my head is that it will increase the toxicity if free metal ions become bioavailable.

Additionally, the peer-reviewed science literature source by Jiaming Lu and David Dreisinger, **Hydrometallurgy.** ***Two-stage countercurrent solvent extraction of copper from cuprous chloride solution: Cu(II) loading coupled with Cu(I) oxidation by oxygen and iron***

scrubbing. From this source, I have learned that by using the countercurrent solvent extraction of copper from cuprous chloride solution it would control the pH. The pH of the solution is a critical factor that affects the solubility of copper. Adjusting the pH can help in selective precipitating of extracting copper ions but the downside is that cost of chemicals is not economically feasible and contamination control is hard to attain.

Conclusion

The experiment shows a single displacement reaction between iron and copper(II)chloride. The observations are aligned with theoretical predictions, confirming that copper displaces iron due to its higher reactivity. Iron(II)chloride formation and the deposition of copper were clear signs that there are chemical changes. This experiment reinforces the concept of reactivity and electron transfer in redox reactions but also highlights the practical implications of metal reactivity in real world applications such as corrosion and metal displacement processes.

References:

Koppenol, W.H. (n.d.). New Comprehensive Biochemistry. *Chemistry of Iron and Copper in Radical Reaction*, Volume *28* (1994), 3-24.
https://doi.org/10.1016/S0167-7306(08)60437-8

Lu, J., & Dreisinger, D. (n.d.). Hydrometallurgy. *Two-stage countercurrent solvent extraction of copper from cuprous chloride solution: Cu(II) loading coupled with Cu(I) oxidation by oxygen and iron scrubbing*, *Volume 150* (December 2014), 41-46.
https://doi.org/10.1016/j.hydromet.2014.09.003