Problem 12 Zinc layers Report

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PROBLEM STATEMENT

12. Zinc Layers

If a **copper coin** and small **granules of zinc** are immersed into a solution of **zinc sulphate** and then heated, a **layer of zinc** appears on the coin. What is the **thickness** of the zinc layer? What **other metals** can be covered with zinc in such an experiment? Investigate and explain the effect.

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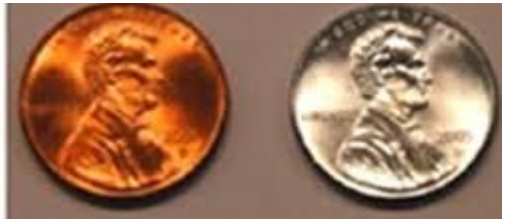
INTRODUCTION

ALCHEMY

- Alchemists attempted to “**purify**” certain metals into “noble metals” like **silver** or **gold**.
- This particular experiment is a modern **illusion**-version of “alchemy”.
- On the **surface** of the copper coin, a layer of **zinc** metal is formed, causing it to appear **silver**.



THEORY

THEORY - HYDROLYTIC EQUILIBRIUM

- The solution is **heated** to a boil and copper coins, that have been thoroughly cleaned, are dropped in.
- This particular phenomenon, is **not** a redox-oxidation reaction, but an **equilibrium** between Zinc and it's ions.
- In a solution of $ZnSO_4$, Zn granules and Cu coins, the Zinc ions in $ZnSO_4$ gets **reduced** to **Zn metal**. This new Zinc forming "sits" on the coin due to this **interface** between Cu and Fe which works **catalytically**.
- The zinc set on the coin is the **solid Zinc metal layer** we see, that practically turns the coin into a silver colour.

THEORY - COINS

- On the surface of coins containing **Fe**, there is a **redox-oxidation dynamic** between Cu and Fe.
- Theoretically, the experiment will be successful with coins made from an alloy containing Fe, like 2 and 5 cent coins. We can easily figure out the presence of Fe by seeing witch coins get **magnetized**.
- 2 and 5 cent coins contain Fe whereas 10 and 20 cent coins do not.

THEORY - REPLACING $ZnSO_4$ AND Zn

- Fe for example is **less drastic** than Zn in the activity series.
- Fe has a smaller redox-oxidation dynamic.
- The equilibrium between Fe and it's ions **cannot proceed** in the presence of Copper so if we replace Zn with **Fe** and $ZnSO_4$ with **$FeSO_4$**, the phenomenon will not proceed.
- If we replace Zn with a **more drastic** metal like **Ba**, a redox-oxidation reaction will take place and not the phenomenon we want to inspect:

  $ZnSO_4 + Ba \Rightarrow BaSO_4 + Zn$
- When a base like **NaOH** is added, the redox-oxidation reaction proceeds **immediately** because we have redox-oxidation dynamics occurring from the hydroxide too.

HYPOTHESES & PARAMETERS

HYPOTHESES

1

The phenomenon **won't proceed** with the **10** and **20** cent coins in the solution of $ZnSO_4$ and Zn because they do not contain **Fe**.

2

The phenomenon **won't proceed** if the $ZnSO_4$ is replaced with **$FeSO_4$** and Zn with **Fe** because Fe is **less drastic** than Zn and already exists in the coin.

3

The phenomenon won't proceed if the Cu coin is replaced by Cu **foil** because the Cu foil is **pure** Cu and not Copper alloy containing **Fe**.

VARIABLES

CONTROLLED

- ENVIRONMENTAL TEMPERATURE
- SOLUTION TEMPERATURE
- $ZnSO_4/FeSO_4$ CONCENTRATION
- AMOUNT OF Zn/Fe METAL

DEPENDENT

- MASS AND COLOUR

INDEPENDENT

- DIFFERENT COINS/FOIL
- REPLACING Zn WITH Fe AND $ZnSO_4$ WITH $FeSO_4$
- NaOH ADDITION

⚠ POSSIBLE ERRORS ⚠

- Scale precision
- Water concentration
- Coin mass (manufacturing)
- Coin surface dirt

EXPERIMENTS

&

RESULTS

EXPERIMENTAL SETUP-MATERIALS

- Different coins (2, 5, 10, 20 cent)
- copper foil pieces
- 250 mL Beaker
- $ZnSO_4/FeSO_4$
- Zn/Fe granules
- NaOH
- Hot Plate
- Safety Glasses and gloves
- Metal Tweezers
- Stop Watch
- Precision scale

EXPERIMENT 1 ✔

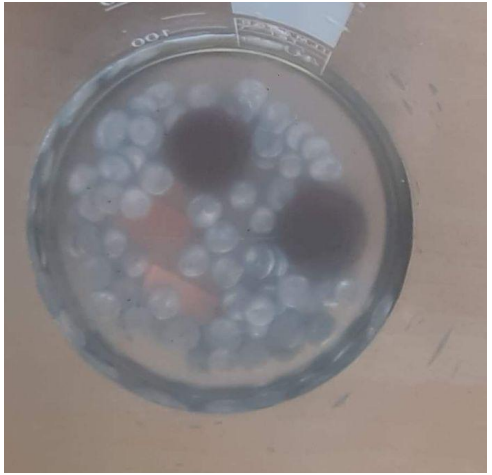
- 2 cent coin (3.06gr)
- 15gr $ZnSO_4$
- 30gr Zn granules
- after the experiment: 3.062gr

EXPERIMENT 2 ✔

- 5 cent coin (3.971gr)
- 15gr $ZnSO_4$
- 30gr Zu granules
- after the experiment: 3.973gr

EXPERIMENT 3

- 10 cent coin (4.07gr)
- 15gr ZnSO4
- 30gr Zu granules
- after the experiment: 4.07

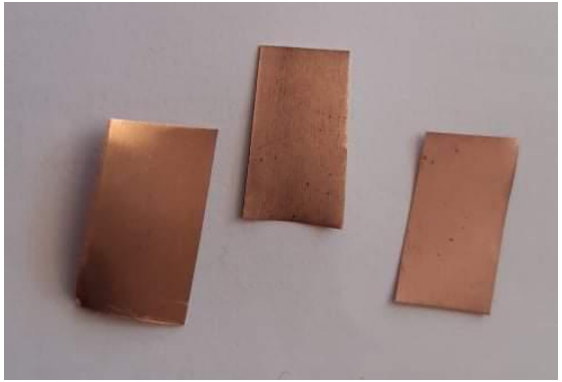


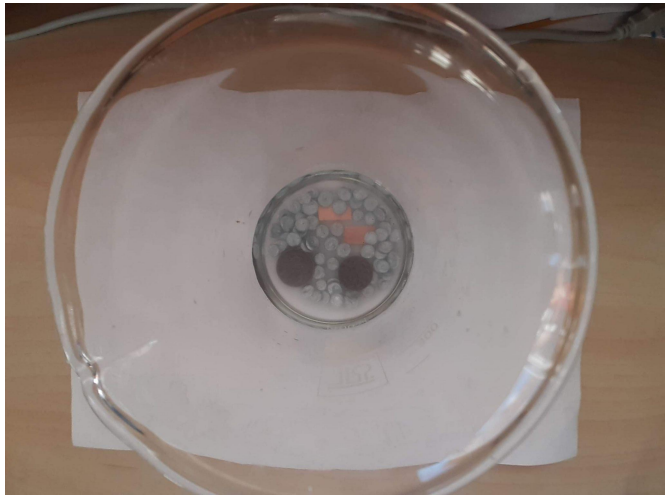
EXPERIMENT 4

- 20 cent coin (5.731gr)
- 15gr ZnSO4
- 30gr Zu granules
- after the experiment: 5.731

EXPERIMENT 5

- Cu foil pieces (0,21gr)
- 15gr $ZnSO_4$
- 30gr Zu granules
- after the experiment: 0.21gr





EXPERIMENT 6

- 2 cent coin (3.06gr)
- 15gr $FeSO_4$
- 30gr Fe granules
- after the experiment: 3.06gr

EXPERIMENT 7

- 5 cent coin (3.971gr)
- 15gr $FeSO_4$
- 30gr Fe granules
- after the experiment: 3.971gr

EXPERIMENT 8

- Coins
- $ZnSO_4$
- Zn
- NaOH

➢ When **NaOH** was added to to the solution, the reaction proceeded **immediately**.

➢ In the solutions with the 10, 20 cent coins and Cu foil pieces the phenomenon **proceeded** too because it was an oxidation-reaction and not the phenomenon we were investigating.

CONCLUSIONS

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- The phenomenon **proceeded** in the experiment with the **2** and **5** cent coins but **not** in the experiment with the **10**, **20** cent coins and Cu **foil**.
- In the successful experiments the 2 and 5 cent coins changed from copper red to a **silver-grey** colour.
- In the successful experiments, the **mass** of the 2 and 5 cent coins **changed** indicating the formation of the Zn layer.
- The phenomenon **didn't proceed** when we replaced Zn and ZnSO4 with **Fe** and **FeSO4**.
- When we added **NaOH** to the solution the reaction proceeded immediately but it was not the phenomenon we were investigating but a redox-oxidation reaction.

HYPOTHESES

1

The phenomenon **won't proceed** with the **10** and **20** cent coins in the solution of $ZnSO_4$ and Zn because they do not contain **Fe**.

CONFIRMED

2

The phenomenon **won't proceed** if the $ZnSO_4$ is replaced with **$FeSO_4$** and Zn with **Fe** because Fe is **less drastic** than Zn and already exists in the coin.

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The phenomenon won't proceed if the Cu coin is replaced by Cu **foil** because the Cu foil is **pure** Cu and not Copper alloy containing **Fe**.

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THANK YOU

CLARIFICATIONS

CALIPER MEASUREMENTS

- We measured the coins of the successful experiments with a caliper but the tool wasn't able to detect the formation of the Zn layer because it was too thin.

ENVIRONMENTAL TEMPERATURE

- To make sure the environmental temperature stable, we used an arduino DTH-22 sensor.

WHAT IS GALVANIZING?

Galvanizing is one of the most popular methods of **coating** and **protecting** the metal. Galvanization is done by applying a protective **zinc** coating to the metal. This coating is mainly done to **prevent rust** and corrosion, which provides a longer useful life and increased safety. This particular process uses the phenomenon of the Zn layer formation.