**Chemical and Physical Changes**

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CH184

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**Introduction**

This experiment was developed on the core concept of different substances and solutions reacting with one another. The crux of the experiment was to differentiate between a chemical and a physical change when the solutions were mixed. Some of the results were obvious as to which sort of change they were, but others proved more difficult to differentiate.

The main differences in the changes are what lies underneath the surface. A physical change will not change its underlying chemical composition (Carolina). Water may change from a solid to a liquid, but it’s still water, which can move back and forth between the states. A chemical change involves changing the underlying chemical bonds, resulting in a new substance. An example from the experiment is the first activity performed by mixing Hydrochloric Acid with Sodium Carbonate. The substance violently bubbled and was slightly heated, indicating a chemical reaction. The reaction looks like this:

|  |
| --- |
| Na2CO3 + 2 HCl 🡪 2 NaCl + H2CO3 |

Figure : Na2CO3 and HCl reaction (Laney, 49).

I used a few different substances in this experiment. Chief among them were Sodium Carbonate (Na2CO3), Hydrochloric Acid (HCl), Copper (II) Sulfate (CuSO4), Sodium Hydroxide(NaOH), Magnesium (Mg) ribbon, Sodium polyacrylate, and Phenolphthalein (Carolina). Some more mundane substances used were food coloring, sugar, salt, aluminum, and a nail.

**Data**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Activity** | **Color of Initial Items** | **Color of Final Items** | **Initial Temp. (°C)** | **Final Temp. (°C)** | **Observations** | **Type of Change** | **Explanation** |
| 1 | Both HCl and NaCO3 are clear | Clear | HCl - 19  NaCO3 - 19 | 20.5 | Violently Bubbled and fizzed when mixed  Temperature increased  Solution is still clear, but has air bubbles inside it | Chemical | The violent eruption in the solution when mixed indicated a chemical change. There was no state change. |
| 2 | Water is clear and Sodium Polyacrylate is a white power | Murky white/grey | Water is 20 degrees | 20 | Water immediately turned into a gel-like substance. When the thermometer was inserted, the imprint stayed | Physical | The water changed its state from a liquid to a solid. |
| 3 | CuSO4 is is blue  Na2CO3 is clear | Cloudy Blue | CuSO4 - 20  Na2CO3 - 20 | 19 | The solutions immediately formed a white, cloudy substance in the blue liquid. | Chemical | A new substance was formed in the mixing |
| 4A | The tea candle is white | White |  |  | The candle burned. The wick is now blackened. | Chemical | Combustion is a chemical change, and the state of the object is not changing. |
| 4B | White/Clear | Clear |  |  | The ice melted and is now water | Physical | The state of the ice changed, indicating physical change. |
| 5 | Sugar is white, water is clear | Murky white | Water - 20 | 20 | It’s just watery sugar | Physical | The state didn’t necessarily change, and we really just have water and sugar together. It could theoretically still be separated. |
| 6A | NaOH is clear  Phenolphthalein is clear | Pink | NaOH - 20 | 20.5 | The drop of Phenolphthalein immediately turned red. | Chemical | The change in color and the fact that the solution doesn’t seem reversible. |
| 6B | HCl is clear  NaOH/Phen is pink | Pink | HCl - 20 | 30 | The solution stayed the same color, but heated up 10 degrees | Chemical | The chemical reaction created enough energy to raise the temperature by about 10 degrees. |
| 7 | CuSO4 is blue  NaOH is clear | White-ish blue | Both are 20 | 22 | The solution congealed into a blue gel. | Chemical | The temperature was raised, which means a chemical change took place. |
| 8 | Blue water is blue  Yellow water is yellow | Dark Green | Both are 20 | 20 | The solution turned dark green | Physical | The solution changed color, but it’s a simple mixing of colors. No new chemical bonds are being formed. |
| 9 | HCl is clear  Mg is silver | The Mg turned white before dissolving | HCl - 20 | 32 | The ribbon started fizzing and jumping around. | Chemical | The solution heated up. |
| 10 | CuSO4 is blue  Salt is white | A split blue and greenish gradient | CuSO4 - 20 | 20 | The salt sank to the bottom | Physical | The solution could be evaporated to retrieve the original substances. |
| 11 | CuSO4/salt blue/green | The aluminum is blackened | CuSO4/salt - 20 | 26 | The Aluminum started to bubble and blacken | Chemical | Heat was created, and the aluminum can’t be returned to its original state. |
| 12 | CuSO4 is blue  Nail is silver/grey | The nail has a rust colored coat on it | CuSO4 - 20 | 20 | The nail began rusting, but it’s just a thin coat over it | Chemical | The nail has a rust-like substance on it. (After looking it up, it’s the copper appearing visible on the nail.) |

**Calculations**

Much of this experiment just involved putting the solutions in a polystyrene test tube, mixing them, and then cleaning out the test tube to do it over again. I did have to throw away one test tube from activity 2 which contained a thick, gel-like solid that would’ve been more work than it’s worth to clean out.

Most of the chemical reactions will involve a raised temperature in the Final Temp column. The reactions require energy to break chemical bonds, but they also release energy when the bonds are formed. “If more energy is released than consumed, then the chemical reaction evolves heat” (De Leon). All the chemical reactions in the table above have at least some change from the 20°C room temperature base, which the solutions were measured at. The physical reactions also don’t have any temperature change because there’s no chemical bonds being broken or formed.

**Conclusion**

This experiment was interesting, and time consuming, to perform. I learned much about the differences in the types of reactions. There were some reactions that I was unsure about, so I looked them up to clarify what was happening.

As an example, I looked up the Copper sulfate (CuSO4) and the nail experiment (OMSI). I thought that the Copper sulfate was causing the nail to rust, but I was able to wipe it off easily, so I thought that was incorrect. I found that the CuSO4 and some of the Iron were trading places. The substance formed on the nail was the copper materializing as a solid.

There were many other experiments that piqued my interest such as activity 6, the Sodium hydroxide (NaOH) and the Phenolphthalein solution. These two clear substances formed a beautiful pink substance when mixed. Then, I added Hydrochloric acid (HCl) to the mix, and it heated up a whole 10°C, which I would think takes a huge amount of energy. I also mentioned activity 2, where water and Sodium polyacrylate powder were mixed. This immediately turned the water into a thick gel.

Overall, the activities were fun, and I got to learn a lot about the different types of reactions and how each substance would interact with another.

**References**

Carolina. Chemical and Physical Changes Investigation Manual. Accessed 26 May 2021.

Laney. Experiment 9 – Double Displacement Reaction. <https://laney.edu/huisunkim/wp-content/uploads/sites/407/2017/08/9-Double-Displacement-Reactions.pdf>

De Leon, N. Heat and Chemical Reactions. <https://cpanhd.sitehost.iu.edu/C101webnotes/quantchem/rxnheat.html>

OMSI. Trading Places. https://omsi.edu/sites/all/FTP/files/chemistry/U2TradingPlaces.pdf

**Obligatory Proof Selfie**

I took this after I cleaned most of the stuff up, which is why I don’t have my PPE on.

