**Qualitative Study of Redox Reactions**

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**ABSTRACT**

Redox reactions or oxidation-reduction reactions can be used to determine the reactivity of metals with ions. By finding the reactivity of metals, an activity series can be created which ranks metals in order of most reducing power to least reducing power. The four metals used in this experiment were iron, zinc, copper and magnesium. The aqueous solution used was 6 M HCl and the hydronium ion from HCl acted as the oxidizing agent. Out of the four possible reactions, there was one mixture with no reaction. The other three mixtures had reactions with differing intensity levels and allow for an activity series to be created.

1. **INTRODUCTION**

The purpose of this experiment was to create an activity series that ranked the reducing powers of four metals: iron (Fe), zinc (Zn), copper (Cu) and magnesium (Mg). The activity series was created by reacting metals with HCl and forming redox reactions. Redox reactions or oxidation/reduction reactions change the oxidation states of the atoms involved and allow for a visible reaction to be observed and recorded. If an immediate reaction were to occur in the formation of hydrogen gas between a metal and a hydronium ion, the metal would be labeled as a strong reducing agent. Ultimately, these observations allow for an activity series to be constructed based on the intensity of reactions that occur. The expected results in this experiment were at least one of the four metals would not react with HCl under normal conditions and the rest of the reactions would have differing levels of reactivity.

1. **EXPERIMENTAL**

The metals used in the redox reactions were iron, zinc, copper and magnesium in the form of powder. The metals are the reducing agents in a redox reaction. The oxidizing agents are the hydronium ions, H+ (*aq*), from a solution of 6 M HCl. Test tubes were used to contain the reactions and four test tubes were labeled for each metal prior to the placement of the metal powders into them. The iron powder was black in color, the zinc powder was a gray asphalt color, the copper powder was brown and the magnesium powder was black. The HCl solution was a yellow and clear liquid. After a little bit of each metal powder was placed in their respective test tubes, approximately 1.0 mL of HCl was added to each test tube one at a time with a graduated cylinder. A reaction may or may not have occurred and observations were recorded. Observations included the relative time it took for bubbles or hydrogen gas to form and a change in color and volume of the solution in the test tubes.

The materials used in this experiment were: 6 M HCl solution, test tubes, test tube rack, graduated cylinders, beakers, metal powders and a hot water bath.

1. **RESULTS AND DISCUSSION**

The first reaction was between iron powder (Fe) and HCl. After 2 seconds, bubbles began forming but there was no color change. The time it took for bubbles to form indicates that iron is not the strongest reducing agent. The second reaction was between zinc powder (Zn) and HCl. There is an immediate reaction with bubbles forming instantaneously but there is no color change. From this reaction, zinc is a strong reducing agent and can potentially be the strongest of the four metals. The third reaction was between copper powder (Cu) and HCl. There is no reaction or bubbles at all. The mixture had to be added to a hot water bath in order to create a small reaction where some bubbles formed. Otherwise, under normal conditions, there is no reaction between copper and HCl. The fourth reaction was between magnesium and HCl. This reaction was also immediate but it was clearly stronger because the volume of the mixture exploded up the test tube and there were much more bubbles formed than seen in the zinc reaction. Based off of the observations and the relative times it took for each reaction to occur, the activity series would be: Mg > Zn > Fe > Cu. There is no particular trend that is seen on the periodic table for the four metals.

The activity series created in this experiment is helpful because you could determine whether certain reactions would occur or not based on which metal is a stronger reducing agent. For example, a reaction between iron (II) (aq) and Cu (s) will not occur because Cu is a weaker reducing agent than iron. However, a reaction between iron (II) (aq) and Zn (s) will occur because Zn is a stronger reducing agent than iron. An activity series can also provide a clue to how reduction potentials, a measure of the ability for an ion to be reduced, are created. But they cannot provide specific measurements unless they are accounted for beforehand when the activity series is created. Nevertheless, activity series are significant in determining whether a metal will react based on the strength of the reducing power of the metal.

1. **CONCLUSION**

Redox reactions are important for many different reasons. In this particular experiment, redox reactions were used to create an activity series which can be helpful in analyzing reactions and whether they would occur or not. Moreover, an activity series can explain a lot about the chemicals involved. In the order of reducing power, there is no obvious trend for the metals on the periodic table. But the results we obtained were qualitatively obtained. If a quantitative study of redox reactions was conducted, there could be a better understanding about why certain metals are stronger reducing agents and how reduction potentials are created.