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AP Chemistry - 3rd Period

04 October 2012

**Net Ionic Equations Lab**

Data:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Compounds:** | **NaCl** | **MgSO4** | **Na2CO3** | **Na3PO4** | **KBr** | **NaOH** | **NaNO3** | **KI** | **HC2H3O2** |
| **AgNO3** | PPT | DNR | PPT | Yellow color change, PPT | Light yellow color change, PPT | Bronze color change, PPT | DNR | Light yellow color change, PPT | DNR |
| **BaCl2** | DNR | PPT | PPT | PPT | DNR | Bubbles seen | DNR | DNR | Bubbles seen |
| **CaCl2** | DNR | DNR | PPT | PPT | DNR | PPT | DNR | DNR | DNR |
| **CuSO4** | DNR | DNR | PPT | PPT | DNR | Dark blue color change, PPT | DNR | Orange color change, cloudy | DNR |
| **SrCl2** | DNR | Slightly cloudy | PPT | PPT | DNR | Bubbles seen | DNR | DNR | DNR  |
| **Fe(NO3)3** | DNR | DNR | Orange color change, PPT | PPT | DNR | Orange color change | DNR | Bronze color change | DNR |
| **(NH4)2SO4** | DNR | DNR | DNR | DNR | DNR | DNR | DNR | DNR | DNR |
| **HCl** | DNR | DNR | DNR | DNR | DNR | DNR | DNR | DNR | DNR |
| **H2SO4** | DNR | DNR | DNR | DNR | DNR | DNR | DNR | DNR | DNR |
| **NH4NO3** | DNR | DNR | DNR | DNR | DNR | DNR | DNR | DNR | DNR |

Key: **DNR:** Does Not React

 **PPT:** Precipitate formed

Conclusion:

 After completing this lab, it can be concluded that when two aqueous solutions are mixed, some will undergo a reaction and produce a measurable precipitate, while other may not react at all. There is also the possibility to see examples of a reaction occurring due to color change or bubbling, meaning a gas is being given off. The results of all 90 reactions can be seen in the data table above. If the result is labeled as no reaction occurring, it means that the resulting products were both aqueous and no change was observable. Knowing the aqueous compounds that were being used, it is possible to write out the chemical equations, seeing which reactions do produce a precipitate and which do not react; the observations in the chart should reiterate the outcomes of these chemical equations.

Discussion of Theory:

 After reacting 90 combinations of aqueous solutions, it is possible to write chemical equations for these reactions and see which reactions are actually occurring and which are considered as "does not react". The way compounds separate into their cations and anions in a reaction, and the resulting compounds they form when they rearrange are what affect solubility. Some cations will always be soluble, such as Group 1 cations. These solubility rules are what define whether a product is aqueous, meaning it is soluble, or insoluble, instead forming a precipitate. Some things will be soluble in water, and some will not be, because of their polarity and the way the cations and anions of the compound being dissolved react with the water molecules. If dissociation is able to occur, meaning the water completely surrounds the compound and is able to split it into its ions, the substance will be soluble.

 If, after writing the balanced chemical equation of a reaction, there is a solid product, the aqueous products and reactants can be broken down into their ions, and the equation simplified to what is known as a net ionic equation. The net ionic equation shows the ions that form the precipitate product, removing any other ions that remain aqueous on both ends of the reaction- these are often called spectator ions. The net ionic equation shows only the parts of the reaction that take part in the chemical change- a net ionic equation cannot be written if no reaction is occuring.

 The reactions occurring in this lab are metathesis reactions, meaning the cations and anions are exchanging partners from the reactants to the products. These type of reactions are sometimes referred to as double replacement reactions. Within metathesis reactions are three different types: precipitation, neutralization, and gas formation. For this lab, precipitation was the most commonly seen reaction. As the name suggests, in a precipitation reaction a precipitate is formed. Precipitation reactions are important because they create a solid product, which could be dried and collected. This type of reaction would be helpful when finding the percentage of a component of a compound. Neutralization reactions are associated with acid-base reactions. One common use of the neutralization reaction is in titrations, when the concentration of an unknown substance is being determined. Neutralization reactions produce water molecules as a product. Lastly comes gas formation reactions, not seen quite as commonly in this lab. The net ionic equation for the reactions of this lab would show which of these three reactions is occurring, as the products would show either a solid, water, or gas. Metathesis reactions include three very important and commonly used reactions. All three are related to solubility and the way aqueous solutions react.

Sources of Error:

 As with any scientific lab, there are sources of error present. In the set up of this lab, all of the chemicals were placed on the same plastic sheet, with no solid divider separating each of the solutions. This could have affected the reactions, as two solutions that were placed next to each other could have mixed, affecting the result of the reaction when the second reactant solution was added. There was also a marker used to create a grid on the plastic sheet, and there are chemicals within the marker that could have reacted to the solutions. As the solutions mixed the volume grew, and some of the solutions ran into the marker lines. These are sources of error that could be corrected had the experiment been performed with in a well plate, or other such tool that would keep each mixture separate. Another source of error could come from the number of drops used of each solution. For example, if not enough of the second reactant was added in comparison to the first reactant to clearly show that a reaction was occurring, it could have been incorrectly assumed that the two solutions did not react. This could have occurred in the case of a neutralization reaction, as there is a specific amount of reactant that neutralizes the other, and this amount makes the fact that a reaction is occurring quite clear.

Analysis Questions:

1. From the data, you can generalize that: Any compound with a Group 1 cation will be soluble; Group 7 anions including Chlorine, Bromine, and Iodine will be soluble when bonded to almost every other element; any cation or anion bonded to Nitrate will be soluble; the Silver cation often makes compounds insoluble; strong acids (like HCl and H2SO4) will be soluble.

2. 1) Ag+ (aq) + Cl- (aq) --> AgCl (s)

 2) Ba2+ (aq) + SO42- (aq) --> BaSO4 (s)

 3) Ca2+ (aq) + CO32- (aq) --> CaCO3 (s)

 4) 2Fe3+ (aq) + 3CO32- (aq) --> Fe2(CO3)3 (s)

 5) Ca2+ (aq) + 2OH- (aq) --> Ca(OH)2 (s)

 6) Ag+ (aq) + Br- (aq) --> AgBr (s)

 7) Sr2+ (aq) + CO32- (aq) --> SrCO3 (s)

 8) 3Cu2+ (aq) + 2PO43- (aq) --> Cu3(PO4)2 (s)

 9) Ba2+ (aq) + SO42- (aq) --> BaSO4 (s)

 10) Cu2+ (aq) + 2OH- (aq) --> Cu(OH)2 (s)

3. There are three types of metathesis reactions: precipitation reactions, neutralization reactions, and gas formation reactions. In a precipitation reaction, the products formed are insoluble, meaning a precipitate is created. An example of this type of reaction from the lab would be: CaCl2 (aq) + 2NaOH (aq) --> Ca(OH)2 (s) + 2NaCl (aq). The compound labeled with *(s)* stands for solid, meaning it is precipitate. The second type of metathesis reaction, a neutralization reaction, is a reaction in which the products formed are neutral water molecules. From this lab an example reaction would be: HCl (aq) + NaOH (aq) --> H2O (l) + NaCl (aq). The net ionic equation for these type of reactions would be H+ + OH- --> H2O (l), proving water molecules are formed. Lastly, a gas formation reaction is reaction in which one of the products formed is a compound with a low boiling point and low solubility, meaning it forms a gas. An example of this type of reaction would be H2SO4 (aq) + Na2CO3 (aq) --> H2O (l) + CO2 (g) + Na2SO4 (aq).

4. Some things are not soluble in water because of their polarity. Water is a polar solvent, and both polar and ionic compounds are polar also. Things dissolve because of the attraction of cations and anions. When a compound is mixed with water, the anion of that compound is attracted to the hydrogens in water, because of its positive charge. The same goes for the cation of the compound, it is attracted to the negatively charged oxygen in water. These ions are mixed, and the water is able to completely surround the ions of the compound and it is able to be dissolved, because of this hydration. The ions then dissociate in water, making it soluble. If things are not soluble, it is because this hydration and dissociation in water is not occurring with the ions of the compound.

5. A double replacement reaction that produces two aqueous products is considered a "no reaction" because there is no measurable substance formed, such as a precipitate. There would still simply be a mix of ions all in a solution; there is no change from the state in which the reaction began.