Cloudy with a Chance of Precipitate

Estimated Time: 30 minutes

SUMMARY
Precipitates form in aqueous (in water) solutions when positively and negatively charged particles, called ions, crystallize and form solids. These solids are *insoluble* in water, meaning they do not dissolve well. In this activity, two soluble ionic compounds—sodium carbonate and magnesium sulfate—are combined in water. While the separate solutions appear clear, the combination of both results in a solid precipitate.

WHAT YOU'LL LEARN

- Safety in a chemistry experimental setting.
- Terms related to solution chemistry: aqueous, dissociate, precipitate, insoluble/soluble.

Materials Used

- 5 g (1 tsp) washing soda (sodium carbonate)
- 15 g (1 Tbsp) Epsom salt (magnesium sulfate)
- Water
- 2 clear plastic cups
- Plastic spoons
- Eye dropper
- Liquid food coloring (optional)

Resources Used

- https://www.uwgb.edu/safety-environmental-management/environmental-policies/materials-safe-for-sewer/

WHAT TO DO

1. In one cup, add 5 g of washing soda to ½ cup of warm water. Stir until the solid is completely dissolved. In the second dish, add 15 g of Epsom salt to 2 Tbsp of warm water. Again, stir until the Epsom salt can no longer dissolve. Make observations of each solution. Is any solid visible? Have the students record and share their observations.
2. To the solution of the Epsom salt, add 3-5 drops of liquid food coloring for the added visual effect. This is not necessary, but creates a colorful precipitate as opposed to a white one.
3. Draw some of the Epsom salt solution into an eye dropper. Place the filled eyedropper into the solution of the washing soda. Expel the Epsom salt solution and watch the formation of a solid. This solid is known as a *precipitate*. Again, make observations of the chemical change. What does the precipitate look like? Does the precipitate cloud the entire solution? Does it settle at the bottom of the dish?

4. Discuss the chemical change in terms of the salts involved. Depending on the academic level of the student, this can be discussed in terms of the common names (i.e. washing soda and Epsom salt) or the chemical formulas (i.e. sodium carbonate and magnesium sulfate).

$$washing\ soda\ solution + Epsom\ salt\ solution \rightarrow dissolved\ salt + solid\ salt$$

$$Na_2CO_3(aq) + MgSO_4(aq) \rightarrow Na_2SO_4(aq) + MgCO_3(s)$$

In this reaction, two aqueous (dissolved in water) salts (washing soda and Epsom salt) are combined. The result is one aqueous salt and one insoluble salt, which is observed as a solid. The solid salt, $MgCO_3$ is known as a *precipitate*, because it is an insoluble salt that resulted from the combination of two soluble salts in water. Why are both reactants and one product (Na_2CO_3, $MgSO_4$, Na_2SO_4) aqueous but not $MgCO_3$? Ultimately, it comes down to the ionic structure of these salts: the way the Mg^{2+}, CO_3^{2-}, Na^+, and SO_4^{2-} ions arrange themselves in a salt. For $MgCO_3$, the structure is significantly different from $MgSO_4$. In a way, it's like Mg^{2+} and CO_3^{2-} are hugging each other so tightly that they do not let go in the water (*Titanic*, much?). On the other hand, Mg^{2+} isn't as fond of SO_4^{2-}, so it is easier to let go of each other in the water. This difference is observable to the human eye when the precipitate forms. Precipitates indicate differences in the energy holding the ions of a salt together. So, while it takes little energy to separate Na^+ and CO_3^{2-} or Mg^{2+} and SO_4^{2-} ions in water, Mg^{2+} and CO_3^{2-} hold on to each other much more tightly as a salt. Because of this energy difference, the $MgCO_3$ salt remains as a solid, or Jack and Rose, if you will. This is seen when a precipitate, colorful or otherwise, forms immediately as the solutions are combined.

TIPS

- While these salts, sodium carbonate and magnesium sulfate, are found around the household, it is important to practice safe handling of the materials. Keep solutions away from the face, particularly the eyes, nose, and mouth. Wash hands thoroughly before and after the experiment. Dispose of the final solution in the drain (as stated per University of Wisconsin Green Bay Environmental and Safety Management website).
- The explanation of the precipitation is largely dependent on the student's understanding of solutions chemistry. If the explanation feels difficult to break down, feel free to focus on the experiment itself. Make observations, predictions, etc., without considering the scientific explanation of the precipitation reaction. As always, check out our other chemical change activities for a change in pace!