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Common Ion Effect Worksheet

Demonstration #1 — Colorful Acid Eruptions

The reaction that causes the foaming is

 $CaCO_3(s) \ + \ 2H_3O^+(aq) \ \rightarrow \ CO_2(g) \ + \ 3H_2O(l) \ + \ Ca^{2+}(aq)$

The greater the hydronium ion concentration, the faster the reaction.

Hydrochloric acid and acetic acid are Bronsted acids—they ionize in water to produce hydronium ions (H_3O^+) and their conjugate bases, chloride ion and acetate ion, respectively (Equations 1 and 2).

$$HCl(aq) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$$

 $CH_3CO_2H(aq) + H_2O(l) \rightarrow H_3O^+(aq) + CH_3CO_2^-(aq)$

The following table summarizes the observations and conclusions in this demonstration. The concentration of the acid and conjugate base components is 1 M in all cases.

	Hydrochloric Acid	Acetic Acid
"Rainbow Acid" Color		
pH		
Rate of Reaction with CaCO ₃	Fast/Moderate/Weak	Fast/Moderate/Weak
Acid Strength	Strong/Weak	Strong/Weak

Effect of Common Ion

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Rate of Reaction with CaCO ₃	

Based on these observationa, are both reactions reversible? If not, why?

Demonstration #2 — Carbon Dioxide and pH

Carbon dioxide dissolved in water is a weak acid, establishing equilibrium with its products, the hydronium ion and the bicarbonate ion. The solution is initially acidic. Bromthymol blue is yellow in an acidic solution, blue-green in a neutral solution, and blue in a basic solution.

 $\begin{array}{ccc} \mathrm{CO}_2(\mathrm{aq}) \ + \ 2\mathrm{H}_2\mathrm{O}(\mathrm{l}) & \xleftarrow{} & \mathrm{H}_3\mathrm{O}^+(\mathrm{aq}) \ + \ \mathrm{HCO}_3^-(\mathrm{aq}) \\ \textit{carbon dioxide} & \textit{bydronium ion} \quad \textit{bicarbonate ion} \end{array}$

What is the color change when bubbles are blown into the solution? Why does it occur?

Explain the color change when powder, sodium bicarbonate is added to the solution.

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Demonstration #3 — Weak Base Color Cycle

"Ammonium hydroxide" is a concentrated solution of ammonia in water. Ammonia (NH_3) is a weak base, reacting with water to form ammonium ions and hydroxide ions (Equation 1).

 $\begin{array}{ccc} \mathrm{NH}_3(\mathrm{aq}) \ + \ \mathrm{H}_2\mathrm{O}(\mathrm{aq}) & \xleftarrow{} & \mathrm{NH}_4^+(\mathrm{aq}) \ + \ \mathrm{OH}^-(\mathrm{aq}) \\ ammonia & ammonium \ ion & by droxide \ ion \end{array}$

Explain why the solution changes color when the solid, ammonium chloride, NH₄Cl, is added to the beaker.