

#### 4.4 Carbonate solubility in acid

**Subjects:** Chemical reactions, gas forming reactions, solubility, properties of acids, kinetics

**Description:** When calcium carbonate is added to water, it is practically insoluble. When added to acid it dissolves producing carbon dioxide. (Optional kinetics: Higher acid concentrations will increase the reaction rate and will produce more carbon dioxide gas in less time). In Procedure B, iron carbonate produced in Demo 4.3 (or produced prior to this demo) is reacted with hydrochloric acid (HCl). The HCl dissolves the carbonate, producing iron chloride, which is soluble.

Reaction A Materials:	Additional optional materials for kinetics:
Marble chips‡ Or CaCO <sub>3</sub> powder‡ 1M HCl‡ water 2 100 mL beaker spatula and tweezers	Sodium carbonate or bicarbonate‡ 0.1M HCl‡ 6M HCl‡ 6 100 mL beakers

‡Marble chips and the carbonates are stored in the general chemical storage cabinets. Hydrochloric acid is stored in the cabinet under the hood on the right.

#### Procedure A: Solubility of CaCO<sub>3</sub>

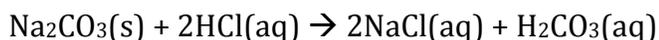
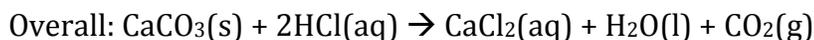
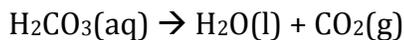
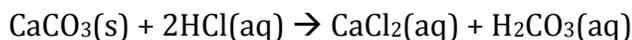
1. Pour acid and water into each of the labeled beakers.
2. Add calcium carbonate to the water and then to the acid and observe.
3. The calcium carbonate will dissolve in the acid producing CO<sub>2</sub> gas. It will not dissolve in pure water. The K<sub>sp</sub> for calcium carbonate in water is 3.4 x 10<sup>-9</sup>.

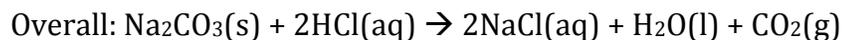
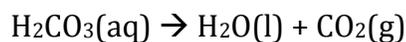
#### Kinetics option:

1. Add acids to pre-labeled beakers.
2. Add carbonates to each of the different concentrations of acids and observe the difference in reaction rates.

#### Discussion:

The reaction of metal carbonates or bicarbonates with acids produces the metal halide and carbonic acid, which decomposes to carbon dioxide and water as follows:





The concentration of solutions can have an effect of the rate of the reaction. In this case, the higher the concentration of the acid, the faster the reaction takes place.

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### Procedure B: Iron carbonate in HCl

#### Materials:

$\text{Fe}_2(\text{CO}_3)_3^*$  in solution

1M HCl

6M HCl

2 100 mL beakers

1 250 mL beaker (if making  $\text{Fe}_2(\text{CO}_3)_3$ )

Stir bar

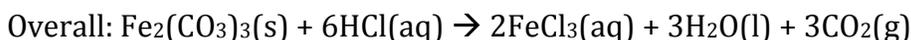
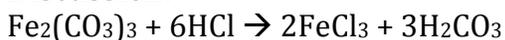
Stir plate

\*(Saved from demo 4.3 or produce beforehand by adding ~50 mL 0.1 M  $\text{Na}_2\text{CO}_3$  to ~50 mL 0.1M  $\text{FeCl}_3$  in a 250 mL beaker)

#### Procedure:

1. Add 1M HCl to one 100 mL beaker and add 6M HCl to the other 100 mL beaker
2. Add the stir bar to the iron carbonate solution and place it on a stir plate and stir.
3. Slowly add 1M HCl until solution is transparent.
4. If the reaction goes too slowly, add the 6M HCl.

#### Discussion:



**Safety:** HCl is corrosive. Be sure to wear proper protective equipment including gloves and safety glasses.

**Disposal:** Solutions from procedure A can be flushed down the sink with water. Iron chloride should be disposed of in an appropriate aqueous waste container.

**References:** None