Kinetics: Rate of Reaction Lab

(Adapted from AP Investigation 10: How Long Will That Marble Statue Last?)

Introduction:

Many historic buildings and monuments are made from limestone or marble. Limestone and marble are minerals that contain large amounts of calcium carbonate, CaCO3. Since the industrial revolution, air pollutants (chiefly in the form of oxides of sulfur and nitrogen) have been absorbed into the atmosphere, leading to the production of rainwater that has become significantly more acidic. This *acid rain* will react with the limestone buildings, eroding the stone and causing much disfigurement and damage.

Learning Intentions:

Investigate how the speed of the chemical reaction between solid calcium carbonate and a solution of hydrochloric acid is affected by changing variables relating to the two reactants.

A1 – recognize that rate is described in terms of some quantity per unit time.

A2 – identify properties that could be monitored in order to determine a reaction rate.

A2 – recognize the factors that control reaction rate.

A2 – calculate the rate of a reaction using experimental data.

A5 – use collision theory to explain the effect of one of the following factors on reaction rate: concentration, temperature, surface area.

Prelab Questions:

2HCl(aq) +CaCO3(s) 🡪 CaCl2(aq) + CO2(g) + H2O(l)

1. List the factors that you think may affect the speed at which calcium carbonate will react with hydrochloric acid.
2. Suggest properties that you could monitor in order to measure the rate of the reaction.

Materials:

The following materials will be available to you in the laboratory.

 HCl (various concentrations) ice

 CaCO3 (chunks and powder) thermometer

 graduated cylinder stopwatches

 balance beakers

 hot plate

Procedure:

Choose a factor that affects reaction rate and a property to monitor. Design a procedure that will allow you to test your chosen factor. Use a separate piece of paper and number your steps. Don’t forget to include a sample data table and a sample rate calculation.

Hints: The mass of calcium carbonate used for each trial should be less than 1.5 g. The volume of HCl used for each trial should be less than 30 mL.

Analysis:

Summarize and explain your results using collision theory (key words: collisions, successful collisions, minimum energy, proper geometry, frequency, and fraction). Your analysis should also include rate calculations. Use a separate piece of paper and complete sentences.